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PROPOSED CLEANUP ACTION PLAN

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

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1. INTRODUCTION

1.1 PURPOSE

SLR International Corp has prepared this proposed Cleanup Action Plan (CAP) on behalf of Crowley Marine Services as part of the soil and groundwater investigation and cleanup being conducted at the former Columbia Marine Lines facility located at 6305 Lower River Road in Vancouver, Washington. The work is being conducted under Order No. DE 85-591, issued to Columbia Marine Lines by the Washington State Department of Ecology (Ecology) on August 19, 1985. Crowley Marine Services, a successor to Columbia Marine Lines, is conducting the work.

The purpose of this CAP is to describe the process by which a remedial action has been recommended for the site. The CAP was developed in compliance with the Ecology's Model Toxics Control Act (MTCA) Cleanup Regulation in Chapter 173-340 of the Washington Administrative Code (WAC) and with the United States Environmental Protection Agency (USEPA) *Interim Final Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA* (October 1998). Because past remedial actions have been implemented at the facility, the CAP focuses on presenting site data, identifying relevant cleanup levels, and evaluating potential final remedial actions.

The CAP has the following objectives:

- Present background information describing the site, its history, local geology and hydrogeology, and the results of past work at the site.
- Identify relevant receptors and exposure pathways.
- Identify relevant cleanup standards based on these receptors and pathways.
- Compare site contaminant levels to cleanup standards.
- Recommend a final remedy.

1.2 ORGANIZATION

This report presents the following information:

- Section 1: Introduction, Purpose, and Organization
- Section 2: Site Description, History, Property Ownership, and Land Use
- Section 3: Previous Environmental Investigations
- Section 4: Previous Remedial Actions
- Section 5: 2007 Soil and Groundwater Sampling Events
- Section 6: Nature and Extent of Contamination
- Section 7: Contaminant Fate and Transport
- Section 8: Exposure Assessment
- Section 9: Cleanup Standards
- Section 10: Comparison to Cleanup Levels
- Section 11: Recommended Action
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2. SITE DESCRIPTION

2.1 PROPERTY DESCRIPTION

The former Columbia Marine Lines site is located immediately north of the Columbia River and approximately 3 miles west of the city of Vancouver in Section 18, Township 2N, Range 1E, as shown on **Figure 1**. Columbia Marine Lines formerly operated a marine repair facility and periodically placed wastewater in a series of infiltration ponds. **Figure 2** presents an aerial photograph illustrating the site, which is loosely defined by the extents of the former ponds, which lie on property currently owned by Alcoa (Aluminum Company of America).

Site topography is uneven and the outer edges of the former ponds are noticeable as humps in the ground surface. The highest point lies at an approximate elevation of 32 feet above mean sea level. The Columbia River is tidally dominated and typically ranges from minus 5 to positive 5 feet above mean sea level.

The majority of the site is sparsely vegetated with grasses and mosses. Willows, alders, and brush are present in isolated low-lying areas in the northern portion of the site. Two rectangular wastewater treatment lagoons operated by Evergreen Aluminum (Glencoe Washington LLC) are located on Evergreen's property to the northwest of the site.

2.2 SITE HISTORY

Columbia Marine Lines operated a marine repair facility and periodically placed wastewater in infiltration ponds on the property currently owned by Alcoa. As described in a May 21, 1984 letter from Columbia Marine Lines to Ecology, the wastewater included barge slops, wash water from barge gas freeing operations, and tug bilge slops. Gas freeing was conducted to remove vapors from vessel compartments that had been used in hauling of diesel fuel, making the vessel interior safe for hot work. Three pond locations are visible on historical aerial photographs of the vicinity (**Figure 3**). The South Pond is visible in photos dated 1963 and 1964; the West Pond in photos dated 1968 and 1970; and the East Pond in photos dated 1971, 1972, 1973, 1974, 1977, 1980, 1982, and 1983.

Use of the south pond was discontinued, and the pond was apparently filled, sometime between 1966 and 1968. Use of the west pond was discontinued, and the pond was apparently filled, sometime between 1970 and 1971. In January 1984, all liquids were removed from the East Pond, and the pond was filled with dredge sand to prevent accumulation of surface water. On April 3, 1984, Columbia Marine Lines notified Ecology in writing of the past practice and closure of the former pond. In response to the notification from Columbia Marine Lines, Ecology issued Order No. DE 85-591 on August 19, 1985. In subsequent years, soil and groundwater characterization work was completed, and an interim corrective action was implemented. The interim action consisted of groundwater extraction, non-aqueous phase liquid (NAPL) hydrocarbon removal, and re-infiltration of extracted groundwater.

The interim action system consisted of three components: a groundwater recovery well located in a gravel-filled recovery trench, an oil/water separator, and a gravel-filled infiltration trench. Groundwater within the trench and well was depressed by a submersible pump with a float control switch. The pump discharged to the oil/water separator, and water from the oil/water separator flowed to the infiltration trench. The principle of operation was to create a groundwater depression in the gravel-filled recovery trench which had been excavated into the former East and West Ponds. The depression would cause liquid hydrocarbons to collect in the recovery trench and flow toward the well. Liquid hydrocarbons were to be prevented from flowing downgradient by the groundwater mound created by the infiltration trench. The interim action was conducted from 1986 to 1995 until NAPL was reduced to below recoverable levels.

Beginning in 2000, a separate interim remedial action measure (IRAM) was implemented at the site. The IRAM consisted of a dual phase extraction and bioventing system. Using a vacuum blower, the system extracted vapors, groundwater, and NAPL from five extraction wells located on site. The extracted vapors were treated with activated carbon prior to discharge to the atmosphere. The liquids were separated and pumped through an oil/water separator to remove NAPL. The water was pumped through activated carbon drums to the infiltration trench. The system operated, with periods of down time, from approximately 2001 to 2005 when operation of the system was no longer removing sufficient hydrocarbons in the vapor or liquid phases to warrant continued operation. Additional detail on the IRAM system is included in **Section 4** of this report.

2.3 PROPERTY OWNERSHIP AND LAND USE

Property ownership in the vicinity of the former ponds is illustrated on **Figure 2**. The information on Figure 2 was obtained from the Clark County, Washington internet website, and property lines are approximate. SLR did not independently verify the accuracy of property ownership information obtained from Clark County's website.

The operations portion of the former Columbia Marine Lines facility is currently owned and operated by Tidewater Barge Lines. Alcoa owns the property where the former ponds were located. There have been no significant changes in the surface features in the vicinity of the former pond areas since the initial closure of the East Pond by filling in 1984.

The current zoning classification for the Alcoa property is industrial. Surrounding land use patterns indicate that the properties will continue to have industrial land uses. Potable water is supplied to the properties by the city of Vancouver. Access to the site is restricted by fencing and site security measures.

3. PREVIOUS ENVIRONMENTAL INVESTIGATIONS

Since 1984, several phases of subsurface investigation have been conducted at the site to delineate the extent of petroleum-impacted soil in the vicinity of the former wastewater ponds, and two separate remedial actions have been conducted. Twenty-one monitoring wells (MW-1 to MW-21) and four extraction wells (EX-1, EX-2, RW-4 and RW-5) were completed during the investigation. From 1999 to 2007, several Geoprobe borings were completed to provide soil data in areas of suspected TPH impact as well as additional groundwater data. Monitoring well locations are shown on **Figure 2**. Geoprobe locations are shown on **Figure 4**.

GeoEngineers Inc. began work at the site in 1983. Their report titled *Report of Hydrogeologic Services, Barge Waste Disposal Facility, Vancouver, Washington, for Crowley Environmental Services Corp* – dated November 28, 1983 – presented monitoring well boring log subsurface information and groundwater monitoring levels. Groundwater samples were collected by Crowley Environmental Services.

The results of the first phase of investigation instigated additional subsurface work. The results of the second subsurface investigation were presented by GeoEngineers in their report titled *Report of Phase 2*

Subsurface Investigation, Former Barge Waste Disposal Area, Vancouver, Washington, for Columbia Marine Lines, dated April 9, 1985. In this report, GeoEngineers recommended that a free hydrocarbon recovery program be implemented. Construction of the interim action system was documented in GeoEngineers' September 12, 1985 report titled *Report of Construction Monitoring, Free Hydrocarbon Recovery and Water Disposal Gallery Construction, Columbia Marine Line, Vancouver, Washington, for Crowley Environmental Services, Corp.*

The extent of contaminants was investigated and reported in a third investigation by GeoEngineers titled *Report of Phase 3 Hydrogeologic Services, Former Barge Waste Disposal Site, Vancouver, Washington for Columbia Marine Lines,* dated April 14, 1986. This report was used by Kennedy/Jenks/Chilton to prepare their *Data Evaluation/Risk Assessment, Former Barge Waste Disposal Site, Columbia Marine Lines, Vancouver, Washington,* report dated May 15, 1986.

Foss Environmental performed monitoring of recovery system operations and free phase hydrocarbon recovery services. In early 1995, these services were transferred to FBN Environmental. Converse Consultants produced a report titled *Summary Memorandum Tasks 1 and 2*, dated April 13, 1995, describing the environmental work conducted at the site.

In 1996, Crowley contracted SECOR International Incorporated to conduct additional subsurface investigation services. The subsurface investigations conducted by SECOR consisted of the following activities:

- In May 1999, nine Geoprobe soil borings (GP-1 through GP-9) were completed by Cascade Drilling Inc. of Portland, Oregon, using a track mounted Geoprobe rig. The purpose of the borings was to evaluate residual hydrocarbon extent in the vicinity of the three former ponds.

- On September 9, 1999, monitoring well MW-20 was abandoned by casing removal. Cascade Drilling removed the well casing from the borehole and overdrilled the borehole to a depth of 78 bgs. The borehole was backfilled with bentonite chips to the ground surface. A copy of the Washington Resource Protection Well Report is included in Appendix B.

- In September 1999, 13 Geoprobe soil borings (GP-1A through GP-13A) were completed by Cascade Drilling Inc. of Portland, Oregon, using a track-mounted Geoprobe rig. The borings were located in the vicinity of wells MW-1, MW-7, MW-8, MW-18 and MW-19, for the purpose of further evaluating the extent of residual total petroleum hydrocarbon as diesel (TPH-D) in the vicinity of the former West Pond.

- On January 31, 2002, 11 Geoprobe borings (GPC-1 to GPC-11) were completed. These borings were located near previous borings to evaluate the effectiveness of the total fluids and bioventing system.

- On May 10, 2005, 16 Geoprobe borings (GPD-1 to GPD-16) were completed. These borings were also located near previous borings to evaluate the effectiveness of the total fluids and bioventing system.

In July 2007, Crowley contracted SLR to provided environmental services related to the Site. In August 2007, SLR coordinated the drilling of 8 Geoprobe borings in the vicinity of the former East and West pond locations. The purpose of the borings was to further delineate impacts in the vicinity of the wast pond, to collect data from areas near previous borings to evaluate the effectiveness of the total fluids and bioventing system, and to collect additional analytical data required for assessing potential risks to human health and the environment. This August 2007 work is further discussed in **Section 3** of this report.

4. PREVIOUS REMEDIAL ACTIONS

The interim action recovery trench resulted in the removal of the bulk of the NAPL at the site. By the time it was shut down in 1995, operation of the recovery trench appeared to have removed the recoverable free phase hydrocarbon in the subsurface. Results of operation of the trench have previously been reported to Ecology in reports prepared by GeoEngineers and Converse Consultants and are not discussed in detail in this report. This report focuses on the results of the feasibility testing and IRAM activities conducted by SECOR.

4.1 FEASIBILITY TEST RESULTS

SECOR conducted an aquifer test in February 1996 to evaluate hydraulic characteristics of the shallow aquifer in the dredge fill. In February 1999, SECOR conducted a bioventing pilot test to evaluate the feasibility of bioventing as a remedial alternative.

4.1.1 Aquifer Testing

Aquifer testing was performed at the site to evaluate hydraulic characteristics of the shallow water-bearing dredge fill. Tests were performed during February 1996 when the aquifer yield was assumed to be greatest. Slug tests were performed on wells MW-1, MW-7, MW-18, and EX-2 to collect data to estimate aquifer transmissivity. A step-drawdown test and a pumping test were conducted on well EX-2. During the pumping test, 0.55 gallon per minute (gpm) was recovered from EX-2, a 4-inch diameter groundwater well. The pump test data indicate a lateral formation transmissivity of 0.0005 square foot per minute (ft^2/min), which is consistent for a silt material. The results of this test were reported in SECOR's *Cleanup Action Plan* dated September 26, 1996.

4.1.2 Bioventing and Total Fluids Extraction Pilot Test

A bioventing pilot test was conducted in February 2000 on the shallow sandy fill material in the vicinity of the former West Pond. The objective of the bioventing and total fluids extraction pilot test was to evaluate the following site-specific parameters for full-scale remediation system design:

- Rate of Biorespiration
- Soil Vapor Extraction Flow Rate Versus Applied Vacuum
- Radius of Influence
- Total Fluids Recovery Rate

The pilot test results indicated that bioventing and total fluids extraction was a feasible alternative for accelerating natural biodegradation of petroleum hydrocarbons at the site. The full scale design of the IRAM was based on the following design parameters derived from the results of the pilot test.

- *Vacuum Versus Flow Rate:* The design vacuum was approximately 4 inches of mercury (" Hg), and the design flow rate was approximately 20 standard cubic feet per minute (scfm) per well.

- *Radius of Influence:* The design radius of influence was 30 feet, based on an induced vacuum radius of influence ranging from 11 to 43 feet and observed increases in oxygen concentrations in wells that were 30 to 50 feet from the extraction point.

- *Soil Vapor Concentrations and Air Emissions Estimates:* 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) indicated that the blower discharge should be treated with vapor phase activated carbon.

- *Biodegradation Rates:* Hydrocarbon degradation rates ranging from 3 mg/Kg per day to 160 mg/Kg per day were observed in monitoring points during the pilot test.

- *Total Fluids Production:* The average groundwater extraction rate were expected to range between 0.2 gpm and 1 gpm per well.

The results of the bioventing test were originally reported in SECOR's Dual *Phase Extraction and Bioventing Pilot Test Report* dated May 19, 2000.

4.2 IRAM SYSTEM

The dual phase extraction system was installed in November and December 2000. Vapors and liquids were extracted from five wells (RW-1, RW-2, RW-3, RW-4, and RW-6). It operated intermittently during the startup period through mid-February 2001. Other than brief shutdowns for maintenance or biorespiration testing, the system operated continuously through February 2003, when it was shut down. The system was restarted in December 2004 through December 2005 to evaluate whether contaminant rebound had occurred during the shut down period. **Appendix A** of this report discusses the operation of the IRAM system in further detail.

Based on the laboratory analytical results, the blower operating hours, and the measured airflow rates, the estimated mass of hydrocarbons removed during IRAM operation by vapor extraction was approximately 4,000 pounds.

Liquids removed from the ground were treated by oil/water separation and activated carbon prior to being discharged into the existing on-site infiltration trench. Based on the laboratory analytical results and the measured volume of groundwater extracted, the estimated mass of hydrocarbons removed during IRAM operation by groundwater extraction was approximately 690 pounds.

Results of biorespiration testing were used to determine oxygen utilization rates and biodegradation rates. Based on the observed biorespiration rates, the estimated mass of hydrocarbons removed by bioventing was 11,000 pounds.

5. 2007 SOIL AND GROUNDWATER INVESTIGATION

SLR conducted soil and groundwater sampling in the vicinity of former ponds that were used historically for infiltration of wastewater generated at the former Columbia Marine Lines facility. The sampling was completed to achieve the following goals:

1. Collect additional analytical data for purposes of calculating risk based cleanup levels for the site using Ecology's spreadsheet for calculating Method B TPH cleanup levels. Analyses included:

- Total petroleum hydrocarbons as gasoline (TPH-g) and as diesel (TPH-d)
- Extractable petroleum hydrocarbons (EPH) / volatile petroleum hydrocarbons (VPH);
- Benzene, toluene, ethylbenzene, and xylenes (BTEX);
- Additional gasoline residuals such as naphthalene, 1-methyl naphthalene, 2-methy naphthalene, n-hexane, methyl tert-butyl ether (MTBE), ethylene dibromide (EDB), and 1,2-dichloroethane (EDC)
- Carcinogenic polynuclear aromatic hydrocarbons (cPAHs)

2. Collect additional soil and groundwater data in the vicinity of the former East Pond, near MW-2, MW-5, MW-6, and MW-10, as requested by Ecology.

3. Analyze one sample for semivolatile organic compound (SVOC) priority pollutants and volatile organic compounds (VOCs), as requested by Ecology.

5.1 GEOPROBE EVENT

5.1.1 Procedures

Eight temporary Geoprobe borings (GPE-1 – GPE-8) were completed on August 24, 2007 to collect soil and shallow groundwater samples for laboratory analysis. Approximate boring locations are shown on **Figure 4**. Geoprobe services were provided by ESN Northwest Inc. of Olympia, Washington. The Geoprobe borings were advanced from the ground surface through the fill sand and into the native silt. The total depth ranged from 11 to 13 feet. The borings were completed as continuous-core borings allowing for visual inspection of the recovered soil. Samples were collected from areas of highest apparent impact by TPH, based on field observations.

5.1.2 Description of Geology

SLR observed the following strata within the eight Geoprobe borings completed (in order of depth below ground surface (bgs)): organic surface layer, dry-to-moist brown sand layer, grayish-to-black stained sand layer, and gray silt layer. The dry–to-moist brown sand layer extended to approximately 5 to 7 feet below ground surface (bgs). The grayish-to-black stained sand layer had a petroleum odor and extended below the dry-to-moist brown sand layer to approximately 10 feet bgs. A moist grey silt layer was present below the grayish-to-black sand extending to the total depth of the eight borings. Groundwater was encountered in borings GPE-1, GPE-2, and GPE-3 at approximately 12 to 13 feet bgs. Continuous soil cores were collected and the lithology recorded on boring logs by an SLR field staff. Soil boring logs are included in **Appendix B** of this report.

5.1.3 Samples Collected

Two soil samples were collected per boring, one from the moist brown sand and one from the grayish-to-black sand. Soil samples were prepared for laboratory analysis for TPH-G and volatile compounds using EPA Method 5035 sampling kits. Groundwater samples were collected from borings GPE-1, GPE-2, and GPE-3 using a peristaltic pump to purge several volumes of groundwater from a temporary well screen installed at the bottom of the boring and filling the appropriate sample bottles. All samples were labeled, stored on ice, and delivered to Test America of Beaverton, Oregon for laboratory analysis.

The following laboratory analyses were conducted on the soil samples:

- All 16 Samples – NWTPH-Gx
- All 16 Samples – NWTPH-Dx
- Samples GPE-1-11, GPE-2-11, GPE-4-11, GPE-6-11, GPE-7-10 – BTEX, naphthalene, 1-methyl naphthalene, 2-methyl naphthalene, n-hexane, MTBE, ethylene dibromide (EDB), 1,2-dichloroethane (EDC) by 8260C
- Samples GPE-1-11, GPE-2-11, GPE-4-11, GPE-6-11, GPE-7-10 – PAHs by 8270SIM
- Samples GPE-1-11, GPE-2-11, GPE-4-11, GPE-6-11, GPE-7-10 – EPH/VPH
- Samples GPE-2-11 – base-neutral-acid priority pollutants by 8270SIM
- Samples GPE-2-11 – VOCs by 8260

The following laboratory analyses were conducted on the groundwater samples:

- All 3 Samples – NWTPH-Gx
- All 3 Samples – NWTPH-Dx
- Samples GPE-1, GPE-2 – PAHs by 8270SIM
- Samples GPE-1, GPE-2 – BTEX, naphthalene, 1-methyl naphthalene, 2-methyl naphthalene, n-hexane, MTBE, ethylene dibromide (EDB), 1,2-dichloroethane (EDC) by 8260C

5.2 GROUNDWATER SAMPLING EVENT

5.2.1 Procedures

In the course of the investigation and remediation conducted thus far for the former Columbia Marine Lines site, 21 monitoring wells and 4 extraction wells have been installed on-site: MW-1 through MW-21, EX-1, EX-2, RW-4, and RW-5. MW-20 was a deep well that was abandoned in 1999 (App. 3) to prevent the downward migration of contamination via the well. Monitoring wells MW-5, MW-6, and MW-15 were apparently destroyed between 2002 and 2005, as these wells could not be located during the October 2005 groundwater sampling event. In addition, the location of monitoring well EX-1 is not known.

On August 30 and 31, 2007, SLR personnel conducted groundwater sampling from the remaining 17 on-site monitoring wells and 3 extraction wells. Groundwater was present in 12 monitoring wells and 2 extractoin wells. Historically, it has not been uncommon for wells MW-18 and MW-21 to be dry. During this event, these 3 wells were dry, and wells MW-7, MW-8, MW-9, MW-10, MW-14, and RW-5 were also dry.

Samples were collected using a peristaltic pump with new tubing being used for each well. If water levels allowed, the monitoring wells were purged prior to collecting samples. Groundwater pH, temperature, ORP, dissolved oxygen, and conductivity were monitored during purging of the wells. If water levels were low that samples were collected immediately to ensure adequate sample volume was obtained. Groundwater monitoring data sheets completed in the field are included in **Appendix C** of this report.

5.2.2 Samples Collected

Groundwater samples were collected from on-site groundwater monitoring wells MW-1, MW-2, MW-3, MW-4, MW-11, MW-12, MW-13, MW-16, MW-17, MW-19, EX-2, and RW-4. Groundwater samples were not collected from MW-7, MW-8, MW-9, MW-10, MW-14, MW-18, MW-21, and RW-5 which were all dry. The well locations are shown on **Figure 2**.

Samples for volatiles analysis were collected such that there was no headspace in the sample bottle. The samples were labeled, stored on ice, and transported under chain-of-custody protocol to TestAmerica for analysis.

The following laboratory analyses were conducted on the groundwater samples:

- All 11 samples – NWTPH-Gx
- All 11 samples – NWTPH-Dx
- MW-1, MW-2, MW-3, MW-16, MW-17, MW-19 – BTEX, naphthalene, 1-methyl naphthalene, 2-methyl naphthalene, n-hexane, MTBE, ethylene dibromide (EDB), 1,2-dichloroethane (EDC) by 8260C
- MW-1, MW-2, MW-16, MW-19 – PAHs by 8270SIM
- MW-19 – base-neutral-acid priority pollutants by 8270SIM
- MW-19 – VOCs by 8260C

5.3 PORT OF VANCOUVER GROUNDWATER SAMPLING EVENT

In July 2007, the Port of Vancouver sampled four groundwater monitoring wells (MW-2 , MW-3, MW-7, and MW-19) as part of its due diligence related to a potential purpose of the property. The results are included in the tables provided in this report.

6. NATURE AND EXTENT OF CONTAMINATION

6.1 SITE GEOLOGY AND HYDROGEOLOGY

The soils encountered during the subsurface investigations consisted of unconsolidated sands (dredge fill material) and an underlying silty flood plain deposit. The silt was encountered at depths ranging from 12 feet below ground surface (bgs) to 14.5 feet bgs. Saturated soil was encountered within the unconsolidated sands. Copies of historical soil boring logs are included in **Appendix C** of this report. Cross sections illustrating lithology and contaminant distribution are presented as **Figure 5** and **Figure 6**. **Figure 4** shows the approximate locations of the cross sections.

Groundwater flow in the southern area of the site has historically been oriented in a southwesterly direction toward the Columbia River. The groundwater flow direction in the northwestern portion of the site has been to the northwest. Historical groundwater gradients are illustrated on Figures included in **Appendix E**.

Since decommissioning the East Pond in 1984, recoverable NAPL appears to have been eliminated at the site through recovery and/or biodegradation. During initial monitoring after decommissioning the ponds, up to 6 feet of NAPL was measured in MW-8. However, in 1999, prior to operation of the dual phase extraction and bioventing IRAM system, NAPL was observed only at MW-8 and MW-19, at thicknesses of 0.18 foot and 0.02 foot, respectively. Operation of the IRAM appears to have successfully removed observable free product at the site. The system has not operated in nearly two years, and no free product has been observed in site wells.

6.2 SOIL AND GROUNDWATER ANALYTICAL RESULTS

6.2.1 Soil Analytical Results

Historical soil TPH and BTEX data is presented in **Table 1**. Additional analytical data from the 2007 soil sampling event, including results for analysis of gasoline residuals, PAHs, VOCs, and SVOCs, is presented in **Table 2**. Table 2 contains the raw data from the laboratory analytical reports. All compounds that were detected in at least one sample are included on Table 2. Laboratory analytical results for the August 2007 soil sampling event are included in **Appendix F.**

Table 3 contains data adjusted per MTCA guidelines for use in Eclogy's TPH cleanup level calculation spreadsheet. In Table 3, for each individual analytical parameter, the following adjustments were made, as applicable, in the order described below, per the MTCA Workbook, p. 46:

- Step 1 – If all results for the parameter for all tests and all samples are below the detection limit, a zero was entered for that parameter.
- Step 2 – If the parameter was below the detection limit for that particular sample, but has been detected in other locations or samples on site, one half the detection limit was entered for that parameter.
- Step 3 – If results overlap from different tests (e.g., EPH and VPH, or VOC and PAH), the higher of the two values was used.
- Step 4 – When VPH AR_EC>12-13 was detected and EPH AR_EC>12-16 was also detected, the higher of the two values was used.
- Step 5 – To prevent double counting, the following species concentrations were subtracted from the corresponding carbon fraction (see table below). Where a parameter was not detected, one half of the detection limit was subtracted from the carbon fraction.

Individual Paramater	Carbon Fraction
n-Hexane (C_6H_6)	AL_EC>5 -6
Ethylbenzene and Xylenes (C_8H_{10})	AR_EC>8-10
Naphthalene ($C_{10}H_8$)*	AR_EC>10-12
Benzo(a)anthracene ($C_{18}H_{12}$)	AR_EC>16-21
Benzo(b)fluoranthene ($C_{20}H_{12}$)	AR_EC>16-21
Benzo(k)fluoranthene ($C_{20}H_{12}$)	AR_EC>16-21
Benzo(a)pyrene ($C_{20}H_{12}$)	AR_EC>16-21
Chrysene ($C_{18}H_{12}$)	AR_EC>16-21
Dibenzo(a,h)anthracene ($C_{22}H_{14}$)	AR_EC>21-34
Indeno(1,2,3-cd)pyrene ($C_{22}H_{12}$)	AR_EC>21-34

Based on the results of the August 2007 sampling event, the following contaminants of interest (COIs) – defined as chemicals that have been detected in one or more samples – have been identified for site soil:

- TPH-Gx
- TPH-Dx Diesel
- TPH-Dx Heavy Oil

- PAHs: acenaphthene, anthracene, benzo(k)fluoranthene, benzo(ghi)perylene, benzo(a)pyrene, chrysene, dibenzo(a,h)anthracene, fluoranthene, fluorene, indeno(1,2,3-cd)pyrene, phenanthrene, and pyrene
- VOCs: acetone, carbon disulfide, 2-butanone, n-butylbenzene, sec-butylbenzene, tert-butylbenzene, isopropylbenzene, and n-propylbenzene

BTEX components have been detected in site soil in the past; however, they were not detected during the August 2007 event, which followed several years of active remediation. Therefore, BTEX compounds are not identified as COIs for the site.

The COIs identified above are not to be confused with Indicator Hazardous Substances, as defined in MTCA 173-340-703. Indicator Hazardous Substances have been selected by comparing the COIs to applicable cleanup standards, as discussed in **Section 9**.

TPH-Dx diesel analytical results for soil are presented on **Figure 7**. **Figure 7** also illustrates the approximate estimated extent of TPH-Dx diesel impacts that exceed 2,000 ug/L.

6.2.2 Groundwater Analytical Results

Historical groundwater elevation and TPH and BTEX analytical data for monitoring wells MW-1 through MW-21 is presented in **Table 4**. Results of August 2007 analyses for SVOCs, PAHs, and VOCs are presented in **Table 5** and **Table 6**. Laboratory analytical results for the August 2007 groundwater sampling event are included in **Appendix G.** The data from the Port of Vancouver's sampling event is included in **Appendix H.**

Based on the results of the July and August 2007 groundwater sampling events, the following COIs have been identified for site groundwater:

- TPH-Gx
- TPH-Dx Diesel
- TPH-Dx Heavy Oil
- PAHs: acenaphthene, flouranthene, flourene, 1-methylnaphthalene, phenanthrene, pyrene
- VOCs: acetone, sec-butylbenzene, chloroethane, isopropylbenzene, n-propylbenzene, toluene, and n-butylbenzene

BTEX components have been detected in site groundwater in the past; however, other than toluene in one sample, they were not detected during the 2007 groundwater sampling events, which followed several years of active remediation. Therefore, BTEX compounds, other than toluene, are not identified as COIs for site groundwater.

The COIs identified above are not to be confused with Indicator Hazardous Substances, as defined in MTCA 173-340-703. Indicator Hazardous Substances have been selected by comparing the COIs to applicable cleanup standards, as discussed in **Section 9.**

TPH-Dx diesel analytical results for groundwater are presented on **Figure 8**. Historically, TPH-Dx has been analyzed with a silica gel cleanup; however, it was not used for the August 2007 sampling event. The results from the last sampling event with silica gel cleanup and the results without silica gel cleanup are included. Where a well was dry, the most recent data was presented on the figure. Based on this data, **Figure 8** illustrates the approximate estimated extent of TPH-Dx diesel impacts that exceed 500 ug/L.

7. CONTAMINANT FATE AND TRANSPORT

The BIOSCREEN model was used to evaluate the fate and transport of TPH-Dx contamination in groundwater, from the source area to the Columbia River. BIOSCREEN is a screening model which simulates transport of contaminants in groundwater. It was developed for the Air Force Center for Environmental Excellence (AFCEE) Technology Transfer Division at Brooks Air Force Base by Groundwater Services, Inc., Houston, Texas.

The software, programmed in the Microsoft Excel spreadsheet environment and based on the Domenico analytical solute transport model, simulates the effects of advection, dispersion, adsorption, and decay on contaminant transport. For the Crowley site, adsorption and decay are key factors that limit migration of contaminated groundwater.

BIOSCREEN includes three different model types:

- Solute transport without decay
- Solute transport with biodegradation modeled as a first-order decay process
- Solute transport with biodegradation modeled as an "instantaneous" biodegradation reaction

To evaluate fate and transport of TPH-Dx at the site, relevant site data was entered into the Excel Spreadsheet model. The data input into the model is outlined in **Appendix I**. The results of the spreadsheet model are also included in **Appendx I**. Using site-specific and default model parameters, the BIOSCREEN model indicates that TPH-Dx does not migrate more than a few feet from the source. The inhibited migration is due to the high retardation of the long chain hydrocarbons that make up the TPH, which result in it being adsorbed to soil particles (see **Section I.3** of **Appendix I**). This low mobility is confirmed by soil analytical data sets indicating higher concentrations of TPH at shallow depths, and lower concentrations beneath.

A sensitivity analysis was conducted on the model results, and that analysis determined that the limiting factor was the retardation factor, which is dependent on the partition coefficient. To evaluate an ultra-conservative case, the range of values for 6 key variables that are input into the model was assessed, and the model input was changed to use conservative values at the upper or lower end of the range, whichever would result in higher predicted mobility. Even under this ultra-conservative scenario, the furthest the TPH was predicted to migrate was 120 feet. Further migration is limited by retardation and biodegradation.

The results of the BIOSCREEN modeling correspond favorably with the observation that no TPH has migrated to downgradient wells MW-13 and MW-14. Additionally, these results indicate that TPH will never migrate beyond 120 feet downgradient of the source, even under ultra-conservative conditions.

8. EXPOSURE ASSESSMENT

This section describes the methods used to estimate exposures for relevant receptors at the site. The exposure assessment provides a scientifically defensible basis for the selection of potentially exposed hypothetical human receptors and the most likely ways they might be exposed to COIs at the site. In addition to evaluating potential receptors and exposure pathways, this section also evaluates the possibility of chemical migration from soil to groundwater and from soil and groundwater into air.

The following four conditions are necessary for chemical exposure to occur:

1. A chemical source and a mechanism of chemical release to the environment. For the Crowley site, the chemical source was the historical discharge of wastewater to the ponds, which has impacted soil and groundwater at the site.

