Preliminary Site Characterization Report for the Harbor Oil Site

Prepared for the Voluntary Group
for the Harbor Oil Site RI/FS

August 8, 2008

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AND
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Acronyms

AMSL	above mean sea level
AOC	Administrative Settlement Agreement and Order on Consent for Remedial Investigation/Feasibility Study
ARI	Analytical Resources, Inc.
ASTM	American Society for Testing and Materials
AWQC	ambient water quality criteria
BAF	bioaccumulation factor
bgs	below ground surface
BSAF	biota-sediment accumulation factor
CVAA	cold vapor atomic absorption
DEQ	Oregon Department of Environmental Quality
dw	dry weight
EPA	US Environmental Protection Agency
EPC	exposure point concentration
EMRI	Energy & Materials Recovery, Inc.
EW	extraction wells
GC/ECD	gas chromatography/electron capture detection
GC/MS	gas chromatography/mass spectrometry
GC/FID	gas chromatography/flame ionization detection
GPS	global positioning system
HQ	hazard quotient
ICP-AES	inductively coupled plasma-atomic emission spectrometry
ICP-MS	inductively coupled plasma-mass spectrometry
ID	identification
IDW	investigation-derived waste
LCS	laboratory control sample
LOAEL	lowest-observed-adverse-effects level
LNAPL	light non-aqueous phase liquids
ml/min	milliliters per minute
MS	matrix spike
MSD	matrix spike duplicate

NTU	nephelometric turbidity unit
NWTPH-D	Northwest total petroleum hydrocarbons – diesel
NWTPH-Dx	Northwest total petroleum hydrocarbons – diesel extractable
NWTPH-G	Northwest total petroleum hydrocarbons – gasoline
ORNL	Oak Ridge National Laboratory
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
PEC	probable effect concentrations
PVC	polyvinyl chloride
ppm	parts per million
ppt	parts per thousand
QAPP	quality assurance project plan
QA/QC	quality assurance/quality control
RBC	risk-based concentration
RI/FS	remedial investigation/feasibility study
RL	reporting limit
RPD	relative percent difference
SDG	sample delivery group
SIM	selected ion monitoring
SL	screening level
SLV	screening level value
SM	standard method
SVOC	semivolatile organic compound
TEC	threshold effects concentration
TPH	total petroleum hydrocarbons
TPH-Dx	diesel-extractable total petroleum hydrocarbons
TRV	toxicity reference value
UCL	upper confidence limit
VOC	volatile organic compound
WP	work plan
ww	wet weight

EXECUTIVE SUMMARY

On May 31, 2007, Portland General Electric Company, Bonneville Power Administration, Avista Corporation, NorthWestern Corporation, Union Oil Company of California, and Waste Management Disposal Services of Oregon, Inc. (Voluntary Group for the Harbor Oil Site RI/FS [Voluntary Group]) entered into an Administrative Settlement Agreement and Order on Consent for Remedial Investigation/Feasibility Study (the AOC), Docket No. CERCLA-10-2007-0106, with the US Environmental Protection Agency (EPA) for the Harbor Oil Superfund Site (Site) in Portland, Oregon. In accordance with the AOC, the Site encompasses the Harbor Oil Facility (Facility), an approximately 4.1-acre parcel of property located at 11535 N Force Avenue, Portland, Oregon, and any areas of contamination extending from the Facility into the wetlands and Force Lake. The AOC statement of work requires that the Voluntary Group prepare a Preliminary Site Characterization Summary report.

The Preliminary Site Characterization Summary report presents the findings from the Phase 1 RI sampling effort which included the characterization of soils and groundwater on the Facility, soils in the adjacent wetlands, and lake sediments and surface water within the Site. It includes the following information:

- Phase 1 field activities and deviations from the remedial investigation/feasibility study (RI/FS) Work Plan (WP)
- Local geology and hydrogeology
- Nature and extent of impacts at the Site, including a comparison of constituent concentrations to screening levels
- Data gaps and recommended Phase 2 sampling activities

Phase 1 Field Sampling Activities

Phase 1 Facility soil and groundwater field sampling activities were initiated on April 17, 2008. The field sampling activities consisted of the following:

- Collection of soil samples from hand-auger and direct-push borings at 43 locations
- Development of eight existing monitoring wells, including rehabilitation of four of the eight existing monitoring well monuments and concrete pads
- Installation and development of eight new monitoring wells
- Collection of groundwater samples from the 16 existing and new monitoring wells and the plant well

- Completion of aquifer slug tests at nine of the existing and new monitoring wells
- Collection of water level measurements from the 16 existing and new monitoring wells, and from three existing "extraction wells" (i.e., EW wells) that had been installed by Energy & Materials Recovery, Inc. (EMRI) for potential future use as product recovery wells.

Collection of thirty-eight surface soil samples from the wetlands adjacent to the Facility on April 23 and 24, 2008. Subsurface soil interval samples were collected at six of those locations.

Collection of three surface water samples from Force Lake on April 21 and 22, 2008.

Collection of eleven surface sediment samples from Force Lake and three surface sediment samples from North Lake on April 21 and April 22, 2008.

Local Geology and Hydrogeology

The local geologic and hydrogeologic conditions encountered during Phase 1 were similar to those described in the WP. Local geologic conditions were defined based on the numerous shallow (i.e., approximately 10 ft below ground surface [bgs]) direct-push borings and three deeper (i.e., approximately 50 ft bgs) borings installed during Phase 1.

One non-native (i.e., fill) lithologic layer and several native lithologic layers are present beneath the Facility:

- Approximately 0 to 3 ft bgs: Fill, primarily rock fragments and gravel, silty/sandy matrix, trace to little brick fragments, foundry sand, pieces of wood or cobbles, poorly sorted, medium dense, moist.
- Approximately 3 to 8 ft bgs: Very fine- to fine-grained sand, moderately sorted (some micro-stratification), trace silt, very loose to loose, gray, wet.
- Approximately 8 to 37 ft bgs: Silt, some clay, trace sand, moderate plasticity, olive gray to light gray to gray brown, soft to medium stiff, moist.
- Approximately 37 to 48 ft bgs: Fine- to medium-grained sand, trace silt, poorly graded, gray, loose to medium dense, wet.
- Approximately 48 to 50 ft bgs: Silt, some clay, trace sand, moderate plasticity, light gray brown to gray, soft to medium stiff, moist to wet.

Local geologic conditions below a depth of approximately 50 ft bgs were based on lithologic information for the plant well and prior interpretations of local geologic conditions. Below 50 ft bgs, the silt appears to extend to a depth of approximately 95 ft bgs. Below this depth is the Troutdale Formation which consists of consolidated cobbles, gravel, sand and silt.

Locally, groundwater occurs in three zones beneath the Facility. The shallow zone extends to a depth of approximately 8 ft bgs, where groundwater occurs under water table conditions in the fill and underlying sand unit. The intermediate zone extends from approximately 8 to 95 ft bgs, and includes the silt and sand layers found in that depth interval. The underlying deep zone is found in the Troutdale Formation.

Based on water level elevations measured in monitoring wells installed in the shallow and intermediate zones on June 9, 2008, groundwater in both zones flows in a southwest/west direction under relatively low gradients. The estimated horizontal groundwater velocities in the shallow and intermediate zones, based on the June 9, 2009 water level measurements, are 0.05 and 0.01 ft/day, respectively. Groundwater flow directions and velocities were not determined for the deep zone because only one monitoring well (B-4) and the plant well are completed in that zone, and water level measurements could only be obtained from monitoring well B-4.

The vertical gradient between the shallow zone and intermediate zone is slightly downward near the north side of the Facility, based on the June 9, 2008 water level measurements. The vertical gradient was slightly upward in the middle of the Facility and increasingly upward near the south side of the Facility.

Nature and Extent of Impacts

Facility Soil

Total polychlorinated biphenyl (PCB) concentrations exceed industrial screening levels mainly in the Facility driveway entrance, in the central portion of the Facility (i.e., in the tank farm and used oil processing, former tanker truck cleaning operation, former unlined holding pond, and current stormwater treatment system areas, and in the southern portion of the “C” shaped area), and near monitoring well GA-30. Total DDT concentrations exceed industrial screening levels mainly in the Facility driveway exit and central portion of the Facility. The highest total polynuclear aromatic hydrocarbon (PAH) and total petroleum hydrocarbon (TPH) concentrations were detected in the central portion of the Facility, near the north corner of the new base oil plant, in the southwest corner of the Facility, and in the Facility driveway exit. Arsenic, lead and mercury concentration distributions did not exhibit a particular pattern on the Facility.

Groundwater

Total PCBs were not detected in shallow, intermediate or deep zone groundwater. DDDs were detected in shallow zone groundwater in the central portion of the Facility and along the southern Facility property boundary; DDDs were also detected in intermediate and deep zone groundwater at monitoring wells MW-2i and B-4, respectively, but at very low concentrations. Total PAHs were detected in shallow zone groundwater in the central portion of the Facility, along the southern Facility property boundary, and in the new base oil plant area, but were not detected in intermediate or deep zone groundwater. While a number of volatile organic compounds (VOCs) were detected in shallow zone groundwater, with the exception of acetone, no VOCs were detected in intermediate zone groundwater. Tetrachloroethene and acetone were the only VOCs detected in deep groundwater. The acetone detected in the groundwater samples appears to be due to laboratory cross-contamination. The tetrachloroethene detected in deep groundwater does not appear to be Facility-related because it was not detected in either shallow or intermediate zone groundwater. Also, as was discussed in the WP, tetrachloroethene has been detected in other deep groundwater monitoring wells in the general vicinity of the Site. Arsenic was detected at the majority of well locations, with the highest concentrations generally detected in shallow monitoring wells. Lead was detected in one shallow monitoring well located near North Force Avenue and at the plant well. Mercury was not detected in groundwater.

Wetland Soils

Based on the Phase 1 results, the highest constituent concentrations were found in three areas: the former drainage ditch area along the western boundary of the Facility; in the area between the current stormwater treatment system discharge and Force Lake; and at one location just south of the Facility property boundary roughly halfway between the current stormwater treatment system discharge and North Force Avenue. Other notable sampling results include the total PAH concentrations detected in the northeast corner of the wetlands and the total DDT concentrations detected at two locations along North Force Avenue.

Force Lake Surface Water

Only four constituents (arsenic, barium, copper, and acetone) were detected at least once in the surface water samples. Of these constituents, concentrations of barium were greater than the ecological screening levels in all three samples, and concentrations of arsenic were greater than the human health screening levels in all three samples.

Force Lake Sediments

Concentrations of metals, PCBs, and pesticides were relatively consistent throughout Force Lake. Metals concentrations (e.g., arsenic, lead, and mercury) had little spatial variability. The highest total PCB and total DDT concentrations were detected in the middle portion of Force Lake. Total PAH concentrations were highest in samples from the northern portion of Force Lake, and total TPH concentrations were highest in samples in the central western portion of Force Lake.

North Lake Sediments

Although several constituents were detected in the North Lake sediment samples, constituent migration from Force Lake to North Lake has been limited. The concentrations of arsenic and nickel in North Lake were less than the regional background soil values. Concentrations of copper and vanadium were similar to those in Force Lake. No clear gradient for benzo(a)pyrene exists based on the distance of the three sampling locations away from the culverts that connect North Lake to Force Lake, and concentrations of benzo(a)pyrene in the three samples collected from North Lake were lower than the concentration detected at the Force Lake sampling location closest to the culverts connecting the two lakes. This suggests that there has been limited constituent migration. DDTs were only detected at the North Lake sediment sampling location closest to the culverts; the detected concentration was three times lower than the concentration detected at the closest Force Lake sediment sampling location.

Data Gaps and Recommended Phase 2 Sampling Activities

The following summarizes identified data gaps by media and recommended Phase 2 sampling activities:

Facility Soil – The lateral extent of impacts in soil needs to be further defined in four specific areas on the Facility. To fill this data gap, it is recommended that soil samples be collected on the Facility in the following areas:

1) Two locations between Phase 1 sampling locations SL-17 and SL-18 to further define the extent of impacts in the central portion of the Facility.
2) Two additional locations near monitoring well GA-30.
3) One location further to the northeast of the north corner of the new base oil plant.
4) Two locations near the Facility driveway exit.

The vertical extent of impacts in soil needs to be further defined in one area. To fill this data gap, it is recommended that two additional subsurface soil samples be collected from one location near monitoring well MW-2i to further define the vertical extent of impacts in this area. Constituent concentrations are higher in the lower (i.e., deep) subsurface sample than they are in the upper (i.e., intermediate) subsurface sample in this area.

Wetland Soil – The lateral extent of impacts in wetland soil needs to be further defined along the western and southwestern edge of the wetlands. To fill this data gap, it is recommended that surface soil samples be collected at four additional locations in this area. The vertical extent of impacts in wetland soil needs to be further defined in two areas where only surface soil samples were collected and constituent concentrations in those samples were high when compared to other wetland soil sampling locations. To fill this data gap, it is recommended that subsurface wetland soil samples be collected at Phase 1 sampling locations WS-11 and WS-25.

Groundwater – No additional samples are proposed, other than continued monthly monitoring of groundwater elevations and Force Lake elevations.

Lake Surface Water – No additional samples are proposed.

Lake Sediment – No additional samples are proposed.

Biota Tissue – No biota samples are proposed at this time. A field survey is proposed as part of Phase 2 to determine if shrew are present in the wetlands.

1.0 INTRODUCTION

On May 31, 2007, Portland General Electric Company, Bonneville Power Administration, Avista Corporation, NorthWestern Corporation, Union Oil Company of California, and Waste Management Disposal Services of Oregon, Inc. (Voluntary Group for the Harbor Oil Site RI/FS [Voluntary Group]) entered into an Administrative Settlement Agreement and Order on Consent for Remedial Investigation/Feasibility Study (the AOC), Docket No. CERCLA-10-2007-0106, with the US Environmental Protection Agency (EPA) for the Harbor Oil Superfund Site (Site) in Portland, Oregon. In accordance with the AOC, the Site encompasses the Harbor Oil Facility (Facility), an approximately 4.1-acre parcel of property located at 11535 N Force Avenue, Portland, Oregon, and any areas of contamination extending from the Facility into the wetlands and Force Lake. The AOC statement of work requires that the Voluntary Group prepare a summary report that compiles the data collected during Phase 1 of the RI; that summary report is referred to as the Preliminary Site Characterization Summary report.

This document is the Preliminary Site Characterization Summary report for the Site. It presents the findings from the Phase 1 RI sampling effort which included the characterization of soils and groundwater on the Facility, soils in the adjacent wetlands, and lake sediments and surface water within the Site boundaries. This document includes the following information:

- Phase 1 field activities and deviations from the remedial investigation/feasibility study (RI/FS) Work Plan (WP)
- Local geology and hydrogeology
- Nature and extent of impact at the Site, including a comparison of constituent concentrations to screening levels
- Data gaps and potential Phase 2 sampling activities

In addition, this report is supported by the following appendices:

- Appendix A – Data Tables
- Appendix B – Field Forms and Notes
- Appendix C – Slug Test Results
- Appendix D – Data Management
- Appendix E – Data Validation
- Appendix F – Laboratory Report Forms (Form 1s)
- Appendix G – Chain-of-Custody Forms
- Appendix H – Parameters for Risk-Based Threshold Calculations

All appendices will be provided as a compact disk at the back of the Preliminary Site Characterization Report.

This report was prepared for the Voluntary Group by Windward Environmental LLC (Windward), Bridgewater Group, Inc., and GeoDesign, Inc.

2.0 PHASE 1 FIELD ACTIVITIES AND DEVIATIONS FROM WORK PLAN

This section describes the Phase 1 RI field activities conducted at the Site. A complete data summary of analytical results is provided in Appendix A.

As part of the Phase 1 sampling program, soil and groundwater samples were collected on the Facility (Map 1). In addition, soil samples were collected in the wetlands adjacent to the Facility, sediment and surface water samples were collected from Force Lake, and sediment samples were collected from North Lake (Map 2). All sampling locations were identified and documented using a global positioning system (GPS) unit with sub-meter accuracy. Copies of the field logbooks, protocol modification forms, field logs and site access agreements are provided in Appendix B.

The following subsections summarize the methodologies used to collect the samples, present the final sampling locations, and describe any deviations from the quality assurance project plan (QAPP).

2.1 Facility Soil and Groundwater Sampling

Phase 1 Facility soil and groundwater field sampling activities were initiated on April 17, 2008. The field sampling activities consisted of the following:

- Collection of soil samples from hand-auger and direct-push borings at 43 locations
- Development of eight existing monitoring wells, including rehabilitation of four of the eight existing monitoring well monuments and concrete pads
- Installation and development of eight new monitoring wells
- Collection of groundwater samples from the 16 existing and new monitoring wells and the plant well
- Completion of aquifer slug tests at nine of the existing and new monitoring wells
- Collection of water level measurements from the 16 existing and new monitoring wells, and from three existing “extraction wells” (EW wells) that were installed by Energy & Materials Recovery, Inc. (EMRI) for potential future use as product recovery wells.

The field activities were conducted, with a few minor deviations, in accordance with the QAPP (Bridgewater et al. 2008a), and are briefly described in Sections 2.1.1 to 2.1.4.

Onsite boreholes were abandoned with hydrated bentonite chips according to the QAPP (Bridgewater et al. 2008a), and an asphalt patch was placed in areas paved with asphalt to restore surface conditions. Soil and groundwater sampling locations were documented, photographed, and logged with GPS equipment in accordance with the QAPP (Bridgewater et al. 2008a). Soil and groundwater sampling and aquifer testing equipment was decontaminated between each location, and investigation-derived waste (IDW) was stored onsite, in accordance with the QAPP (Bridgewater et al. 2008a). IDW water and solids laboratory analytical results have been submitted to Waste Management for purposes of profiling the IDW for land disposal or treatment by the end of August 2008.

2.1.1 Facility Soil Sampling

Soil samples were collected from 43 locations on the Facility from April 24 to May 2, 2008 (Map 1). Soil samples were collected at seventeen locations (i.e., SB-01 to SB-09, SP-01 to SP-03, SL-01 to SL-04, and SL-11) using a hand auger, and at 25 locations (i.e., SL-05 to SL-10, SL-12 to SL-28, SL-30, and SL-31) using direct-push drilling equipment. Because of angle-boring limitations of the direct-push drilling equipment, soil samples were collected from an angle-boring beneath Tank 23 (sample location SL-29) using a roto-sonic drill rig at a 45-degree angle.

Soil samples were collected from locations consistent with the QAPP (Bridgewater et al. 2008a), with the following exceptions:

- Direct-push drilling attempts at SL-11 indicated that the area was located over reinforced concrete covered by asphalt. Because of refusal, the location was moved approximately 12 ft northeast, and the soil sample was collected with a hand auger instead of the direct-push equipment due to the presence of a subsurface natural gas line.
- SL-26 was originally located inside the tank farm and used oil processing area inside the unloading and loading rack concrete containment. It was relocated approximately 24 ft southwest just outside the unloading and loading rack to avoid compromising the concrete containment. EPA approved the revised location.

Hand-auger soil samples were collected from the depths designated in the QAPP (Bridgewater et al. 2008a), with one exception. At SL-11, the hand-auger soil sample was collected at 0.5 to 1.5 ft below ground surface (bgs). This depth interval was sampled instead of the designated sampling interval of 0.0 to 1.0 ft bgs because of differences in the surface conditions at the new location, as discussed above.

Soil samples from direct-push borings were generally collected at the intervals designated in the QAPP (Bridgewater et al. 2008a); however, some soil sample depths were altered slightly from those specified in the QAPP based on the actual fill thickness encountered in the field and based on field screening results. As detailed on the boring logs (Appendix B), sampling intervals ranged from 0.0 to 5.0 ft bgs for SL-11 to SL-19;

from 0.5 to 10.0 ft bgs for SL-01 to SL-10; and from 0.0 to 10.25 ft bgs for SL-20 to SL-31.)

In order to provide sufficient soil volume for quality assurance/quality control (QA/QC) samples, it was necessary to collect samples from several closely spaced borings. One hand-auger boring provided sufficient soil volume to fill the laboratory-supplied sample containers for a standard sample; two hand-auger borings were necessary at soil-sampling locations where additional QA/QC samples (i.e., splits or replicates) were collected in accordance with QAPP (Bridgewater et al. 2008a). The stainless steel hand auger had a 1-ft-long, 3-inch-diameter barrel with open sides. At the direct-push locations, three direct-push borings were necessary to collect a standard sample at the selected interval; five to six direct-push borings were necessary at soil sampling locations where additional QA/QC samples were collected in accordance with the QAPP (Bridgewater et al. 2008a).

The additional hand-auger borings completed at QA/QC locations were installed within 1 ft of the original hand-auger location. The direct-push borings were, on average, installed in a 1- to 1.5-square foot (ft^2) area for the three-boring clusters and in a 2 to 3 ft^2 area for the five- or six-boring clusters. The replicate soil sample was collected approximately 3 ft from the original soil sampling location, with the three replicate borings located within a 1 to 1.5 ft^2 area of the original replicate boring.

Additional soil samples were collected during the installation of monitoring wells MW-2s, MW-2i, and MW4s based on field screening results (see Appendix B).

Table 2-1 presents the coordinates for Facility surface and subsurface soil samples. Observations of soil sample characteristics and field-screening results were recorded on the soil sample collection forms, which are provided in Appendix B.

Table 2-1. Final Sampling Location Coordinates for Facility Soil Samples Collected During the Phase 1 Sampling Event

Sample ID	Date/Time	Sampling Location Coordinates[a]			
		X[b]	Y[b]	Latitude[c]	Longitude[c]
Soil Berm					
SB01-6-24 SB200-6-24[d]	04.25.08 / 0750	714571	7640788	-122.69355	45.60577
SB02-6-24 SB201-6-24[e]	04.25.08 / 0820	714626	7640698	-122.69390	45.60592
SB03-6-24	04.25.08 / 0840	714655	7640604	-122.69427	45.60599
SB04-6-24	04.24.08 / 0905	714700	7640509	-122.69465	45.60610
SB05-6-24	04.25.08 / 0855	714743	7640398	-122.69509	45.60621
SB06-6-24	04.25.08 / 0905	714806	7640334	-122.69534	45.60638
SB07-6-24	04.25.08 / 0920	714868	7640331	-122.69536	45.60655
SB08-6-24[f]	04.24.08 / 0935	714947	7640359	-122.69526	45.60677
SB09-6-24	04.25.08 / 0940	715037	7640438	-122.69496	45.60702
Soil Stockpile					
SP01-6-72[g]	04.25.08 / 1010	715033	7640461	-122.69487	45.60701
SP02-6-72	04.24.08 / 1005	714989	7640439	-122.69495	45.60689
SP03-6-72	04.25.08 / 1035	714958	7640410	-122.69506	45.60680
Facility Soil					
SL01-24-36	04.24.08 / 1500	715048	7640498	-122.69473	45.60706
SL02-24-36	04.24.08 / 1430	714963	7640676	-122.69402	45.60684
SL03-24-36	04.24.08 / 1415	714905	7640775	-122.69363	45.60669
SL04-24-36[f]	04.24.08 / 1045	714860	7640852	-122.69333	45.60657
SL05-12-24[f] SL05-48-72[f] SL05-96-120	04.29.08 / 0820 04.29.08 / 0845 04.29.08 / 0900	714868	7640446	-122.69491	45.60656
SL06-24-36 SL06-60-84 SL06-96-120	04.29.08 / 1430 04.29.08 / 1440 04.29.08 / 1450	714770	7640466	-122.69482	45.60629
SL07-30-42 SL07-60-84 SL07-96-120	04.29.08/1000 04.29.08/1025 04.29.08/1035	714744	7640628	-122.69419	45.60623
SL08-18-30 SL08-48-72 SL08-96-120	04.30.08/1435 04.30.08/1440 04.30.08/1500	714758	7640704	-122.69389	45.60628
SL09-12-24 SL09-36-48 SL09-60-84 SL09-96-120	04.30.08/0945 04.30.08/0950 04.30.08/1000 04.30.08/1020	714809	7640606	-122.69428	45.60641
SL10-6-18 SL10-48-72 SL10-96-120	04.30.08/1140 04.30.08/1200 04.30.08/1215	714800	7640656	-122.69409	45.60639

Table 2-1. Final Sampling Location Coordinates for Facility Soil Samples Collected During the Phase 1 Sampling Event

Sample ID	Date/Time	Sampling Location Coordinates[a]			
		X[b]	Y[b]	Latitude[c]	Longitude[c]
SL11-6-18	05.02.08/0940	714770	7640940	-122.69297	45.60633
SL12-0-12[h]	05.02.08/0920	714785	7640857	-122.69330	45.60636
SL13-42-60	05.01.08/1515	714809	7640767	-122.69365	45.60642
SL14-0-12	05.02.08/0820	714833	7640670	-122.69403	45.60648
SL15-18-30 SL15-36-48	05.01.08/0910 05.01.08/0915	714831	7640578	-122.69439	45.60647
SL16-18-30	05.01.08/0750	714780	7640555	-122.69448	45.60633
SL17-12-24	04.30.08/1535	714717	7640597	-122.69431	45.60616
SL18-12-24	05.02.08/0745	714681	7640722	-122.69381	45.60607
SL19-24-36	05.02.08/0800	714585	7640842	-122.69334	45.60581
SL20-12-24 SL20-48-72 SL20-96-120	04.28.08/1400 04.28.08/1430 04.28.08/1435	714819	7640462	-122.69484	45.60643
SL21-18-30 SL21-48-72 SL21-96-120	04.28.08/1525 04.28.08/1540 04.28.08/1550	714802	7640495	-122.69471	45.60638
SL22-24-36 SL22-48-72 SL22-96-120	04.25.08/1410 04.25.08/1415 04.25.08/1420	714874	7640415	-122.69503	45.60657
SL23-24-36 SL23-52-78 SL23-96-120	04.25.08/1510 04.25.08/1515 04.25.08/1520	714883	7640365	-122.69523	45.60660
SL24-24-36 SL24-48-72 SL24-96-120	04.28.08/0840 04.28.08/1000 04.28.08/1015	714932	7640424	-122.69501	45.60673
SL25-12-24 SL25-36-60 SL25-96-120	04.30.08/0810 04.30.08/0815 04.30.08/0830	714832	7640783	-122.69359	45.60649
SL26-0-12 SL26-48-72 SL26-96-120	05.01.08/1430 05.01.08/1440 05.01.08/1450	714836	7640706	-122.69389	45.60649
SL27-12-24 SL27-48-72 SL27-96-120	04.29.08/1520 04.29.08/1535 04.29.08/1545	714884	7640691	-122.69396	45.60662
SL28-12-24 SL28-48-72 SL28-96-120	04.29.08/1250 04.29.08/1300 04.29.08/1310	714892	7640643	-122.69415	45.60664
SL303-12-24[i] SL304-48-72[j] SL305-96-120[k]	04.29.08/1330 04.29.08/1350 04.29.08/1400	714892	7640643	-122.69415	45.60664
SL29-0-18[f,l]	05.01.08/1115	714920	7640570	-122.69443	45.60671

Table 2-1. Final Sampling Location Coordinates for Facility Soil Samples Collected During the Phase 1 Sampling Event

Sample ID	Date/Time	Sampling Location Coordinates[a]			
		X[b]	Y[b]	Latitude[c]	Longitude[c]
SL29-66-102[f,l] SL29-138-174[l]	05.01.08/1100 05.01.08/1145				
SL30-6-18 SL30-60-84 SL30-96-120	04.28.08/1150 04.28.08/1200 04.28.08/1215	715028	7640491	-122.69475	45.60700
SL31-6-18 SL31-60-84 SL31-96-120	04.28.08/1050 04.28.08/1200 04.28.08/1215	715015	7640523	-122.69463	45.60697
Additional Soil Samples Collected During Monitoring Well Installation					
MW2s-12-24[m] MW2s-48-72[m] MW2s-96-120[m]	05.05.08/0820 05.05.08/0825 05.05.08/0835	714747	7640493	-122.69472	45.60623
MW2i-168-180[m]	05.05.08/1030	714745	7640496	-122.69471	45.60623
MW4s-12-24[m] MW4s-48-72[m] MW4s-96-120[m]	05.05.08/1330 05.05.08/1340 05.05.08/1345	714892	7640601	-122.69431	45.60664

[a] Target coordinates were provided in the QAPP (Bridgewater et al. 2008a).

[b] Coordinates are in Oregon State Plane, N, NAD83, US ft.

[c] Coordinates are in degrees and decimal minutes, NAD83.

[d] Field duplicate of SB01-6-24.

[e] Field duplicate of SB02-6-24.

[f] EPA split samples were collected at these locations.

[g] Rinsate blank SP01-RB was collected at SP-01.

[h] Rinsate blank SL12-RB was collected at SL-12.

[i] Field replicate of SL28-12-24.

[j] Field replicate of SL28-48-72.

[k] Field replicate of SL28-96-120.

[l] Reported as inches along the boring angled at 45 degrees.

[m] Represents additional soil samples collected based on field screening results during monitoring well installation.

[n] Rinsate blank MW4s-RB was collected at MW-4s (soil sampling).

ID – identification

2.1.2 Facility Monitoring Well Installation

Eight new monitoring wells (i.e., MW-1s, MW-2s, MW-2i, MW-3s, MW-4s, MW-4i, MW-5s and MW-5i) were installed on the Facility from May 2 to May 6, 2008 (Map 1). Five new shallow wells (i.e., MW-1s, MW-2s, MW-3s, MW-4s, and MW-5s) were installed at depths ranging from 12.5 to 15 ft bgs. Three new intermediate wells (i.e., MW-2i, MW-4i, and MW-5i) were installed at depths ranging from 48 to 49.5 bgs.

Each well consisted of 2-inch diameter polyvinyl chloride (PVC) schedule 40 casing with a 10-ft long screen (slot size 10 or 0.01-inch openings), which was flush-mounted and installed with a Rotosonic SRO 71 drill rig using 6.25-inch-diameter casing. The 10-ft-long screen was installed at the bottom of each boring. The filter pack, consisting of 10/20 silica sand, was placed in the annular space around the screen from the bottom of the well to approximately 0.5 ft above the screen in shallow monitoring wells and approximately 2 ft above the screen in intermediate monitoring wells. The remaining annular space was filled to approximately 1 to 1.5 ft bgs with 3/8-inch hydrated bentonite chips. The final 1 to 1.5-ft of annular space was filled with a grout mixture consisting of Portland cement, sand, and bentonite (1-ft of grout at wells with smaller concrete pads with limited or no truck traffic and 1.5-ft of grout at wells with truck-proof concrete pads). Flush-mounted outer casings were set in the concrete pads installed at each well. New water-tight lockable well caps were installed on each well, with new Sherwood monuments bolted to the outer flush-mounted casing ring. Well identifications were stamped into the metal ring at each well. The wells were located, designed, constructed, and installed in accordance with the QAPP (Bridgewater et al. 2008a). Table 2-2 presents the location coordinates for the new and existing groundwater monitoring wells, the Facility plant well (PW-01), and the EW wells. Table 2-3 summarizes well construction information for the new and existing monitoring wells and for the plant well.

Table 2-2. Final Location Coordinates for New and Existing Monitoring Wells, Facility Plant Well, and EW Wells

Well ID	Well Location Coordinates[a]			
	X[b]	Y[b]	Latitude[c]	Longitude[c]
New Monitoring Wells				
MW-1s	714824	7640340	-122.69532	45.60643
MW-2s	714747	7640493	-122.69472	45.60623
MW-2i	714745	7640496	-122.69471	45.60623
MW-3s	715024	7640556	-122.69450	45.60700
MW-4s	714892	7640601	-122.69431	45.60664
MW-4i	714894	7640599	-122.69432	45.60664
MW-5s	714745	7640664	-122.69405	45.60624
MW-5i	714746	7640661	-122.69406	45.60624
Existing Monitoring Wells				
A-18	714941	7640499	-122.69471	45.60676
A-19	714869	7640411	-122.69505	45.60656
A-20	714571	7640857	-122.69327	45.60578
B-4	714739	7640509	-122.69465	45.60621
GA-29	714896	7640356	-122.69527	45.60663
GA-30	714925	7640429	-122.69498	45.60672
GA-33	714662	7640633	-122.69416	45.60601
GA-34	714835	7640882	-122.69321	45.60650
Extraction Wells[d]				
EW-1	714907	7640662	-122.69407	45.60668
EW-2	714920	7640539	-122.69456	45.60671
EW-3	715015	7640509	-122.69468	45.60697
Plant Well				
PW-01	714736	7640909	-122.69309	45.60623

a Target coordinates were provided in the QAPP (Bridgewater et al. 2008a).

b Coordinates are in Oregon State Plane, N, NAD83, US ft.

c Coordinates are in degrees and decimal minutes, NAD83.

d Extraction wells were installed by EMRI for potential use in recovering product, but they have never been used for that purpose.

Table 2-3. Well Construction Details for On-Facility Wells

Well ID	Casing Material	Nominal Casing Dia. (in)	Casing Elevation (ft AMSL)	Ground Surface Elevation (ft AMSL)	Total Depth (ft bgs)	Screen Interval (ft bgs)	Filter Pack Interval (ft bgs)	Seal Interval (ft bgs)
New Monitoring Wells								
MW-1s	PVC	2.00	13.07	13.5	13.5	3.5-13.5	3.0-13.5	0.0-3.0
MW-2s	PVC	2.00	12.42	12.7	15.5	5.5-15.5	5.0-15.5	0.0-5.0
MW-2i	PVC	2.00	12.38	12.7	48.0	38.0-48.0	35.0-48.0	0.0-35.0
MW-3s	PVC	2.00	14.60	14.9	12.5	2.5-12.5	2.0-12.5	0.0-2.0
MW-4s	PVC	2.00	12.79	13.1	13.0	3.0-13.0	2.5-13.0	0.0-2.5
MW-4i	PVC	2.00	12.85	13.1	49.5	39.5-49.5	37.5-49.5	0.0-37.5
MW-5s	PVC	2.00	12.01	12.3	13.5	3.5-13.5	3.0-13.5	0.0-3.0
MW-5i	PVC	2.00	11.98	12.3	50.0	40.0-50.0	38.0-50.0	0.0-38.0
Existing Monitoring Wells								
A-18	PVC	2.00	13.48	13.7	10.5	5.5-10.5	4.5-10.5	0.0-4.5
A-19	PVC	2.00	13.34	13.6	20.5	10.5-20.5	9.5-20.5	0.0-9.5
A-20	PVC	2.00	13.14	13.4	20.5	10.5-20.5	9.5-20.5	0.0-9.5
B-4	PVC	2.00	12.74	13.0	94.5	84.5-94.5	unk	unk
GA-29	PVC	2.00	13.14	13.4	15.5	5.5-15.5	4.5-15.5	0.0-4.5
GA-30	PVC	2.00	13.43	13.6	14.0	4.0-14.0	3.0-14.0	0.0-3.0
GA-33	PVC	2.00	12.29	12.5	15.0	5.0-15.0	4.0-15.0	0.0-4.0
GA-34	PVC	2.00	14.10	14.3	14.5	4.5-14.5	3.5-14.5	0.0-3.5
EW-1	PVC	4.00	13.32	13.6	unk	unk	na	unk
EW-2	PVC	4.00	13.49	13.8	unk	unk	na	unk
EW-3	PVC	4.00	17.14	14.2	unk	unk	na	unk
Plant Well								
PW-01	Steel	4.00	13.79	13.8	97	na	na	0-30

[a] Target coordinates were provided in the QAPP (Bridgewater et al. 2008a).

[b] Coordinates are in Oregon State Plane, N, NAD83, US ft.

[c] Coordinates are in degrees and decimal minutes, NAD83.

ID – identification

UNK - Unknown

2.1.3 Water Level and Free Product Measurements

In accordance with the QAPP (Bridgewater et al. 2008a), water level measurements were initially collected from the new and existing monitoring wells and Force Lake between May 12 and May 15, 2008, during Phase 1 groundwater sampling. A complete round of water level measurements was collected from the 16 existing and new monitoring wells, the three EW wells, and Force Lake on June 9, 2008. This first monthly round of water level measurements was used to produce groundwater elevation figures described in Section 3.0. A second complete round of water level measurements was made on July 9, 2008. Due to lack of access through the sanitary seal, water level measurements were not made at the Facility plant well.

Note that water level measurements in the EW wells were not included in the QAPP because even though the EW wells are screened in the shallow groundwater zone, EMRI did not provide well construction information for these wells. Water levels were measured in the EW wells to further characterize shallow groundwater zone elevations near the new base oil plant; the quality and usefulness of these measurements will be evaluated during the RI.

Floating free product (i.e., light non-aqueous phase liquid [LNAPL]) was present in monitoring well GA-30. Product thickness was measured during each water level monitoring event.

Water level and product thickness measurements were made in each well in accordance with the QAPP (Bridgewater et al. 2008a). A summary of water level and product thickness measurements is presented in Table 2-4.

Table 2-4. Summary of Groundwater Elevation and Free-Product Thickness Measurements

Well ID	Date	Measuring Point Elevation (ft AMSL)[a]	Depth to Water (ft)	Groundwater Elevation (ft AMSL)[b]	Free-Product Thickness (ft)
MW-1s	5/15/08	13.07	3.80	9.27	--
	6/9/08		3.76	9.31	--
	7/9/08		4.86	8.21	--
MW-2s	5/14/08	12.42	2.83	9.59	--
	6/9/08		2.25	10.17	--
	7/9/08		2.68	9.74	--
MW-2i	5/14/08	12.38	2.24	10.14	--
	6/9/08		0.99	11.39	--
	7/9/08		1.20	11.18	--
MW-3s	5/14/08	14.60	1.48	13.12	--
	6/9/08		1.01	13.59	--
	7/9/08		1.60	13.00	--

Table 2-4. Summary of Groundwater Elevation and Free-Product Thickness Measurements

Well ID	Date	Measuring Point Elevation (ft AMSL)[a]	Depth to Water (ft)	Groundwater Elevation (ft AMSL)[b]	Free-Product Thickness (ft)
MW-4s	5/15/08	12.79	0.97	11.82	--
	6/9/08		0.78	12.01	--
	7/9/08		1.03	11.76	--
MW-4i	5/15/08	12.85	2.48	10.37	--
	6/9/08		1.20	11.65	--
	7/9/08		1.49	11.36	--
MW-5s	5/15/08	12.01	0.60	11.41	--
	6/9/08		0.44	11.57	--
	7/9/08		0.78	11.23	--
MW-5i	5/15/08	11.98	1.36	10.62	--
	6/9/08		0.33	11.65	--
	7/9/08		0.51	11.47	--
A-18	5/16/08	13.48	1.73	11.75	--
	6/9/08		1.51	11.97	--
	7/9/08		1.94	11.54	--
A-19	5/13/08	13.34	3.05	10.29	--
	6/9/08		2.80	10.54	--
	7/9/08		3.44	9.90	--
A-20	5/13/08	13.14	0.98	12.16	--
	6/9/08		0.91	12.23	--
	7/9/08		1.57	11.57	--
B-4	5/13/08	12.74	2.59	10.15	--
	6/9/08		0.92	11.82	--
	7/9/08		1.15	11.59	--
GA-29	5/13/08	13.14	3.56	9.58	--
	6/9/08		3.36	9.78	--
	7/9/08		4.41	8.73	--
GA-30	5/16/08	13.43	2.68	10.84[c]	0.10
	6/9/08		2.39	11.06[c]	0.02
	7/9/08		3.19	10.26[c]	0.02
GA-33	5/12/08	12.29	1.72	10.57	--
	6/9/08		1.69	10.60	--
	7/9/08		2.31	9.98	--
GA-34	5/12/08	14.10	0.95	13.15	--
	6/9/08		0.81	13.29	--
	7/9/08		1.28	12.82	--
EW-1	6/9/08	13.32	0.63	12.69	--
	7/9/08		1.00	12.32	--

Table 2-4. Summary of Groundwater Elevation and Free-Product Thickness Measurements

Well ID	Date	Measuring Point Elevation (ft AMSL)[a]	Depth to Water (ft)	Groundwater Elevation (ft AMSL)[b]	Free-Product Thickness (ft)
EW-2	6/9/08	13.49	1.67	11.82	--
	7/9/08		--[d]	--[d]	--[d]
EW-3	6/9/08	17.14	4.87	12.27	--
	7/9/08		5.41	11.73	--
PW-01	--[e]	13.79	--[e]	--[e]	--[e]
Force Lake	5/13/08	12.15	2.81	9.34	--
	5/14/08		2.90	9.25	--
	6/9/08		2.87	9.28	--
	7/9/08		3.33	8.82	--

[a] All measuring point elevations were professionally surveyed on May 9, 2008. Reported elevations are AMSL, City of Portland Elevation Datum.

[b] Groundwater elevations calculated using measuring point elevations and depth-to-water measurements.

[c] Free product (LNAPL) was measured. A specific gravity of 0.85 was assumed for calculating the corrected groundwater elevation.

[d] Measurement not obtained because equipment blocked access to well during field visit.

[e] Measurement not obtained because of lack of access through the sanitary seal.

AMSL – above mean sea level

ID – identification

2.1.4 Facility Groundwater Sampling

A total of 17 wells (16 monitoring wells and the plant well) were sampled from May 12 to May 16, 2008. The 16 monitoring wells consisted of 8 existing monitoring wells (i.e., A-18, A-19, A-20, GA-29, GA-30, GA-33, GA-34, and B-4) and 8 new monitoring wells (i.e., MW-1, MW-2s, MW-2i, MW-3s, MW-4s, MW-4i, MW-5s, and MW-5i). The only deviation from the QAPP during groundwater sampling was during the collection of a groundwater sample from PW-01. At this well, there was limited access because the submersible pump column and sanitary seal had been bolted to the top of casing. This well was purged prior to sampling by operating the down-hole pump for 15 minutes at approximately 45 gallons per minute until approximately 675 gallons, or approximately three casing volumes, had been removed from the well. The well was then sampled using a peristaltic pump and 0.25-inch-diameter, disposable Teflon® tubing placed approximately 15 ft bgs into the casing.

The remaining 16 wells were purged and sampled using low-flow techniques and a GeoTech peristaltic pump with ¼-inch-diameter, disposable Teflon® tubing placed near or slightly above the center of each well screen until drawdown levels and water quality parameters had stabilized, in accordance with the QAPP (Bridgewater et al. 2008a).

Water quality measurements were recorded using a calibrated YSI 556 MPS multi-parameter meter and a Hach turbidimeter.