2. Environmental transport mechanisms (e.g., volatilization) and media (e.g., groundwater) for the released chemical.

3. A point of contact between the contaminated medium and the receptor (i.e., the exposure point).

4. An exposure route (e.g., ingestion of contaminated groundwater) at the exposure point.

All four of these elements must be present for an exposure pathway to be considered complete and for chemical exposure to occur. For the Crowley site, the exposure pathway analysis was completed by developing a Conceptual Site Model (CSM) for chemical sources, migration pathways, exposure points of contact, and exposure routes. The CSM links sources of chemicals with potentially exposed hypothetical receptors and associated complete exposure pathways. The CSM is presented on **Figure 9**, which presents the logic used to identify complete exposure pathways.

Human receptors selected for evaluation in this assessment were identified on the basis of proximity to the site, proposed activities that could possibly result in direct or indirect contact with COIs, and future site plans (the site is expected to remain industrial in the future). Based on the expected current and future uses of the site, the following hypothetical receptors were identified:

- Outdoor industrial worker
- Indoor industrial worker
- Excavation worker
- Terrestrial ecological receptor

A discussion documenting the potentially complete exposure pathways that have been identified on the CSM is provided below.

8.1 OUTDOOR INDUSTRIAL WORKER

The following exposure pathways were assumed to be potentially complete for the outdoor industrial worker receptor:

- Incidental ingestion of surface soil;
- Dermal contact with surface soil;
- Inhalation of particulates from surface soil;
- Inhalation of vapors from soil in ambient air; and
- Inhalation of vapors from groundwater in ambient air.

The first two pathways for this receptor have been evaluated in **Section 8** of this report by assuming direct contact cleanup levels using MTCA.

Due to the low levels of VOCs at the site, the inhalation of vapors from soil and groundwater pathways are not considered significant, and they have not been evaluated in this report. Because the soil impacts are at depth, the inhalation of particulates pathway is also not considered significant.

8.2 INDOOR INDUSTRIAL WORKER

The following exposure pathways were assumed to be potentially complete for the indoor industrial worker receptor:

- Inhalation of vapors from soil in ambient air; and
- Inhalation of vapors from groundwater in ambient air.

Due to the low levels of VOCs at the site, the inhalation of vapors from soil and groundwater pathways are not considered significant, and they have not been evaluated in this report.

8.3 EXCAVATION WORKER

The following exposure pathways were assumed to be potentially complete for the excavation worker receptor:

- Incidental ingestion of soil;
- Dermal contact with soil;
- Incidental ingestion of groundwater; and
- Incidental dermal contact with groundwater.
- Inhalation of vapors from soil in trench air;
- Inhalation of vapors from groundwater in trench air;

Because Ecology has not developed screening levels for this receptor, the first four pathways have been evaluated by comparing COI concentrations to risk based concentrations (RBCs) developed by the Oregon Departement of Environmental Quality (ODEQ). The ODEQ RBCs were calculated by ODEQ using standard risk assessment transport models, exposure factors, and toxicity factors.

Due to the low levels of VOCs at the site, the inhalation of vapors from soil and groundwater pathways are not considered significant, and they have not been evaluated in this report.

8.4 TERRESTRIAL ECOLOGICAL RECEPTOR

The following exposure pathways were assumed to be potentially complete for the terrestrial ecological receptor:

- Incidental ingestion of soil;
- Dermal contact with soil;

The pathways for this receptor have been evaluated in **Section 8** of this report by determining terrestrial ecological cleanup levels using MTCA.

9. CLEANUP STANDARDS

Cleanup standards for the site have been developed pursuant to the MTCA cleanup regulations using an assessment of potentially sensitive receptors and local soil and groundwater quality. The following discussion presents the rationale for deriving the applicable cleanup standards.

9.1 MODEL TOXICS CONTROL ACT

MTCA requires that remedial actions at a site achieve a cleanup level that protects human health and the environment. The cleanup must comply with MTCA cleanup standards. The methods for identifying, investigating, and remediating hazardous waste sites are defined, and cleanup levels are set for groundwater, soil, surface water, and air in WAC 173-340 Sections 720 through 750.

Under MTCA, site-specific cleanup levels are contingent upon the anticipated future land use of the site. The regulation specifies three "methods" for use in establishing site cleanup levels for specific environmental media. Briefly, these are:

- **Method A** cleanup levels are set by the state of Washington and are delineated in the regulation for a specific subset of chemicals for environmental media. These values can be used as cleanup levels during "routine" site cleanups (e.g., few contaminants at the site, and all contaminants have Method A cleanup levels).

- **Method B** is the standard method for site cleanups under MTCA. Method B cleanup levels involve calculation of media-specific values for a given chemical from specified formulae provided in the regulation. The formulae require input of chemical-specific toxicological parameters, as well as physiological and exposure-based parameters. Parameter values and sources are explicitly stated in the regulation.

- **Method C** is the conditional method for site cleanups under MTCA. MTCA Method C levels involve calculations similar to Method B, with some modification of specific parameter values to meet special conditions associated with the site (i.e., industrial sites).

9.2 GROUNDWATER

9.2.1 Non-Potable Determination for the Perched Groundwater

Cleanup levels for groundwater must protect the highest beneficial use and reasonable maximum exposure expected to occur under both current and potential future site use conditions. Under typical conditions, the highest beneficial use is considered to be as potable water; however, based on the following criteria, the shallow perched groundwater in which the contamination is present is not potable, per WAC 173-340-720(2):

1. Shallow site groundwater is not a current source of drinking water

2. Shallow site groundwater is perched and is not a viable future drinking water source:

   - Per WAC 173-340-720(2)(a)(i), groundwater is not a potential future source of drinking water if it is not present in sufficient quantity to yield greater than 0.5 gpm on a sustainable basis to a well constructed in compliance with WAC 173-160.

- ♦ State requirements for drinking water wells (WAC 173-160) require an 18-foot casing, which would place a well screen in the unproductive silt/clay zone which is below the sandy zone supporting the perched groundwater containing the petroleum impacts and which would produce even less water than the perched groundwater.

- ♦ During a short term pump test conducted for 8 hours on February 22, 1996, the perched groundwater in the sandy zone above the silt/clay was pumped at 0.55 gpm from EX-2, a 4-inch diameter groundwater monitoring well. However, this was a short term pump test conducted during a period of very heavy rain and flooding, and it is not reasonable that this yield could be continued on a sustainable basis.

- ♦ During long-term operation of the IRAM dual phase extraction system, which pumped liquids and vapors from five 2-inch diameter wells, a sustained flow rate of 0.05 gpm was obtained from the perched groundwater in the sandy zone above the silt/clay. This is more realistic of actual long term yields than the February 1996 pump test. In fact, sustained yields from a well might be lower because the vacuum applied to the wells by the dual phase extraction system likely enhanced the yield from these wells. (The 0.05 gpm value was calculated as discussed in **Section A.4** in **Appendix A.**).

3. Transport of petroleum constituents from the contaminated groundwater to a current or potential source of drinking water is unlikely due to the following factors per WAC 173-340-720(1)(b):

   - The extent of affected groundwater is limited to the area of the former ponds in the perched sandy zone above the silt/clay aquitard.

   - State requirements for drinking water wells (WAC 173-160) require an 18-foot casing, which would place a well screen in the silt/clay zone, below the zone of petroleum impacts.

   - Transport to a deeper aquifer is improbable because of the low permeability of the silt/clay zone. Boring logs for MW-20 and EX-2 indicate that the silt/clay zone is 17 feet to 21 feet thick.

   - Transport to an adjacent aquifer is unlikely due to the low mobility of the contaminants, as demonstrated by the BIOSCREEN modeling.

   - The nearest known drinking water supply well is approximately ½-mile from the site and is screened at a depth of 110 feet.

The proposed groundwater cleanup levels for the site are not based on a drinking water beneficial use. Therefore, groundwater cleanup levels have been developed by site-specific risk assessment for nonpotable use, per WAC 173-340-7230(6)(c). For the site-specific risk assessment, a Conceptual Site Model has been developed (**Section 7** of this report), and the following potentially complete exposure pathways identified in the CSM are evaluated against relevant screening levels in the succeeding sections:

1. Migration to surface water designated with a drinking water beneficial use
2. Direct contact by an excavation worker
3. Vapor intrusion

9.2.2 Protection of Surface Water

Consistent with the provisions in MTCA [WAC 173-340-720 (1)(c) and (3)(b)(v) for groundwater cleanup standards], MTCA cleanup levels allow groundwater cleanups based on protecting surface water. Therefore, the proposed groundwater cleanup levels and points of compliance for the site have been based on protection of surface water in the Columbia River, as discussed in **Section 9.3**.

9.2.3 Direct Contact by the Excavation Worker Receptor

Because MTCA does not establish cleanup levels for the excavation worker receptor, for this CAP, ODEQ RBCs have been used to evaluate this potential exposure pathway. The ODEQ RBCs were calculated by ODEQ using standard risk assessment transport models, exposure factors, and toxicity factors. The ODEQ RBCs are therefore applicable as screening levels for determining whether the presence of a substance would cause exceedence of a hazard quotient (HQ) of 1 or excess cancer risk of greater than one in one million (1×10^{-6}), as specified in WAC 173-340-730(6)(a).

For the COIs identified in **Section 6.2.2**,, applicable groundwater cleanup levels are in listed in **Table 4** (TPH-Gx, and TPH-Dx), **Table 5** (SVOCs), and **Table 6** (VOCs). When ODEQ did not establish an RBC for a particular compound, it was because ODEQ assumed that it is not physically possible to exceed the unacceptable risk level by this pathway, i.e. it has a low toxicity or it has a low solubility, such that it cannot exceed the concentration that would be required to cause the relevant risk level.

None of the MDCs for any of the COIs exceed any of these screening levels; therefore, exposure to groundwater by an excavation worker does not pose a threat to human health.

9.2.4 Vapor Intrusion Pathway

Very low levels of some VOCs were detected in site groundwater; however, the concentrations of these compounds are below screening levels established for the vapor intrusion pathway. Ecology does not have screening levels; however, the ODEQ has established RBCs for the vapor intrusion pathway.

For the COIs identified in **Section 6.2.2**, applicable ODEQ RBCs are in listed in **Table 4** (TPH-Gx, and TPH-Dx), **Table 5** (SVOCs), and **Table 6** (VOCs). Where ODEQ did not establish an RBC for a particular compound, it did so because it has assumed that it is not physically possible to exceed the unacceptable risk level by this pathway, i.e. it has a low toxicity or it has a low vapor pressure, such that it cannot exceed the concentration that would be required to cause the relevant risk level.

9.3 SURFACE WATER

No adverse impact due to site contaminants, such as water quality violations or a visible oil sheen, is allowed on surface water, including the Columbia River. The highest beneficial use of the Columbia River is as drinking water, and to protect the use of the Columbia River as a downstream drinking water source, the MTCA Method A groundwater cleanup levels for drinking water beneficial use (Table 720-1 of MTCA) are proposed, as required by 173-340-730(2)(b)(ii).

For compounds for which Method A cleanup levels are not provided in MTCA, Ecology has calculated Method B potable water cleanup levels and published them on its internet website. Where neither Method A nor Method B levels are available, USEPA Region 6 screening levels, federal Maximum Contaminant Levels (MCLs), or State of Washington water quality criteria may be used to develop cleanup levels.

For the COIs identified in **Section 6.2.2**, applicable potable water cleanup levels are in listed in **Table 4** (TPH-Gx, TPH-Dx, and BTEX), **Table 5** (SVOCs and PAHs), and **Table 6** (VOCs). For TPH-Gx, the cleanup level is 800 µg/L when benzene is present in groundwater, and it is 1,000 µg/L when benzene is not present. No Benzene is present in the groundwater samples collected since implementation of the IRAM, therefore the 1,000 ug/L cleanup level applies for TPH-Gx.

The only parameters for which the maximum detected concentration (MDC) in post-IRAM groundwater data exceeds the cleanup level are:

- TPH-Dx Diesel
- TPH-Dx Heavy Oil

Therefore, these compounds have been identified as Indicator Hazardous Substances.

Ecology has provided a spreadsheet for calculating site-specific Method B cleanup levels for sites with TPH using the EPH/VPH test. Relevant EPH/VPH data from MW-2 for the Port of Vancouver July 2007 sampling event and VOC and PAH data from the August 2007 SLR sampling event was input into the MTCA spreadsheet. The completed spreadsheet is included in **Appendix J**. The resulting Method B TPH cleanup level for potable water was 828 ug/L.

The regulatory point of compliance for protection of surface waters is "the point at which hazardous substances are released to surface waters" WAC 173-340-730(6)(a). For properties near, but not abutting the surface water, a conditional point of compliance may be established between the source area and the surface water, per WAC 173-340-720(8)(d)(ii). Under this provision, MW-13 and MW-14 are proposed as conditional points of compliance for protection of surface water. These wells are located south of the source area, between it and the Columbia River. Establishment of the conditional points of compliance at MW-13 and MW-14 is a conservative approach; WAC 173-340-720(8)(d)(i) allows for establishment of conditional points of compliance in the actual surface water body, and MW-13 and MW-14 are approximately 50 feet from the Columbia River, providing added protection.

Therefore, the proposed cleanup standard for the protection of surface water is that groundwater at the points of compliance (MW-13 and MW-14), must meet the Method A cleanup levels for TPH-Dx Diesel and TPH-Dx Heavy Oil of 500 ug/L or the Method B cleanup level (using the EPH/VPH test) of 828 ug/L.

9.4 SOIL

9.4.1 Generic Soil Cleanup Levels

Method A cleanup levels are listed in Tables 740-1 (Unrestricted Land Use) and Table 745-1 (Industrial Properties) of MTCA. Method A cleanup levels are not site specific. For compounds for which Method A cleanup levels are not provided in MTCA, Ecology has calculated Method B cleanup levels and published them on its internet website. Method A cleanup levels are used where available, and Method B cleanup levels are used where Method A levels are not available. Where neither Method A or Method B levels are available, USEPA Region 6 screening levels were used.

For the COIs identified in **Section 6.2.1**, applicable groundwater cleanup levels are in listed in **Table 1** (TPH-Gx, TPH-Dx, BTEX, Naphthalene, and MTBE) and **Table 2** (SVOCs, PAHs, and VOCs). The cleanup level for TPH-Gx that contains benzene is 30 mg/Kg, and the cleanup level for TPH-Gx that doesn't contain benzene is 100 mg/Kg. No Benzene was present in soil samples collected during the August 2007 event, therefore, the 100 mg/Kg cleanup level applies for TPH-Gx. The only parameters for which the maximum detected concentration exceeds the individual constituent generic soil cleanup levels are:

- TPH-Gx
- TPH-Dx Diesel
- TPH-Dx Heavy Oil
- 1-Methylnaphthalene
- Benzo(a)anthracene
- Benzo(b)fluoranthene
- Benzo(k)fluoranthene
- Benzo(a)pyrene
- Chrysene

These constituents are all associated with the TPH related to residual diesel in the soil. As such, TPH has been selected as an Indicator Hazardous Substance for soil at the site. To further evaluate these compounds, the chemical data for three data sets was input into a cleanup level calculation spreadsheet developed by Ecology. The spreadsheet calculations are presented in the following subsection.

9.4.2 Method B Spreadsheet Cleanup Levels

Ecology has provided a spreadsheet for calculating site-specific Method B cleanup levels for sites with TPH using the EPH/VPH test. The data included in **Table 3** was input into the MTCA spreadsheet. The completed spreadsheets are included in **Appendix J**. Data from the following data points were used:

- GP3-7-8 (1999), total TPH concentration of 9,634 mg/Kg
- GPE6-11 (2007), total TPH concentration of 3,588 mg/Kg
- GPE7-10 (2007), total TPH concentration of 6,511 mg/Kg

Results for GPE1-11, GPE2-11, and GPE-4-11 were not used. The total TPH concentration in these wells was only 80 mg/Kg, 68 mg/Kg, and 60 mg/Kg, respectively, which is not representative of the TPH concentrations that are of concern at the site.

The results of the spreadsheet calculations were:

		Direct Contact Pathway		
Sample ID	**Total TPH** (mg/Kg)	**Method B Soil Cleanup Level for Unrestricted Land Use** (mg/Kg)	**Method C Soil Cleanup Level for Industrial Land Use** (mg/Kg)	**Protection of Groundwater Quality (Leaching Pathway)** (mg/Kg)
GP3-7-8	9,634	2,493	33,563	100% NAPL

Sample ID	Total TPH (mg/Kg)	Direct Contact Pathway: Method B Soil Cleanup Level for Unrestricted Land Use (mg/Kg)	Direct Contact Pathway: Method C Soil Cleanup Level for Industrial Land Use (mg/Kg)	Protection of Groundwater Quality (Leaching Pathway) (mg/Kg)
GPE6-11	3,588	893	33,814	100% NAPL
GPE7-10	6,511	1,865	33,373	100% NAPL
Average	6,578	1,750	33,583	100% NAPL

These results indicate that the TPH mixture at the site does not pose a threat to human health via the direct contact pathway. These cleanup levels are higher than the generic Method B levels because they are based on site-specific petroleum fractions identified by laboratory analysis of the above samples.

Additionally, the spreadsheet calculations show that, under industrial exposure assumptions (which result in lower estimated risk than unrestricted land use cleanup levels), the estimated lifetime excess cancer risks for 1-methylnaphthalene, benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, and chrysene are below the acceptable risk levels of 1×10^{-5} and 1×10^{-6}.

9.4.3 Excavation Worker Cleanup Levels

Because MTCA does not establish cleanup levels for the excavation worker receptor, ODEQ RBCs have been used to evaluate this potential exposure pathway. The ODEQ RBCs were calculated by ODEQ using standard risk assessment transport models, exposure factors, and toxicity factors. The ODEQ RBCs are therefore applicable as screening levels for determining whether the presence of a substance would cause exceedence of a hazard quotient (HQ) of 1 or excess cancer risk of greater than one in one million (1×10^{-6}).

For the COIs identified in **Section 6.2.1**, applicable groundwater cleanup levels are in listed in **Table 1** (TPH-Gx, TPH-Dx, BTEX, Naphthalene, and MTBE) and **Table 2** (SVOCs, PAHs, and VOCs). Where ODEQ did not establish an RBC for a particular compound, it did so because it has assumed that it is not physically possible to exceed the unacceptable risk level by this pathway, i.e. it has a low toxicity such that it cannot exceed the concentration that would be required to cause the relevant risk level.

The maximum detected concentration of COIs on site does not exceed any of these screening levels; therefore, exposure to soil by an excavation worker does not pose a threat to human health.

9.4.4 Terrestrial Ecological Cleanup Levels

Table 749-2 of MTCA establishes soil cleanup levels for terrestrial ecological receptors. For the COIs identified in **Section 6.2.1**, applicable groundwater cleanup levels are in listed in **Table 1** (TPH-Gx, TPH-Dx, BTEX, Naphthalene, and MTBE) and **Table 2** (SVOCs, PAHs, and VOCs).

With the exception of TPH-Dx Diesel, the maximum detected concentration of COIs on site does not exceed any of these screening levels. However, as discussed in **Section 10.2**, a statistical analysis of the soil data indicates that site soils meet this cleanup level criteria.

9.4.5 Vapor Intrusion

The vapor intrusion pathway is not significant. Very low levels of some VOCs were detected in site groundwater; however, the concentrations of these compounds fall far below screening levels established for the vapor intrusion pathway. Ecology does not have screening levels; however, the ODEQ has established RBCs for the vapor intrusion pathway.

For the COIs identified in **Section 6.2.1**, applicable groundwater cleanup levels are in listed in **Table 1** (TPH-Gx, TPH-Dx, BTEX, Naphthalene, and MTBE) and **Table 2** (SVOCs, PAHs, and VOCs). Where ODEQ did not establish an RBC for a particular compound, it did so because it has assumed that it is not physically possible to exceed the unacceptable risk level by this pathway, i.e. it has a low toxicity or it has a low vapor pressure, such that it cannot exceed the concentration that would be required to cause the relevant risk level.

9.4.6 Residual Saturation

NAPL petroleum that is present in the vadose zone at levels above the residual saturation level may flow downwards toward the water table, coming into direct contact with groundwater. Residual saturation is defined as the amount of liquid that will remain in the soil after it has been completely drained, i.e. how much will remain in soil pores and adsorbed to particles and that will not further drain by gravity.

Literature Review

Laboratory residual saturation values for different types of petroleum products from several literature sources are summarized in Cohen and Mercer (1993). Residual saturation values reported in Cohen and Mercer for middle distillates range from 12,625 mg/Kg in fine to medium sand, such as the soil found in upper site layers, to 17,000 mg/Kg in silt to fine sand, such the soil found beneath the sand. Literature residual saturation values for fuel oils range from 21,250 mg/Kg in the fine to medium sand to 34,000 mg/Kg in silt to fine sand.

Further literature review suggests that residual saturation is inversely proportional to grain size and moisture content, i.e. it increases with decreasing grain size and decreases with increasing moisture content. Most studies did not addressed moisture content, and the two studies that did address moisture content (Hoag and Marley, 1986, and Ostendorf, et. al. 1991) focused on gasoline residual levels, which are not applicable to the product at the site.

Site Data

Site hydrocarbons have been identified as a "highly weathered diesel fuel oil" (North Creek Analytical, Inc., 1999). Residual saturation values for the hydrocarbon at the site are thus likely to be comparable to those observed for fuel oils in the literature.

Site-specific residual saturation values may be inferred from soil data collected at the site:

- A sample collected from GP-3 from a depth of 3-4 feet bgs contained 14,000 mg/Kg TPH. The sample collected at a depth of 7-8 feet bgs contained only 7,600 mg/Kg TPH.

- A sample collected from GPD-3 from a depth of 7 feet bgs contained 6,340 mg/Kg TPH. The sample collected at a depth of 11 feet bgs contained 5,570 mg/Kg TPH.

- A sample collected from GPD-9 from a depth of 10 feet bgs contained 12,100 mg/Kg TPH. The sample collected at a depth of 14 feet bgs contained only 225 mg/Kg TPH.

- A sample collected from GPD-14 from a depth of 7 feet bgs contained 3,190 mg/Kg TPH. The sample collected at a depth of 10 feet bgs contained 1,500 mg/Kg TPH.

- A sample collected from GPE-2 from a depth of 5 feet bgs contained 1,900 mg/Kg TPH. The sample collected at a depth of 11 feet bgs contained only 34 mg/Kg TPH.

- A sample collected from GPE-8 from a depth of 6 feet bgs contained 7,080 mg/Kg TPH. The sample collected at a depth of 9 feet bgs did not contain detectable levels of TPH.

These soils are fine to medium-grained sands. Considering the 24 year and greater age of the hydrocarbon release, this evidence indicates that the petroleum hydrocarbons are not mobile and are not migrating. The residual saturation level of the hydrocarbon product at the site is likely greater than 14,000 mg/Kg in the fine to medium grained sand of the upper soil layer. This level is consistent with values published for fuel oil in the literature, i.e. greater than 20,000 mg/Kg for fine to medium grained sand.

10. COMPARISON TO CLEANUP STANDARDS

10.1 GROUNDWATER

The most recent groundwater data is summarized in **Table 7**, which includes a statistics on the data set. Land use at the site is industrial, and future land use is expected to remain industrial. Potentially complete exposure pathways for groundwater that have been evaluated include:

- Use as drinking water: Site shallow groundwater is not a drinking water source. It will not produce sufficiently high yields on a sustained basis.

- Protection of nearby surface water: Cleanup standards established for groundwater at the site must be protective of the Columbia River. Applicable surface water cleanup levels are exceeded in the perched, shallow aquifer; however, conditional points of compliance will be established for the protection of surface water.

- Direct contact by excavation worker: Site groundwater levels do not exceed any of the ODEQ RBCs for this pathway, and this pathway does not pose an unacceptable risk to receptors.

- Vapor Intrusion: Site groundwater levels do not exceed any of the ODEQ RBCs for this pathway, and this pathway does not pose an unacceptable risk to receptors.

Based on the evaluation of these potential exposure pathways, the following groundwater cleanup standard is proposed for the site:

<u>Cleanup Levels:</u>

- 1,000 µg/L TPH-Gx (Method A, Benzene is not present)
- 500 ug/L TPH-Dx Diesel (Method A)
- 500 ug/L TPH-Dx Heavy Oil (Method A)

Conditional Point of Compliance

- MW-13 and MW-14:

Groundwater at the site currently meets this cleanup standard.

10.2 SOIL

Land use at the site is industrial, and future land use is expected to remain industrial. Potential exposure pathways for soil include:

- Direct contact by the outdoor industrial worker receptor: The calculated cleanup level for direct contact is 33,583 mg/Kg of TPH. The standard point of compliance is from ground surface to 15 feet below ground surface. None of the site samples exceed this cleanup level. Additionally, under the industrial scenario, the HI and lifetime excess cancer risk associated with the individual COIs do not exceed 1 and 1 x 10^{-6}, respectively.

- Migration to groundwater: Although site groundwater is not a viable drinking water source, the migration to groundwater cleanup level was calculated automatically by the MTCA spreadsheet. Due to the low mobility of the degraded diesel present at the site, the spreadsheeet did not calculate a cleanup level for the protection of groundwater, noting that 100% NAPL would still be protective of groundwater. By definition, none of the site soil samples can exceed this cleanup level.

- Direct contact by excavation worker: Site soil levels do not exceed any of the ODEQ RBCs for this pathway, and this pathway does not pose an unacceptable risk to receptors.

- Direct contact by terrestrial ecological receptors: The applicable MTCA cleanup levels for this pathway are 15,000 mg/Kg for TPH-Dx Diesel and 15,000 mg/Kg for TPH-Dx Heavy Oil. The standard point of compliance is from ground surface to a depth of 15 feet bgs.

- Vapor Intrusion: Site soil levels do not exceed any of the ODEQ RBCs for this pathway, and this pathway does not pose an unacceptable risk to receptors.

Based on the evaluation of these potential exposure pathways, the following soil cleanup standard is proposed for the site:

Cleanup Levels:

- 12,000 mg/Kg TPH-Gx Gasoline (Terrestrial Ecological Level for Industrial Sites)
- 15,000 mg/Kg TPH-Dx Diesel (Terrestrial Ecological Level for Industrial Sites)
- 15,000 mg/Kg TPH-Dx Heavy Oil (Terrestrial Ecological Level for Industrial Sites)

Standard Point of Compliance

- Ground surface to 15 feet below ground surface.

Compliance with this cleanup standard is evaluated by calculating the upper one-sided ninety-five percent confidence limit on the soil mean concentration (95UCL) and comparing it to the cleanup level. It was calculated using the EPA Microsoft Excel Add-In ProUCL. ProUCL calculates UCLs using multiple methods. SLR's standard practice is to use the result from the Standard Bootstrap method. Some agencies require use of the Chebyshev method. For completeness, results from both methods are included.

Table 8 presents TPH-Dx data for soil borings at the site. The Chebyshev 95UCL for all soil data collected since 1999 is 8,092 mg/Kg TPH-Dx Diesel. This value is below the 15,000 mg/Kg cleanup level. Only one data point exceeds twice the cleanup level; however, it was sampled in 1999 in an area that has since been actively remediated. Only 3 soil samples have exceeded the cleanup level, representing 4% of all samples, and, again, these samples were collected from areas that were since actively remediated. The extent to which active remediation has lowered TPH levels on site is illustrated by the comparison of data presented in **Table 10**, which presents the results of analysis on soil samples collected from adjacent locations in 1999, 2002, 2005, and 2007.

Based on the data summarized in **Table 8**, site soil meets the cleanup standard.

11. RECOMMENDED ACTION

There are no currently complete exposure pathways for which site COIs exceed established cleanup levels and screening levels. MW-13 and MW-14 are recommended as conditional points of compliance for the protection of surface water; however, considering the hydrocarbons are not mobile, and, in 30 years, they have not migrated from the source area, it is not likely that the hydrocarbons will ever reach the Columbia River, and further monitoring is not warranted.

Based on this information, no further action is recommended for the site.

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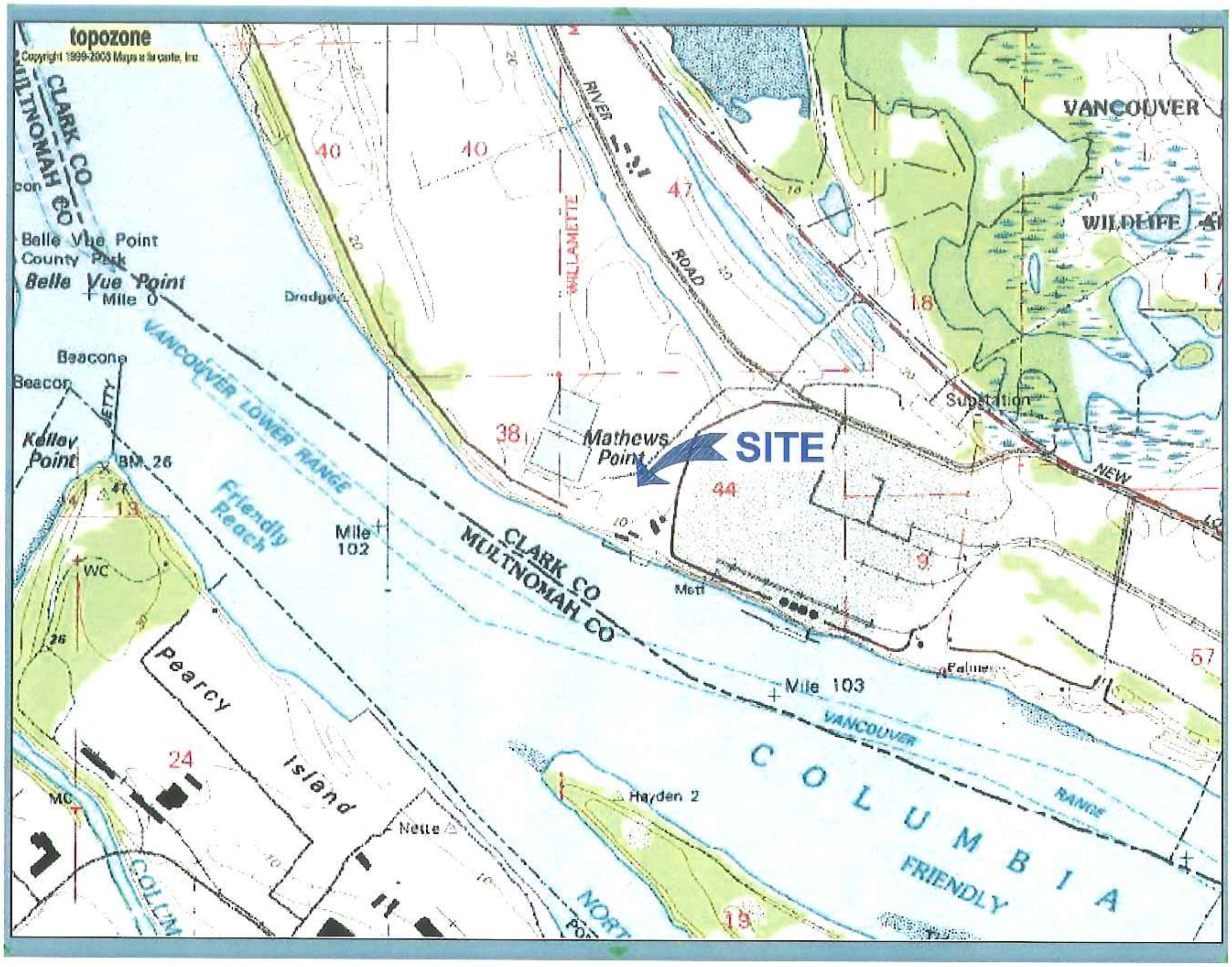
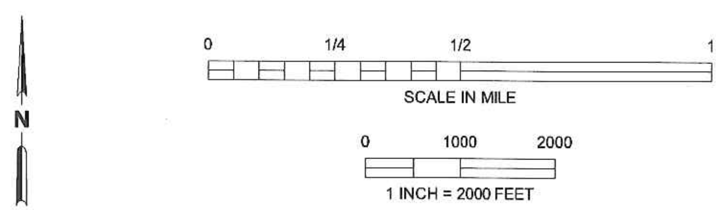
FIGURES





REFERENCE: USGS 7.5 MINUTE QUADRANGLE; VANCOUVER, WASHINGTON; 1990

SLR International Corp 1800 Blankenship Road Suite 440 West Linn, OR 97068 T: 503-723-4423 F: 503-723-4436	DATE 07/07 DWN. EMG APPR. ______ REVIS. ______ PROJECT NO. **008.0205.00007**	**FIGURE 1** FORMER COLUMBIA MARINE LINES FACILITY 6305 LOWER RIVER ROAD VANCOUVER, WASHINGTON **SITE LOCATION MAP**

APPENDIX A

IRAM OPERATION

This Appendix to the report summarizes the operation of each of the following components of the IRAM system:

- Dual phase extraction system
- Venturi groundwater extraction system
- Vapor discharge controls
- Water discharge controls

A.1 DUAL PHASE EXTRACTION

Vapors and liquids were extracted from five wells (RW-1, RW-2, RW-3, RW-4, and RW-6). Until April 2002, the system was connected to RW-5. Because the water level in RW-5 was too high to effectively remove vapors, it was disconnected and RW-6/EX-2 connected.

Groundwater was extracted from all five wells. Initially, the system was removing free phase hydrocarbons from RW-1, RW-2 and RW-3. No free phase hydrocarbon had been observed in RW-4, RW-5 or RW-6. At the time of shutdown, none of the wells were extracting free phase hydrocarbon.

System operational data is presented in **Table A-1**. When the system was shut down in December 2005, the blower had operated for 21,250 hours. Vacuum measured in the knockout drum during operation ranged from 55 to 80 inches of water column ("wc). Vacuum in the stingers at the wells ranged from 42 to 65 "wc. Vacuum in the well casing ranged from 14 to 22 "wc. The vacuum induced at the vapor monitoring points ranged from 0.01 to 0.73 "wc.

Induced vacuum was periodically measured in vapor monitoring points to evaluate the effect the system was having in the subsurface surrounding the extraction wells. Induced vacuum indicated that the extraction wells had pulled vapors away from the monitoring point, resulting in airflow through the subsurface. Points PT-1 through PT-4 were installed with the system in December 2000. Points PT-5 through PT-8 were installed in March 2002. Locations are shown in **Figure 4**. Induced vacuums measured at the monitoring points indicate that the effective radius of influence of the vapor extraction system was between 20 and 30 feet. The strongest influence was observed at PT-7, which is located between RW-1 and RW-6/EX-2. The weakest influence was observed at PT-4, which is to the west-northwest of RW-2. Influence from RW-2 in the direction of PT-4 was likely limited due to the presence of the former extraction trench, which lies in between the two locations. The data indicated that the vacuum was propagating farthest in the area around RW-4.

A.2 VENTURI SYSTEM

The venturi system was installed to remove groundwater from wells that were expected to produce more groundwater than the dual phase extraction system could handle. It consisted of a centrifugal pump and two loops of hose with venturis that could be used to remove liquid from the wells. The venturi system was extracting liquids from RW-3 and RW-5 until it was shut down in August 16, 2001. The system was shut down due to fouling in the hoses caused by the minerals in the groundwater. The fouling required excessive maintenance. Additionally, the vacuum provided by the blower was sufficient to remove water, and the additional extraction capability of the venturi system was not necessary.

A.3 AIR DISCHARGE

Vapors extracted from the ground were treated by activated carbon prior to discharge. During operation and maintenance checks, the volatile organic carbon (VOC) concentration in the blower discharge, between each series of vapor phase carbon drums, and in the discharge stack was measured in the field using a PID and by collection of samples for laboratory analysis. The airflow rate in the discharge stack was also monitored. The airflow rate was controlled to around 150 cubic feet per minute (cfm).

A sample of the blower discharge air collected on December 5, 2000, contained 1,020 milligrams per per cubic meter (mg/m^3) of gasoline range hydrocarbons. A sample collected on January 17, 2001 contained 253 mg/m^3 of gasoline range hydrocarbons and no detectable BTEX. A sample collected on October 18, 2001 contained 350 mg/m^3 of gasoline range hydrocarbons; benzene was detected at 0.226 mg/m^3, toluene at 0.347 mg/m^3, ethylbenzene at 0.252 mg/m^3 and total xylenes at 1.62 mg/m^3 .

Mass removed by vapor extraction is calculated on **Table A-2**. Based on the laboratory analytical results, the blower operating hours, and the measured airflow rates, the estimated mass of hydrocarbons removed by vapor extraction during the period of IRAM system operation was approximately 4,000 pounds.

SECOR contacted the Southwest Clean Air Agency (SWCAA) to determine if air pollution controls were required at this estimated emission rate, and SWCAA indicated that a permit would be required for any air pollution source emitting over 1 ton of VOCs per year. Based on measurements, the average mass removed annually was 750 lbs; therefore, a permit was not required.

A.4 WATER DISCHARGE

Liquids removed from the ground were treated by oil/water separation and activated carbon prior to being discharged into the existing on-site infiltration trench. In line flow meters were used to measure the amount of water removed by the dual phase extraction system and by the venturi system. Flow meter readings were recorded on a regular basis during operations and maintenance visits. The data is presented in Table A-1. Over 330,000 gallons of water were extracted during the period of IRAM operation. The average rate of water removal, based on blower operating hours, was approximately 370 gallons per day (gpd). A flow of 370 gallons per day from 5 wells corresponds to a sustained flow rate of 0.05 gpm per well

The effluent stream was sampled at least quarterly to monitor for carbon breakthrough. Water samples were collected prior to carbon treatment, midstream of carbon treatment, and after carbon treatment. Prior to February 2002, samples were analyzed for BTEX and NWTPH-Dx. Subsequently, the effluent samples were analyzed for NWTPH-Dx and NWTPH-Gx only, based on non-detection of BTEX in past samples. Effluent analytical results are summarized in **Table A-3**. The total amount of hydrocarbon removed was approximately 690 pounds, as calculated on **Table A-4**.

A.5 BIORESPIRATION TEST

The rate of biodegradation was calculated from the rates of oxygen depletion and carbon dioxide generation in the subsurface. These are measured by monitoring the oxygen and carbon dioxide concentrations in vapor monitoring points for a period of time after the total fluids extraction blower was shut down. When the blower was shut down, air flow into the wells was cut off, oxygen was depleted, and carbon dioxide was generated through microbial metabolism.

A.5.1 Biorespiration Test Methodology

SECOR conducted biorespirations test from March 12 to March 13, 2001 and from April 4 to April 8, 2002. Prior to conducting the tests, the system had been operated continuously for at least three weeks, during which time the subsurface airflow conditions were assumed to have reached steady-state. Groundwater and vapors were being extracted from RW-1, RW-2, RW-3, RW-4, and RW-5 (2001 test) or RW-6/EX-2 (2002 test) prior to conducting the tests.

During the tests, oxygen and carbon dioxide concentrations were monitored in vapor monitoring points. Vapor monitoring points PT-1, PT-2, PT-3 and PT-4 were installed on October 4, 2000. These points and MW-1, MW-18, MW-21 and EX-2 were monitored for the 2001 test. On April 1, 2002, prior to the 2002 test, vapor monitoring points PT-5, PT-6, PT-7 and PT-8 were installed.

Prior to beginning the tests, airtight seals were installed at the top of each of the vapor monitoring points. The seals were constructed of either threaded or slip-on PVC caps through which ¼-inch holes had been drilled. Clear, flexible Tygon Tubing was inserted through the cap. The tube was sealed to the cap using a silicon sealant. The tube was inserted into each vapor monitoring point to a depth of approximately 8 feet below the top of the well casing (TOC) in the screened interval. Oxygen, carbon dioxide, and induced vacuum measurements were taken through the drop tubes to more accurately measure those parameters in the screened interval.

With the system on, oxygen and carbon dioxide concentrations and the induced vacuum were measured in vapor monitoring points PT-1 to PT-8. The locations of the recovery wells, monitoring wells, and vapor monitoring points are shown on **Figure 4**. Oxygen concentrations were measured using a Gastec Genesis Portable LEL/O_2 Meter with an internal air-draw pump. The meter was calibrated onsite using a 12% oxygen and 50% LEL (as methane) gas mixture. Carbon dioxide concentrations were measured using a Telaire 1320 Portable Carbon Dioxide Measuring System. The meter was factory calibrated in the laboratory prior to use. Induced vacuum was measured using Magnahellic vacuum gauges with a sensitivity of 0.01 to 10 inches of water.

For the 2001 test, at 11:07 a.m. on March 12, 2001, the blower was shut off. Oxygen and induced vacuum levels were measured in the 8 monitoring points continuously, approximately every 15 minutes, for the first 2 hours of system shutdown. After this initial period, measurements were made approximately every hour for another 4 hours. Oxygen and vacuum levels were also measured in the morning and afternoon of March 13, 2001, and on the afternoon of March 15, 2001. Data collected during the test is shown in **Table A-6**. After data was collected on March 15, 2001, the blower was turned back on, and the system is currently operating continuously.

For the 2002 test, at 9:20 a.m. on April 4, 2002, the blower was shut off. Oxygen and induced vacuum levels were measured in the eight monitoring points, approximately every 15 minutes, for the first 4 hours of system shutdown. Due to the reading stabilization time of the meter, carbon dioxide measurements were only collected every 20 to 25 minutes for the first 4 hours. After this initial period, measurements were made approximately every hour for another 3 hours. Oxygen and vacuum levels were also measured in the morning and afternoon of April 5, 2002, and on the afternoon of April 8, 2002. Data collected during the test is shown in **Table A-7**.

A.5.2 Biorespiration Test Results

Oxygen and carbon dioxide concentrations were measured in the eight vapor monitoring points for a period of approximately 74 hours. Initial readings were taken to establish a baseline for normal continuous system operation. Initial oxygen levels ranged between 19.9% to 21.2%. The oxygen concentration in ambient air is 20.9%. Baseline induced vacuum levels ranged from 0.00 to 0.48 inches of water column ("wc). These induced vacuum values and the distances to the respective monitoring points confirm that the vacuum radius of influence of the extraction points was approximately 20 to 30 feet.

A.5.2.2 Oxygen and Carbon Dioxide Concentration

Measured oxygen and carbon dioxide concentrations are recorded on **Table A-5** for the 2001 test and **Table A-6** for the 2002 test.

For the 2001 test, the oxygen concentration versus time for all four of the vapor monitoring points (PT-1 to PT-4) is graphed on **Graph A-1**. The oxygen concentration versus time for all four of the monitoring wells (MW-1, MW-18, MW-21, and EX-2) is graphed on **Graph A-2**. The greatest initial decreases in oxygen concentration were measured in vapor monitoring points PT-3 and PT-4. After 28 hours following blower shutdown, oxygen levels had dropped to 17.9%, 2.4%, 5.2%, and 2.0% for PT-1, PT-2, PT-3, and PT-4, respectively. Oxygen levels in wells MW-1, MW-18 and MW-21 remained near pre-test levels with no significant decrease. Oxygen levels in EX-2 decreased 16.3% after 74 hours.

For the 2002 test, the oxygen concentration versus time for PT-1 through PT-4 are plotted on **Graph A-3** and for PT-5 to PT-8 on **Graph A-4**. Carbon dioxide concentrations in PT-1 through PT-4 are plotted on **Graph A-5** and for PT-5 to PT-8 on **Graph A-6**. The greatest initial decreases in oxygen concentration were measured in vapor monitoring points PT-3, PT-4 and PT-8. The concentration in PT-3 dropped from 20.8% to 5.8% over the course of the test. PT-3, PT-4 and PT-8 also experienced the greatest initial increase in carbon dioxide production. Carbon dioxide in PT-3 increased from 0.43% at the beginning of the test to 1.3% towards the end of the test.

A.5.2.3 Biorespiration Rate

Results of the biorespiration test were used to determine oxygen utilization rates from the plot of oxygen concentration versus time (Leeson and Hinchee, 1995b). **Graphs A-1 to A-4** show the oxygen utilization curves observed during the biorespiration tests. Using the slope of the initial linear part of each curve, the oxygen utilization rates for each vapor monitoring point were calculated.

Graphs A-5 and A-6 show the carbon dioxide production rate for PT-1 through PT-8 during the 2002 test. Using the slope of the initial linear part of the curve, the carbon dioxide production rates were calculated. Vapor monitoring points PT-3, PT-4, and PT-8 experienced the greatest oxygen depletion rates and carbon dioxide production rates.

Hydrocarbon biodegradation rates were estimated using the stoichiometric relationship for oxidation of hexane. (The ratio of oxygen required for degradation to the concentration 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 hexane-equivalent per kilogram soil per day (mg/Kg-d) was estimated using biodegradation rate equations developed by Leeson and Hinchee (1995). Oxygen depletion rates and the corresponding biodegradation rates are summarized on **Table A-7.** Biodegradation rates assume a radius of influence of 20 feet across a depth of 10 feet.

The data indicates that the highest rates of TPH biodegradation occurred at PT-3 (-9.8 mg/Kg-d), PT-4 (-11.7 mg/Kg-d) and PT-8 (-6.6 mg/Kg-d). Average calculated mass removal for the 2001 and 2002 tests was 4.6 lbs/day. Assuming 50% efficiency in the radius of influence (due to channeling and heterogeneity), this value corresponds to an overall rate of 11.5 lbs/day. The system operated approximately 880 days, resulting in an estimated removal of over 10,000 lbs of hydrocarbon.

A.5.2.4 Comparison of Biorespiration Test Results

Results of all three biorespiration tests are presented in **Table A-7.** Results of the April 2002 biorespiration compare favorably to the March 2001 and February 2000 results. In general, data from the April 2002 biorespiration test showed lower mass reduction rates than data from the March 2001 and February 2000 test. The lower rates are likely due lower initial hydrocarbon concentrations resulting from biodegradation that occurred during the operation of the IRAM system. Based on the results seen in the tests, the amount of hydrocarbons available for degradation during the April 2002 test is significantly less than the amount available during the March 2001 and February 2000 test, resulting in lower oxygen depletion rates. The March 2001 test also had lower degradation rates than the February 2000 test which supports the hypothesis that operation of the IRAM has reduced the amount of hydrocarbons in the soil, resulting in reduced observed rates of biorespiration.

A.6 BIODEGRADATION RATE CALCULATIONS

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 degrees F
C = mass ratio of hydrocarbon to oxygen required for mineralization = 1/3.5
ρ_k = soil bulk density (g/cm^3)(dry soil)

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 θ = 0.35 and ρ_k = 1.72 were used (Table 1-7 from Leeson and Hinchee, 1995).

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

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

$$\theta_a = 0.21$$

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

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

$$k_B = -0.46k_o$$

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 –12% O_2 in 24 hours, respectively. For Run Two, only MW-8 was monitored, and the initial oxygen depletion rate was -216% O_2. For Run Three, vacuum influence was observed at P-3D and P-4D. The initial oxygen depletion rate was -216% O_2 and –36% O_2 in 24 hours, respectively. Using an average k_o of -160% O_2/day:

k_B = -0.46 (160%O_2/day)
k_B = -74mg/Kg - day

A.7 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.

Figure A-1. Oxygen Concentratoin vs. Time
PT Points - 2001 Biorespiration Test
Former Columbia Marine Lines Facility

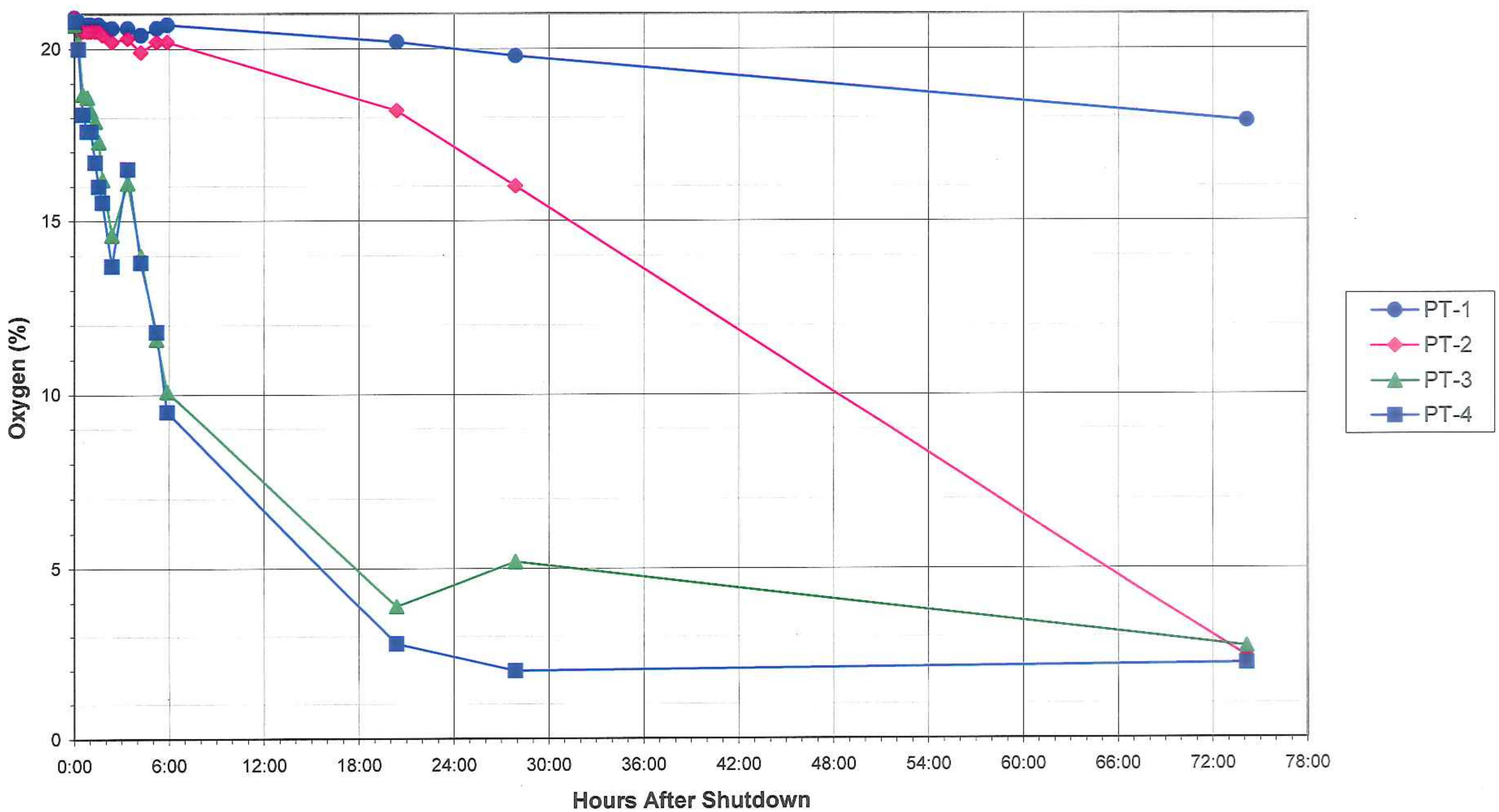


Figure A-2. Oxygen Concentration vs. Time
MW and EX Wells - 2001 Biorespiration Test
Former Columbia Marine Lines Facility

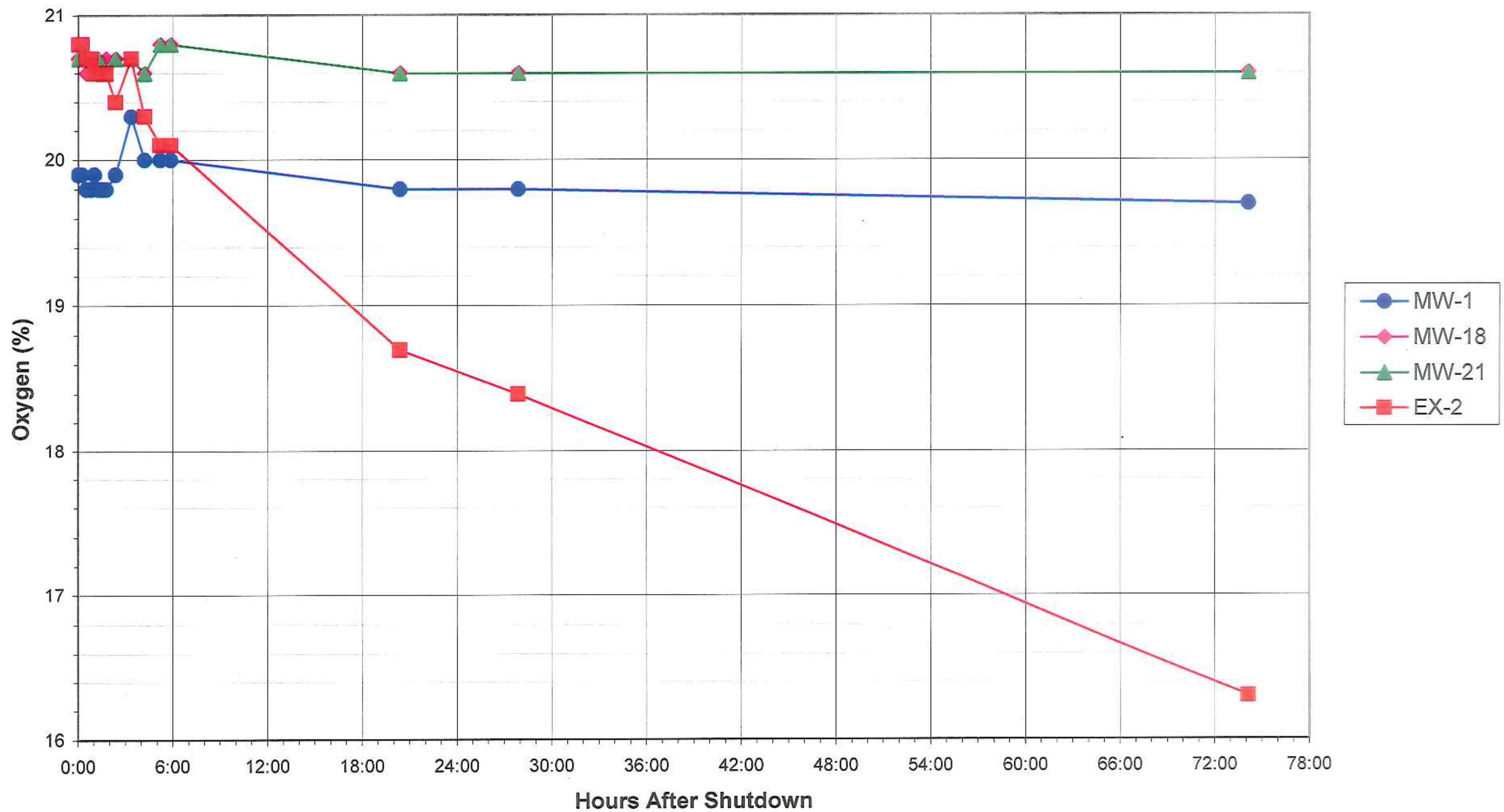


Figure A-3. % Oxygen vs. Time
PT-1 through PT-4 - 2002 Biorespiration Test
Former Columbia Marine Line Facility (Crowley)

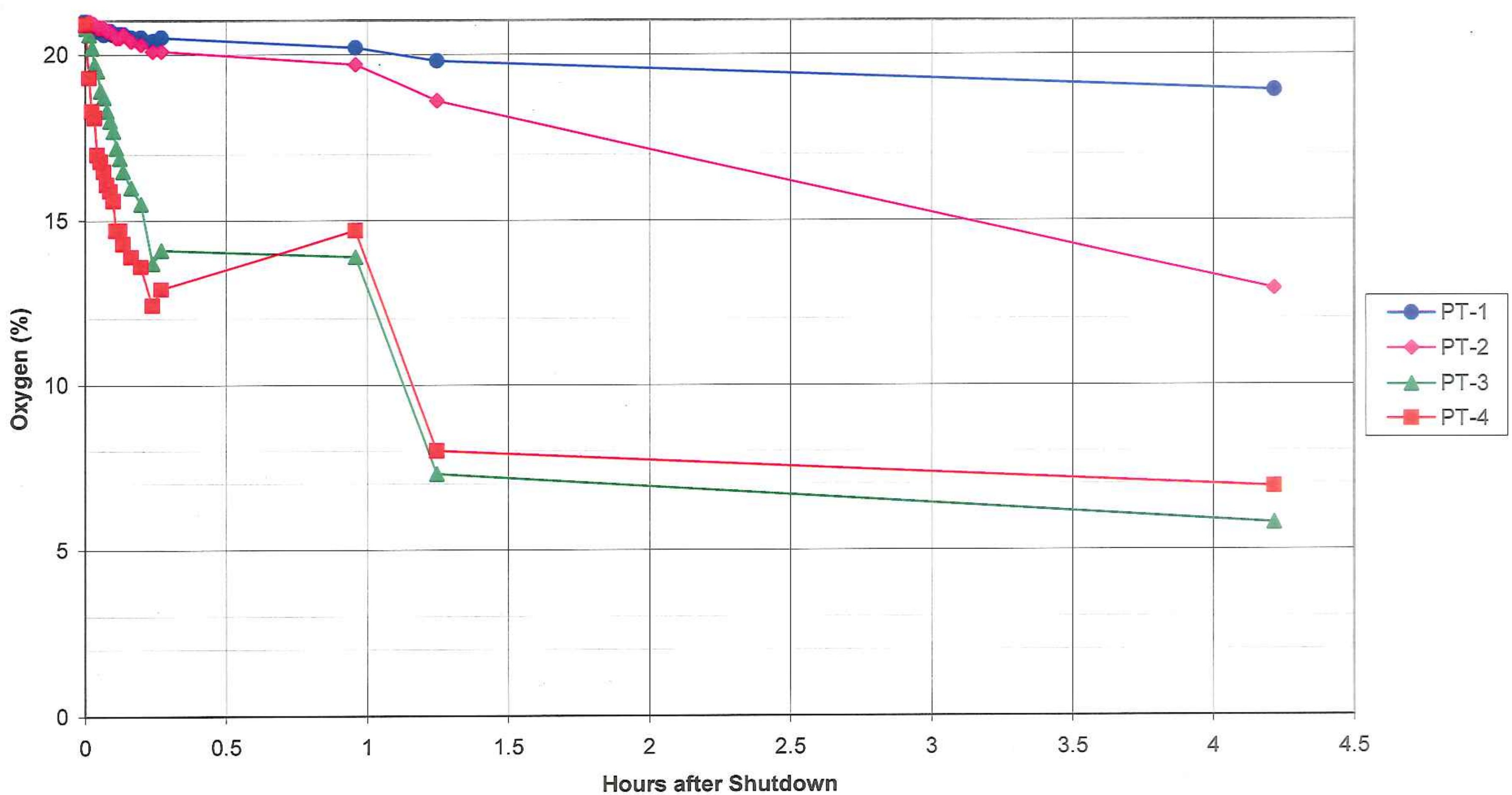


Figure A-4. % Oxygen vs. Time
PT-5 through PT-8 2002 Biorespiration Test
Former Columbia Marine Line Facility (Crowley)

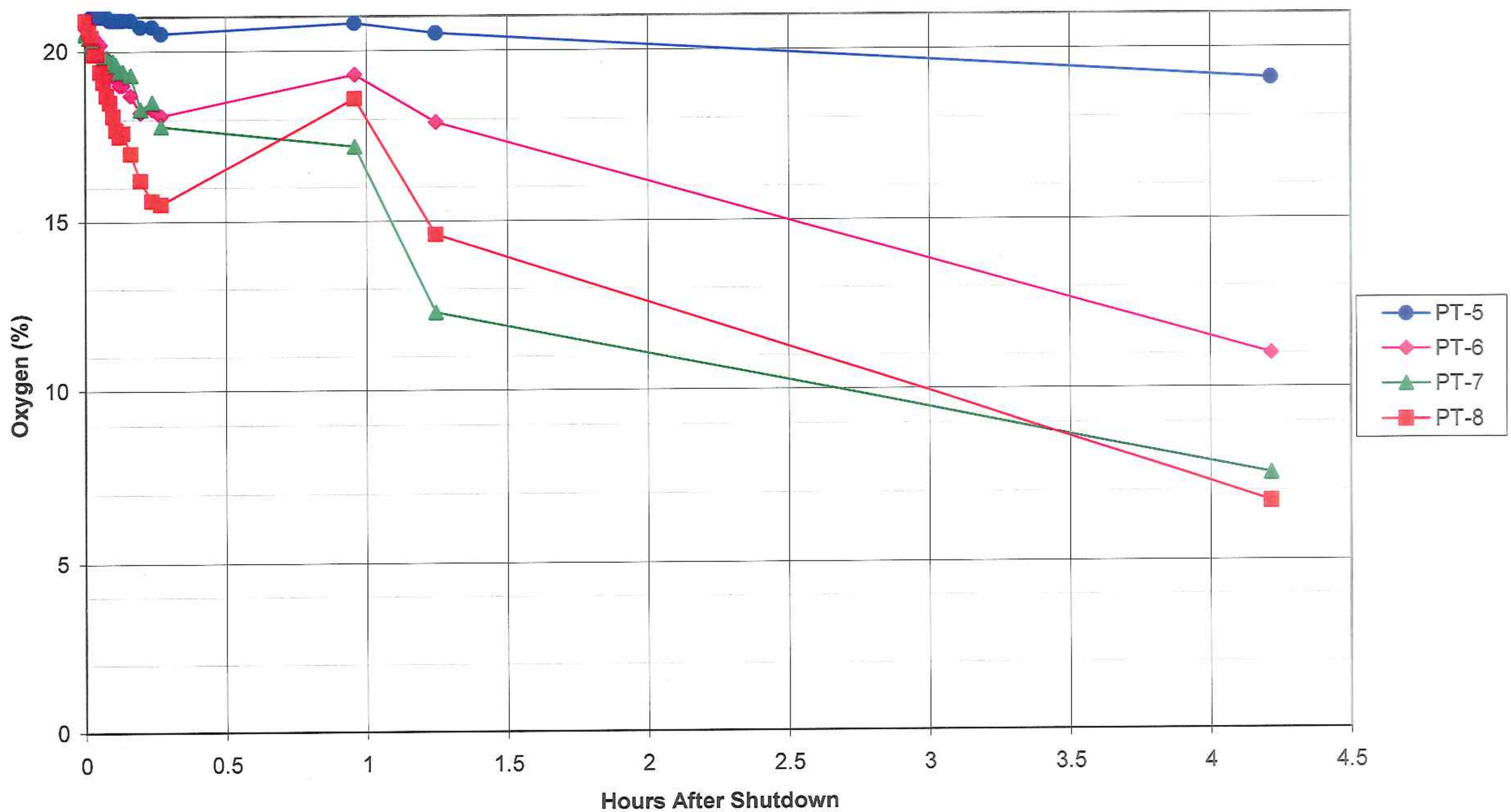


Figure A-5. Carbon Dioxide vs. Time
PT-1 through PT-4 - 2002 Biorespiration Test
Former Columbia Marine Lines Facility (Crowley)