Each well was purged at varying rates between 151 milliliters per minute (ml/min) and 442 ml/min. The selected rate was based on each well's ability to stabilize without excessive (> 0.33 ft) drawdown. Several wells, including A-19, B-4, GA-29, MW-2s, MW-4s, MW-5s, and MW-5i, had stable water quality parameter measurements, although drawdown exceeded the 0.33-ft target value. In these instances, the peristaltic pump was operating at the lowest possible setting.

The only well that did not stabilize, based on turbidity readings, was A-20. The first purging attempt revealed that there was relatively high turbidity and intermittent gas bubbling, consistent with what one would observe when opening a well that is under positive pressure. The gas did not have any odor. The second purging attempt (one day after the first) revealed similarly high turbidity and gas bubbling. Therefore, the groundwater sample was collected from this well without stabilized parameters. Gas did not appear to be entrained in the groundwater sample.

Table 2-5 provides a summary of stabilized water quality measurement data obtained during groundwater sampling.

Table 2-5. Stabilized Water Quality Measurement Data for Groundwater Samples Collected During Phase 1

Well ID	Date/Time	Temperature (°C)	DO (mg/L)	pH	Oxidation-Reduction Potential (mV)	Conductivity (μS/cm)	Turbidity (NTU)
GW-MW1s	05.15.08/1115	11.6	0.07	6.69	-54.2	479	1.6
GW300[a]	15.15.08/1130	na	na	na	na	Na	na
GW-MW2s	05.14.08/1530	13.6	0.47	6.61	-46.7	1823	6.9
GW-MW2i[b]	05.14.08/1015	13.8	0.15	6.91	-135.4	979	3.2
GW-MW3s[b]	05.14.08/0815	12.5	0.21	6.57	-139.1	1,386	1.4
GW-MW4s	05.15.08/1430	16.1	0.15	6.91	-136.5	957	2.9
GW-MW4i	05.15.08/1600	15.7	0.14	7.42	-130.1	828	2.2
GW-MW5s[b]	05.15.08/0830	14.8	0.23	6.58	-82.1	1,012	2.5
GW-MW5i	05.15.08/0745	15.0	0.15	6.74	-134.4	890	1.9
GW-A18	05.15.08/0930	15.1	0.15	6.71	-130.9	893	3.0
GW-A19	05.13.08/1315	12.3	0.31	6.43	-98.6	1,858	5.8
GW-A20[c]	05.13.08/0815	12.7	0.20	6.42	-76.1	649	265
GW-B4	05.13.08/1500	13.2	0.33	6.88	-128.7	1,439	4.1
GW-GA29	05.13.08/1030	10.8	0.23	6.31	-36.7	757	1.1
GW-GA30[d]	05.16.08/1100[d]	na	na	na	na	na	na
GW-GA33	05.12.08/1445	12.0	0.22	6.53	-98.7	883	0.8
GW-GA34	05.12.08/1215	13.5	0.26	6.63	-91.5	632	1.4
GW-PW01[b]	05.14.08/1330	14.6	2.03[e]	7.53	16.7	354	1.8

[a] Replicate groundwater sample at MW-1s.

[b] EPA split samples were collected at these locations.

[c] Groundwater sample collected despite turbidity readings above 10 NTUs, as discussed in Section 2.1.4.

[d] Groundwater sample was not collected because of the presence of free product in GA-30. A sample of the free product (LNAPL-GA30) was collected.

[e] May not reflect actual aquifer condition because of the purging method, as discussed in Section 2.1.4.

C – centigrade

DO– dissolved oxygen

na – not available

NTU – nephelometric turbidity unit

2.1.5 Facility Well Development and Well Monument Rehabilitation

Seven of the eight existing monitoring wells and eight new monitoring wells at the Site (Map 1) were developed in accordance with the procedures described in the QAPP (Bridgewater et al. 2008a). As noted above, at the plant well (i.e., PW-01) the pump prevented sufficient access for the development equipment and GA-30 was not redeveloped due to the presence of LNAPL. The remaining 15 monitoring wells displayed adequate recovery after well development and appeared suitable for water-level measurements and groundwater sampling (although a sample was collected from A-20 without stabilized parameters as discussed in Section 2.1.4).

Four existing well monuments (i.e., A-19, GA-29, GA-30, and GA-34) were rehabilitated. The wells had various degrees of damage to the concrete pad and flush-mounted cover; however, none of these wells appeared to have damaged well casings or well seals. Each expandable well cap appeared water-tight (when initially removed for well development). Boart Longyear, under GeoDesign's supervision, removed the old concrete pads, flush-mounted outer casings, and monuments at all of the wells. A new Sherwood aluminum monument and a flush-mounted outer casing were installed at each well and secured with a new truck-proof concrete pad at monitoring wells A-19, GA-29, and GA-30 and with a regular pad at monitoring well GA-34 (which is located in an area that has no truck access). As added protection from stormwater runoff, 2-inch-diameter PVC risers were added to the existing PVC casings in each of the four wells.

2.1.6 Aquifer Slug Testing

Aquifer slug tests were conducted on nine monitoring wells, MW-1s, MW-2s, MW-3s, MW-4s, MW-4i, MW-5i, GA-29, GA-34, and B-4, on May 22 and 23, 2008. The aquifer slug tests were conducted in accordance with the QAPP (Bridgewater et al. 2008a), except that each well was tested using only slug removal instead of slug injection and removal. This deviation was necessary because of the following field conditions:

- The water level in each intermediate and shallow well was approximately 1 to 3 ft bgs. These conditions would have provided approximately 0.16 gallons per ft or a slug of 0.32 gallon per well (averaging 2 ft of casing between the water table and ground surface).
- An injected slug of that size (i.e., 0.33 gallon) would have imposed only a minor, although measurable, amount of stress on the well, resulting in limited data from the slug test.
- Slug injection could have resulted in "over slugging" and the spilling of water over the top of the casing, invalidating the test.
- If the water level in any of the shallow wells was below the screened interval (i.e., >3 ft bgs), the injection of a slug could have caused water to enter the screen above the water table, infiltrating the vadose zone (also invalidating the test).

EPA approved a revision to the slug testing method specified in the QAPP (Bridgewater et al. 2008a). The revised procedure for slug testing was as follows:

- Water levels were measured prior to slug test implementation over an approximate 20-minute period until the water level was stable and equilibrated with the atmosphere.

- A 1.91-inch-diameter, 5-ft-long slug with weighted PVC sand-filled casing was lowered into each of the shallow wells (i.e., MW-1s, MW-2s, MW-3s, MW-4s, GA-29, and GA-34). At the intermediate and deep wells (i.e., MW-4i, MW-5i, and B-4), a 1.91-inch-diameter, 10-ft-long slug with weighted PVC sand-filled casing was lowered into each well.
- The slug remained in the well until the water level stabilized. The slug was then immediately removed from the well (within approximately 5 to 10 seconds), and the water level was measured frequently during the first minutes of the test (every 5 to 10 seconds), then more slowly (every 20 to 30 seconds, then every 1 to 5 minutes) for the remainder of the test until the water rebounded back to within 90 to 95% of the static level.

Given this deviation, slug tests were conducted on six shallow groundwater monitoring wells (MW-1s, MW-2s, MW-3s, MW-4s, GA-29 and GA-34), rather than the three wells identified in the QAPP (GA-29, GS-34 and MW-5s); MW1s, MW-2s, MW-3s and MW-4s were substituted for MW-5s to obtain hydraulic conductivity information over more of the Facility. Consistent with the QAPP, slug tests were conducted on two intermediate monitoring wells; a slug test was performed on MW-4i rather than MW-2i because the recovery at MW-2s was very slow and subsequent pre-test static water level at MW-2i would have been suspect. Also, a slug test was performed on deep monitoring well B-4 to obtain hydraulic conductivity information for the deep zone.

The time required for tested wells to rebound to within 90 to 95% of the static water level ranged from 27 seconds (MW-1s) to 86 minutes (MW-2s). Drawdown in the shallow monitoring wells ranged from 2.78 to 3.54 ft, excluding MW-1s. Recovery was so rapid in MW-1s that the first water level measurement, approximately 12 seconds after the slug was removed, was only 0.15 ft from the original static level. Drawdown in the two intermediate monitoring wells (MW-4i, MW-5i) and on deep monitoring well (B-4) ranged from 3.32 to 7.80 ft. Each well, with the exception of MW-1s, was adequately stressed by the removal of the slug to obtain the necessary data to calculate the hydraulic conductivity. Slug testing data and analyses summaries are presented in Appendix C.

2.2 Wetland Sampling

Surface and subsurface soil samples were collected from the wetlands adjacent to the Facility on April 23 and 24, 2008. The wetland sampling locations were accessed from either North Force Avenue or from the southwestern corner of the Facility.

2.2.1 Wetland Surface Soil

Thirty-eight surface soil samples were collected from the wetlands area on April 23 and 24, 2008 (Map 2). Subsurface soil interval samples were collected at six locations (i.e., WS-06, WS-19, WS-26, DS-02, DS-03, and DS-05) as discussed in Section 2.2.2.

In accordance with the QAPP (Bridgewater et al. 2008a), surface soil samples were collected from the upper 6 inches with a decontaminated stainless steel spoon and bowl. A stainless steel spoon was not used to collect wetland soil samples at stations WS-17, WS-18, and WS-20 because the stations were inundated with approximately 6 to 12 inches of water. Instead, soil samples were collected with a decontaminated stainless steel hand auger. At each location, overlying vegetation and debris were removed before the sample was collected. Samples were processed in the field at the sampling location. After all sampling containers had been filled, extra material was returned to the sampling location.

Table 2-6 presents the coordinates for the wetland surface soil samples. One soil target station, WS-33, was relocated because the location at the target coordinates was on top of a small soil mound. After consultation with the EPA oversight representative, the sampling location was moved approximately 5 ft to the southeast of the target location to better characterize soils near the ditch located next to North Force Avenue (Map 2). Observations of soil sample characteristics were recorded on the surface sediment collection forms provided in Appendix B.

Table 2-6. Final Sampling Location Coordinates for Wetland Surface Soil Samples Collected During Phase 1

Sample ID[a]	Date/Time	Sampling Location Coordinates[b]			
		X[c]	Y[c]	Latitude[d]	Longitude[d]
WS01-0-6	04.24.08/1050	7640297	715141	45.60730	-122.69553
WS02-0-6	04.24.08/1030	7640248	715058	45.60707	-122.69571
WS03-0-6	04.24.08/0711	7640208	714967	45.60682	-122.69585
WS04-0-6[e]	04.23.08/0815	7640149	714869	45.60654	-122.69607
WS05-0-6	04.24.08/1115	7640321	715078	45.60713	-122.69542
WS07-0-6	04.24.08/0747	7640218	714893	45.60661	-122.69581
WS08-0-6	04.23.08/1547	7640173	714802	45.60636	-122.69597
WS09-0-6	04.24.08/0925	7640383	715104	45.60720	-122.69519
WS10-0-6	04.24.08/1013	7640337	715000	45.60691	-122.69535
WS11-0-6	04.24.08/0825	7640292	714912	45.60667	-122.69552
WS12-0-6	04.23.08/1710	7640238	714823	45.60642	-122.69572
WS13-0-6	04.23.08/1523	7640196	714742	45.60620	-122.69588
WS14-0-6	04.23.08/1650	7640261	714759	45.60625	-122.69562
WS15-0-6	04.23.08/1500	7640217	714685	45.60604	-122.69579
WS16-0-6	04.23.08/1630	7640329	714785	45.60632	-122.69536
WS17-0-6	04.24.08/1258	7640288	714697	45.60608	-122.69551
WS18-0-6	04.24.08/1238	7640349	714727	45.60617	-122.69528
WS20-0-6	04.24.08/1217	7640379	714653	45.60597	-122.69515

Table 2-6. Final Sampling Location Coordinates for Wetland Surface Soil Samples Collected During Phase 1

Sample ID[a]	Date/Time	Sampling Location Coordinates[b]			
		X[c]	Y[c]	Latitude[d]	Longitude[d]
WS21-0-6	04.23.08/1253	7640447	714671	45.60602	-122.69489
WS22-0-6	04.23.08/1139	7640509	714684	45.60606	-122.69465
WS23-0-6	04.23.08/1311	7640463	714607	45.60585	-122.69482
WS24-0-6	04.23.08/1327	7640566	714606	45.60585	-122.69442
WS25-0-6	04.23.08/1154	7640633	714622	45.60590	-122.69415
WS27-0-6	04.23.08/1050	7640707	714535	45.60567	-122.69386
WS28-0-6	04.23.08/1027	7640661	714455	45.60545	-122.69403
WS29-0-6	04.23.08/1210	7640771	714551	45.60572	-122.69361
WS30-0-6[f]	04.23.08/0858	7640733	714474	45.60550	-122.69375
WS200-0-6[g]					
WS31-0-6	04.23.08/1003	7640724	714369	45.60521	-122.69377
WS32-0-6	04.23.08/0642	7640823	714470	45.60550	-122.69340
WS33-0-6[e]	04.23.08/0725	7640780	714382	45.60525	-122.69356
DS01-0-6	04.24.08/0900	7640453	715053	45.60707	-122.69490
WS201-0-6[h]					
DS04-0-6	04.24.08/0806	7640279	714794	45.60635	-122.69556

[a] Sampling information for locations WS06, WS19, WS26, DS02, DS03, and DS05 is presented in Section 2.2.2 because the surface intervals were collected along with the subsurface intervals at these locations. No subsurface intervals were collected for any other wetland locations.

[b] Target coordinates were provided in the QAPP (Bridgewater et al. 2008a).

[c] Coordinates are in NAD83 HARN State Plane Oregon North, US ft.

[d] Coordinates are in decimals degrees, NAD83.

[e] EPA split samples were collected at these locations.

[f] A rinsate blank WS30-RB was collected at WS-30.

[g] Field duplicate of WS30-0-6.

[h] Field duplicate of DS01-0-6.

ID – identification

2.2.2 Wetland Subsurface Soil

Six subsurface wetland soil samples (i.e., WS-19, DS-03, WS-26, DS-02, and DS-05, and WS-06) were collected on April 23 and 24, 2008, using a hand auger (Map 2). Subsurface soil samples were collected at wetland locations as indicated in the QAPP (Bridgewater et al. 2008a), with the exception of DS-03. This location was moved approximately 10 ft northwest because of continued refusal at the target location caused by cobbles and riprap located just below the surface.

The hand auger borings were advanced to the sampling depths described in the QAPP (Bridgewater et al. 2008a). Two hand-auger borings provided sufficient soil volume for a standard sample; three to four hand-auger borings were necessary when additional QA/QC samples (i.e., splits or replicates) were collected. Standard hand-auger sampling locations were within 1 ft of the original hand-auger location. Replicate subsurface soil samples were collected approximately 3 ft from the original subsurface soil sampling location.

Table 2-7 presents the coordinates for the subsurface soil samples.

Table 2-7. Final Sampling Location Coordinates for Wetland Subsurface Soil Samples Collected During Phase 1

Sample ID	Date/Time	Sampling Location Coordinates[a]			
		X[b]	Y[b]	Latitude[c]	Longitude[c]
WS06-0-6	04.24.08/1250	714983	7640253	-122.69568	45.60686
WS06-6-12	04.24.08/1310				
WS06-24-36	04.24.08/1340				
WS300-0-6[d]	04.24.08/1300	714983	7640253	-122.69568	45.60686
WS301-6-12[e]	04.24.08/1305				
WS302-24-36[f]	04.24.08/1320				
WS19-0-6[g]	04.23.08/0915	714743	7640387	-122.69513	45.60621
WS19-6-12	04.23.08/0950				
WS19-24-36[g]	04.23.08/1025				
WS26-0-6[g]	04.23.08/1250	714540	7640571	-122.69439	45.60567
WS26-6-12	04.23.08/1310				
WS26-24-36[g]	04.23.08/1325				
DS02-0-6	04.23.08/1540	714981	7640362	-122.69525	45.60686
DS02-6-12	04.23.08/1550				
DS02-24-36	04.23.08/1600				
DS03-0-6[g]	04.23.08/1110	714837	7640292	-122.69551	45.60646
DS03-6-12	04.23.08/1140				
DS03-24-36[g]	04.23.08/1215				
DS05-0-6[g]	04.24.08/0800	714700	7640303	-122.69545	45.60609
DS05-6-12	04.24.08/0815				
DS05-24-36[g]	04.24.08/0840				

[a] Target coordinates were provided in the QAPP (Bridgewater et al. 2008a).

[b] Coordinates are in NAD83 HARN State Plane Oregon North, US ft.

[c] Coordinates are in decimal degrees, NAD83.

[d] Field replicate of WS06-0-6.

[e] Field replicate of WS06-6-12.

[f] Field replicate of WS06-24-36.

[g] EPA split samples were collected at these locations.

ID – identification

2.3 Lake Sampling

Surface water and sediment samples were collected from Force Lake and North Lake on April 21 and 22, 2008. Sampling locations in Force Lake were accessed using a canoe that was launched from the parking area on the eastern side of the lake (near North Force Avenue). The canoe was portaged from Force Lake to access the sampling locations in North Lake.

2.3.1 Surface Water

Three surface water samples, and one field duplicate sample, were collected from Force Lake on April 21 and 22, 2008 (Map 2). In accordance with the QAPP (Bridgewater et al. 2008a), water samples were collected approximately 1 ft below the water surface using a decontaminated 5-L Niskin bottle sampler that was manually deployed from a canoe. Two to three water grabs were necessary to fill the required volume of sample containers needed by the laboratory for analysis. Samples were processed in the canoe at the location where the samples were collected so that extra water could be discarded at the sampling location.

In addition to surface water samples, *in situ* water quality measurements were taken at the three sampling locations at 1 ft below the water surface. Temperature, dissolved oxygen, salinity, and conductivity were measured using a YSI meter. Water hardness was measured using a LaMotte water hardness kit. Table 2-8 presents the coordinates of the water sampling locations, and Table 2-9 presents the water quality results.

Table 2-8. Final Sampling Location Coordinates for Water Samples Collected During Phase 1

Sample ID	Date/Time	Sampling Location Coordinates[a]			
		X[b]	Y[b]	Latitude[c]	Longitude[c]
SW-01	04.21.08/0817	7640019	714462	45.60542	-122.69654
SW-02[d]	04.22.08/0935	7640405	714219	45.60478	-122.69501
SW-03	04.21.08/0956	7640304	714630	45.60590	-122.69544
SW-300[e]					

[a] Target coordinates were provided in the QAPP (Bridgewater et al. 2008a).

[b] Coordinates are in NAD83 HARN State Plane Oregon North, US ft.

[c] Coordinates are in decimal degrees, NAD83.

[d] An EPA split sample was collected at this location.

[e] Field duplicate of SW-03.

ID – identification

Table 2-9. *In Situ* Water Quality Data for the Three Water Samples Collected During Phase 1

Sample ID	Temperature (°C)	Dissolved Oxygen (mg/L)	Salinity (ppt)	Conductivity (mS/cm)	Hardness (ppm)
SW-01	10.0	5.59	0.2	275.5	880
SW-02	10.4	6.34	0.2	274.8	444
SW-03[a]	11.1	6.31	0.2	283.0	460

[a] The water quality measurements at SW-03 also apply to the duplicate samples (SW-300) collected at this location.

ID – identification

ppm – parts per million

ppt – parts per thousand

2.3.2 Surface Sediment

Eleven surface sediment samples, and one field duplicate sample, were collected from Force Lake; three surface sediment samples were collected from North Lake on April 21 and April 22, 2008 (Map 2). In accordance with the QAPP (Bridgewater et al. 2008a), surface sediment samples were collected using a decontaminated 0.02-m^2 Ekman grab sampler that was manually deployed from a canoe. Grab samples were rejected if less than 8 cm of sediment was penetrated by the Ekman sampler. For most sediment samples, only one grab was necessary to obtain sufficient volume to fill the sample containers needed by the laboratory for analysis. Additional grab samples were necessary at locations where replicate or split samples were collected. Samples were processed in the canoe at the sampling location so that extra sediment could be discarded at the sampling location.

Lake sediment target station SE-08 was relocated approximately 20 ft away from the shoreline because the substrate at the target location adjacent to the shore was obstructed by root debris. Multiple grab attempts in the vicinity were unsuccessful at obtaining acceptable sediment recovery, and sufficient sediment volume could not be collected. It should be noted that the initial target coordinates were based on the Force Lake sampling grid, and were not intended to target a particular source. After the sample was collected, EPA was consulted to ensure that this relocation was acceptable. EPA approved of the relocation of the sampling station, and thus the sample was retained and sent to the laboratory.

Lake sediment target station SE-101 was relocated approximately 20 ft away from the target location (Map 2). Multiple grab attempts at the target location were unsuccessful because the rocky substrate prevented acceptable sediment recovery and the collection of sufficient sample volume. The EPA oversight representative approved the relocation of the sampling station.

Because of the high water content of the lake sediment samples, the standard procedures for volatile organic compound (VOC) sample collection (EPA Method 5035A) had to be slightly modified. For lake sediment samples, a decontaminated stainless steel spoon was used to collect sediment from the Ekman sampler to fill the pre-set EasyDraw Syringe®. Caution was used to minimize disturbance to the sediment that could have resulted in the evaporative loss of VOCs. The EPA oversight representative was informed of the issue and approved the modification to the standard procedures.

Table 2-10 presents the coordinates for the surface sediment samples. Observations of gross sediment sample characteristics were recorded on the surface sediment collection forms provided in Appendix B.

Table 2-10. Final Sampling Location Coordinates for Surface Sediment Samples Collected During Phase 1

Sample ID	Date/Time	Sampling Location Coordinates[a]			
		X[b]	Y[b]	Latitude[c]	Longitude[c]
SE01-0-4	04.21.08/0708	7639954	714445	45.60536	-122.69679
SE02-0-4[d]	04.22.08/0910	7640276	714612	45.60585	-122.69555
SE03-0-4	04.22.08/0627	7640179	714441	45.60537	-122.69591
SE04-0-4	04.21.08/0745	7640084	714263	45.60488	-122.69626
SE05-0-4[e]	04.21.08/1542	7640409	714434	45.60537	-122.69501
SE06-0-4	04.21.08/1140	7640310	714265	45.60490	-122.69538
SE200-0-4[f]					
SE07-0-4	04.21.08/1219	7640219	714093	45.60442	-122.69572
SE08-0-4	04.21.08/1509	7640616	714399	45.60529	-122.69420
SE09-0-4	04.21.08/1415	7640567	714255	45.60489	-122.69437
SE10-0-4	04.21.08/1350	7640445	714071	45.60438	-122.69483
SE11-0-4	04.21.08/1313	7640451	713865	45.60381	-122.69479
SE101-0-4[d]	04.22.08/0745	7639831	714566	45.60569	-122.69728
SE102-0-4	04.22.08/0700	7639839	714591	45.60576	-122.69725
SE103-0-4	04.22.08/0721	7639836	714653	45.60593	-122.69727

[a] Target coordinates were provided in the QAPP (Bridgewater et al. 2008a).

[b] Coordinates are in NAD83 HARN State Plane Oregon North, US ft.

[c] Coordinates are in decimal degrees, NAD83.

[d] EPA split samples were collected at these locations.

[e] Rinsate blank SE05-RB was collected at SE-05.

[f] Field duplicate of SE06-0-4.

ID – identification

3.0 LOCAL GEOLOGY AND HYDROGEOLOGY

The local geologic and hydrogeologic conditions encountered during Phase 1 were similar to those described in the WP (Bridgewater et al. 2008b).

Sections 3.1 and 3.2 provide a description of the local geology and hydrogeology based on information gathered during Phase 1 of the RI. Figures 3-1 and 3-2 present groundwater contours for the shallow and intermediate groundwater zones, respectively, based on the first complete round of water level measurements made on June 9, 2008. Figures illustrating groundwater contours for the second complete round of water level measurements were not prepared because the directions of groundwater flow in the shallow and intermediate zones were similar to those presented in Figures 3-1 and 3-2, even though water levels were lower on July 9, 2008. Additional figures illustrating groundwater contours for both zones will be prepared after additional rounds of monthly water levels have been collected.

Two geologic cross sections (A-A', which trends approximately east to west, and the B-B', which trends approximately north to south across the Facility) are presented in Figures 3-4 and 3-5; Figure 3-3 shows the location of each cross section line.

3.1 Local Geology

Local geologic conditions described in this section are based on the lithology recorded on numerous shallow (i.e., approximately 10 ft bgs) direct-push boring logs and deeper (i.e., approximately 50 ft bgs) boring logs for intermediate monitoring wells MW-2i, MW-4i, and MW-5i (see Appendix B). Local geologic conditions below a depth of approximately 50 ft bgs were based on lithologic information for the plant well and cross sections prepared by Golder Associates (see Appendix E in the WP).

One non-native (i.e., fill) lithologic layer and native lithologic layers are present on the Facility, as presented in the geologic cross sections (Figures 3-4 and 3-5). The native lithologic layers are consistent with a fluvial depositional environment of predominantly low energy[1], as indicated by the high percentage of silts and clays in most of the soil samples. Occasionally, the fluvial depositional environment changed to moderate energy[2], as indicated by the fine- to medium-grained sand layers detected in some of the soil samples. The non-native and native distinct lithologic layers are described below:

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[1] Sediment deposited in lacustrine environments, swamps, marshes, deltas and lagoons.
[2] Sediments deposited in outwash plains, alluvial fans, along coast and shorelines, by rivers and streams, flooding, and meltwater from snow and glaciers.

- Approximately 0 to 3 ft bgs: Fill, primarily rock fragments and gravel, silty/sandy matrix, trace to little brick fragments, foundry sand, pieces of wood or cobbles, poorly sorted, medium dense, moist.
- Approximately 3 to 8 ft bgs: Very fine- to fine-grained sand, moderately sorted (some micro-stratification), trace silt, very loose to loose, gray, wet.
- Approximately 8 to 37 ft bgs: Silt, some clay, trace sand, moderate plasticity, olive gray to light gray to gray brown, soft to medium stiff, moist.
- Approximately 37 to 48 ft bgs: Fine- to medium-grained sand, trace silt, poorly graded, gray, loose to medium dense, wet.
- Approximately 48 to 50 ft bgs: Silt, some clay, trace sand, moderate plasticity, light gray brown to gray, soft to medium stiff, moist to wet.

3.2 Local Hydrogeology

Figures 3-1 and 3-2 show the shallow and intermediate groundwater elevations measured on June 9, 2008. In general, groundwater in the shallow and intermediate saturated zones flows in a southwest/west direction under relatively low gradients. A summary of the hydrogeologic characteristics for the shallow and intermediate groundwater zones is provided in Table 3-1.

Table 3-1. Hydrogeology Characteristics of Shallow and Intermediate Groundwater Zones

Groundwater Zone	Gradient (ft/ft)	Advective Velocity (ft/day)	Sand Porosity (%)
Shallow groundwater zone	0.014[a]	0.05[b]	35[c]
Intermediate groundwater zone	0.001[d]	0.01[e]	35[c]

[a] Based on a hydraulic head difference of 4.28 ft and a distance of 298 ft between MW-3s and MW-1s.

[b] Based on the average hydraulic conductivity value of 1.24 ft/day from the aquifer slug tests conducted on MW-2s, MW-3s, MW-4s, GA-29 and GA-34.

[c] Based on the average porosity of sand (between 25 and 50%) (Freeze and Cherry 1979).

[d] Based on the same hydraulic head difference of 0.26 ft between MW-2i and MW-5i and between MW-2i and MW-4i, and an average of the distances between MW-2i and MW-4i and between MW-2i and MW-5i (approximately 180 ft).

[e] Based on the average hydraulic conductivity value of 4.44 ft/day calculated from the aquifer slug test conducted on MW-4i and MW-5i.

The vertical gradient between the shallow zone and intermediate zone is slightly downward near the north side of the Facility, as demonstrated by the water levels measured in MW-4s and MW-4i. During the first complete round of water level measurements (i.e., June 9, 2008), the difference in water levels between MW-4s and MW-4i was -0.36 ft (minus indicates that the head in the intermediate well was lower than in the shallow well) or a downward vertical gradient of 0.01 ft/ft (with an approximately 35 foot difference in well screen elevations). The vertical gradient was slightly upward in the middle of the Facility and increasingly upward near the south side of the Facility, as demonstrated by the MW-5 and MW-2 well clusters, respectively. During the first complete round of water level measurements, the difference in water level elevations between MW-5s and MW-5i was +0.08 ft or an upward gradient of 0.002 ft/ft (with an approximately 35 foot difference in well screen elevation), and the difference in water levels hydraulic heads in MW-2s and MW-2i was +1.22 ft or an upward gradient of 0.035 ft/ft (with an approximately 35 foot difference in well screen elevation). Vertical gradients at these three well clusters were similar in direction and magnitude during the second complete round of water level measurements.

4.0 ANALYTICAL METHODS

This section summarizes the analytical methods and procedures followed during Phase 1, as discussed in detail in the QAPP (Bridgewater et al. 2008a). This section also briefly discusses any laboratory deviations that occurred.

4.1 Summary of Analytical Methods

All media were analyzed for metals, total petroleum hydrocarbons (TPH), polycyclic aromatic hydrocarbons (PAHs), VOCs, organochlorines pesticides, and polychlorinated biphenyl (PCB) Aroclors (Table 4-1). Selected Facility soil and wetland soil samples were also analyzed for semivolatile organic compounds (SVOCs) based on their proximity to potential source areas. All samples were shipped to Analytical Resources, Inc. (ARI), for analysis using the methods outlined in the QAPP and summarized in Table 4-2.

4.2 Laboratory Deviations

Laboratory methods were performed as outlined in the QAPP (Bridgewater et al. 2008a), with the following exceptions:

- All chemistry analyses were conducted by ARI as specified in Section 3.4.1 of the QAPP, with one exception. ARI does not perform metals analysis on LNAPL samples; therefore, the metals analysis for sample LNAPL-GA-30 was performed by Spectra Laboratories in Tacoma, Washington.
- Table 3-3 of the QAPP noted that only the surface samples collected at four wetland soil core locations would be analyzed for SVOCs; however, samples collected from the two deeper depths of these four cores were also analyzed for SVOCs. The SVOC analyses for these eight samples were incorrectly requested on the chain-of-custody forms.
- Tables 3-10 and 3-13 of the QAPP specified that silica gel cleanup methods would be used for all TPH analyses. Because only diesel-extractable TPH (TPH-Dx) analyses require this cleanup method, it was not conducted for the other TPH analyses.

Table 4-1. Summary of Phase 1 Laboratory Analyses by Media

Constituent Group	Facility Soil	Wetland Soil	Ground-water	Surface Water	Lake Sediment
Conventionals	X[a]	X[a]	X[b]	X[c]	X[a]
PCBs (as 7 Aroclors)	X	X	X	X	X
Organochlorine pesticides	X	X	X	X	X
Metals (including mercury) [d]	X	X	X	X	X
TPH (including gasoline, diesel, and motor oil fractions) with silica gel cleanup	X	X	X		X
PAHs	X	X	X	X	X
SVOCs	X[e]	X[e]			
VOCs	X	X	X	X	X

[a] TOC and total solids were analyzed in the laboratory. Grain size was also analyzed in the laboratory for sediment samples.

[b] The following conventionals were analyzed in the field and in the laboratory: pH, specific conductance, salinity, and total dissolved solids.

[c] The following conventionals were analyzed in the field: temperature, dissolved oxygen and water hardness.

[d] The following metals were analyzed in all samples: antimony, arsenic, barium, cadmium, chromium, cobalt, copper, lead, mercury, selenium, vanadium, and zinc. These metals were selected based on historical analytical results that exceeded human health or ecological screening values. Iron and manganese were also analyzed in groundwater samples to assess redox conditions.

[e] SVOC analyses were conducted on the surface soil samples collected near areas of potential concern located on the Facility (i.e., SL-05, SL-06, SL-07, SL-08, SL-09, SL-10, SL-20, SL-21, SL-22, SL-23, SL-25, SL-26, SL-27, SL-28, SL-29, SL-30, and SL-31), on wetland soil samples collected from the drainage ditch (i.e., DS-01 through DS-05), and on wetland soil samples collected along the southwest side of the Facility (i.e., WS-16, WS-19, WS-22, WS-25, and WS-29).

PAH – polycyclic aromatic hydrocarbon

PCB – polychlorinated biphenyl

TPH – total petroleum hydrocarbons

SVOC – semivolatile organic compound

VOC – volatile organic compound

Table 4-2. Laboratory Analytical Methods

Parameter	Method	Reference
PCBs as Aroclors	GC/ECD	EPA 8082
Organochlorine pesticides	GC/ECD	EPA 8081A
PAHs	GC/MS	EPA 8270-SIM
SVOCs (including PAHs, phthalates, phenols, and other SVOCs)	GC/MS	EPA 8270D
TPHs (diesel and oil fractions) with silica gel cleanup	GC/FID	NWTPH-D and NWTPH-Dx
TPHs (gasoline fraction) with silica gel cleanup	GC/FID	NWTPH-G
VOCs	GC/MS	EPA 8260B
Mercury	CVAA	EPA 7471A
Other metals[a]	ICP-AES and ICP-MS	EPA 6010B and 6020
Grain size	sieve/ hydrometer	ASTM D422
TOC	combustion	Plumb (1981)
Total solids	oven-dried	EPA 160.3
pH	electrometric	EPA 150.1
Specific conductance	electrometric	SM 2510B
Salinity	electrometric	SM 2520B
Total dissolved solids	gravimetric	EPA 160.1

[a] Metals analyzed included antimony, arsenic, barium, cadmium, chromium, cobalt, copper, lead, nickel, selenium, vanadium, and zinc. Iron and manganese were also analyzed in groundwater samples.

ASTM – American Society for Testing and Materials
CVAA – cold vapor atomic absorption
EPA – US Environmental Protection Agency
GC/ECD – gas chromatography/electron capture detection
GC/MS – gas chromatography/mass spectrometry
GC/FID – gas chromatography/flame ionization detection
ICP-AES – inductively coupled plasma-atomic emission spectrometry
ICP-MS – inductively coupled plasma-mass spectrometry
NWTPH-D – Northwest total petroleum hydrocarbons – diesel
NWTPH-Dx – Northwest total petroleum hydrocarbons – diesel extractable
NWTPH-G – Northwest total petroleum hydrocarbons – gasoline
PAH – polycyclic aromatic hydrocarbon
PCB – polychlorinated biphenyl
SIM – selected ion monitoring
SM – standard method
SVOC – semivolatile organic compound
TPH – total petroleum hydrocarbons
VOC – volatile organic compound

5.0 NATURE AND EXTENT OF IMPACTS

This section summarizes the Phase 1 laboratory analytical results. Each of the following subsections provide summary data tables that present detection frequencies, concentration ranges, and a comparison of concentrations with ecological and human health screening levels.

Constituents are included in the summary tables if they were detected in at least one sample of a given media. Constituents are not included in the tables with screening level comparisons if no applicable screening levels are available. All data are presented in Appendix A and are available electronically in the attached CD. To illustrate general trends in the nature and extent of impact, maps were created to show concentrations of total PCBs, total DDTs, total PAHs[3], total TPH[4], arsenic, lead, and mercury in all media (Maps 3 through 16). These constituents and constituent groups have a high frequency of individual samples with concentrations greater than screening levels in one or multiple media.

The summary information provided in the tables and maps in this section is based on sampling locations rather than individual samples (i.e., the results of field duplicate and field replicate samples were combined with the results of the original sample before the information was summarized, per the procedures listed in the Appendix D).

5.1 Facility Soil and Groundwater

This section presents the laboratory analytical data for surface and subsurface soil samples and groundwater samples collected at the Facility.

5.1.1 Facility Surface and Subsurface Soil

Surface soil samples were collected on the Facility at 33 locations; subsurface soil samples were collected at 21 locations (Map 1). Surface soil sample depths ranged from 0 to 3 ft bgs, intermediate subsurface soil sample depths ranged from 3 to 7 ft bgs, and deep subsurface soil sample depths ranged from 8 to 15 ft bgs.[5] In addition, soil samples were collected at 9 locations along the soil berm, and 3 samples were collected from the soil stockpile (Map 1).

[3] Total PAHs refers to the concentration sum of HPAHs (i.e., pyrene, benzo[g,h,i]perylene, indeno[1,2,3-cd]pyrene, fluoranthene, chrysene, benzo[a]pyrene, dibenzo[a,h]anthracene, benzo[a]anthracene, benzo[a]anthracene/chrysene, total benzofluoranthenes) and LPAHs (anthracene, acenaphthylene, acenaphthene, phenanthrene, fluorine, naphthalene).

[4] Total TPH refers to the sum of the following constituents: TPH-gasoline, TPH-diesel range, and TPH-motor oil range.

[5] The variation in the sampling depths was based on field conditions, primarily on the thickness of the gravel fill at the Facility.

Table 5-1 presents a summary of the laboratory analytical results for Facility soil samples, presented separately for each category listed below. Constituent concentrations in soil were compared with industrial screening levels (i.e., EPA Region 6 screening levels and Oregon Department of Environmental Quality [DEQ] risk based concentrations [RBCs]) in Table 5-2. Results are summarized below.

- **Surface soil intervals**: Of the 188 constituents and constituent groups that were analyzed for in surface soil samples, only 89 individual constituents or constituent groups were detected at least once, and only 21 had concentrations greater than the industrial human health screening levels in one or more samples.
- **Intermediate subsurface soil intervals**: Of the 188 constituents and constituent groups that were analyzed for in intermediate intervals of subsurface soil samples, only 78 individual constituents or constituents groups were detected at least once, and only 18 had concentrations greater than the industrial human health screening levels in one or more samples.
- **Deep subsurface soil intervals**: Of the 188 constituents and constituent groups that were analyzed for in deep intervals of subsurface samples, only 69 individual constituents or constituent groups were detected at least once, and only 8 had concentrations greater than the industrial human health screening levels in one or more samples.
- **Soil stockpile**: Of the 145 constituents and constituent groups that were analyzed for in soil stockpile samples, only 55 individual constituents or constituent groups were detected at least once, and only 2 had concentrations greater than the industrial human health screening levels in one or more samples.
- **Soil berm**: Of the 145 constituents and constituent groups that were analyzed for in soil berm samples, only 53 individual constituents or constituent groups were detected at least once, and only 8 had concentrations greater than the industrial human health screening levels in one or more samples.

Table 5-2 also includes a comparison of constituent concentrations with residential screening levels. A future hypothetical residential scenario was created in response to EPA comments, which stated that an assessment of risks associated with residential living is necessary to determine if CERCLA actions are needed to restrict future residential land use. As discussed in the WP, the zoning and comprehensive plan designation for the facility indicate that the current and likely future land use of the facility is industrial, particularly given its Industrial Sanctuary Designation. Because no residential areas are currently located near the Site and no residential developments are planned, the future hypothetical residential scenario will be assessed using a screening approach as requested by EPA.

A complete summary of analytical results is provided in Appendix A. Total PCB, total DDT, total PAH, total TPH, arsenic, lead, and mercury concentrations are shown on Maps 3 though 9, respectively. Total PCB concentrations exceeded industrial screening levels mainly in the Facility driveway entrance, in the central portion of the Facility (i.e., in the tank farm and used oil processing, former tanker truck cleaning operation, former unlined holding pond, and current stormwater treatment system areas, in the southern portion of the "C" shaped area), and near monitoring well GA-30. Total DDT concentrations exceeded industrial screening levels mainly in the Facility driveway exit and central portion of the Facility. The highest total PAH and TPH concentrations were detected in the central portion of the Facility, near the north corner of the new base oil plant, in the southwest corner of the Facility, and in the Facility driveway exit. Arsenic, lead and mercury had different concentration distributions as illustrated in Maps 7, 8 and 9, respectively.