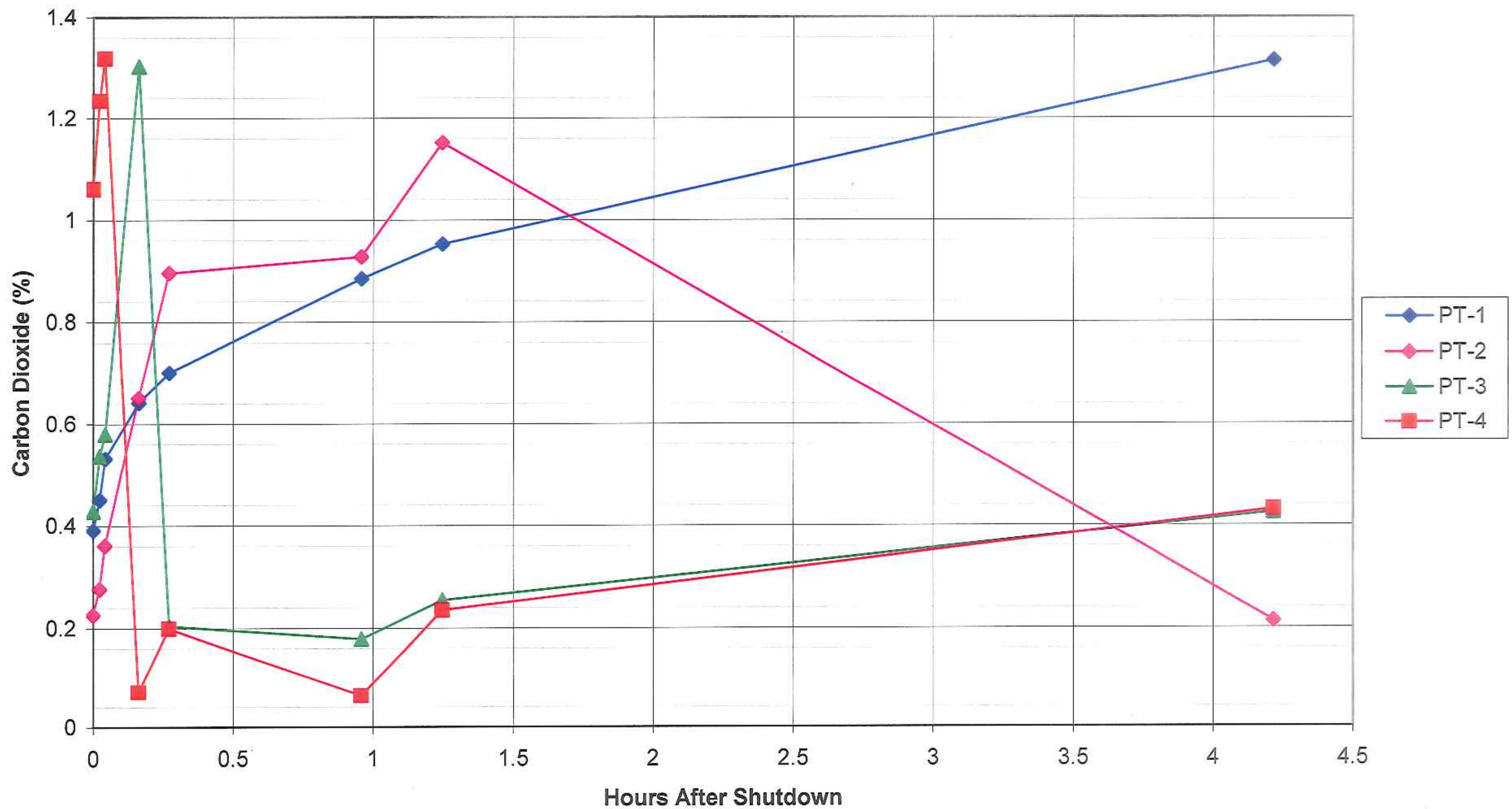
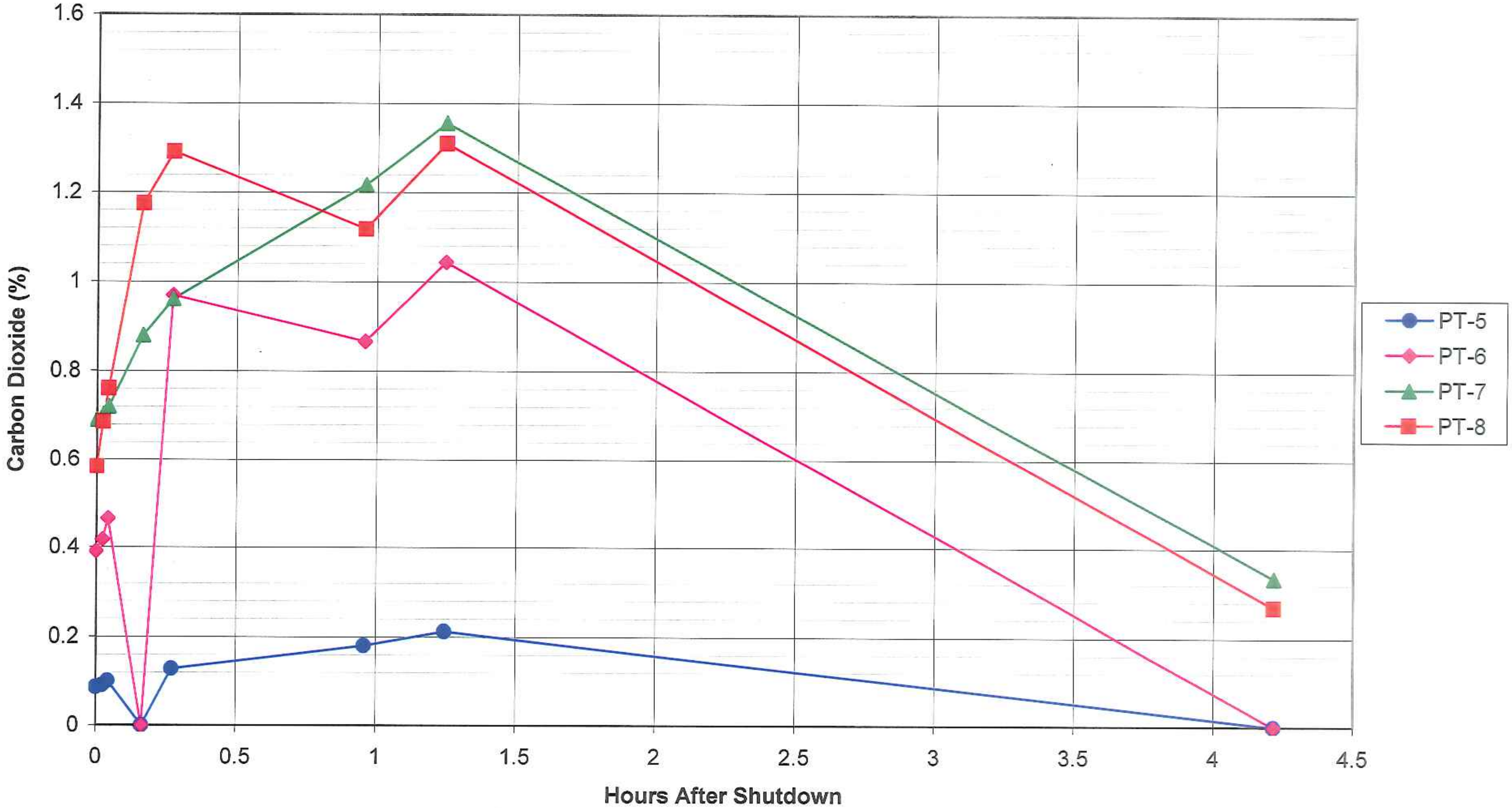
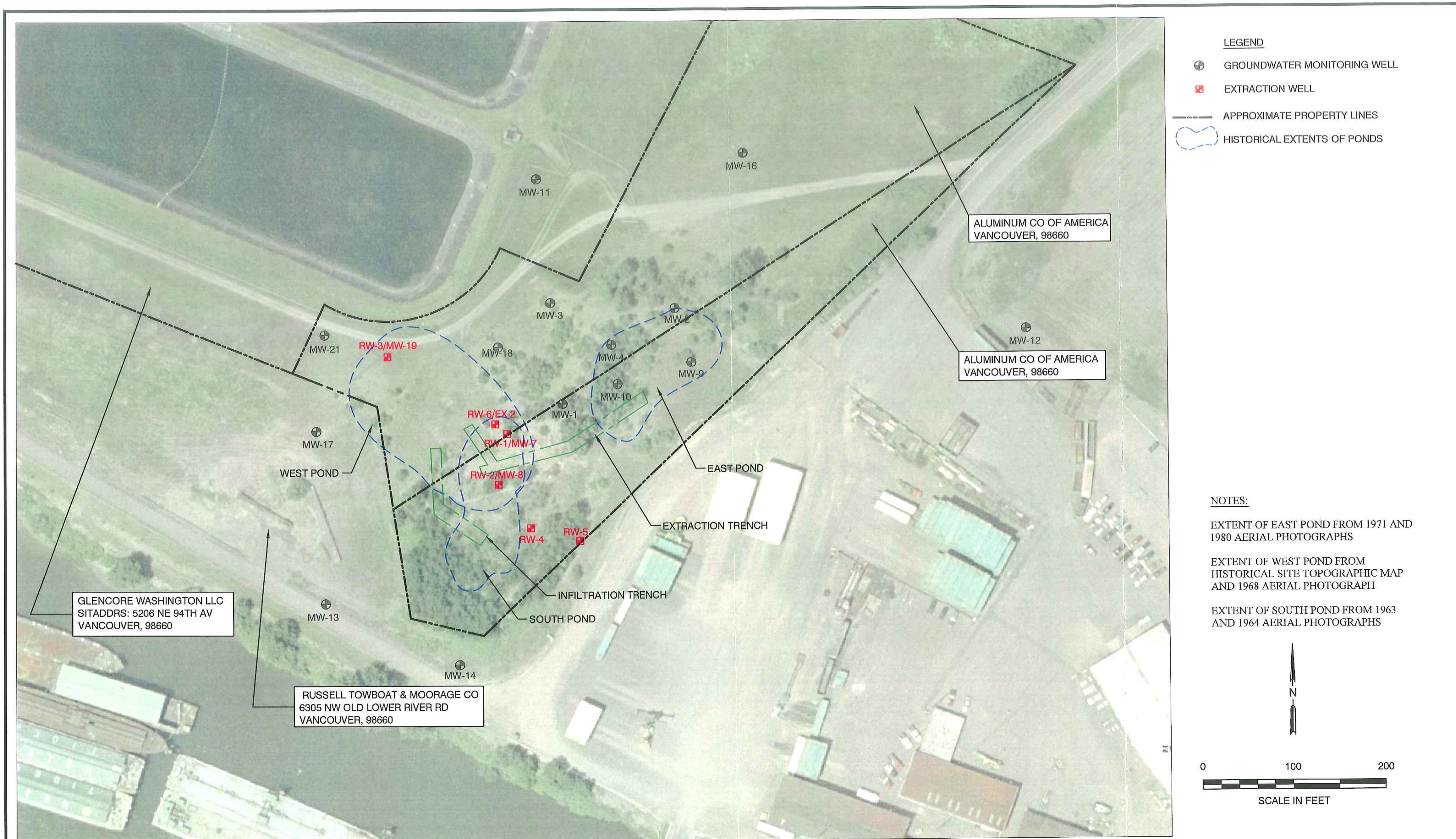


Figure A-6. Carbon Dioxide vs. Time
PT-5 through PT-8 - 2002 Biorespiration Test
Former Columbia Marine Lines (Crowley)





NOTE: PROPERTY LINES ARE APPROXIMATE. PROPERTY LINES AND OWNERSHIP INFORMATION ARE BASED ON INFORMATION AVAILABLE ON THE CLARK COUNTY INTERNET WEB SITE.

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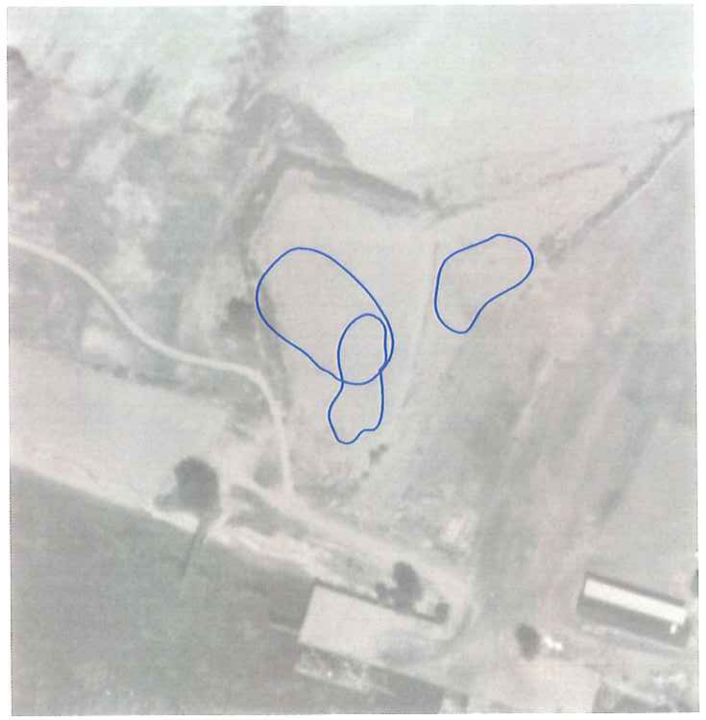
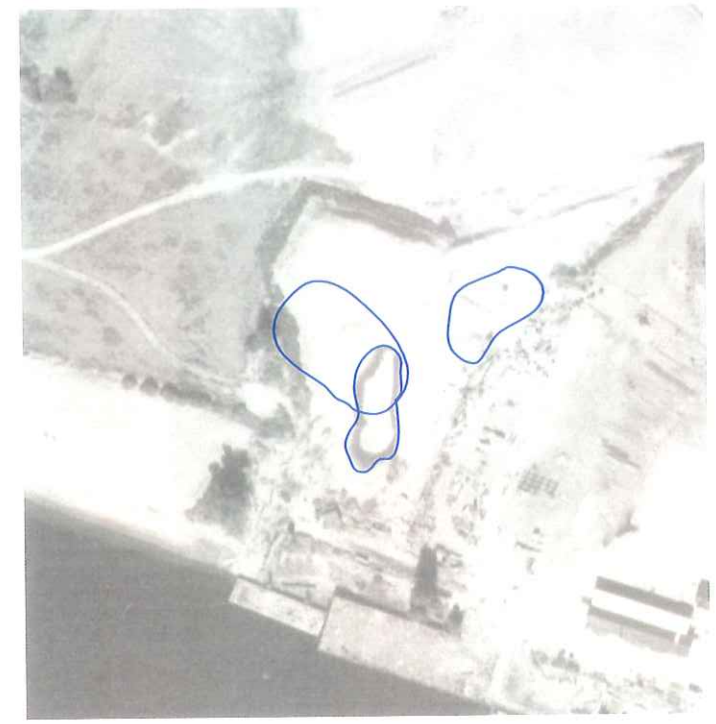
FIGURE 2
FORMER COLUMBIA MARINE LINES FACILITY
6305 LOWER RIVER ROAD
VANCOUVER, WASHINGTON
SITE PLAN

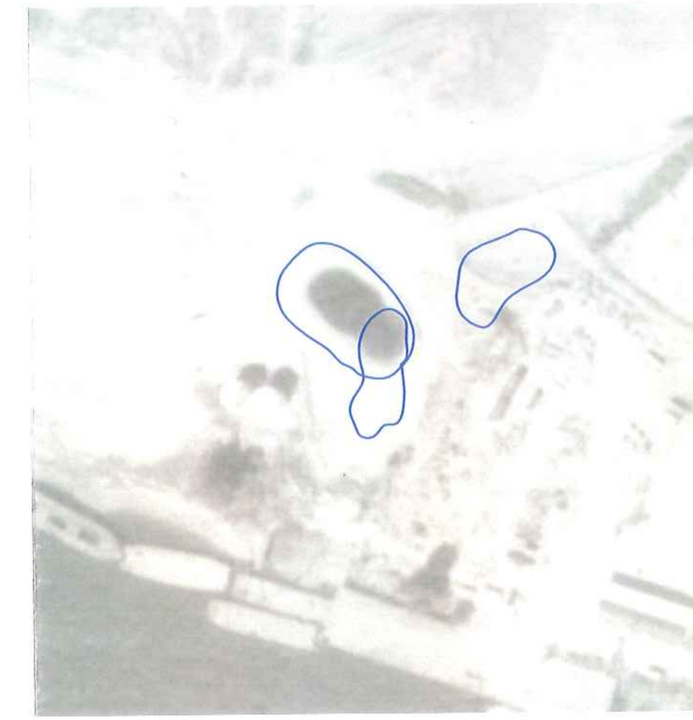


1961

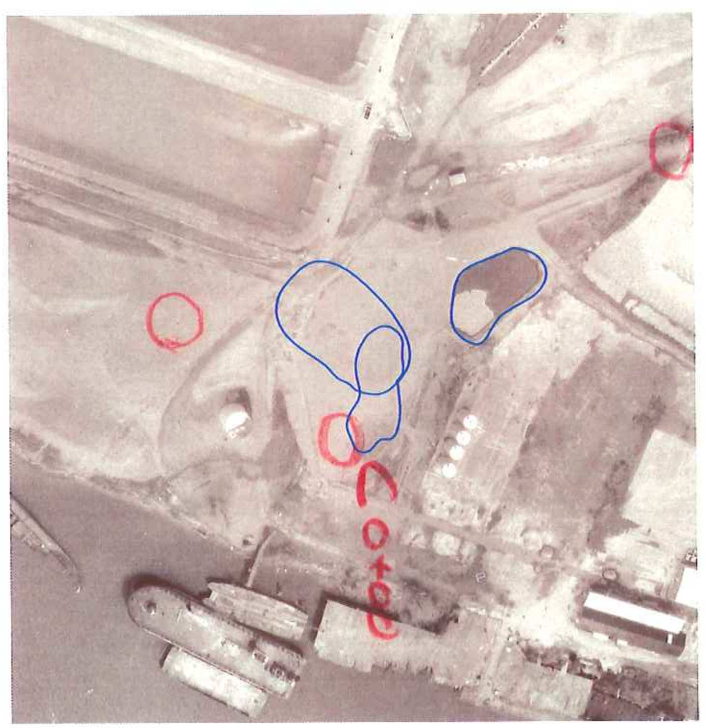
1963



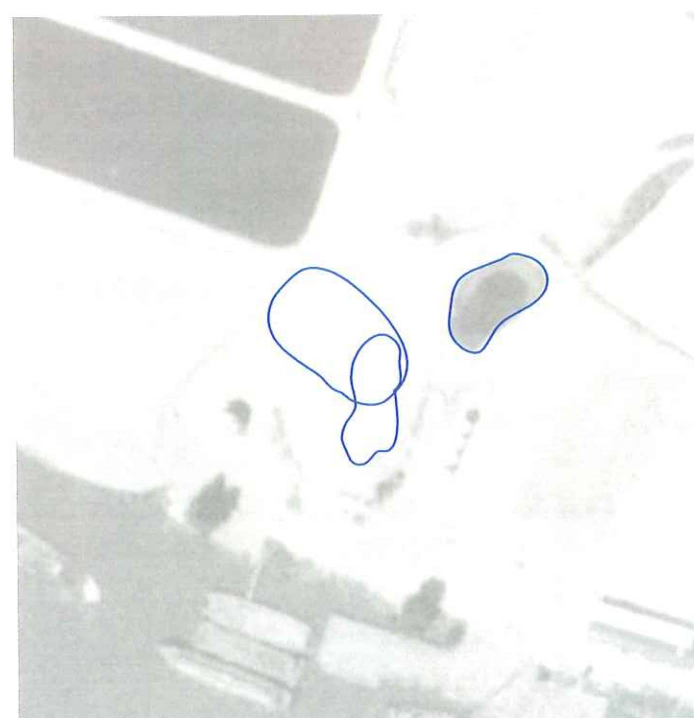
1964



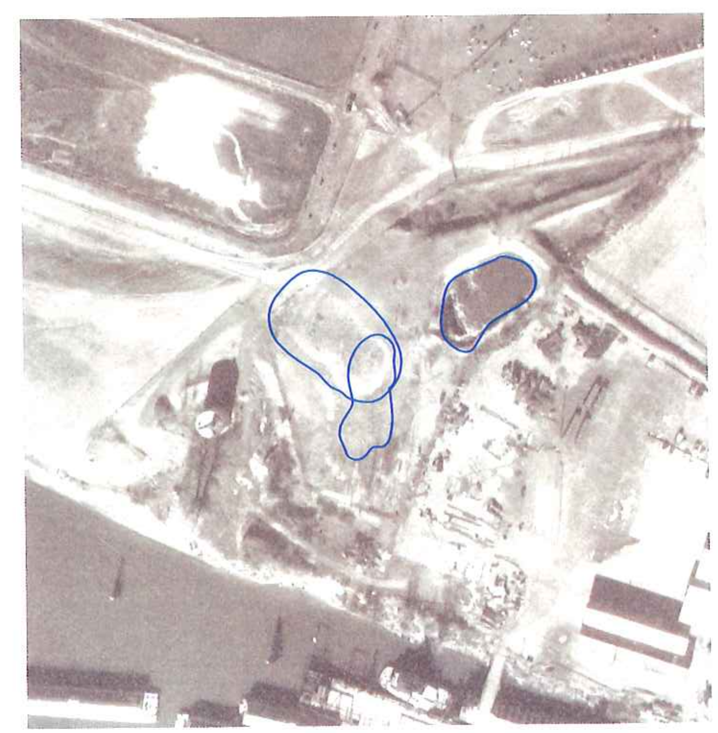
1968



1971



1971



1980

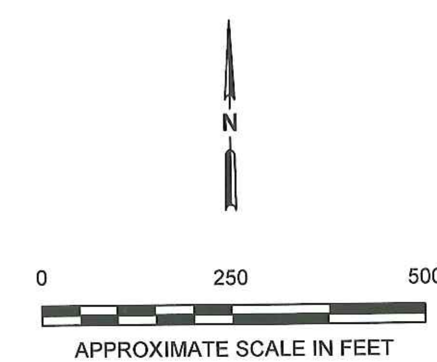


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FIGURE 3
FORMER COLUMBIA MARINE
LINES FACILITY
6305 LOWER RIVER ROAD
VANCOUVER, WASHINGTON
HISTORICAL AERIAL PHOTOGRAPHS

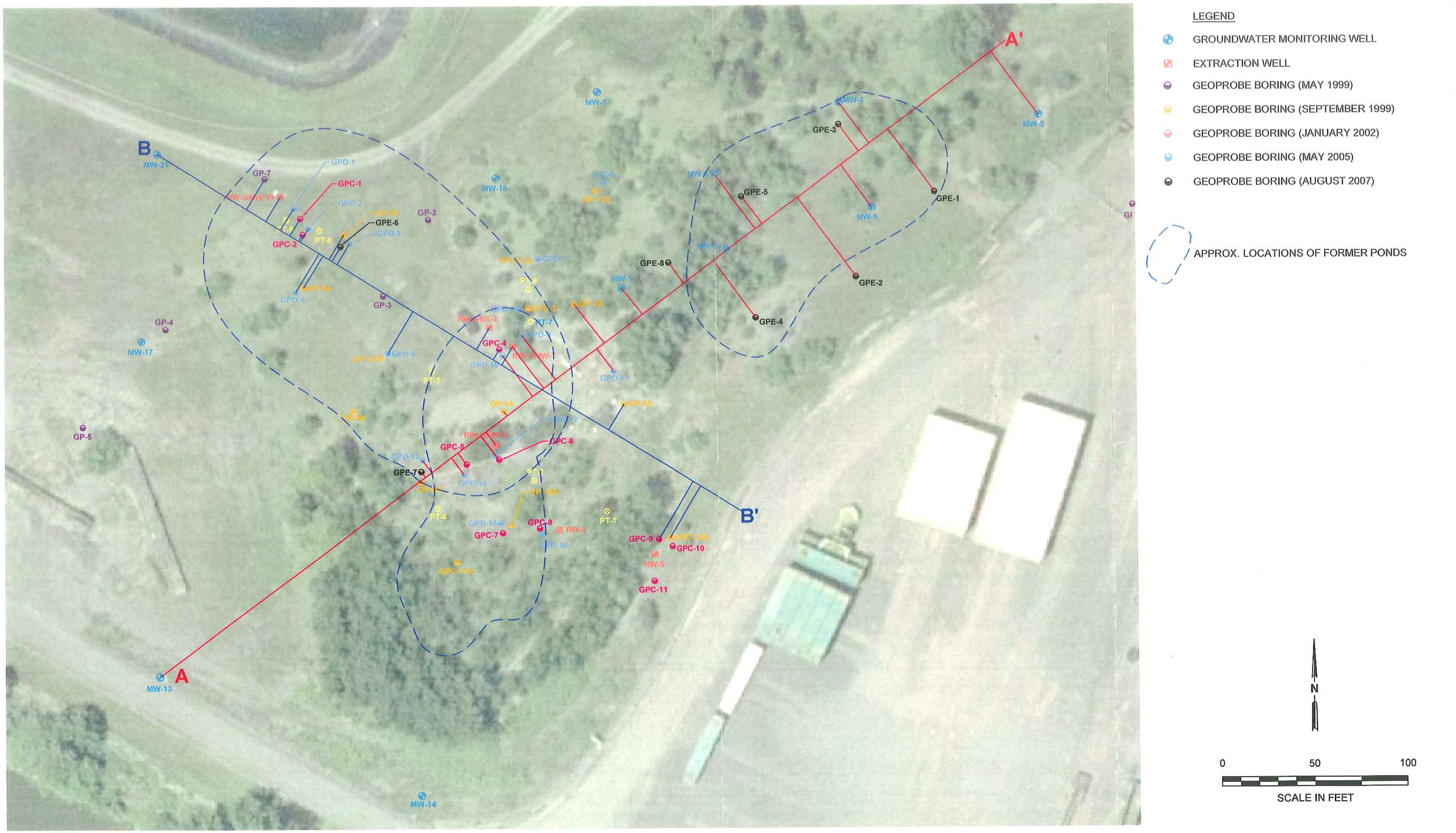

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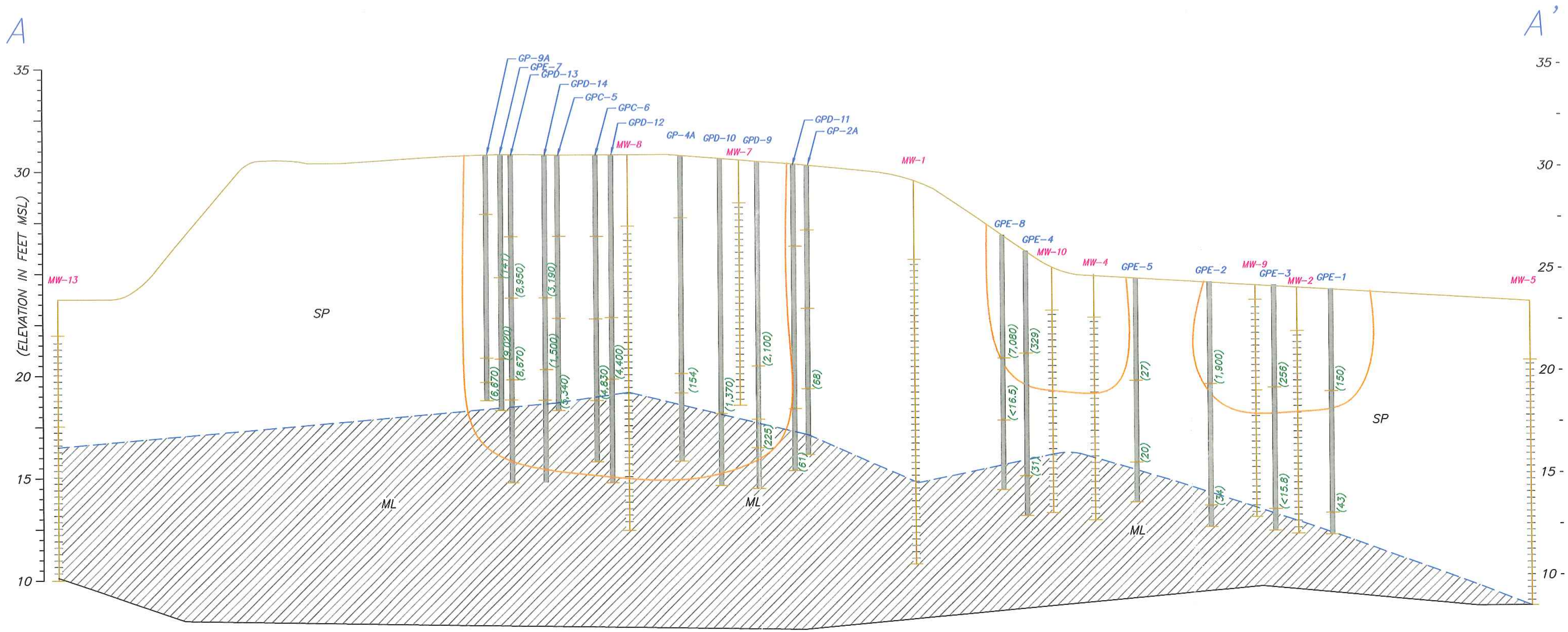
FIGURE 4
FORMER COLUMBIA MARINE LINES FACILITY
6305 LOWER RIVER ROAD
VANCOUVER, WASHINGTON
SITE PLAN WITH GEOPROBE AND CROSS SECTION LOCATIONS



LEGEND

— — APPROXIMATE CONTACT

—— APPROXIMATE EXTENT OF TPH-Dx> 100mg/kg

SP SAND

ML SILT

WELL ID

SCREENED INTERVAL

MONITORING WELL

GEOPROBE BORING ID #

(SOIL TPH-Dx DIESEL RESULTS IN mg/kg)

GEOPROBE BORING

NOTES

VERTICAL SCALE: 1"=5'

HORIZONTAL SCALE: 1"=40'

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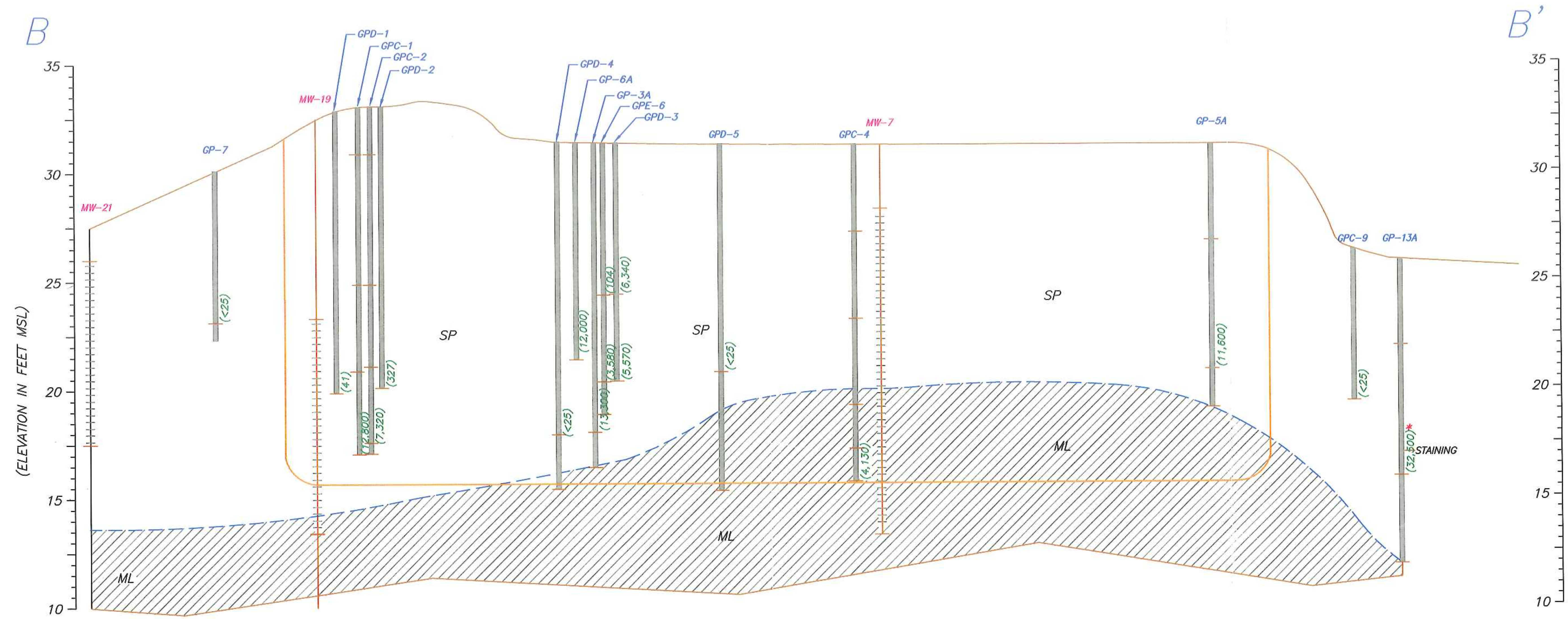
FIGURE 5
FORMER COLUMBIA MARINE LINES FACILITY
6305 LOWER RIVER ROAD
VANCOUVER, WASHINGTON
CROSS-SECTION A-A