Table 5-1. Constituent Concentrations Detected in Phase 1 Facility Soil Samples

Constituent	Unit	Sample Type/ Depth	Detection Frequency		Detected Concentrations				RL or Range of RLs if Not Detected
			Ratio	%	Minimum	Maximum	Mean	Median	
Metals									
Arsenic	mg/kg dw	surface	33/33	100%	0.7	20.6 J	3.3	2.8	na
	mg/kg dw	intermediate	22/22	100%	1.3 J	14.5 J	3.6	3.2	na
	mg/kg dw	deep	21/21	100%	1.1 J	4.4	2.4	2.4	na
	mg/kg dw	soil berm	9/9	100%	1.5	9.6	4.5	3.8	na
	mg/kg dw	soil stockpile	3/3	100%	3.1	4.3	3.8	4.1	na
Barium	mg/kg dw	surface	33/33	100%	36.5	342	140	120	na
	mg/kg dw	intermediate	22/22	100%	103	385	180	170	na
	mg/kg dw	deep	21/21	100%	122	253	200	200	na
	mg/kg dw	soil berm	9/9	100%	76.4 J	341 J	150	140	na
	mg/kg dw	soil stockpile	3/3	100%	118 J	172 J	140	130	na
Cadmium	mg/kg dw	surface	17/33	52%	0.2 J	0.7	0.44	0.40	0.2 – 0.3
	mg/kg dw	intermediate	9/22	41%	0.3 J	0.5 J	0.40	0.40	0.2 – 0.3
	mg/kg dw	deep	6/21	29%	0.3 J	0.6 J	0.40	0.40	0.3
	mg/kg dw	soil berm	6/9	67%	0.2	0.6	0.38	0.40	0.2 – 0.3
	mg/kg dw	soil stockpile	2/3	67%	0.3	0.4	0.35	0.40	0.2
Chromium	mg/kg dw	surface	33/33	100%	4.0	63	22	20	na
	mg/kg dw	intermediate	22/22	100%	5.7 J	91 J	24	18	na
	mg/kg dw	deep	21/21	100%	12.2	36.5	29	30	na
	mg/kg dw	soil berm	9/9	100%	12.3	76	26	19	na
	mg/kg dw	soil stockpile	3/3	100%	13.6 J	25.4	20	21	na
Cobalt	mg/kg dw	surface	33/33	100%	4.1 J	30	12	11	na
	mg/kg dw	intermediate	22/22	100%	2.8 J	35 J	9.8	8.4	na
	mg/kg dw	deep	21/21	100%	6.3	12.4	9.4	9.4	na
	mg/kg dw	soil berm	9/9	100%	6.6	32	14	12	na
	mg/kg dw	soil stockpile	3/3	100%	7.8 J	13.8	11	10	na

Table 5-1. Constituent Concentrations Detected in Phase 1 Facility Soil Samples

Constituent	Unit	Sample Type/ Depth	Detection Frequency		Detected Concentrations				RL or Range of RLs if Not Detected
			Ratio	%	Minimum	Maximum	Mean	Median	
Copper	mg/kg dw	surface	33/33	100%	9.4	1,070	120	48	na
	mg/kg dw	intermediate	22/22	100%	10.4	1,370	110	21	na
	mg/kg dw	deep	21/21	100%	13.3	42.1 J	32	32	na
	mg/kg dw	soil berm	9/9	100%	14.3 J	1,240 J	170	42	na
	mg/kg dw	soil stockpile	3/3	100%	36.4	94.6 J	72	85	na
Lead	mg/kg dw	surface	33/33	100%	3	183	35	26	na
	mg/kg dw	intermediate	22/22	100%	4 J	60 J	16	13	na
	mg/kg dw	deep	21/21	100%	6 J	20	9.5	9.0	na
	mg/kg dw	soil berm	9/9	100%	6 J	65 J	35	33	na
	mg/kg dw	soil stockpile	3/3	100%	13	31 J	24	29	na
Mercury	mg/kg dw	surface	14/33	42%	0.04	1.93 J	0.22	0.10	0.04 – 0.06
	mg/kg dw	intermediate	8/22	36%	0.05	0.47	0.13	0.085	0.04 – 0.06
	mg/kg dw	deep	8/21	38%	0.06 J	0.11	0.078	0.075	0.06 – 0.08
	mg/kg dw	soil berm	7/9	78%	0.04 J	0.23	0.086	0.060	0.05
	mg/kg dw	soil stockpile	2/3	67%	0.06 J	0.07 J	0.065	0.065	0.06
Nickel	mg/kg dw	surface	33/33	100%	4	50 J	15	13	na
	mg/kg dw	intermediate	22/22	100%	5 J	35 J	17	16	na
	mg/kg dw	deep	21/21	100%	12	22 J	19	19	na
	mg/kg dw	soil berm	9/9	100%	11	30	11	14	na
	mg/kg dw	soil stockpile	3/3	100%	13 J	20	17	14	na
Selenium	mg/kg dw	surface	1/33	3%	0.7 J	0.7 J	0.70	0.70	0.5 – 0.7
	mg/kg dw	intermediate	1/22	5%	0.8	0.8	0.80	0.80	0.6 – 0.7
Vanadium	mg/kg dw	surface	33/33	100%	29.4 J	165	81	81	na
	mg/kg dw	intermediate	22/22	100%	15.5 J	102 J	50	46	na
	mg/kg dw	deep	21/21	100%	32.2	88.4	66	64	na
	mg/kg dw	soil berm	9/9	100%	49.7	116	87	94	na
	mg/kg dw	soil stockpile	3/3	100%	47.1 J	85.8	64	59	na

Table 5-1. Constituent Concentrations Detected in Phase 1 Facility Soil Samples

Constituent	Unit	Sample Type/ Depth	Detection Frequency		Detected Concentrations				RL or Range of RLs if Not Detected
			Ratio	%	Minimum	Maximum	Mean	Median	
Zinc	mg/kg dw	surface	33/33	100%	35	718 J	160	120	na
	mg/kg dw	intermediate	22/22	100%	26 J	785 J	120	70	na
	mg/kg dw	deep	21/21	100%	57	107 J	75	73	na
	mg/kg dw	soil berm	9/9	100%	52 J	539 J	160	120	na
	mg/kg dw	soil stockpile	3/3	100%	72	140 J	110	130	na
PAHs									
2-Methylnaphthalene	µg/kg dw	surface	26/33	79%	14	29,000	2,500	300	9.7 – 62
	µg/kg dw	intermediate	19/22	86%	6.3	11,000	1,800	230	4.8 – 5.0
	µg/kg dw	deep	5/21	24%	4.9	320	72	7.4	4.8 – 5.0
	µg/kg dw	soil berm	7/9	78%	13	54	27	22	5.0
	µg/kg dw	soil stockpile	3/3	100%	140	260	200	190	na
Acenaphthene	µg/kg dw	surface	19/33	58%	5.3	4,000	820	460	4.8 – 62
	µg/kg dw	intermediate	18/22	82%	5.0	28,000	2,300	120	4.8 – 5.0
	µg/kg dw	deep	3/21	14%	9.8 JN	67	32	20	4.8 – 5.0
	µg/kg dw	soil berm	1/9	11%	700	700	700	700	4.6 – 15
	µg/kg dw	soil stockpile	1/3	33%	9.2	9.2	9.2	9.2	14 – 15
Acenaphthylene	µg/kg dw	surface	5/33	15%	5.3	140	66	63	4.8 – 390
	µg/kg dw	intermediate	2/22	9%	8.2	350	180	180	4.8 – 150
	µg/kg dw	soil stockpile	1/3	33%	6.3 JN	6.3 JN	6.3	6.3	14 – 15
Anthracene	µg/kg dw	surface	28/33	85%	14	6,400	870	350	9.7 – 62
	µg/kg dw	intermediate	18/22	82%	9.0	4,500	780	270	4.8 – 5.0
	µg/kg dw	deep	3/21	14%	25	270	160	180	4.8 – 5.0
	µg/kg dw	soil berm	7/9	78%	7.9	2,300	340	17	5.0
	µg/kg dw	soil stockpile	3/3	100%	53	110	77	66	na
Benzo(a)anthracene	µg/kg dw	surface	28/33	85%	15	1,900	410	220	9.7 – 62
	µg/kg dw	intermediate	18/22	82%	5.4	3,100	430	160	4.8 – 5.0
	µg/kg dw	deep	3/21	14%	8.8	190	77	32	4.8 – 5.0
	µg/kg dw	soil berm	9/9	100%	6.9	5,700	680	31	na
	µg/kg dw	soil stockpile	3/3	100%	25	48	35	31	na

Table 5-1. Constituent Concentrations Detected in Phase 1 Facility Soil Samples

Constituent	Unit	Sample Type/ Depth	Detection Frequency		Detected Concentrations				RL or Range of RLs if Not Detected
			Ratio	%	Minimum	Maximum	Mean	Median	
Benzo(a)pyrene	µg/kg dw	surface	30/33	91%	11	1,700	380	230	15 – 62
	µg/kg dw	intermediate	17/22	77%	10	1,000	220	160	4.8 – 5.0
	µg/kg dw	deep	3/21	14%	5.9	250	110	81	4.8 – 5.0
	µg/kg dw	soil berm	9/9	100%	9.9	3,800	500	44	na
	µg/kg dw	soil stockpile	3/3	100%	32	81	55	53	na
Benzo(b)fluoranthene	µg/kg dw	surface	29/33	88%	14	1,300	370	250	15 – 62
	µg/kg dw	intermediate	19/22	86%	6.4	1,200	250	100	4.8
	µg/kg dw	deep	3/21	14%	14	210	93	53	4.8 – 5.0
	µg/kg dw	soil berm	9/9	100%	15	2,900	410	57	na
	µg/kg dw	soil stockpile	3/3	100%	36	91	70	84	na
Benzo(g,h,i)perylene	µg/kg dw	surface	29/33	88%	5.7	520	140	110	15 – 62
	µg/kg dw	intermediate	16/22	73%	5.0	190	56	22	4.8 – 130
	µg/kg dw	deep	2/21	10%	24	82	53	53	4.8 – 5.0
	µg/kg dw	soil berm	9/9	100%	12	730	130	24	na
	µg/kg dw	soil stockpile	3/3	100%	18	52	37	40	na
Benzo(k)fluoranthene	µg/kg dw	surface	30/33	91%	11 J	1,100	280	180	15 – 62
	µg/kg dw	intermediate	17/22	77%	7.4	1,100	190	75	4.8 – 5.0
	µg/kg dw	deep	4/21	19%	4.8	99	41	31	4.8 – 5.0
	µg/kg dw	soil berm	9/9	100%	6.4	3,500	460	29	na
	µg/kg dw	soil stockpile	3/3	100%	21	84	47	36	na
Total benzofluoranthenes	µg/kg dw	surface	30/33	91%	11 J	2,400	640	420	15 – 62
	µg/kg dw	intermediate	19/22	86%	6.4	2,300	420	180	4.8
	µg/kg dw	deep	4/21	19%	4.8	310	110	64	4.8 – 5.0
	µg/kg dw	soil berm	9/9	100%	21	6,400	870	81	na
	µg/kg dw	soil stockpile	3/3	100%	72	168	120	110	na
Chrysene	µg/kg dw	surface	31/33	94%	13 J	3,100	600	230	37 – 62
	µg/kg dw	intermediate	19/22	86%	5.9	2,800	470	130	4.8
	µg/kg dw	deep	3/21	14%	18	310	140	87	4.8 – 5.0
	µg/kg dw	soil berm	9/9	100%	11	6,100	760	41	na
	µg/kg dw	soil stockpile	3/3	100%	41	81	61	62	na

Table 5-1. Constituent Concentrations Detected in Phase 1 Facility Soil Samples

Constituent	Unit	Sample Type/ Depth	Detection Frequency		Detected Concentrations				RL or Range of RLs if Not Detected
			Ratio	%	Minimum	Maximum	Mean	Median	
Dibenzo(a,h)anthracene	µg/kg dw	surface	13/33	39%	10	260	86	67	4.7 – 70
	µg/kg dw	intermediate	7/22	32%	5.0 JN	120	37	16	4.8 – 130
	µg/kg dw	deep	2/21	10%	8.3	25	17	17	4.8 – 5.0
	µg/kg dw	soil berm	3/9	33%	29	210	90	34	4.6 – 14
Dibenzofuran	µg/kg dw	surface	22/33	67%	7.2	2,900	350	130	9.7 – 62
	µg/kg dw	intermediate	15/22	68%	6.4	12,000	1,400	130	4.8 – 190
	µg/kg dw	deep	2/21	10%	6.4	49 JN	28	28	4.8 – 7.8
	µg/kg dw	soil berm	4/9	44%	5.1	150	50	24	5.0 – 14
	µg/kg dw	soil stockpile	3/3	100%	35	54	41	35	na
Fluoranthene	µg/kg dw	surface	30/33	91%	9.7	3,700	1,100	400	15 – 62
	µg/kg dw	intermediate	20/22	91%	7.3	23,000	2,200	210	4.8
	µg/kg dw	deep	5/21	24%	5.0	190	58	33	4.8 – 5.0
	µg/kg dw	soil berm	9/9	100%	16	17,000	2,000	66	na
	µg/kg dw	soil stockpile	3/3	100%	52	100	73	69	na
Fluorene	µg/kg dw	surface	21/33	64%	7.2	5,000	880	540	4.8 – 62
	µg/kg dw	intermediate	18/22	82%	7.4	15,000	1,600	260	4.8 – 5.0
	µg/kg dw	deep	3/21	14%	16 JN	100	47	26	4.8 – 5.0
	µg/kg dw	soil berm	1/9	11%	400	400	400	400	4.6 – 15
	µg/kg dw	soil stockpile	2/3	67%	13	16	15	15	14
Indeno(1,2,3-cd)pyrene	µg/kg dw	surface	23/33	70%	8.6	490	140	93	4.7 – 62
	µg/kg dw	intermediate	14/22	64%	5.9	200	56	29	4.8 – 130
	µg/kg dw	deep	2/21	10%	14	57	36	36	4.8 – 5.0
	µg/kg dw	soil berm	9/9	100%	8.9	750	120	16	na
	µg/kg dw	soil stockpile	3/3	100%	14	33	24	26	na
Naphthalene	µg/kg dw	surface	22/33	67%	5.8	19,000	1,400	110	9.7 – 62
	µg/kg dw	intermediate	16/22	73%	4.8	8,400	890	67	4.8 – 60
	µg/kg dw	deep	5/21	24%	6.8	76	24	12	4.8 – 5.0
	µg/kg dw	soil berm	5/9	56%	11	48	28	24	5.0 – 14
	µg/kg dw	soil stockpile	3/3	100%	78	150	100	84	na

Table 5-1. Constituent Concentrations Detected in Phase 1 Facility Soil Samples

Constituent	Unit	Sample Type/ Depth	Detection Frequency		Detected Concentrations				RL or Range of RLs if Not Detected
			Ratio	%	Minimum	Maximum	Mean	Median	
Phenanthrene	µg/kg dw	surface	30/33	91%	35	15,000	1,700	310	9.7 – 20
	µg/kg dw	intermediate	22/22	100%	7.8	41,000	4,000	200	na
	µg/kg dw	deep	5/21	24%	8.3	350	96	34	4.8 – 5.0
	µg/kg dw	soil berm	9/9	100%	7.9	8,800	1,000	63	na
	µg/kg dw	soil stockpile	3/3	100%	120	130	120	120	na
Pyrene	µg/kg dw	surface	31/33	94%	16	3,700	1,200	420	20 – 62
	µg/kg dw	intermediate	20/22	91%	8.2	16,000	1,700	260	4.8
	µg/kg dw	deep	6/21	29%	5.0	620	160	29	4.8 – 5.0
	µg/kg dw	soil berm	9/9	100%	18	16,000	1,900	65	na
	µg/kg dw	soil stockpile	3/3	100%	66	120	100	110	na
Total cPAHs	µg/kg dw	surface	31/33	94%	14.0	2,300	510	290	33 – 56
	µg/kg dw	intermediate	19/22	86%	5.0	1,600	300	120	4.3
	µg/kg dw	deep	4/21	19%	4.6	320	110	56	4.3 – 4.5
	µg/kg dw	soil berm	9/9	100%	14.7	5,200	690	60	na
	µg/kg dw	soil stockpile	3/3	100%	45	110	76	73	na
Total HPAHs	µg/kg dw	surface	32/33	97%	36 J	15,900	4,400	1,600	62
	µg/kg dw	intermediate	20/22	91%	15.5	49,000	5,400	940	4.8
	µg/kg dw	deep	6/21	29%	5.0	2,030	480	90	4.8 – 5.0
	µg/kg dw	soil berm	9/9	100%	105	57,000	7,000	380	na
	µg/kg dw	soil stockpile	3/3	100%	326	670	500	510	na
Total LPAHs	µg/kg dw	surface	30/33	91%	62	44,000	4,600	970	9.7 – 20
	µg/kg dw	intermediate	22/22	100%	7.8	90,000	8,500	470	na
	µg/kg dw	deep	6/21	29%	15	860	220	83	4.8 – 5.0
	µg/kg dw	soil berm	9/9	100%	7.9	12,200	1,400	80	na
	µg/kg dw	soil stockpile	3/3	100%	280	360 JN	320	310	na
Total PAHs	µg/kg dw	surface	33/33	100%	36 J	53,000	8,400	1,900	na
	µg/kg dw	intermediate	22/22	100%	7.8	138,000	13,000	990	na
	µg/kg dw	deep	8/21	38%	5.0	2,900	520	32	4.8 – 5.0
	µg/kg dw	soil berm	9/9	100%	113	69,000	8,400	460	na
	µg/kg dw	soil stockpile	3/3	100%	690 JN	990	820	790	na

Table 5-1. Constituent Concentrations Detected in Phase 1 Facility Soil Samples

Constituent	Unit	Sample Type/ Depth	Detection Frequency		Detected Concentrations				RL or Range of RLs if Not Detected
			Ratio	%	Minimum	Maximum	Mean	Median	
Phthalates									
Bis(2-ethylhexyl)phthalate	µg/kg dw	surface	15/17	88%	11 J	5,300	1,100	590	56 – 59
Butyl benzyl phthalate	µg/kg dw	surface	3/17	18%	190	1,700	1,100	1,400	20 – 440
Other SVOCs									
1,2,4-Trichlorobenzene	µg/kg dw	surface	1/33	3%	7.2 J	7.2 J	7.2	7.2	4.8 – 590
1,2-Dichlorobenzene	µg/kg dw	surface	7/32	22%	1.3 JN	140	23	3.3	1.0 – 440
	µg/kg dw	intermediate	6/22	27%	1.3	290	65	9.0	1.0 – 380
	µg/kg dw	deep	3/21	14%	2.7	4.3	3.6	3.8	1.6 – 2.2
1,3-Dichlorobenzene	µg/kg dw	surface	3/31	10%	1.4 J	2.2 JN	1.9	2.0	1.0 – 440
	µg/kg dw	intermediate	1/22	5%	120 J	120 J	120	120	1.0 – 380
	µg/kg dw	deep	1/21	5%	27	27	27	27	1.6 – 2.2
1,4-Dichlorobenzene	µg/kg dw	surface	10/32	31%	2.2	99	20	5.7	1.0 – 440
	µg/kg dw	intermediate	4/22	18%	1.6	490 J	130	8.4	1.0 – 380
	µg/kg dw	deep	2/21	10%	3.9	61	33	33	1.6 – 2.2
2,4-Dimethylphenol	µg/kg dw	surface	1/17	6%	70	70	70	70	20 – 440
4-Methylphenol	µg/kg dw	surface	2/17	12%	58	700	380	380	20 – 440
Carbazole	µg/kg dw	surface	3/17	18%	40	940	380	160	20 – 440
Hexachlorobenzene	µg/kg dw	soil berm	1/9	11%	42	42	42	42	2.4 – 120
	µg/kg dw	soil stockpile	1/3	33%	18	18	18	18	2.9 – 12
PCBs									
Aroclor-1242	µg/kg dw	intermediate	2/22	9%	140	1,300	700	700	32 – 130
	µg/kg dw	deep	1/21	5%	38	38	38	38	32 – 33
Aroclor-1248	µg/kg dw	surface	16/33	48%	46	7,400	1,100	660	32 – 180
	µg/kg dw	intermediate	1/22	5%	140	140	140	140	32 – 650
	µg/kg dw	soil berm	2/9	22%	120	390	260	260	32 – 160
Aroclor-1254	µg/kg dw	surface	9/33	27%	74	3,800	900	610	32 – 1,700
	µg/kg dw	intermediate	1/22	5%	4,300	4,300	4,300	4,300	32 – 330
	µg/kg dw	soil berm	2/9	22%	230	450	340	340	32 – 320
	µg/kg dw	soil stockpile	1/3	33%	65	65	65	65	48 – 320

Table 5-1. Constituent Concentrations Detected in Phase 1 Facility Soil Samples

Constituent	Unit	Sample Type/ Depth	Detection Frequency		Detected Concentrations				RL or Range of RLs if Not Detected
			Ratio	%	Minimum	Maximum	Mean	Median	
Aroclor-1260	µg/kg dw	surface	24/33	73%	39	3,300	880	450	32 – 160
	µg/kg dw	intermediate	5/22	23%	36	300	180	180	32 – 650
	µg/kg dw	soil berm	7/9	78%	41	610	320	260	32 – 97
	µg/kg dw	soil stockpile	3/3	100%	66 J	660	290	130	na
Total PCBs	µg/kg dw	surface	25/33	76%	39	14,500	1,900	760	32 – 160
	µg/kg dw	intermediate	6/22	27%	36	5,600	1,100	290	32 – 200
	µg/kg dw	deep	1/21	5%	38	38	38	38	32 – 170
	µg/kg dw	soil berm	8/9	89%	41	840	430	520	32
	µg/kg dw	soil stockpile	3/3	100%	66 J	660	310	200	na
Pesticides									
2,4'-DDD	µg/kg dw	surface	25/33	76%	7.4	5,900	1,000	230	2.0 – 200
	µg/kg dw	intermediate	11/22	50%	7.1 J	5,800	740	89	1.9 – 20
	µg/kg dw	deep	2/21	10%	2.2	3,400	1,700	1,700	2.0 – 4.9
	µg/kg dw	soil berm	6/9	67%	17	950	260	150	4.9 – 5.0
	µg/kg dw	soil stockpile	3/3	100%	96	250	170	160	na
2,4'-DDE	µg/kg dw	surface	1/33	3%	7.0	7.0	7.0	7.0	2.0 – 2,400
2,4'-DDT	µg/kg dw	surface	1/33	3%	3.0 J	3.0 J	3.0	3.0	2.0 – 2,400
	µg/kg dw	soil berm	4/9	44%	94 J	920	360	220	4.9 – 6.0
4,4'-DDD	µg/kg dw	surface	32/33	97%	5.0	20,000	3,000	450	2.0
	µg/kg dw	intermediate	18/22	82%	2.6 J	21,000	1,600	84	2.0 – 9.7
	µg/kg dw	deep	7/21	33%	1.6 J	14,000	2,000	3.2	2.0 – 4.9
	µg/kg dw	soil berm	7/9	78%	5.0 J	1,900	440	220	4.9 – 27
	µg/kg dw	soil stockpile	3/3	100%	310	580	440	430	na
4,4'-DDE	µg/kg dw	surface	8/33	24%	3.9 J	260	50	18	2.0 – 2,600
	µg/kg dw	intermediate	7/22	32%	3.2 J	160	43	31	1.9 – 990
	µg/kg dw	deep	1/21	5%	5.1	5.1	5.1	5.1	2.0 – 2,400
	µg/kg dw	soil berm	4/9	44%	66	580	220	110	4.9 – 6.0
	µg/kg dw	soil stockpile	3/3	100%	18 J	28 J	22	19	na

Table 5-1. Constituent Concentrations Detected in Phase 1 Facility Soil Samples

Constituent	Unit	Sample Type/ Depth	Detection Frequency		Detected Concentrations				RL or Range of RLs if Not Detected
			Ratio	%	Minimum	Maximum	Mean	Median	
4,4'-DDT	µg/kg dw	surface	9/33	27%	9.6	3,800	690	57	2.0 – 490
	µg/kg dw	intermediate	6/22	27%	1.2 J	2,700	500	37	2.0 – 49
	µg/kg dw	deep	1/21	5%	23,000	23,000	23,000	23,000	2.0 – 4.9
	µg/kg dw	soil berm	9/9	100%	7.1 J	7,600	1,100	110	na
	µg/kg dw	soil stockpile	2/3	67%	81 J	130	110	110	42
Total DDTs	µg/kg dw	surface	32/33	97%	5.0	26,000	4,000	640	2.0
	µg/kg dw	intermediate	18/22	82%	2.6 J	30,000	2,300	150	2.0 – 9.7
	µg/kg dw	deep	7/21	33%	1.6 J	40,000	5,700	3.2	2.0 – 4.9
	µg/kg dw	soil berm	9/9	100%	7.1 J	12,000	1,900	150	na
	µg/kg dw	soil stockpile	3/3	100%	430	940 J	700	740	na
VOCs									
1,1,1-Trichloroethane	µg/kg dw	surface	1/33	3%	170	170	170	170	1.0 – 1,100
1,1,2-Trichloroethane	µg/kg dw	surface	2/33	6%	1.5 J	41	22	22	1.0 – 1,100
1,1-Dichloroethane	µg/kg dw	surface	3/33	9%	1.1	680	230	1.3	1.0 – 1,100
	µg/kg dw	intermediate	1/22	5%	1.9	1.9	1.9	1.9	1.0 – 380
1,2,4-Trimethylbenzene	µg/kg dw	surface	18/33	55%	2.3	36,000 J	3,600	23	1.0 – 7.1
	µg/kg dw	intermediate	18/22	82%	1.3 J	9,700	1,100	29	1.4 – 1.6
	µg/kg dw	deep	4/21	19%	6.6	2,100 J	530	11	1.7 – 6.9
	µg/kg dw	soil stockpile	1/3	33%	2.7	2.7	2.7	2.7	1.1 – 1.3
1,3,5-Trimethylbenzene	µg/kg dw	surface	16/33	48%	1.5	12,000	1,200	5.7	1.0 – 120
	µg/kg dw	intermediate	13/22	59%	1.8	3,900	580	30	1.0 – 71
	µg/kg dw	deep	3/21	14%	2.0	660 J	220	2.1	1.6 – 2.2
2-Chlorotoluene	µg/kg dw	deep	1/21	5%	2.4	2.4	2.4	2.4	1.6 – 2.2
Acetone	µg/kg dw	surface	29/33	88%	11	800	140	70	5.6 – 5,600
	µg/kg dw	intermediate	17/22	77%	19	720	100	46	360 – 1,900
	µg/kg dw	deep	21/21	100%	28	150 J	68	58	na
	µg/kg dw	soil berm	9/9	100%	12	220	120	130	na
	µg/kg dw	soil stockpile	3/3	100%	86	220	140	110	na

Table 5-1. Constituent Concentrations Detected in Phase 1 Facility Soil Samples

Constituent	Unit	Sample Type/ Depth	Detection Frequency		Detected Concentrations				RL or Range of RLs if Not Detected
			Ratio	%	Minimum	Maximum	Mean	Median	
Benzene	µg/kg dw	surface	16/33	48%	1.1	6,400	430	4.7	1.0 – 120
	µg/kg dw	intermediate	15/22	68%	1.5	600	85	11	1.1 – 380
	µg/kg dw	deep	13/21	62%	1.9	860 J	71	2.7	1.7 – 2.2
	µg/kg dw	soil berm	2/9	22%	1.4	1.8	1.6	1.6	0.9 – 1.2
	µg/kg dw	soil stockpile	1/3	33%	1.5	1.5	1.5	1.5	1.1 – 1.3
Carbon disulfide	µg/kg dw	surface	18/33	55%	1.4	460	28	2.9	1.0 – 1,100
	µg/kg dw	intermediate	9/22	41%	1.3	11 J	3.3	2.9	1.1 – 380
	µg/kg dw	deep	3/21	14%	2.0 J	4.3 J	2.9	2.4	1.6 – 8.8
	µg/kg dw	soil stockpile	1/3	33%	5.1	5.1	5.1	5.1	1.1 – 1.6
Chlorobenzene	µg/kg dw	surface	5/33	15%	1.2 JN	320	110	90	1.0 – 1,100
	µg/kg dw	intermediate	10/22	45%	3.8	2,900 J	410	12	1.0 – 120
	µg/kg dw	deep	3/21	14%	9.3	66	34	26	1.6 – 2.2
	µg/kg dw	soil stockpile	1/3	33%	3.6	3.6	3.6	3.6	1.1 – 1.3
Chloroethane	µg/kg dw	surface	1/33	3%	2.9	2.9	2.9	2.9	1.0 – 1,100
cis-1,2-Dichloroethene	µg/kg dw	surface	3/33	9%	1.6 J	130,000	43,000	2.5	1.0 – 1,100
	µg/kg dw	intermediate	5/22	23%	1.2	490	100	8.6	1.0 – 120
	µg/kg dw	deep	1/21	5%	2.4	2.4	2.4	2.4	1.6 – 2.2
p-Cymene	µg/kg dw	surface	16/33	48%	1.3 J	11,000 J	810	6.3	1.0 – 83
	µg/kg dw	intermediate	8/22	36%	1.4 J	620	260	160	1.0 – 75
	µg/kg dw	deep	2/21	10%	3.0	11	7.0	7.0	1.6 – 2.2
Dichloromethane	µg/kg dw	surface	8/33	24%	2.0	370	91	2.9	1.9 – 2,200
	µg/kg dw	intermediate	3/22	14%	2.7	29	12	3.6	2.1 – 770
	µg/kg dw	deep	4/21	19%	4.5	6.2	5.2	5.1	3.1 – 4.5
	µg/kg dw	soil berm	3/9	33%	2.1	2.9	2.5	2.4	1.9 – 2.5
Ethylbenzene	µg/kg dw	surface	12/33	36%	2.0 J	26,000	2,500	7.3	1.0 – 120
	µg/kg dw	intermediate	11/22	50%	1.4	1,600	490	11	1.2 – 120
	µg/kg dw	deep	2/21	10%	2.7	43	23	23	1.6 – 2.2
Isopropylbenzene	µg/kg dw	surface	13/31	42%	1.3	2,300	280	15	1.0 – 120
	µg/kg dw	intermediate	13/22	59%	1.6	1,100	230	74	1.1 – 120
	µg/kg dw	deep	2/21	10%	14	110	60	60	1.6 – 2.2

Table 5-1. Constituent Concentrations Detected in Phase 1 Facility Soil Samples

Constituent	Unit	Sample Type/ Depth	Detection Frequency		Detected Concentrations				RL or Range of RLs if Not Detected
			Ratio	%	Minimum	Maximum	Mean	Median	
Methyl ethyl ketone	µg/kg dw	surface	17/33	52%	8.4	110 J	32	22	5.0 – 5,600
	µg/kg dw	intermediate	7/22	32%	7.0	100	26	11	4.8 – 1,900
	µg/kg dw	deep	13/21	62%	8.8	28 J	16	13	8.7 – 10
	µg/kg dw	soil berm	7/9	78%	7.6	26	15	14	4.9 – 5.9
	µg/kg dw	soil stockpile	3/3	100%	13	22	18	18	na
Methyl isobutyl ketone	µg/kg dw	surface	2/33	6%	5.2 J	18	12	12	4.8 – 5,600
	µg/kg dw	intermediate	2/22	9%	30	100	65	65	4.8 – 1,900
n-Butylbenzene	µg/kg dw	surface	16/33	48%	1.4 J	12,000	1,000	4.3	1.0 – 83
	µg/kg dw	intermediate	11/22	50%	1.3	2,600	720	250	1.1 – 1.6
	µg/kg dw	deep	1/21	5%	1.9	1.9	1.9	1.9	1.6 – 2.2
n-Propylbenzene	µg/kg dw	surface	16/32	50%	1.3	6,700	640	8.6	1.0 – 120
	µg/kg dw	intermediate	13/22	59%	1.6	2,800	680	110	1.1 – 120
	µg/kg dw	deep	3/21	14%	2.5	160	60	13	1.6 – 2.2
sec-Butylbenzene	µg/kg dw	surface	10/31	32%	1.2	2,000	210	5.8	1.0 – 1,100
	µg/kg dw	intermediate	8/22	36%	1.3	740	230	32	1.1 – 120
Styrene	µg/kg dw	surface	1/33	3%	1.9	1.9	1.9	1.9	1.0 – 1,100
tert-Butyl methyl ether	µg/kg dw	surface	3/33	9%	2.2	6.9	4.6	4.7	1.0 – 1,100
	µg/kg dw	intermediate	9/22	41%	2.5	69	14	9.8	1.0 – 380
	µg/kg dw	deep	15/21	71%	2.0	39	15	10	1.7 – 2.1
tert-Butylbenzene	µg/kg dw	intermediate	1/22	5%	2.0	2.0	2.0	2.0	1.0 – 380
Tetrachloroethene	µg/kg dw	surface	3/33	9%	1.9 J	4.0	2.6	1.9	1.0 – 1,100
	µg/kg dw	intermediate	1/22	5%	3.0 J	3.0 J	3.0	3.0	1.0 – 380
Toluene	µg/kg dw	surface	21/33	64%	1.2	49,000	2,700	2.9	1.0 – 120
	µg/kg dw	intermediate	13/22	59%	1.8	4,000	610	5.0	1.1 – 380
	µg/kg dw	deep	3/21	14%	3.9	13	7.7	5.8	1.6 – 6.7
	µg/kg dw	soil berm	3/9	33%	1.4	1.5	1.4	1.4	0.9 – 1.2
	µg/kg dw	soil stockpile	2/3	67%	2.2	4.0	3.1	3.1	1.1
trans-1,2-Dichloroethene	µg/kg dw	surface	1/33	3%	5,500	5,500	5,500	5,500	1.0 – 1,100

Table 5-1. Constituent Concentrations Detected in Phase 1 Facility Soil Samples

Constituent	Unit	Sample Type/ Depth	Detection Frequency		Detected Concentrations				RL or Range of RLs if Not Detected
			Ratio	%	Minimum	Maximum	Mean	Median	
Trichloroethene	µg/kg dw	surface	4/33	12%	1.5	2,400	600	3.5	1.0 – 1,100
	µg/kg dw	intermediate	2/22	9%	2.3	3.2	2.8	2.8	1.0 – 380
	µg/kg dw	deep	1/21	5%	2.2	2.2	2.2	2.2	1.6 – 2.2
Vinyl chloride	µg/kg dw	surface	1/33	3%	1,200	1,200	1,200	1,200	1.0 – 1,100
	µg/kg dw	intermediate	1/22	5%	13	13	13	13	1.0 – 380
	µg/kg dw	deep	1/21	5%	13	13	13	13	1.6 – 2.2
o-Xylene	µg/kg dw	surface	17/33	52%	1.6	33,000	2,300	10	1.0 – 83
	µg/kg dw	intermediate	11/22	50%	1.2	2,700	460	10	1.2 – 380
	µg/kg dw	deep	3/21	14%	2.3	11	5.7	3.5	1.6 – 4.5
m,p-Xylene	µg/kg dw	surface	18/33	55%	1.5	120,000 J	7,200	11	1.0 – 83
	µg/kg dw	intermediate	15/22	68%	1.3	5,300	900	28	1.4 – 380
	µg/kg dw	deep	3/21	14%	1.7	4,400 J	1,500	4.9	1.6 – 13
	µg/kg dw	soil stockpile	1/3	33%	1.1 J	1.1 J	1.1	1.1	1.3
Total xylenes	µg/kg dw	surface	19/33	58%	1.8 J	150,000 J	8,900	18	1.0 – 83
	µg/kg dw	intermediate	16/22	73%	1.3	7,300	1,200	28	1.4 – 380
	µg/kg dw	deep	3/21	14%	4.0	4,400 J	1,500	8.4	1.6 – 13
	µg/kg dw	soil stockpile	1/3	33%	1.1 J	1.1 J	1.1	1.1	1.3
Petroleum									
TPH - Gasoline range	mg/kg dw	surface	23/33	70%	8.9	3,800	310	64	5.6 – 8.2
	mg/kg dw	intermediate	15/22	68%	13	850	240	170	6.9 – 11
	mg/kg dw	deep	6/21	29%	13	45	31	34	11 – 14
	mg/kg dw	soil berm	2/9	22%	5.3	10	7.5	7.5	6.1 – 8.1
	mg/kg dw	soil stockpile	1/3	33%	21	21	21	21	7.4 – 8.8
TPH – diesel range	mg/kg dw	surface	33/33	100%	8.0	11,000	1,500	520	na
	mg/kg dw	intermediate	19/22	86%	13	2,800	670	280	6.3 – 7.0
	mg/kg dw	deep	3/21	14%	12	560	240	140	7.5 – 9.0
	mg/kg dw	soil berm	8/9	89%	6.3	68	30	23	29
	mg/kg dw	soil stockpile	3/3	100%	59	130	87	68	na

Table 5-1. Constituent Concentrations Detected in Phase 1 Facility Soil Samples

Constituent	Unit	Sample Type/ Depth	Detection Frequency		Detected Concentrations				RL or Range of RLs if Not Detected
			Ratio	%	Minimum	Maximum	Mean	Median	
TPH – motor oil range	mg/kg dw	surface	33/33	100%	38	10,000	2,200	620	na
	mg/kg dw	intermediate	20/22	91%	14	2,800	740	180	13 – 14
	mg/kg dw	deep	6/21	29%	18	1,000	180	21	15 – 18
	mg/kg dw	soil berm	9/9	100%	37	320	130	110	na
	mg/kg dw	soil stockpile	3/3	100%	170	310	250	260	na
Total petroleum hydrocarbons	mg/kg dw	surface	33/33	100%	46	19,000	3,700	1,300	na
	mg/kg dw	intermediate	20/22	91%	14	5,400	1,400	390	13 – 14
	mg/kg dw	deep	6/21	29%	18	1,600	300	26	15 – 18
	mg/kg dw	soil berm	9/9	100%	43	390	160	110	na
	mg/kg dw	soil stockpile	3/3	100%	240	440	330	320	na
Conventionals									
Total organic carbon	% dw	surface	32/33	97%	0.545	14.6	2.8	1.9	0.020
	% dw	intermediate	22/22	100%	0.153	41.3	4.8	1.4	na
	% dw	deep	21/21	100%	0.532	2.78	0.99	0.87	na
	% dw	soil berm	9/9	100%	0.435	2.54	1.3	1.6	na
	% dw	soil stockpile	3/3	100%	1.66	2.31	2.1	2.3	na
Total solids	% ww	surface	33/33	100%	69.40	94.70	85	86	na
	% ww	intermediate	22/22	100%	65.80	83.10	74	74	na
	% ww	deep	21/21	100%	54.20	70.40	62	62	na
	% ww	soil berm	9/9	100%	76.00	93.70	85	87	na
	% ww	soil stockpile	3/3	100%	82.60	86.50	84	83	na

Note: Summary statistics are provided by location, not sample (i.e., duplicate samples were combined with the original sample, as described in Appendix D).

Note: All means and medians are reported to two significant figures.

cPAH – carcinogenic polycyclic aromatic hydrocarbon
dw – dry weight
J – estimated concentration
JN – tentative identification with estimated concentration
HPAH – high-molecular-weight polycyclic aromatic hydrocarbon
LPAH – low-molecular-weight polycyclic aromatic hydrocarbon
na – not applicable
PAH – polycyclic aromatic hydrocarbon
PCB – polychlorinated biphenyl
RL – reporting limit
SVOC – semivolatile organic compound
TPH – total petroleum hydrocarbon
VOC – volatile organic compound
ww – wet weight

Table 5-2. Comparison of Constituent Concentrations in Phase 1 Facility Soil Samples to Screening Levels

			Detection Frequency		Human Health Industrial SL[a]				Human Health Residential SL[b]			
Constituent	Unit	Sample Type/ Depth	Ratio	%	Screening Level	No. Detects > SL	% Detects > SL	% Samples > SL	Screening Level	No. Detects > SL	% Detects > SL	% Samples >SL
Metals												
Arsenic	mg/kg dw	surface	33/33	100%	1.7	26	79%	79%	0.39	33	100%	100%
	mg/kg dw	intermediate	22/22	100%	1.7	16	73%	73%	0.39	22	100%	100%
	mg/kg dw	deep	21/21	100%	1.7	14	67%	67%	0.39	21	100%	100%
	mg/kg dw	soil berm	9/9	100%	1.7	8	89%	89%	0.39	9	100%	100%
	mg/kg dw	soil stockpile	3/3	100%	1.7	3	100%	100%	0.39	3	100%	100%
Barium	mg/kg dw	surface	33/33	100%	6,200	0	0%	0%	1,600	0	0%	0%
	mg/kg dw	intermediate	22/22	100%	6,200	0	0%	0%	1,600	0	0%	0%
	mg/kg dw	deep	21/21	100%	6,200	0	0%	0%	1,600	0	0%	0%
	mg/kg dw	soil berm	9/9	100%	6,200	0	0%	0%	1,600	0	0%	0%
	mg/kg dw	soil stockpile	3/3	100%	6,200	0	0%	0%	1,600	0	0%	0%
Cadmium	mg/kg dw	surface	17/33	52%	56	0	0%	0%	3.9	0	0%	0%
	mg/kg dw	intermediate	9/22	41%	56	0	0%	0%	3.9	0	0%	0%
	mg/kg dw	deep	6/21	29%	56	0	0%	0%	3.9	0	0%	0%
	mg/kg dw	soil berm	6/9	67%	56	0	0%	0%	3.9	0	0%	0%
	mg/kg dw	soil stockpile	2/3	67%	56	0	0%	0%	3.9	0	0%	0%
Chromium	mg/kg dw	surface	33/33	100%	100,000	0	0%	0%	100,000	0	0%	0%
	mg/kg dw	intermediate	22/22	100%	100,000	0	0%	0%	100,000	0	0%	0%
	mg/kg dw	deep	21/21	100%	100,000	0	0%	0%	100,000	0	0%	0%
	mg/kg dw	soil berm	9/9	100%	100,000	0	0%	0%	100,000	0	0%	0%
	mg/kg dw	soil stockpile	3/3	100%	100,000	0	0%	0%	100,000	0	0%	0%
Cobalt	mg/kg dw	surface	33/33	100%	2,100	0	0%	0%	900	0	0%	0%
	mg/kg dw	intermediate	22/22	100%	2,100	0	0%	0%	900	0	0%	0%
	mg/kg dw	deep	21/21	100%	2,100	0	0%	0%	900	0	0%	0%
	mg/kg dw	soil berm	9/9	100%	2,100	0	0%	0%	900	0	0%	0%
	mg/kg dw	soil stockpile	3/3	100%	2,100	0	0%	0%	900	0	0%	0%
Copper	mg/kg dw	surface	33/33	100%	1,100	0	0%	0%	290	5	15%	15%
	mg/kg dw	intermediate	22/22	100%	1,100	1	5%	5%	290	2	9%	9%
	mg/kg dw	deep	21/21	100%	1,100	0	0%	0%	290	0	0%	0%
	mg/kg dw	soil berm	9/9	100%	1,100	1	11%	11%	290	1	11%	11%
	mg/kg dw	soil stockpile	3/3	100%	1,100	0	0%	0%	290	0	0%	0%

Table 5-2. Comparison of Constituent Concentrations in Phase 1 Facility Soil Samples to Screening Levels

Constituent	Unit	Sample Type/ Depth	Detection Frequency		Human Health Industrial SL[a]				Human Health Residential SL[b]			
			Ratio	%	Screening Level	No. Detects > SL	% Detects > SL	% Samples > SL	Screening Level	No. Detects > SL	% Detects > SL	% Samples >SL
Lead	mg/kg dw	surface	33/33	100%	3.0	32	97%	97%	3.0	32	97%	97%
	mg/kg dw	intermediate	22/22	100%	3.0	22	100%	100%	3.0	22	100%	100%
	mg/kg dw	deep	21/21	100%	3.0	21	100%	100%	3.0	21	100%	100%
	mg/kg dw	soil berm	9/9	100%	3.0	9	100%	100%	3.0	9	100%	100%
	mg/kg dw	soil stockpile	3/3	100%	3.0	3	100%	100%	3.0	3	100%	100%
Mercury	mg/kg dw	surface	14/33	42%	9.3	0	0%	0%	2.3	0	0%	0%
	mg/kg dw	intermediate	8/22	36%	9.3	0	0%	0%	2.3	0	0%	0%
	mg/kg dw	deep	8/21	38%	9.3	0	0%	0%	2.3	0	0%	0%
	mg/kg dw	soil berm	7/9	78%	9.3	0	0%	0%	2.3	0	0%	0%
	mg/kg dw	soil stockpile	2/3	67%	9.3	0	0%	0%	2.3	0	0%	0%
Nickel	mg/kg dw	surface	33/33	100%	620	0	0%	0%	160	0	0%	0%
	mg/kg dw	intermediate	22/22	100%	620	0	0%	0%	160	0	0%	0%
	mg/kg dw	deep	21/21	100%	620	0	0%	0%	160	0	0%	0%
	mg/kg dw	soil berm	9/9	100%	620	0	0%	0%	160	0	0%	0%
	mg/kg dw	soil stockpile	3/3	100%	620	0	0%	0%	160	0	0%	0%
Selenium	mg/kg dw	surface	1/33	3%	570	0	0%	0%	39	0	0%	0%
	mg/kg dw	intermediate	1/22	5%	570	0	0%	0%	39	0	0%	0%
Vanadium	mg/kg dw	surface	33/33	100%	570	0	0%	0%	39	29	88%	88%
	mg/kg dw	intermediate	22/22	100%	570	0	0%	0%	39	16	73%	73%
	mg/kg dw	deep	21/21	100%	570	0	0%	0%	39	20	95%	95%
	mg/kg dw	soil berm	9/9	100%	570	0	0%	0%	39	9	100%	100%
	mg/kg dw	soil stockpile	3/3	100%	570	0	0%	0%	39	3	100%	100%
Zinc	mg/kg dw	surface	33/33	100%	100,000	0	0%	0%	2,300	0	0%	0%
	mg/kg dw	intermediate	22/22	100%	100,000	0	0%	0%	2,300	0	0%	0%
	mg/kg dw	deep	21/21	100%	100,000	0	0%	0%	2,300	0	0%	0%
	mg/kg dw	soil berm	9/9	100%	100,000	0	0%	0%	2,300	0	0%	0%
	mg/kg dw	soil stockpile	3/3	100%	100,000	0	0%	0%	2,300	0	0%	0%

Table 5-2. Comparison of Constituent Concentrations in Phase 1 Facility Soil Samples to Screening Levels

			Detection Frequency		Human Health Industrial SL[a]				Human Health Residential SL[b]			
Constituent	Unit	Sample Type/ Depth	Ratio	%	Screening Level	No. Detects > SL	% Detects > SL	% Samples > SL	Screening Level	No. Detects > SL	% Detects > SL	% Samples >SL
PAHs												
Acenaphthene	µg/kg dw	surface	19/33	58%	1,600,000	0	0%	0%	370,000	0	0%	0%
	µg/kg dw	intermediate	18/22	82%	1,600,000	0	0%	0%	370,000	0	0%	0%
	µg/kg dw	deep	3/21	14%	1,600,000	0	0%	0%	370,000	0	0%	0%
	µg/kg dw	soil berm	1/9	11%	1,600,000	0	0%	0%	370,000	0	0%	0%
	µg/kg dw	soil stockpile	1/3	33%	1,600,000	0	0%	0%	370,000	0	0%	0%
Anthracene	µg/kg dw	surface	27/32	84%	9,000,000	0	0%	0%	2,200,000	0	0%	0%
	µg/kg dw	intermediate	18/22	82%	9,000,000	0	0%	0%	2,200,000	0	0%	0%
	µg/kg dw	deep	3/21	14%	9,000,000	0	0%	0%	2,200,000	0	0%	0%
	µg/kg dw	soil berm	7/9	78%	9,000,000	0	0%	0%	2,200,000	0	0%	0%
	µg/kg dw	soil stockpile	3/3	100%	9,000,000	0	0%	0%	2,200,000	0	0%	0%
Benzo(a)anthracene	µg/kg dw	surface	28/33	85%	2,300	0	0%	0%	150	16	57%	48%
	µg/kg dw	intermediate	18/22	82%	2,300	1	6%	5%	150	9	50%	41%
	µg/kg dw	deep	3/21	14%	2,300	0	0%	0%	150	1	33%	5%
	µg/kg dw	soil berm	9/9	100%	2,300	1	11%	11%	150	2	22%	22%
	µg/kg dw	soil stockpile	3/3	100%	2,300	0	0%	0%	150	0	0%	0%
Benzo(a)pyrene	µg/kg dw	surface	30/33	91%	230	14	47%	42%	15	28	93%	85%
	µg/kg dw	intermediate	17/22	77%	230	5	29%	23%	15	15	88%	68%
	µg/kg dw	deep	3/21	14%	230	1	33%	5%	15	2	67%	10%
	µg/kg dw	soil berm	9/9	100%	230	3	33%	33%	15	8	89%	89%
	µg/kg dw	soil stockpile	3/3	100%	230	0	0%	0%	15	3	100%	100%
Benzo(b)fluoranthene	µg/kg dw	surface	29/33	88%	2,300	0	0%	0%	150	17	59%	52%
	µg/kg dw	intermediate	19/22	86%	2,300	0	0%	0%	150	7	37%	32%
	µg/kg dw	deep	3/21	14%	2,300	0	0%	0%	150	1	33%	5%
	µg/kg dw	soil berm	9/9	100%	2,300	1	11%	11%	150	3	33%	33%
	µg/kg dw	soil stockpile	3/3	100%	2,300	0	0%	0%	150	0	0%	0%
Benzo(k)fluoranthene	µg/kg dw	surface	30/33	91%	23,000	0	0%	0%	1,500	0	0%	0%
	µg/kg dw	intermediate	17/22	77%	23,000	0	0%	0%	1,500	0	0%	0%
	µg/kg dw	deep	4/21	19%	23,000	0	0%	0%	1,500	0	0%	0%
	µg/kg dw	soil berm	9/9	100%	23,000	0	0%	0%	1,500	1	11%	11%
	µg/kg dw	soil stockpile	3/3	100%	23,000	0	0%	0%	1,500	0	0%	0%

Table 5-2. Comparison of Constituent Concentrations in Phase 1 Facility Soil Samples to Screening Levels

Constituent	Unit	Sample Type/ Depth	Detection Frequency		Human Health Industrial SL[a]				Human Health Residential SL[b]			
			Ratio	%	Screening Level	No. Detects > SL	% Detects > SL	% Samples > SL	Screening Level	No. Detects > SL	% Detects > SL	% Samples >SL
Chrysene	µg/kg dw	surface	31/33	94%	230,000	0	0%	0%	15,000	0	0%	0%
	µg/kg dw	intermediate	19/22	86%	230,000	0	0%	0%	15,000	0	0%	0%
	µg/kg dw	deep	3/21	14%	230,000	0	0%	0%	15,000	0	0%	0%
	µg/kg dw	soil berm	9/9	100%	230,000	0	0%	0%	15,000	0	0%	0%
	µg/kg dw	soil stockpile	3/3	100%	230,000	0	0%	0%	15,000	0	0%	0%
Dibenzo(a,h)anthracene	µg/kg dw	surface	13/33	39%	230	1	8%	3%	15	12	92%	36%
	µg/kg dw	intermediate	7/22	32%	230	0	0%	0%	15	4	57%	18%
	µg/kg dw	deep	2/21	10%	230	0	0%	0%	15	1	50%	5%
	µg/kg dw	soil berm	3/9	33%	230	0	0%	0%	15	3	100%	33%
Dibenzofuran	µg/kg dw	surface	22/33	67%	170,000	0	0%	0%	15,000	0	0%	0%
	µg/kg dw	intermediate	15/22	68%	170,000	0	0%	0%	15,000	0	0%	0%
	µg/kg dw	deep	2/21	10%	170,000	0	0%	0%	15,000	0	0%	0%
	µg/kg dw	soil berm	4/9	44%	170,000	0	0%	0%	15,000	0	0%	0%
	µg/kg dw	soil stockpile	3/3	100%	170,000	0	0%	0%	15,000	0	0%	0%
Fluoranthene	µg/kg dw	surface	30/33	91%	890,000	0	0%	0%	230,000	0	0%	0%
	µg/kg dw	intermediate	20/22	91%	890,000	0	0%	0%	230,000	0	0%	0%
	µg/kg dw	deep	5/21	24%	890,000	0	0%	0%	230,000	0	0%	0%
	µg/kg dw	soil berm	9/9	100%	890,000	0	0%	0%	230,000	0	0%	0%
	µg/kg dw	soil stockpile	3/3	100%	890,000	0	0%	0%	230,000	0	0%	0%
Fluorene	µg/kg dw	surface	21/33	64%	1,200,000	0	0%	0%	260,000	0	0%	0%
	µg/kg dw	intermediate	18/22	82%	1,200,000	0	0%	0%	260,000	0	0%	0%
	µg/kg dw	deep	3/21	14%	1,200,000	0	0%	0%	260,000	0	0%	0%
	µg/kg dw	soil berm	1/9	11%	1,200,000	0	0%	0%	260,000	0	0%	0%
	µg/kg dw	soil stockpile	2/3	67%	1,200,000	0	0%	0%	260,000	0	0%	0%
Indeno(1,2,3-cd)pyrene	µg/kg dw	surface	23/33	70%	2,300	0	0%	0%	150	8	35%	24%
	µg/kg dw	intermediate	14/22	64%	2,300	0	0%	0%	150	1	7%	5%
	µg/kg dw	deep	2/21	10%	2,300	0	0%	0%	150	0	0%	0%
	µg/kg dw	soil berm	9/9	100%	2,300	0	0%	0%	150	1	11%	11%
	µg/kg dw	soil stockpile	3/3	100%	2,300	0	0%	0%	150	0	0%	0%

Table 5-2. Comparison of Constituent Concentrations in Phase 1 Facility Soil Samples to Screening Levels

Constituent	Unit	Sample Type/ Depth	Detection Frequency		Human Health Industrial SL[a]				Human Health Residential SL[b]			
			Ratio	%	Screening Level	No. Detects > SL	% Detects > SL	% Samples > SL	Screening Level	No. Detects > SL	% Detects > SL	% Samples >SL
Naphthalene	µg/kg dw	surface	22/33	67%	1,500	2	9%	6%	1,500	2	9%	6%
	µg/kg dw	intermediate	16/22	73%	1,500	2	13%	9%	1,500	2	13%	9%
	µg/kg dw	deep	5/21	24%	1,500	0	0%	0%	1,500	0	0%	0%
	µg/kg dw	soil berm	5/9	56%	1,500	0	0%	0%	1,500	0	0%	0%
	µg/kg dw	soil stockpile	3/3	100%	1,500	0	0%	0%	1,500	0	0%	0%
Pyrene	µg/kg dw	surface	31/33	94%	670,000	0	0%	0%	230,000	0	0%	0%
	µg/kg dw	intermediate	20/22	91%	670,000	0	0%	0%	230,000	0	0%	0%
	µg/kg dw	deep	6/21	29%	670,000	0	0%	0%	230,000	0	0%	0%
	µg/kg dw	soil berm	9/9	100%	670,000	0	0%	0%	230,000	0	0%	0%
	µg/kg dw	soil stockpile	3/3	100%	670,000	0	0%	0%	230,000	0	0%	0%
Phthalates												
Bis(2-ethylhexyl)phthalate	µg/kg dw	surface	15/17	88%	140,000	0	0%	0%	35,000	0	0%	0%
Butyl benzyl phthalate	µg/kg dw	surface	3/17	18%	240,000	0	0%	0%	240,000	0	0%	0%
Other SVOCs												
1,2,4-Trichlorobenzene	µg/kg dw	surface	1/33	3%	26,000	0	0%	0%	14,000	0	0%	0%
1,2-Dichlorobenzene	µg/kg dw	surface	7/32	22%	3,800	0	0%	0%	3,800	0	0%	0%
	µg/kg dw	intermediate	6/22	27%	3,800	0	0%	0%	3,800	0	0%	0%
	µg/kg dw	deep	3/21	14%	3,800	0	0%	0%	3,800	0	0%	0%
1,3-Dichlorobenzene	µg/kg dw	surface	3/31	10%	1,100	0	0%	0%	1,100	0	0%	0%
	µg/kg dw	intermediate	1/22	5%	1,100	0	0%	0%	1,100	0	0%	0%
	µg/kg dw	deep	1/21	5%	1,100	0	0%	0%	1,100	0	0%	0%
1,4-Dichlorobenzene	µg/kg dw	surface	10/32	31%	540	0	0%	0%	540	0	0%	0%
	µg/kg dw	intermediate	4/22	18%	540	0	0%	0%	540	0	0%	0%
	µg/kg dw	deep	2/21	10%	540	0	0%	0%	540	0	0%	0%
2,4-Dimethylphenol	µg/kg dw	surface	1/17	6%	1,400,000	0	0%	0%	120,000	0	0%	0%
4-Methylphenol	µg/kg dw	surface	2/17	12%	340,000	0	0%	0%	31,000	0	0%	0%
Carbazole	µg/kg dw	surface	3/17	18%	96,000	0	0%	0%	24,000	0	0%	0%
Hexachlorobenzene	µg/kg dw	soil berm	1/9	11%	1,200	0	0%	0%	300	0	0%	0%
	µg/kg dw	soil stockpile	1/3	33%	1,200	0	0%	0%	300	0	0%	0%

Table 5-2. Comparison of Constituent Concentrations in Phase 1 Facility Soil Samples to Screening Levels

Constituent	Unit	Sample Type/ Depth	Detection Frequency		Human Health Industrial SL[a]				Human Health Residential SL[b]			
			Ratio	%	Screening Level	No. Detects > SL	% Detects > SL	% Samples > SL	Screening Level	No. Detects > SL	% Detects > SL	% Samples >SL
PCBs												
Aroclor-1242	µg/kg dw	intermediate	2/22	9%	830	1	50%	5%	220	1	50%	5%
	µg/kg dw	deep	1/21	5%	830	0	0%	0%	220	0	0%	0%
Aroclor-1248	µg/kg dw	surface	16/33	48%	830	7	44%	21%	220	12	75%	36%
	µg/kg dw	intermediate	1/22	5%	830	0	0%	0%	220	0	0%	0%
	µg/kg dw	soil berm	2/9	22%	830	0	0%	0%	220	1	50%	11%
Aroclor-1254	µg/kg dw	surface	9/33	27%	830	3	33%	9%	220	7	78%	21%
	µg/kg dw	intermediate	1/22	5%	830	1	100%	5%	220	1	100%	5%
	µg/kg dw	soil berm	2/9	22%	830	0	0%	0%	220	2	100%	22%
	µg/kg dw	soil stockpile	1/3	33%	830	0	0%	0%	220	0	0%	0%
Aroclor-1260	µg/kg dw	surface	24/33	73%	830	10	42%	30%	220	16	67%	48%
	µg/kg dw	intermediate	5/22	23%	830	0	0%	0%	220	2	40%	9%
	µg/kg dw	soil berm	7/9	78%	830	0	0%	0%	220	5	71%	56%
	µg/kg dw	soil stockpile	3/3	100%	830	0	0%	0%	220	1	33%	33%
Total PCBs	µg/kg dw	surface	25/33	76%	830	11	44%	33%	220	19	76%	58%
	µg/kg dw	intermediate	6/22	27%	830	1	17%	5%	220	3	50%	14%
	µg/kg dw	deep	1/21	5%	830	0	0%	0%	220	0	0%	0%
	µg/kg dw	soil berm	8/9	89%	830	1	13%	11%	220	6	75%	67%
	µg/kg dw	soil stockpile	3/3	100%	830	0	0%	0%	220	1	33%	33%
Pesticides												
4,4'-DDD	µg/kg dw	surface	32/33	97%	11,000	3	9%	9%	2,400	7	22%	21%
	µg/kg dw	intermediate	18/22	82%	11,000	1	6%	5%	2,400	1	6%	5%
	µg/kg dw	deep	7/21	33%	11,000	1	14%	5%	2,400	1	14%	5%
	µg/kg dw	soil berm	7/9	78%	11,000	0	0%	0%	2,400	0	0%	0%
	µg/kg dw	soil stockpile	3/3	100%	11,000	0	0%	0%	2,400	0	0%	0%
4,4'-DDE	µg/kg dw	surface	8/33	24%	7,700	0	0%	0%	1,700	0	0%	0%
	µg/kg dw	intermediate	7/22	32%	7,700	0	0%	0%	1,700	0	0%	0%
	µg/kg dw	deep	1/21	5%	7,700	0	0%	0%	1,700	0	0%	0%
	µg/kg dw	soil berm	4/9	44%	7,700	0	0%	0%	1,700	0	0%	0%
	µg/kg dw	soil stockpile	3/3	100%	7,700	0	0%	0%	1,700	0	0%	0%

Table 5-2. Comparison of Constituent Concentrations in Phase 1 Facility Soil Samples to Screening Levels

			Detection Frequency		Human Health Industrial SL[a]				Human Health Residential SL[b]			
Constituent	Unit	Sample Type/ Depth	Ratio	%	Screening Level	No. Detects > SL	% Detects > SL	% Samples > SL	Screening Level	No. Detects > SL	% Detects > SL	% Samples >SL
4,4'-DDT	µg/kg dw	surface	9/33	27%	7,700	0	0%	0%	1,700	1	11%	3%
	µg/kg dw	intermediate	6/22	27%	7,700	0	0%	0%	1,700	1	17%	5%
	µg/kg dw	deep	1/21	5%	7,700	1	100%	5%	1,700	1	100%	5%
	µg/kg dw	soil berm	9/9	100%	7,700	0	0%	0%	1,700	1	11%	11%
	µg/kg dw	soil stockpile	2/3	67%	7,700	0	0%	0%	1,700	0	0%	0%
Total DDTs	µg/kg dw	surface	32/33	97%	7,700	1	3%	3%	1,700	10	31%	30%
	µg/kg dw	intermediate	18/22	82%	7,700	1	6%	5%	1,700	4	22%	18%
	µg/kg dw	deep	7/21	33%	7,700	1	14%	5%	1,700	1	14%	5%
	µg/kg dw	soil berm	9/9	100%	7,700	1	11%	11%	1,700	2	22%	22%
	µg/kg dw	soil stockpile	3/3	100%	7,700	0	0%	0%	1,700	0	0%	0%
VOCs												
1,1,1-Trichloroethane	µg/kg dw	surface	1/33	3%	15,000	0	0%	0%	15,000	0	0%	0%
1,1,2-Trichloroethane	µg/kg dw	surface	2/33	6%	190	0	0%	0%	190	0	0%	0%
1,1-Dichloroethane	µg/kg dw	surface	3/33	9%	7,700	0	0%	0%	7,700	0	0%	0%
	µg/kg dw	intermediate	1/22	5%	7,700	0	0%	0%	7,700	0	0%	0%
1,2,4-Trimethylbenzene	µg/kg dw	surface	18/33	55%	5,500	2	11%	6%	5,200	2	11%	6%
	µg/kg dw	intermediate	18/22	82%	5,500	1	6%	5%	5,200	1	6%	5%
	µg/kg dw	deep	4/21	19%	5,500	0	0%	0%	5,200	0	0%	0%
	µg/kg dw	soil stockpile	1/3	33%	5,500	0	0%	0%	5,200	0	0%	0%
1,3,5-Trimethylbenzene	µg/kg dw	surface	16/33	48%	1,200	2	13%	6%	1200	2	13%	6%
	µg/kg dw	intermediate	13/22	59%	1,200	2	15%	9%	1200	2	15%	9%
	µg/kg dw	deep	3/21	14%	1,200	0	0%	0%	1200	0	0%	0%
Acetone	µg/kg dw	surface	29/33	88%	6,000,000	0	0%	0%	1,400,000	0	0%	0%
	µg/kg dw	intermediate	17/22	77%	6,000,000	0	0%	0%	1,400,000	0	0%	0%
	µg/kg dw	deep	21/21	100%	6,000,000	0	0%	0%	1,400,000	0	0%	0%
	µg/kg dw	soil berm	9/9	100%	6,000,000	0	0%	0%	1,400,000	0	0%	0%
	µg/kg dw	soil stockpile	3/3	100%	6,000,000	0	0%	0%	1,400,000	0	0%	0%

Table 5-2. Comparison of Constituent Concentrations in Phase 1 Facility Soil Samples to Screening Levels

Constituent	Unit	Sample Type/ Depth	Detection Frequency		Human Health Industrial SL[a]				Human Health Residential SL[b]			
			Ratio	%	Screening Level	No. Detects > SL	% Detects > SL	% Samples > SL	Screening Level	No. Detects > SL	% Detects > SL	% Samples >SL
Benzene	µg/kg dw	surface	16/33	48%	52	2	13%	6%	52	2	13%	6%
	µg/kg dw	intermediate	15/22	68%	52	5	33%	23%	52	5	33%	23%
	µg/kg dw	deep	13/21	62%	52	1	8%	5%	52	1	8%	5%
	µg/kg dw	soil berm	2/9	22%	52	0	0%	0%	52	0	0%	0%
	µg/kg dw	soil stockpile	1/3	33%	52	0	0%	0%	52	0	0%	0%
Carbon disulfide	µg/kg dw	surface	18/33	55%	720,000	0	0%	0%	720,000	0	0%	0%
	µg/kg dw	intermediate	9/22	41%	720,000	0	0%	0%	720,000	0	0%	0%
	µg/kg dw	deep	3/21	14%	720,000	0	0%	0%	720,000	0	0%	0%
	µg/kg dw	soil stockpile	1/3	33%	720,000	0	0%	0%	720,000	0	0%	0%
Chlorobenzene	µg/kg dw	surface	5/33	15%	2,600	0	0%	0%	2,600	0	0%	0%
	µg/kg dw	intermediate	10/22	45%	2,600	1	10%	5%	2,600	1	10%	5%
	µg/kg dw	deep	3/21	14%	2,600	0	0%	0%	2,600	0	0%	0%
	µg/kg dw	soil stockpile	1/3	33%	2,600	0	0%	0%	2,600	0	0%	0%
Chloroethane	µg/kg dw	surface	1/33	3%	370	0	0%	0%	370	0	0%	0%
cis-1,2-Dichloroethene	µg/kg dw	surface	3/33	9%	400	1	33%	3%	400	1	33%	3%
	µg/kg dw	intermediate	5/22	23%	400	1	20%	5%	400	1	20%	5%
	µg/kg dw	deep	1/21	5%	400	0	0%	0%	400	0	0%	0%
Dichloromethane	µg/kg dw	surface	8/33	24%	22,000	0	0%	0%	8,900	0	0%	0%
	µg/kg dw	intermediate	3/22	14%	22,000	0	0%	0%	8,900	0	0%	0%
	µg/kg dw	deep	4/21	19%	22,000	0	0%	0%	8,900	0	0%	0%
	µg/kg dw	soil berm	3/9	33%	22,000	0	0%	0%	8,900	0	0%	0%
Ethylbenzene	µg/kg dw	surface	12/33	36%	230,000	0	0%	0%	230,000	0	0%	0%
	µg/kg dw	intermediate	11/22	50%	230,000	0	0%	0%	230,000	0	0%	0%
	µg/kg dw	deep	2/21	10%	230,000	0	0%	0%	230,000	0	0%	0%
n-Butylbenzene	µg/kg dw	surface	16/33	48%	240,000	0	0%	0%	14,000	0	0%	0%
	µg/kg dw	intermediate	11/22	50%	240,000	0	0%	0%	14,000	0	0%	0%
	µg/kg dw	deep	1/21	5%	240,000	0	0%	0%	14,000	0	0%	0%
n-Propylbenzene	µg/kg dw	surface	16/32	50%	230,000	0	0%	0%	14,000	0	0%	0%
	µg/kg dw	intermediate	13/22	59%	230,000	0	0%	0%	14,000	0	0%	0%
	µg/kg dw	deep	3/21	14%	230,000	0	0%	0%	14,000	0	0%	0%

Table 5-2. Comparison of Constituent Concentrations in Phase 1 Facility Soil Samples to Screening Levels

Constituent	Unit	Sample Type/ Depth	Detection Frequency		Human Health Industrial SL[a]				Human Health Residential SL[b]			
			Ratio	%	Screening Level	No. Detects > SL	% Detects > SL	% Samples > SL	Screening Level	No. Detects > SL	% Detects > SL	% Samples >SL
sec-Butylbenzene	µg/kg dw	surface	10/31	32%	220,000	0	0%	0%	11,000	0	0%	0%
	µg/kg dw	intermediate	8/22	36%	220,000	0	0%	0%	11,000	0	0%	0%
Styrene	µg/kg dw	surface	1/33	3%	1,700,000	0	0%	0%	1,700,000	0	0%	0%
tert-Butyl methyl ether	µg/kg dw	surface	3/33	9%	500	0	0%	0%	500	0	0%	0%
	µg/kg dw	intermediate	9/22	41%	500	0	0%	0%	500	0	0%	0%
	µg/kg dw	deep	15/21	71%	500	0	0%	0%	500	0	0%	0%
tert-Butylbenzene	µg/kg dw	intermediate	1/22	5%	390,000	0	0%	0%	13,000	0	0%	0%
Tetrachloroethene	µg/kg dw	surface	3/33	9%	37	0	0%	0%	37	0	0%	0%
	µg/kg dw	intermediate	1/22	5%	37	0	0%	0%	37	0	0%	0%
Toluene	µg/kg dw	surface	21/33	64%	520,000	0	0%	0%	520,000	0	0%	0%
	µg/kg dw	intermediate	13/22	59%	520,000	0	0%	0%	520,000	0	0%	0%
	µg/kg dw	deep	3/21	14%	520,000	0	0%	0%	520,000	0	0%	0%
	µg/kg dw	soil berm	3/9	33%	520,000	0	0%	0%	520,000	0	0%	0%
	µg/kg dw	soil stockpile	2/3	67%	520,000	0	0%	0%	520,000	0	0%	0%
trans-1,2-Dichloroethene	µg/kg dw	surface	1/33	3%	1,000	1	100%	3%	1,000	1	100%	3%
Trichloroethene	µg/kg dw	surface	4/33	12%	9.9	1	25%	3%	9.9	1	25%	3%
	µg/kg dw	intermediate	2/22	9%	9.9	0	0%	0%	9.9	0	0%	0%
	µg/kg dw	deep	1/21	5%	9.9	0	0%	0%	9.9	0	0%	0%
Vinyl chloride	µg/kg dw	surface	1/33	3%	10	1	100%	3%	10	1	100%	3%
	µg/kg dw	intermediate	1/22	5%	10	1	100%	5%	10	1	100%	5%
	µg/kg dw	deep	1/21	5%	10	1	100%	5%	10	1	100%	5%
o-Xylene	µg/kg dw	surface	17/33	52%	10,000	1	6%	3%	10,000	1	6%	3%
	µg/kg dw	intermediate	11/22	50%	10,000	0	0%	0%	10,000	0	0%	0%
	µg/kg dw	deep	3/21	14%	10,000	0	0%	0%	10,000	0	0%	0%
m,p-Xylene	µg/kg dw	surface	18/33	55%	10,000	1	6%	3%	10,000	1	6%	3%
	µg/kg dw	intermediate	15/22	68%	10,000	0	0%	0%	10,000	0	0%	0%
	µg/kg dw	deep	3/21	14%	10,000	0	0%	0%	10,000	0	0%	0%
	µg/kg dw	soil stockpile	1/3	33%	10,000	0	0%	0%	10,000	0	0%	0%

Table 5-2. Comparison of Constituent Concentrations in Phase 1 Facility Soil Samples to Screening Levels

Constituent	Unit	Sample Type/ Depth	Detection Frequency		Human Health Industrial SL[a]				Human Health Residential SL[b]			
			Ratio	%	Screening Level	No. Detects > SL	% Detects > SL	% Samples > SL	Screening Level	No. Detects > SL	% Detects > SL	% Samples >SL
Petroleum												
TPH – gasoline range	mg/kg dw	surface	23/33	70%	110	9	39%	27%	110	9	39%	27%
	mg/kg dw	intermediate	15/22	68%	110	9	60%	41%	110	9	60%	41%
	mg/kg dw	deep	6/21	29%	110	0	0%	0%	110	0	0%	0%
	mg/kg dw	soil berm	2/9	22%	110	0	0%	0%	110	0	0%	0%
	mg/kg dw	soil stockpile	1/3	33%	110	0	0%	0%	110	0	0%	0%
TPH – diesel range	mg/kg dw	surface	33/33	100%	23,000	0	0%	0%	23,000	0	0%	0%
	mg/kg dw	intermediate	19/22	86%	23,000	0	0%	0%	23,000	0	0%	0%
	mg/kg dw	deep	3/21	14%	23,000	0	0%	0%	23,000	0	0%	0%
	mg/kg dw	soil berm	8/9	89%	23,000	0	0%	0%	23,000	0	0%	0%
	mg/kg dw	soil stockpile	3/3	100%	23,000	0	0%	0%	23,000	0	0%	0%
TPH – motor oil range	mg/kg dw	surface	33/33	100%	23,000	0	0%	0%	23,000	0	0%	0%
	mg/kg dw	intermediate	20/22	91%	23,000	0	0%	0%	23,000	0	0%	0%
	mg/kg dw	deep	6/21	29%	23,000	0	0%	0%	23,000	0	0%	0%
	mg/kg dw	soil berm	9/9	100%	23,000	0	0%	0%	23,000	0	0%	0%
	mg/kg dw	soil stockpile	3/3	100%	23,000	0	0%	0%	23,000	0	0%	0%

Note: Summary statistics are provided by location, not sample (i.e., duplicate samples were combined with the original sample, as described in Appendix D).

[a] The industrial human health screening levels are the lowest of the EPA Region 6 industrial SLs (EPA 2007a) or DEQ RBCs (soil ingestion, dermal contact, inhalation; volatilization to outdoor air; vapor intrusion to buildings; leaching to groundwater) (DEQ 2007).

[b] The residential human health screening levels are the lowest of the EPA Region 6 residential SLs (EPA 2007a) or DEQ RBCs (soil ingestion, dermal contact, inhalation; volatilization to outdoor air; vapor intrusion to buildings; leaching to groundwater) (DEQ 2007).

[c] Screening levels for total DDTs are based on 4,4′-DDT.

cPAH – carcinogenic polycyclic aromatic hydrocarbon
dw – dry weight
HPAH – high-molecular-weight polycyclic aromatic hydrocarbon
J – estimated concentration
JN – tentative identification with estimated concentration
LPAH – low-molecular-weight polycyclic aromatic hydrocarbon
na – not applicable
PAH – polycyclic aromatic hydrocarbon
PCB – polychlorinated biphenyl
RL – reporting limit
SVOC – semivolatile organic compound
SL – screening level
TPH – total petroleum hydrocarbon
VOC – volatile organic compound

5.1.2 Facility Groundwater

Groundwater samples were collected from a total of 11 shallow zone wells, 3 intermediate zone wells, and 2 deep zone wells at the Facility (Map 1). Shallow zone well depths ranged from 0 to 20 ft bgs, intermediate zone well depths ranged from 35 to 50 ft bgs, and deep zone well depths ranged from 80 to 100 ft bgs. In addition, an LNAPL sample was collected from GA-30, the only well where free product was observed.

Table 5-3 presents a summary of the laboratory analytical results for the groundwater samples, and Table 5-4 presents a summary of the laboratory analytical results for the LNAPL sample. Constituent concentrations detected in the groundwater samples were compared to human health screening levels (i.e., EPA Region 6 tap water screening levels or DEQ RBCs). The results are summarized below.

- **Shallow zone wells**: Of the 149 constituents and constituent groups that were analyzed for in shallow groundwater samples, only 43 individual constituents or constituent groups were detected at least once, and only 11 were detected at concentrations greater than the human health screening levels in at least one well.
- **Intermediate zone wells**: Of the 149 constituents and constituent groups that were analyzed for in intermediate groundwater samples, only 8 individual constituents or constituent groups were detected at least once, and only 3 were detected at concentrations greater than the human health screening levels in at least one well.
- **Deep zone wells**: Of the 149 constituents and constituent groups that were analyzed for in deep groundwater samples, only 11 individual constituents or constituent groups were detected at least once, and only 5 were detected at concentrations greater than the human health screening levels in at least one well.

A complete summary of analytical results is provided in Appendix A. Total PCB, total DDT, total PAH, total TPH, arsenic, lead, and mercury concentrations are shown on Maps 3 through 9, respectively. Water quality parameter data for these wells are provided in Section 2.1.

Total PCBs were not detected in shallow, intermediate or deep zone groundwater (Map 3). Total DDTs were detected in shallow zone groundwater in the central portion of the Facility and along the southern Facility property boundary; total DDTs were also detected intermediate and deep zone groundwater at monitoring wells MW-2i and B-4, respectively, but at concentrations below human health screening levels. Total PAHs were detected in shallow zone groundwater in the central portion of the Facility, along the southern Facility property boundary, and in the new base oil plant area; total PAHs were not detected in intermediate or deep zone groundwater. Arsenic was detected at the majority of well locations, with the highest concentrations generally detected in shallow wells. Lead was detected in the two wells located near North Force Avenue (at one shallow well [A-20] and at one deep well [PW-01]). Mercury was not detected in groundwater. While a number of VOCs were detected in shallow zone groundwater, with the exception of acetone, no VOCs were detected in intermediate zone groundwater. Tetrachloroethene and acetone were the only VOCs detected in deep groundwater. The acetone detected in the groundwater samples appears to be due to laboratory cross-contamination. The tetrachloroethene detected in deep groundwater does not appear to be Site-related because it was not detected in either shallow or intermediate zone groundwater. Also, as was discussed in the WP, tetrachloroethene has been detected in other deep groundwater monitoring wells in the general vicinity of the Site.

Table 5-3. Constituent Concentrations Detected in Phase 1 Facility Groundwater Samples and Comparison to Screening Levels

Constituent	Fraction[a]	Unit	Depth Category	Detection Frequency		Detected Concentrations				RL or Range of RLs if Not Detected	Human Health SL[b]			
				Ratio	%	Minimum	Maximum	Mean	Median		SL	No. Detects > SL	% Detects > SL	% Samples > SL
Metals														
Antimony	D	µg/L	shallow	2/11	18%	0.2	0.2	0.20	0.20	0.2	1.5	0	0%	0%
	T	µg/L	shallow	1/11	9%	0.2	0.2	0.20	0.20	0.2	1.5	0	0%	0%
Arsenic	D	µg/L	shallow	11/11	100%	1.6	28.7	11	11	na	0.045	11	100%	100%
	D	µg/L	intermediate	3/3	100%	2.4	4.7	3.5	3.4	na	0.045	3	100%	100%
	D	µg/L	deep	1/2	50%	6.3	6.3	6.3	6.3	0.2	0.045	1	100%	50%
	T	µg/L	shallow	11/11	100%	1.8	30.0	11	11	na	0.045	11	100%	100%
	T	µg/L	intermediate	3/3	100%	2.3	4.6	3.4	3.3	na	0.045	3	100%	100%
	T	µg/L	deep	2/2	100%	0.3	6.4	3.4	3.4	na	0.045	2	100%	100%
Barium	D	µg/L	shallow	11/11	100%	65	383	180	160	na	730	0	0%	0%
	D	µg/L	intermediate	3/3	100%	121	139	130	130	na	730	0	0%	0%
	D	µg/L	deep	2/2	100%	9	202	110	110	na	730	0	0%	0%
	T	µg/L	shallow	11/11	100%	65	385	190	160	na	730	0	0%	0%
	T	µg/L	intermediate	3/3	100%	123	136	130	130	na	730	0	0%	0%
	T	µg/L	deep	2/2	100%	9	204	110	110	na	730	0	0%	0%
Cadmium	T	µg/L	shallow	2/11	18%	0.3	0.4	0.35	0.40	0.2	1.8	0	0%	0%
Chromium	T	µg/L	shallow	1/11	9%	8	8	8.0	8.0	5	5500	0	0%	0%
Cobalt	D	µg/L	shallow	4/11	36%	4	14	8.0	7.0	3	73	0	0%	0%
	T	µg/L	shallow	5/11	45%	3	13	6.6	4.0	3	73	0	0%	0%
Copper	D	µg/L	shallow	1/11	9%	5	5	5.0	5.0	2	140	0	0%	0%
	T	µg/L	shallow	3/11	27%	3 J	11	5.7	3.0	2	140	0	0%	0%
Iron	D	µg/L	shallow	11/11	100%	1,720	48,200	24,000	25,000	na	2,600	10	91%	91%
	D	µg/L	intermediate	3/3	100%	7,920	11,600	9,400	8,800	na	2,600	3	100%	100%
	D	µg/L	deep	1/2	50%	13,700	13,700	14,000	14,000	50	2,600	1	100%	50%
	T	µg/L	shallow	11/11	100%	3,130	48,200	25,000	25,000	na	2600	11	100%	100%
	T	µg/L	intermediate	3/3	100%	7,690	11,400	9,300	8,800	na	2,600	3	100%	100%
	T	µg/L	deep	2/2	100%	100	14,000	7,100	7,000	na	2,600	1	50%	50%
Lead	D	µg/L	deep	1/2	50%	3	3	3.0	3.0	1	15	0	0%	0%

Table 5-3. Constituent Concentrations Detected in Phase 1 Facility Groundwater Samples and Comparison to Screening Levels

Constituent	Fraction[a]	Unit	Depth Category	Detection Frequency		Detected Concentrations				RL or Range of RLs if Not Detected	Human Health SL[b]			
				Ratio	%	Minimum	Maximum	Mean	Median		SL	No. Detects > SL	% Detects > SL	% Samples > SL
	T	µg/L	shallow	1/11	9%	3	3	3.0	3.0	1	15	0	0%	0%
	T	µg/L	deep	1/2	50%	8	8	8.0	8.0	1	15	0	0%	0%
Manganese	D	µg/L	shallow	11/11	100%	1,350	6,510	3,100	2,500	na	170	11	100%	100%
	D	µg/L	intermediate	3/3	100%	563	867	700	660	na	170	3	100%	100%
	D	µg/L	deep	2/2	100%	122	1,590	860	860	na	170	1	50%	50%
	T	µg/L	shallow	11/11	100%	1,360	6,440	3,100	2,500	na	170	11	100%	100%
	T	µg/L	intermediate	3/3	100%	570	849	690	660	na	170	3	100%	100%
	T	µg/L	deep	2/2	100%	124	1,600	860	850	na	170	1	50%	50%
Nickel	D	µg/L	shallow	4/11	36%	10 J	20	13	10	10	73	0	0%	0%
	T	µg/L	shallow	2/11	18%	10	20	15	20	10	73	0	0%	0%
Selenium	D	µg/L	shallow	3/11	27%	0.5	0.6	0.53	0.50	0.5 – 2	18	0	0%	0%
	T	µg/L	shallow	5/11	45%	0.5	1.5	0.80	0.50	0.5 – 2	18	0	0%	0%
Vanadium	D	µg/L	shallow	1/11	9%	9	9	9.0	9.0	3	18	0	0%	0%
	T	µg/L	shallow	2/11	18%	9	20	15	20	3	18	1	50%	9%
Zinc	D	µg/L	shallow	1/11	9%	40	40	40	40	10	1,100	0	0%	0%
	D	µg/L	deep	1/2	50%	9,870	9,870	9,900	9,900	10	1,100	1	100%	50%
	T	µg/L	shallow	3/11	27%	10	50	30	30	10	1,100	0	0%	0%
	T	µg/L	deep	1/2	50%	10,100	10,100	10,000	10,000	10	1,100	1	100%	50%
PAHs														
2-Methylnaphthalene	N	µg/L	shallow	3/11	27%	0.14	1.8	0.84	0.58	0.10	nc	nc	nc	nc
Acenaphthene	N	µg/L	shallow	5/11	45%	0.15	2.7	0.80	0.42	0.10	37	0	0%	0%
Anthracene	N	µg/L	shallow	3/11	27%	0.10	0.24	0.16	0.15	0.10	180	0	0%	0%
Dibenzofuran	N	µg/L	shallow	1/11	9%	0.16	0.16	0.16	0.16	0.10	1.2	0	0%	0%
Fluoranthene	N	µg/L	shallow	1/11	9%	0.12	0.12	0.12	0.12	0.10	150	0	0%	0%
Fluorene	N	µg/L	shallow	3/11	27%	0.17	0.46	0.31	0.29	0.10	24	0	0%	0%
Naphthalene	N	µg/L	shallow	3/11	27%	0.12	1.2	0.49	0.16	0.10	0.62	1	33%	9%
Phenanthrene	N	µg/L	shallow	2/11	18%	0.13	0.25	0.19	0.19	0.10	nc	nc	nc	nc
Total HPAHs	N	µg/L	shallow	1/11	9%	0.12	0.12	0.12	0.12	0.10	nc	nc	nc	nc

Table 5-3. Constituent Concentrations Detected in Phase 1 Facility Groundwater Samples and Comparison to Screening Levels

Constituent	Fraction[a]	Unit	Depth Category	Detection Frequency		Detected Concentrations				RL or Range of RLs if Not Detected	Human Health SL[b]			
				Ratio	%	Minimum	Maximum	Mean	Median		SL	No. Detects > SL	% Detects > SL	% Samples > SL
Total LPAHs	N	µg/L	shallow	5/11	45%	0.23	3.1	1.5	1.1	0.10	nc	nc	nc	nc
Total PAHs	N	µg/L	shallow	5/11	45%	0.23	3.3	1.5	1.1	0.10	nc	nc	nc	nc
Pesticides														
2,4'-DDD	N	µg/L	shallow	4/11	36%	0.0063 J	0.032	0.014	0.0087	0.010	nc	nc	nc	nc
	N	µg/L	intermediate	1/3	33%	0.012	0.012	0.012	0.012	0.010	nc	nc	nc	nc
	N	µg/L	deep	1/2	50%	0.0073 J	0.0073 J	0.0073	0.0073	0.010	nc	nc	nc	nc
4,4'-DDD	N	µg/L	shallow	6/11	55%	0.0071 J	0.12	0.036	0.024	0.010	0.28	0	0%	0%
	N	µg/L	intermediate	1/3	33%	0.036	0.036	0.036	0.036	0.010	0.28	0	0%	0%
	N	µg/L	deep	1/2	50%	0.014	0.014	0.014	0.014	0.010	0.28	0	0%	0%
Total DDTs[c]	N	µg/L	shallow	6/11	55%	0.0071 J	0.15	0.044	0.031	0.010	0.20	0	0%	0%
	N	µg/L	intermediate	1/3	33%	0.048	0.048	0.048	0.048	0.010	0.20	0	0%	0%
	N	µg/L	deep	1/2	50%	0.021 J	0.021 J	0.021	0.021	0.010	0.20	0	0%	0%
VOCs														
1,2,4-Trimethylbenzene	N	µg/L	shallow	1/11	9%	3.7	3.7	3.7	3.7	1.0	1.2	1	100%	9%
1,3,5-Trimethylbenzene	N	µg/L	shallow	2/11	18%	1.5	2.4	2.0	2.0	1.0	1.2	2	100%	18%
Acetone	N	µg/L	shallow	8/11	73%	5.5	18	10	9.0	5.0	550	0	0%	0%
	N	µg/L	intermediate	1/3	33%	9.4	9.4	9.4	9.4	5.0	550	0	0%	0%
	N	µg/L	deep	1/2	50%	10	10	10	10	5.0	550	0	0%	0%
Benzene	N	µg/L	shallow	4/11	36%	2.0	140	37	3.3	1.0	0.35	4	100%	36%
Chlorobenzene	N	µg/L	shallow	5/11	45%	2.1	100	24	6.5	1.0	9.1	1	20%	9%
Isopropylbenzene	N	µg/L	shallow	1/11	9%	8.3	8.3	8.3	8.3	1.0	nc	nc	nc	nc
n-Propylbenzene	N	µg/L	shallow	2/11	18%	1.8	11	6.4	6.5	1.0	6.1	1	50%	9%
tert-Butyl methyl ether	N	µg/L	shallow	7/11	64%	1.4	160	31	5.4	1.0	11	2	29%	18%
Tetrachloroethene	N	µg/L	deep	1/2	50%	1.4	1.4	1.4	1.4	1.0	0.10	1	100%	50%
Toluene	N	µg/L	shallow	1/11	9%	4.8	4.8	4.8	4.8	1.0	230	0	0%	0%
o-Xylene	N	µg/L	shallow	1/11	9%	4.0	4.0	4.0	4.0	1.0	140	0	0%	0%
m,p-Xylene	N	µg/L	shallow	2/11	18%	1.4	5.0	3.2	3.2	1.0	21	0	0%	0%
Total xylenes	N	µg/L	shallow	2/11	18%	1.4	9.0	5.2	5.2	1.0	nc	nc	nc	nc

Table 5-3. Constituent Concentrations Detected in Phase 1 Facility Groundwater Samples and Comparison to Screening Levels

Constituent	Fraction[a]	Unit	Depth Category	Detection Frequency		Detected Concentrations				RL or Range of RLs if Not Detected	Human Health SL[b]			
				Ratio	%	Minimum	Maximum	Mean	Median		SL	No. Detects > SL	% Detects > SL	% Samples > SL
Petroleum														
TPH – gasoline range	N	mg/L	shallow	2/11	18%	0.48	0.81	0.65	0.65	0.25	13	0	0%	0%
TPH – diesel range	N	mg/L	shallow	1/11	9%	0.26 J	0.26 J	0.26	0.26	0.25	10	0	0%	0%
Total petroleum hydrocarbons	N	mg/L	shallow	1/11	9%	0.26 J	0.26 J	0.26	0.26	0.50	nc	nc	nc	nc
Conventionals														
Total dissolved solids	N	mg/L	shallow	11/11	100%	252	1,040	570	490	na	nc	nc	nc	nc
	N	mg/L	intermediate	3/3	100%	438	484	470	480	na	nc	nc	nc	nc
	N	mg/L	deep	2/2	100%	172	936	550	550	na	nc	nc	nc	nc
pH	N	SU	shallow	11/11	100%	6.60	6.93	6.7	6.6	na	nc	nc	nc	nc
	N	SU	intermediate	3/3	100%	6.90 J	7.15	7.0	7.0	na	nc	nc	nc	nc
	N	SU	deep	2/2	100%	6.87	7.06	7.0	7.0	na	nc	nc	nc	nc
Salinity	N	ppt	shallow	11/11	100%	0.20	0.80	0.45	0.40	na	nc	nc	nc	nc
	N	ppt	intermediate	3/3	100%	0.40	0.40	0.40	0.40	na	nc	nc	nc	nc
	N	ppt	deep	2/2	100%	0.10	0.70	0.40	0.40	na	nc	nc	nc	nc
Conductivity	N	umhos/cm	shallow	11/11	100%	466	1,620	930	870	na	nc	nc	nc	nc
	N	umhos/cm	intermediate	3/3	100%	804	844	820	820	na	nc	nc	nc	nc
	N	umhos/cm	deep	2/2	100%	304	1,330	820	820	na	nc	nc	nc	nc

Note: Summary statistics are provided by location, not sample (i.e., duplicate samples were combined with the original sample, as described in Appendix D).