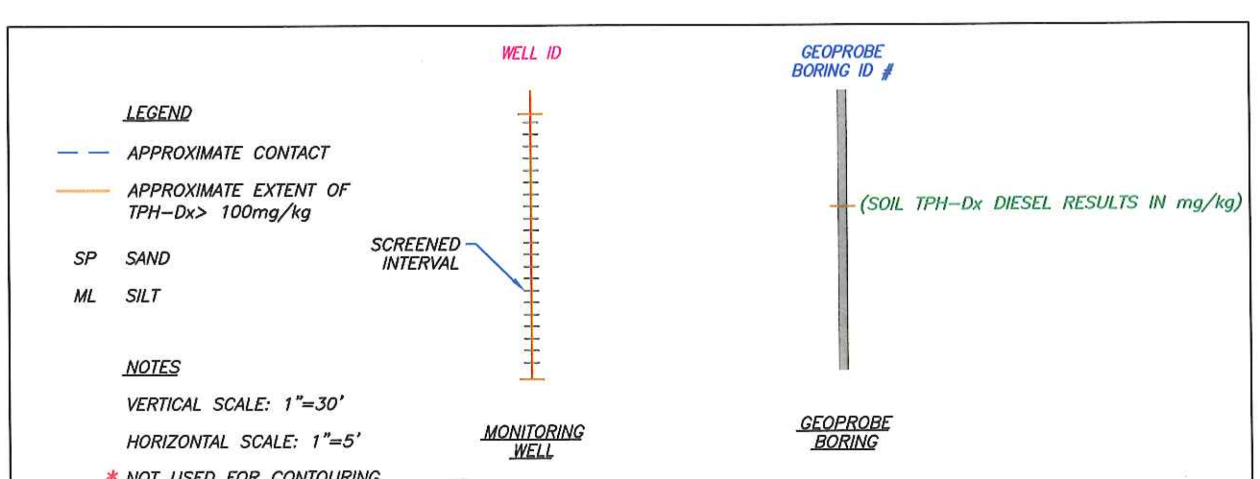


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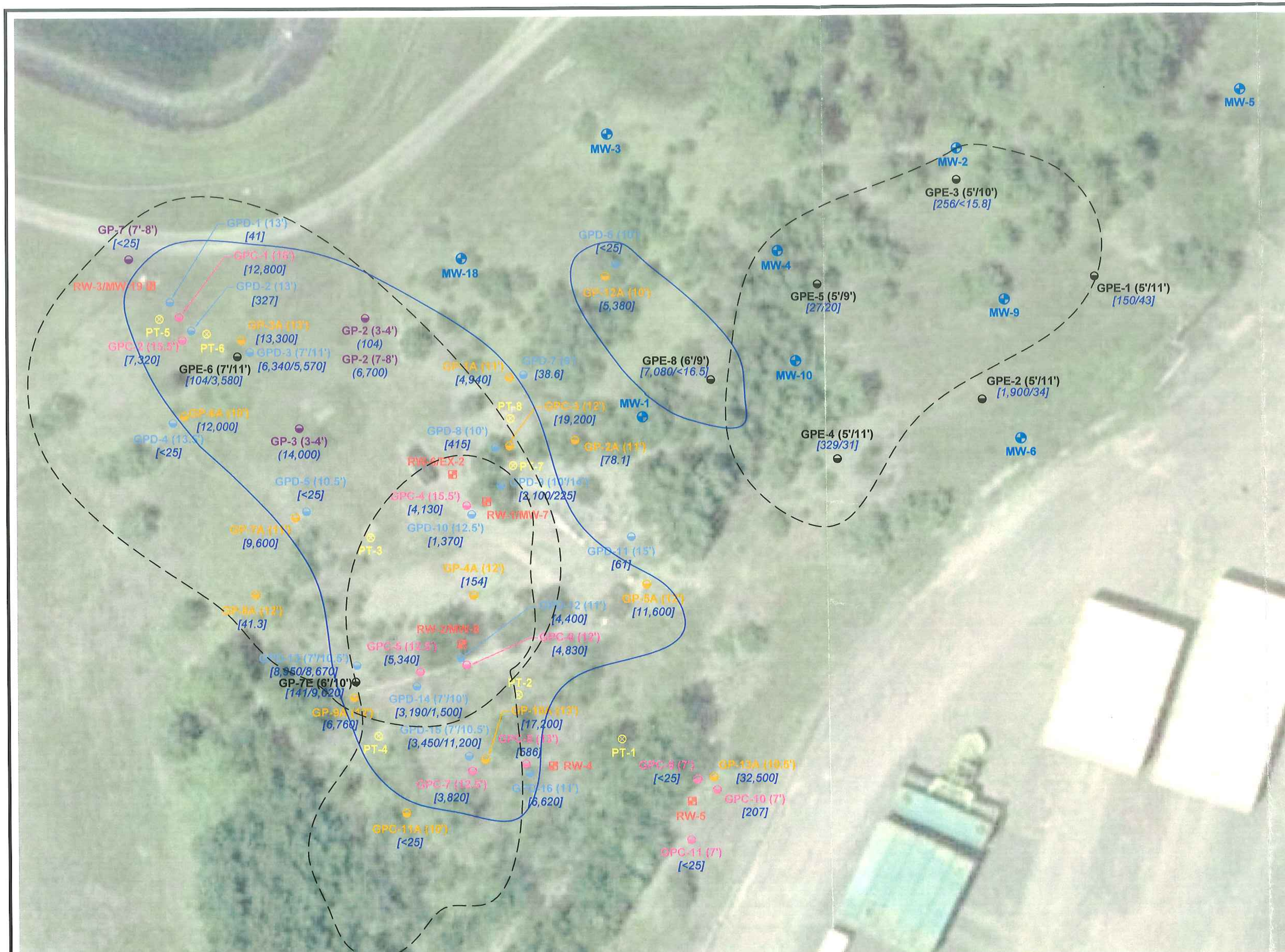
FIGURE 6
FORMER COLUMBIA MARINE
LINES FACILITY
6305 LOWER RIVER ROAD
VANCOUVER, WASHINGTON
CROSS-SECTION B-B



LEGEND

- GROUNDWATER MONITORING WELL
- EXTRACTION WELL
- GEOPROBE BORING (MAY 1999)
- GEOPROBE BORING (SEPTEMBER 1999)
- GEOPROBE BORING (JANUARY 2002)
- GEOPROBE BORING (MAY 2005)
- GEOPROBE BORING (AUGUST 2007)
- [5,380] TPH-D ANALYTICAL RESULTS (mg/Kg)
- APPROX. LOCATIONS OF FORMER PONDS
- APPROX. EXTENT OF SOIL THP-DX EXCEEDING 2,000 MG/KG

SLR International Corp
1800 Blankenship Road
Suite 440
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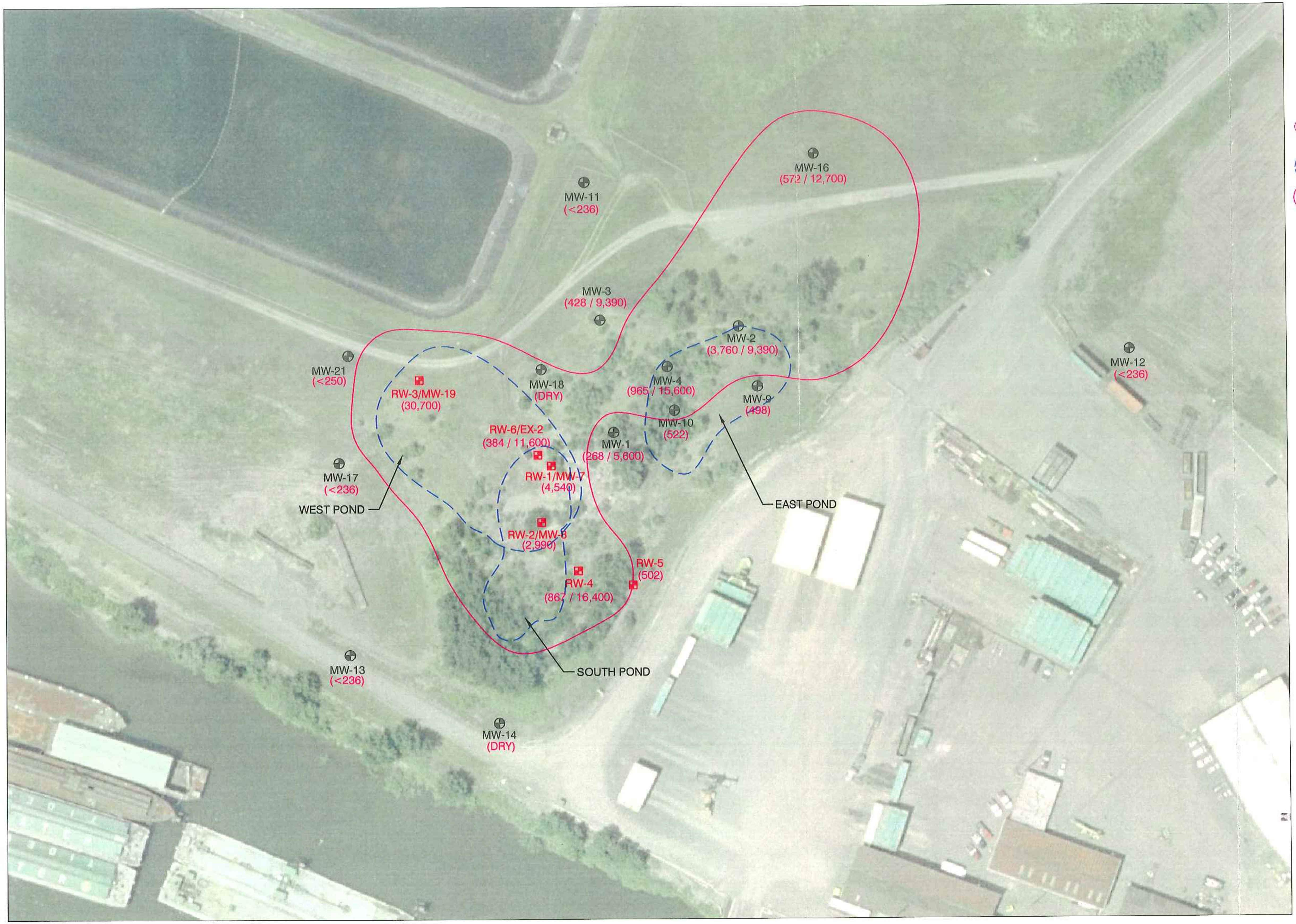
DATE 07/07
DWN. EMG
APPR.
REVIS.
PROJECT NO. 008.0205.00007

FIGURE 7
FORMER COLUMBIA MARINE LINES FACILITY
6305 LOWER RIVER ROAD
VANCOUVER, WASHINGTON
SOIL DATA AND LOCATIONS OF AUGUST 2007 DIRECT PUSH BORINGS



LEGEND

GROUNDWATER MONITORING WELL

EXTRACTION WELL

(428 / 9,390) TPH-DX DIESEL RESULT (WITH SILICA GEL CLEANUP / WITHOUT SILICA GEL CLEANUP)

HISTORICAL EXTENTS OF PONDS

APPROXIMATE EXTENT OF GROUNDWATER WITH > 500 UG/L TPH-DX DIESEL

NOTES:

EXTENT OF EAST POND FROM 1971 AND 1980 AERIAL PHOTOGRAPHS

EXTENT OF WEST POND FROM HISTORICAL SITE TOPOGRAPHIC MAP AND 1968 AERIAL PHOTOGRAPH

EXTENT OF SOUTH POND FROM 1963 AND 1964 AERIAL PHOTOGRAPHS

N

0 100 200

SCALE IN FEET

NOTE: PROPERTY LINES ARE APPROXIMATE. PROPERTY LINES AND OWNERSHIP INFORMATION ARE BASED ON INFORMATION AVAILABLE ON THE CLARK COUNTY INTERNET WEB SITE.

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DATE 07/07
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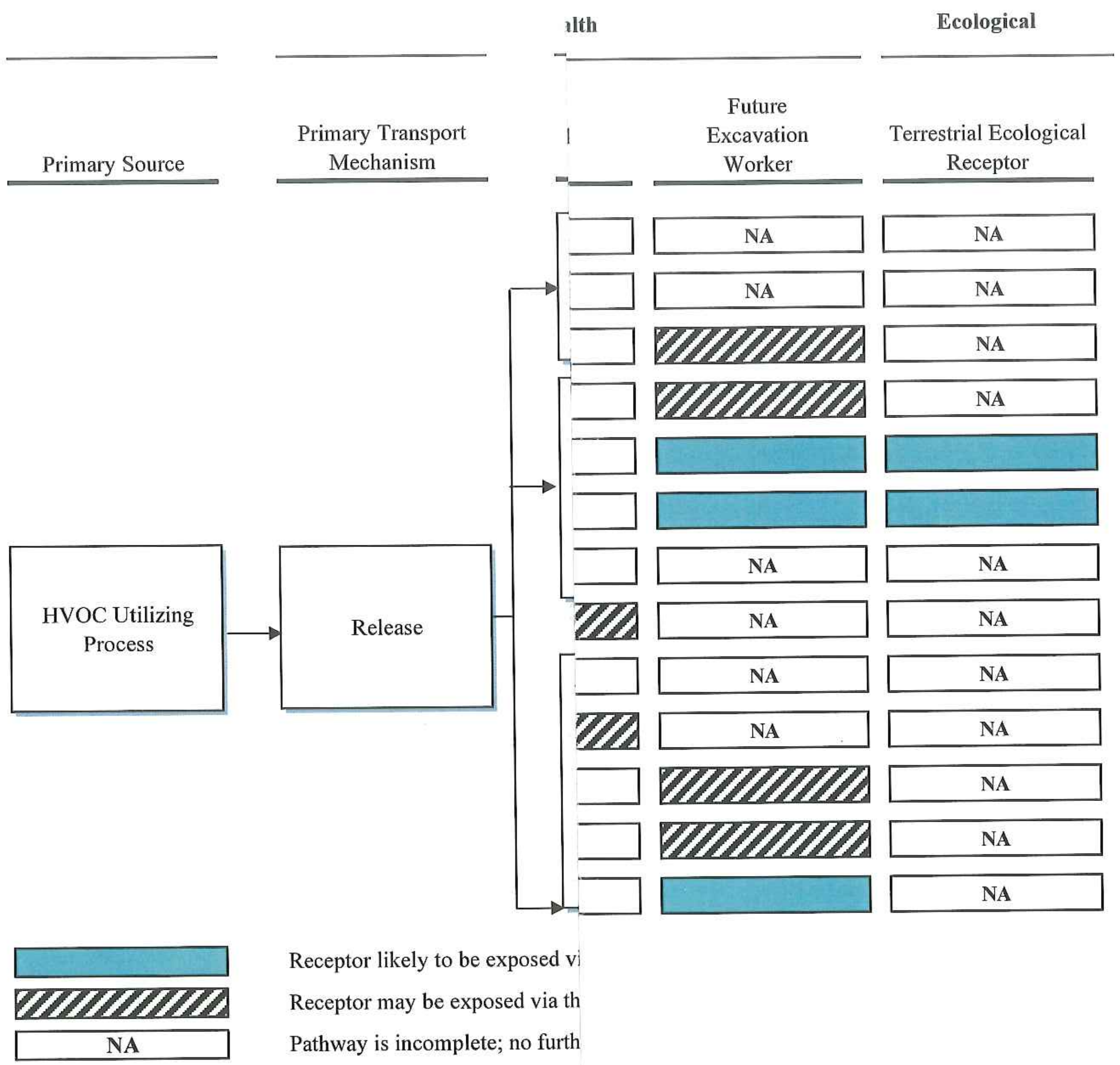
REVIS. ____
PROJECT NO. 008.0205.00007

FIGURE 8
FORMER COLUMBIA MARINE LINES FACILITY
6305 LOWER RIVER ROAD
VANCOUVER, WASHINGTON
GROUNDWATER EXTENT OF TPH-DX


ılth
Ecological
Primary Source
Primary Transport Mechanism
Future Excavation Worker
Terrestrial Ecological Receptor
HVOC Utilizing Process
Release
Receptor likely to be exposed vi
Receptor may be exposed via th
NA
Pathway is incomplete; no furth

TABLES

Table 1. Soil Analytical Data
Former Columbia Marine Lines Facility
6305 Lower River Road, Vancouver, Washington

Sample Location	Depth (feet bgs)	Sample Date	TPH-Gx (mg/Kg)	TPH-Dx		BTEX (mg/Kg)				Naphthalene (mg/Kg)	MTBE (mg/Kg)
				Diesel (mg/Kg)	Heavy Oil (mg/Kg)	Benzene	Toluene	Ethyl-benzene	Total Xylenes		
GP1	2.5 - 3.0	5/6/1999	5.29	<25	<50	<0.05	<0.05	<0.05	<0.05	--	--
GP2	3 - 4	5/6/1999	<2.5	104	<50	<0.05	<0.05	<0.05	<0.05	--	--
	7 - 8	5/6/1999	584	6,700	<500	0.25	0.25	0.25	0.25	--	--
GP3	3 - 4	5/6/1999	13.7	14,000	<2500	<0.05	<0.05	<0.05	<0.05	--	--
	7 - 8	5/6/1999	--	--	--	<1.0	<1.0	<1.0	<1.0	<1.0	<10.0
GP4	3 - 4	5/6/1999	<2.5	<25	<50	<0.05	<0.05	<0.05	<0.05	--	--
GP5	3 - 4	5/6/1999	<2.5	<25	<50	<0.05	<0.05	<0.05	<0.05	--	--
GP6	7 - 8	5/6/1999	<2.5	<25	<50	<0.05	<0.05	<0.05	<0.05	--	--
GP7	7 - 8	5/6/1999	<2.5	<25	<50	<0.05	<0.05	<0.05	<0.05	--	--
GP8	3 - 4	5/6/1999	<2.5	<25	<50	<0.05	<0.05	<0.05	<0.05	--	--
GP9	3 - 4	5/6/1999	<2.5	<25	<50	<0.05	<0.05	<0.05	<0.05	--	--
GP1A	11.0	9/10/1999	--	4,940	370	--	--	--	--	--	--
GP2A	11.0	9/10/1999	--	78	112	--	--	--	--	--	--
GP3A	13.0	9/10/1999	--	13,300	626	--	--	--	--	--	--
GP4A	12.0	9/10/1999	--	154	82	--	--	--	--	--	--
GP5A	12.0	9/10/1999	--	11,600	863	--	--	--	--	--	--
GP6A	10.0	9/14/1999	--	12,000	671	--	--	--	--	--	--
GP7A	11.0	9/14/1999	--	9,600	<1000	--	--	--	--	--	--
GP8A	12.0	9/10/1999	--	41	<50	--	--	--	--	--	--
GP9A	12.0	9/10/1999	--	6,670	<500	--	--	--	--	--	--
GP10A	13.0	9/10/1999	--	17,200	<1000	--	--	--	--	--	--
GP11A	10.0	9/14/1999	--	<25	<50	--	--	--	--	--	--
GP12A	10.0	9/14/1999	--	5,380	<500	--	--	--	--	--	--
GP13A	10.5	9/14/1999	--	32,500	<2500	--	--	--	--	--	--
GPC1	16.0	1/31/2002	--	12,800	602	--	--	--	--	--	--
GPC2	15.5	1/31/2002	--	7,320	275	--	--	--	--	--	--
GPC3	11.5-12.0	1/31/2002	--	19,200	625	--	--	--	--	--	--
GPC4	15-15.5	1/31/2002	--	4,130	<500	--	--	--	--	--	--
GPC5	12.0-12.5	1/31/2002	--	5,340	<500	--	--	--	--	--	--
GPC6	11.5-12.0	1/31/2002	--	4,830	492	--	--	--	--	--	--
GPC7	3.5-4.0	1/31/2002	--	<25	<50	--	--	--	--	--	--
	12-12.5	1/31/2002	--	3,820	<500	--	--	--	--	--	--
GPC8	3.5-4.0	1/31/2002	--	68	<50	--	--	--	--	--	--
	12.5-13.0	1/31/2002	--	586	<50	--	--	--	--	--	--
GPC9	6.5-7.0	1/31/2002	--	<25	<50	--	--	--	--	--	--
GPC10	6.5-7.0	1/31/2002	--	207	71	--	--	--	--	--	--
GPC11	6.5-7.0	1/31/2002	--	<25	<50	--	--	--	--	--	--
GPD1	13.0	5/10/2005	--	41	<0.5	--	--	--	--	--	--
GPD2	13.0	5/10/2005	--	327	61	--	--	--	--	--	--
GPD3	7.0	5/10/2005	--	6,340	277	--	--	--	--	--	--
	11.0	5/10/2005	--	5,570	277	--	--	--	--	--	--
GPD4	13.5	5/10/2005	--	<25	<50	--	--	--	--	--	--
GPD5	10.5	5/10/2005	--	<25	<50	--	--	--	--	--	--
GPD6	7.0	5/10/2005	--	<25	<50	--	--	--	--	--	--
	10.0	5/10/2005	--	<25	<50	--	--	--	--	--	--
GPD7	9.0	5/10/2005	--	39	<50	--	--	--	--	--	--
GPD8	10.0	5/10/2005	--	415	<50	--	--	--	--	--	--
GPD9	10.0	5/10/2005	--	12,100	536	--	--	--	--	--	--
	14.0	5/10/2005	--	225	207	--	--	--	--	--	--
GPD10	12.5	5/10/2005	--	1,370	158	--	--	--	--	--	--
GPD11	15.0	5/10/2005	--	61	<50	--	--	--	--	--	--
GPD12	11.0	5/10/2005	--	4,400	609	--	--	--	--	--	--
GPD13 [1]	7.0	5/10/2005	241	8,950	320	<0.093	<0.093	0.15	0.821	<0.268	--
	10.5	5/10/2005	--	8,670	<50	--	--	--	--	--	--
GPD14	7.0	5/10/2005	--	3,190	199	--	--	--	--	--	--
	10.0	5/10/2005	--	1,500	289	--	--	--	--	--	--
GPD15 [2]	7.0	5/10/2005	60.1	3,450	<50	<0.0861	<0.0861	<0.0861	<0.0861	<0.107	--
	10.5	5/10/2005	--	11,200	<250	--	--	--	--	--	--
GPD16	11.0	5/10/2005	--	6,620	238	--	--	--	--	--	--

Table 1. Soil Analytical Data
Former Columbia Marine Lines Facility
6305 Lower River Road, Vancouver, Washington

Sample Location	Depth (feet bgs)	Sample Date	TPH-Gx (mg/Kg)	TPH-Dx		BTEX (mg/Kg)				Naphthalene (mg/Kg)	MTBE (mg/Kg)
				Diesel (mg/Kg)	Heavy Oil (mg/Kg)	Benzene	Toluene	Ethylbenzene	Total Xylenes		
GPE-1	5.0	8/24/2007	<5.73	150	234	--	--	--	--	--	--
	11.0	8/24/2007	10.2	43	<32.8	<0.00201	<0.00201	<0.00535	<0.0134	0.0272	<0.00134
GPE-2	5.0	8/24/2007	45.7	1,900	520	--	--	--	--	--	--
	11.0	8/24/2007	6.18	34	<31.0	<0.00172	<0.00172	<0.00458	<0.0114	<0.0161	<0.00114
GPE-3	5.0	8/24/2007	<3.94	256	416	--	--	--	--	--	--
	10.0	8/24/2007	<4.17	<15.8	<31.7	--	--	--	--	--	--
GPE-4	5.0	8/24/2007	<4.26	329	462	--	--	--	--	--	--
	11.0	8/24/2007	<4.21	31	<33.2	<0.00148	<0.00148	<0.00395	<0.00987	<0.0174	<0.000987
GPE-5	5.0	8/24/2007	<4.09	27	58	--	--	--	--	--	--
	9.0	8/24/2007	<4.14	20	<32.1	--	--	--	--	--	--
GPE-6	7.0	8/24/2007	<4.19	104	66	--	--	--	--	--	--
	11.0	8/24/2007	753	3,580	192	<0.00202	<0.00202	<0.0054	<0.0135	<0.719	<0.00135
GPE-7	6.0	8/24/2007	<3.93	141	81.4	--	--	--	--	--	--
	10.0	8/24/2007	173	9,020	<668	<0.00249	<0.00249	<0.00663	<0.0166	<2.48	<0.00166
GPE-8	6.0	8/24/2007	18.1	7,080	<637	--	--	--	--	--	--
	9.0	8/24/2007	<5.15	<16.5	<33.1	--	--	--	--	--	--
Method A Cleanup Levels - Unrestricted Land Us			**100**	**2,000**	**2,000**	**0.03**	**7**	**6**	**9**	**5**	**0.1**
Method A Cleanup Levels - Industrial Properties			**100**	**2,000**	**2,000**	**0.03**	**7**	**6**	**9**	**5**	**0.1**
Terrestrial Ecological Cleanup Level			**12,000**	**15,000**	**15,000**	**NE**	**NE**	**NE**	**NE**	**NE**	**NE**
ODEQ Excavation Worker RBC			**NE**	**NE**	**NE**	**9,400**	**NE**	**NE**	**NE**	**20,000**	**NE**
ODEQ Vapor Intrusion RBC			**NE**	**NE**	**NE**	**1.2**	**2,200**	**11,000**	**1,300**	**3,400**	**36**

NOTES

NE = Not established
TPH-G = Total petroleum hydrocarbons as gasoline analysis by Washington DOE Method WTPH-G or by Northwest Method NWTPH-G; results in milligrams per kilogram (mg/Kg).
TPH-D = TPH as diesel analysis by Washington DOE Method WTPH-D or by Northwest Method NWTPH-D with silica gel cleanup analysis based on possible biogenic intererence; results in mg/Kg.
TPH-O = TPH as heavy oil analysis by Washington DOE Method WTPH-D or by Northwest Method NWTPH-D with silica gel cleanup analysis based on possible biogenic intererence; results in mg/Kg.
BTEX = Benzene, toluene, ethylbenzene, and total xylene analysis by EPA Method 8021B; results in mg/Kg.
MTBE = Methyl tert-butyl ether
-- = Not measured, not analyzed, or not sampled.
< Not detected above the indicated detection limit.

Table 2. MTCA Soil and Groundwater Compounds
Former Columbia Marine Lines Facility
6305 Lower River Road, Vancouver, Washington

Test	Chemical	GP3-7-8 (mg/kg)'	GPE-1-11 (mg/kg)	GPE-2-11 (mg/kg)	GPE-4-11 (mg/kg)	GPE-6-11 (mg/kg)	GPE-7-10 (mg/kg)	MTCA Method A / Method B Cleanup Level (mg/kg)	Exceeds MTCA Method A / Method B Cleanup Level?	MTCA Terrestrial Ecological Cleanup Level (mg/kg)	ODEQ Excavation Worker RBC (mg/kg)	ODEQ Vapor Intrusion RBC (mg/kg)
EPH	AL_EC>5-6	--	--	--	--	--	--	NA	NA	NA	NA	NA
EPH	AL_EC>6-8	--	--	--	--	--	--	NA	NA	NA	NA	NA
EPH	AL_EC>8-10	**94.3**	<6.34	<6.15	<6.44	**38.4**	**121**	NA	NA	NA	NA	NA
EPH	AL_EC>10-12	**961**	<6.34	<6.15	<6.44	**347**	**753**	NA	NA	NA	NA	NA
EPH	AL_EC>12-16	**3130**	**16.1**	<6.15	**9.64**	**1350**	**2560**	NA	NA	NA	NA	NA
EPH	AL_EC>16-21	**1730**	**17.2**	**8.57**	**9.35**	**971**	**1610**	NA	NA	NA	NA	NA
EPH	AL_EC>21-34	**339**	**9.52**	<6.15	**7.98**	**165**	**224**	NA	NA	NA	NA	NA
EPH	AR_EC>8-10	--	<6.34	<6.15	<6.44	<6.80	<13.3	NA	NA	NA	NA	NA
EPH	AR_EC>10-12	**46.6**	<6.34	<6.15	<6.44	**19**	**42.8**	NA	NA	NA	NA	NA
EPH	AR_EC>12-16	**412**	<6.34	<6.15	<6.44	**151**	**301**	NA	NA	NA	NA	NA
EPH	AR_EC>16-21	**409**	**10.2**	<6.15	**6.46**	**331**	**561**	NA	NA	NA	NA	NA
EPH	AR_EC>21-34	**237**	<6.34	<6.15	<6.44	**70.2**	**112**	NA	NA	NA	NA	NA
VPH	AL_EC>5-6	<250	<6.69	<6.39	<6.60	<13.2	<82.7	NA	NA	NA	NA	NA
VPH	AL_EC>6-8	<250	<6.69	<6.39	<6.60	<13.2	<82.7	NA	NA	NA	NA	NA
VPH	AL_EC>8-10	<250	<6.69	<6.39	<6.60	**19**	<82.7	NA	NA	NA	NA	NA
VPH	AL_EC>10-12	**856**	<6.69	**7.16**	<6.60	**47.8**	**62.3**	NA	NA	NA	NA	NA
VPH	AL_EC>12-16	--	--	--	--	--	--	NA	NA	NA	NA	NA
VPH	AL_EC>16-21	--	--	--	--	--	--	NA	NA	NA	NA	NA
VPH	AL_EC>21-34	--	--	--	--	--	--	NA	NA	NA	NA	NA
VPH	AR_EC>8-10	<250	<6.69	<6.39	<6.60	<13.2	<82.7	NA	NA	NA	NA	NA
VPH	AR_EC>10-12	**649**	<6.69	<6.39	<6.60	**93.2**	**108**	NA	NA	NA	NA	NA
VPH	AR_EC>12-13	**1500**	<6.69	**23.5**	<6.60	**186**	**244**	NA	NA	NA	NA	NA
VPH	AR_EC>16-21	--	--	--	--	--	--	NA	NA	NA	NA	NA
VPH	AR_EC>21-34	--	--	--	--	--	--	NA	NA	NA	NA	NA
VOC 8260B	Benzene	<1	<0.00201	<0.00172	<0.00148	<0.00202	<0.00249	NA	NA	NA	NA	NA
VOC 8260B	Toluene	<1	<0.00201	<0.00172	<0.00148	<0.00202	<0.00249	NA	NA	NA	NA	NA
VOC 8260B	Ethylbenzene	<1	<0.00535	<0.00458	<0.00395	<0.00540	<0.0063	NA	NA	NA	NA	NA
VOC 8260B	Xylenes	<2	<0.0134	<0.0114	<0.00987	<0.0135	<0.0166	NA	NA	NA	NA	NA
PAH 8270M-SIM	Naphthalene	<1	**0.0272**	<0.0161	<0.0174	<0.719	<2.48	5	No	NE	20,000	
PAH 8270M-SIM	1-Methyl Naphthalene	--	**0.067**	<0.0161	**0.0438**	**10.6**	**36.1**	24	Yes	NE	NE	NE
PAH 8270M-SIM	2-Methyl Naphthalene	**0.4**	**0.0263**	<0.0161	<0.0174	**6.43**	<0.354	32	No	NE	NE	NE
VOC 8260B	n-Hexane	--	<0.00669	<0.00572	<0.00493	0.0159	<0.00829	NA	NA	NA	NA	NA
VOC 8260B	MTBE	<10	<0.00134	<0.00114	<0.000987	<0.00135	<0.00166	NA	NA	NA	NA	NA
VOC 8260B	Ethylene Dibromide (EDB)	--	<0.00669	<0.00572	<0.00493	<0.00675	<0.00829	NA	NA	NA	NA	NA
VOC 8260B	1,2 Dichloroethane	--	<0.00167	<0.00143	<0.00123	<0.00169	<0.00207	NA	NA	NA	NA	NA
PAH 8270M-SIM	Benzo(a)anthracene	<.4	**0.219**	<0.0161	<0.0174	**0.449**	**0.529**	0.14	Yes	NE	590	NE
PAH 8270M-SIM	Benzo(b)fluoranthene	<.4	**0.167**	<0.0161	<0.0174	**0.292**	<0.354	0.14	Yes	NE	590	NE
PAH 8270M-SIM	Benzo(k)fluoranthene	<.4	**0.107**	<0.0161	<0.0174	**0.183**	<0.354	0.14	Yes	NE	5,900	NE
PAH 8270M-SIM	Benzo(a)pyrene	<.4	**0.138**	<0.0161	<0.0174	**0.272**	<0.354	0.14	Yes	300	59	NE
PAH 8270M-SIM	Chrysene	**0.485**	**0.43**	<0.0161	<0.0174	**0.727**	**0.803**	0.14	Yes	NE	59,000	NE

Table 2. MTCA Soil and Groundwater Compounds
Former Columbia Marine Lines Facility
6305 Lower River Road, Vancouver, Washington

Test	Chemical	GP3-7-8 (mg/kg)'	GPE-1-11 (mg/kg)	GPE-2-11 (mg/kg)	GPE-4-11 (mg/kg)	GPE-6-11 (mg/kg)	GPE-7-10 (mg/kg)	MTCA Method A / Method B Cleanup Level (mg/kg)	Exceeds MTCA Method A / Method B Cleanup Level?	MTCA Terrestrial Ecological Cleanup Level (mg/kg)	ODEQ Excavation Worker RBC (mg/kg)	ODEQ Vapor Intrusion RBC (mg/kg)
PAH 8270M-SIM	Dibenzo(a,h)anthracene	<.4	**0.0226**	<0.0161	<0.0174	<0.180	<0.354	0.23	No	NE	59	NE
PAH 8270M-SIM	Indeno(1,2,3-cd)pyrene	<.4	**0.0603**	<0.0161	<0.0174	<0.180	<0.354	0.14	No	NE	590	NE
PAH 8270M-SIM	Acenaphthene	**0.685**	**0.02**	<0.0161	<0.0174	**0.526**	**1.39**	4800	No	NE	NE	NE
PAH 8270M-SIM	Acenaphthylene	**0.4**	<0.0343	<0.0161	<0.0174	<0.360	<1.06	4800	No	NE	NE	NE
PAH 8270M-SIM	Anthracene	**3.48**	**0.0827**	<0.0161	<0.0174	**0.858**	**0.984**	100000	No	NE	NE	NE
PAH 8270M-SIM	Benzo(ghi)perylene	<.4	**0.076**	<0.0161	<0.0174	<0.180	<0.354	0.23	No	NE	59	NE
PAH 8270M-SIM	Fluoranthene	**0.428**	**0.535**	<0.0161	<0.0174	**0.599**	1.14	3200	No	NE	NE	NE
PAH 8270M-SIM	Fluorene	**2.45**	**0.0975**	<0.0161	**0.0265**	**1.48**	4.43	3200	No	NE	NE	NE
PAH 8270M-SIM	Phenanthrene	**8.9**	**0.205**	<0.0161	**0.0817**	**4.54**	**10.7**	100000	No	NE	NE	NE
PAH 8270M-SIM	Pyrene	**0.999**	**0.474**	<0.0161	**0.0217**	**0.883**	**1.38**	2400	No	NE	NE	NE
VOC 8260B	Acetone		--	**0.0534**	--	**0.102**	--	8000	No	NE	NE	NE
VOC 8260B	Carbon Disulfide		--	**0.00347**	--	**0.00517**	--	720	No	NE	NE	NE
VOC 8260B	2-Butanone		--	<0.0172	--	**0.0216**	--	34000	No	NE	NE	NE
VOC 8260B	n-Butylbenzene		--	<0.00572	--	**0.327**	--	240	No	NE	NE	31,000
VOC 8260B	sec-Butylbenzene		--	<0.00572	--	**0.193**	--	220	No	NE	NE	38,000
VOC 8260B	tert-Butylbenzene		--	<0.00572	--	**0.0146**	--	390	No	NE	NE	NE
VOC 8260B	Isopropylbenzene		--	<0.00572	--	**0.252**	--	240	No	NE	NE	14,000
VOC 8260B	n-Propylbenzene		--	<0.00572	--	**0.426**	--	240	No	NE	NE	6,600

NOTES

NE = Not established

Table 3. Adjusted MTCA Soil and Groundwater Compounds
Former Columbia Marine Lines Facility
6305 Lower River Road, Vancouver, Washington

Chemical	GP3-7-8 (mg/kg)'	GPE-6-11 (mg/kg)	GPE-7-10 (mg/kg)
AL_EC>5-6	125	6.58	41.35
AL_EC>6-8	125	6.60	41.35
AL_EC>8-10	94	38.40	121.00
AL_EC>10-12	961	347.00	753.00
AL_EC>12-16	3130	1350.00	2560.00
AL_EC>16-21	1730	971.00	1610.00
AL_EC>21-34	339	165.00	224.00
AR_EC>8-10	125	6.59	41.34
AR_EC>10-12	856	92.84	106.76
AR_EC>12-13-16	1500	186.00	301.00
AR_EC>16-21	409	329.08	559.14
AR_EC>21-34	237	70.02	111.65
Benzene	0.00	0.00	0.00
Toluene	0.00	0.00	0.00
Ethylbenzene	0.00	0.00	0.00
Xylenes	0.00	0.00	0.00
Naphthalene	0.50	0.36	1.24
1-Methyl Naphthalene	0.20	10.60	36.10
2-Methyl Naphthalene	0.4	6.43	0.18
n-Hexane	0	0.00	0.00
MTBE	0	0.00	0.00
Ethylene Dibromide (EDB)	0	0.00	0.00
1,2 Dichloroethane	0	0.00	0.00
Benzo(a)anthracene	0.2	0.45	0.53
Benzo(b)fluoranthene	0.2	0.29	0.18
Benzo(k)fluoranthene	0.2	0.18	0.18
Benzo(a)pyrene	0.2	0.27	0.18
Chrysene	0.485	0.73	0.80
Dibenzo(a,h)anthracene	0.2	0.09	0.18
Indeno(1,2,3-cd)pyrene	0.2	0.09	0.18
Acenaphthene	0.685	0.53	1.39
Acenaphthylene	0.4	0.18	0.53
Anthracene	3.48	0.86	0.98
Benzo(ghi)perylene	0.2	0.09	0.09
Fluoranthene	0.428	0.60	1.14
Fluorene	2.45	1.48	4.43
Phenanthrene	8.9	4.54	10.70
Pyrene	0.999	0.88	1.38

(shaded) Not detected in that sample.
Result of 0 indicates not detected in any samples.

Table 4. Historic Groundwater Database
Former Columbia Marine Lines Facility
6305 Lower River Road, Vancouver, Washington

Sample Location/ TOC Elevation (feet)	Sample Date	Silica Gel Cleanup (TPH-Dx)	TPH-Gx (µg/L)	TPH-Dx (µg/L)		BTEX (µg/L)				PAHs (µg/L)	DTW (feet)	LHT (feet)	WTE (feet)
				Diesel	Heavy Oil	Benzene	Toluene	Ethyl-benzene	Total Xylenes				
MW-1	11/8/1983	No	--	--	--	<20	<20	<20	--	--	--	--	--
31.66	12/13/1984	No	--	--	--	<5	<5	<5	<5	--	--	--	--
	11/13/1995	No	<80	12,000	<5,000	<0.50	<0.50	<0.50	<0.50	ND	9.19	0.00	22.47
	8/1/1996	NA	--	--	--	--	--	--	--	--	10.23	0.00	21.43
	10/30/1997	NA	--	--	--	--	--	--	--	--	9.54	0.00	22.12
	10/29/1998	No	233	5,430	1,230	<0.50	<0.50	<0.50	<1.0	--	12.26	0.00	19.40
	5/7/1999	NA	--	--	--	--	--	--	--	--	9.51	0.00	22.15
31.69	10/14/1999	No	--	10,400	2,850	--	--	--	--	--	12.39	0.00	19.30
	10/20/2000	No	269	8,140	1,060	<0.50	<0.50	<0.50	<1.0	--	--	--	--
	10/20/2000	Yes	--	1,980	<500	--	--	--	--	--	--	--	--
	6/28/2001	Yes	392	796	<625	<0.5	<0.5	<0.5	<1.0	--	11.80	0.00	19.89
	2/12/2002	Yes	--	271	<500	--	--	--	--	--	9.65	0.00	22.04
	5/13/2005	Yes	--	<250	<500	--	--	--	--	--	10.09	0.00	21.60
	10/20/2005	Yes	--	268	<476	--	--	--	--	--	13.49	0.00	18.20
	8/30/2007	No	<80	5,600	1,250	<1.00	<1.00	<1.00	<3.00	<0.0943			
MW-2	11/8/1983	No	--	--	--	510	450	100	770	--	--	--	--
33.97	2/5/1986	No	--	--	--	69	390	110	900	--	--	--	--
	8/28/1990	No	<50	26,400	--	<100	<100	<100	566	--	--	--	--
	8/2/1994	No	3100	10,000	--	6	3	35	110	ND	--	--	--
	11/13/1995	No	4000	40,000	7,400	2	2	22	110	--	12.95	0.00	21.02
	8/1/1996	No	<80	4,700	--	2	1	20	44	--	13.75	0.00	20.22
	10/30/1997	NA	--	--	--	--	--	--	--	--	13.55	0.00	20.42
	10/29/1998	No	3220	9,030	<2,500	<0.50	1	<0.50	6	--	14.92	0.00	19.05
	5/7/1999	NA	--	--	--	--	--	--	--	--	12.79	0.00	21.18
33.98	10/14/1999	No	--	9,060	3,460	--	--	--	--	--	15.06	0.00	18.92
	10/20/2000	No	862	7,740	1,610	2	<0.50	<0.50	<1.0	--	--	--	--
	10/20/2000	Yes	--	2,480	747	--	--	--	--	--	--	--	--
	6/28/2001	Yes	900	8,400	2,240	1	1	1	3	--	14.93	0.00	19.05
	2/12/2002	Yes	--	5,700	1,750	--	--	--	--	--	12.28	0.00	21.70
	5/13/2005	Yes	--	2,070	836	--	--	--	--	--	14.61	0.00	19.37
	10/20/2005	Yes	--	3,760	1,190	--	--	--	--	--	16.27	0.00	17.71
	7/11/2007	NA								DET			
	8/30/2007	No	180	9,390	2,850	<1.00	<1.00	<1.00	<3.00	24.3			
MW- 3	11/8/1983	No	--	--	--	95	64	15	90	--	--	--	--
30.90	12/17/1984	No	--	--	--	<1	<1	<1	--	--	--	--	--
	11/13/1995	No	290	4,600	<5,000	<0.50	<0.50	<0.50	<0.50	--	11.24	0.00	19.66
	8/1/1996	NA	--	--	--	--	--	--	--	--	11.11	0.00	19.79
	10/30/1997	NA	--	--	--	--	--	--	--	--	11.23	0.00	19.67
	10/30/1998	No	280	11,400	4,100	<0.50	2	<0.50	<1.0	--	12.28	0.00	18.62
	5/7/1999	NA	--	--	--	--	--	--	--	--	9.98	0.00	20.92
30.96	10/14/1999	No	--	15,500	4,890	--	--	--	--	--	12.33	0.00	20.98

Table 4. Historic Groundwater Database
Former Columbia Marine Lines Facility
6305 Lower River Road, Vancouver, Washington

Sample Location/ TOC Elevation (feet)	Sample Date	Silica Gel Cleanup (TPH-Dx)	TPH-Gx (µg/L)	TPH-Dx (µg/L)		BTEX (µg/L)				PAHs (µg/L)	DTW (feet)	LIIT (feet)	WTE (feet)
				Diesel	Heavy Oil	Benzene	Toluene	Ethyl-benzene	Total Xylenes				
	6/28/2001	Yes	529	1,560	<588	<0.5	<0.5	<0.5	1	--	12.27	0.00	18.69
	2/12/2002	Yes	--	435	<500	--	--	--	--	--	9.42	0.00	21.54
	5/13/2005	Yes	--	710	<500	--	--	--	--	--	11.83	0.00	19.13
	10/20/2005	Yes	--	428	<476	--	--	--	--	--	13.50	0.00	17.46
	8/30/2007	No	<80	9,390	3,920	<1.00	<1.00	<1.00	<3.00	--			
MW-4 28.42	11/8/1983	No	--	--	--	700	150	110	800	--	--	--	--
	12/12/1984	No	--	--	--	<1	<1	<1	<1	--	--	--	--
	11/13/1995	No	390	7,800	<500	3	1	1	7	--	8.27	0.00	20.15
	8/1/1996	No	380	11,000	--	2	5	<0.50	<1.0	--	8.40	0.00	20.02
	10/30/1997	NA	--	--	--	--	--	--	--	--	8.45	0.00	19.97
	10/29/1998	No	1120	11,200	2,920	<0.50	1	<0.50	<1.0	--	9.65	0.00	18.77
	5/7/1999	NA	--	--	--	--	--	--	--	--	7.26	0.00	21.16
28.64	10/14/1999	No	--	17,200	5,180	--	--	--	--	--	9.74	0.00	18.90
	6/28/2001	NA	--	--	--	--	--	--	--	--	10.68	0.00	17.96
	2/12/2002	NA	--	--	--	--	--	--	--	--	6.68	0.00	21.96
	5/13/2005	Yes	--	965	<500	--	--	--	--	--	8.12	0.00	20.52
	10/20/2005	Yes	--	319	<476	--	--	--	--	--	10.88	0.00	17.76
	8/30/2007	No	87.6	15,600	3,330	--	--	--	--	--			
MW-5 23.37	11/8/1983	No	--	--	--	35	<2	<2	--	--	--	--	--
	12/17/1984	No	--	--	--	<20	380	<20	--	--	--	--	--
	11/13/1995	No	<80	2,600	770	<0.50	<0.50	<0.50	<0.50	--	3.07	0.00	20.30
	8/1/1996	NA	--	--	--	--	--	--	--	--	3.60	0.00	19.77
	10/29/1998	NA	--	--	--	--	--	--	--	--	--	--	--
	5/7/1999	NA	--	--	--	--	--	--	--	--	2.45	0.00	20.92
23.38	10/14/1999	No	--	2,380	680	--	--	--	--	--	4.85	0.00	18.53
	6/28/2001	NA	--	--	--	--	--	--	--	--	--	--	--
	2/12/2002	NA	--	--	--	--	--	--	--	--	--	--	--
	Unable to locate - possibly destroyed										--	--	--
MW-6 26.14	12/12/1984	No	--	--	--	<1	<1	<1	<1	--	--	--	--
	11/13/1995	No	740	48,000	<5,000	<0.50	<0.50	<0.50	<0.50	--	5.23	0.00	20.91
	8/1/1996	NA	--	--	--	--	--	--	--	--	5.50	0.00	20.64
	10/30/1998	No	<80	27,000	6,790	<0.50	<0.50	<0.50	<1.0	--	5.44	0.00	20.70
	5/7/1999	NA	--	--	--	--	--	--	--	--	3.18	0.00	22.96
24.76	10/14/1999	No	--	19,700	2,810	--	--	--	--	--	5.41	0.00	19.35
	10/20/2000	No	936	30,200	2,360	<0.50	<0.50	<0.50	<1.0	--	--	--	--
	10/20/2000	Yes	--	13,500	1,390	--	--	--	--	--	--	--	--
	6/28/2001	Yes	212	5,660	822	<0.50	<0.50	<0.50	<1.0	--	5.28	0.00	19.48
	2/12/2002	Yes	--	31,500	3,380	--	--	--	--	--	2.87	0.00	21.89
	Unable to locate - possibly destroyed										--	--	--

Table 4. Historic Groundwater Database
Former Columbia Marine Lines Facility
6305 Lower River Road, Vancouver, Washington

Sample Location/ TOC Elevation (feet)	Sample Date	Silica Gel Cleanup (TPH-Dx)	TPH-Gx (µg/L)	TPH-Dx (µg/L) Diesel	TPH-Dx (µg/L) Heavy Oil	BTEX (µg/L) Benzene	BTEX (µg/L) Toluene	BTEX (µg/L) Ethyl-benzene	BTEX (µg/L) Total Xylenes	PAHs (µg/L)	DTW (feet)	LHT (feet)	WTE (feet)
MW-7	11/8/1983	No	--	--	--	<20	<20	<20	--	--	--	--	--
33.36	8/2/1994	No	1600	7,700		<2.5	<2.5	<2.5	<2.5	ND	--	--	--
	11/13/1995	No	1800	43,000	<5,000	2	1	<1.0	<1.0	--	12.54	0.00	20.82
	8/1/1996	NA	--	--	--	--	--	--	--	--	13.55	0.62	20.31
	10/30/1997	NA	--	--	--	--	--	--	--	--	13.24	0.17	20.26
	10/30/1998	No	DET[a]	DET	ND	--	--	--	--	--	14.51	0.07	18.91
	5/7/1999	NA	--	--	--	--	--	--	--	--	11.82	0.02	21.56
	8/24/1999	No	--	35,800	<10,000	--	--	--	--	--	--	--	--
	8/24/1999	Yes	--	28,900	<5,000	--	--	--	--	--	--	--	--
33.40	10/14/1999	No	--	25,800	3,950	--	--	--	--	--	14.70	0.00	18.70
	10/20/2000	No	2110	61,800	<10,000	<2.5	<2.5	<2.5	<5.0	--	--	--	--
	10/20/2000	Yes	--	76,100	<5,000	--	--	--	--	--	--	--	--
	6/28/2001	NA	--	--	--	--	--	--	--	--	15.41	0.00	17.99
	2/12/2002	Yes	--	1,590	<500	--	--	--	--	--	--	--	--
	5/13/2005	Yes	<80	1,450	<500	<0.50	<0.50	<0.50	<1.0	--	13.84	0.00	19.56
	10/21/2005	Yes	<800	4,540	<481	<5.00	<5.00	<5.00	<10.0	--	15.42	0.00	17.98
MW-8	11/8/1983	No	--	--	--	208	<2	<2	--	--	--	--	--
33.49	11/13/1995	No	5400	490,000	41,000	2	2	2	5	--	12.90	0.50	20.99
	8/1/1996	NA	--	--	--	--	--	--	--	--	12.98	0.15	20.63
	10/30/1997	NA	--	--	--	--	--	--	--	--	13.20	0.21	20.46
	10/30/1998	No		DET	DET	--	--	--	--	--	14.94	0.14	18.66
	5/7/1999	NA	--	--	--	--	--	--	--	--	12.05	0.37	21.74
33.53	10/14/1999	No	--	19,500	2,400	--	--	--	--	--	15.31	0.18	18.36
	6/28/2001	NA	--	--	--	--	--	--	--	--	15.99	0.00	17.54
	2/12/2002	Yes	--	2,990	<500	--	--	--	--	--	--	--	--
	5/13/2005	Purged dry with insufficient recharge for sampling.									13.77	0.00	19.76
	10/21/2005	Purged dry with insufficient recharge for sampling.									15.45	0.00	18.08
MW-9	12/13/1984	No	--	--	--	<1	<1	<1	<1	--	--	--	--
26.36	11/13/1995	No	<80	880	630	<0.50	<0.50	<0.50	<0.50	--	4.25	0.00	22.11
	8/1/1996	NA	--	--	--	--	--	--	--	--	5.81	0.00	20.55
	10/30/1997	NA	--	--	--	--	--	--	--	--	1.87	0.00	24.49
	10/30/1998	No	<80	5,760	2,300	<0.50	<0.50	<0.50	<1.0	--	6.31	0.00	20.05
	5/7/1999	NA	--	--	--	--	--	--	--	--	5.02	0.00	21.34
26.38	10/14/1999	No	--	4,250	2,330	--	--	--	--	--	7.25	0.00	19.13
	10/14/1999	Yes	--	446	811	--	--	--	--	--	--	--	--
	6/28/2001	NA	--	--	--	--	--	--	--	--	6.87	0.00	19.51
	2/11/2002	NA	--	--	--	--	--	--	--	--	4.41	0.00	21.97
	5/13/2005	Yes	--	498	<500	--	--	--	--	--	5.74	0.00	20.64
	10/20/2005	Yes	--	824	852	--	--	--	--	--	8.44	0.00	17.94

Table 4. Historic Groundwater Database
Former Columbia Marine Lines Facility
6305 Lower River Road, Vancouver, Washington

Sample Location/ TOC Elevation (feet)	Sample Date	Silica Gel Cleanup (TPH-Dx)	TPH-Gx (µg/L)	TPH-Dx (µg/L)		BTEX (µg/L)				PAHs (µg/L)	DTW (feet)	LIIT (feet)	WTE (feet)
				Diesel	Heavy Oil	Benzene	Toluene	Ethyl-benzene	Total Xylenes				
MW-10	11/13/1995	No	760	<250	<500	1	1	1	2	--	5.09	0.00	20.80
25.89	8/1/1996	NA	--	--	--	--	--	--	--	--	5.62	0.00	20.27
	10/30/1997	NA	--	--	--	--	--	--	--	--	5.64	0.00	20.25
	10/30/1998	NA	--	--	--	--	--	--	--	--	DRY	DRY	DRY
	5/7/1999	NA	--	--	--	--	--	--	--	--	4.53	0.00	21.36
25.92	10/14/1999	NA	--	--	--	--	--	--	--	--	6.81	0.00	19.11
	6/28/2001	NA	--	--	--	--	--	--	--	--	7.04	0.00	18.88
	2/11/2002	NA	--	--	--	--	--	--	--	--	4.01	0.00	21.91
	5/13/2005	Yes	--	522	1,910	--	--	--	--	--	5.46	0.00	20.46
	10/20/2005	NA	--	--	--	--	--	--	--	--	DRY	DRY	DRY
MW-11	12/17/1984	No	--	--	--	<1	<1	<1	--	--	--	--	--
25.89	8/2/1994	No	<200	<500	--	<0.50	<0.50	<0.50	1	ND	--	--	--
	11/13/1995	No	<80	11,000	<500	<0.50	<0.50	<0.50	<0.50	--	6.57	0.00	19.32
	8/1/1996	NA	--	--	--	--	--	--	--	--	6.71	0.00	19.18
	10/30/1997	NA	--	--	--	--	--	--	--	--	6.75	0.00	19.14
	10/29/1998	No	<80	3,160	700	<0.50	<0.50	<0.50	<1.0	--	8.12	0.00	17.77
	5/7/1999	NA	--	--	--	--	--	--	--	--	5.49	0.00	20.40
25.90	10/14/1999	No	--	3,160	<500	--	--	--	--	--	8.12	0.00	17.78
	10/14/1999	Yes	--	<250	<500	--	--	--	--	--	--	--	--
	6/28/2001	NA	--	--	--	--	--	--	--	--	3.90	0.00	22.00
	2/11/2002	NA	--	--	--	--	--	--	--	--	4.91	0.00	20.99
	5/13/2005	Yes	--	<250	<500	--	--	--	--	--	6.21	0.00	19.69
	10/21/2005	Yes	--	<236	<472	--	--	--	--	--	9.26	0.00	16.64
	8/31/2007	No	<80	402	<476	--	--	--	--	--			
MW-12	12/18/1984	No	--	--	--	<1	<1	<1	--	--	--	--	--
28.17	11/13/1995	No	<80	<250	<500	<0.50	<0.50	<0.50	<0.50	--	6.07	0.00	22.10
	8/1/1996	No	<80	<250	--	<0.50	<0.50	<0.50	<1	--	7.15	0.00	21.02
	10/30/1997	NA	--	--	--	--	--	--	--	--	6.61	0.00	21.56
	10/29/1998	No	<80	<250	<500	<0.50	<0.50	<0.50	<1.0	--	8.01	0.00	20.16
	5/7/1999	NA	--	--	--	--	--	--	--	--	6.36	0.00	21.81
28.28	10/14/1999	No	--	<250	<500	--	--	--	--	--	8.34	0.00	19.94
	6/28/2001	NA	--	--	--	--	--	--	--	--	8.24	0.00	20.04
	2/11/2002	NA	--	--	--	--	--	--	--	--	5.76	0.00	22.52
	5/13/2005	Yes	--	<250	<500	--	--	--	--	--	6.61	0.00	21.67
	10/20/2005	Yes	--	<236	<472	--	--	--	--	--	9.41	0.00	18.87
	8/30/2007	No	<80	<238	<476	--	--	--	--	--			

Table 4. Historic Groundwater Database
Former Columbia Marine Lines Facility
6305 Lower River Road, Vancouver, Washington

Sample Location/ TOC Elevation (feet)	Sample Date	Silica Gel Cleanup (TPH-Dx)	TPH-Gx (µg/L)	TPH-Dx (µg/L)		BTEX (µg/L)				PAHs (µg/L)	DTW (feet)	LIIT (feet)	WTE (feet)
				Diesel	Heavy Oil	Benzene	Toluene	Ethyl-benzene	Total Xylenes				
MW-13 22.78	12/19/1984	No	--	--	--	<1	<1	<1	<2	--	--	--	--
	2/5/1986	No	--	--	--	<1	<1	<1	<2	--	--	--	--
	8/28/1990	No	<50	<50	--	<100	<100	<100	<100	--	--	--	--
	8/2/1994	No	<200	1,200	--	<0.50	<0.50	<0.50	<0.50	ND	--	--	--
	11/13/1995	No	<80	1,400	<500	<0.50	<0.50	<0.50	<0.50	--	10.60	0.00	12.18
	8/1/1996	No	<80	900		<0.50	<0.50	<0.50	<1	--	10.70	0.00	12.08
	10/30/1997	No	<80	1,530	750	<0.50	<0.50	<0.50	<1	--	10.48	0.00	12.30
	10/29/1998	NA	--	--	--	--	--	--	--	--	--	--	--
	5/7/1999	NA	--	--	--	--	--	--	--	--	9.60	0.00	13.18
22.75	10/14/1999	No	--	1,500	854	--	--	--	--	--	11.19	0.00	11.56
	10/14/1999	Yes	--	<250	<500	--	--	--	--	--	--	--	--
	6/28/2001	Yes	<80	<250	<500	<0.50	<0.50	<0.50	<1.0	--	11.18	0.00	11.57
	2/12/2002	Yes	--	<250	<500	--	--	--	--	--	9.33	0.00	13.42
	5/13/2005	Yes	--	<250	<500	--	--	--	--	--	9.91	0.00	12.84
	10/20/2005	Yes	--	<238	<476	--	--	--	--	--	11.72	0.00	11.03
	9/13/2007	Yes	--	<243	<485	--	--	--	--	--	11.72	0.00	11.03
MW-14 26.25	12/19/1984	No	--	--	--	<1	<1	<1	--	--	--	--	--
	11/13/1995	No	<80	1,000	<500	<0.50	<0.50	<0.50	<0.50	--	8.08	0.00	18.17
	8/1/1996	No	<80	1,800	--	<0.50	<0.50	<0.50	<1	--	9.15	0.00	17.10
	10/30/1997	No	<80	<250	<500	<0.50	<0.50	<0.50	<1	--	8.89	0.00	17.36
	10/29/1998	NA	--	--	--	--	--	--	--	--	--	--	--
	5/7/1999	NA	--	--	--	--	--	--	--	--	8.03	0.00	18.22
26.28	10/14/1999	No	--	3,820	1,810	--	--	--	--	--	11.73	0.00	14.55
	10/14/1999	Yes	--	<250	<500	--	--	--	--	--	--	--	--
	6/28/2001	Yes	108	<294	<588	<0.50	<0.50	<0.50	<1.0	--	11.95	0.00	14.33
	2/12/2002	Yes	--	<250	<500	--	--	--	--	--	6.56	0.00	19.72
	5/13/2005	Yes	--	<250	<500	--	--	--	--	--	7.85	0.00	18.43
	10/20/2005	Yes	--	<250	<500	--	--	--	--	--	9.56	0.00	16.72
MW-15 26.24	2/5/1986	No	--	--	--	<1	<1	<1	<2	--	--	--	--
	8/2/1994	No	<200	<500	--	<0.50	<0.50	<0.50	<0.50	ND	--	--	--
	11/13/1995	NA	--	--	--	--	--	--	--	--	--	--	--
	8/1/1996	NA	--	--	--	--	--	--	--	--	--	--	--
	5/7/1999	NA	--	--	--	--	--	--	--	--	--	--	--
	10/14/1999	NA	--	--	--	--	--	--	--	--	--	--	--
	6/28/2001	NA	--	--	--	--	--	--	--	--	--	--	--
	2/11/2002	NA	--	--	--	--	--	--	--	--	--	--	--
	Unable to locate - possibly destroyed												

Table 4. Historic Groundwater Database
Former Columbia Marine Lines Facility
6305 Lower River Road, Vancouver, Washington

Sample Location/ TOC Elevation (feet)	Sample Date	Silica Gel Cleanup (TPH-Dx)	TPH-Gx (µg/L)	TPH-Dx (µg/L)		BTEX (µg/L)				PAHs (µg/L)	DTW (feet)	LIIT (feet)	WTE (feet)
				Diesel	Heavy Oil	Benzene	Toluene	Ethyl-benzene	Total Xylenes				
MW-16 31.13	2/5/1986	No	--	--	--	93	<10	<10	240	--	--	--	--
	8/28/1990	No	1000	4,910	--	<100	<100	<100	445	--	--	--	--
	8/2/1994	No	1,100[c]	11,000[c]	--	2.0[c]	0.73[c]	0.74[c]	4.8[c]	11[c]	--	--	--
	11/13/1995	No	900	10,000	2,100	1	1	53	8	--	9.94	0.00	21.19
	8/1/1996	No	740	<500	--	<0.50	2	<0.50	3	--	10.36	0.00	20.77
	10/30/1997	No	1220	9,010	2,700	<0.50	<0.50	8	4	--	10.26	0.00	20.87
	10/29/1998	No	482	11,600	2,590	<0.50	4	<0.50	<1.0	--	11.43	0.00	19.70
	5/7/1999	No	--	--	--	--	--	--	--	--	9.33	0.00	21.80
	8/24/1999	No	--	9,900	2,130	--	--	--	--	--	--	--	--
	8/24/1999	Yes	--	842	<500	--	--	--	--	--	--	--	--
29.67	10/14/1999	No	--	12,300	2,650	--	--	--	--	--	11.50	0.00	18.17
	10/14/1999	Yes	--	1,190	<500	--	--	--	--	--	--	--	--
	10/20/2000	No	463	13,200	1,530	<0.50	5	<0.50	<1.0	--	--	--	--
	10/20/2000	Yes	--	1,510	<500	--	--	--	--	--	--	--	--
	6/28/2001	Yes	361	1,800	<500	<0.50	1	<0.50	<1.0	--	11.35	0.00	18.32
	2/11/2002	NA	--	--	--	--	--	--	--	--	8.60	0.00	21.07
	5/13/2005	Yes	--	1,220	<500	--	--	--	--	--	9.87	0.00	19.80
	10/21/2005	Yes	--	572	<472	--	--	--	--	--	12.65	0.00	17.02
	8/31/2007	No	116	12,700	2,800	<1.00	<1.00	<1.00	<3.00	6.95			
MW-17 33.94	2/5/1986	No	--	--	--	<1	<1	<1	<2	--	--	--	--
	11/13/1995	NA	--	--	--	--	--	--	--	--	DRY	DRY	DRY
	8/1/1996	NA	--	--	--	--	--	--	--	--	14.62	0.00	19.32
	10/30/1997	NA	--	--	--	--	--	--	--	--	15.61	0.00	18.33
	10/29/1998	NA	--	--	--	--	--	--	--	--	DRY	DRY	DRY
	5/7/1999	NA	--	--	--	--	--	--	--	--	13.42	0.00	20.52
33.97	10/14/1999	NA	--	--	--	--	--	--	--	--	DRY	DRY	DRY
	6/28/2001	NA	--	--	--	--	--	--	--	--	DRY	DRY	DRY
	2/11/2002	NA	--	--	--	--	--	--	--	--	12.68	0.00	21.29
	5/13/2005	Yes	--	<250	<500	--	--	--	--	--	14.64	0.00	19.33
	10/20/2005	Yes	--	<236	<472	--	--	--	--	--	17.74	0.00	16.23
	8/30/2007	No	<80	<236	<472	--	--	--	--	--			
MW-18 33.19	11/13/1995	No	<80	4,900	2,100	<0.50	<0.50	<0.50	<0.50	--	8.47	0.00	24.72
	8/1/1996	No	<80	9,600	--	<0.50	1	1	<1.0	--	9.96	0.00	23.23
	10/30/1997	NA	--	--	--	--	--	--	--	--	DRY	DRY	DRY
	10/29/1998	NA	--	--	--	--	--	--	--	--	DRY	DRY	DRY
	5/7/1999	NA	--	--	--	--	--	--	--	--	DRY	DRY	DRY
33.24	10/14/1999	NA	--	--	--	--	--	--	--	--	DRY	DRY	DRY
	6/28/2001	NA	--	--	--	--	--	--	--	--	DRY	DRY	DRY
	2/11/2002	NA	--	--	--	--	--	--	--	--	DRY	DRY	DRY
	5/13/2005	NA	--	--	--	--	--	--	--	--	DRY	DRY	DRY
	10/20/2005	NA	--	--	--	--	--	--	--	--	DRY	DRY	DRY