Note: All means and medians are reported to two significant figures.

[a] Fraction: D = dissolved; T = total; N = not applicable

[b] The human health screening levels are the lowest of EPA Region 6 tap water screening values (EPA 2007a) or DEQ RBCs (volatilization to outdoor air, vapor intrusion to buildings, or groundwater in excavation) (DEQ 2007).

[c] Screening levels for total DDTs is based on 4,4'-DDT.

cPAH – carcinogenic polycyclic aromatic hydrocarbon
HPAH – high-molecular-weight polycyclic aromatic hydrocarbon
J – estimated concentration
JN – tentative identification with estimated concentration
LPAH – low-molecular-weight polycyclic aromatic hydrocarbon
na – not applicable
nc – no criteria
PAH – polycyclic aromatic hydrocarbon
PCB – polychlorinated biphenyl
ppt – parts per thousand
RL – reporting limit
SVOC – semivolatile organic compound

Table 5-4. Constituent Concentrations Detected in the Phase 1 Facility Light Non-Aqueous Phase Liquid Sample

Constituent	Unit	Detection Frequency		Detected Concentrations				RL (if Not Detected)
		Ratio	%	Minimum	Maximum	Mean	Median	
Metals								
Barium	µg/L	1/1	100%	130	130	130	130	na
Chromium	µg/L	1/1	100%	11	11	11	11	na
Cobalt	µg/L	1/1	100%	40	40	40	40	na
Copper	µg/L	1/1	100%	9	9	9.0	9.0	na
Lead	µg/L	1/1	100%	40	40	40	40	na
Vanadium	µg/L	1/1	100%	20	20	20	20	na
Zinc	µg/L	1/1	100%	120	120	120	120	na
PAHs								
1-Methylnaphthalene	µg/kg ww	1/1	100%	34,000 J	34,000 J	34,000	34,000	na
Acenaphthene	µg/kg ww	1/1	100%	56,000	56,000	56,000	56,000	na
Anthracene	µg/kg ww	1/1	100%	44,000 J	44,000 J	44,000	44,000	na
Chrysene	µg/kg ww	1/1	100%	44,000 J	44,000 J	44,000	44,000	na
Fluoranthene	µg/kg ww	1/1	100%	72,000	72,000	72,000	72,000	na
Fluorene	µg/kg ww	1/1	100%	48,000 J	48,000 J	48,000	48,000	na
Phenanthrene	µg/kg ww	1/1	100%	96,000	96,000	96,000	96,000	na
Pyrene	µg/kg ww	1/1	100%	100,000	100,000	100,000	100,000	na
Total cPAHs	µg/kg ww	1/1	100%	45,000 J	45,000 J	45,000	45,000	na
Total HPAHs	µg/kg ww	1/1	100%	220,000 J	220,000 J	220,000	220,000	na
Total LPAHs	µg/kg ww	1/1	100%	244,000 J	244,000 J	240,000	240,000	na
Total PAHs	µg/kg ww	1/1	100%	460,000 J	460,000 J	460,000	460,000	na
PCBs								
Aroclor-1248	µg/kg ww	1/1	100%	14,000	14,000	14,000	14,000	na
Aroclor-1254	µg/kg ww	1/1	100%	7,000	7,000	7,000	7,000	na
Aroclor-1260	µg/kg ww	1/1	100%	5,200	5,200	5,200	5,200	na
Total PCBs	µg/kg ww	1/1	100%	26,000	26,000	26,000	26,000	na
VOCs								
n-Butylbenzene	µg/kg ww	1/1	100%	4,400	4,400	4,400	4,400	na
n-Propylbenzene	µg/kg ww	1/1	100%	2,800	2,800	2,800	2,800	na
sec-Butylbenzene	µg/kg ww	1/1	100%	2,700	2,700	2,700	2,700	na
Toluene	µg/kg ww	1/1	100%	3,800	3,800	3,800	3,800	na
o-Xylene	µg/kg ww	1/1	100%	3,800	3,800	3,800	3,800	na
Total xylenes	µg/kg ww	1/1	100%	3,800	3,800	3,800	3,800	na
Petroleum								
TPH – gasoline range	mg/kg ww	1/1	100%	17,000	17,000	17,000	17,000	na
TPH – diesel range	mg/kg ww	1/1	100%	480,000	480,000	480,000	480,000	na
TPH – motor oil range	mg/kg ww	1/1	100%	470,000	470,000	470,000	470,000	na
Total TPH	mg/kg ww	1/1	100%	950,000	950,000	950,000	950,000	na

Note: Summary statistics are provided by location, not sample (i.e., duplicate samples were combined with the original sample, as described in Appendix D).

Note: All means and medians are reported to two significant figures.

cPAH – carcinogenic polycyclic aromatic hydrocarbon
J – estimated concentration
HPAH – high-molecular-weight polycyclic aromatic hydrocarbon
LPAH – low-molecular-weight polycyclic aromatic hydrocarbon
nc – no criteria
PAH – polycyclic aromatic hydrocarbon
PCB – polychlorinated biphenyl
RL – reporting limit
TPH – total petroleum hydrocarbon
VOC – volatile organic compound
ww – wet weight
na – not applicable

5.2 Wetland Soil Sampling

Soil samples were collected from 38 locations in the wetlands and former drainage ditch adjacent to the Facility, including surface soil samples from 38 locations, intermediate subsurface soil interval samples from 6 of those locations, and deep subsurface soil interval samples from the same 6 locations (Map 2). Surface soil samples were collected from 0 to 0.5 ft bgs, intermediate interval subsurface samples were collected from 0.5 to 1 ft bgs, and deep interval subsurface samples were collected from 2 to 3 ft bgs.

Table 5-5 presents a summary of the laboratory analytical results for these samples, and Table 5-6 presents a comparison of these data to wildlife-based ecological screening levels and residential human health screening levels. The results are summarized below.

- **Surface (0 – 0.5 ft bgs) soil intervals**: Of the 188 constituents and constituent groups that were analyzed for in wetland surface soil samples, only 73 individual constituents or constituent groups were detected at least once, and only 18 were detected at concentrations greater than the wildlife-based ecological screening levels and 16 were detected at concentrations greater than the residential human health screening levels, in one or more samples.
- **Intermediate (0.5 – 1.0 ft bgs) soil intervals**: Of the 188 constituents and constituent groups that were analyzed for in intermediate intervals of subsurface wetland soil samples, only 63 individual constituents or constituent groups were detected at least once, and only 12 were detected at concentrations greater than the wildlife-based ecological screening levels and 5 were detected at concentrations greater than the residential human health screening levels, in one or more samples.
- **Deep (2.0 – 3.0 ft bgs) soil intervals**: Of the 188 constituents and constituent groups that were analyzed for in deep intervals of subsurface wetland soil samples, only 49 individual constituents or constituent groups were detected at least once, and only 9 were detected at concentrations greater than the wildlife-based ecological screening levels and 4 were detected at concentrations greater than the residential human health screening levels, in one or more samples.

A complete summary of analytical results is provided in Appendix A. Total PCB, total DDT, total PAH, total TPH, arsenic, lead, and mercury concentrations are shown on Maps 10 through 16, respectively.

Based on the Phase 1 results, the highest constituent concentrations were found in three areas: the former drainage ditch area along the western boundary of the Facility (samples DS-01, DS-02, WS-11, and WS-07); in the area between the current stormwater treatment system discharge and Force Lake (WS-19, WS-20, and WS-21); and sampling location WS-25. Other notable sampling results include the total PAH concentrations detected in the northeast corner of the wetlands (WS-29) and the total DDT concentrations detected at two locations along North Force Avenue (WS-31 and WS-33).

Table 5-5. Constituent Concentrations Detected in the Phase 1 Wetland Soil Samples, Including the Ditch Soil Samples

Constituent	Unit	Depth Interval (ft bgs)	Detection Frequency		Detected Concentrations				RL or Range of RLs if Not Detected
			Ratio	%	Minimum	Maximum	Mean	Median	
Metals									
Antimony	mg/kg dw	0 - 0.5	5/38	13%	0.7 J	1 J	0.80	0.70	0.3 – 0.9
Arsenic	mg/kg dw	0 - 0.5	38/38	100%	1.5	53.1	9.3	6.0	na
	mg/kg dw	0.5 - 1.0	6/6	100%	2.4	19.8	7.4	5.4	na
	mg/kg dw	2.0 - 3.0	6/6	100%	2.4	5.3	4.0	4.2	na
Barium	mg/kg dw	0 - 0.5	38/38	100%	75.5	481	190	180	na
	mg/kg dw	0.5 - 1.0	6/6	100%	111	287	190	200	na
	mg/kg dw	2.0 - 3.0	6/6	100%	145	219	190	190	na
Cadmium	mg/kg dw	0 - 0.5	35/38	92%	0.3	4	1.0	0.80	0.3 – 0.4
	mg/kg dw	0.5 - 1.0	5/6	83%	0.3	1.1	0.54	0.50	0.3
	mg/kg dw	2.0 - 3.0	3/6	50%	0.4	0.6	0.47	0.40	0.3
Chromium	mg/kg dw	0 - 0.5	38/38	100%	8.9	149	35	26	na
	mg/kg dw	0.5 - 1.0	6/6	100%	15.3	38	24	20	na
	mg/kg dw	2.0 - 3.0	6/6	100%	20.6	31.2	26	27	na
Cobalt	mg/kg dw	0 - 0.5	38/38	100%	4.2	34.3	11	9.5	na
	mg/kg dw	0.5 - 1.0	6/6	100%	7.0 J	12.7	10	10	na
	mg/kg dw	2.0 - 3.0	6/6	100%	8.3	15.1	11	10	na
Copper	mg/kg dw	0 - 0.5	38/38	100%	21.5	149	59	48	na
	mg/kg dw	0.5 - 1.0	6/6	100%	25.7	61.1	36	31	na
	mg/kg dw	2.0 - 3.0	6/6	100%	29.5	40.8	34	34	na
Lead	mg/kg dw	0 - 0.5	38/38	100%	12	320	66	40	na
	mg/kg dw	0.5 - 1.0	6/6	100%	13	76	28	20	na
	mg/kg dw	2.0 - 3.0	6/6	100%	9	24	15	15	na
Mercury	mg/kg dw	0 - 0.5	35/38	92%	0.07	0.4	0.17	0.15	0.07 – 0.2
	mg/kg dw	0.5 - 1.0	6/6	100%	0.06 J	0.15	0.11	0.11	na
	mg/kg dw	2.0 - 3.0	4/6	67%	0.07 J	0.13 J	0.093	0.085	0.06 – 0.07

Table 5-5. Constituent Concentrations Detected in the Phase 1 Wetland Soil Samples, Including the Ditch Soil Samples

Constituent	Unit	Depth Interval (ft bgs)	Detection Frequency		Detected Concentrations				RL or Range of RLs if Not Detected
			Ratio	%	Minimum	Maximum	Mean	Median	
Nickel	mg/kg dw	0 - 0.5	38/38	100%	10	48	24	23	na
	mg/kg dw	0.5 - 1.0	6/6	100%	16	29	21	20	na
	mg/kg dw	2.0 - 3.0	6/6	100%	17	24	21	20	na
Vanadium	mg/kg dw	0 - 0.5	38/38	100%	32.6	148	69	63	na
	mg/kg dw	0.5 - 1.0	6/6	100%	45.2	82.1	60	58	na
	mg/kg dw	2.0 - 3.0	6/6	100%	50.8	98 J	69	61	na
Zinc	mg/kg dw	0 - 0.5	38/38	100%	87	735	220	160	na
	mg/kg dw	0.5 - 1.0	6/6	100%	64	203	120	100	na
	mg/kg dw	2.0 - 3.0	6/6	100%	74	106	87	84	na
PAHs									
2-Methylnaphthalene	µg/kg dw	0 - 0.5	36/38	95%	5.0	930	150	69	72 – 120
	µg/kg dw	0.5 - 1.0	5/6	83%	6.1	310	90	28	5.0
	µg/kg dw	2.0 - 3.0	2/6	33%	6.3	6.3	6.3	6.3	4.7 – 5.0
Acenaphthene	µg/kg dw	0 - 0.5	10/38	26%	5.4	18	12	12	4.8 – 220
	µg/kg dw	0.5 - 1.0	1/6	17%	16	16	16	16	4.7 – 9.8
	µg/kg dw	2.0 - 3.0	1/6	17%	65	65	65	65	4.7 – 5.0
Acenaphthylene	µg/kg dw	0 - 0.5	19/38	50%	4.8	100	26	11	4.8 – 220
	µg/kg dw	0.5 - 1.0	3/6	50%	4.9	59	24	6.7	4.7 – 9.8
Anthracene	µg/kg dw	0 - 0.5	37/38	97%	4.9	730 J	95	26	15
	µg/kg dw	0.5 - 1.0	5/6	83%	7.1	210	54	17	5.0
	µg/kg dw	2.0 - 3.0	2/6	33%	4.8	5.9	5.4	5.4	4.7 – 5.0
Benzo(a)anthracene	µg/kg dw	0 - 0.5	37/38	97%	19	590 J	100	56	72
	µg/kg dw	0.5 - 1.0	6/6	100%	5.0	120	40	27	na
	µg/kg dw	2.0 - 3.0	2/6	33%	5.0	42	24	24	4.7 – 5.0
Benzo(a)pyrene	µg/kg dw	0 - 0.5	38/38	100%	26	860 J	140	71	na
	µg/kg dw	0.5 - 1.0	6/6	100%	7.9	110	43	33	na
	µg/kg dw	2.0 - 3.0	3/6	50%	5.0	41	17	5.0	4.7 – 5.0

Table 5-5. Constituent Concentrations Detected in the Phase 1 Wetland Soil Samples, Including the Ditch Soil Samples

Constituent	Unit	Depth Interval (ft bgs)	Detection Frequency		Detected Concentrations				RL or Range of RLs if Not Detected
			Ratio	%	Minimum	Maximum	Mean	Median	
Benzo(b)fluoranthene	µg/kg dw	0 - 0.5	38/38	100%	31	990	230	130	na
	µg/kg dw	0.5 - 1.0	6/6	100%	18	260	81	45	na
	µg/kg dw	2.0 - 3.0	5/6	83%	5.4	39	15	7.8	5.0
Benzo(g,h,i)perylene	µg/kg dw	0 - 0.5	37/38	97%	8.8	1,100	120	42	72
	µg/kg dw	0.5 - 1.0	6/6	100%	7.6	79	30	24	na
	µg/kg dw	2.0 - 3.0	2/6	33%	5.0	14	9.5	9.5	4.7 – 5.0
Benzo(k)fluoranthene	µg/kg dw	0 - 0.5	38/38	100%	22	1,400	180	79	na
	µg/kg dw	0.5 - 1.0	6/6	100%	10 J	240	67	34	na
	µg/kg dw	2.0 - 3.0	4/6	67%	6.9	42	18	11	4.7 – 5.0
Total benzofluoranthenes	µg/kg dw	0 - 0.5	38/38	100%	62	2,300 J	410	190	na
	µg/kg dw	0.5 - 1.0	6/6	100%	35 J	500	150	86	na
	µg/kg dw	2.0 - 3.0	5/6	83%	7.2	81	29	16	5.0
Chrysene	µg/kg dw	0 - 0.5	38/38	100%	35	1,300	190	94	na
	µg/kg dw	0.5 - 1.0	6/6	100%	10 J	210	71	44	na
	µg/kg dw	2.0 - 3.0	5/6	83%	4.8	47	16	7.3	5.0
Dibenzo(a,h)anthracene	µg/kg dw	0 - 0.5	8/38	21%	5.0 J	64 J	26	12	4.8 – 220
	µg/kg dw	0.5 - 1.0	2/6	33%	12	12	12	12	4.7 – 9.8
Dibenzofuran	µg/kg dw	0 - 0.5	26/38	68%	4.9	210	44	23	4.8 – 220
	µg/kg dw	0.5 - 1.0	3/6	50%	9.0	110	46	19	4.7 – 9.8
	µg/kg dw	2.0 - 3.0	1/6	17%	9.2	9.2	9.2	9.2	4.7 – 5.0
Fluoranthene	µg/kg dw	0 - 0.5	38/38	100%	42	1,400 J	230	120	na
	µg/kg dw	0.5 - 1.0	6/6	100%	10 J	510	140	73	na
	µg/kg dw	2.0 - 3.0	6/6	100%	6.0	79	24	14	na
Fluorene	µg/kg dw	0 - 0.5	14/38	37%	5.4	97	30	27	4.8 – 220
	µg/kg dw	0.5 - 1.0	3/6	50%	6.2	48	21	8.8	4.7 – 9.8
	µg/kg dw	2.0 - 3.0	1/6	17%	11	11	11	11	4.7 – 5.0

Table 5-5. Constituent Concentrations Detected in the Phase 1 Wetland Soil Samples, Including the Ditch Soil Samples

Constituent	Unit	Depth Interval (ft bgs)	Detection Frequency		Detected Concentrations				RL or Range of RLs if Not Detected
			Ratio	%	Minimum	Maximum	Mean	Median	
Indeno(1,2,3-cd)pyrene	µg/kg dw	0 - 0.5	37/38	97%	9.3	540	69	31	72
	µg/kg dw	0.5 - 1.0	6/6	100%	6.1	59 J	21	15	na
	µg/kg dw	2.0 - 3.0	1/6	17%	10	10	10	10	4.7 – 5.0
Naphthalene	µg/kg dw	0 - 0.5	38/38	100%	5.0	560	120	71	na
	µg/kg dw	0.5 - 1.0	5/6	83%	9.0	360	100	59	5.0
	µg/kg dw	2.0 - 3.0	4/6	67%	5.4	15	9.5	8.8	4.7 – 5.0
Phenanthrene	µg/kg dw	0 - 0.5	38/38	100%	22	1,000	180	91	na
	µg/kg dw	0.5 - 1.0	6/6	100%	5.4 J	490	120	47	na
	µg/kg dw	2.0 - 3.0	5/6	83%	4.8	29	13	12	5.0
Pyrene	µg/kg dw	0 - 0.5	38/38	100%	45	1,600 J	310	120	na
	µg/kg dw	0.5 - 1.0	6/6	100%	16 J	620	150	80	na
	µg/kg dw	2.0 - 3.0	6/6	100%	5.3	64	20	13	na
Total HPAHs	µg/kg dw	0 - 0.5	38/38	100%	263	7,500 J	1,600	720	na
	µg/kg dw	0.5 - 1.0	6/6	100%	101 J	2,220 J	650	360	na
	µg/kg dw	2.0 - 3.0	6/6	100%	12.5	378	100	55	na
Total LPAHs	µg/kg dw	0 - 0.5	38/38	100%	33	1,600 JN	420	220	na
	µg/kg dw	0.5 - 1.0	6/6	100%	5.4 J	1,180	280	110	na
	µg/kg dw	2.0 - 3.0	5/6	83%	4.8	98	38	26	5.0
total cPAHs	µg/kg dw	0 - 0.5	38/38	100%	38	1,130 J	210	100	na
	µg/kg dw	0.5 - 1.0	6/6	100%	13.7 J	180 J	66	48	na
	µg/kg dw	2.0 - 3.0	5/6	83%	4.8	56	17	7.8	4.5
Total PAHs	µg/kg dw	0 - 0.5	38/38	100%	296	8,400 J	2,000	920	na
	µg/kg dw	0.5 - 1.0	6/6	100%	107 J	3,400 J	930	480	na
	µg/kg dw	2.0 - 3.0	6/6	100%	12.5	427	130	87	na
Phthalates									
Bis(2-ethylhexyl)phthalate	µg/kg dw	0 - 0.5	10/10	100%	22	9,100	1,000	79	na
	µg/kg dw	0.5 - 1.0	4/4	100%	14 J	180	88	80	na
	µg/kg dw	2.0 - 3.0	1/4	25%	22	22	22	22	20

Table 5-5. Constituent Concentrations Detected in the Phase 1 Wetland Soil Samples, Including the Ditch Soil Samples

Constituent	Unit	Depth Interval (ft bgs)	Detection Frequency		Detected Concentrations				RL or Range of RLs if Not Detected
			Ratio	%	Minimum	Maximum	Mean	Median	
Butyl benzyl phthalate	µg/kg dw	0.5 - 1.0	1/4	25%	86	86	86	86	20
Di-n-butyl phthalate	µg/kg dw	0 - 0.5	3/10	30%	59	2,400	850	100	20 – 88
	µg/kg dw	0.5 - 1.0	2/4	50%	22	56	39	39	20
	µg/kg dw	2.0 - 3.0	1/4	25%	31	31	31	31	20
Other SVOCs									
1,4-Dichlorobenzene	µg/kg dw	0 - 0.5	2/38	5%	2.3 J	19 J	11	11	1.5 – 7.7
4-Methylphenol	µg/kg dw	0 - 0.5	4/10	40%	25	190	110	110	20 – 1,000
	µg/kg dw	0.5 - 1.0	2/4	50%	17 J	49	33	33	20
	µg/kg dw	2.0 - 3.0	1/4	25%	31	31	31	31	20
Benzoic acid	µg/kg dw	0 - 0.5	8/10	80%	250	28,000	3,900	500	590 – 880
	µg/kg dw	0.5 - 1.0	4/4	100%	120 J	1,400	480	200	na
	µg/kg dw	2.0 - 3.0	2/4	50%	120 J	280	200	200	200
Benzyl alcohol	µg/kg dw	0 - 0.5	5/10	50%	15 J	2,100	470	34	20 – 99
	µg/kg dw	0.5 - 1.0	2/4	50%	39	180	110	110	20
Carbazole	µg/kg dw	0 - 0.5	4/10	40%	12 J	66 J	41	44	20 – 1,000
	µg/kg dw	0.5 - 1.0	1/4	25%	13 J	13 J	13	13	20
Pentachlorophenol	µg/kg dw	0 - 0.5	1/10	10%	80 J	80 J	80	80	98 – 5,200
Phenol	µg/kg dw	0 - 0.5	3/10	30%	53	64 J	58	56	20 – 1,000
PCBs									
Aroclor-1260	µg/kg dw	0 - 0.5	25/38	66%	35	1,800	420	120	32 – 160
	µg/kg dw	0.5 - 1.0	3/6	50%	64	170	100	66	32 – 33
Total PCBs	µg/kg dw	0 - 0.5	25/38	66%	35	1,800	420	120	32 – 990
	µg/kg dw	0.5 - 1.0	3/6	50%	64	170	100	66	32 – 33
Pesticides									
2,4'-DDD	µg/kg dw	0 - 0.5	27/38	71%	5.6 JN	2,300	310	59	2.0 – 50
	µg/kg dw	0.5 - 1.0	4/6	67%	6.4	63	29	23	2.0
	µg/kg dw	2.0 - 3.0	1/6	17%	2.2	2.2	2.2	2.2	1.9 – 2.0
2,4'-DDE	µg/kg dw	0 - 0.5	3/38	8%	4.5 J	370	130	8.7	2.0 – 390

Table 5-5. Constituent Concentrations Detected in the Phase 1 Wetland Soil Samples, Including the Ditch Soil Samples

Constituent	Unit	Depth Interval (ft bgs)	Detection Frequency		Detected Concentrations				RL or Range of RLs if Not Detected
			Ratio	%	Minimum	Maximum	Mean	Median	
2,4'-DDT	µg/kg dw	0 - 0.5	16/38	42%	14 J	11,000	800	47	2.0 – 160
4,4'-DDD	µg/kg dw	0 - 0.5	35/38	92%	2.4 J	5,100	480	120	2.5 – 130
	µg/kg dw	0.5 - 1.0	6/6	100%	2.6	140	48	15	na
	µg/kg dw	2.0 - 3.0	3/6	50%	2.4 J	4.6	3.2	2.6	1.9 – 2.0
4,4'-DDE	µg/kg dw	0 - 0.5	27/38	71%	13	2,700	310	60	2.4 – 160
	µg/kg dw	0.5 - 1.0	4/6	67%	3.9	19	11	11	2.0 – 20
	µg/kg dw	2.0 - 3.0	1/6	17%	4.0	4.0	4.0	4.0	1.9 – 2.0
4,4'-DDT	µg/kg dw	0 - 0.5	27/38	71%	2.7 J	27,000	1,300	50	4.9 – 160
	µg/kg dw	0.5 - 1.0	1/6	17%	7.0	7.0	7.0	7.0	2.0 – 20
Total DDTs	µg/kg dw	0 - 0.5	37/38	97%	2.7 J	46,000	2,200	270	130
	µg/kg dw	0.5 - 1.0	6/6	100%	13	200	75	28	na
	µg/kg dw	2.0 - 3.0	4/6	67%	2.4 J	6.8	4.0	3.3	1.9 – 2.0
VOCs									
1,2,4-Trimethylbenzene	µg/kg dw	0 - 0.5	3/38	8%	3.6 J	9.2	7.2	8.7	1.5 – 7.7
Acetone	µg/kg dw	0 - 0.5	38/38	100%	120 JN	2,300	590	460	na
	µg/kg dw	0.5 - 1.0	6/6	100%	76	410	180	100	na
	µg/kg dw	2.0 - 3.0	6/6	100%	21	210	91	71	na
Benzene	µg/kg dw	0 - 0.5	22/38	58%	1.8	56	10	5.4	1.6 – 7.7
	µg/kg dw	0.5 - 1.0	3/6	50%	3.2	12	8.4	10	1.6 – 2.0
	µg/kg dw	2.0 - 3.0	5/6	83%	1.7	2.5	2.1	1.9	1.8
Carbon disulfide	µg/kg dw	0 - 0.5	3/38	8%	3.9	7.5	5.7	5.6	1.5 – 7.7
cis-1,2-Dichloroethene	µg/kg dw	0 - 0.5	3/38	8%	1.9	9.7	4.8	2.7	1.5 – 7.7
	µg/kg dw	0.5 - 1.0	1/6	17%	4.9	4.9	4.9	4.9	1.6 – 2.7
p-Cymene	µg/kg dw	0 - 0.5	3/38	8%	3.4 J	72 J	28	8.2	1.5 – 7.7
Dichloromethane	µg/kg dw	0 - 0.5	2/38	5%	4.1	5.3	4.7	4.7	3.0 – 15
	µg/kg dw	0.5 - 1.0	2/6	33%	4.4	4.6	4.5	4.5	3.1 – 5.4
	µg/kg dw	2.0 - 3.0	1/6	17%	4.1	4.1	4.1	4.1	3.2 – 3.8

Table 5-5. Constituent Concentrations Detected in the Phase 1 Wetland Soil Samples, Including the Ditch Soil Samples

Constituent	Unit	Depth Interval (ft bgs)	Detection Frequency		Detected Concentrations				RL or Range of RLs if Not Detected
			Ratio	%	Minimum	Maximum	Mean	Median	
Ethylbenzene	µg/kg dw	0 - 0.5	1/38	3%	3.0	3.0	3.0	3.0	1.5 – 7.7
	µg/kg dw	0.5 - 1.0	1/6	17%	3.4	3.4	3.4	3.4	1.6 – 2.0
Methyl ethyl ketone	µg/kg dw	0 - 0.5	38/38	100%	12	260	64	45	na
	µg/kg dw	0.5 - 1.0	4/6	67%	9.7	60	29	23	9.0 – 9.2
	µg/kg dw	2.0 - 3.0	3/6	50%	13	30	21	19	7.9 – 8.9
Methyl isobutyl ketone	µg/kg dw	0 - 0.5	1/38	3%	15	15	15	15	7.5 – 39
	µg/kg dw	0.5 - 1.0	1/6	17%	16	16	16	16	7.8 – 10
tert-Butyl methyl ether	µg/kg dw	2.0 - 3.0	1/6	17%	2.1	2.1	2.1	2.1	1.5 – 1.9
Tetrachloroethene	µg/kg dw	0 - 0.5	2/38	5%	5.1	30	18	18	1.5 – 7.7
Toluene	µg/kg dw	0 - 0.5	33/38	87%	1.8	68	13	9.6	1.6 – 7.0
	µg/kg dw	0.5 - 1.0	3/6	50%	3.2	65	25	6.3	1.6 – 2.0
	µg/kg dw	2.0 - 3.0	3/6	50%	1.6	1.9	1.8	1.8	1.5 – 1.9
Trichloroethene	µg/kg dw	0 - 0.5	2/38	5%	2.4	4.7	3.6	3.6	1.5 – 7.7
	µg/kg dw	0.5 - 1.0	1/6	17%	2.8	2.8	2.8	2.8	1.6 – 2.0
o-Xylene	µg/kg dw	0 - 0.5	1/38	3%	5.2	5.2	5.2	5.2	1.5 – 7.7
	µg/kg dw	0.5 - 1.0	1/6	17%	4.4	4.4	4.4	4.4	1.6 – 2.0
m,p-Xylene	µg/kg dw	0 - 0.5	5/38	13%	2.0 J	6.3	3.2	2.7	1.5 – 7.7
	µg/kg dw	0.5 - 1.0	1/6	17%	11	11	11	11	1.6 – 2.0
Total xylenes	µg/kg dw	0 - 0.5	5/38	13%	2.0 J	11.5	4.2	2.7	1.5 – 7.7
	µg/kg dw	0.5 - 1.0	1/6	17%	15	15	15	15	1.6 – 2.0
Petroleum									
TPH – gasoline range	mg/kg dw	0 - 0.5	2/38	5%	19	20	20	20	9.4 – 58
TPH – diesel range	mg/kg dw	0 - 0.5	37/38	97%	8.4	1,600	280	64	10
	mg/kg dw	0.5 - 1.0	5/6	83%	11	360	98	42	8.3
	mg/kg dw	2.0 - 3.0	1/6	17%	18	18	18	18	7.5 – 8.1
TPH – motor oil range	mg/kg dw	0 - 0.5	38/38	100%	42	5,200	930	310	na
	mg/kg dw	0.5 - 1.0	5/6	83%	34	1,100	320	110	17
	mg/kg dw	2.0 - 3.0	4/6	67%	19	52	29	23	15 – 16

Table 5-5. Constituent Concentrations Detected in the Phase 1 Wetland Soil Samples, Including the Ditch Soil Samples

Constituent	Unit	Depth Interval (ft bgs)	Detection Frequency		Detected Concentrations				RL or Range of RLs if Not Detected
			Ratio	%	Minimum	Maximum	Mean	Median	
Total petroleum hydrocarbons	mg/kg dw	0 - 0.5	38/38	100%	52	6,700	1,200	370	na
	mg/kg dw	0.5 - 1.0	5/6	83%	45	1,500	420	150	17
	mg/kg dw	2.0 - 3.0	4/6	67%	19	70	34	23	15 – 16
Conventionals									
Total organic carbon	% dw	0 - 0.5	38/38	100%	2.09	30.2	9.9	7.3	na
	% dw	0.5 - 1.0	6/6	100%	1.19	5.39	2.3	1.8	na
	% dw	2.0 - 3.0	6/6	100%	0.371	1.54	1.1	1.2	na
Total solids	% ww	0 - 0.5	38/38	100%	16.10	76.90	50	52	na
	% ww	0.5 - 1.0	6/6	100%	40.70	69.10	58	58	na
	% ww	2.0 - 3.0	6/6	100%	58.50	66.90	62	61	na

Note: Summary statistics are provided by location, not sample (i.e., duplicate samples were combined with the original sample, as described in Appendix D).

Note: All means/medians are reported to two significant figures.

cPAH – carcinogenic polycyclic aromatic hydrocarbon
dw – dry weight
J – estimated concentration
JN – tentative identification with estimated concentration
HPAH – high-molecular-weight polycyclic aromatic hydrocarbon
LPAH – low-molecular-weight polycyclic aromatic hydrocarbon
na – not applicable
PAH – polycyclic aromatic hydrocarbon
PCB – polychlorinated biphenyl
RL – reporting limit
SVOC – semivolatile organic compound
TPH – total petroleum hydrocarbon
VOC – volatile organic compound
ww – wet weight

Table 5-6. Comparison of Constituent Concentrations Detected in Phase 1 Wetland Soil and Ditch Samples to Screening Levels

Constituent	Unit	Depth Interval (ft bgs)	Detection Frequency		Ecological SL[a]				Residential Human Health SL[b]			
			Ratio	%	SL	No. Detects > SL	% Detects > SL	% Samples > SL	SL	No. Detects > SL	% Detects > SL	% Samples > SL
Metals												
Antimony	mg/kg dw	0 - 0.5	5/38	13%	0.27	5	100%	13%	3.1	0	0%	0%
Arsenic	mg/kg dw	0 - 0.5	38/38	100%	18	4	11%	11%	0.39	38	100%	100%
	mg/kg dw	0.5 - 1.0	6/6	100%	18	1	17%	17%	0.39	6	100%	100%
	mg/kg dw	2.0 - 3.0	6/6	100%	18	0	0%	0%	0.39	6	100%	100%
Barium	mg/kg dw	0 - 0.5	38/38	100%	330	1	3%	3%	1,600	0	0%	0%
	mg/kg dw	0.5 - 1.0	6/6	100%	330	0	0%	0%	1,600	0	0%	0%
	mg/kg dw	2.0 - 3.0	6/6	100%	330	0	0%	0%	1,600	0	0%	0%
Cadmium	mg/kg dw	0 - 0.5	35/38	92%	0.36	32	91%	84%	3.9	1	3%	3%
	mg/kg dw	0.5 - 1.0	5/6	83%	0.36	3	60%	50%	3.9	0	0%	0%
	mg/kg dw	2.0 - 3.0	3/6	50%	0.36	3	100%	50%	3.9	0	0%	0%
Chromium	mg/kg dw	0 - 0.5	38/38	100%	26	19	50%	50%	100,000	0	0%	0%
	mg/kg dw	0.5 - 1.0	6/6	100%	26	2	33%	33%	100,000	0	0%	0%
	mg/kg dw	2.0 - 3.0	6/6	100%	26	3	50%	50%	100,000	0	0%	0%
Cobalt	mg/kg dw	0 - 0.5	38/38	100%	13	6	16%	16%	900	0	0%	0%
	mg/kg dw	0.5 - 1.0	6/6	100%	13	0	0%	0%	900	0	0%	0%
	mg/kg dw	2.0 - 3.0	6/6	100%	13	1	17%	17%	900	0	0%	0%
Copper	mg/kg dw	0 - 0.5	38/38	100%	28	37	97%	97%	290	0	0%	0%
	mg/kg dw	0.5 - 1.0	6/6	100%	28	4	67%	67%	290	0	0%	0%
	mg/kg dw	2.0 - 3.0	6/6	100%	28	6	100%	100%	290	0	0%	0%
Lead	mg/kg dw	0 - 0.5	38/38	100%	11	38	100%	100%	3.0	38	100%	100%
	mg/kg dw	0.5 - 1.0	6/6	100%	11	6	100%	100%	3.0	6	100%	100%
	mg/kg dw	2.0 - 3.0	6/6	100%	11	4	67%	67%	3.0	6	100%	100%
Mercury	mg/kg dw	0 - 0.5	35/38	92%	0.1	21	60%	55%	2.3	0	0%	0%
	mg/kg dw	0.5 - 1.0	6/6	100%	0.1	3	50%	50%	2.3	0	0%	0%
	mg/kg dw	2.0 - 3.0	4/6	67%	0.1	1	25%	17%	2.3	0	0%	0%
Nickel	mg/kg dw	0 - 0.5	38/38	100%	38	2	5%	5%	160	0	0%	0%
	mg/kg dw	0.5 - 1.0	6/6	100%	38	0	0%	0%	160	0	0%	0%

Table 5-6. Comparison of Constituent Concentrations Detected in Phase 1 Wetland Soil and Ditch Samples to Screening Levels

Constituent	Unit	Depth Interval (ft bgs)	Detection Frequency		Ecological SL[a]				Residential Human Health SL[b]			
			Ratio	%	SL	No. Detects > SL	% Detects > SL	% Samples > SL	SL	No. Detects > SL	% Detects > SL	% Samples > SL
	mg/kg dw	2.0 - 3.0	6/6	100%	38	0	0%	0%	160	0	0%	0%
Vanadium	mg/kg dw	0 - 0.5	38/38	100%	7.8	38	100%	100%	39	37	97%	97%
	mg/kg dw	0.5 - 1.0	6/6	100%	7.8	6	100%	100%	39	6	100%	100%
	mg/kg dw	2.0 - 3.0	6/6	100%	7.8	6	100%	100%	39	6	100%	100%
Zinc	mg/kg dw	0 - 0.5	38/38	100%	50	38	100%	100%	2,300	0	0%	0%
	mg/kg dw	0.5 - 1.0	6/6	100%	50	6	100%	100%	2,300	0	0%	0%
	mg/kg dw	2.0 - 3.0	6/6	100%	50	6	100%	100%	2,300	0	0%	0%
PAHs												
Acenaphthene	µg/kg dw	0 - 0.5	10/38	26%	20,000	0	0%	0%	370,000	0	0%	0%
	µg/kg dw	0.5 - 1.0	1/6	17%	20,000	0	0%	0%	370,000	0	0%	0%
	µg/kg dw	2.0 - 3.0	1/6	17%	20,000	0	0%	0%	370,000	0	0%	0%
Anthracene	µg/kg dw	0 - 0.5	37/38	97%	nc	nc	nc	nc	2,200,000	0	0%	0%
	µg/kg dw	0.5 - 1.0	5/6	83%	nc	nc	nc	nc	2,200,000	0	0%	0%
	µg/kg dw	2.0 - 3.0	2/6	33%	nc	nc	nc	nc	2,200,000	0	0%	0%
Benzo(a)anthracene	µg/kg dw	0 - 0.5	37/38	97%	nc	nc	nc	nc	150	4	11%	11%
	µg/kg dw	0.5 - 1.0	6/6	100%	nc	nc	nc	nc	150	0	0%	0%
	µg/kg dw	2.0 - 3.0	2/6	33%	nc	nc	nc	nc	150	0	0%	0%
Benzo(a)pyrene	µg/kg dw	0 - 0.5	38/38	100%	130,000	0	0%	0%	15	38	100%	100%
	µg/kg dw	0.5 - 1.0	6/6	100%	130,000	0	0%	0%	15	4	67%	67%
	µg/kg dw	2.0 - 3.0	3/6	50%	130,000	0	0%	0%	15	1	33%	17%
Benzo(b)fluoranthene	µg/kg dw	0 - 0.5	38/38	100%	nc	nc	nc	nc	150	16	42%	42%
	µg/kg dw	0.5 - 1.0	6/6	100%	nc	nc	nc	nc	150	1	17%	17%
	µg/kg dw	2.0 - 3.0	5/6	83%	nc	nc	nc	nc	150	0	0%	0%
Benzo(k)fluoranthene	µg/kg dw	0 - 0.5	38/38	100%	nc	nc	nc	nc	1,500	0	0%	0%
	µg/kg dw	0.5 - 1.0	6/6	100%	nc	nc	nc	nc	1,500	0	0%	0%
	µg/kg dw	2.0 - 3.0	4/6	67%	nc	nc	nc	nc	1,500	0	0%	0%
Chrysene	µg/kg dw	0 - 0.5	38/38	100%	nc	nc	nc	nc	15,000	0	0%	0%
	µg/kg dw	0.5 - 1.0	6/6	100%	nc	nc	nc	nc	15,000	0	0%	0%

Table 5-6. Comparison of Constituent Concentrations Detected in Phase 1 Wetland Soil and Ditch Samples to Screening Levels

Constituent	Unit	Depth Interval (ft bgs)	Detection Frequency		Ecological SL[a]				Residential Human Health SL[b]			
			Ratio	%	SL	No. Detects > SL	% Detects > SL	% Samples > SL	SL	No. Detects > SL	% Detects > SL	% Samples > SL
	µg/kg dw	2.0 - 3.0	5/6	83%	nc	nc	nc	nc	15,000	0	0%	0%
Dibenzo(a,h)anthracene	µg/kg dw	0 - 0.5	8/38	21%	nc	nc	nc	nc	15	3	38%	8%
	µg/kg dw	0.5 - 1.0	2/6	33%	nc	nc	nc	nc	15	0	0%	0%
Dibenzofuran	µg/kg dw	0 - 0.5	26/38	68%	2	26	100%	68%	15,000	0	0%	0%
	µg/kg dw	0.5 - 1.0	3/6	50%	2	3	100%	50%	15,000	0	0%	0%
	µg/kg dw	2.0 - 3.0	1/6	17%	2	1	100%	17%	15,000	0	0%	0%
Fluoranthene	µg/kg dw	0 - 0.5	38/38	100%	nc	nc	nc	nc	230,000	0	0%	0%
	µg/kg dw	0.5 - 1.0	6/6	100%	nc	nc	nc	nc	230,000	0	0%	0%
	µg/kg dw	2.0 - 3.0	6/6	100%	nc	nc	nc	nc	230,000	0	0%	0%
Fluorene	µg/kg dw	0 - 0.5	14/38	37%	30,000	0	0%	0%	260,000	0	0%	0%
	µg/kg dw	0.5 - 1.0	3/6	50%	30,000	0	0%	0%	260,000	0	0%	0%
	µg/kg dw	2.0 - 3.0	1/6	17%	30,000	0	0%	0%	260,000	0	0%	0%
Indeno(1,2,3-cd)pyrene	µg/kg dw	0 - 0.5	37/38	97%	nc	nc	nc	nc	150	4	11%	11%
	µg/kg dw	0.5 - 1.0	6/6	100%	nc	nc	nc	nc	150	0	0%	0%
	µg/kg dw	2.0 - 3.0	1/6	17%	nc	nc	nc	nc	150	0	0%	0%
Naphthalene	µg/kg dw	0 - 0.5	38/38	100%	3,900,000	0	0%	0%	1,500	0	0%	0%
	µg/kg dw	0.5 - 1.0	5/6	83%	3,900,000	0	0%	0%	1,500	0	0%	0%
	µg/kg dw	2.0 - 3.0	4/6	67%	3,900,000	0	0%	0%	1,500	0	0%	0%
Pyrene	µg/kg dw	0 - 0.5	38/38	100%	nc	nc	nc	nc	230,000	0	0%	0%
	µg/kg dw	0.5 - 1.0	6/6	100%	nc	nc	nc	nc	230,000	0	0%	0%
	µg/kg dw	2.0 - 3.0	6/6	100%	nc	nc	nc	nc	230,000	0	0%	0%
Phthalates												
Bis(2-ethylhexyl)phthalate	µg/kg dw	0 - 0.5	10/10	100%	4,500	1	10%	10%	35,000	0	0%	0%
	µg/kg dw	0.5 - 1.0	4/4	100%	4,500	0	0%	0%	35,000	0	0%	0%
	µg/kg dw	2.0 - 3.0	1/4	25%	4,500	0	0%	0%	35,000	0	0%	0%
Butyl benzyl phthalate	µg/kg dw	0.5 - 1.0	1/4	25%	nc	nc	nc	nc	240,000	0	0%	0%
Di-n-butyl phthalate	µg/kg dw	0 - 0.5	3/10	30%	200,000	0	0%	0%	nc	nc	nc	nc
	µg/kg dw	0.5 - 1.0	2/4	50%	200,000	0	0%	0%	nc	nc	nc	nc

Table 5-6. Comparison of Constituent Concentrations Detected in Phase 1 Wetland Soil and Ditch Samples to Screening Levels

Constituent	Unit	Depth Interval (ft bgs)	Detection Frequency		Ecological SL[a]				Residential Human Health SL[b]			
			Ratio	%	SL	No. Detects > SL	% Detects > SL	% Samples > SL	SL	No. Detects > SL	% Detects > SL	% Samples > SL
	µg/kg dw	2.0 - 3.0	1/4	25%	200,000	0	0%	0%	nc	nc	nc	nc
Other SVOCs												
1,4-Dichlorobenzene	µg/kg dw	0 - 0.5	2/38	5%	20,000	0	0%	0%	540	0	0%	0%
4-Methylphenol	µg/kg dw	0 - 0.5	4/10	40%	nc	nc	nc	nc	31,000	0	0%	0%
	µg/kg dw	0.5 - 1.0	2/4	50%	nc	nc	nc	nc	31,000	0	0%	0%
	µg/kg dw	2.0 - 3.0	1/4	25%	nc	nc	nc	nc	31,000	0	0%	0%
Benzoic acid	µg/kg dw	0 - 0.5	8/10	80%	nc	nc	nc	nc	100,000,000	0	0%	0%
	µg/kg dw	0.5 - 1.0	4/4	100%	nc	nc	nc	nc	100,000,000	0	0%	0%
	µg/kg dw	2.0 - 3.0	2/4	50%	nc	nc	nc	nc	100,000,000	0	0%	0%
Benzyl alcohol	µg/kg dw	0 - 0.5	5/10	50%	nc	nc	nc	nc	1,800,000	0	0%	0%
	µg/kg dw	0.5 - 1.0	2/4	50%	nc	nc	nc	nc	1,800,000	0	0%	0%
Carbazole	µg/kg dw	0 - 0.5	4/10	40%	nc	nc	nc	nc	24,000	0	0%	0%
	µg/kg dw	0.5 - 1.0	1/4	25%	nc	nc	nc	nc	24,000	0	0%	0%
Pentachlorophenol	µg/kg dw	0 - 0.5	1/10	10%	3,000	0	0%	0%	3,000	0	0%	0%
Phenol	µg/kg dw	0 - 0.5	3/10	30%	30,000	0	0%	0%	1,800,000	0	0%	0%
PCBs												
Aroclor-1260	µg/kg dw	0 - 0.5	25/38	66%	nc	nc	nc	nc	220	10	40%	26%
	µg/kg dw	0.5 - 1.0	3/6	50%	nc	nc	nc	nc	220	0	0%	0%
Total PCBs	µg/kg dw	0 - 0.5	25/38	66%	4,000	0	0%	0%	220	10	40%	26%
	µg/kg dw	0.5 - 1.0	3/6	50%	4,000	0	0%	0%	220	0	0%	0%
Pesticides												
4,4'-DDD	µg/kg dw	0 - 0.5	35/38	92%	10	30	86%	79%	2,400	2	6%	5%
	µg/kg dw	0.5 - 1.0	6/6	100%	10	4	67%	67%	2,400	0	0%	0%
	µg/kg dw	2.0 - 3.0	3/6	50%	10	0	0%	0%	2,400	0	0%	0%
4,4'-DDE	µg/kg dw	0 - 0.5	27/38	71%	10	27	100%	71%	1,700	2	7%	5%
	µg/kg dw	0.5 - 1.0	4/6	67%	10	2	50%	33%	1,700	0	0%	0%
	µg/kg dw	2.0 - 3.0	1/6	17%	10	0	0%	0%	1,700	0	0%	0%
4,4'-DDT	µg/kg dw	0 - 0.5	27/38	71%	10	20	74%	53%	1,700	2	7%	5%

Table 5-6. Comparison of Constituent Concentrations Detected in Phase 1 Wetland Soil and Ditch Samples to Screening Levels

Constituent	Unit	Depth Interval (ft bgs)	Detection Frequency		Ecological SL[a]				Residential Human Health SL[b]			
			Ratio	%	SL	No. Detects > SL	% Detects > SL	% Samples > SL	SL	No. Detects > SL	% Detects > SL	% Samples > SL
	µg/kg dw	0.5 - 1.0	1/6	17%	10	0	0%	0%	1,700	0	0%	0%
Total DDTs [c]	µg/kg dw	0 - 0.5	37/38	97%	10	36	97%	95%	1,700	5	14%	13%
	µg/kg dw	0.5 - 1.0	6/6	100%	10	6	100%	100%	1,700	0	0%	0%
	µg/kg dw	2.0 - 3.0	4/6	67%	10	0	0%	0%	1,700	0	0%	0%
VOCs												
1,2,4-Trimethylbenzene	µg/kg dw	0 - 0.5	3/38	8%	nc	nc	nc	nc	5,200	0	0%	0%
Acetone	µg/kg dw	0 - 0.5	38/38	100%	1,300,000	0	0%	0%	1,400,000	0	0%	0%
	µg/kg dw	0.5 - 1.0	6/6	100%	1,300,000	0	0%	0%	1,400,000	0	0%	0%
	µg/kg dw	2.0 - 3.0	6/6	100%	1,300,000	0	0%	0%	1,400,000	0	0%	0%
Benzene	µg/kg dw	0 - 0.5	22/38	58%	3,300,000	0	0%	0%	52	1	5%	3%
	µg/kg dw	0.5 - 1.0	3/6	50%	3,300,000	0	0%	0%	52	0	0%	0%
	µg/kg dw	2.0 - 3.0	5/6	83%	3,300,000	0	0%	0%	52	0	0%	0%
Carbon disulfide	µg/kg dw	0 - 0.5	3/38	8%	nc	nc	nc	nc	720,000	0	0%	0%
cis-1,2-Dichloroethene	µg/kg dw	0 - 0.5	3/38	8%	nc	nc	nc	nc	400	0	0%	0%
	µg/kg dw	0.5 - 1.0	1/6	17%	nc	nc	nc	nc	400	0	0%	0%
Dichloromethane	µg/kg dw	0 - 0.5	2/38	5%	730,000	0	0%	0%	8,900	0	0%	0%
	µg/kg dw	0.5 - 1.0	2/6	33%	730,000	0	0%	0%	8,900	0	0%	0%
	µg/kg dw	2.0 - 3.0	1/6	17%	730,000	0	0%	0%	8,900	0	0%	0%
Ethylbenzene	µg/kg dw	0 - 0.5	1/38	3%	nc	nc	nc	nc	230,000	0	0%	0%
	µg/kg dw	0.5 - 1.0	1/6	17%	nc	nc	nc	nc	230,000	0	0%	0%
tert-Butyl methyl ether	µg/kg dw	2.0 - 3.0	1/6	17%	nc	nc	nc	nc	500	0	0%	0%
Tetrachloroethene	µg/kg dw	0 - 0.5	2/38	5%	nc	nc	nc	nc	37	0	0%	0%
Toluene	µg/kg dw	0 - 0.5	33/38	87%	200,000	0	0%	0%	520,000	0	0%	0%
	µg/kg dw	0.5 - 1.0	3/6	50%	200,000	0	0%	0%	520,000	0	0%	0%
	µg/kg dw	2.0 - 3.0	3/6	50%	200,000	0	0%	0%	520,000	0	0%	0%
Trichloroethene	µg/kg dw	0 - 0.5	2/38	5%	nc	nc	nc	nc	9.9	0	0%	0%
	µg/kg dw	0.5 - 1.0	1/6	17%	nc	nc	nc	nc	9.9	0	0%	0%
o-Xylene	µg/kg dw	0 - 0.5	1/38	3%	120,000	0	0%	0%	10,000	0	0%	0%

Table 5-6. Comparison of Constituent Concentrations Detected in Phase 1 Wetland Soil and Ditch Samples to Screening Levels

Constituent	Unit	Depth Interval (ft bgs)	Detection Frequency		Ecological SL[a]				Residential Human Health SL[b]			
			Ratio	%	SL	No. Detects > SL	% Detects > SL	% Samples > SL	SL	No. Detects > SL	% Detects > SL	% Samples > SL
	µg/kg dw	0.5 - 1.0	1/6	17%	120,000	0	0%	0%	10,000	0	0%	0%
m,p-Xylene	µg/kg dw	0 - 0.5	5/38	13%	120,000	0	0%	0%	10,000	0	0%	0%
	µg/kg dw	0.5 - 1.0	1/6	17%	120,000	0	0%	0%	10,000	0	0%	0%
Petroleum												
TPH – gasoline range	mg/kg dw	0 - 0.5	2/38	5%	nc	nc	nc	nc	110	0	0%	0%
TPH – diesel range	mg/kg dw	0 - 0.5	37/38	97%	nc	nc	nc	nc	23,000	0	0%	0%
	mg/kg dw	0.5 - 1.0	5/6	83%	nc	nc	nc	nc	23,000	0	0%	0%
	mg/kg dw	2.0 - 3.0	1/6	17%	nc	nc	nc	nc	23,000	0	0%	0%
TPH – motor oil range	mg/kg dw	0 - 0.5	38/38	100%	nc	nc	nc	nc	23,000	0	0%	0%
	mg/kg dw	0.5 - 1.0	5/6	83%	nc	nc	nc	nc	23,000	0	0%	0%
	mg/kg dw	2.0 - 3.0	4/6	67%	nc	nc	nc	nc	23,000	0	0%	0%

Note: Summary statistics are provided by location, not sample (i.e., duplicate samples were combined with the original sample, as described in Appendix D).

[a] The ecological screening level are based on relevant ecological thresholds protective of plants, invertebrates, birds, and mammals presented in EPA Eco SSLs (EPA 2005), ORNL (Efroymson et al. 1997a; 1997b), or DEQ SLVs (DEQ 2001).

[b] The human health screening level are the lowest of the EPA Region 6 residential SLs (EPA 2007a) or DEQ RBCs (soil ingestion, dermal contact, inhalation; volatilization to outdoor air; vapor intrusion to buildings; or leaching to groundwater) (DEQ 2007).

[c] The screening levels for 4,4'-DDT were applied to total DDTs.

cPAH – carcinogenic polycyclic aromatic hydrocarbon
dw – dry weight
HPAH – high-molecular-weight polycyclic aromatic hydrocarbon
LPAH – low-molecular-weight polycyclic aromatic hydrocarbon
na – not applicable
nc – no criteria
PAH – polycyclic aromatic hydrocarbon
PCB – polychlorinated biphenyl
RL – reporting limit
SL – screening level
SVOC – semivolatile organic compound
TPH – total petroleum hydrocarbon
VOC – volatile organic compound
ww – wet weight

5.3 Lake Sampling

Eleven surface sediment samples and three surface water samples were collected from Force Lake, and three surface sediment samples were collected from North Lake (Map 2). Surface sediment samples represented the top 4 inches of sediment.

5.3.1 Surface Water

Tables 5-7 and 5-8 present a summary of the laboratory analytical results for the three surface water samples collected from Force Lake. Constituent concentrations in water were compared to both human health (i.e., EPA human health ambient water quality criteria [AWQCs]) and ecological (i.e., EPA freshwater AWQCs and Tier II values) screening levels. Of the 142 constituents and constituent groups that were analyzed for in surface water samples, only four constituents (arsenic, barium, copper, and acetone) were detected at least once in the surface water samples. Of these constituents, concentrations of barium were greater than the ecological screening levels in all three samples, and concentrations of arsenic were greater than the human health screening levels in all three samples.

A complete summary of analytical results is provided in Appendix A. Total PCB, total DDT, total PAH, total TPH, arsenic, lead, and mercury concentrations are shown on Maps 10 to 16.

Table 5-7. Constituent Concentrations Detected in Phase 1 Surface Water Samples from Force Lake

Constituent	Fraction[a]	Unit	Detection Frequency		Detected Concentrations				RL or Range of RLs if Not Detected
			Ratio	%	Minimum	Maximum	Mean	Median	
Metals									
Arsenic	D	µg/L	3/3	100%	0.9	1.0	0.97	1.0	na
	T	µg/L	3/3	100%	1.1	1.2	1.2	1.2	na
Barium	D	µg/L	3/3	100%	26	28	27	26	na
	T	µg/L	3/3	100%	30	31	30	30	na
Copper	D	µg/L	1/3	33%	4	4	4.0	4.0	2
	T	µg/L	1/3	33%	6	6	6.0	6.0	2
VOCs									
Acetone	N	µg/L	3/3	100%	5.4	6.5	6.0	6.2	na

Note: Summary statistics are provided by location, not sample (i.e., duplicate samples were combined with the original sample, as described in Appendix D).

Note: All means and medians are reported to two significant figures.

[a] Fraction: D = dissolved; T = total; N = not applicable

na – not applicable RL – reporting limit VOC – volatile organic compound

Table 5-8. Comparison of Constituent Concentrations in Phase 1 Surface Water Samples in Force Lake to Screening Levels

Constituent	Fraction[a]	Unit	Detection Frequency		Ecological SL[b]				Human Health SLs[c]			
			Ratio	%	Screening Level	No. Results > SL	% Detects > SL	% Samples > SL	Screening Level	No. Results > SL	% Detects > SL	% Samples > SL
Metals												
Arsenic	D	µg/L	3/3	100%	150	0	0%	0%	0.018	3	100%	100%
	T	µg/L	3/3	100%	150	0	0%	0%	0.018	3	100%	100%
Barium	D	µg/L	3/3	100%	4	3	100%	100%	1,000	0	0%	0%
	T	µg/L	3/3	100%	4	3	100%	100%	1,000	0	0%	0%
Copper	D	µg/L	1/3	33%	9	0	0%	0%	1,300	0	0%	0%
	T	µg/L	1/3	33%	9	0	0%	0%	1,300	0	0%	0%

Note: Summary statistics are provided by location, not sample (i.e., duplicate samples were combined with the original sample, as described in Appendix D).

SL – screening level

[a] Fraction: D = dissolved; T = total

[b] The ecological screening levels are the lowest of EPA's freshwater AWQC (EPA 2006) or Tier II values (Suter and Tsao 1996).

[c] The human health screening levels are based on EPA human health AWQC values (EPA 2006), the lowest of water and organism or organism-only consumption.

5.4.2 Surface Sediment

Table 5-9 presents a summary of the laboratory analytical results for the 11 surface sediment samples collected from both Force Lake and for the 3 surface sediment samples collected from North Lake. Constituent concentrations in sediment were compared to both ecological (i.e., threshold effects concentrations for the protection of benthic invertebrates) and residential human health (i.e., EPA Region 6 screening levels and DEQ RBCs) screening levels (Table 5-10). The results are summarized below.

- **Force Lake**: Of the 163 constituents and constituent groups that were analyzed for in Force Lake sediment samples, only 49 individual constituents or constituent groups were detected at least once, and only 11 were detected at concentrations greater than the ecological screening levels and 3 were detected at concentrations greater than the residential human health screening levels in at least one sample.
- **North Lake**: Of the 163 constituents and constituent groups that were analyzed for in North Lake sediment samples, only 34 individual constituents or constituent groups were detected at least once, and only 5 were detected at concentrations greater than the ecological screening levels and 3 were detected at concentrations greater than the residential human health screening levels in at least one sample.

A complete summary of analytical results is provided in Appendix A. Total PCB, total DDT, total PAH, total TPH, arsenic, lead, and mercury concentrations are shown on Maps 10 through 16, respectively.

Concentrations of metals, PCBs, and pesticides were relatively consistent throughout Force Lake. Metals concentrations (e.g., arsenic, lead, and mercury) had little spatial variability (Maps 14 to 16, respectively). The highest total PCB and total DDT concentrations were detected in the middle portion of Force Lake, and samples towards the edge of the lake had the lowest concentrations (Maps 10 and 11). The spatial variation of PAH and TPH concentrations was slightly different. Total PAH concentrations were highest in samples SE-02 and SE-03 in the northern portion of Force Lake, and total TPH concentrations were highest in samples SE-03, SE-04, and SE-06 in the central western portion of Force Lake (Maps 12 and 13).

Detected concentrations of total PAHs, total TPHs, arsenic, and lead in the three sediment samples collected from North Lake were relatively similar (Maps 1, 13 to 15, respectively). Total PCBs and mercury were not detected in any sediment samples from North Lake (Maps 10 and 16). Total DDTs were detected at only one of the three samples collected from North Lake (Map 11). This detected concentration was lower than concentrations in Force Lake and was collected from the sampling location (SE-101) closest to the culverts that connect North Lake to Force Lake.

Table 5-9. Concentrations of Constituents Detected in Phase 1 Surface Sediment Samples in Force Lake and North Lake

Constituent	Unit	Location	Detection Frequency		Detected Concentrations				RL or Range of RLs if Not Detected
			Ratio	%	Minimum	Maximum	Mean	Median	
Metals									
Arsenic	mg/kg dw	Force Lake	11/11	100%	2.6	7	5.5	6.0	na
	mg/kg dw	North Lake	3/3	100%	3.2	5.0	4.0	3.8	na
Barium	mg/kg dw	Force Lake	11/11	100%	128	220	190	200	na
	mg/kg dw	North Lake	3/3	100%	124	208	170	190	na
Cadmium	mg/kg dw	Force Lake	8/11	73%	2	2	2.0	2.0	0.3 – 0.7
Chromium	mg/kg dw	Force Lake	11/11	100%	7.7	34	26	28	na
	mg/kg dw	North Lake	3/3	100%	17	30	24	24	na
Cobalt	mg/kg dw	Force Lake	11/11	100%	7.3	15	13	13	na
	mg/kg dw	North Lake	3/3	100%	10.3	12	11	11	na
Copper	mg/kg dw	Force Lake	11/11	100%	16.2	72	53	58	na
	mg/kg dw	North Lake	3/3	100%	49.0	71.4	60	60	na
Lead	mg/kg dw	Force Lake	11/11	100%	9	56	40	47	na
	mg/kg dw	North Lake	3/3	100%	13	18	15	15	na
Mercury	mg/kg dw	Force Lake	1/11	9%	0.2 J	0.2 J	0.20	0.20	0.06 – 0.3
Nickel	mg/kg dw	Force Lake	11/11	100%	11	31	24	26	na
	mg/kg dw	North Lake	3/3	100%	17	25	21	21	na
Vanadium	mg/kg dw	Force Lake	11/11	100%	32.7	74	60	62	na
	mg/kg dw	North Lake	3/3	100%	61.8	76	69	69	na
Zinc	mg/kg dw	Force Lake	11/11	100%	80	229	170	190	na
	mg/kg dw	North Lake	3/3	100%	99	119	110	110	na
PAHs									
2-Methylnaphthalene	µg/kg dw	Force Lake	7/11	64%	7.9	31	19	19	5.0 – 30
Acenaphthene	µg/kg dw	Force Lake	5/11	45%	5.0	11 JN	8.2	8.0	5.0 – 30
Acenaphthylene	µg/kg dw	Force Lake	3/11	27%	5.0	7.0	6.0	5.9	5.0 – 30
Anthracene	µg/kg dw	Force Lake	6/11	55%	5.9	26	14	13	5.0 – 30
Benzo(a)anthracene	µg/kg dw	Force Lake	11/11	100%	6.9	74	37	39	na
	µg/kg dw	North Lake	3/3	100%	32	35	33	33	na

Table 5-9. Concentrations of Constituents Detected in Phase 1 Surface Sediment Samples in Force Lake and North Lake

Constituent	Unit	Location	Detection Frequency		Detected Concentrations				RL or Range of RLs if Not Detected
			Ratio	%	Minimum	Maximum	Mean	Median	
Benzo(a)pyrene	µg/kg dw	Force Lake	11/11	100%	7.9	83	46	50	na
	µg/kg dw	North Lake	3/3	100%	30	38	34	33	na
Benzo(b)fluoranthene	µg/kg dw	Force Lake	11/11	100%	8.4	71	35	30	na
	µg/kg dw	North Lake	3/3	100%	36	71	51	47	na
Benzo(g,h,i)perylene	µg/kg dw	Force Lake	9/11	82%	14	71	34	32	5.0
	µg/kg dw	North Lake	1/3	33%	20	20	20	20	19 – 20
Benzo(k)fluoranthene	µg/kg dw	Force Lake	11/11	100%	8.4	71	35	30	na
	µg/kg dw	North Lake	2/3	67%	36	47	42	42	23
Total benzofluoranthenes	µg/kg dw	Force Lake	11/11	100%	16.8	142	71	60	na
	µg/kg dw	North Lake	3/3	100%	71	94	79	72	na
Chrysene	µg/kg dw	Force Lake	11/11	100%	9.4	110	59	64	na
	µg/kg dw	North Lake	3/3	100%	42	54	50	53	na
Dibenzo(a,h)anthracene	µg/kg dw	Force Lake	3/11	27%	5.4	6.5	6.1	6.4	5.0 – 30
Dibenzofuran	µg/kg dw	Force Lake	3/11	27%	5.0	7.4	6.1	6.0	5.0 – 30
Fluoranthene	µg/kg dw	Force Lake	11/11	100%	20	190	89	76	na
	µg/kg dw	North Lake	3/3	100%	61	96	84	94	na
Fluorene	µg/kg dw	Force Lake	6/11	55%	5.9	26	13	11	5.0 – 30
Indeno(1,2,3-cd)pyrene	µg/kg dw	Force Lake	9/11	82%	11	59	27	26	5.0
Naphthalene	µg/kg dw	Force Lake	11/11	100%	5.4	61	23	23	na
	µg/kg dw	North Lake	1/3	33%	21	21	21	21	20
Phenanthrene	µg/kg dw	Force Lake	11/11	100%	15	120	58	52	na
	µg/kg dw	North Lake	3/3	100%	34	58	46	45	na
Pyrene	µg/kg dw	Force Lake	11/11	100%	23	180	100	95	na
	µg/kg dw	North Lake	3/3	100%	69	110	88	84	na
Total cPAHs	µg/kg dw	Force Lake	11/11	100%	11.6	118	62	64	na
	µg/kg dw	North Lake	3/3	100%	46	55	51	51	na
Total HPAHs	µg/kg dw	Force Lake	11/11	100%	84	910	450	430	na
	µg/kg dw	North Lake	3/3	100%	306	411	370	400	na

Table 5-9. Concentrations of Constituents Detected in Phase 1 Surface Sediment Samples in Force Lake and North Lake

Constituent	Unit	Location	Detection Frequency		Detected Concentrations				RL or Range of RLs if Not Detected
			Ratio	%	Minimum	Maximum	Mean	Median	
Total LPAHs	µg/kg dw	Force Lake	11/11	100%	20	230	100	110	na
	µg/kg dw	North Lake	3/3	100%	34	79	53	45	na
Total PAHs	µg/kg dw	Force Lake	11/11	100%	104	1,060	560	520	na
	µg/kg dw	North Lake	3/3	100%	340	480	430	460	na
PCBs									
Aroclor-1254	µg/kg dw	Force Lake	7/11	64%	58	71	65	66	32 – 49
Aroclor-1260	µg/kg dw	Force Lake	7/11	64%	35	60	49	50	32 – 33
Total PCBs	µg/kg dw	Force Lake	7/11	64%	93	131	110	120	32 – 49
Pesticides									
2,4'-DDD	µg/kg dw	Force Lake	8/11	73%	8.6 JN	61 JN	40	42	4.8 – 25
4,4'-DDD	µg/kg dw	Force Lake	11/11	100%	11 J	47	37	42	na
	µg/kg dw	North Lake	1/3	33%	25 J	25 J	25	25	23 – 25
4,4'-DDE	µg/kg dw	Force Lake	11/11	100%	9.1	150	92	100	na
	µg/kg dw	North Lake	1/3	33%	26	26	26	26	23 – 25
Total DDTs [a]	µg/kg dw	Force Lake	11/11	100%	22 J	250	160	180	na
	µg/kg dw	North Lake	1/3	33%	51 J	51 J	51	51	23 – 25
VOCs									
Acetone	µg/kg dw	Force Lake	10/11	91%	78 JN	1,100	720	740	35
	µg/kg dw	North Lake	3/3	100%	200	320	270	290	na
Carbon disulfide	µg/kg dw	Force Lake	11/11	100%	4.9	140	40	24	na
	µg/kg dw	North Lake	3/3	100%	5.9	9.7	8.2	9.1	na
Methyl ethyl ketone	µg/kg dw	Force Lake	10/11	91%	9.4	140	85	89	5.3
	µg/kg dw	North Lake	3/3	100%	29	45	38	40	na
Toluene	µg/kg dw	Force Lake	3/11	27%	1.2	17	6.6	1.5	6.0 – 8.2
	µg/kg dw	North Lake	2/3	67%	3.2	10	6.6	6.6	3.8
Petroleum									
TPH – gasoline range	mg/kg dw	Force Lake	1/11	9%	31	31	31	31	7.7 – 80

Table 5-9. Concentrations of Constituents Detected in Phase 1 Surface Sediment Samples in Force Lake and North Lake

Constituent	Unit	Location	Detection Frequency		Detected Concentrations				RL or Range of RLs if Not Detected
			Ratio	%	Minimum	Maximum	Mean	Median	
TPH – diesel range	mg/kg dw	Force Lake	11/11	100%	16	270	98	92	na
	mg/kg dw	North Lake	3/3	100%	26 J	32	29	29	na
TPH – motor oil range	mg/kg dw	Force Lake	11/11	100%	130	2,000	760	760	na
	mg/kg dw	North Lake	3/3	100%	200	280	240	250	na
Total petroleum hydrocarbons	mg/kg dw	Force Lake	11/11	100%	150	2,300	870	840	na
	mg/kg dw	North Lake	3/3	100%	230	310	270	280	na
Grain size									
Fractional % phi >-1 (>2000 microns)	% dw	Force Lake	3/11	27%	0.4	1.7	1.0	0.90	0.1
	% dw	North Lake	2/3	67%	1.7	7.8	4.8	4.8	0.1
Fractional % phi -1-0 (1000-2000 microns)	% dw	Force Lake	10/11	91%	0.1	6.9	0.98	0.25	0.1
	% dw	North Lake	3/3	100%	0.1	5.5	2.2	1.1	na
Fractional % phi 0-1 (500-1000 microns)	% dw	Force Lake	11/11	100%	0.2	19.9	2.4	0.30	na
	% dw	North Lake	3/3	100%	0.1	7.9	4.0	3.9	na
Fractional % phi 1-2 (250-500 microns)	% dw	Force Lake	11/11	100%	0.2	37.2	5.4	0.60	na
	% dw	North Lake	3/3	100%	0.3	14.2	6.4	4.7	na
Fractional % phi 2-3 (125-250 microns)	% dw	Force Lake	11/11	100%	1.4	54.6	11	3.8	na
	% dw	North Lake	3/3	100%	2.2	20.3	10	7.4	na
Fractional % phi 3-4 (62.5-125 microns)	% dw	Force Lake	11/11	100%	4.8	21.7	13	14	na
	% dw	North Lake	3/3	100%	3.3	16.1	9.9	10	na
Fractional % phi 4-5 (31.2-62.5 microns)	% dw	Force Lake	10/10	100%	1.2	31.3	17	18	na
	% dw	North Lake	3/3	100%	7.1	30.3	21	27	na
Fractional % phi 5-6 (15.6-31.2 microns)	% dw	Force Lake	10/10	100%	2.5	33.2	25	27	na
	% dw	North Lake	3/3	100%	5.7	16.0	11	12	na
Fractional % phi 6-7 (7.8-15.6 microns)	% dw	Force Lake	10/10	100%	1.1	20.6	14	15	na
	% dw	North Lake	3/3	100%	3.7	14.6	9.0	8.6	na
Fractional % phi 7-8 (3.9-7.8 microns)	% dw	Force Lake	10/10	100%	1.0	13.6	9.5	9.6	na
	% dw	North Lake	3/3	100%	3.5	12.7	7.8	7.3	na
Fractional % phi 8-9 (1.95-3.9 microns)	% dw	Force Lake	10/10	100%	0.3	5.8	3.5	3.8	na

Table 5-9. Concentrations of Constituents Detected in Phase 1 Surface Sediment Samples in Force Lake and North Lake

Constituent	Unit	Location	Detection Frequency		Detected Concentrations				RL or Range of RLs if Not Detected
			Ratio	%	Minimum	Maximum	Mean	Median	
	% dw	North Lake	3/3	100%	2.0	5.3	3.6	3.6	na
Fractional % phi 9-10 (0.98-1.95 microns)	% dw	Force Lake	10/10	100%	0.2	2.8	1.7	1.8	na
	% dw	North Lake	3/3	100%	1.9	4.4	3.3	3.6	na
Fractional % phi 10+ (< 0.98 micron)	% dw	Force Lake	10/10	100%	0.7	6.7	4.3	4.6	na
	% dw	North Lake	3/3	100%	4.2	10.6	7.9	9.0	na
Total gravel	% dw	Force Lake	3/11	27%	0.4	1.7	1.0	0.90	0.1
	% dw	North Lake	2/3	67%	1.7	7.8	4.8	4.8	0.1
Total sand	% dw	Force Lake	11/11	100%	9.1	96.6	32	20	na
	% dw	North Lake	3/3	100%	6.0	64.0	33	28	na
Total silt	% dw	Force Lake	10/10	100%	5.8	81.1	65	72	na
	% dw	North Lake	3/3	100%	20.0	73.6	49	55	na
Total clay	% dw	Force Lake	10/10	100%	1.2	15.1	9.5	9.6	na
	% dw	North Lake	3/3	100%	8.1	20.3	15	16	na
Total fines (percent silt+clay)	% dw	Force Lake	11/11	100%	1.7	90.8	68	80	na
	% dw	North Lake	3/3	100%	28.1	93.9	64	71	na
Conventionals									
Total organic carbon	% dw	Force Lake	11/11	100%	1.34	13.1	7.1	6.7	na
	% dw	North Lake	3/3	100%	1.97	4.93	3.0	2.1	na
Total solids	% ww	Force Lake	11/11	100%	12.70	67.10	24	15	na
	% ww	North Lake	3/3	100%	27.10	36.60	32	32	na

Note: Summary statistics are provided by location, not sample (i.e., duplicate samples were combined with the original sample, as described in Appendix D).

Note: All means and medians are reported to two significant figures.

cPAH – carcinogenic polycyclic aromatic hydrocarbon
dw – dry weight
J – estimated concentration
JN – tentative identification with estimated concentration
HPAH – high-molecular-weight polycyclic aromatic hydrocarbon
LPAH – low-molecular-weight polycyclic aromatic hydrocarbon
na – not applicable
PAH – polycyclic aromatic hydrocarbon
PCB – polychlorinated biphenyl
RL – reporting limit
SVOC – semivolatile organic compound
TPH – total petroleum hydrocarbon
VOC – volatile organic compound
ww – wet weight

Table 5-10. Comparison of Constituent Concentrations in Phase 1 Surface Sediment Samples to Screening Levels

			Detection Frequency		Ecological SL[a]				Residential Human Health SL[b]			
Constituent	Unit (dw)	Location	Ratio	%	SL	No. Detects > SL	% Detects > SL	% Samples > SL	SL	No. Detects > SL	% Detects > SL	% Samples > SL
Metals												
Arsenic	mg/kg	Force Lake	11/11	100%	9.8	0	0%	0%	0.39	11	100%	100%
	mg/kg	North Lake	3/3	100%	9.8	0	0%	0%	0.39	3	100%	100%
Barium	mg/kg	Force Lake	11/11	100%	nc	nc	nc	nc	1,600	0	0%	0%
	mg/kg	North Lake	3/3	100%	nc	nc	nc	nc	1,600	0	0%	0%
Cadmium	mg/kg	Force Lake	8/11	73%	0.99	8	100%	73%	3.9	0	0%	0%
Chromium	mg/kg	Force Lake	11/11	100%	43	0	0%	0%	100,000	0	0%	0%
	mg/kg	North Lake	3/3	100%	43	0	0%	0%	100,000	0	0%	0%
Cobalt	mg/kg	Force Lake	11/11	100%	nc	nc	nc	nc	900	0	0%	0%
	mg/kg	North Lake	3/3	100%	nc	nc	nc	nc	900	0	0%	0%
Copper	mg/kg	Force Lake	11/11	100%	32	9	82%	82%	290	0	0%	0%
	mg/kg	North Lake	3/3	100%	32	3	100%	100%	290	0	0%	0%
Lead	mg/kg	Force Lake	11/11	100%	36	8	73%	73%	80	0	0%	0%
	mg/kg	North Lake	3/3	100%	36	0	0%	0%	80	0	0%	0%
Mercury	mg/kg	Force Lake	1/11	9%	0.18	1	100%	9%	2.3	0	0%	0%
Nickel	mg/kg	Force Lake	11/11	100%	23	8	73%	73%	160	0	0%	0%
	mg/kg	North Lake	3/3	100%	23	1	33%	33%	160	0	0%	0%
Vanadium	mg/kg	Force Lake	11/11	100%	nc	nc	nc	nc	39	10	91%	91%
	mg/kg	North Lake	3/3	100%	nc	nc	nc	nc	39	3	100%	100%
Zinc	mg/kg	Force Lake	11/11	100%	120	9	82%	82%	2,300	0	0%	0%
	mg/kg	North Lake	3/3	100%	120	0	0%	0%	2,300	0	0%	0%

Table 5-10. Comparison of Constituent Concentrations in Phase 1 Surface Sediment Samples to Screening Levels

Constituent	Unit (dw)	Location	Detection Frequency		Ecological SL[a]				Residential Human Health SL[b]			
			Ratio	%	SL	No. Detects > SL	% Detects > SL	% Samples > SL	SL	No. Detects > SL	% Detects > SL	% Samples > SL
PAHs												
Acenaphthene	µg/kg	Force Lake	5/11	45%	nc	nc	nc	nc	370,000	0	0%	0%
Anthracene	µg/kg	Force Lake	6/11	55%	57	0	0%	0%	2,200,000	0	0%	0%
Benzo(a)anthracene	µg/kg	Force Lake	11/11	100%	110	0	0%	0%	150	0	0%	0%
	µg/kg	North Lake	3/3	100%	110	0	0%	0%	150	0	0%	0%
Benzo(a)pyrene	µg/kg	Force Lake	11/11	100%	150	0	0%	0%	15	8	73%	73%
	µg/kg	North Lake	3/3	100%	150	0	0%	0%	15	3	100%	100%
Benzo(b)fluoranthene	µg/kg	Force Lake	11/11	100%	nc	nc	nc	nc	150	0	0%	0%
	µg/kg	North Lake	3/3	100%	nc	nc	nc	nc	150	0	0%	0%
Benzo(k)fluoranthene	µg/kg	Force Lake	11/11	100%	nc	nc	nc	nc	1,500	0	0%	0%
	µg/kg	North Lake	2/3	67%	nc	nc	nc	nc	1,500	0	0%	0%
Chrysene	µg/kg	Force Lake	11/11	100%	170	0	0%	0%	15,000	0	0%	0%
	µg/kg	North Lake	3/3	100%	170	0	0%	0%	15,000	0	0%	0%
Dibenzo(a,h)anthracene	µg/kg	Force Lake	3/11	27%	33	0	0%	0%	15	0	0%	0%
Dibenzofuran	µg/kg	Force Lake	3/11	27%	nc	nc	nc	nc	15,000	0	0%	0%
Fluoranthene	µg/kg	Force Lake	11/11	100%	420	0	0%	0%	230,000	0	0%	0%
	µg/kg	North Lake	3/3	100%	420	0	0%	0%	230,000	0	0%	0%
Fluorene	µg/kg	Force Lake	6/11	55%	77	0	0%	0%	260,000	0	0%	0%
Indeno(1,2,3-cd)pyrene	µg/kg	Force Lake	9/11	82%	nc	nc	nc	nc	150	0	0%	0%
Naphthalene	µg/kg	Force Lake	11/11	100%	180	0	0%	0%	12,000	0	0%	0%
	µg/kg	North Lake	1/3	33%	180	0	0%	0%	12,000	0	0%	0%
Phenanthrene	µg/kg	Force Lake	11/11	100%	200	0	0%	0%	nc	nc	nc	nc
	µg/kg	North Lake	3/3	100%	200	0	0%	0%	nc	nc	nc	nc

Table 5-10. Comparison of Constituent Concentrations in Phase 1 Surface Sediment Samples to Screening Levels

Constituent	Unit (dw)	Location	Detection Frequency		Ecological SL[a]				Residential Human Health SL[b]			
			Ratio	%	SL	No. Detects > SL	% Detects > SL	% Samples > SL	SL	No. Detects > SL	% Detects > SL	% Samples > SL
Pyrene	µg/kg	Force Lake	11/11	100%	200	0	0%	0%	230,000	0	0%	0%
	µg/kg	North Lake	3/3	100%	200	0	0%	0%	230,000	0	0%	0%
PCBs												
Aroclor-1254	µg/kg	Force Lake	7/11	64%	60	5	71%	45%	220	0	0%	0%
Aroclor-1260	µg/kg	Force Lake	7/11	64%	60	0	0%	0%	220	0	0%	0%
Total PCBs	µg/kg	Force Lake	7/11	64%	60	7	100%	64%	220	0	0%	0%
Pesticides												
4,4'-DDD	µg/kg	Force Lake	11/11	100%	4.9	11	100%	100%	2,400	0	0%	0%
	µg/kg	North Lake	1/3	33%	4.9	1	100%	33%	2,400	0	0%	0%
4,4'-DDE	µg/kg	Force Lake	11/11	100%	3.2	11	100%	100%	1,700	0	0%	0%
	µg/kg	North Lake	1/3	33%	3.2	1	100%	33%	1,700	0	0%	0%
Total DDTs[c]	µg/kg	Force Lake	11/11	100%	4.2	11	100%	100%	1,700	0	0%	0%
	µg/kg	North Lake	1/3	33%	4.2	1	100%	33%	1,700	0	0%	0%
VOCs												
Acetone	µg/kg	Force Lake	10/11	91%	nc	nc	nc	nc	1,400,000	0	0%	0%
	µg/kg	North Lake	3/3	100%	nc	nc	nc	nc	1,400,000	0	0%	0%
Carbon disulfide	µg/kg	Force Lake	11/11	100%	nc	nc	nc	nc	720,000	0	0%	0%
	µg/kg	North Lake	3/3	100%	nc	nc	nc	nc	720,000	0	0%	0%
Toluene	µg/kg	Force Lake	3/11	27%	nc	nc	nc	nc	520,000	0	0%	0%
	µg/kg	North Lake	2/3	67%	nc	nc	nc	nc	520,000	0	0%	0%
Petroleum												
TPH – gasoline range	mg/kg	Force Lake	1/11	9%	nc	nc	nc	nc	13,000	0	0%	0%
TPH – diesel range	mg/kg	Force Lake	11/11	100%	nc	nc	nc	nc	23,000	0	0%	0%

Table 5-10. Comparison of Constituent Concentrations in Phase 1 Surface Sediment Samples to Screening Levels

			Detection Frequency		Ecological SL[a]				Residential Human Health SL[b]			
Constituent	Unit (dw)	Location	Ratio	%	SL	No. Detects > SL	% Detects > SL	% Samples > SL	SL	No. Detects > SL	% Detects > SL	% Samples > SL
	mg/kg	North Lake	3/3	100%	nc	nc	nc	nc	23,000	0	0%	0%
TPH – motor oil range	mg/kg	Force Lake	11/11	100%	nc	nc	nc	nc	23,000	0	0%	0%
	mg/kg	North Lake	3/3	100%	nc	nc	nc	nc	23,000	0	0%	0%

Note: Summary statistics are provided by location, not sample (i.e., duplicate samples were combined with the original sample, as described in Appendix D).

[a] The ecological screening levels are based on the threshold effects concentrations for the protection of benthic invertebrates (MacDonald et al. 2000).

[b] The human health screening levels are the lowest of EPA Region 6 residential SLs (EPA 2007a) or DEQ RBCs (soil ingestion, dermal contact, or inhalation) (DEQ 2007).

[c] The screening levels for 4,4'-DDT were applied to total DDTs.

cPAH – carcinogenic polycyclic aromatic hydrocarbon
dw – dry weight
J – estimated concentration
JN – tentative identification with estimated concentration
HPAH – high-molecular-weight polycyclic aromatic hydrocarbon
LPAH – low-molecular-weight polycyclic aromatic hydrocarbon
na – not applicable
nc – no criteria
PAH – polycyclic aromatic hydrocarbon
PCB – polychlorinated biphenyl
RL – reporting limit
SVOC – semivolatile organic compound
TPH – total petroleum hydrocarbon
VOC – volatile organic compound

6.0 DATA GAPS

This section presents an analysis of the results of the Phase 1 sampling effort and the questions identified in the QAPP (Bridgewater et al. 2008a) to assess whether there are data gaps that should be addressed as part of a Phase 2 sampling event. Potential data gaps are discussed by media in the subsections below.

The following summarizes identified data gaps by media and recommended Phase 2 sampling activities:

Facility Soil – The lateral extent of impacts in soil needs to be further defined in four specific areas on the Facility. To fill this data gap, it is recommended that soil samples be collected on the Facility in the following areas:

1) Two locations between Phase 1 sampling locations SL-17 and SL-18 to further define the extent of impacts in the central portion of the Facility.
2) Two additional locations near monitoring well GA-30.
3) One location further to the northeast of the north corner of the new base oil plant.
4) Two locations near the Facility driveway exit.

The vertical extent of impacts in soil needs to be further defined in one area. To fill this data gap, it is recommended that two additional subsurface soil samples be collected from one location near monitoring well MW-2i to further define the vertical extent of impacts in this area. Constituent concentrations are higher in the lower (i.e., deep) subsurface sample than they are in the upper (i.e., intermediate) subsurface sample in this area.

Wetland Soil – The lateral extent of impacts in wetland soil needs to be further defined along the western and southwestern edge of the wetlands. To fill this data gap, it is recommended that surface soil samples be collected at four additional locations in this area. The vertical extent of impacts in wetland soil needs to be further defined in two areas where only surface soil samples were collected and constituent concentrations in those samples were high when compared to other wetland soil sampling locations. To fill this data gap, it is recommended that subsurface wetland soil samples be collected at two locations at Phase 1 sampling locations WS-11 and WS-25.

Groundwater – None, other than continued monthly monitoring of groundwater elevations and Force Lake elevations.

Lake Surface Water – No additional samples are proposed.

Lake Sediment – No additional samples are proposed.

Biota Tissue – No biota samples are proposed at this time. A field survey is proposed as part of Phase 2 to determine if shrew are present in the wetlands.

Map 17 shows the approximate proposed Phase 2 Facility soil sampling locations. Map 18 shows the approximate proposed Phase 2 wetland soil sampling locations. Table 6-1 summarizes recommended sampling depths and laboratory analyses.

Table 6-1. Proposed Phase 2 RI Sampling Areas, Number of Sampling Locations, Sample Depths, and Laboratory Analyses

				Laboratory Analyses						
Media	**Area**	**Number of Sampling Locations**	**Sample Depths (ft bgs)**	**PCBs**	**Organo-chlorine pesticides**	**PAHs**	**TPHs**	**As**	**Pb**	**VOCs**
Facility Soil	Central portion of the Facility, between sampling locations SL-17 and SL-18	2	Surface (1-2), 4-6, and 8-10	X	X	X	X	X	X	
	Near monitoring well GS-30	2	4-6	X			X	X	X	
	North corner of new base oil plant	1	4-6			X	X		X	X
	Facility driveway exit	2	Surface (1-2)		X	X	X		X	
	Near monitoring well MW-2i	1	16-18 and 20-22		X	X			X	
Wetland Soils	Western and southwestern boundary of wetlands	4	Surface (0-0.5)	X	X	X	X	X	X	
	Subsurface soil from WS-25 and WS-11	2	Subsurface (0.5-1 and 2-3)	X	X	X	X	X	X	

PAH – polycyclic aromatic hydrocarbon

PCB – polychlorinated biphenyl

TPH – total petroleum hydrocarbon

VOC – volatile organic compound

6.1 Facility Soil

The need for Phase 2 sampling of soils at the Facility was assessed based on a review of validated Phase 1 data and the questions posed in the QAPP (Bridgewater et al. 2008a), including:

- Are additional soil data needed to define the extent of impacts for purposes of estimating remedial quantities for the FS?
- Are additional subsurface soils data needed to determine the depth of impacts?
- Are additional soil data needed to refine the areas of localized impact (e.g., to determine if a release occurred from Tank 23)?
- Are additional soils data needed from the stockpile to characterize constituent concentrations for future management?

This section discusses the results of the Phase 1 sampling effort in relation to these questions.

6.1.1 Refinement of Extent of Impacts for Purposes of Estimating Remedial Quantities in Soil

During the Phase 1 sampling effort, surface soil samples were collected at 33 locations and subsurface soil samples were collected at 21 locations (Map 1). These Phase 1 Facility soil data were evaluated to identify areas where soil data are needed to further define the extent of impacts for purposes of estimating remedial quantities, if based on the risk assessment results, it is determined that such estimates are needed to support the FS.

The areas were identified by comparing constituent concentrations in Facility soil samples with industrial human health screening levels (i.e., EPA Region 6 industrial soil screening levels and DEQ RBCs). Table 6-2 lists the sampling locations and depth intervals where constituent concentrations exceed industrial human health screening levels. The spatial distribution of surface and subsurface soil concentrations was also evaluated to determine if these areas coincided with the areas of potential concern identified in the WP.

The following lists the identified areas and discusses whether additional sampling is recommended during Phase 2 to further define the extent of impacts.

- **Facility driveway entrance:** The highest total PCB concentration detected in Facility surface soil was detected at sampling location SL-12, in the Facility driveway entrance (Map 3). The lateral extent of PCB concentrations in surface soil in this area is generally bounded by the samples collected at locations SL-11 and SL-13, as well as the office/shop/warehouse building, which has been on the Facility since the 1950s and the Facility property boundary. For this reason, no sampling is recommended in this area during Phase 2.

- **Central portion of the Facility:** Surface and subsurface soils in this area contain total PCBs (Map 3), total DDTs (Map 4), total PAHs (Map 5), total TPH (Map 6), and certain metals (e.g., arsenic [Map 7] and lead [Map 8]) at concentrations that exceed industrial human health screening levels and background levels for metals. Areas of potential concern identified in the WP that are located in this area include the tank farm and used oil processing area, the former tanker truck cleaning operation, the former unlined holding pond, the current stormwater treatment system, the southern portion of the "C" shaped area, and the driveway. The lateral extent of this area is generally bounded by samples collected at locations SL-13 and SL-18 to the east and SL-05 and the historical sample collected by EPA (DP03) to the west. This area is also generally bounded to the west by the new base oil plant (where soils were removed as part of its construction), Tank 23 (discussed below), and by the Facility boundary to the south. Although the extent of this area is generally bounded, it may extend to the south towards the wetlands where the highest total DDT concentration was detected at WS-25 (46,000 µg/kg dw; wetland soil samples are discussed in Section 6.3). Thus, it is recommended that surface and subsurface soil samples be collected at two additional locations in the area between sampling locations SL-17 and SL-18 (Map 17); these samples would be analyzed for PCBs, organochlorine pesticides, PAHs, petroleum hydrocarbons, arsenic, and lead.
- **Tank 23:** The soil samples collected at location SL-29 indicate that lead is the only constituent that was detected above its industrial soil screening level and background level, and only in the surface soil sample collected beneath Tank 23. Additionally, constituent concentrations in samples collected at this location generally decrease with depth. No further sampling is recommended for Tank 23, based on the constituent concentrations detected at sampling location SL-29 and on access limitations.
- **Southwest corner of the Facility:** The benzo(a)pyrene concentration detected in the intermediate (i.e., upper) subsurface sample collected at SL-23 exceeds its industrial human health screening level. The gasoline-range petroleum hydrocarbon concentration detected in the intermediate subsurface soil sample collected at SL-22 exceeded its screening level. The source of the PAHs and gasoline-range petroleum hydrocarbons detected in this area is uncertain, given that it does not coincide with any of the potential areas of concern identified in the WP. This area was largely undeveloped until the 1980s, and thus the PAHs and gasoline-range petroleum hydrocarbons may be the result of fill placed in this area. Regardless, the extent of this area is generally bounded by the samples collected at SL-05 and the historical

sample collected by EPA (DP03) to east, the ditch and wetland samples collected to the west, as well as by the Facility property boundary to the south and the new base oil plant to the north. Thus, no further sampling is recommended in this area during Phase 2.

- **GA-30:** Soil samples were collected at location SL-24 to determine if the free product detected in monitoring well GA-30 is limited in extent. Given the arsenic, lead, total PCB, and gasoline-range petroleum hydrocarbon concentrations detected in the intermediate subsurface soil sample collected at SL-24, and the lack of any nearby soil samples in this area to bound the extent of impacts, it is recommended that intermediate subsurface soil samples be collected at two additional locations in this area (Map 17), and that these samples be analyzed for arsenic, lead, PCBs, and petroleum hydrocarbons.
- **North corner of the new base oil plant:** Soil samples were collected at locations SL-30 and SL-31 to determine the extent of the petroleum hydrocarbons detected in prior samples collected by EMRI in this area. The only constituent detected above an industrial screening level at location SL-30 was lead, which was detected above its screening level and background level only in the surface sample collected at this location. At SL-31, lead, benzo(a)pyrene, 1,2,4-trimethylbenzene, 1,3,5-trimethylbenzene, and gasoline-range petroleum hydrocarbons exceeded their industrial human health screening levels in the intermediate subsurface sample. Thus, it is recommended that one additional intermediate subsurface soil sample be collected further to the northeast to better define the extent of this area; the sample would be analyzed for lead, PAHs, VOCs, and petroleum hydrocarbons.
- **Facility driveway exit:** Lead, benzo(a)pyrene, total DDT, and gasoline-range petroleum hydrocarbon concentrations exceeded industrial screening levels in the surface soil sample collected at SL-19. Given the lack of any nearby soil samples to bound the extent of this area, it is recommended that surface soil samples be collected at two additional locations in this area (Map 17); the samples would be analyzed for lead, PAHs, organochlorine pesticides, and petroleum hydrocarbons.
- **Soil stockpile:** During Phase 1, the lateral extent of the soil stockpile was mapped with a GPS. As a result, it is possible to better estimate the volume of the stockpile for purposes of the FS. As will be discussed below, the sampling results for the soil stockpile are sufficient for the evaluation of future management options. No further sampling is recommended in this area during Phase 2.
- **Soil berm:** Nine soil samples (SB-01 through SB-09) were collected along the length of the soil berm. These sampling results, along with available information on the height and width of the soil berm, provide sufficient information for estimating remedial

quantities. Thus, no further sampling is recommended in this area during Phase 2.

- **Drainage ditch:** Four soil samples were collected along the portion of the drainage ditch that ran along the north side of the Facility. These sampling results, along with field observations of the depth of fill and depth to the bottom of the former ditch made during the Phase 1 investigation, provide sufficient information for estimating remedial quantities. Thus, no further sampling is recommended in this area during Phase 2.

Table 6-2. Locations with Constituent Concentrations in Facility Soil Greater than Industrial Human Health Screening Levels

			Metal		PAHs				PCBs	DDTs	VOCs										TPH
Depth Group	Location ID	Sample Depth (ft bgs)	Arsenic	Lead	Benzo(a) anthracene	Benzo(a)pyrene	Dibenzo(a,h) anthracene	Naphthalene	Total PCBs	Total DDTs (SL based on 4,4'-DDT)	1,2,4-Trimethylbenzene	1,3,5-Trimethylbenzene	Benzene	Chlorobenzene	cis-1,2-Dichloroethene	trans-1,2-Dichloroethene	Trichloroethene	Vinyl chloride	o-Xylene	m,p-Xylene	TPH - Gasoline range
Surface	MW-2s	1 – 2	X[a]	X[b]					X[a]	X[a]											
Surface	MW-4s	1 – 2	X[a]	X[b]		X[a]				X[a]											
Surface	SL-01	2 – 3	X[a]	X[b]																	
Surface	SL-02	2 – 3	X[a]	X[b]																	
Surface	SL-03	2 – 3	X[a]	X[a]																	
Surface	SL-04	2 – 3	X[a]	X[a]																	
Surface	SL-05	1 – 2	X[a]	X[a]																	
Surface	SL-06	2 – 3	X[a]	X[b]		X[a]			X[a]												
Surface	SL-07	2.5 – 3.5	X[a]	X[a]		X[a]															
Surface	SL-08	1.5 – 2.5	X[a]	X[a]		X[a]															X[a]
Surface	SL-09	1 – 2	X[a]	X[b]		X[a]			X[a]												X[a]
Surface	SL-10	0.5 – 1.5	X[a]	X[a]		X[a]		X[a]			X[a]	X[a]	X[a]		X[a]	X[a]	X[a]	X[a]			X[a]
Surface	SL-11	0.5 – 1.5																			
Surface	SL-12	0 – 1		X[b]					X[a]												
Surface	SL-13	3.5 – 5	X[a]	X[a]																	
Surface	SL-14	0 – 1	X[a]	X[b]		X[a]	X[a]		X[a]												X[a]
Surface	SL-15	1.5 – 2.5	X[a]	X[b]		X[a]			X[a]	X[a]											X[a]
Surface	SL-16	1.5 – 2.5	X[a]	X[b]		X[a]			X[a]	X[a]											X[a]
Surface	SL-17	1 – 2	X[a]	X[b]		X[a]			X[a]	X[a]											
Surface	SL-18	1 – 2		x																	
Surface	SL-19	2 – 3	X[a]	X[b]		X[a]				X[a]											X[a]
Surface	SL-20	1 – 2	X[b]	X[a]																	

Table 6-2. Locations with Constituent Concentrations in Facility Soil Greater than Industrial Human Health Screening Levels

			Metal		PAHs				PCBs	DDTs	VOCs										TPH
Depth Group	Location ID	Sample Depth (ft bgs)	Arsenic	Lead	Benzo(a) anthracene	Benzo(a)pyrene	Dibenzo(a,h) anthracene	Naphthalene	Total PCBs	Total DDTs (SL based on 4,4'-DDT)	1,2,4-Trimethylbenzene	1,3,5-Trimethylbenzene	Benzene	Chlorobenzene	cis-1,2-Dichloroethene	trans-1,2-Dichloroethene	Trichloroethene	Vinyl chloride	o-Xylene	m,p-Xylene	TPH - Gasoline range
Surface	SL-21	1.5 – 2.5		X[a]																	
Surface	SL-22	2 – 3	X[a]	X[b]																	
Surface	SL-23	2 – 3	X[a]	X[a]																	
Surface	SL-24	2 – 3	X[a]	X[b]																	
Surface	SL-25	1 – 2		X[b]		X[a]			X[a]												
Surface	SL-26	0 – 1		X[b]					X[a]												
Surface	SL-27	1 – 2		X[b]		X[a]		X[a]			X[a]	X[a]	X[a]						X[a]	X[a]	X[a]
Surface	SL-28	1 – 2	X[a]	X[b]		X[a]			X[a]												X[a]
Surface	SL-29	0 – 1.5	X[a]	X[b]																	
Surface	SL-30	0.5 – 1.5	X[a]	X[b]																	
Surface	SL-31	0.5 – 1.5	X[a]	X[a]																	
Intermediate	MW-2s	4 – 6	X[a]	X[b]		X[a]				X[a]											X[a]
Intermediate	MW-4s	4 – 6	X[a]	X[a]																	
Intermediate	SL-05	4 – 6	X[a]	X[a]																	
Intermediate	SL-06	5 – 7	X[a]	X[a]																	
Intermediate	SL-07	5 – 7	X[a]	X[a]														X[a]			
Intermediate	SL-08	4 – 6		X[a]																	
Intermediate	SL-09	3 – 4	X[a]	X[a]				X[a]					X[a]								X[a]
Intermediate	SL-09	5 – 7	X[a]	X[a]									X[a]								
Intermediate	SL-10	4 – 6	X[a]	X[a]		X[a]		X[a]				X[a]			X[a]						X[a]
Intermediate	SL-15	3 – 4		X[a]	X[a]	X[a]															X[a]
Intermediate	SL-20	4 – 6	X[a]	X[a]																	

Table 6-2. Locations with Constituent Concentrations in Facility Soil Greater than Industrial Human Health Screening Levels

			Metal		PAHs				PCBs	DDTs	VOCs										TPH
Depth Group	Location ID	Sample Depth (ft bgs)	Arsenic	Lead	Benzo(a) anthracene	Benzo(a)pyrene	Dibenzo(a,h) anthracene	Naphthalene	Total PCBs	Total DDTs (SL based on 4,4'-DDT)	1,2,4-Trimethylbenzene	1,3,5-Trimethylbenzene	Benzene	Chlorobenzene	cis-1,2-Dichloroethene	trans-1,2-Dichloroethene	Trichloroethene	Vinyl chloride	o-Xylene	m,p-Xylene	TPH - Gasoline range
Intermediate	SL-21	4 – 6	X[a]	X[a]									X[a]								
Intermediate	SL-22	4 – 6	X[a]	X[b]																	X[a]
Intermediate	SL-23	4.3 – 6.5	X[b]	X[b]		X[a]															
Intermediate	SL-24	4 – 6	X[b]	X[b]					X[a]												X[a]
Intermediate	SL-25	3 – 5		X[a]									X[a]	X[a]							X[a]
Intermediate	SL-26	4 – 6		X[a]																	
Intermediate	SL-27	4 – 6		X[a]									X[a]								X[a]
Intermediate	SL-28	4 – 6		X[a]																	
Intermediate	SL-29	5.5 – 8.5	X[a]	X[a]																	
Intermediate	SL-30	5 – 7	X[a]	X[a]																	
Intermediate	SL-31	5 – 7	X[a]	X[b]		X[a]					X[a]	X[a]									X[a]
Deep	MW-2i	14 – 15	X[a]	X[b]		X[a]				X[a]											
Deep	MW-2s	8 – 10		X[a]																	
Deep	MW-4s	8 – 10	X[a]	X[a]																	
Deep	SL-05	8 – 10	X[a]	X[a]																	
Deep	SL-06	8 – 10		X[a]																	
Deep	SL-07	8 – 10		X[a]														X[a]			
Deep	SL-08	8 – 10		X[a]																	
Deep	SL-09	8 – 10		X[a]																	
Deep	SL-10	8 – 10		X[a]																	
Deep	SL-20	8 – 10	X[a]	X[a]																	
Deep	SL-21	8 – 10	X[a]	X[a]																	

Table 6-2. Locations with Constituent Concentrations in Facility Soil Greater than Industrial Human Health Screening Levels

			Metal		PAHs				PCBs	DDTs	VOCs										TPH
Depth Group	Location ID	Sample Depth (ft bgs)	Arsenic	Lead	Benzo(a) anthracene	Benzo(a)pyrene	Dibenzo(a,h) anthracene	Naphthalene	Total PCBs	Total DDTs (SL based on 4,4'-DDT)	1,2,4-Trimethylbenzene	1,3,5-Trimethylbenzene	Benzene	Chlorobenzene	cis-1,2-Dichloroethene	trans-1,2-Dichloroethene	Trichloroethene	Vinyl chloride	o-Xylene	m,p-Xylene	TPH - Gasoline range
Deep	SL-22	8 – 10	X[a]	X[a]																	
Deep	SL-23	8 – 10	X[a]	X[a]																	
Deep	SL-24	8 – 10	X[a]	X[a]																	
Deep	SL-25	8 – 10	X[a]	X[a]																	
Deep	SL-26	8 – 10	X[a]	X[a]																	
Deep	SL-27	8 – 10	X[a]	X[a]																	
Deep	SL-28	8 – 10		X[a]									X[a]								
Deep	SL-29	11.5 – 14.5	X[a]	X[a]																	
Deep	SL-30	8 – 10	X[a]	X[a]																	
Deep	SL-31	8 – 10	X[a]	X[a]																	

PAH – polycyclic aromatic hydrocarbon

PCB – polychlorinated biphenyl

SL – screening level

TPH – total petroleum hydrocarbon

VOC – volatile organic compound

[a] Detected concentration greater than industrial Human Health screening level

[b] Detected concentration greater than background and Industrial Human Health screening level

6.1.2 Depth of Impacts

Maps 3 through 6 illustrate that for total PCBs, total DDT, total PAHs, and total TPH, respectively, constituent concentrations were low or were not detected in the deep subsurface soil samples collected during Phase 1. Maps 7, 8, and 9 illustrate that arsenic, lead and mercury concentrations generally decrease with depth or approach background levels in the lower (i.e., deep) subsurface soil samples. The one exception is at MW-2i near the south edge of the Facility where the concentration of total DDTs is higher in the deep subsurface sample than in the surface and intermediate subsurface samples, and where lead and benzo(a)pyrene concentrations exceed industrial human health screening levels and background levels at a depth of 14 to 15 ft bgs. For this reason, it is recommended that additional soil samples be collected at depths of 16 to 18 and 20 to 22 ft bgs near MW-2i; these samples would be analyzed for PAHs, organochlorine pesticides, and lead.

6.1.3 Characterization of stockpile for management

The final question is whether additional soils data are needed from the soil stockpile to characterize constituent concentrations for future management. The three soil samples collected from the soil stockpile provide sufficient information to characterize the soil stockpile for future management decisions.

6.2 Groundwater

The need for Phase 2 sampling of groundwater at the Facility was assessed based on a review of validated Phase 1 data and the questions posed in the QAPP (Bridgewater et al. 2008a), including:

- Are additional groundwater data needed to characterize the vertical or lateral extent of constituent migration off the Harbor Oil Facility?
- Are additional groundwater data needed to characterize the extent of Facility-related constituents detected in groundwater migrating vertically to the deep groundwater zone?
- Are additional groundwater data needed to determine if constituents are migrating onto the Harbor Oil Facility from upgradient sources?

This section discusses the results of the Phase 1 sampling effort in relation to these questions.

6.2.1 Characterization of Vertical or Lateral Off-Site Migration

The Phase 1 groundwater sampling results do not indicate that constituents have migrated from the shallow zone to the intermediate zone. Concentrations of metals in the intermediate zone are similar to or lower than those detected in the shallow zone (Table 5-3). For organic contaminants, there also appears to be no migration from the shallow zone to the intermediate zone. No PAHs or petroleum hydrocarbons were detected in the intermediate zone. With the exception of acetone (likely associated with laboratory cross-contamination), no VOCs were detected in the intermediate zone. The one exception is the detection of 2,4'-DDD and 4,4'-DDD in one of the three intermediate-depth wells (MW-2i). DDTs are relatively insoluble and immobile. In addition, the groundwater elevation measurements that have been made thus far indicate that there is an *upward* gradient from the intermediate to the shallow zone at this location. Those factors both strongly suggest that the presence of DDD in the intermediate zone reflects a problem with the integrity of deep well B-4 which was installed sometime prior to 1990, not migration of DDD from the shallow zone. In any event, the concentrations of DDD detected in MW-2i are below its human health screening level (Table 5-3), and no further investigation is recommended during Phase 2.

Facility groundwater data are sufficient to characterize migration of constituents in shallow groundwater to off-Facility areas (e.g., to the wetlands and Force Lake). Groundwater samples collected at the four shallow monitoring wells located along the south side of the Facility define the concentrations of constituents migrating off the Facility. Groundwater samples collected to characterize the shallow groundwater zone and Force Lake, along with the slug test results for shallow zone wells, will be sufficient to estimate the volume of shallow groundwater flowing off the Facility and the associated constituent mass flux, once additional monthly measurements of shallow zone and Force Lake elevations are made. Additional measurements are needed to determine how and if the magnitude of the shallow groundwater gradient changes between the wet and dry seasons.

6.2.2 Characterization of Vertical Migration to the Deep Groundwater Zone

The Phase 1 groundwater sampling results do not indicate that constituents have migrated from the shallow zone through the intermediate zone to the deep zone. Groundwater samples collected from the three intermediate zone wells and two deep zone wells sampled during Phase 1 were analyzed for a broad suite of parameters and constituents, including conventional parameters, PCBs, organochlorine pesticides, metals, petroleum hydrocarbons, PAHs, and VOCs (see Table 4-1). Table 5-3 lists the constituents that were detected in these groundwater samples. Metals concentrations in the intermediate and deep zones are similar to or lower than those detected in the shallow zone. More importantly, no PAHs or petroleum hydrocarbons were detected in either the intermediate or deep zones. Acetone was detected in one intermediate well (MW-4i) and one deep well (B-4). As was discussed above, the acetone detected in groundwater samples collected from these wells appears to be due the laboratory cross-contamination. Tetrachloroethene was detected in the plant well groundwater sample, but not in any of the other shallow, intermediate, or deep groundwater samples. These results strongly support the conclusion that the tetrachloroethene detected in the plant well is due to off-Facility sources as discussed in Section 3.2.2 of the WP; the James River Corp. well located northwest of the Facility contained 20 µg/L of tetrachloroethene when it was sampled in 1989 or 1990. Both 2,2'-DDD and 4,4'-DDD were detected in one deep well (B-4) at concentrations lower than those detected in nearby intermediate well MW-2i. As was discussed above, DDTs are relatively insoluble and immobile. In addition, the groundwater elevation measurements that have been made thus far indicate that there is an *upward* gradient from the deep zone to the intermediate zone and from the intermediate zone to the shallow zone at this location. Those factors both strongly suggest that the presence of DDD in the deep zone reflects a problem with the integrity of well B-4, not migration of DDD from the shallow zone through the intermediate zone to the deep zone. In any event, the concentrations of DDD detected in deep well B-4 are below human health screening levels (Table 5-3), and no further investigation is recommended during Phase 2.

6.2.3 Characterization of On-Site Migration from Up-Gradient Sources

Section 3.2.2 of the WP discussed potential up-gradient sources, including several potential sources located to the north of the Site where shallow groundwater underlying these potential sources flows toward and onto the Facility. These potential sources include the former Farmer's Plant Aide facility, Peninsula Terminal Railroad, Stockyards, and Star Oil. The potential for the migration of contaminants from up-gradient sources via the shallow groundwater pathway is sufficiently characterized for the shallow groundwater zone. Total PCBs, total DDT, total PAH, and total TPH concentrations were below detection limits in both upgradient shallow wells MW-3s and GA-34. Concentrations of metals were comparable to those detected elsewhere in shallow zone groundwater on the Facility. Three VOCs (chlorobenzene, acetone, and benzene) were detected in GA-34 and one VOC (tert-butyl methyl ether) was detected in MW-3s. Although chlorobenzene was detected in three other shallow monitoring wells on the Facility, the concentration detected at monitoring well GA-34 is substantially higher than it is anywhere else on the Facility suggesting the potential for this VOC to be migrating onto the Facility from up-gradient sources. This may also explain the presence of acetone and benzene at this location. As was discussed in Section 3.2.2.5 of the WP, solvents including acetone were transloaded on the Peninsula Terminal Railroad facility and benzene was detected in soil samples collected during an investigation of that facility. It is also possible that the acetone detected at GA-34 is due to laboratory cross-contamination. Upgradient sources may also explain the presence of tert-butyl methyl ether in monitoring well MW-3s. This constituent was not reported to have been detected on the Peninsula Terminal Railroad facility, but could have been associated with the documented releases on that facility or potential releases at other upgradient sources. At this time, no further characterization of migration from up-gradient sources is recommended during Phase 2.

6.3 Wetland Soil

The need for Phase 2 sampling of soil in adjacent wetlands was assessed based on a review of validated Phase 1 data and the questions posed in the QAPP (Bridgewater et al. 2008a), including:

- Are additional wetland soil data needed to refine the areas of localized impact?
- Are additional subsurface soil data needed to determine the depth of impacts?
- Are additional wetland soil data needed to characterize the extent of Facility-related impacts in soils beyond the designated wetland soil sampling area in Phase 1?

This section discusses the results of the Phase 1 sampling effort in relation to these questions.

6.3.1 Refinement of Nature and Extent of Impacts

During the Phase 1 sampling effort, wetland surface soil samples were collected from 38 locations, intermediate subsurface wetland soil samples were collected from 6 of these locations, and deep subsurface wetland soil samples were collected from the same 6 locations (Map 2). These Phase 1 wetland soil data were reviewed to determine whether additional wetland data were needed to refine the nature and extent of impacts in surface and subsurface soils. Constituent concentrations in wetland soil samples were compared to ecological and residential human health screening levels (Section 5.2). The spatial distribution of wetland surface and subsurface soil concentrations was also evaluated to assess whether the Phase 1 sampling locations were sufficient to define the extent of impacts. Table 6-3 presents a list of constituents with detected concentrations greater than screening levels.

Table 6-3. Wetland Soil Samples with Detected Concentrations Greater than Screening Levels

Sample Type	Ecological Levels[a]	Residential Human Health Levels[b]
Wetland surface soil	antimony, arsenic, barium, cadmium, chromium, cobalt, copper, lead, mercury, nickel, vanadium, zinc, dibenzofuran, bis(2-ethylhexyl) phthalate, 4,4'-DDD, 4,4'-DDE, 4,4'-DDT, total DDTs	arsenic, cadmium, lead, vanadium, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenzo(a,h)anthracene, indeno(1,2,3-cd)pyrene, Aroclor 1260, total PCBs, 4,4'-DDD, 4,4'-DDE, 4,4'-DDT, total DDTs, benzene
Wetland subsurface soil	arsenic, cadmium, chromium, cobalt, copper, lead, mercury, vanadium, zinc, dibenzofuran, 4,4'-DDD, 4,4'-DDE, total DDTs	arsenic, lead, vanadium, benzo(a)pyrene, benzo(b)fluoranthene

[a] The ecological screening levels are based on relevant ecological thresholds protective of plants, invertebrates, birds, and mammals presented in EPA Eco SSLs (EPA 2005), ORNL (Efroymson et al. 1997a; 1997b), or DEQ SLVs (DEQ 2001).

[b] The human health residential screening levels are the lowest screening level from either the EPA Region 6 residential SL (EPA 2007a) or DEQ RBCs (for soil ingestion, dermal contact, inhalation; volatilization to outdoor air; vapor intrusion to buildings; or leaching to groundwater) (DEQ 2007).

Wetland Surface Soil

Concentrations of most of the constituents analyzed were higher in the former drainage ditch area than elsewhere in the wetlands, extending from DS-01 to WS-11, as well as at sampling location WS-25 (just south of the Facility) (Maps 10 through 16). Constituent concentrations at other wetland sampling locations near WS-25 were generally much lower than those detected at WS-25, and thus the extent of this area appears to be well characterized and relatively small.

Concentrations of many constituents were also higher than they were elsewhere in the wetlands between Force Lake and the current stormwater treatment system discharge, located at the southern boundary of the Facility. This is based on the total PCB and total DDT concentrations detected at two locations (WS-20 and WS-21), and total PAH concentrations detected further to the west at four locations (DS-04, WS-17 to WS-22, and WS-23).

Based on this analysis of constituent concentrations in the wetland surface soil samples, the density of samples collected as part of the Phase 1 sampling effort appears to be sufficient to characterize the spatial variability of surface soil impacts and identify localized areas of impact, at a spatial scale relevant to humans and ecological receptors. Thus, no additional wetland surface soil samples are required to estimate ecological and human health risks or refine the nature and extent of surface soil impacts in wetland soils.

Wetland Subsurface Soil

Detected constituent concentrations in wetland subsurface soils were compared to ecological and human health screening levels. Constituents with detected concentrations greater than these screening levels were then further examined to assess patterns regarding depth of impacts.

The constituents identified in Table 6-3 as having concentrations in subsurface soil samples greater than the ecological or human health screening levels are presented by sampling location in Table 6-4.

For these constituents, 49 of the 83 constituent/location pairs followed a pattern of decreasing concentration from the surface interval to the deep interval. Of the 34 constituent/location pairs that did not follow this pattern, the majority (88% or 30 constituent/location pairs) had concentrations in the intermediate or deep interval that were somewhat higher than the surface interval but were within a factor of 2. The remaining four constituent/location pairs are discussed below.

- **WS-26 and dibenzofuran:** The concentration of dibenzofuran detected in the intermediate interval was approximately 3 times the concentration detected in the surface interval; dibenzofuran was not detected in the deep interval.
- **DS-03 and arsenic:** The concentration detected in the deep interval was approximately 2 times the concentration detected in the intermediate interval; regardless the arsenic concentration in the deep interval sample was below its background level.
- **DS-03 and benzo(a)pyrene:** The concentration detected in the deep interval was approximately 5 times the concentration detected in the intermediate interval, but was comparable to the concentration detected in the surface interval.
- **DS-03 and benzo(b)fluoranthene:** The concentration detected in the deep interval was approximately 2 times the concentration detected in the intermediate interval, but was less than the concentration detected in the surface interval.

Thus, the Phase 1 sampling results indicate that constituent concentrations decrease with depth with the two minor exceptions discussed above. To further characterize the downward extent of impacts, it is recommended that additional subsurface samples be collected at two locations where the highest constituent concentrations were detected in wetland surface soils and no subsurface soil samples were collected during Phase 1. No subsurface soil samples were collected from areas with the highest total PCB (WS-11) or total DDT (WS-25) concentrations. Subsurface soils from these two locations are proposed to be sampled as part of Phase 2.

Table 6-4. Summary of Detected Concentrations in Surface and Subsurface Wetland Soil for Constituents with Subsurface Soil Concentrations Greater than the Ecological or Human Health Screening Levels

	DS-02 (depth; ft bgs)			DS-03 (depth; ft bgs)			DS-05 (depth; ft bgs)			WS-06 (depth; ft bgs)			WS-19 (depth; ft bgs)			WS-26 (depth; ft bgs)		
Constituent	**0-0.5**	**0.5-1.0**	**2.0-3.0**	**0-0.5**	**0.5-1.0**	**2.0-3.0**	**0-0.5**	**0.5-1.0**	**2.0-3.0**	**0-0.5**	**0.5-1.0**	**2.0-3.0**	**0-0.5**	**0.5-1.0**	**2.0-3.0**	**0-0.5**	**0.5-1.0**	**2.0-3.0**
Metals																		
Arsenic	**53.1**	**19.8**	4.7	2.8	2.4	5.3	11.4	4.1	2.4	6.3	5.2	3.6	18	7.1	3.3	7.0	5.5	4.9
Cadmium	**2.1**	**1.1**	nd	0.3	nd	**0.6**	**2.1**	0.3	nd	**0.4**	0.3	nd	**1.2**	**0.5**	**0.4**	**0.8**	**0.5**	**0.4**
Chromium	**82**	**38**	**31.2**	13.8	15.3	23.9	**56 J**	20.5 J	**29.2 J**	**32.5 J**	**32.9 J**	**29 J**	**47**	19.5	20.6	14.6	16.9	21.8
Cobalt	11.3	9.8	**15.1**	8.6	12.7	9.9	12 J	7.0 J	8.9 J	11.4 J	10.6 J	11 J	**18.4**	11.6	8.3	8.2	9.9	10.5
Copper	**137**	**61.1**	**34.1**	**32.8**	26.3	**40.8**	**68.7**	25.7	**30.6**	**47.3**	**42.6**	**33.7**	**93.1**	**30.1**	**29.5**	21.5	**32.8**	**36.0**
Lead	**137**	**76**	**13**	**20**	**13**	**24**	**90**	**16**	9	**30**	**23**	10	**72**	**24**	**16**	**48**	**16**	**16**
Mercury	**0.3**	**0.15 J**	nd	nd	0.1	0.08 J	**0.3 J**	**0.13 J**	0.07 J	**0.16**	**0.15**	nd	**0.2 J**	0.08 J	**0.13 J**	0.10 J	0.06 J	0.09 J
Vanadium	**103**	**82.1**	**86.3**	**56.7**	**70.1**	**59.6**	**92 J**	**46.5 J**	**62.7 J**	**69.4 J**	**67.6 J**	**98 J**	**128**	**47.8**	**50.8**	**40.5**	**45.2**	**58.8**
Zinc	**307**	**203**	**97**	**181**	**118**	**106**	**263**	**64**	**75**	**135**	**100**	**79**	**735**	**136**	**74**	**124**	**89**	**89**
PAHs																		
Benzo(a)pyrene	120	110	5	38	7.9	41	96	13	nd	27	16	nd	860 J	50	nd	120	59	5.0
Benzo(b)fluoranthene	240	260	16	82	18	39	98	26	nd	64	40	7.2	870 J	50	7.8	69	89	5.4
Dibenzofuran	**67**	**110**	nd	nd	nd	nd	**31**	**9.0**	nd	**4.9**	nd	nd	nd	nd	**9.2**	**6.5**	**19**	nd
Pesticides																		
4,4'-DDE	nd	**12**	nd	nd	nd	nd	**62**	3.9	nd	**26**	10	nd	nd	nd	nd	**270**	**19**	4.0
4,4'-DDT	nd	nd	nd	**41 J**	7.0	nd	nd	nd	nd	3.4 J	nd	nd	nd	nd	nd	nd	nd	nd
Total DDTs	**210**	**160 J**	nd	**210 J**	**33**	2.6	**330**	**22**	2.4 J	**35 J**	**13**	nd	**730**	**200**	6.8	**270**	**22**	4.0

J – estimated concentration

nd – not detected

PAH – polycyclic aromatic hydrocarbon

Bold concentrations exceed ecological screening level.

Underlined results exceed human health screening level.

6.3.2 Delineation of Impacts in Wetland Soils

Constituent concentrations in Phase 1 wetland surface soil samples along the western boundary of the Site were evaluated to determine if the wetland boundary extends far enough to the west to assess the nature and extent of impacts and risks.

Constituent concentrations in wetland soil samples collected along the western and southwestern boundary used during Phase 1 sampling (i.e., WS-01, WS-02, WS-03, WS-04, WS-08, WS-13, and WS-15) were compared to ecological and human health risk thresholds to determine the potential for risks at these locations. Constituent concentrations that were greater than ecological or human health risk thresholds in these boundary samples were then compared to constituent concentrations from other wetland soil samples to determine if the extent of Phase 1 sampling can adequately characterize the extent of impacts.

Selected constituents with concentrations that were greater than the ecological or human health screening levels and had high detection frequencies were further evaluated using site-specific risk thresholds.[6] Preliminary ecological and human health risk thresholds were back-calculated using human health toxicity values, ecological lowest-observed-adverse-effects-level (LOAEL) toxicity reference values (TRVs), literature-based bioaccumulation factors (BAFs), and the exposure assumptions (e.g., body weight, ingestion rate) presented in the draft risk assessment scoping memorandum (Windward and Bridgewater 2008). The preliminary TRVs and BAFs are presented in Appendix H. Table 6-5 presents a comparison of constituent concentrations in wetland soils along the western and southwestern boundaries of the wetland to back-calculated preliminary ecological thresholds; Table 6-6 presents a comparison of these concentrations to back-calculated preliminary recreational human health thresholds.

[6] A comprehensive screen was not conducted for this analysis; the risk assessments may reveal additional constituents with concentrations greater than screening levels.

Table 6-5. Comparison of Constituent Concentrations in Wetland Soils along the Western Site Boundary to Preliminary Ecological Thresholds (Dietary Pathway) and Background Values

Constituent	Units	Overall Wetland Soil Concentration		Wetland Soil Boundary Concentration[b]		Preliminary Risk-Based Terrestrial Receptor Wetland Soil LOAEL TRV Threshold[c]			Regional Soil Background Value[d]
		Range of Detects	EPC[a]	Range of Detects	EPC[a]	Red-Tailed Hawk	Cottontail	Shrew	
Total PCBs	µg/kg dw	35 – 1,800	790	35 to 110	110	14,000	18,000	**15 (3/3)**	na
Total DDTs	µg/kg dw	2.7 – 46,000	15,000	20 to 196	160	3,200	330,000	930	na
Arsenic	mg/kg dw	1.5 – 53.1	12	2.7 to 9.3	7.3	44,000	48	30	7
Copper	mg/kg dw	21.5 – 149	83	28.3 to 49.7	48	1,100	290	**33 (5/7)[e]**	36
Lead	mg/kg dw	12 to– 320	85	27 to 51	45	1,000	1,300	**35 (3/7)**	17
Mercury	mg/kg dw	0.07 – 0.4	0.23	0.07 to 0.17	0.17	7.5	**0.028 (7/7)**	**0.0023 (7/7)**	0.07
Total PAHs	µg/kg dw	296 – 8,400	3,500	296 to 620	360	400,000	1,200,000	93,000	na

[c] EPCs are UCLs calculated using ProUCL 4.0 (EPA 2007b), the maximum detect, or half of the maximum reporting limit, as described in the draft Risk Assessment Scoping Memo (Windward and Bridgewater 2008).

[b] Wetland boundary soil locations include WS-01, WS-02, WS-03, WS-04, WS-08, WS-13, and WS-15.

[c] **Bold** indicates that at least one wetland boundary soil concentration was greater than the preliminary threshold. For these constituents, the number of wetland boundary samples greater than the threshold is provided (as a fraction of the detected concentrations at the boundary locations).

[d] Background values are from DEQ (2002).

[e] The copper risk-based preliminary threshold for shrew was less than the regional background soil value; the five locations with concentrations greater than the risk-based preliminary threshold were also greater than the regional background soil value.

dw – dry weight

EPC – exposure point concentration

LOAEL – lowest-observed-adverse-effects level

na – not available

PAH – polycyclic aromatic hydrocarbon

PCB – polychlorinated biphenyl

TRV – toxicity reference value

UCL – upper confidence limit

Table 6-6. Comparison of Constituent Concentrations in Wetland Soils along the Western Site Boundary to Preliminary Recreational Human Health Thresholds and Background Values

Constituent	Units	Overall Wetland Soil Concentration		Wetland Soil Boundary Concentration[b]		Residential Human Health Screening Level[c, d]	Preliminary Risk-Based Human Health Recreational Threshold[d]		Regional Soil Background Value[e]
		Range of Detects	EPC[a]	Range of Detects	EPC[a]		Threshold	Basis	
Total PCBs	µg/kg dw	35– 1,800	790	35 to 110	110	220	5,100	cancer	na
Total DDTs	µg/kg dw	2.7 – 46,000	15,000	20 to 196	160	**172 (2/7)**	36,000	cancer	na
Arsenic	mg/kg dw	1.5 – 53.1	12	2.7 to 9.3	7.3	**0.4 (7/7)**[f]	**8.2 (1/7)**	cancer	7
Copper	mg/kg dw	21.5 – 149	83	28.3 to 49.7	48	291	15,000	non-cancer	36
Mercury	mg/kg dw	0.07 – 0.4	0.23	0.07 to 0.17	0.17	2	3.8	non-cancer	0.07
cPAHs	µg/kg dw	38 – 1,130	380	38 to 73	71	na	270	cancer	na

[a] EPCs are UCLs calculated using ProUCL 4.0 (EPA 2007b), the maximum detect, or half of the maximum reporting limit, as described in the draft Risk Assessment Scoping Memo (Windward and Bridgewater 2008).

[b] Wetland boundary soil locations include WS-01, WS-02, WS-03, WS-04, WS-08, WS-13, and WS-15.

[c] The human health residential screening levels are the lowest of the EPA Region 6 residential SLs (EPA 2007a) or DEQ RBCs (soil ingestion, dermal contact, inhalation; volatilization to outdoor air; vapor intrusion to buildings; or leaching to groundwater) (DEQ 2007).

[d] **Bold** indicates that at least one wetland boundary soil concentration was greater than the preliminary threshold. For these constituents, the number of wetland boundary samples greater than the preliminary threshold is provided (as a fraction of the detected concentrations at the boundary locations).

[e] Background values are from DEQ (2002).

[f] The residential human health screening levels for arsenic was lower than the regional soil background value. The concentration detected at one boundary location (WS-02) was greater than the background value.

dw – dry weight

EPC – exposure point concentration

na – not available

PAH – polycyclic aromatic hydrocarbon

PCB – polychlorinated biphenyl

UCL – upper confidence limit

Based on the preliminary back-calculated human health and ecological risk-based thresholds, risks were greater than the preliminary risk threshold for cottontail from mercury; for shrew from total PCBs, copper, lead, and mercury; and for humans (recreational use) from arsenic. In addition, detected concentrations of total DDTs and arsenic were greater than the residential human health screening level. A comparison of the magnitude of the difference between the wetland soil concentrations near the boundary and the preliminary soil threshold indicates that risks would be relatively low (within a factor of 2 compared to the acceptable threshold) for the following: cottontail from mercury; shrew from copper and lead, humans based on recreational exposure from arsenic; and humans based on residential exposure from arsenic or total DDTs. However, wetland soil boundary concentrations indicate that risks to shrew from total PCBs and mercury are likely to be relatively higher (exceed the acceptable risks threshold by a factor of 6 or more).

Concentration gradients relative to the Phase 1 western and southwestern Site boundary were examined for these three constituents to assess their spatial distribution and whether impacts extend beyond the Phase 1 Site sampling boundary:

- Total PCBs were detected at three of the seven locations along the western boundary of the wetlands (Map 10). PCBs were not detected at any of the locations north of the drainage ditch area. The three locations with detected concentrations (WS-04, WS-08, and WS-13) were located near the golf course. The concentrations detected at these locations were lower than the concentrations at nearby locations that were closer to the Facility.
- Mercury was detected at all seven locations along the western boundary of the wetlands (Map 16). As with PAHs, the concentrations at the boundary locations were lower than the concentrations detected in the wetland ditch samples. At some of these locations, mercury was detected at lower concentrations closer to the Facility compared with the concentrations detected near the western Site boundary.

A comparison of constituent concentrations in individual samples relative to back-calculated preliminary risk thresholds based on conservative assumptions indicates that ecological and human health risks are generally low along the Site boundary, except for risks to shrew[7] from PCBs and mercury. Constituent concentrations along the western and southwestern boundary of the wetlands were generally lower than those in other areas in the wetland (Maps 10 and 16). Therefore, it is recommended that four additional surface samples be collected along the western and southwestern edge of the current wetland boundary to characterize the extent of impacts; the samples would be analyzed for PCBs, organochlorine pesticides, PAHs, TPHs, arsenic, and lead. The golf course, which was constructed by filling and grading and is generally higher in elevation than the adjacent wetland, would serve as the southwestern boundary.

[7] The presence of shrew has not been confirmed at the Site; however, the habitat would be suitable.

6.4 Lake Surface Water

As discussed in the QAPP (Bridgewater et al. 2008a), no surface water samples will be collected as part of Phase 2 sampling. The Force Lake water samples collected in Phase 1 adequately characterize constituent concentrations in the shallow lake, which is assumed to be well mixed. In addition, the majority of constituents that were analyzed for were not detected in the lake surface water samples collected as part of the Phase 1 sampling effort (see Section 5.3.1).

6.5 Lake Sediment

The need for Phase 2 sampling of lake sediment at the Site was assessed based on a review of validated Phase 1 data and the questions posed in the QAPP (Bridgewater et al. 2008a), including:

- Are additional sediment data needed to refine the areas of localized impacts within Force Lake?
- Are subsurface sediment data needed to characterize the nature and extent of Facility-related impacts and/or evaluate potential remedial quantities for the FS?
- Are additional sediment data needed to characterize the extent of Facility-related impacts in sediments beyond Force Lake?
- If surface sediment concentrations in Force Lake are higher than benchmarks associated with benthic toxicity, are bioassays needed to assess risks to the benthic invertebrate community?

This section discusses the results of the Phase 1 sampling effort in relation to these questions.

6.5.1 Refinement of Nature and Extent of Impacts in Force Lake

During the Phase 1 sampling effort, 11 surface sediment samples were collected from Force Lake. These Phase 1 sediment data were reviewed to determine whether additional sediment data are needed to refine the nature and extent of Facility-related impacts (including localized areas and depth of impacts). Detected concentrations in Force Lake were compared to both ecological and human health screening level. The spatial distribution of constituent concentrations in surface sediment was also evaluated.

Concentrations of arsenic, vanadium, and benzo(a)pyrene were greater than the residential human health screening levels. Concentrations of cadmium, copper, lead, mercury, nickel, zinc, total PCBs, 4,4’-DDD, 4,4’-DDE, and total DDTs were greater than ecological screening levels protective of benthic invertebrates. The maximum detected concentrations were not greater than the screening levels by more than a factor of 3, except for arsenic and benzo(a)pyrene (compared to the human health screening level) and 4,4'-DDD, 4,4'-DDE, and total DDTs (compared to the ecological screening level).

The density of sediment sampling in the Force Lake during Phase 1 is adequate to distinguish patterns of constituent distribution in the lake sediments. Furthermore, the available data are sufficient to characterize risks within a spatial scale relevant for the evaluation of risks to humans, fish, birds, and mammals. Although home ranges of aquatic invertebrates are smaller than the sampling density, the Phase 1 sampling appears to have provided sufficient coverage within the lake to assess risks for this receptor. Therefore, no additional surface sediment data are needed to estimate ecological and human health risks or to refine the nature and extent of impacts in Force Lake sediment.

The differing spatial extent and variability of constituent concentrations within the lake may indicate the operation of differing mechanisms by which the impacts have occurred, or differing patterns of sediment deposition within the lake. For instance, it may be that the adjacent wetlands are a greater source of sediments than the golf course, and that a higher rate of sediment deposition in the northern part of the lake has buried older sediments containing higher constituent concentrations that remain on the surface at other locations within the lake.

Additional information addressing these questions regarding the sedimentation patterns in Force Lake and potential depth of impacts could be obtained through the collection of subsurface sediment samples. However, because the constituent concentrations in Force Lake surface sediment are generally low compared to probable effect concentrations (PECs) (see Section 6.5.3), and the hydraulic nature of the lake suggests that subsurface sediment are unlikely to be re-exposed, the collection of subsurface sediment samples is unlikely to provide any information that would be useful for either the RI or the FS. The majority of the benthic invertebrate biomass exists in the top six inches of the sediment. In addition, none of the ecological receptors outlined in the Site conceptual model are expected to come into contact with subsurface sediments. For these reasons, subsurface sediment sampling is not recommended during Phase 2.

6.5.2 Sediment Chemistry in North Lake

During the Phase 1 sampling effort, three sediment samples were collected from North Lake to assess whether impacts from the Facility could have extended beyond Force Lake into North Lake. Concentrations of constituents detected in sediment samples collected from North Lake were compared to ecological and human health screening levels to determine the potential for risks from constituents present in North Lake. Constituent concentrations that were greater than ecological or human health screening levels in these samples were then compared to the constituent concentrations in samples collected from Force Lake to determine whether constituents appear to have the potential to migrate from Force Lake into North Lake.

Table 6-7 presents a summary of the constituents that were detected in at least one of the sediment samples collected from North Lake. The North Lake sediment constituent concentrations were compared to those of sediment samples taken from Force Lake, to human health and ecological screening levels, and to background values for metals.

Table 6-7. Comparison of Detected North Lake Sediment Concentrations and Concentrations in Force Lake to Ecological Screening Levels, Residential Human Health Screening Levels and Background Values

Constituent	Unit	Force Lake			North Lake			Screening Level		Regional Soil Background Value[d]
		Detection Frequency	Average Detect[a]	Max Detect[a]	Detection Frequency	Average Detect[a]	Max Detect[a]	Ecological[b]	Human Health[c]	
Metals										
Arsenic	mg/kg dw	11/11	5.5	7	3 / 3	4.0	5.0	9.8	0.39	7
Barium	mg/kg dw	11/11	190	220	3 / 3	170	208	nc	1,600	na
Chromium	mg/kg dw	11/11	26	34	3 / 3	24	30	43	100,000	42
Cobalt	mg/kg dw	11/11	13	15	3 / 3	11	12	nc	900	na
Copper	mg/kg dw	11/11	**53**	**72**	3 / 3	**60**	**71.4**	32	290	36
Lead	mg/kg dw	11/11	**40**	**56**	3 / 3	15	18	36	80	17
Nickel	mg/kg dw	11/11	**24**	**31**	3 / 3	21	**25**	23	160	38
Vanadium	mg/kg dw	11/11	60	74	3 / 3	69	76	nc	39	na
Zinc	mg/kg dw	11/11	**170**	**229**	3 / 3	110	119	120	2,300	86
PAHs										
Benzo(a)anthracene	µg/kg dw	11/11	37	74	3 / 3	33	35	110	150	na
Benzo(a)pyrene	µg/kg dw	11/11	46	83	3 / 3	34	38	150	15	na
Benzo(b)fluoranthene	µg/kg dw	11/11	35	71	3 / 3	51	71	nc	150	na
Benzo(g,h,i)perylene	µg/kg dw	9/11	34	71	1 / 3	20	20	nc	nc	na
Benzo(k)fluoranthene	µg/kg dw	11/11	35	71	2 / 3	42	47	nc	1,500	na
Chrysene	µg/kg dw	11/11	59	110	3 / 3	50	54	170	15,000	na
Fluoranthene	µg/kg dw	11/11	89	190	3 / 3	84	96	420	230,000	na
Naphthalene	µg/kg dw	11/11	23	61	1 / 3	21	21	180	12,000	na
Phenanthrene	µg/kg dw	11/11	58	120	3 / 3	46	58	200	nc	na
Pyrene	µg/kg dw	11/11	100	180	3 / 3	88	110	200	230,000	na
Total benzofluoranthenes	µg/kg dw	11/11	71	142	3 / 3	79	94	nc	nc	na
Total cPAHs	µg/kg dw	11/11	62	118	3 / 3	51	55	nc	nc	na
Total HPAHs	µg/kg dw	11/11	454	910	3 / 3	370	411	nc	nc	na

Table 6-7. Comparison of Detected North Lake Sediment Concentrations and Concentrations in Force Lake to Ecological Screening Levels, Residential Human Health Screening Levels and Background Values

Constituent	Unit	Force Lake			North Lake			Screening Level		Regional Soil Background Value[d]
		Detection Frequency	Average Detect[a]	Max Detect[a]	Detection Frequency	Average Detect[a]	Max Detect[a]	Ecological[b]	Human Health[c]	
Total LPAHs	µg/kg dw	11/11	101	230	3/3	53	79	nc	nc	na
Total PAHs	µg/kg dw	11/11	555	1,060	3/3	430	480	nc	nc	na
Pesticides										
4,4'-DDD	µg/kg dw	11/11	**37**	**47**	1/3	**25**	**25 J**	4.9	2,400	na
4,4'-DDE	µg/kg dw	11/11	**92**	**150**	1/3	**26**	**26**	3.2	1,700	na
Total DDTs	µg/kg dw	11/11	**160**	**250**	1/3	**51**	**51 J**	4.2	1,700	na
Petroleum										
Total petroleum hydrocarbons	mg/kg dw	11/11	870	2,300	3/3	273	310	nc	nc	na
TPH – diesel range	mg/kg dw	11/11	98	270	3/3	29	32	nc	23,000	na
TPH – motor oil range	mg/kg dw	11/11	760	2,000	3/3	243	280	nc	23,000	na
VOCs										
Acetone	µg/kg dw	10/11	720	1,100	3/3	270	320	nc	1,400,000	na
Carbon disulfide	µg/kg dw	11/11	40	140	3/3	8.2	9.7	nc	720,000	na
Methyl ethyl ketone	µg/kg dw	10/11	85	140	3/3	38	45	nc	nc	na
Toluene	µg/kg dw	3/11	6.6	17	2/3	6.6	10	nc	520,000	na

[a] **Bold** concentrations are greater than the ecological screening levels. Underlined concentrations are greater than the human health screening levels.

[b] The ecological screening levels are based on the threshold effects concentrations protective of benthic invertebrates (MacDonald et al. 2000).

[c] The human health screening levels are the lowest of the EPA Region 6 residential SLs (EPA 2007a) or DEQ RBCs (soil ingestion, dermal contact, or inhalation) (DEQ 2007). Residential human health screening levels are used as a default because no recreation-specific screening levels are available.

[d] Background values are from DEQ (2002). No sediment-specific values are available, and thus the background soil values are presented here for comparison purposes.

cPAH – carcinogenic polycyclic aromatic hydrocarbon
dw – dry weight
J – estimated concentration
HPAH – high-molecular-weight polycyclic aromatic hydrocarbon
LPAH – low-molecular-weight polycyclic aromatic hydrocarbon
Na – not applicable
nc – no criteria
PAH – polycyclic aromatic hydrocarbon
TPH – total petroleum hydrocarbon

A total of 9 metals, 11 individual PAHs, 2 DDT isomers, 2 petroleum ranges, and 4 VOCs were detected in North Lake sediment samples. No clear gradient of constituent concentrations existed based on a comparison of the constituent concentrations at the sampling locations and their distance from the culverts that connect North Lake to Force Lake (Maps 10 through 16). Of these detected constituents, a total of five constituents or totals (i.e., copper, nickel, 4,4'-DDD, 4,4'-DDE, and total DDTs) had concentrations greater than the ecological screening levels, and three constituents (i.e., arsenic, vanadium, and benzo[a]pyrene) had concentrations greater than the residential human health screening levels (Table 6-7). These constituents are discussed below.

- **Arsenic:** All concentrations in North Lake were less than the regional soil background value.
- **Copper:** Detected concentrations in North Lake were greater than the regional soil background value. The ranges of concentrations in North Lake were similar to those in Force Lake, and similar to the mean of detected concentrations in wetland surface soil.
- **Nickel:** All concentrations in North Lake (and Force Lake) were less than the regional soil background value.
- **Vanadium:** Detected concentrations in North Lake were similar to those in Force Lake, and no clear gradient existed in the North Lake samples. No regional soil background value is available. Concentrations in vanadium were similar to the mean of detected concentrations in wetland surface soil.
- **Benzo(a)pyrene:** Detected concentrations in North Lake were lower than in those in Force Lake, and no clear gradient existed in the North Lake samples. No regional soil background value is available.
- **DDTs:** DDTs were detected at only one of the three locations in North Lake. This detected concentration was lower than concentrations in Force Lake and was collected from the sampling location (SE-101) closest to the culverts that connect North Lake to Force Lake. No regional soil background value is available.

Concentrations of all other constituents for which screening levels were available were less than the screening levels.

Based on this analysis, constituent migration from Force Lake into North Lake has been limited. The concentrations of arsenic and nickel in North Lake were less than the regional background soil values. Concentrations of copper and vanadium were similar to those in Force Lake and to the mean detected concentrations in the wetland soil. Although no regional soil background values are available for vanadium, the similar concentrations detected throughout the wetlands may indicate that these concentrations are typical of a larger area. Concentrations of benzo(a)pyrene in the three samples collected from North Lake ranged from 30 to 38 μg/kg dw and were lower than the concentration detected at the Force Lake sampling location closest to the culverts (50 μg/kg dw at

SE-01). No clear gradient for benzo(a)pyrene exists based on the distance of the three sampling locations from the culverts that connect North Lake to Force Lake, suggesting that constituent migration has been limited. DDTs were only detected at SE-101, the North Lake location closest to the culverts. The detected concentration at SE-101 (51 µg/kg dw) was three times lower than the concentration detected at the closest location in Force Lake (150 µg/kg dw at SE-01). Based on this analysis, it appears that any potential for the migration of constituents from Force Lake to North Lake is limited and that no additional sampling is necessary beyond Force Lake.

6.5.3 Benthic Tissue Bioassays

Surface sediment concentrations in Force Lake were compared to ecological sediment screening levels based on the protection of benthic invertebrates to determine whether bioassays should be considered to further assess risks to the benthic invertebrate community.

Detected concentrations of cadmium, copper, lead, mercury, zinc, total PCBs, 4.4'-DDD, 4,4'-DDE, and total DDTs in Force Lake were greater than the threshold effects concentrations (TECs) protective of benthic invertebrates (MacDonald et al. 2000). With the exception of DDTs, the maximum detected concentrations of these constituents were greater than their respective TECs by a factor of approximately 2 or less. The detected concentrations of 4.4'-DDD , 4,4'-DDE, and total DDTs were greater than their TECs by factors of 10, 47, and 60, respectively.

TECs are conservative screening thresholds that identify concentrations below which adverse effects on benthic organisms are not expected and their exceedance does not necessarily predict toxicity. Probable effect concentrations (PECs), while still conservative, are more appropriate thresholds for determining whether adverse effects may be expected. The PECs for 4,4'-DDD, 4,4'-DDE, and total DDTs are 28, 31.3, and 572 µg/kg, respectively. The maximum detected sediment concentrations in Force Lake were greater than their PECs by a factor of 2 and 5 for 4,4'-DDD and 4,4'-DDE, respectively. The maximum detected concentration of total DDTs in Force Lake was less than the PEC.

Constituent concentrations detected in Force Lake sediment were generally lower than the conservative TECs used to evaluate these data. Sediment concentrations of DDT isomers were slightly greater than PECs; however, the higher concentration of a single constituent group was not considered to be sufficient justification for conducting benthic bioassay tests during Phase 2. Thus, benthic bioassays are not recommended during Phase 2.

6.6 Biota Tissue

No tissue samples were collected as part of the Phase 1 sampling effort. Instead, the QAPP stated that soil and sediment data from Phase 1 would be evaluated to determine if tissue should be collected as part of the

Phase 2 effort (Bridgewater et al. 2008a). Potential biota tissue that could be collected include fish, invertebrates (e.g., earthworms), and small mammals.

6.6.1 Comparison to DEQ Bioaccumulation Screening Levels

As discussed in the QAPP (Bridgewater et al. 2008a), wetland soil samples and lake sediment samples were compared to DEQ bioaccumulation screening levels (Tables 6-8 and 6-9). DEQ's bioaccumulation sediment and soil screening levels are conservative back-calculated screening thresholds based on generic exposure parameters designed to be protective of all ecological receptors. These screening levels serve as conservative screening values that can be used to indicate whether the risks from specific constituents should be further assessed. More reasonable estimates of risk will be calculated in the baseline ecological risk assessment using receptor-specific parameters and toxicity data specific to the exposure pathways and scenarios being evaluated at this Site.

For metals (i.e., arsenic, cadmium, lead, mercury, and selenium), DEQ bioaccumulation sediment screening levels are based on regional background values. Constituent concentrations may be greater than the regional background values but do not necessarily indicate a potential for risk.

Based on data presented in Table 6-8, wetland surface soil EPCs calculated for arsenic, lead, 4,4'-DDD, 4,4'-DDE, and 4,4'-DDT were greater than the DEQ wildlife SLV. The Force Lake sediment EPCs calculated for cadmium, lead, mercury, total PCBs, and total DDTs were greater than the DEQ bioaccumulation SLV (Table 6-9).

Therefore, as stated in the QAPP (Bridgewater et al. 2008a), tissue data will be generated for these constituents through the use of literature-derived biota-sediment accumulation factors (BSAFs) and BAFs or through the collection of empirical data. Section 6.6.2 presents a comparison of preliminary site-specific risk-based thresholds that were back-calculated using literature-based BSAFs and BAFs to assess the potential for adverse effects to ecological receptors and to assess whether the collection of tissue data is warranted.

Table 6-8. Comparison of DEQ Ecological Soil Screening Level Thresholds to Wetland Surface Soil Concentrations for DEQ-Defined Bioaccumulative Constituents

Constituent	Unit	DEQ Wildlife SLV[a]	Wetland Surface Soil		
			Detection Frequency	EPC[b, c]	Maximum Detect[b]
Metals					
Arsenic	mg/kg dw	10	38/38	**12**	**53.1**
Cadmium	mg/kg dw	6	35/38	1.2	4
Lead	mg/kg dw	16	38/38	**85**	**320**
Mercury	mg/kg dw	1.5	35/38	0.23	0.4
Selenium	mg/kg dw	2	0/38	1.5	nd
PCBs					
Total PCBs	µg/kg dw	4,000	25/38	790	1,800
Pesticides					
4,4'-DDD	µg/kg dw	10	35/38	**2,000**	**5,100**
4,4'-DDE	µg/kg dw	10	27/38	**810**	**2,700**
4,4'-DDT	µg/kg dw	10	27/38	**8,100**	**27,000**
Chlordane	µg/kg dw	9,000	0/38	40	nd
Other SVOCs					
Pentachlorophenol	µg/kg dw	30,000	1/10	2,600	80 J

[a] Soil SLVs are based on the lowest bird or mammal SLV as presented in DEQ (2001).

[b] **Bold** values indicate that concentrations were greater than the DEQ wildlife SLVs.

[c] EPCs are UCLs calculated using ProUCL 4.0 (EPA 2007b), the maximum detect, or half of the maximum reporting limit, as described in the draft risk assessment scoping memorandum (Windward and Bridgewater 2008).

DEQ – Oregon Department of Environmental Quality

dw – dry weight

EPC – exposure point concentration

J – estimated concentration

SLV – screening level value

SVOC – semivolatile organic compound

UCL – upper confidence limit

Table 6-9. Comparison of DEQ Ecological Sediment Bioaccumulation Thresholds to Force Lake Surface Sediment Concentrations for DEQ-Defined Bioaccumulative Constituents

Constituent[a]	Unit	DEQ Bioaccum-ulation SLV	Force Lake		
			Detection Frequency	EPC[b, c]	Maximum Detect[b]
Metals					
Arsenic	mg/kg dw	7[d]	11/11	6.4	7
Cadmium	mg/kg dw	1[d]	8/11	**2**	**2**
Lead	mg/kg dw	17[d]	11/11	**62**	**56**
Mercury	mg/kg dw	0.07[d]	1/11	**0.2**	**0.2 J**
Selenium	mg/kg dw	2[d]	0/11	2	nd
PAHs					
Fluoranthene	µg/kg dw	37,000[e]	11/11	120	190
Pyrene	µg/kg dw	1,900[e]	11/11	130	180
PCBs					
Total PCBs	µg/kg dw	22[e]	7/11	**120**	**131**
Pesticides					
Chlordane	µg/kg dw	0.5[e]	0/11	**6**	nd
Dieldrin	µg/kg dw	1.8[e]	0/11	**13**	nd
Total DDTs	µg/kg dw	0.34[e]	11/11	**200**	**250**
Other SVOCs					
Hexachlorobenzene	µg/kg dw	61,000[e]	0/11	**6**	nd

[a] Pentachlorophenol is not included in this table because it was not analyzed in lake sediment (see Section 4.1).

[b] **Bold** values indicate that concentrations were greater than the DEQ bioaccumulation SLVs.

[c] EPCs are UCLs calculated using ProUCL 4.0 (EPA 2007b), the maximum detect, or half of the maximum reporting limit, as described in the draft Risk Assessment Scoping Memo (Windward and Bridgewater 2008).

[d] Sediment bioaccumulation SLVs for inorganic constituents are based on background values presented in DEQ (2007).

[e] Sediment bioaccumulation SLVs for organic constituents are based on the lower of bird and freshwater fish SLVs protective of populations of these animals presented in DEQ (2007).

dw – dry weight

DEQ – Oregon Department of Environmental Quality

J – estimated concentration

EPC – exposure point concentration

nd – not detected

PAH – polycyclic aromatic hydrocarbon

SLV – screening level value

SVOC – semivolatile organic compound

UCL – upper confidence limit

6.6.2 Comparison to Calculated Risk-Based Thresholds

Preliminary risk-based thresholds were back-calculated for ecological receptors for representative bioaccumulative constituents and were compared to soil concentrations for terrestrial receptors and to sediment concentrations for aquatic receptors. These constituents were selected based on high detection frequencies, exceedance of ecological or human health screening level, and high toxicity to receptors.[8] It should be noted that the assumptions used for preliminary screen are conservative and will be refined in the ecological risk assessment for assessing risks to ecological receptors to reflect more appropriate assumptions, including estimates of bioavailability, and to take into account site-specific considerations.

The preliminary thresholds are the soil or sediment concentration at which the LOAEL TRV-based hazard quotient (HQ) for ecological receptors would be equal to 1.0, the point above which adverse effects could occur. Literature BAFs and BSAFs were used to estimate the relationship between prey tissue and either soil or sediment concentrations[9] (Appendix H). These preliminary thresholds were calculated based on the receptor-specific exposure parameters (e.g., body weight, ingestion rate) and methods presented in the draft risk assessment scoping memorandum (Windward and Bridgewater 2008).

6.6.2.1 Terrestrial Species

Preliminary risk-based thresholds for soil were back-calculated for red-tailed hawk, cottontail, and shrew (Table 6-10).

[8] The list of constituents for which preliminary risk-based thresholds were calculated was selected as described in the text. A complete analysis of all constituents will be conducted in the baseline risk assessments.

[9] For the purposes of this preliminary screen, it was conservatively assumed that the ratio of percent organic carbon in sediments and soils to the percent lipids in biota prey tissue was 1 when applying BSAFs and BAFs to predict prey tissue concentrations for organic constituents.

Table 6-10. Comparison of Wetland Surface Soil Concentrations to Preliminary Ecological Soil Thresholds for Terrestrial Receptors Based on the Dietary Pathway and Background Values

Constituent	Unit	Wetland Surface Soil Concentration		Preliminary Risk-Based Terrestrial Receptor Wetland Soil LOAEL Threshold[b]			Regional Soil Background Value[c]
		Range of Detects	EPC[a]	Red-Tailed Hawk	Cottontail	Shrew	
Total PCBs	µg/kg dw	35 – 1,800	790	14,000	18,000	**15 (25/25)**	na
Total DDTs	µg/kg dw	2.7 – 46,000	15,000	**3,200 (5/37)**	330,000	**930 (7/37)**	na
Arsenic	mg/kg dw	1.5 – 53.1	12	44,000	**48 (2/38)**	**30 (2/38)**	7
Copper	mg/kg dw	21.5 – 149	83	1,100	290	**33 (29/38)[d]**	36
Lead	mg/kg dw	12 – 320	85	1,000	1,300	**35 (23/38)**	17
Mercury	mg/kg dw	0.07 – 0.4	0.23	7.5	**0.028 (35/35)[e]**	**0.0023 (35/35)[e]**	0.07
Total PAHs	µg/kg dw	296 – 8,400	3,500	400,000	1,200,000	93,000	na

[a] EPCs are UCLs calculated using ProUCL 4.0 (EPA 2007b), the maximum detect, or half of the maximum reporting limit, as described in the draft risk assessment scoping memorandum (Windward and Bridgewater 2008).

[b] **Bold** wetland soil thresholds indicate that at least one wetland boundary soil concentration was greater than the threshold. For these constituents, the number of wetland boundary samples greater than the preliminary threshold is provided (as a fraction of the detected concentrations).

[c] Background values are from DEQ (2002).

[d] The copper preliminary risk-based threshold for shrew was less than the regional background soil value; however, 28 of the 29 locations with concentrations greater than the preliminary risk-based threshold also were greater than the regional background soil value.

[e] Of the 35 locations where mercury was detected, three were equal to the background soil value (0.07 mg/kg dw), and the other 33 had concentrations that were greater than the background value and the preliminary threshold.

dw – dry weight

EPC – exposure point concentration

LOAEL – lowest-observed-adverse-effects level

na – not available

UCL – upper confidence limit

PCB – polychlorinated biphenyl

Based on this comparison of wetland soil concentrations to the preliminary thresholds for terrestrial receptors, the following receptor/constituent pairs had concentrations that were greater than the preliminary thresholds for each receptor:

- **Red-tailed hawk**: total DDTs
- **Cottontail**: arsenic and mercury
- **Shrew**: total PCBs, total DDTs, arsenic, copper, lead, and mercury

The extent to which detected concentrations were greater than the preliminary thresholds for hawk and cottontail was generally low, especially when EPCs were compared to preliminary thresholds. However, higher risks are likely from total PCBs, total DDTs, and mercury for shrew and from mercury for cottontail. Concentrations of these constituents in wetland soils, as discussed in Section 6.3.1, were variable. Concentrations of total PCBs, lead, and mercury throughout the wetlands were greater than the preliminary threshold for shrew, and the mercury concentrations throughout the wetlands were greater than the preliminary threshold for cottontail. However, comparisons of concentrations of total DDTs with shrew indicate that risks are being driven by constituent concentrations in localized areas.

The wetland soil thresholds for shrew are significantly lower than those for hawk or cottontail because of the characteristics and feeding habits of shrew. Shrew consume over 50% of their body weight per day and also may incidentally ingest a significant amount of sediment.[10] In addition, shrew feed primarily on invertebrates, which bioaccumulate constituents at a higher rate than plants consumed by the small mammals that have been observed at the Site (i.e., cottontail and voles). Because the calculated thresholds are based on literature BAFs, there is considerable uncertainty in these values.

Based on these preliminary screening results, the evaluation of dietary risks to shrews needs to be further evaluated. However, because the presence of shrews at the Site has not been confirmed, a field survey will be conducted as part of Phase 2 to determine whether shrew utilize habitat areas within the Site. The results of this survey will indicate whether shrew represent a relevant ecological receptor that may be exposed to contaminants from the Site and whether the evaluation of dietary risk estimates should be further refined, since shrew were selected as a receptor of concern in the WP based on their feeding habits (i.e., they are higher up on the food chain than most rodents) and the type of habitat present at the Site.

[10] Additional information regarding the diet and feeding habits of shrew can be found in the draft risk assessment scoping memorandum (Windward and Bridgewater 2008).

6.6.2.2 Aquatic Species

Preliminary threshold concentrations in sediment were back-calculated for great blue heron, ruddy duck, mosquitofish, and brown bullhead using the assumptions described in Section 6.2.2 (Table 6-11).

Based on the comparison of Force Lake sediment concentrations to the preliminary thresholds for aquatic receptors, the only detected sediment constituent concentrations that were greater than preliminary thresholds were from total DDTs and mercury for ruddy duck, from copper for mosquitofish, and from copper for bullhead. These constituents are briefly discussed below.

- Total DDTs were detected in all 11 Force Lake sediment samples; and of these, 7 had concentrations that were greater than the preliminary threshold for ruddy duck. Based on the EPC, DDT concentrations in Force Lake were greater than the preliminary threshold by a factor of 1.25.
- Mercury was detected in 1 of the 11 Force Lake sediment samples. The single detected concentration of 0.2 mg/kg dw was just above the calculated preliminary threshold of 0.19 mg/kg dw for ruddy duck.
- Copper was detected in all of the Force Lake sediment samples, with concentrations ranging from 16.2 to 72 mg/kg dw. The EPC calculated for copper was greater than the thresholds for mosquitofish and bullhead by a factor of 17 and 6, respectively.

The calculated thresholds for ruddy duck are the lowest of any of the aquatic receptors based on the assumed higher rate of incidental sediment ingestion, which is a function of the feeding habits of this duck.

The calculated thresholds for both mosquitofish and bullhead indicate that risks to fish from the concentrations of copper detected in Force Lake are likely to be elevated. No regional sediment background value is available, but lake sediment concentrations can be compared to the regional soil background value of 36 mg/kg dw. The maximum detected lake sediment concentration in Force Lake (72 mg/kg dw at SE-06) was greater than this background value by a factor of 2, and the mean copper concentration (54 mg/kg dw) was greater than the background value by a factor of 1.5. Thus, copper concentrations are not highly elevated in relation to background.

Based on this screening exercise, risks to aquatic birds via dietary exposure to contaminated prey are expected to be low. Risks to fish are also expected to be low, with the exception of copper. However, the maximum copper concentration in the lake was only a factor of 2 greater than background and thus, the use of BSAFs to model prey tissue data is sufficient for the calculation of risks to aquatic receptors.

Table 6-11. Comparison of Force Lake Sediment Concentrations to Ecological Soil Thresholds for Aquatic Receptors Based on the Dietary or Tissue-Residue Pathway and Background Values

Constituent	Unit	Lake Sediment Concentration		Risk-Based Aquatic Receptor Lake Sediment LOAEL Threshold[b, c]				Regional Soil Background Value[d]
		Range of Detects	EPC[a]	Great Blue Heron	Ruddy Duck	Mosquito-fish	Brown Bullhead	
Total PCBs	µg/kg dw	93 – 131	120	1,200	1,600	190[e]	140[e]	na
Total DDTs	µg/kg dw	22 – 250	200	290	**160 (7/11)**	1,600[e]	750[e]	na
Arsenic	mg/kg dw	2.6 – 7	6.4	1,600	332	10	28	7
Copper	mg/kg dw	16.2 – 72	78	320	75	**5 (11/11)**	**13 (11/11)**	36
Lead	mg/kg dw	9 – 56	62	580	190	na	na	17
Mercury	mg/kg dw	0.2	0.2	1.2	**0.19 (1/1)**	1.2[e]	1.9[e]	0.07
Total PAHs	µg/kg dw	104 – 1,060	740	780,000	390,000	350,000	910,000	na

a EPCs are UCLs calculated using ProUCL 4.0 (EPA 2007b), the maximum detect, or half of the maximum reporting limit, as described in the draft Risk Assessment Scoping Memo (Windward and Bridgewater 2008).

b Sediment thresholds are based on the dietary pathway for all constituent-receptor pairs, except where noted.

c **Bold** wetland sediment thresholds indicate that at least one sediment concentration was greater than the preliminary threshold. For these constituents, the number of samples that had concentrations that were greater than the threshold is provided (as a fraction of the detected concentrations in Force Lake sediment).

d Background values are from DEQ (2002). No sediment-specific values are available, and thus the background soil values are presented here for comparison purposes.

e Sediment thresholds are based on the estimated tissue residue pathway (sediment thresholds were back-calculated using a literature BSAF and tissue-residue TRVs).

dw – dry weight

EPC – exposure point concentration

LOAEL – lowest-observed-adverse-effects level

na – not available

PAH – polycyclic aromatic hydrocarbon

PCB – polycyclic aromatic hydrocarbon

UCL – upper confidence limit

7.0 DATA VALIDATION SUMMARY

All samples were submitted to ARI for laboratory analysis and were analyzed in 24 sample delivery groups (SDGs). Independent third-party data validation was performed by EcoChem, Inc., on all chemistry results following EPA guidance (1999; 2004). Five SDGs, which included 21% of all results, were selected for full-level data validation by the project QA/QC coordinator to ensure that minimum QAPP requirements were met. The five SDGs that were selected covered all matrices and analyses represented in the dataset selected for full-level validation. Summary-level data validation was performed on all remaining results, with one exception. Calibration information was not available for the metals analysis of the LNAPL sample, so these results underwent a compliance screening-level data validation. The complete data validation reports are provided in Appendix D.

The data validation included a review of all QC summary forms, including initial and continuing calibration, internal standard, surrogate, laboratory control sample (LCS), matrix spike (MS), matrix spike duplicate (MSD), and interference check sample summary forms, as applicable. The majority of the data did not require qualification or were J- or UJ-qualified, indicating an estimated value or an estimated reporting limit (RL), respectively. Eight percent of all results were J- or UJ- qualified. Forty-seven results were rejected by the data validator and will not be used for any purpose in the Harbor Oil RI/FS. Rejected results account for 0.2% of the dataset, so the QAPP-specified goal for completeness of 95% was met. Based on the information reviewed, the overall data quality is considered acceptable for use as qualified.

Issues that resulted in the qualification of data are summarized below. Detailed information regarding every qualified sample is presented in Appendix D.

- A total of 47 results for 23 constituents were rejected during data validation because of extremely low surrogate, internal standard, MS/MSD or LCS recoveries. Rejected results included six results for vinyl acetate; four results for 3,3'-dichlorobenzidine; three results each for aniline and bromoform; two results each for 1,1,2,2-tetrachloroethane, 1,2,3-trichlorobenzene, 1,2,3-trichloropropane, 1,3-dichlorobenzene, 2,4-dinitrophenol, 2-chlorotoluene, 4-chlorotoluene, bromobenzene, hexachlorocyclopentadiene, isopropylbenzene, sec-butylbenzene, and tert-butylbenzene; and one result each for 1,2-dichlorobenzene, 1,4-dichlorobenzene, 4,6-dinitro-o-cresol, 4-chloroaniline, anthracene, dibromochloromethane, and n-propylbenzene. Rejected results will not be used for any purpose in the Harbor Oil RI/FS.
- A total of 700 results for various metals, VOCs, PAHs, other SVOCs, TPH-diesel, and TPH-gasoline were qualified as

estimated because of MS/MSD recoveries outside of control limits. Detected results for four individual PAHs, one VOC, and one SVOC were J-qualified as estimated because of a high relative percent difference (RPD) between the results of the MS and MSD samples.

- A total of 259 results for 86 constituents (VOCs [66], SVOCs [18], TPH-diesel, and TPH-gasoline) were J- or UJ-qualified as estimated because surrogate recoveries were outside of QC limits. Of these, 189 results were non-detected concentrations; 70 were detected concentrations.
- A total of 840 results for VOCs and 37 results for PAHs were J- or UJ-qualified as estimated because internal standard recoveries were outside of QC limits. Of these, 757 results were non-detected concentrations; 120 were detected concentrations. Some of these results also had surrogate recoveries outside of QC limits, as noted above.
- A total of 108 results for 4 pesticides, 4 VOCs, 2 SVOCs, and 1 PAH were J- or UJ-qualified as estimated because the associated continuing calibration verification samples were outside of control limits.
- A total of 108 results for various metals were J-qualified as estimated because of high percent differences between the original sample result and the laboratory replicate result.
- A total of 31 results for DDT compounds and 4 results for Aroclor 1260 were P-qualified by ARI to indicate that the RPDs of the dual-column concentrations were above QC limits of 40%. These results were either J-qualified (27) or JN-qualified (8) to indicate estimated concentrations or tentative identification at estimated concentrations, respectively. Results with dual-column RPDs greater than 60% were JN-qualified. Results with dual-column RPDs greater than 40% and less than 60% were J-qualified.
- Nine undetected results for trans-1,3-dichloropropene and one undetected result for benzo(a)pyrene were UJ-qualified because of low LCS recoveries.
- Five carbon disulfide results with detected concentrations ranging from 1.6 to 8.8 µg/kg dw, one methylene chloride result (2.1 µg/kg dw), and one acetone result (35 µg/kg dw) were qualified as non-detect with elevated RLs because contamination was found in the associated rinsate blank or trip blank samples.
- Four phenol results with detected concentrations ranging from 24 to 28 µg/kg dw, and one methylene chloride result (380 µg/kg dw) were qualified as non-detect with elevated RLs because of laboratory method blank contamination.
- A total of 69 VOC results in two samples and the results for Aroclor 1221 and Aroclor 1232 in four samples were J- or UJ-qualified because the samples were reanalyzed 1 to 2 days

beyond of maximum holding times. The samples were originally analyzed within holding times but were re-analyzed for QA purposes or to achieve lower RLs. Two other samples were analyzed 2 days outside of the 24-hour holding time for pH and were J-qualified as estimated. These samples, GW-MW5i and GW-A18, were received at the laboratory on a Saturday and were analyzed for pH on the next business day.

- The laboratory M-qualified several results because of poor spectral matching. These results were JN-qualified as tentative identification at estimated concentration during data validation. JN-qualified results include 18 results for acetone; 6 results for fluorene; 5 results for benzo(k)fluoranthene; 4 results for dibenzofuran; 3 results each for acenaphthene and acenaphthylene; 2 results for chlorobenzene; and 1 result each for 1,2-dichlorobenzene, 1,3-dichlorobenzene, n-butylbenzene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene.
- A total of 71 metals results were J- or UJ-qualified because the associated contract-required detection limit samples were outside of QC limits. Of these, 40 detected results for mercury, 18 results for copper (3 detected and 15 non-detected), 12 results for nickel (2 detected and 10 non-detected), and 1 non-detected result for selenium were qualified as estimated.
- Sample SL25-36-60 was analyzed for both low- and medium-level VOCs. The results from these analyses differed significantly; specifically, the results of the medium-level analysis were approximately 10 times greater for all detected constituents. Re-analysis using both the low- and medium-level methods were performed on archived sample aliquots. The results of the re-analysis confirmed both sets of results from the original analyses. As a conservative approach, the results from the original medium-level analysis (the higher of the two original analyses) were selected as the final results.
- Detected concentrations of 4,4'-DDD were outside of acceptable retention time windows for eight samples. All but two of these samples were reanalyzed following dilution. This constituent was detected within the correct retention time window in the dilution analyses; the results from these analyses were selected. Although this constituent was reported outside of method acceptance limits in two samples without dilution, the laboratory considers this constituent to be present and correctly identified. These two results (for samples SL06-60-84 and SL07-30-42) were JN-qualified by EcoChem.
- A total of 186 results (69 pesticides, 58 PCB Aroclors, 21 PAHs, 21 other SVOCs, and 16 VOCs) were Y-qualified by the laboratory as non-detects with elevated RLs because of background interferences. The Y-qualifier indicates that chromatographic interference in the sample prevented adequate resolution of the compound at the standard RLs.

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