Table 4. Historic Groundwater Database
Former Columbia Marine Lines Facility
6305 Lower River Road, Vancouver, Washington

Sample Location/ TOC Elevation (feet)	Sample Date	Silica Gel Cleanup (TPH-Dx)	TPH-Gx (µg/L)	TPH-Dx (µg/L)		BTEX (µg/L)				PAHs (µg/L)	DTW (feet)	LHT (feet)	WTE (feet)
				Diesel	Heavy Oil	Benzene	Toluene	Ethyl-benzene	Total Xylenes				
MW-19 33.67	12/5/1986	No	--	--	--	140	<10	30	<20	--	--	--	--
	8/28/1990	No	<50	35,200	--	<100	<100	<100	<100	--	--	--	--
	11/13/1995	No	4300	69,000	<25,000	<2.5	<2.5	<2.5	<2.5	--	14.77	0.00	18.90
	8/1/1996	NA	--	--	--	--	--	--	--	--	14.24	0.00	19.43
	10/30/1997	No	2860	21,600	3,180	<0.50	<0.50	<0.50	1	--	14.47	0.00	19.20
	10/30/1998	No	DET[a]	DET	DET	--	--	--	--	--	16.11	0.75	18.16
	5/7/1999	NA	--	--	--	--	--	--	--	--	12.95	0.00	20.72
33.72	10/14/1999	No	--	35,000	4,280	--	--	--	--	--	15.43	0.02	18.31
	10/14/1999	Yes	--	5,280	<500	--	--	--	--	--	--	--	--
	6/28/2001	NA	--	--	--	--	--	--	--	--	15.85	0.00	17.87
	2/12/2002	Yes	--	19,800	<5,000	--	--	--	--	--	--	--	--
	5/13/2005	Yes	390	9,990	1,260	<0.50	<0.50	<0.50	<1.0	--	14.08	0.00	19.64
	10/21/2005	Yes	<800	35,500	4,140	<5.00	<5.00	<5.00	<10.0	--	16.93	0.00	16.79
	8/31/2007	No	--	30,700	4,680	--	--	--	--	--	--	--	--
MW-20 30.36	2/5/1986	No	--	--	--	<1	<1	<1	<2	--	--	--	--
	11/13/1995	No	<80	870	730	<0.50	<0.50	<0.50	<0.50	--	21.99	0.00	8.37
	8/1/1996	NA	--	--	--	--	--	--	--	--	22.66	0.00	7.70
	10/30/1997	NA	--	--	--	--	--	--	--	--	23.72	0.00	6.64
	10/30/1998	No	<80	<250	<500	<0.50	<0.50	<0.50	<1.0	--	27.70	0.00	2.66
	5/7/1999	NA	--	--	--	--	--	--	--	--	19.30	0.00	11.06
	10/20/2000	No	294	14,500	1,340	<0.50	1	<0.50	<1.0	--	--	--	--
	10/20/2000	Yes	--	878	<500	--	--	--	--	--	--	--	--
	6/28/2001	NA	--	--	--	--	--	--	--	--	--	--	--
	Well Abandoned												

Table 4. Historic Groundwater Database
Former Columbia Marine Lines Facility
6305 Lower River Road, Vancouver, Washington

Sample Location/ TOC Elevation (feet)	Sample Date	Silica Gel Cleanup (TPH-Dx)	TPH-Gx (µg/L)	TPH-Dx (µg/L)		BTEX (µg/L)				PAHs (µg/L)	DTW (feet)	LHT (feet)	WTE (feet)
				Diesel	Heavy Oil	Benzene	Toluene	Ethyl-benzene	Total Xylenes				
MW-21	2/5/1986	No	--	--	--	<1	<1	<1	<2	--	--	--	--
30.06	11/13/1995	NA	--	--	--	--	--	--	--	--	DRY	DRY	DRY
	8/1/1996	NA	--	--	--	--	--	--	--	--	10.65	0.00	19.41
	10/30/1997	NA	--	--	--	--	--	--	--	--	11.50	0.00	18.56
	10/29/1998	NA	--	--	--	--	--	--	--	--	DRY	DRY	DRY
	5/7/1999	NA	--	--	--	--	--	--	--	--	9.57	0.00	20.49
30.08	10/14/1999	NA	--	--	--	--	--	--	--	--	DRY	DRY	DRY
	6/28/2001	NA	--	--	--	--	--	--	--	--	DRY	DRY	DRY
	2/11/2002	NA	--	--	--	--	--	--	--	--	7.15	0.00	22.93
	5/13/2005	Yes	--	<250	<500	--	--	--	--	--	8.91	0.00	21.17
	10/20/2005	NA	--	--	--	--	--	--	--	--	DRY	DRY	DRY
RW-4	10/20/2000	No	782	10,400	1,020	<0.50	1	1	<1.0	--	--	--	--
	10/20/2000	Yes	--	<250	<500	--	--	--	--	--	--	--	--
	6/28/2001	Yes	550	806	<588	<0.5	1	<0.5	<0.50	--	16.27	0.00	--
	2/12/2002	No	--	2,430	<500						12.38	0.00	--
	5/13/2005	Yes	--	2,280	<500	--	--	--	--	--	14.28	0.00	--
	10/21/2005	Yes	--	867	<476	--	--	--	--	--	16.40	0.00	--
	8/30/2007	No	--	16,400	2,090	--	--	--	--	--	--	--	--
RW-5	10/20/2000	No	491	12,700	2,720	<0.50	<0.50	<0.50	<0.50	--	--	--	--
	10/20/2000	Yes	--	696	<500	--	--	--	--	--	--	--	--
	6/28/2001	Yes	2010	29,000	1,580	<0.5	<0.5	1	2	--	9.42	0.00	--
	2/12/2002	Yes	--	405	<500	--	--	--	--	--	6.7	0.00	--
	5/13/2005	Yes	--	2,120	<500	--	--	--	--	--	8.12	0.00	--
	10/20/2005	Yes	--	502	<481	--	--	--	--	--	9.74	0.00	--
P-1 29.35	11/13/1995	NA	--	--	--	--	--	--	--	--	9.74	0.00	19.61
P-2 25.22	11/13/1995	NA	--	--	--	--	--	--	--	--	4.35	0.00	20.87
EX-1 32.30	11/13/1995	NA	--	--	--	--	--	--	--	--	14.72	0.00	17.58
EX-2	2/3/1996	No	5300	13,000	2,500	1	1	1	2	--	--	--	--
33.53	6/28/2001	Yes	1580	2,020	<500	<0.50	1	1	3	--	14.52	0.00	19.01
	2/12/2002	Yes	--	1,040	<500	--	--	--	--	--	11.59	0.00	21.94
	5/13/2005	Yes	--	1,060	<500	--	--	--	--	--	13.40	0.00	20.13
	10/20/2005	Yes	--	384	<481	--	--	--	--	--	15.21	0.00	18.32
	8/31/2007		104	11,600	1,270	<1.0	<1.0	<1.0	<3.0	--	--	--	--
PMX-1	8/25/1993	NA	--	--	--	<5.0	<5.0	<5.0	<5.0	--	--	--	--

Table 4. Historic Groundwater Database
Former Columbia Marine Lines Facility
6305 Lower River Road, Vancouver, Washington

Sample Location/ TOC Elevation (feet)	Sample Date	Silica Gel Cleanup (TPH-Dx)	TPH-Gx (µg/L)	TPH-Dx (µg/L)		BTEX (µg/L)				PAHs (µg/L)	DTW (feet)	LHT (feet)	WTE (feet)
				Diesel	Heavy Oil	Benzene	Toluene	Ethyl-benzene	Total Xylenes				
PMX-2	8/24/1993	NA	--	--	--	<5.0	<5.0	<5.0	<5.0	--	--	--	--
PMX-3	8/24/1993	NA	--	--	--	<5.0	<5.0	<5.0	<5.0	--	--	--	--
PMX-4	8/24/1993	NA	--	--	--	<5.0	<5.0	<5.0	<5.0	--	--	--	--
PMX-5	8/24/1993	NA	--	--	--	<5.0	<5.0	<5.0	<5.0	--	--	--	--
PMX-6	8/24/1993	NA	--	--	--	<5.0	<5.0	<5.0	<5.0	--	--	--	--
PMX-7	8/24/1993	NA	--	--	--	<5.0	<5.0	<5.0	<5.0	--	--	--	--
GP1	5/7/1999	No	<80	335	<500	<0.5	<0.5	<0.5	<1.0	--	5.05	0.00	21.50
GP2	5/7/1999	No	2,710	17,900	<500	<2.50	6	<2.50	<5.0	--	10.3	0.00	21.94
GP3	5/7/1999	No	2,780	13,100	<500	<0.5	1	<0.5	<1.0	--	10.9	0.00	21.19
GP4	5/7/1999	No	<80	486	<500	<0.5	<0.5	<0.5	<1.0	--	10.2	0.00	20.55
GP5	5/7/1999	No	<80	1,970	<500	<0.5	<0.5	<0.5	<1.0	--	6.86	0.00	20.11
GP6	5/7/1999	No	<80	<250	<500	<0.5	<0.5	<0.5	<1.0	--	8.89	0.00	18.28
GP7	5/7/1999	No	<80	11,800	<500	<0.5	<0.5	<0.5	<1.0	--	10.5	0.00	20.37
GP8	5/7/1999	No	48	15,200	<500	<0.5	<0.5	<0.5	<1.0	--	7.71	0.00	21.66
GP9	5/7/1999	No	<80	4,930	<500	<0.5	<0.5	<0.5	<1.0	--	8.06	0.00	21.60
GPE-1-GW	8/24/2007	No	199	2,830	714	<1.00	<1.00	<1.00	<3.00	9.89	12.0	--	--
GPE-2-GW	8/24/2007	No	<80	1,170	<490	<1.00	<1.00	<1.00	<3.00	0.780	12.0	--	--
GPE-3-GW	8/24/2007	No	162	5,590	1,660	--	--	--	--	--	12.0	--	--
MTCA Method A Cleanup Level			**800**	**500**	**500**	**5**	**1,000**	**700**	**1,000**	**0.1[d]**			
MTCA Method B Cleanup Level				**828**									

TOC = Top of casing elevation relative to assigned benchmark.
TPH-G = Total petroleum hydrocarbons as gasoline analysis by Washington DOE Method WTPH-G; results in milligrams per liter (mg/L).
TPH-D = TPH as diesel and heavy oil analysis by Washington DOE Method WTPH-D (extended) with silica gel cleanup analysis based on possible biogenic intererence; results in mg/L.
BTEX = Benzene, toluene, ethylbenzene, and total xylene analysis by EPA Method 8020; results in micrograms per liter (mg/L).
HVOCs = Halogenated volatile organic compound analysis by EPA Method 8010/8260B; results in mg/L.
PAHs = Polynuclear aromatic hydrocarbon analysis by EPA Method 8310; results in mg/L.
DTW = Depth to water below top of casing.
LHT = Liquid hydrocarbon thickness.

Table 4. Historic Groundwater Database
Former Columbia Marine Lines Facility
6305 Lower River Road, Vancouver, Washington

Sample Location/ TOC Elevation (feet)	Sample Date	Silica Gel Cleanup (TPH-Dx)	TPH-Gx (µg/L)	TPH-Dx (µg/L)		BTEX (µg/L)				PAHs (µg/L)	DTW (feet)	LHT (feet)	WTE (feet)
				Diesel	Heavy Oil	Benzene	Toluene	Ethyl-benzene	Total Xylenes				

WTE = Water table elevation.
-- = Not measured, not analyzed, or not sampled.
ND = Not detected above laboratory method reporting limit (MRL).
a = Detected (DET) hydrocarbons in gasoline range appear to be due to overlap of diesel-range hydrocarbons.
b = Isopropylbenzene was detected 8.18 mg/L, and n-Propylbenzene was detected at 10.9 mg/L. All other HVOCs were ND.
c = Results include higher of 08/02/94 MW-16 or blind duplicate listed as "MW-30." Fluorene was detected at 11 mg/L in MW-30; all other PAH results were below laboratory MRLs.
d = Model Toxics Control Act (MTCA) Method A cleanup level for carcinogenic PAHs.

Analytical methods prior to 1995 include Hydrocarbon Scan by EPA Methods 3510/Modified 8015, and Oil and Grease by EPA Method 413.1.
Note: Water elevation corrected if liquid hydrocarbon present; corrected water level elevation = TOC - DTW + (LHT x 0.8).

Table 5. Monitoring Wells SVOCs
Former Columbia Marine Lines Facility
6305 Lower River Road, Vancouver, Washington

Sample ID	MW 2 (SVOC Analysis)	MW 3 (SVOC Analysis)	MW 7 (SVOC Analysis)	MW 19 (SVOC Analysis)	MW 2 (SVOC Analysis)	MW 1 (PAH Analysis)	MW 2 (PAH Analysis)	MW 16 (PAH Analysis)	MTCA Method A Cleanup Levels [1] (ug/L)	MTCA Method B Cleanup Levels [1] (ug/L)	MTCA Method C Cleanup Levels [1] (ug/L)	US EPA Region 6 Human Health Medium-Specific Screening Levels [2] (ug/L)		ODEQ Excavation Worker RBC (ug/L)	ODEQ Vapor Intrusion RBC (ug/L)
												MCL (ug/L)	Tap Water (ug/L)		
Sample Date	7/11/2007	7/11/2007	7/11/2007	7/12/2007	8/30/2007	8/30/2007	8/30/2007	8/31/2007							
SVOCs per EPA Method 8270-SIM (ug/L)															
Acenaphthene	**0.64**	**0.119**	<0.556	**4.17**	<4.76	<0.189	**1.06**	**1.33**	NE	960	2,100	NE	370	25,000	NE
Fluoranthene	<0.189	**0.622**	<0.556	<1.94	<19.0	<0.0943	<0.472	**1.35**	NE	640	1,400	NE	1,500	9,600	NE
Fluorene	**1.38**	**0.433**	<0.556	**3.48**	**5.1**	<0.0943	**2.43**	**2.22**	NE	640	1,400	NE	240	14,000	NE
1-Methylnaphthalene	NA	NA	NA	NA	NA	<0.0943	**19.9**	**1.07**	NE	2.4	5.3	NE	NE	NE	NE
Phenanthrene	<0.189	<0.0962	<0.556	**5.02**	<19.0	NA	NA	NA	NE	NE	NE	NE	NE	79,000	NE
Pyrene	<0.189	**0.446**	<0.556	**3.32**	<19.0	<0.0943	<0.472	**0.977**	NE	480	1,100	NE	180	5,800	NE

Notes:
[1] = Model Toxics Control Act Cleanup (MTCA) Regulation, WAC 173-340. 2006 MTCA Method A and B values from Ecology website CLARC tables (https://fortress.wa.gov/ecy/clarc/reporting/CLARCReporting.aspx).
[2] = US EPA Region 6 Human Health Medium-Specific Screening Levels (http://www.epa.gov/earth1r6/6pd/rcra_c/pd-n/screen.htm).
[3] = Carcinogenic PAHs- Cleanup Levels for carcinogenic PAHs under 2001 MTCA are based on a total value of 0.1ug/l for groundwater using the Toxicity Equivalency.
[4] = Cleanup level basedo n total of naphthalene, 1-methylnaphthalen, and 2-methylnaphtalene.
Bold – indicates detections above the reported MRL.
MCL = US EPA Maximum Contaminant Level
ug/L = micrograms per liter
NE = Not Established

Table 6. Monitoring Wells VOCs
Former Columbia Marine Lines Facility
6305 Lower River Road, Vancouver, Washington

Sample ID	MW 2	MW 3	MW 7	MW 19	MW 1	MW 2	MW 16	MTCA Method A Cleanup Levels [1] (ug/L)	MTCA Method B Cleanup Levels [1] (ug/L)	MTCA Method C Cleanup Levels [1] (ug/L)	US EPA Region 6 Human Health Medium-Specific Screening Levels 2007 [2]		ODEQ Excavation Worker RBC (ug/L)	ODEQ Vapor Intrusion RBC (ug/L)
Sample Date	7/11/2007	7/11/2007	7/11/2007	7/12/2007	8/30/2007	8/30/2007	8/31/2007				MCL (ug/L)	Tap Water (ug/L)		
VOCs per EPA Method 8260B (ug/L)														
Acetone	<25	<50	<50	**36.3**	<20	<20	**26.0**	NE	800	1,800	NE	5,500	NE	NE
Chloroethane	<1	<2	<2	<1	**1.17**	**1.59**	**1.14**	NE	15	15	NE	4	19,000	11,000
Isopropylbenzene	<2	<4	<4	**7.39**	<1	<1	**1.82**	NE	NE	NE	NE	660	51,000	NE
n-Butylbenzene	<5	<10	<10	<5	<1	**1.04**	<1	NE	NE	NE	NE	61	11,000	NE
n-Propylbenzene	<1	<2	<2	**8.94**	<1	<1	**2.08**	NE	NE	NE	NE	61	18,000	NE
sec-Butylbenzene	<1	<2	<2	**1.2**	<1	<1	<1	NE	NE	NE	NE	61	12,000	NE
Toluene	<1	<2	<2	**1.82**	<1	<1	<1	1,000	640	1,400	1,000	2,300	78,000	2,500,000

Notes:

[1] = Model Toxics Control Act Cleanup (MTCA) Regulation, WAC 173-340. 2006 MTCA Method A and B values from Ecology website CLARC tables (https://fortress.wa.gov/ecy/clarc/reporting/CLARCReporting.aspx) downloaded April 2006. If MTCA Method A and B values wer not available or not established on the Ecology websited CLARC tables, the 2001 MTCA values wer used. 2001 Method A values are from Ecology Publication 94-06, amended February 12, 2001. 2001 Method B values are from MTCA Cleanup Levels and Risk Calculations (CLARC) Version 3.1, Ecology Publication 94-115, updated November 2001.

[2] = US EPA Region 6 Human Health Medium-Specific Screening Levels, version 9b (May 2007). Downloaded July 2007 (http://www.epa.gov/earth1r6/6pd/rcra_c/pd-n/screen.htm).

Bold – indicates detections above the reported MRL.

MCL = US EPA Maximum Contaminant Level

ug/L = micrograms per liter

NE = Not Established

Table 7. Statistics for Most Recent Groundwater Data
Former Columbia Marine Lines Facility
6305 Lower River Road, Vancouver, Washington

Sample Location/ TOC Elevation (feet)	Sample Date	Silica Gel Cleanup (TPH-Dx)	TPH-Gx (µg/L)	TPH-Dx (µg/L)	
				Diesel	Heavy Oil
With Silica Gel Cleanup					
MW-1	5/13/2005	Yes	NA	<250	<500
	10/20/2005	Yes	NA	268	<476
MW-2	5/13/2005	Yes	NA	2070	836
	10/20/2005	Yes	NA	3760	1190
MW- 3	5/13/2005	Yes	NA	710	<500
	10/20/2005	Yes	NA	428	<476
MW-4	5/13/2005	Yes	NA	965	<500
	10/20/2005	Yes	NA	319	<476
MW-5	10/14/1999	No	NA	2380	680
MW-6	6/28/2001	Yes	212	5660	822
	2/12/2002	Yes	NA	31500	3380
MW-7	5/13/2005	Yes	<80	1450	<500
	10/21/2005	Yes	<800	4540	<481
MW-8	2/12/2002	Yes	NA	2990	<500
MW-9	5/13/2005	Yes	NA	498	<500
	10/20/2005	Yes	NA	824	852
MW-10	5/13/2005	Yes	NA	522	1910
MW-11	5/13/2005	Yes	NA	<250	<500
	10/21/2005	Yes	NA	<236	<472
MW-12	5/13/2005	Yes	NA	<250	<500
	10/20/2005	Yes	NA	<236	<472
MW-13	5/13/2005	Yes	NA	<250	<500
	10/20/2005	Yes	NA	<238	<476
MW-14	5/13/2005	Yes	NA	<250	<500
	10/20/2005	Yes	NA	<250	<500
MW-16	5/13/2005	Yes	NA	1220	<500
	10/21/2005	Yes	NA	572	<472
MW-17	5/13/2005	Yes	NA	<250	<500
	10/20/2005	Yes	NA	<236	<472
MW-19	5/13/2005	Yes	390	9990	1260
	10/21/2005	Yes	<800	35500	4140
RW-4	5/13/2005	Yes	NA	2280	<500
	10/21/2005	Yes	NA	867	<476
RW-5	5/13/2005	Yes	NA	2120	<500
	10/20/2005	Yes	NA	502	<481
MW-20	10/20/2000	Yes	NA	878	<500
MW-21	5/13/2005	Yes	NA	<250	<500
EX-2	5/13/2005	Yes	NA	1060	<500
	10/20/2005	Yes	NA	384	<481
Number of Analyses			39	39	39
Number of Detections			2	27	9
Minimum			212	319	680
Average			288	3,356	599
Maximum			390	35,500	4,140
90UCL					

Table 7. Statistics for Most Recent Groundwater Data
Former Columbia Marine Lines Facility
6305 Lower River Road, Vancouver, Washington

Sample Location/ TOC Elevation (feet)	Sample Date	Silica Gel Cleanup (TPH-Dx)	TPH-Gx (µg/L)	TPH-Dx (µg/L)	
				Diesel	Heavy Oil
Without Silica Gel Cleanup					
MW-1	8/30/2007		<80	5600	1250
MW-2	8/30/2007		108	9390	2850
MW-3	8/30/2007		<80	9390	3920
MW-4	8/30/2007		87.6	15600	3330
MW-11	8/31/2007		<80	402	<476
MW-12	8/31/2007		<80	<238	<476
MW-16	8/31/2007		116	12700	2800
MW-17	8/30/2007		<80	<236	<472
MW-19	8/31/2007		NA	30700	4680
EX-2	8/31/2007		104	11600	1270
RW-4	8/31/2007		NA	16400	2090
Number of Analyses			11	11	11
Number of Detections			4	9	8
Minimum			88	402	1,250
Average			68	10,184	2,082
Maximum			116	30,700	4,680
90UCL					

TPH-G = Total petroleum hydrocarbons as gasoline analysis by Washington DOE l
TPH-D = TPH as diesel and heavy oil analysis by Washington DOE Method WTPI results in mg/L.

Table 8. TPH-D Data
Former Columbia Marine Lines Facility
6305 Lower River Road, Vancouver, Washington

Sample Location / TOC Elevation (feet)	Depth (feet bgs)	Sample Date	TPH-D (mg/Kg)	TPH-O (mg/Kg)
GP1	2.5 - 3.0	5/6/1999	<25	<50
GP2	3 - 4	5/6/1999	104	<50
	7 - 8	5/6/1999	6,700	<500
GP3	3 - 4	5/6/1999	14,000	<2500
GP4	3 - 4	5/6/1999	<25	<50
GP5	3 - 4	5/6/1999	<25	<50
GP6	7 - 8	5/6/1999	<25	<50
GP7	7 - 8	5/6/1999	<25	<50
GP8	3 - 4	5/6/1999	<25	<50
GP9	3 - 4	5/6/1999	<25	<50
GP1A	11.0	9/10/1999	4,940	370
GP2A	11.0	9/10/1999	78	112
GP3A	13.0	9/10/1999	13,300	626
GP4A	12.0	9/10/1999	154	81.7
GP5A	12.0	9/10/1999	11,600	863
GP6A	10.0	9/14/1999	12,000	671
GP7A	11.0	9/14/1999	9,600	<1000
GP8A	12.0	9/10/1999	41	<50
GP9A	12.0	9/10/1999	6,670	<500
GP10A	13.0	9/10/1999	17,200	<1000
GP11A	10.0	9/14/1999	<25	<50
GP12A	10.0	9/14/1999	5,380	<500
GP13A	10.5	9/14/1999	32,500	<2500
GPC1	16.0	1/31/2002	12,800	602
GPC2	15.5	1/31/2002	7,320	275
GPC3	11.5-12.0	1/31/2002	19,200	625
GPC4	15-15.5	1/31/2002	4,130	<500
GPC5	12.0-12.5	1/31/2002	5,340	<500
GPC6	11.5-12.0	1/31/2002	4,830	492
GPC7	3.5-4.0	1/31/2002	<25	<50
	12-12.5	1/31/2002	3,820	<500
GPC8	3.5-4.0	1/31/2002	68	<50
	12.5-13.0	1/31/2002	586	<50
GPC9	6.5-7.0	1/31/2002	<25	<50
GPC10	6.5-7.0	1/31/2002	207	70.8
GPC11	6.5-7.0	1/31/2002	<25	<50
GPD1	13.0	5/10/2005	41	<0.5
GPD2	13.0	5/10/2005	327	60.7
GPD3	7.0	5/10/2005	6,340	277
	11.0	5/10/2005	5,570	277
GPD4	13.5	5/10/2005	<25	<50
GPD5	10.5	5/10/2005	<25	<50
GPD6	7.0	5/10/2005	<25	<50
	10.0	5/10/2005	<25	<50
GPD7	9.0	5/10/2005	39	<50
GPD8	10.0	5/10/2005	415	<50
GPD9	10.0	5/10/2005	12,100	536
	14.0	5/10/2005	225	207
GPD10	12.5	5/10/2005	1,370	158
GPD11	15.0	5/10/2005	61	<50
GPD12	11.0	5/10/2005	4,400	609
GPD13 [1]	7.0	5/10/2005	8,950	320
	10.5	5/10/2005	8,670	<50
GPD14	7.0	5/10/2005	3,190	199
	10.0	5/10/2005	1,500	289
GPD15 [2]	7.0	5/10/2005	3,450	<50
	10.5	5/10/2005	11,200	<250
GPD16	11.0	5/10/2005	6,620	238

Table 8. TPH-D Data
Former Columbia Marine Lines Facility
6305 Lower River Road, Vancouver, Washington

Sample Location / TOC Elevation (feet)	Depth (feet bgs)	Sample Date	TPH-D (mg/Kg)	TPH-O (mg/Kg)
GPE-1	5.0	8/24/2007	150	234
	11.0	8/24/2007	43	<32.8
GPE-2	5.0	8/24/2007	1,900	520
	11.0	8/24/2007	34	<31.0
GPE-3	5.0	8/24/2007	256	416
	10.0	8/24/2007	<15.8	<31.7
GPE-4	5.0	8/24/2007	329	462
	11.0	8/24/2007	31	<33.2
GPE-5	5.0	8/24/2007	27	58
	9.0	8/24/2007	20	<32.1
GPE-6	7.0	8/24/2007	104	66
	11.0	8/24/2007	3,580	192
GPE-7	6.0	8/24/2007	141	81.4
	10.0	8/24/2007	9,020	<668
GPE-8	6.0	8/24/2007	7,080	<637
	9.0	8/24/2007	<16.5	<33.1
1999 Statistics				
Number of Analyses			23	23
Number of Detections			15	6
Minimum			41	82
Average			5,842	314
Maximum			32,500	863
2002 Statistics				
Number of Analyses			13	13
Number of Detections			10	5
Minimum			68	71
Average			4,488	226
Maximum			19,200	625
2005 Statistics				
Number of Analyses			22	22
Number of Detections			18	11
Minimum			39	61
Average			3,387	160
Maximum			12,100	609
2007 Statistics				
Number of Analyses			16	22
Number of Detections			14	12
Minimum			20	158
Average			1,421	205
Maximum			9,020	609
All Data Statistics				
Number of Analyses			74	74
Number of Detections			57	30
Minimum			20	58
Average			3,918	222
Maximum			32,500	863
95UCL (ProUCL Chebyshev UCL)			5,842	294
95UCL (ProUCL Chebyshev UCL)			8,092	396

Table 9. TPH-D Data
Former Columbia Marine Lines Facility
6305 Lower River Road, Vancouver, Washington

Soil Boring Location	Date	Sample Depth (ft)	TPH-D Result (mg/kg)		Nearby Previous Soil Boring	Date	Sample Depth (ft)	TPH-D Result (mg/kg)	Percentage Reduction
GPD1	5/10/2005	13	41		GPC-1	1/31/2002	16	12,800	100%
GPD2	5/10/2005	13	327		GPC-2	1/31/2002	15.5	7,320	96%
GPD3	5/10/2005	7	6,340				none		NA
		11	5,570		GP-3A	9/10/1999	13	13,300	58%
GPD4	5/10/2005	13.5	12.5	ND	GP-6A	9/10/1999	10	12,000	100%
GPD5	5/10/2005	10.5	12.5	ND	GP-7A	9/10/1999	11	9,600	100%
GPD6	5/10/2005	7	12.5	ND			none		NA
		10	12.5	ND	GP-12A	9/10/1999	10	5,380	100%
GPD7	5/10/2005	9	38.6		GP-1A	9/10/1999	11	4,940	99%
GPD8	5/10/2005	10	415		GPC-3	1/31/2002	12	19,200	98%
GPD9	5/10/2005	10	2,100				none		NA
		14	225				none		NA
GPD10	5/10/2005	12.5	1,370		GPC-4	1/31/2002	15.5	4,130	67%
GPD11	5/10/2005	15	61				none		NA
GPD12	5/10/2005	11	4,400		GPC-6	1/31/2002	12	4,830	9%
GPD13	5/10/2005	7	8,950				none		NA
		10.5	8,670				none		NA
GPD14	5/10/2005	7	3,190				none		NA
		10	1,500				12.5	5,340	72%
GPD15	5/10/2005	7	3,450				none		NA
		10.5	11,200		GP-10A	9/10/1999	13	17,200	35%
					GPC-7	1/31/2002	12.5	3,820	100%
GPD16	5/10/2005	11	6,620		GPC-8	1/31/2002	13	586	-1030%
Average			**2,933**					**8,603**	**66%**

Table A-1. Dual Phase Extraction System Monitoring Data
Former Columbia Marine Lines Facility
6305 Lower River Road, Vancouver, Washington

Date	Blower Runtime (Hours)	Groundwater Recovery: Flowmeter Readings: Knockout Drum (gal)	Groundwater Recovery: Flowmeter Readings: Total Discharge (gal)	Groundwater Recovery: Liquid Removal Rates: Knockout Drum (gpd)	Groundwater Recovery: Liquid Removal Rates: Total[1] (gpd)	VOC Monitoring: Blower Discharge: PID Reading (ppm)	VOC Monitoring: Blower Discharge: Analytical Result (mg/m^3)	VOC Monitoring: Carbon Midpoint #1: PID Reading (ppm)	VOC Monitoring: Carbon Midpoint #1: Air Flowrate (cfm)	VOC Monitoring: Carbon Midpoint #2: PID Reading (ppm)	VOC Monitoring: Carbon Midpoint #2: Air Flowrate (cfm)	VOC Monitoring: Discharge Stack: PID Reading (ppm)	VOC Monitoring: Discharge Stack: Air Flowrate (cfm)	VOC Monitoring: Discharge Stack: Air Flowrate (m^3/min)	Vacuum Monitoring: Vacuum in Knockout Drum ("H2O)	Vacuum Monitoring: PT-1: Oxygen (%)	Vacuum Monitoring: PT-1: Induced Vacuum ("H2O)	Vacuum Monitoring: PT-2: Oxygen (%)	Vacuum Monitoring: PT-2: Induced Vacuum ("H2O)	Vacuum Monitoring: PT-3: Oxygen (%)	Vacuum Monitoring: PT-3: Induced Vacuum ("H2O)	Vacuum Monitoring: PT-4: Oxygen (%)	Vacuum Monitoring: PT-4: Induced Vacuum ("H2O)	Product Thickness in O/W Tank (ft)
11/29/2000	--	--	--	--	--	93.2	--	67.2	--	66.4	--	5.1	125	3.54	58	--	0.05	--	0.62	--	0	--	0.03	0
11/30/2000	--	--	--	--	--	73.9	--	40.8	--	23.3	--	0	118	3.34	59	--	0.06	--	0.7	--	0	--	0.06	--
12/5/2000	--	--	0	--	--	191	1,020	121	--	129	--	73.2	139	3.94	72	20.7	0.07	20.7	0.73	20.5	0	20.7	0.06	--
12/20/2000	--	--	710	--	--	56.8	--	0.0	74.5	0.0	72.5	0.0	149	4.22	56	--	--	--	--	--	--	--	--	--
12/29/2000	--	--	1,489	--	--	71.6	--	0.0	76.5	0.0	69.5	0.0	150	4.25	60	--	0.00	--	0.00	--	0.00	--	0.00	0
1/4/2001	--	--	1,656	--	--	83.7	--	0.0	67.5	0.0	66.5	0.0	141	3.99	60	12.7	--	15.5	--	9	--	8.9	--	--
1/10/2001	--	--	3,214	--	--	73.8	--	0.4	70.0	0.0	68.5	0.0	140	3.96	60	20.0	0.10	19.6	0.60	11.8	0.00	16.7	0.00	0
1/12/2001	--	0	4,387	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1/17/2001	0	260	5,124	--	--	80.2	253	2.4	72.5	4.8	75.5	0.4	157	4.45	60	--	--	--	--	--	--	--	--	--
1/26/2001	74	1,429	7,535	380	783	74.2	--	17.8	--	28.2	--	0.0	--	--	60	--	--	--	--	--	--	--	--	--
2/2/2001	241	3,220	9,167	258	235	36	--	66.7	71.5	82.9	71.0	8.5	151	4.28	60	--	0.09	--	0.63	--	0.01	--	0.05	--
2/7/2001	243	3,271	9,187	556	218	91.5	--	86.8	69.0	114.0	67.0	8.1	151	4.28	60	3.7	0.00	3.5	0.00	3.4	0.00	17.2	0.00	--
2/13/2001	244	3,290	9,242	415	1200	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
2/23/2001	478	6,095	12,094	287	292	65.8	--	0.3	75.5	0.3	71.5	0.6	141	3.99	64	--	0.10	--	0.59	--	0.02	--	0.06	--
2/28/2001	599	7,407	14,350	261	449	89.6	--	4.6	79.5	2.9	72.5	0.1	144	4.08	64	--	0.07	--	0.60	--	0.00	--	0.04	--
3/12/2001	760	10,534	17,785	466	512	--	--	--	--	--	--	--	--	--	64	20.9	0.06	20.9	0.48	20.7	0.00	20.9	0.02	--
3/15/2001	760	10,556	18,685	0	0	90.2	--	25.0	--	30.5	--	0.0	--	--	65	--	--	--	--	--	--	--	--	0.02
5/30/2003	13494	225,488	245,193	405	427	36.8	--	41.6	--	56.8	--	22.2	--	--	75	19.8	0.02	20.9	0.20	19.2	0.01	20.8	0.00	--
12/2/2004	17121	246,300	281,435	138	240	--	--	--	--	--	--	0.7	--	--	60	21.1	0.00	21.1	0.01	21	0.00	21	0.00	--
12/10/2004	17122	246,700	281,435	9600	0	0.9	--	0.0	--	0.5	--	0.0	--	--	50	--	--	--	--	--	--	--	--	--
12/14/2004	17130	254,170	281,625	23589	600	3.4	--	1.4	--	0.6	--	0.3	--	--	60	21	0.01	21	0.02	20.9	0.01	21	0.00	--
12/28/2004	17401	289,300	282,550	3111	82	--	--	--	--	--	--	--	--	--	70	--	--	--	--	--	--	--	--	--
1/3/2005	17442	305,400	282,551	9425	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1/18/2005	17442	305,680	282,831			--	--	--	--	--	--	2.6	--	--	--	--	--	--	--	20.9	0.00	--	--	--
1/27/2005	17442	288	283,240			1.6	--	0.2	--	0.2	--	0.2	--	--	72	20.5	0.01	20.9	0.03	20.1	0.01	9.5	0.00	--
2/11/2005	17801	7,627	285,079	491	123	1.2	--	1.9	--	3.7	--	0.0	--	--	80	--	0.01	--	0.06	--	0.00	--	0.00	--
3/3/2005	18281	12,720	288,290	255	161	0.8	--	0.7	--	0.6	--	0.3	--	--	--	--	--	--	0.10	--	0.00	--	0.01	--
3/17/2005	18618	14,010	289,150	92	61	2.1	--	0.7	--	0.8	--	0.4	--	--	--	--	0.01	--	0.10	--	0.00	--	0.00	--
4/9/2005	19143	16,660	292,280	121	143	--	--	--	--	--	--	--	--	--	--	--	0.20	--	0.28	--	0.00	--	0.00	--
4/27/2005	19599	20,800	296,950	218	246	8.5	--	2.7	--	5.3	--	0.3	--	--	--	--	0.00	--	0.05	--	0.00	--	0.00	--
5/5/2005	19793	23,060	299,200	280	278	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
5/26/2005	19872	23,940	2	267		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
6/9/2005	19899	24,250	29	276	24	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
6/15/2005	20016	24,270	32	4	1	5.5	--	2.3	--	2.1	--	1.5	--	--	--	--	0.00	--	0.00	--	0.00	--	0.00	--
7/1/2005	20093	24,758	790	152	236	31.8	--	16.8	--	22.7	--	57.1	--	--	70	--	0.02	--	0.10	--	0.01	--	0.00	--
8/16/2005	20531	27,530	3,450	152	146	1586	--	1039.0	--	1949.0	--	844.0	--	--	75	20	0.02	20.5	0.03	18.8	0.01	5.6	0.00	--
9/14/2005	20839	29,180	4,890	129	112	740	--	152.0	--	243.0	--	98.3	--	--	70	20.9	0.00	20.9	0.07	20.9	0.00	20.9	0.00	--
11/9/2005	21242	29,247	4,942	4	3	11.6	--	--	--	--	--	22.2	--	--	--	--	--	5.5	0.00	20.8	0.00	3.9	0.00	--
12/8/2005	21256	29,282	4,990	60	82	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1/18/2006	21256	29,284				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Notes

-- Not Measured

[1] Instances where the total volume of water removed is less than the volume removed by in the knockout drum are due to clogging of the liquid phase activated carbon. The clogging caused a high level condition in the tank, triggering shutdown of the blower. Because water backed up in the tank, the volume measured by the discharge flow meter was less than the volume measured by the knockout drum flow meter.

Table A-2. Vapor Extraction Hydrocarbon Removal Rate
Former Columbia Marine Lines Facility
6305 Lower River Road, Vancouver, Washington

Date	PID Conc (ppm)	GRO (mg/m3)	Flowrate (acfm)	Temp (F)	Temp (K)	Pressure (atm)	Flowrate (scfm)	Flowrate (m3/hr)	TPH-G(x) Removal Rate (lb/hr)	Elapsed Time (hours)	HC Removed (lb)
11/30/2000	73.9	296	118	72.6	296	1.0	119	202	0.13	0	0
12/20/2000	56.8	227	149	60.9	289	1.0	147	250	0.12	0	0
12/29/2000	71.6	286	150	57.8	287	1.0	147	250	0.16	0	0
1/4/2001	83.7	335	141	67.5	293	1.0	141	239	0.18	0	0
1/10/2001	73.8	295	140	73.8	296	1.0	142	240	0.16	0	0
1/17/2001	80.2	253	157	52.2	284	1.0	152	259	0.14	0	0
2/2/2001	65	260	70	83.3	302	1.0	72	122	0.07	241	26
2/7/2001	91.5	366	151	71.6	295	1.0	152	258	0.21	243	0.3
2/23/2001	65.8	263	141	78.3	299	1.0	144	244	0.14	478	41
2/28/2001	89.6	358	144	75	297	1.0	146	248	0.20	599	20
3/15/2001	90.2	361	140	75	297	1.0	142	241	0.19	760	31
5/30/2003	36.8	147	150	75	297	1.0	152	258	0.08	13494	1,753
12/10/2004	0.9	4	150	60	289	1.0	148	251	0.00	17122	155
12/14/2004	3.4	14	150	60	289	1.0	148	251	0.01	17130	0.04
1/27/2005	1.6	6	150	60	289	1.0	148	251	0.00	17442	1.7
2/11/2005	1.2	5	150	60	289	1.0	148	251	0.00	17801	1.1
3/3/2005	0.8	3	150	75	297	1.0	152	258	0.00	18281	1.1
3/17/2005	2.1	8	150	75	297	1.0	152	258	0.00	18618	1.1
4/27/2005	8.5	34	150	75	297	1.0	152	258	0.02	19599	12
6/15/2005	5.5	22	150	75	297	1.0	152	258	0.01	20016	6.6
7/1/2005	31.8	127	150	75	297	1.0	152	258	0.07	20093	3.3
8/16/2005	1586	6344	150	75	297	1.0	152	258	3.61	20531	806
9/14/2005	740	2960	150	75	297	1.0	152	258	1.68	20839	815
11/9/2005	11.6	46	150	60	289	1.0	148	251	0.03	21242	344

Table A-3. Effluent Hydrocarbon Analytical Results
Former Columbia Marine Lines Facility
6305 Lower River Road, Vancouver, Washington

Sample	Sample Date	BTEX (µg/L) Benzene	Toluene	Ethyl-benzene	Total Xylenes	Gasoline Range Hydrocarbons (ug/L)	Diesel Range Organics (mg/L)	Heavy Oil Range HC (mg/L)
Liquid Phase Carbon Influent	1/17/2001	<0.5	0.728	7.99	14.4	9,480	1,230[a]	145[a]
	6/7/2001	<0.5	<0.5	<0.5	<1.0	2,190	7.03[a]	<0.5[a]
	10/18/2001	<0.5	<0.5	<0.5	<1.0	3,790	26.5	<0.5
	4/15/2002	--	--	--	--	<80.0	0.485[a]	<0.5[a]
	5/24/2002	--	--	--	--	89	0.624[a]	<0.5[a]
	6/29/2002	--	--	--	--	323	1.53[a]	<0.5[a]
	7/26/2002	--	--	--	--	190	0.426[a]	<0.5[a]
	8/23/2002	--	--	--	--	143	0.377[a]	<0.5[a]
	10/25/2002	--	--	--	--	143	0.808[a]	<0.5[a]
	11/25/2002	--	--	--	--	304	1.51[a]	<0.5[a]
	12/26/2002	--	--	--	--	104	1.59[a]	<0.5[a]
	1/20/2003	--	--	--	--	107	1.82[a]	<0.5[a]
	2/21/2003	--	--	--	--	167	1.72[a]	<0.5[a]
	12/14/2004	<0.500	<0.500	<0.500	<1.00	91.7	0.863	<0.667
	1/27/2005	--	--	--	--	<80.0	0.509	<0.500
	3/3/2005	--	--	--	--	<80.0	0.499	<0.500
	4/8/2005	--	--	--	--	<80.0	<0.250	<0.500
	6/15/2005	--	--	--	--	<80.0	0.636	<0.500
	8/16/2005	--	--	--	--	<80.0	8.96	<0.500
	9/14/2005	--	--	--	--	<80.0	<0.250	<0.500
	11/9/2005	--	--	--	--	<80.0	<0.240	<0.481
	12/8/2005	--	--	--	--	<80.0	<0.236	<0.472
Liquid Phase Carbon Midpoint	12/1/2000	<0.5	<0.5	<0.5	<1.0	1,150	--	--
	1/17/2001	<0.5	<0.5	<0.5	<0.5	1,120	2.8[a]	<0.5[a]
	6/7/2001	<2.5	<2.5	<2.5	<0.5	6,210	44.2[a]	<0.5[a]
	10/18/2001	<0.5	<0.5	<0.5	<1.0	193	2.23	<0.5
	4/15/2002	--	--	--	--	<80.0	0.377[a]	<0.5[a]
	5/24/2002	--	--	--	--	<80.0	<0.25[a]	<0.5[a]
	6/29/2002	--	--	--	--	<80.0	<0.25[a]	<0.5[a]
	7/26/2002	--	--	--	--	<80.0	<0.25[a]	<0.5[a]
	8/23/2002	--	--	--	--	<80.0	<0.25[a]	<0.5[a]
	9/13/2002	--	--	--	--	<80.0	--	--
	10/25/2002	--	--	--	--	<80.0	<0.25[a]	<0.5[a]
	11/25/2002	--	--	--	--	<80.0	0.651[a]	<0.5[a]
	12/26/2002	--	--	--	--	<80.0	0.599[a]	<0.5[a]
	1/20/2003	--	--	--	--	<80.0	0.712[a]	<0.5[a]
	2/21/2003	--	--	--	--	<80.0	0.4[a]	<0.5[a]
	12/14/2004	<0.500	<0.500	<0.500	<1.0	<80.0	<0.250	<0.500
	1/27/2005	--	--	--	--	<80.0	<0.250	<0.500
	3/3/2005	--	--	--	--	<80.0	<0.250	<0.500
	4/8/2005	--	--	--	--	<80.0	<0.250	<0.500
	6/15/2005	--	--	--	--	--	--	--
	8/16/2005	--	--	--	--	--	--	--
	9/14/2005	--	--	--	--	--	--	--
	11/9/2005	--	--	--	--	--	--	--
	12/8/2005	--	--	--	--	--	--	--
Liquid Phase Carbon Effluent	12/1/2000	<0.5	<0.5	<0.5	<0.5	109	--	--
	1/17/2001	<0.5	<0.5	<0.5	<0.5	102	<0.25[a]	<0.5[a]
	6/7/2001	<0.5	<0.5	<0.5	<1.0	173	<0.25[a]	<0.5[a]
	10/18/2001	<0.5	<0.5	<0.5	<1.0	<80.0	0.356	<0.5
	2/7/2002	--	--	--	--	595	5.52[a]	<0.5[a]
	3/27/2002	--	--	--	--	<80.0	1.17[a]	<0.5[a]
	4/15/2002	--	--	--	--	<80.0	0.251[a]	<0.5[a]
	5/24/2002	--	--	--	--	<80.0	<0.25[a]	<0.5[a]
	6/29/2002	--	--	--	--	<80.0	<0.25[a]	<0.5[a]
	7/26/2002	--	--	--	--	<80.0	<0.25[a]	<0.5[a]
	8/23/2002	--	--	--	--	<80.0	<0.25[a]	<0.5[a]
	9/13/2002	--	--	--	--	<80.0	<0.25[a]	<0.5[a]
	10/25/2002	--	--	--	--	<80.0	<0.25[a]	<0.5[a]

Table A-3. Effluent Hydrocarbon Analytical Results
Former Columbia Marine Lines Facility
6305 Lower River Road, Vancouver, Washington

Sample	Sample Date	BTEX (µg/L) Benzene	Toluene	Ethyl-benzene	Total Xylenes	Gasoline Range Hydrocarbons (ug/L)	Diesel Range Organics (mg/L)	Heavy Oil Range HC (mg/L)
	11/25/2002	--	--	--	--	<80.0	<0.25[a]	<0.5[a]
	12/26/2002	--	--	--	--	<80.0	0.39[a]	<0.5[a]
	1/20/2003	--	--	--	--	<80.0	0.948[a]	<0.5[a]
	2/21/2003	--	--	--	--	<80.0	<0.25[a]	<0.5[a]
	4/25/2003	--	--	--	--	<80.0	<0.25[a]	<0.5[a]
	12/14/2004	<0.500	<0.500	<0.500	<1.0	<80.0	<0.312	<0.625
	1/27/2005	--	--	--	--	<80.0	<0.250	<0.500
	3/3/2005	--	--	--	--	<80.0	<0.250	<0.500
	4/8/2005	--	--	--	--	<80.0	<0.250	<0.500
	6/15/2005	--	--	--	--	<80.0	<0.250	<0.500
	8/16/2005	--	--	--	--	<80.0	<0.250	<0.500
	9/14/2005	--	--	--	--	<80.0	<0.250	<0.500
	11/9/2005	--	--	--	--	<80.0	<0.238	<0.476
	12/8/2005	--	--	--	--	<80.0	<0.250	<0.500
Vapor Phase Carbon Influent	12/1/2000	<0.868	<2.73	<2.6	<4.79	1,020	--	--
	1/17/2001	1.1	0.329	0.879	1.06	253	--	--
	10/18/2001	0.226	0.347	0.252	1.62	350	--	--
	8/15/2002	<0.1	<0.1	0.145	1.16	173	--	--

Notes
-- Not measured
a Analysis done utilizing the silica gel cleanup method.

Table A-4. Liquid Hydrocarbon Removal Rate
Former Columbia Marine Lines Facility
6305 Lower River Road, Vancouver, Washington

Date	Flow Meter Reading (gal)	GRO (mg/L)	DRO (mg/L)	HRO (mg/L)	Hydrocarbon Removed (lbs)
12/5/2000	0	9.50	1230.00	145.00	0.0
12/20/2000	710	9.27	1191.24	140.41	7.9
12/29/2000	1,489	9.01	1148.70	135.38	16.1
1/4/2001	1,656	8.96	1139.59	134.30	17.7
1/10/2001	3,214	8.45	1054.52	124.23	31.9
1/12/2001	4,387	8.07	990.48	116.65	40.8
1/17/2001	5,124	7.83	950.24	111.89	45.8
1/26/2001	7,535	7.04	818.61	96.31	58.0
2/2/2001	9,167	6.51	729.51	85.76	62.9
2/7/2001	9,187	6.50	728.42	85.63	62.9
2/13/2001	9,242	6.48	725.41	85.28	63.0
2/23/2001	12,094	5.55	569.70	66.85	64.8
2/28/2001	14,350	4.82	446.53	52.27	60.3
3/12/2001	17,785	3.70	258.99	30.07	43.5
3/15/2001	18,685	3.40	209.85	24.26	37.0
6/7/2001	22400	2.19	7.03	0.25	1.8
10/18/2001	57866	3.79	26.50	0.25	14.8
4/15/2002	105599	0.00	0.49	0.25	0.6
5/24/2002	115999	0.09	0.62	0.25	0.9
6/29/2002	125599	0.32	1.53	0.25	2.2
7/26/2002	132799	0.19	0.43	0.25	1.0
8/23/2002	140266	0.14	0.38	0.25	0.9
10/25/2002	157066	0.14	0.81	0.25	1.6
11/25/2002	165332	0.30	1.51	0.25	2.8
12/26/2002	173599	0.10	1.59	0.25	2.8
1/20/2003	180266	0.11	1.82	0.25	3.3
2/21/2003	188799	0.17	1.72	0.25	3.4
12/14/2004	254,170	0.09	0.86	0.33	2.7
1/27/2005	305968	0.00	0.51	0.25	1.9
3/3/2005	318400	0.00	0.50	0.25	2.0
4/8/2005	322340	0.00	0.13	0.25	1.0
6/15/2005	329950	0.00	0.64	0.25	2.4
8/16/2005	333210	0.00	8.96	0.25	25.6
9/14/2005	334860	0.00	0.13	0.25	1.0
11/9/2005	334927	0.00	0.12	0.24	1.0
12/8/2005	334962	0.00	0.12	0.44	1.5

Total Hydrocarbon Removed: 688.1

Table A-5. Biorespiration Test Data
Former Columbia Marine Lines Facility
6305 Lower River Road, Vancouver, Washington

Time	Time After Shutdown (hours)	PT-1 Vacuum ("wc)	PT-1 O2 conc. (%)	PT-2 Vacuum ("wc)	PT-2 O2 conc. (%)	PT-3 Vacuum ("wc)	PT-3 O2 conc. (%)	PT-4 Vacuum ("wc)	PT-4 O2 conc. (%)	MW-1 Vacuum ("wc)	MW-1 O2 conc. (%)	MW-1 DTW (ft bg toc)	MW-18 Vacuum ("wc)	MW-18 O2 conc. (%)	MW-18 DTW (ft bg toc)	MW-21 Vacuum ("wc)	MW-21 O2 conc. (%)	MW-21 DTW (ft bg toc)	EX-2 Vacuum ("wc)	EX-2 O2 conc. (%)	EX-2 DTW (ft bg toc)
3/12/2001																					
10:43	--	0.06	20.9	0.48	20.9	0	20.7	0.02	20.9	0	19.9	11.28	0	20.7	dry	0	20.7	dry	0	20.8	14.44
	BLOWER SHUTDOWN AT 11:07 AM																				
11:07	0	0	20.9	0	20.9	0	20.7	0	20.8	0	19.9	--	0	20.7	--	0	20.7	--	0	20.8	--
11:22	0:15:00	0	20.8	0	20.6	0	20.2	0	20	0	19.9	11.26	0	20.7	dry	0	20.7	dry	0	20.8	14.44
11:39	0:32:00	--	20.7	--	20.5	--	18.7	--	18.1	--	19.8	--	--	20.6	--	--	20.7	--	--	20.7	--
11:56	0:49:00	--	20.7	--	20.5	--	18.6	--	17.6	--	19.8	--	--	20.6	--	--	20.7	--	--	20.7	--
12:10	1:03:00	--	20.7	--	20.5	--	18.2	--	17.6	--	19.9	11.28	--	20.6	dry	--	20.7	dry	--	20.6	14.43
12:26	1:19:00	--	20.6	--	20.5	--	17.9	--	16.7	--	19.8	--	--	20.6	--	--	20.7	--	--	20.6	--
12:40	1:33:00	--	20.7	--	20.5	--	17.3	--	16	--	19.8	--	--	20.6	--	--	20.6	--	--	20.6	--
12:54	1:47:00	0	20.6	0	20.4	0	16.2	0	15.53	0	19.8	11.28	0	20.7	dry	0	20.6	dry	0	20.6	--
13:30	2:23:00	--	20.6	--	20.2	--	14.6	--	13.7	--	19.9	--	--	20.7	--	--	20.7	--	--	20.4	--
14:30	3:23:00	--	20.6	--	20.3	--	16.1	--	16.5	--	20.3	--	--	20.7	--	--	20.7	--	--	20.7	--
15:20	4:13:00	--	20.4	--	19.9	--	14	--	13.8	--	20	--	--	20.6	--	--	20.6	--	--	20.3	--
16:20	5:13:00	--	20.6	--	20.2	--	11.6	--	11.8	--	20	--	--	20.8	--	--	20.8	--	--	20.1	--
17:00	5:53:00	0	20.7	0	20.2	0	10.1	0	9.5	0	20	11.28	0	20.8	dry	0	20.8	dry	0	20.1	14.42
3/13/2001																					
7:30	20:23:00	0	20.2	0	18.2	0	3.9	0	2.8	0	19.8	11.26	0	20.6	dry	0	20.6	dry	0	18.7	14.41
15:00	27:53:00	0	19.8	0	16	0	5.2	0	2	0	19.8	--	0	20.6	--	0	20.6	--	0	18.4	--
3/15/2001																					
13:15	74:08:00	--	17.9	--	2.4	--	2.7	--	2.2	--	19.7	--	--	20.6	--	--	20.6	--	--	16.3	--

Notes. -- = Not measured

Table A-7. Observed Biorespiration Rates
Former Columbia Marine Lines Facility
6305 Lower River Road, Vancouver, Washington

March 2002 Biorespiration Test

Monitoring Location	Oxygen Depletion Rate (%O_2/day)	Hydrocarbon Biodegradation Rate (mg/Kg/day)	Volume of Influence (ft^3)	Mass of Influence (kg)	Annual Degradation Rate (mg/Kg/yr)	Hydrocarbon Removed (lb/day)
PT-1	-1.8	-0.6	12,566	507,122	-213	-0.7
PT-2	-4.1	-1.3	12,566	507,122	-469	-1.5
PT-3	-29.6	-9.8	12,566	507,122	-3417	-10.9
PT-4	-35.4	-11.7	12,566	507,122	-4091	-13.1
PT-5	-2.2	-0.7	12,566	507,122	-256	-0.8
PT-6	-9.6	-3.2	12,566	507,122	-1108	-3.5
PT-7	-10.0	-3.3	12,566	507,122	-1151	-3.7
PT-8	-19.9	-6.6	12,566	507,122	-2301	-7.3
					Average:	**-5.2**

March 2001 Biorespiration Test

Monitoring Location	Oxygen Depletion Rate (%O_2/day)	Hydrocarbon Biodegradation Rate (mg/Kg/day)	Volume of Influence (ft^3)	Mass of Influence (kg)	Annual Degradation Rate (mg/Kg/yr)	Hydrocarbon Removed (lb/day)
PT-1	-3	-1.1	12,566	507,122	-369	-1.2
PT-2	-6	-1.8	12,566	507,122	-626	-2.0
PT-3	-43	-12.5	12,566	507,122	-4391	-14.0
PT-4	-46	-13.3	12,566	507,122	-4640	-14.8
MW-1	0	0.0	12,566	507,122	0	0.0
MW-18	0	0.0	12,566	507,122	0	0.0
MW-21	0	0.0	12,566	507,122	0	0.0
EX-2	-2	-0.4	12,566	507,122	-152	-0.5
					Average:	**-4.1**

February 2000 Biorespiration Test

Monitoring Location	Oxygen Depletion Rate (%O_2/day)	Hydrocarbon Biodegradation Rate (mg/Kg/day)	Volume of Influence (ft^3)	Mass of Influence (kg)	Annual Degradation Rate (mg/Kg/yr)	Hydrocarbon Removed (lb/day)
Run One						
P-1D	-48	-14	12,566	507,122	-4872	-16
P-2D	-19	-6	12,566	507,122	-1929	-6
MW-8	-15	-4	12,566	507,122	-1523	-5
Run Two						
MW-8	-192	-56	12,566	507,122	-19488	-62
Run Three						
P-3D	-126	-37	12,566	507,122	-12789	-41
P-4D	-552	-160	12,566	507,122	-56028	-179
					Average:	**-51.4**

APPENDIX B

AUGUST 2007 BORING LOGS

Project: Crowley Marine Services	Boring/Well Name: GPE-1
Boring Location:	Job #: 008.0205.00007
Drilling Company: ESN Northwest Inc.	Logged by: Chris Kramer
Equipment: Track mounted Geoprobe	Start Date/Time: 8-24-07 @ 1015
Sampling Method: Split spoon	Finish Date/Time: 8-24-07
Hammer Weight:	Monitoring Device:
Screened Interval (bgs):	First Water (bgs): 12

Sample I.D.	Sample Interval	Recovery (%)	PID (ppm)	Blow Counts	Depth (feet bgs)	USCS Code	Graphic Log	Lithologic Description	Boring Abandonment or Well Construction Details
					0	O		0-1.0 Organics	
						SP		1-2.5 SAND: Brown, dry, loose, medium to coarse.	
								Sharp Contact	
GPE-1-5 @ 1030					5	SP		2.5-6.0 SAND: Brown, slightly moist, medium to coarse.	
						SP		6.0-10.5 SAND: Grayish-to-black stained with odor.	
GPE-1-11 @ 1032					10	ML		10.5-12.0 SILT: Gray, moist.	
					15				
					20				

Depth of Boring (bgs): 12	Filter Pack:
Depth of Well (bgs):	Annulus Seal:
	Surface Seal:

Project: Crowley Marine Services		Boring/Well Name: GPE-2
Boring Location:	Job #: 008.0205.00007	
Drilling Company: ESN Northwest Inc.	Logged by: Chris Kramer	
Equipment: Track mounted Geoprobe	Start Date/Time: 8-24-07 @ 915	
Sampling Method: Split spoon	Finish Date/Time: 8-24-07	
Hammer Weight:	Monitoring Device:	
Screened Interval (bgs):	First Water (bgs): 12	

Sample I.D.	Sample Interval	Recovery (%)	PID (ppm)	Blow Counts	Depth (feet bgs)	USCS Code	Graphic Log	Lithologic Description		Boring Abandonment or Well Construction Details
					0	O		0-2.5	Sandy ORGANICS: Brown, medium to coarse sand.	
GPE-2-5 @ 934					5	SP		2.5-8.0	SAND: Brown, slight moisture, slight odor.	
					10	SP		8.0-11.0	SAND: Black stained with odor, medium to coarse.	
GPE-2-11 @ 949						ML		11.0-12.0	SILT: Gray, no odor.	
					15					
					20					

Depth of Boring (bgs): 12	Filter Pack:
Depth of Well (bgs):	Annulus Seal:
	Surface Seal:

Project: Crowley Marine Services		Boring/Well Name: GPE-3
Boring Location:	Job #: 008.0205.00007	
Drilling Company: ESN Northwest Inc.	Logged by: Chris Kramer	
Equipment: Track mounted Geoprobe	Start Date/Time: 8-24-07 @ 1115	
Sampling Method: Split spoon	Finish Date/Time: 8-24-07	
Hammer Weight:	Monitoring Device:	
Screened Interval (bgs):	First Water (bgs): 12	

Sample I.D.	Sample Interval	Recovery (%)	PID (ppm)	Blow Counts	Depth (feet bgs)	USCS Code	Graphic Log	Lithologic Description		Boring Abandonment or Well Construction Details
					0	O		0-1.0	Sandy ORGANICS: Brown, medium to coarse sand.	
						SP		1.0-4.5	SAND: Brown, medium to coarse, dry to moist, loose.	
GPE-3-5 @ 1147					5	SP		4.5-6.0	SAND: Brown, medium to coarse, moist, tighter pack.	
						SP		6.0-11.0	SAND: Black stained with odor.	
GPE-3-10 @ 1200					10					
						ML		11.0-12.0	SILT: Gray, no odor.	
					15					
					20					

Depth of Boring (bgs): 12	Filter Pack:
Depth of Well (bgs):	Annulus Seal:
	Surface Seal:

Project: Crowley Marine Services	Boring/Well Name: GPE-4
Boring Location:	
Drilling Company: ESN Northwest Inc.	Job #: 008.0205.00007
Equipment: Track mounted Geoprobe	Logged by: Chris Kramer
Sampling Method: Split spoon	Start Date/Time: 8-24-07
Hammer Weight:	Finish Date/Time: 8-24-07
	Monitoring Device:
Screened Interval (bgs):	First Water (bgs): 13

Sample I.D.	Sample Interval	Recovery (%)	PID (ppm)	Blow Counts	Depth (feet bgs)	USCS Code	Graphic Log		Lithologic Description	Boring Abandonment or Well Construction Details
					0	SP		0-2.5	SAND: Medium to coarse, dry, loose.	
									Sharp Contact	
GPE-4-5 @ 1503					5	SP		2.5-7.5	SAND: Rust colored, tighter pack with fines.	
GPE-4-11 @ 1511					10	SP		7.5-12.0	SAND: Black with odor, medium to coarse, moist.	
						ML		12.0-13.0	SILT: Gray	
					15					
					20					

Depth of Boring (bgs): 13	Filter Pack:
Depth of Well (bgs):	Annulus Seal:
	Surface Seal:

Project: Crowley Marine Services		Boring/Well Name:
Boring Location:	Job #: 008.0205.00007	GPE-5
Drilling Company: ESN Northwest Inc.	Logged by: Chris Kramer	
Equipment: Track mounted Geoprobe	Start Date/Time: 8-24-07	
Sampling Method: Split spoon	Finish Date/Time: 8-24-07	
Hammer Weight:	Monitoring Device:	
Screened Interval (bgs):	First Water (bgs): 11	

Sample I.D.	Sample Interval	Recovery (%)	PID (ppm)	Blow Counts	Depth (feet bgs)	USCS Code	Graphic Log	Lithologic Description		Boring Abandonment or Well Construction Details
					0	O		0-0.25	Organics	
						SP		0.25-5.5	SAND: Brown, medium to coarse, dry with no odors.	
GPE-5-5 @ 1247					5					
						SP		5.5-10.0	SAND: Black with odors.	
GPE-5-9 @ 1250										
					10	ML		10.0-11.0	SILT: Gray	
					15					
					20					

Depth of Boring (bgs): 11	Filter Pack:
Depth of Well (bgs):	Annulus Seal:
	Surface Seal: