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Gradient
CORPORATION

August 2, 2006

Mr. Mike Romero
Oregon Department of Environmental Quality
Northwest Region
2020 Southwest Fourth Avenue, Suite 400
Portland, OR 97201

Re: Schnitzer/Premier Edible Oils (PEO) Site – Submittal of final *Work Plan For Additional Characterization of the Premier Edible Oils (PEO) Property*

Dear Mike:

On behalf of Schnitzer Investment Corp. (SIC), Gradient Corporation is submitting this final version of the *Work Plan For Additional Characterization of the Premier Edible Oils (PEO) Property*, which was prepared by Gradient in collaboration with URS Corporation. This version of the Work Plan addresses the comments that were received from the Oregon Department of Environmental Quality (DEQ) regarding the March 2005 draft version of the Work Plan. These comments were transmitted in letters dated May 25, 2005 and May 10, 2006 and in other meetings and communications.

Following a May 3 site visit, DEQ identified several new investigation issues for the PEO site, including evaluations of slag, drums, pipes, and soil piles observed during the site visit. These issues were documented in DEQ's letter to SIC of May 10, 2006. As we have discussed, to facilitate finalization of the Work Plan, the Work Plan does not specifically address these new issues. As indicated in the July quarterly report for the PEO site, however, efforts to evaluate these issues have been initiated and will be conducted and documented separately from the efforts conducted in the Work Plan. The results of these evaluations will be incorporated in the overall remedial investigation documentation that will be prepared for this site.

Please contact me if you have any questions regarding this document or need any additional information.

Sincerely,

Catherine Petito Boyce, S.M.
Principal Scientist

cc: J. Brown/James C. Brown & Associates
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Work Plan for Additional Characterization

of the Premier Edible Oils Property

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Acronym List

AST	Aboveground Storage Tank
ASTM	American Society for Testing and Materials
BTEX	Benzene, Toluene, Ethylbenzene, and Xylenes
bgs	Below ground surface
DRO	Diesel Range Organics
f_{oc}	Fraction Organic Carbon
GC/FID	Gas Chromatograph/Flame Ionization Detection
GC/MS SIM	Gas Chromatograph/Mass Spectrometer with Selective Ion Monitoring
GRO	Gasoline Range Organics
HASP	Health and Safety Plan
LWG	Lower Willamette Group
NAPL	Non-Aqueous Phase Liquid
LNAPL	Lighter than water NAPL
DEQ	Oregon Department of Environmental Quality
PAH	Polycyclic Aromatic Hydrocarbon
PEO	Premier Edible Oils
RI/FS	Remedial Investigation/Feasibility Study
SAP	Sampling and Analysis Plan
SLVs	Screening Level Values
TPH	Total Petroleum Hydrocarbon
URS	URS Corporation
US EPA	United States Environmental Protection Agency
VOCs	Volatile Organic Compounds
VPH	Volatile Petroleum Hydrocarbons

1 Introduction

On behalf of Schnitzer Investment Corp. (Schnitzer), Gradient Corporation (Gradient) in collaboration with URS Corporation (URS) has prepared this Work Plan describing additional investigations to be conducted at the Premier Edible Oils (PEO) site, located in Portland, Oregon. Building upon previous investigations, the efforts described in this Work Plan will provide supplemental information for characterizing the nature and extent of the residual contamination present at the PEO site, particularly petroleum hydrocarbon compounds. Addressing requests from the Oregon Department of Environmental Quality (DEQ) (DEQ, 2004), these investigations will also support a source control evaluation for free-phase petroleum hydrocarbon product in the southwest portion of the site. As discussed with DEQ, complete characterization of the PEO site will require additional information characterizing the environmental conditions and contaminant source areas on the adjacent upgradient Time Oil properties, particularly the Bell Terminal property. As requested by DEQ, this Work Plan includes recommendations for coordinated sampling for the PEO and Bell Terminal properties to assist in characterizing Bell Terminal contaminant sources and their impacts on the residual petroleum contamination observed on the downgradient PEO property.

The PEO property is an 18.5-acre industrial property located within an industrial area adjacent to the Willamette River (Figure 1). Between 1973 and 1997, PEO processed edible oils on the property. During World War II, the site was part of the Oregon Shipbuilding facility and the Northwest Oil Company owned and operated an aboveground petroleum storage facility in the southern portion of the site between 1941 and 1943.[1] Although Schnitzer has owned the property since 1972, it has never occupied or operated on the site. Additional information regarding site background and use is provided in the Remedial Investigation/Feasibility Study (RI/FS) Scope of Work (Bridgewater Group, 2001a). Key site features are shown on Figure 2.

Located directly adjacent to and upgradient of the PEO property, the Bell Terminal facility consists of 10 aboveground storage tanks (ASTs) with more than 12 million gallons of storage capacity, a petroleum product loading rack, and an associated above- and below-ground piping network. This petroleum product storage and transfer facility operated at this location for approximately 50 years, beginning in 1953. Both gasoline and diesel (as well as other products) were handled at this facility (Landau, 2001). As described in the initial conceptual site model prepared for the PEO site (Bridgewater

[1] Available information indicates that the Northwest Oil Company was a predecessor company to Time Oil. See, *e.g.*, LWG, 2004.

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Group, 2001a), releases and migration of petroleum product contamination from sources on the Bell Terminal property have been identified as known or potential sources of contamination on the PEO site. The impact of the Bell Terminal facility releases on the PEO site is further supported by historical information and data that have been collected during investigations at the Bell Terminal facility (*e.g.*, Gradient, 2004b, 2006; James C. Brown & Associates, 2006; Landau, 2004). Additional site characterization needs exist at the Time Oil tank farm (including the Bell Terminal facility). It is unknown when characterization of petroleum product sources and contaminant distribution on the Bell Terminal property will be completed. As reflected in DEQ's request for coordinated sampling at the PEO and Bell Terminal sites, a coordinated approach for collecting and interpreting data for these two properties is required to fully characterize contaminant sources and distribution. As noted above, this Work Plan includes recommendations for coordinated sampling at the two properties.

Investigations previously undertaken at the PEO site include: Phase I and II Environmental Site Assessments (Hanson Engineers, 1996; AGRA, 1996), a Focused Site Characterization (Bridgewater Group, 1998), and numerous sampling events undertaken by Schnitzer during the Remedial Investigation, including soil and groundwater sampling at the PEO site and selected locations in the western portion of the Bell Terminal site (Bridgewater Group, 2001b, 2002; Gradient, 2002, 2003). Locations where groundwater and soil samples were collected in the Focused Site Characterization and Remedial Investigation sampling events conducted by Schnitzer are shown in Figures 3 and 4.

The objectives and scope of work presented this Work Plan reflect a series of communications between DEQ and Schnitzer, including meetings in December 2003, August 2004, January 2005, and May 2006; a March 2004 memorandum prepared on behalf of Schnitzer recommending additional data collection efforts for the southern portion of the PEO site (Gradient, 2004a); an October 2004 letter from DEQ requesting additional sampling for the southern and central portions of the PEO site (DEQ, 2004); and other communications. The objectives and approaches for the planned investigations are presented in Section 2, while management components of the sampling program are described in Section 3.

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2 Scope of Work

2.1 Objectives

Reflecting communications between Schnitzer and DEQ, the primary objectives of the additional site investigations are as follows:

- Source Control Evaluation and Supplemental Product Characterization for the Southern Portion of the Site. DEQ has requested that Schnitzer further delineate the upland and riverward extents of the free-phase residual petroleum hydrocarbon product observed in the southwestern portion of the PEO site, evaluate potential discharge areas, and determine impacts to the Willamette River sediments and surface water, if any. This component will enhance the understanding of the distribution and behavior of residual petroleum hydrocarbon product present in the southwestern portion of the site, including tidal influences on product behavior. Tasks undertaken during this component will include installing additional monitoring wells, conducting additional studies of product behavior and properties, and integrating previous and newly collected data regarding potential impacts on the Willamette River. These investigations will support the overall conceptual site model and the goal of preparing a Source Control Evaluation for the PEO site.
- Additional Site Characterization for the Central Portion of the PEO Site. DEQ has requested further delineation of groundwater concentrations in the central portion of the PEO site. Collection of additional soil and product data is also included in this Work Plan to assist in characterizing the residual petroleum hydrocarbon contamination in this portion of the site and in understanding the nature and magnitude of Bell Terminal sources and their impacts on the contamination observed on the downgradient PEO property.

The following sections describe the specific efforts that will be undertaken to achieve these objectives. Except as specified in the addendum to the Sampling and Analysis Plan (SAP) presented in Appendix A, the efforts encompassed in this Work Plan will follow the sampling and analysis procedures presented in the SAP prepared for the RI/FS, including the procedures for quality assurance and quality control of the collected data (Bridgewater Group, 2001a). Investigation-derived waste will also be addressed in accordance with the procedures specified in the RI/FS SAP (Bridgewater Group, 2001a). Health and safety procedures during the field investigations will follow the Health and Safety Plan (HASP) prepared for the RI/FS (URS, 2001). Any necessary modifications to the previously prepared plan will be separately submitted to DEQ by Schnitzer's field subcontractors.

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2.2 Source Control Evaluation and NAPL Characterization – Southern PEO Site

Tasks undertaken in this component of the additional investigations will assist in identifying the areal extent of the residual petroleum product in the southwestern portion of the site and will provide additional information regarding product behavior, including tidal influence on product behavior. When combined with information from the scientific literature regarding tidal influences on the apparent thickness of product (*e.g.*, Kemblowski and Chiang, 1988; Hunt *et al.*, 1989), this additional information will help document the potential, if any, for the residual hydrocarbon product present in the southwestern portion of the site to be transported to the Willamette River. This enhanced understanding will provide stronger support for the overall conceptual site model, including source control evaluations for the PEO site.

2.2.1 Monitoring Well Installation and Sampling

Free-phase petroleum hydrocarbon product has been observed in monitoring wells in the southwestern portion of the PEO site. To further characterize the northern extent of this product, an additional monitoring well will be installed (*i.e.*, monitoring well MW-18). As shown in Figure 5, MW-18 will be located northwest of MW-02. During well construction, borings will be logged continuously, soil will be field-screened at regular intervals,[2] and 2"-diameter slotted screen will extend from 12 to 27 ft below ground surface (bgs). In addition, soil samples from different layers will be collected for grain size and fraction organic carbon (f_{oc}) analysis. The 2001 SAP provides additional monitoring well construction and development details (Bridgewater Group, 2001a).

In previous communications with DEQ, two other locations had been considered for additional monitoring well installation (shown as PW-A and PW-B on Figure 5). Monitoring wells will not be installed at these locations during these investigations. Location PW-A is not included because it is in close proximity to the existing monitoring well MW-08 (as well as the new monitoring well MW-18) and would not provide significant additional information regarding the northern extent of the residual petroleum product. Similarly, Location PW-B is not included because logs from previous soil borings at locations SHL-21 and SHL-22 sufficiently characterize the eastern extent of residual petroleum product in this portion of the PEO site. As discussed in Section 2.2.2, another area that was considered for monitoring well installation in previous communications with DEQ (*i.e.*, in the vicinity of boring

[2] Field screening of soil will be conducted using a photoionization detector with a 10.2 eV lamp source.

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locations PB-9 and PB-10, located in and near the concrete pad, north and east of SS-91) will be investigated through soil borings in this area.

Consistent with previous monitoring programs at the PEO site, groundwater samples will be collected from the new monitoring well on a quarterly basis for one year. As discussed in Section 2.3.4 (*Coordinated Sampling with Time Oil*), one round of groundwater samples will also be collected from the other wells previously installed in this area (*i.e.*, MW-02, MW-08, MW-09, MW-10, MW-11, MW-12, and MW-13). These samples will be collected during the initial PEO site fieldwork conducted in accordance with this Work Plan or during one of the quarterly groundwater sampling events, depending on coordination outcomes with Time Oil. These samples will be analyzed for volatile organic compounds (VOCs, including petroleum hydrocarbon components such as benzene, toluene, ethylbenzene, and xylenes or Benzene, Toluene, Ethylbenzene, and Xylenes (BTEX), using EPA Method 8260B), polycyclic aromatic hydrocarbon (PAH) compounds (using EPA Method 8270 SIM), and selected metals (*i.e.*, arsenic, chromium, copper, iron, lead, manganese, nickel, silver, and zinc, using EPA Method 6010). As requested by DEQ, these samples will also be analyzed for total petroleum hydrocarbon (TPH) compounds, including analyses of Gasoline Range Organics (GRO) and Diesel Range Organics (DRO) using NWTPH-Gx, NWTPH-Dx, and NWTPH-HCID methods, or equivalent. As discussed in more detail in Section 2.3.1, numerous limitations exist in TPH data for groundwater and the results of such analyses must be carefully interpreted. In accordance with previous practice at the site, groundwater samples will not be collected from the new well (or from a previously existing well) if free product is present at the time of sampling. Similarly, consistent with previous investigations at the site, based on ongoing review of the quarterly sampling analysis results, future modifications to the sampling parameters and frequency of groundwater monitoring for the new well may be proposed.

2.2.2 Soil Boring Installation

As shown in Figure 5, five soil borings will be installed in the southern portion of the PEO site. Soil boring PB-9 will be installed near the center of the former NW Oil Co. tank farm area to further characterize this area, while soil boring PB-10 will be installed along the southern edge of the concrete pad, east of SS-91, to help further characterize the eastern extent of the free-phase petroleum hydrocarbon plume in this portion of the site. Soil borings PB-11, PB-12, and PB-13 will be installed as shown – interspersed among previously sampled locations near the Willamette River shoreline – to further assess

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the riverward extent of LNAPL (lighter than water non-aqueous phase liquid) in this area of the site.[3] These soil borings will be installed in accordance with the procedures described in Section 2.3.3. Similarly, procedures described in Section 2.3.3 will be followed to collect and analyze soil and groundwater samples from these borings.

2.2.3 Product Thickness Monitoring

PEO site investigations undertaken to date have developed information regarding the effect of tidal fluctuations on water table elevations and groundwater flow directions. The effort described in this task will expand upon previous investigations by providing information characterizing the relationship between LNAPL product thickness and tidal fluctuations.

A short-term continuous groundwater level, river stage, and product thickness monitoring survey will be conducted over a period of 48 hours (to extend over 4 tidal cycles) at all monitoring wells within the southern portion of the site with a history of floating product (*i.e.*, wells MW-02, MW-09, MW-11, MW-12, and MW-13). The new monitoring well(s) (*i.e.*, MW-18 or any well installed at locations PB-11, PB-12, or PB-13) will also be included in this survey if product is observed at the new location(s) during the initial monitoring period. The monitoring survey will include the following specific elements:

- At product-containing wells, hourly water level and product thickness measurements will be conducted using a conductivity/optical sounding probe.
- At product-free wells, water level will be monitored at 10-minute intervals using pressure transducers and data loggers.
- During the survey, river stage will be monitored every 10 minutes using a pressure transducer/data logger installed along the river dock.

The survey will be conducted in the fall (*e.g.*, October 2006) and spring (*e.g.*, February 2007) to capture seasonally low and high river stages, respectively.

2.2.4 Product Physical and Chemical Property Measurements

Using disposable bailers, non-aqueous phase liquid (NAPL) product samples will be collected from monitoring well MW-02. NAPL samples will also be collected from monitoring well MW-04

[3] As requested by DEQ, if elevated TPH is detected at PB-11, PB-12, or PB-13, the soil boring at the location(s) where the elevated TPH is observed will be completed as a monitoring well.

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located in the central portion of the PEO site. These two monitoring wells are the locations where product has been observed most consistently and at the greatest thicknesses. The following parameters will be measured in these two samples:

- Specific gravity will be measured at room temperature by weighing a known volume of the NAPL
- Viscosity will be measured at room temperature with a Brookfield viscometer (American Society for Testing and Materials (ASTM) Method D2196), or similar
- Contact angle will be measured using the Sessile drop method described by Cohen and Mercer (1993), or similar
- Interfacial tension between free product and water will be measured using the DuNouy ring method (ASTM D971), or similar

These data are important for assessing the magnitude of the physical forces that determine product entrapment and transport.

Product samples were previously collected from monitoring wells MW-02 and MW-04 in June 2001 and were analyzed for TPH (using Methods NWTPH-Gx and NWTPH-Dx); BTEX (using EPA Method 8021B); VOCs (using EPA Method 8620B); PAH compounds (using GC/MS with selected ion monitoring or EPA Method 8270C); polychlorinated biphenyl (PCB) compounds (using EPA Method 8082); and total metals (using EPA 6000/7000 Series Methods). As a result, additional routine chemical analyses of product samples will not be undertaken during this component of the site investigations.

Product samples will also be archived for potential chemical fingerprinting analyses using modified EPA Method 8015 (Gas Chromatograph/Flame Ionization Detection (GC/FID)), and modified EPA Method 8270 (Gas Chromatograph/Mass Spectrometer with Selective Ion Monitoring (GC/MS SIM)) for PAH compounds and biomarkers (US EPA test methods SW-846). An important goal of these fingerprinting analyses would be to further explore the initial chromatographic evidence that is consistent with a common source for petroleum hydrocarbon materials on the Bell Terminal and downgradient PEO properties. As described in Section 2.3.4, these fingerprinting analyses will only be undertaken if coordinated product samples can be collected from both the PEO and Bell Terminal properties.

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2.2.5 Supplemental Sewer Flow Characterization

Available information suggests that storm sewer lines from the Bell Terminal facility discharge through PEO site piping. To clarify the origins and contributing sources to this storm sewer pipe, additional characterization of this pipe will be undertaken. These activities will include use of sewer locating techniques (*e.g.*, video inspection techniques) to identify the path of this storm sewer pipe as well as inflow locations. This information will enhance source evaluation for the southern portion of the PEO site as well as characterization of the influences of the Bell Terminal facility on the downgradient PEO property.

2.2.6 Additional Source Control Evaluations

In its October 2004 letter, DEQ requested additional investigations to support a source control evaluation, including investigating the riverward extent of the free-phase product, identifying potential discharge areas, and performing verification sampling of shallow groundwater and/or sediment.

In addition to the site-specific data that have been collected by Schnitzer, this task will also include reviewing deepwater river sediment and beach sand data that have been collected near the PEO site during investigations of the Portland Harbor Superfund site. These data include results from an investigation of river sediment within a 6-mile stretch of the Willamette River, including several sampling locations near the PEO site (Weston, 1998). In addition, in 2004, the Lower Willamette Group (LWG) collected beach samples from the vicinity of the PEO property.

As discussed with DEQ, this task of the Work Plan will include reviewing available data from these investigations that are relevant to evaluations of the PEO site. This review will include consideration of relevant Screening Level Values (SLVs) that have been identified by DEQ and the U.S. Environmental Protection Agency (EPA) in the *Portland Harbor Joint Source Control Strategy* document (DEQ and US EPA, 2005). The relevant data and observations will be summarized in both text and figures. It should be noted that caution must be exercised in interpreting the results of the sampling data collected from the river and adjacent sediments due to the presence of multiple confounding sources of many river contaminants. This issue is particularly important for chemicals with a multitude of potential sources, such as PAH compounds and petroleum hydrocarbon compounds. As discussed with DEQ in our January 2005 and May 2006 meetings, following evaluation of these data, the need for and nature of

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any additional data collection to fill any remaining data gaps in the vicinity of the PEO site will be assessed.

2.3 Additional Site Characterization - Central PEO Site

2.3.1 Technical Considerations in Collecting and Interpreting TPH Data

In its October 2004 letter, DEQ requested additional sampling in the central portion of the PEO site. Although DEQ's requests focused on groundwater data as the basis for further characterizing this portion of the site, as discussed below, various technical limitations in TPH data for groundwater may hinder accurate interpretation of such data, particularly for diesel-range and heavier hydrocarbon compounds. Moreover, the interpretation of such groundwater data may be enhanced by consideration of other types of data and contextual information. Thus, as described below, the types of data that will be collected from the central portion of the PEO site include soil and product analyses, as well as the groundwater sampling requested by DEQ. This combined suite of data will more effectively support achievement of DEQ's stated objectives.

Great care must be taken in evaluating groundwater results for PAH and TPH compounds because such results often do not represent actual groundwater quality. Instead, the results often reflect the incidental incorporation into the groundwater sample of NAPL or particles onto which PAH or TPH compounds are adsorbed. If NAPL is present at the water table or if the smear zone is contaminated with these parameters at a given well, then the results of groundwater samples collected from that location will likely be highly variable. Moreover, the groundwater sampling results at such a well are likely to reflect the precise sampling techniques used to collect the sample more than they reflect true groundwater quality.

These factors are of less concern for the volatile fraction of TPH (*i.e.*, GRO or Volatile Petroleum Hydrocarbons (VPH). Many of the constituents of lighter petroleum products (*e.g.*, gasoline) are much more soluble than the constituents in heavier products. As a result, more representative data generally can be derived from analysis of groundwater for GRO or VPH (Cline *et al.*, 1991). In areas where NAPL is present on the water table, however, incidental incorporation of NAPL or sheen material into the sample container would introduce variability into the sample results and would confound interpretation of the groundwater results to the extent that volatile compounds still are present in the NAPL.

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In contrast, PAH compounds and diesel-range or heavier TPH compounds are considered semi-volatile materials, are hydrophobic, and generally have limited solubility. The maximum concentration that any PAH or discrete TPH compound could achieve in a groundwater sample is a function of that chemical's solubility and its mole fraction in the oil that is the source of the groundwater contamination. The maximum concentrations in groundwater that could result from equilibrium with typical diesel fuel have been evaluated for several PAH compounds (Lee *et al.*, 1992). For some of the PAH compounds studied, the maximum concentrations dissolved in groundwater were less than the standard detection limits for these compounds in groundwater. As a result, for example, if fluoranthene (a 4-ring PAH compound) is detected in a groundwater sample, it must be because the sample contains NAPL or particles onto which the fluoranthene is adsorbed.[4]

Even for naphthalene (the most abundant PAH in diesel fuel and among the most soluble), the measured aqueous concentrations in equilibrium with four typical diesel fuels ranged from 0.080 – 0.30 mg/L (Lee *et al.*, 1992). In other words, these are the concentrations that would result if one placed a pint of diesel fuel and a pint of water in a single container. As a result of the natural dispersion and dilution processes that exist in the environment, the actual naphthalene concentrations in groundwater downgradient from a diesel spill would be much less.

In summary, because of their inherent chemical characteristics – *i.e.*, low solubility and high affinity for particles – dissolved forms of PAH compounds and other petroleum product constituents in the semi-volatile range are not expected to be observed in groundwater to any appreciable extent. When they are found in groundwater samples, it is usually not a true representation of groundwater quality, but instead reflects the incidental incorporation of NAPL or contaminated particles into the groundwater samples. Consequently, even though this Work Plan complies with DEQ's request that PAH and TPH compounds be measured in groundwater samples, the use of such data to infer groundwater quality for these parameters (within a quantitative framework) should proceed carefully (if at all). Moreover, as reflected in the scope of work described below, such data should be interpreted in the context of other relevant sampling data and information and the full suite of available information should be considered when interpreting the data to assess nature, extent, fate, and transport of petroleum hydrocarbon compounds at specific sites. Measurements of TPH in soil are more useful in this regard, especially in samples collected from the capillary fringe or smear zone. It is this zone where evidence of the migration

[4] In a study using special sensitive techniques, Lee *et al.* (1992) found aqueous concentrations of fluoranthene in equilibrium with diesel fuels to range from below the detection limit (unspecified) up to 0.0005 mg/L. This maximum detected level is substantially less than the typical detection limit for fluoranthene in water of 0.010 mg/L, using EPA Method 8270.

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of petroleum NAPL can best be found. Measurement of the volatile fraction of TPH (GRO or VPH) in soils can be helpful in this regard as well. In soil sampling (for volatiles especially), care must be taken to collect the sample with minimal disturbance of the soil matrix to minimize the possible loss of volatiles.

2.3.2 Monitoring Well Installation and Sampling

As requested by DEQ, three additional monitoring wells (MW-19, MW-20, and MW-21) will be installed in the central portion of the PEO site to provide supplemental information regarding the extent of contamination in this part of the site. These wells are shown on Figure 6 and are described further below:

- MW-19 to delineate the extent of groundwater contamination downgradient from the former waste water treatment plant
- MW-20 to identify the presence of free-phase product and groundwater condition near the former diesel aboveground storage tank locations
- MW-21 to evaluate the extent of groundwater contamination in the area to the south of Time Oil's Bell Terminal facility

These additional monitoring wells will be installed using the procedures presented in Section 2.2.1. In previous communications with DEQ, two other locations had been considered for additional monitoring wells. As described in Section 2.3.3, one of these locations will be investigated using a soil boring (*i.e.*, PB-8) to further characterize this area (and the option will be retained to complete this boring as a monitoring well if elevated TPH is observed during boring installation). At one other location considered for further investigation (shown as PW-C on Figure 6), no further investigation will be conducted because of its close proximity to existing monitoring well MW-06. Thus, the proposed location would not provide significant additional information regarding the lateral extent of groundwater contamination in this area.

2.3.3 Soil Boring Installation

As illustrated in Figure 6, six soil borings will be drilled with a Geoprobe drill rig to better characterize the lithology and contamination along the Bell Terminal-PEO site border (borings PB-1 to PB-6).[5] Another soil boring (boring PB-8) will be installed to characterize the northern extent of the contamination in the central portion of the site. As described in the SAP, all borings will be logged

[5] If elevated TPH is detected at PB-6, the soil boring at this location will be completed as a monitoring well and soil boring PB-7 will be installed. Soil boring PB-7 will also be installed if elevated TPH is detected at monitoring well location MW-21.

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continuously and soil will be field-screened at regular intervals.[6] Soil samples will be collected from the capillary fringe zone and submitted for chemical analyses. Consistent with previous monitoring programs at the PEO site, these samples will be analyzed for VOCs (using EPA Method 8260B), PAH compounds (using EPA Method 8270 SIM), selected metals (using EPA Method 6010), and TPH compounds (using NWTPH-Gx, NWTPH-Dx, and NWTPH-HCID methods, or equivalent). Similar soil samples and information will be collected during the installation of monitoring well MW-21. Shallow groundwater samples will also be collected from the borings and subjected to TPH analysis. More detailed fingerprinting analyses described in Section A.2.2.2 of Appendix A will be performed only if the coordinated sampling with Time Oil is undertaken (as described in Section 2.3.4). Sections A.2.6.1 and A.2.6.2 of Appendix A present the soil and groundwater sample nomenclature that will be used for the additional site investigation work.

2.3.4 Coordinated Sampling with Time Oil

DEQ recognizes that activities associated with storing millions of gallons of petroleum products on the upgradient Bell Terminal for more than 50 years may have contributed to groundwater and capillary fringe zone soil contamination on the PEO property (DEQ, 2004). Accordingly, DEQ has requested that coordinated sampling activities be conducted on the PEO and Bell Terminal properties. To address this request, this Work Plan includes tasks that would be undertaken in a coordinated sampling event for both properties. These efforts will only be undertaken if the coordinated data can be collected for both properties.

Specific tasks to be conducted in this part of the investigations include the following:

- Collecting one coordinated round of water level measurements. These measurements will be conducted during the upcoming PEO fieldwork or during one of the quarterly groundwater sampling events, depending on coordination outcomes with Time Oil.[7]
- Collecting a coordinated set of capillary fringe soil samples (and product samples, if available) and conducting fingerprinting analysis using the fingerprinting methods described in Section A.2.2.2 (Appendix A) or, at a minimum, using consistent analytical

[6] Field screening of soil from soil boring locations being considered for completion as monitoring wells will include sheen testing as described in Appendix A (*i.e.*, locations PB-6 and PB-8 in the central portion of the PEO site, and PB-11, PB-12, and PB-13 in the southern portion of the PEO site). Soil samples from location MW-21 will also be subjected to sheen testing because information from this sampling location will be used to determine whether soil boring PB-7 is installed.

[7] As discussed in Section 2.2.1, groundwater levels will be measured at all monitoring well locations on the PEO site to provide baseline data for evaluating the new PEO monitoring well locations as well as to provide the PEO component of the coordinated data for assessing potential impacts from Time Oil's Bell Terminal site. The PEO data will be evaluated in conjunction with groundwater data collected by Time Oil for the monitoring wells located on the Bell Terminal.

techniques and reporting procedures. The locations to be included in this coordinated sampling program are shown on Figure 7.[8]

- Collecting one round of groundwater samples to be submitted for chemical analysis (*i.e.*, VOCs, PAH compounds, selected metals, and TPH). Again, these measurements will be conducted during the upcoming PEO fieldwork or during one of the quarterly groundwater sampling events, depending on coordination outcomes with Time Oil.[9]

Moreover, to better characterize potential sources for residual petroleum hydrocarbons associated with the Bell Terminal facility (*e.g.*, arising from historical tank farm practices resulting in releases of petroleum products or petroleum-containing tank sludges, as documented in James C. Brown & Associates, 2006), it is recommended that soil and groundwater samples in addition to those identified on Figure 7 be collected from the Bell Terminal property. At a minimum, soil borings should be installed to collect such samples outside of the access ports to the Bell Terminal tanks where documentation of historical tank maintenance practices suggests that tank sludge disposal may have occurred. At least one soil boring should be installed near the access port to each of the three large and five medium-sized tanks on the Bell Terminal facility. Approximately 4 to 6 additional soil borings should be installed in the southwestern quadrant of the Bell Terminal facility downgradient of the access port locations for the large tanks. Representative discrete soil samples should be collected from multiple depths in each soil boring, including samples from surface, subsurface, and capillary fringe zone depths (i.e., samples should not be composited across depths or sample locations prior to laboratory analysis). All soil and groundwater samples should be analyzed for VOCs, PAH compounds, metals, and TPH. These samples could be collected by either Schnitzer or Time Oil during the coordinated sampling event.

Schnitzer will work with DEQ and Time Oil to address the logistical elements of the coordinated sampling program.

[8] As described in Sections 2.3.2 and 2.3.3, monitoring well MW-21 and soil borings PB-1 through PB-6 will be installed as part of the additional investigations of the central portion of the PEO site, and certain chemical analyses of soil samples from these locations will be undertaken. If the coordinated sampling with Time Oil occurs, the suite of chemical analyses conducted on the collected samples will be expanded to include the fingerprinting analyses discussed in Section A.2.2.2 (Appendix A).

[9] Groundwater samples for chemical analyses will be collected from all monitoring well locations on the PEO site to provide baseline data for evaluating the new PEO monitoring well locations as well as to provide the PEO component of the coordinated data for assessing potential impacts from Time Oil's Bell Terminal site. The PEO data will be evaluated in conjunction with groundwater data collected by Time Oil for the monitoring wells located on the Bell Terminal.

SCHN00303416

3 Management Plan

3.1 Schedule

The proposed schedule for implementation of the additional PEO site investigation activities includes:

Submittal/Scope Activity	Date
Final Work Plan	Submitted to DEQ during the week of July 31, 2006
Initiation of Site Activities	Within 30 days after DEQ approval of final Work Plan
Scope of Work Outline for Additional Source Control Evaluations	Within 90 days after completion of field work
Draft Report	Within 90 days after completion of field work
Final Report	Within 45 days after receipt of DEQ comments on the draft report.

If necessary, a supplemental work plan for additional sampling to support the source control evaluations discussed in Section 2.2.6 will be submitted to DEQ for review and approval. As necessary, additional work plan elements will be processed according to schedules negotiated between Schnitzer and DEQ.

3.2 Project Team

Schnitzer's technical project team consists of:

- Tom Zelenka/Schnitzer – PEO Project Manager
- Jim Jakubiak/Schnitzer – PEO Technical Project Manager
- Catherine Petito Boyce/Gradient – Lead Consultant

In addition, Gradient will direct subcontractors selected by Schnitzer to perform the field tasks. The selected subcontractors will be firms and individuals with the requisite technical expertise to conduct their particular work scope.

SCHN00303417

3.3 DEQ Communications and Reporting

As required by Section VII of Attachment B to Schnitzer's Voluntary Cleanup Agreement, quarterly reports will be submitted to the DEQ by the 15th day of the quarter following the reporting period. The quarterly reports shall summarize the activities performed, sampling data collected or received, problems encountered or resolved during the previous quarter, and activities planned for the upcoming quarter.

SCHN00303418

References

AGRA. 1996. "Phase II Environmental Site Assessment, Industrial Property at 10400 N. Burgard Way, Portland, OR." November.

Bridgewater Group, Inc. 1998. "Focused Site Characterization for 10400 N. Burgard Way." September.

Bridgewater Group, Inc. 2001a. "Remedial Investigation/Feasibility Study, Scope of Work, Premier Edible Oils Site, 10400 North Burgard Way, Portland, Oregon." April.

Bridgewater Group, Inc. 2001b. "Preliminary Results - Remedial Investigation, Premier Edible Oils Site." September 7.

Bridgewater Group, Inc. 2002. "Results – Geoprobe Investigation, Time Oil - Bell Terminal Facility, western area." April 18.

Cline, PV; Delfino, JJ; Rao, PS. 1991. Partitioning of aromatic constituents into water from gasoline and other complex mixtures. *Environ. Sci. Technol.* 25:914-920.

Cohen, RM; Mercer, JW. 1993. "DNAPL Site Evaluation." Report to US EPA, Robert S. Kerr Environmental Research Laboratory (Ada, OK) National Technical Information Service (NTIS) (Springfield, VA) EPA/600/R-93/022, NTIS PB93-150217. February.

Gradient Corporation. 2002. Letter to A. Voss (DEQ) re: Fifth quarterly report for Premier Edible Oils Site, 10400 North Burgard Way, Portland, Oregon. October 14.

Gradient Corporation. 2003. Letter to A. Voss (DEQ) re: Seventh quarterly report for Premier Edible Oils Site, 10400 North Burgard Way, Portland, Oregon. April 17.

Gradient Corporation. 2004a. Memo to A. Voss of DEQ re: Recommended Additional Data Collection for the Southern Portion of the Schnitzer PEO Site, Portland, OR. March 4.

Gradient Corporation. 2004b. Memo to A. Voss of DEQ re: Comments on Time Oil's Phase III Remedial Investigation Report. September 10.

Gradient Corporation. 2006. Memo to C. Humphrey and E. Blischke (U.S. Environmental Protection Agency) re: Comments on the Lower Willamette Group's Draft Conceptual Site Model for the Premier Edible Oils Site. March 1.

Hanson Engineers Inc. 1996. "Environmental Site Assessment (Phase I), Premier Edible Oils Refinery, 10400 North Burgard Way, Portland, Oregon 97203." October.

Hunt, WT; Wiegund, JW; Trompeter, JD. 1989. Free gasoline thickness in monitoring wells related to groundwater elevation change. *In Proceedings of the New Field Techniques for Quantifying the Physical and Chemical Properties of Heterogeneous Aquifers, Dallas, TX.* March.

James C. Brown & Associates. 2006. White Paper – Contaminant Sources at the Premier Edible Oil Site ESCI #2013 Located within the Portland Harbor Superfund Site. March 6.

Kemblowski, MW; Chiang, CY. 1988. Analysis of the measured free product thickness in dynamic aquifers. In *Proceedings of the Conference on Petroleum Hydrocarbons and Organic Chemicals in Groundwater: Prevention, Detection, and Restoration, Houston, TX.* November.

Landau Associates, Inc. (Landau). 2001. "Phase II Remedial Investigation, Time Oil Northwest Terminal, Portland, Oregon." February 9.

Landau Associates, Inc. (Landau). 2004. "Phase III Remedial Investigation Report, Time Oil Northwest Terminal, Portland, Oregon." April 30.

Lee, LS; Hagwell, M; Delfino, JJ; Rao, PS. 1992. Partitioning of polycyclic aromatic hydrocarbons from diesel fuel into water. *Environ. Sci. Technol.*, 26:2104-2110.

Lower Willamette Group (LWG). 2004. "Portland Harbor RI/FS – Draft Conceptual Site Model Update (Volumes 1 through 3)." Prepared by Integral Consulting, Inc. and Groundwater Solutions, Inc. September 17.

Oregon Department of Environmental Quality (DEQ). 2004. Letter to J. Jakubiak of Schnitzer Investment Corp. re: Additional investigations at the former Premier Edible Oils property. October 18.

Oregon Department of Environmental Quality (DEQ) and U.S. Environmental Protection Agency (US EPA). 2005. "Portland Harbor Joint Source Control Strategy." December.

Roy F. Weston, Inc. (Weston). 1998. "Portland Harbor Sediment Investigation Report, Multnomah County, Oregon." US EPA Region 10 (Seattle, WA) EPA 910/R-98-006. May.

URS. 2001. Health and Safety Plan for the RI/FS Scope of Work, Premier Edible Oils Site, 10400 N. Burgard Way, Portland, Oregon. April.

US EPA. "Test Methods for Evaluating Solid Waste, Physical/Chemical Methods." Accessed March 1, 2006 from http://www.epa.gov/epaoswer/hazwaste/test/main.htm.

SCHN00303420

Gradient
CORPORATION

Collaborative Role of URS Corporation

This work plan was prepared by Gradient Corporation in collaboration with URS Corporation (URS) on behalf of Schnitzer Investment Corp. (SIC) to support evaluations of SIC's Premier Edible Oils site. URS has collected, compiled, documented, and interpreted the geological data available for this site, and has contributed to, reviewed, and concurred with the geological interpretations presented in this work plan.

URS CORPORATION

Donald M. Coberley

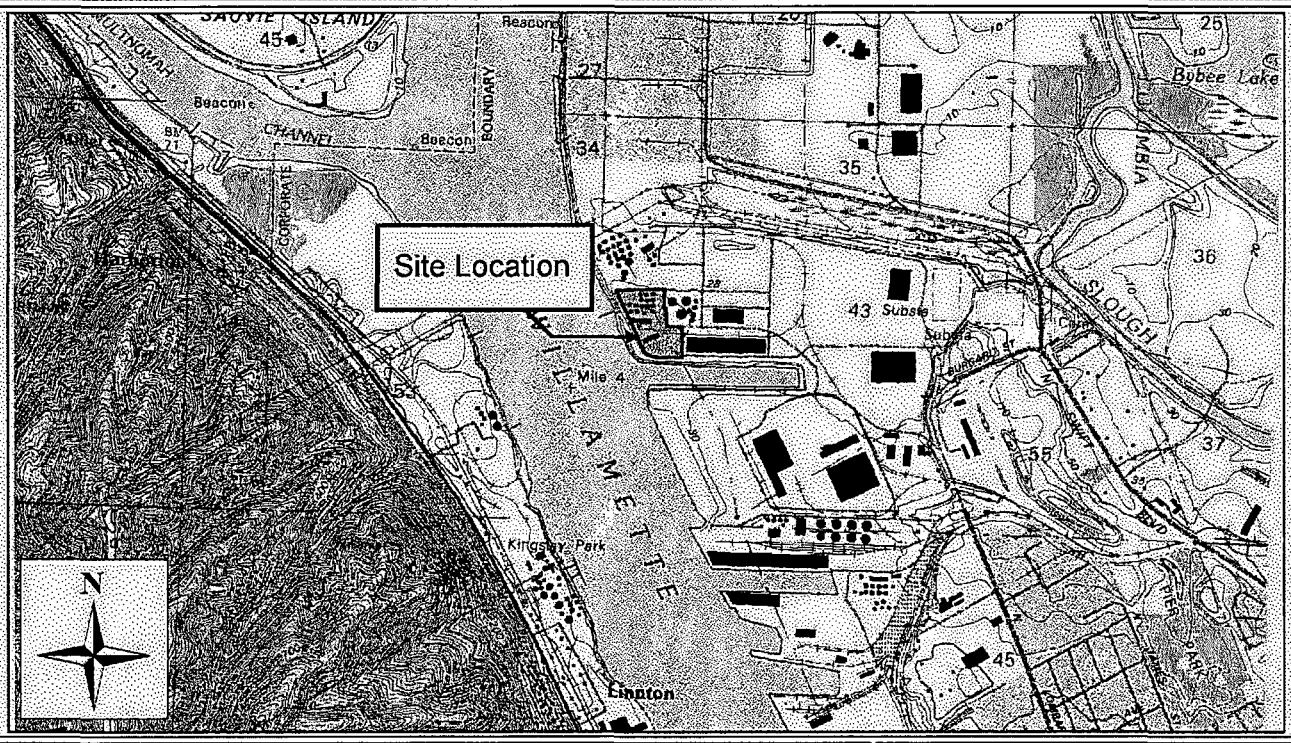
Don Coberley, RPG
Senior Hydrogeologist

REGISTERED
OREGON
DONALD MICHAEL COBERLEY
Donald M. Coberley
No. G1866
GEOLOGIST

SCHN00303421

Figures

\202017\Graphics Group\Other Graphics\101\202017-101_01.ai



Map Source: USGS

Gradient CORPORATION

SUITE 803, 600 STEWART STREET • SEATTLE, WA 98101 • (206)267-2921

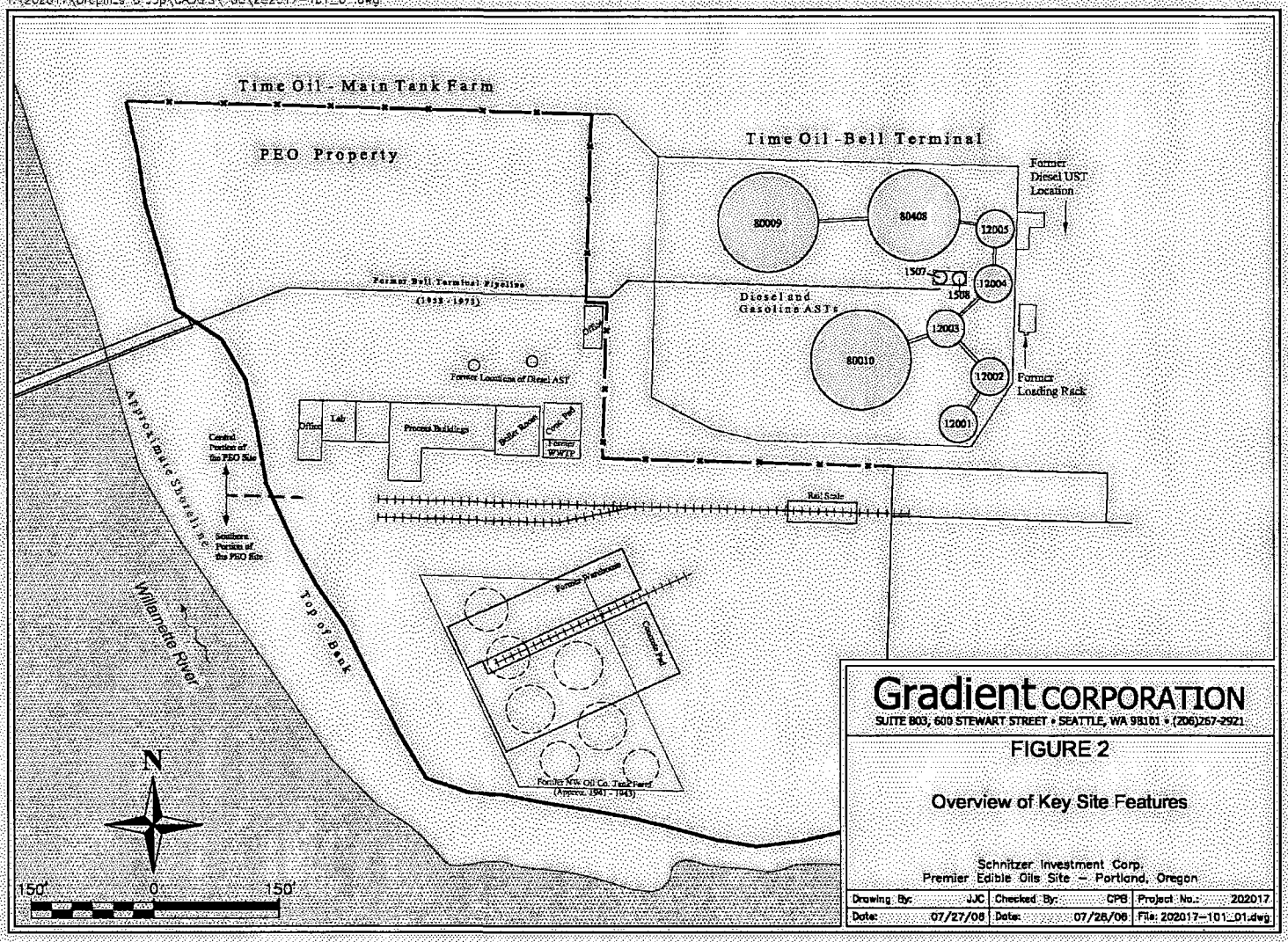
FIGURE 1

Site Location

Schnitzer Investment Corp.
Premier Edible Oils Site — Portland, Oregon

Drawing By:	JJC	Checked By:	CPB	Project No.:	202017
Date:	07/27/06	Date:	07/28/06	File:	202017-101_01.ai

SCHN00303423



Gradient CORPORATION
SUITE 803, 600 STEWART STREET • SEATTLE, WA 98101 • (206)267-2921

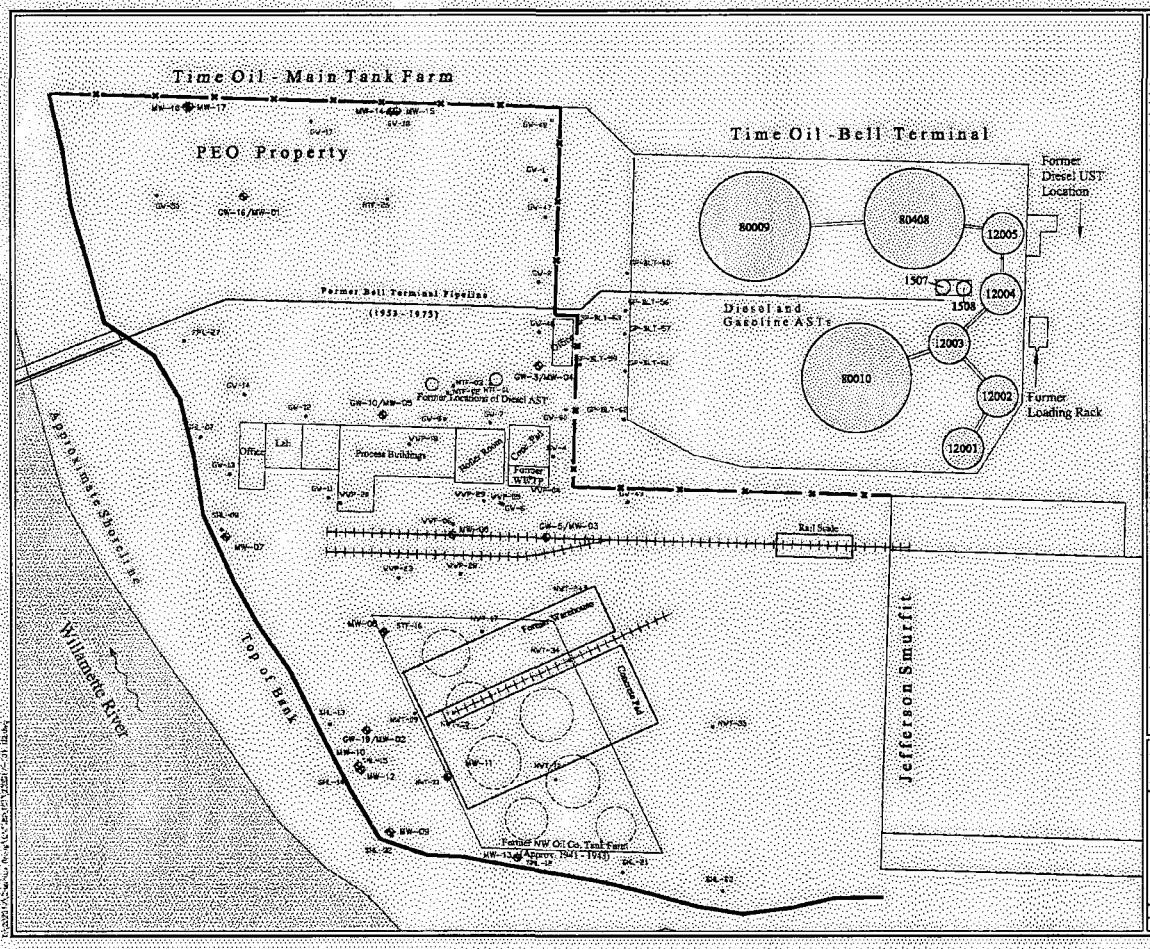
FIGURE 2

Overview of Key Site Features

Schnitzer Investment Corp.
Premier Edible Oils Site – Portland, Oregon

Drawing By:	JJC	Checked By:	CPB	Project No.:	202017
Date:	07/27/06	Date:	07/28/06	File:	202017-101_01.dwg

SCHN00303424



LEGEND

Monitoring Well Location

Geoprobe Location

NOTES:

1) Focused Site Characterization samples (GW-samples) were collected in September 1998.

2) Preliminary Remedial Investigation samples (SHL-, NWT-, STF-, NTF-, FPL-, and WWP-) were collected in May 2001.

3) Bell Terminal samples (GP-BLT samples) were collected by Schnitzer in October 2001.

4) Groundwater sampling at MW-locations was conducted in June and October 2001; March 2002, and January 2003.

Sampling locations shown on this figure reflect sampling conducted by Schnitzer.

N

100' 0 100'

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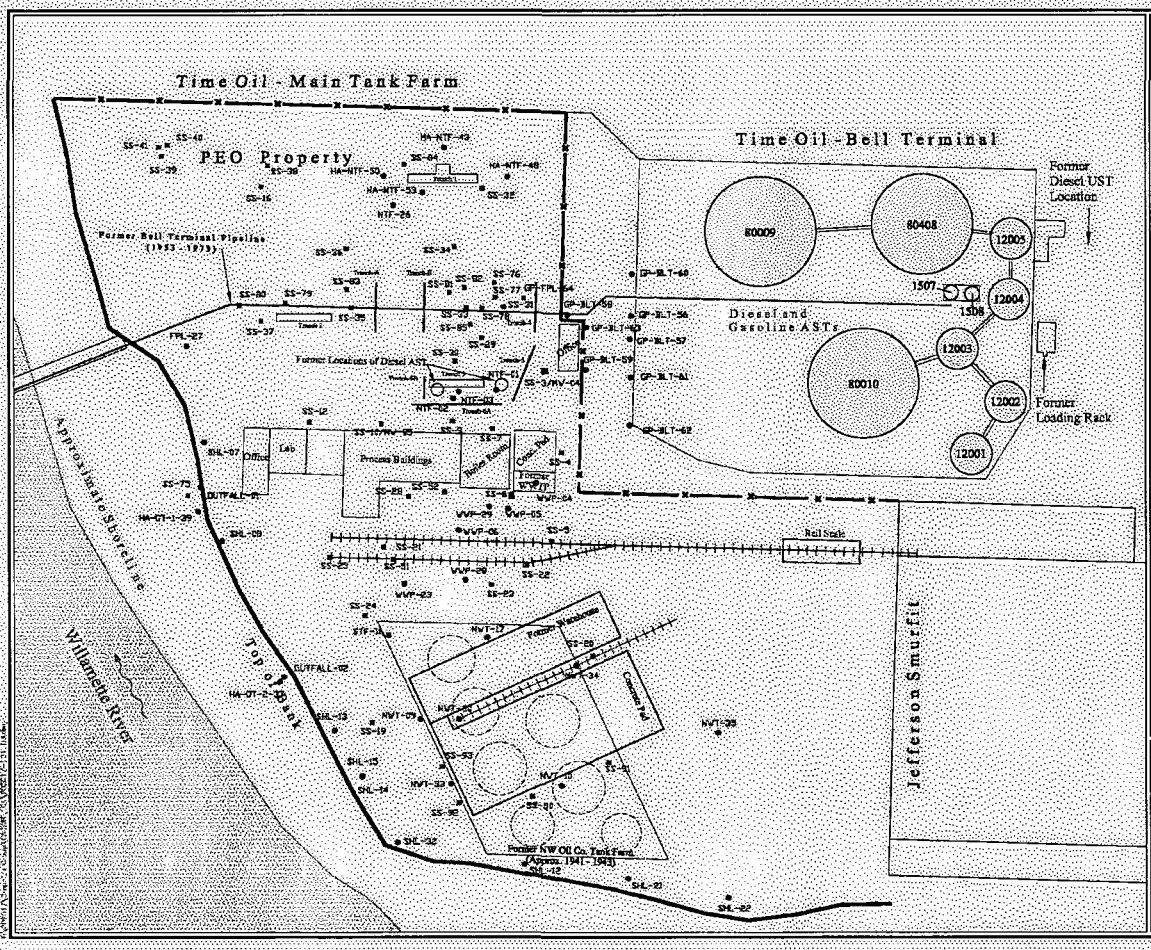
FIGURE 3

Previous Groundwater Sampling Locations

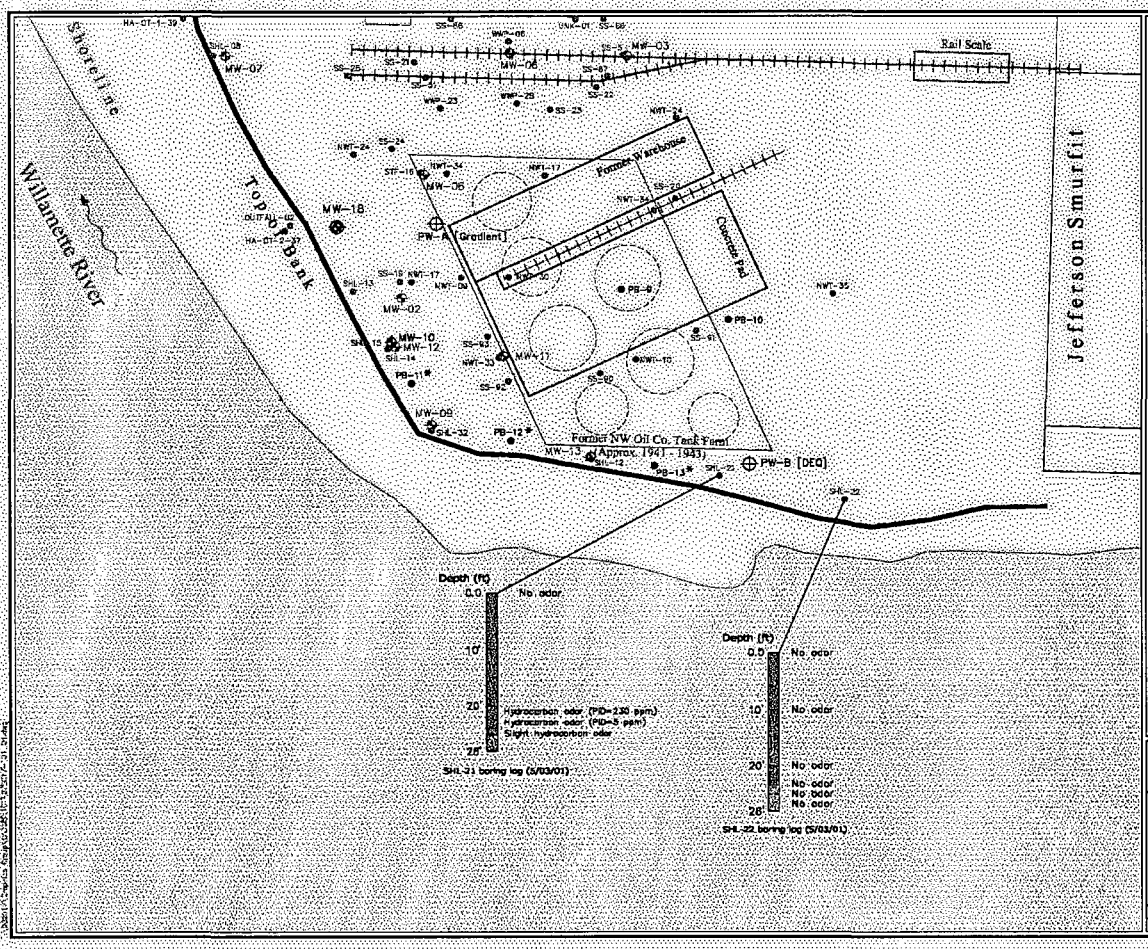
Schnitzer Investment Corp.
Premier Edible Oils Site – Portland, Oregon

Drawing By:	JJC	Checked By:	CPB	Project No.:	202017
Date:	07/27/06	Date:	07/28/06	File:	202017-101_02.dwg

SCHN00303425



SCHN00303426



LEGEND

- New Upper Zone Monitoring Well (included in Sampling Work Plan)
- Proposed Upper Zone Monitoring Well (not included in Sampling Work Plan)
- Existing Upper Zone Monitoring Well (Screen 12-27 FT BGS)
- Existing Lower Zone Monitoring Well (Screen 41-46.7 and 47.4-52.4 FT BGS)
- New Soil Boring
- Previous Boring Location

* If elevated TPH is observed at this location, this soil boring will be completed as a monitoring well.

NOTE:
Former NW Oil Co. tank locations are approximate as interpreted from a 1943 aerial photograph.

N

80' 0 80'
APPROX. SCALE IN FEET

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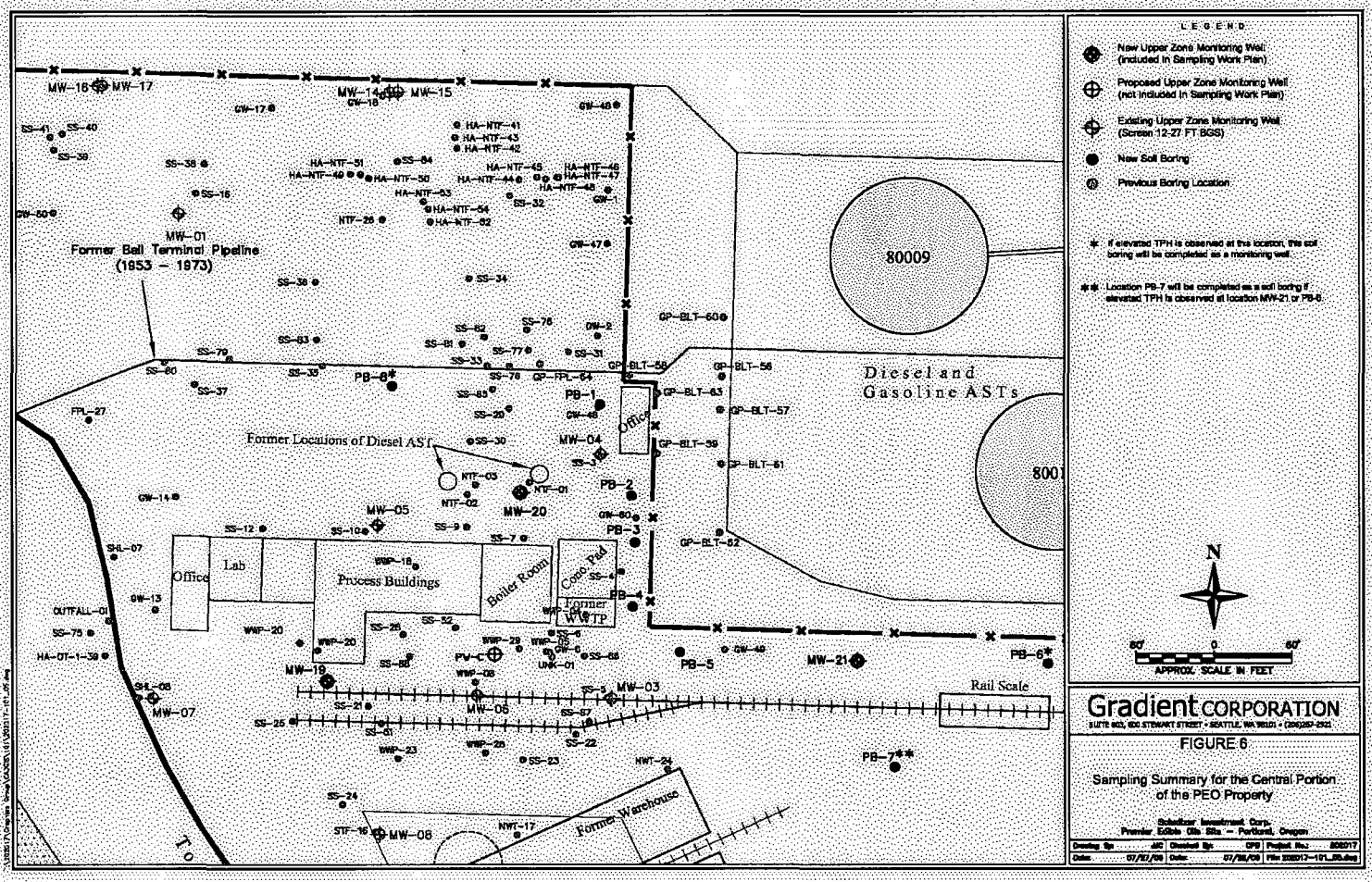
FIGURE 5

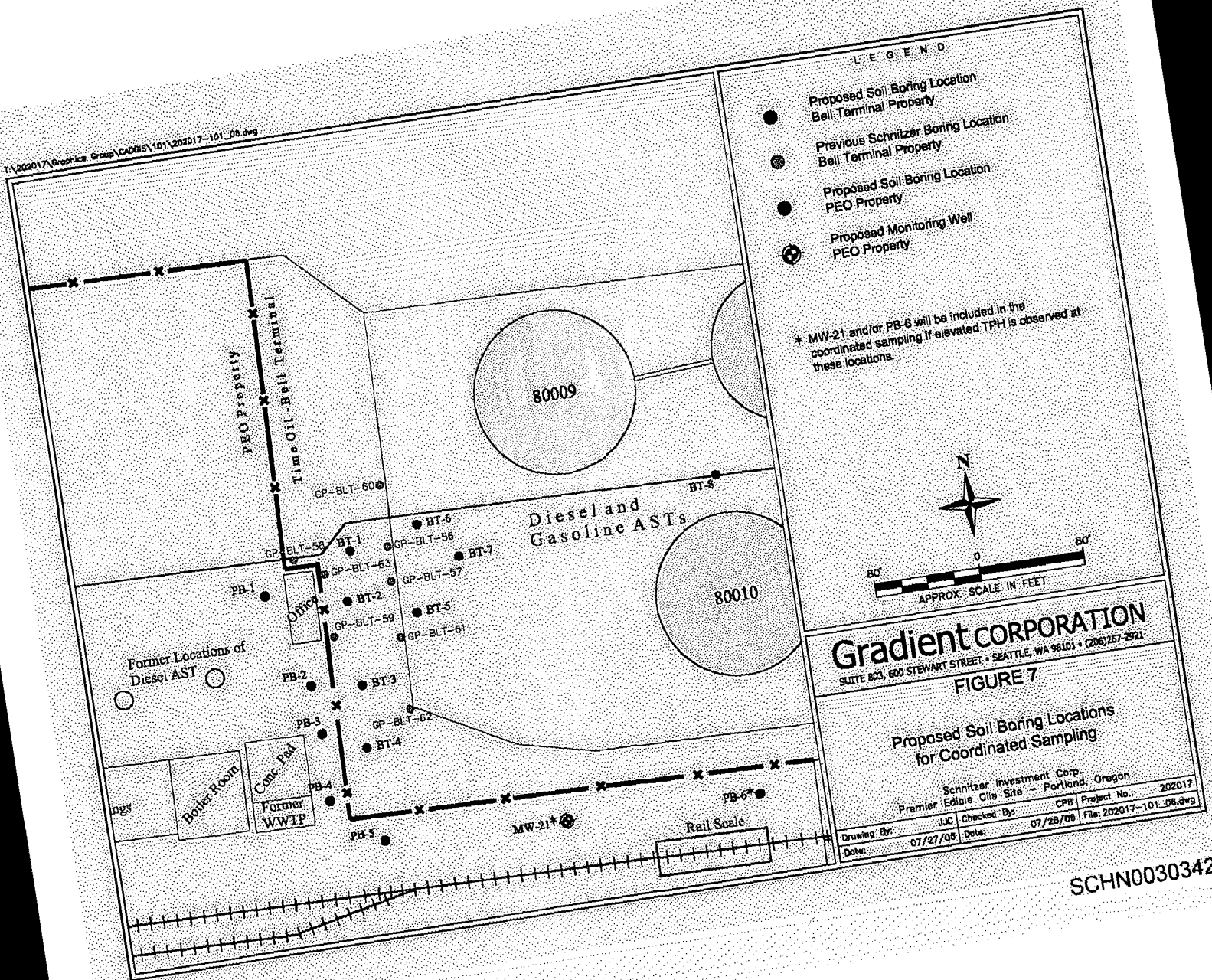
Sampling Summary for the Southern Portion of the PEO Property

Schnitzer Investment Corp.
Premier Edible Oils Site - Portland, Oregon

Drawing By: JJC	Checked By: CPS	Project No.: 202017	
Date: 07/27/06	Date: 07/28/06	File: 202017-101_04.dwg	

SCHN00303427


LEGEND
New Upper Zone Monitoring Well (included in Sampling Work Plan)
Proposed Upper Zone Monitoring Well (not included in Sampling Work Plan)
Existing Upper Zone Monitoring Well (Screen 12-27 FT BGS)
New Soil Boring
Previous Boring Location
* If elevated TPH is observed at this location, the soil boring will be completed as a monitoring well.
** Location PB-7 will be completed as a soil boring if elevated TPH is observed at location MW-21 or PB-6.
N
60' 0 60'
APPROX. SCALE IN FEET
Gradient CORPORATION
SUITE 803, 600 STEWART STREET • SEATTLE, WA 98101 • (206)267-2922
FIGURE 6
Sampling Summary for the Central Portion of the PEO Property
Schnitzer Investment Corp.
Premier Edible Oils Site – Portland, Oregon
Drawing By: JJC Checked By: CPG Project No.: 200017
Date: 07/07/09 Date: 07/08/09 File: 200017-101_05.dwg
Former Bell Terminal Pipeline (1953 – 1973)
Former Locations of Diesel AST
Diesel and Gasoline ASTs
80009
8001
Office
Lab
Process Buildings
Boiler Room
Coon Pad
Former WWTP
Former Warehouse
Rail Scale
MW-01
MW-03
MW-04
MW-05
MW-06
MW-07
MW-08
MW-14
MW-15
MW-16
MW-17
MW-18
MW-19
MW-20
MW-21
PB-1
PB-2
PB-3
PB-4
PB-5
PB-6*
PB-7**
PV-C
OUTFALL-01



SCHN00303429

Appendix A

Addendum to the April 2001 Sampling and Analysis Plan

Addendum to the April 2001 Sampling and Analysis Plan

Premier Edible Oil Property

Portland, Oregon

Prepared for
Schnitzer Investment Corp.
3200 NW Yeon Avenue
Portland, OR 97210

Prepared by

Gradient Corporation
Plaza 600 Building, Suite 803
600 Stewart Street
Seattle, WA 98101

in Collaboration with

URS Corporation
111 SW Columbia, Suite 1500
Portland, OR 97201

August 2, 2006

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Section A2.2.2 Geoprobe Soil Samples A-1
Section A2.6.1 Soil Sample Nomenclature A-2
Section A2.6.2 Groundwater Sample Nomenclature A-3

1 Introduction

This addendum contains amendments to the Sampling and Analysis Plan (SAP) submitted in April 2001 to DEQ by Bridgewater Group as part of the documentation for the Scope of Work for the Remedial Investigation and Feasibility Study (RI/FS) (Bridgewater Group, 2001a).

2 Amended Sections

Section A2.2.2 Geoprobe Soil Samples

As described in the main text of this Work Plan, sheen testing will be conducted for soil collected from certain sampling locations. The sheen testing will be conducted using the following procedure. Soil to be tested (10-20 grams) will be placed in a wide-mouth sample jar (8 oz. or larger), or in a shallow, flat-bottom pan. Deionized water (40-50 l) will be added to the soil. The soil and water will be agitated to mix well. The water surface will be observed for the presence and (if present) color of sheen. The presence of any free globules of hydrocarbon product in the water will also be noted. The observations will be recorded. If a shallow, flat-bottom pan is used, the pan will be decontaminated between tests with Alconox solution, followed by a rinse with deionized water.

If the coordinated sampling with Time Oil is conducted, soil samples from sampling locations PB-1 through PB-5 (and possibly sampling locations PB-6 and/or MW-21, if elevated TPH is observed at these locations) will be placed in an appropriate sample jar provided by the offsite laboratory[1] and cooled to 4°C. (See Table 1 for sample collection, preservation, and holding times.) Selected soil samples collected from the capillary fringe zone will be submitted for fingerprinting analyses using the following methods:

- <u>NWTPH-Gx (GRO) and NWTPH-Dx (DRO)</u>: Gas chromatography with flame ionization detection (GC/FID), providing data on total petroleum hydrocarbons (TPH), n-alkanes, pristane, and phytane as well as a chromatograms for visual evaluation;
- <u>Modified EPA Method 8270</u>: Gas chromatography with mass spectrometry using selected ion monitoring (GC/MS SIM), providing data on parent and alkylated polycyclic aromatic hydrocarbon (PAH) compounds;

[1] Samples will be sent to Wood Hole Group laboratory in Massachusetts for analysis. Soil samples collected for GRO (gasoline range organics) will be methanol-preserved. No chemical preservation is necessary for soil samples collected for DRO (diesel range organics) analysis.

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- Modified EPA Method 8270: GC/MS SIM providing data on steranes and triterpanes (collectively known as biomarkers).

Table 1. Soil Sample Collection, Preservation, and Holding Times

Method	Matrix	Container	Preservation	Holding Time
NWTPH -Gx	Soil	VOC vial or container; add 15 g to 40 mL vial; 25 g to 60 mL vial.	1 mL methanol per 1 g soil (+/- 25%); cool to 4°C.	28 days.
NWTPH -Dx	Soil	4-oz (120 mL) +/- wide mouth amber glass jar with Teflon-lined screw cap.	Cool to 4°C.	Extract within 7 days; analyze extract within 40 days.

Note:
The offsite laboratory will provide containers.

Section A2.6.1 Soil Sample Nomenclature

Consistent with the soil sample nomenclature described in the SAP, the following nomenclature will be used for the soil boring samples collected from the PEO property in this phase of the investigations:

xx-yy-dd-tt

where

xx = the type of sample with:

GP = Geoprobe™ sample

yy = the investigation identifier, with:

PB = PEO boring (for all soil samples collected from the PEO site in this phase of the investigations)

dd = the depth from the existing ground surface to the middle of the sample interval, in feet

(*e.g.*, for a sample collected from 17.5 to 18.5 ft bgs, d=18).

The thickness of the soil sample collected will be detailed in the field notes.

dd can include a decimal point (*e.g.*, dd could equal 12.5)

tt = The sequential sampling location number corresponding to the sample locations identified in Figures 5 through 7 (*e.g.*, for sampling location PB-1, t = 01). Duplicate samples will be identified in the field notes and will be assigned a unique numerical identifier for t.

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If the coordinated sampling with the Time Oil property is undertaken, yy for any soil samples collected by Schnitzer will equal BT (for Bell Terminal).

Section A2.6.2 Groundwater Sample Nomenclature

For Geoprobe™ samples, the following nomenclature will be used for groundwater samples collected from Geoprobe™ borings:

GP-yy-tt

where

yy = the investigation identifier, with:

PB = PEO boring (for all Geoprobe™ groundwater samples collected from the PEO site in this phase of the investigations)

tt = The sequential sampling location number corresponding to the sample locations identified in Figures 5 through 7 (*e.g.*, for sampling location PB-1, t = 01). Duplicate samples will be identified in the field notes and will be assigned a unique numerical identifier for t.

If the coordinated sampling with the Time Oil property is undertaken, yy for any groundwater samples collected by Schnitzer from Geoprobe™ locations will equal BT (for Bell Terminal).

For groundwater samples collected from monitoring wells (including quarterly monitoring samples), the following nomenclature will be used:

MW-tt-nnnnnn

where

tt = The sequential sampling location number corresponding to the sample locations identified in Figures 5 through 7 (*e.g.*, for sampling location MW-18, t = 18). Duplicate samples will be identified in the field notes and will be assigned a unique numerical identifier for t.

nnnnnn = date sample collected (*e.g.*, for January 15, 2006, t = 011506)

Appendix A-17

Time Oil - NW Terminal

TIME OIL NORTHWEST TERMINAL

Oregon DEQ ECSI #: 170

10350 N. Time Oil Rd.
DEQ Site Mgr: Tom Roick
Latitude: 45.6161°
Longitude: -122.7832°
Township/Range/Section: 2N/1W/34, 35

River Mile: 4 East bank

LWG Member ☒ Yes ☐ No

Upland Analytical Data Status: ☒ Electronic Data Available ☐ Hardcopies only

1. SUMMARY OF POTENTIAL CONTAMINANT TRANSPORT PATHWAYS TO THE RIVER

The current understanding of the transport mechanism of contaminants from the uplands portions of the Time Oil site to the river is summarized in this section and Table 1, and supported in following sections.

1.1. Overland Transport

Little to no overland transport of contaminants via soil erosion occurs at the Time Oil Northwest Terminal (Terminal). The tank farms are surrounded by containment walls or berms. Most of the other areas of the site within the former terminal operations areas are paved or covered with gravel fill and stormwater mainly infiltrates the ground. Any stormwater runoff is collected in the storm drain or treated at the onsite wastewater treatment system. No spills or releases to the surface will occur in the future because the terminal is no longer in operation (Landau Associates 2004).

1.2. Riverbank Erosion

The riverbank is outside the former operation areas of the terminal; therefore, no riverbank sediments have been exposed to materials formerly stored or handled at the terminal. Asphaltic concrete riprap placed at the adjacent Schnitzer property has eroded and moved downstream onto an area of the Terminal riverbank.

1.3. Groundwater

Groundwater flow direction in the upper and lower groundwater zones at the Terminal is toward the Willamette River (Landau Associates 2004). Consequently, there is a potential for dissolved chemicals in groundwater or LNAPL from the Main Terminal tank farm to be transported to the river by groundwater flow. Because seeps have not been observed in the riverbank adjacent to the Terminal, groundwater likely discharges to the river below the water line. Additionally, the east-west trending storm drain could historically have provided a preferential pathway for the transport of pentachlorophenol (PCP)-impacted groundwater originating from the wood treatment product formulation source area to the river; however, capture of shallow groundwater with the groundwater intercept system installed in the storm drain line (and the proposed use of *in situ* chemical oxidation in the PCP plume areas) provides capture of contaminant migration in groundwater from this source area to the river (Landau Associates 2004).

1.4. Direct Discharge *(Overwater Activities and Stormwater/Wastewater Systems)*

There is one stormwater outfall at the Terminal which discharges to the Willamette River. Stormwater from the Terminal entrance area, the low topographic area east of the rail spur, and the eastern portion of the property (East Property) is collected into the main storm drain line for discharge into the Willamette River via this private outfall. Time Oil has a general NPDES permit for industrial stormwater discharge. Based on detections of PCP in water collected from the storm drain in _____(*placeholder*), it appears that, historically, upper zone groundwater infiltrated into the storm drain. A groundwater intercept system was installed in the storm drain in October 2002 (see Section 11.2).

Stormwater from the industrial areas of the terminal and wastewater from the currently operating groundwater remediation systems are collected and treated at an onsite wastewater treatment system before discharge to the City of Portland POTW.

1.5. Relationship of Upland Sources to River Sediments

See Final CSM Update.

1.6. Sediment Transport

The Time Oil property is located along the east bank of the river at approximately RM 3.5, across and just upstream of the Multnomah Channel. The offshore channel area in this region is characterized as transitional/depositional in the Portland Harbor Work Plan based on the sediment-profile and time-series bathymetry surveys (Integral et al. 2004). The Sediment Trend Analysis® results suggest that the eastern half of the river here is in dynamic equilibrium, while the western portion alternatively experiences both net accretion and net erosion. Time-series bathymetric change data over the 25-month period from January 2002 through February 2004 (Integral and DEA in prep.) show that the channel slope between the –10 and the –30 foot NAVD88 contours just off of the site is predominately erosional (scour up to 1 foot in extent). Beyond the –30 contour, the channel environment offshore of the site by and large shows no elevation change over this measurement period. No bathymetric change data is available above the –10 foot NAVD88 contour immediately adjacent to the property due to limited survey vessel access.

2. CSM SITE SUMMARY REVISIONS

Date of Last Revision: September 17, 2004

3. PROJECT STATUS

Activity		Date(s)/Comments
PA/XPA	☒	PA Equivalent, 1993
RI	☒	2 phases – 1996 through 2004; risk assessment initiated
FS	☒	Soil stockpile only, 2001
Interim Action/ Source Control	☒	Approximately 12,250 tons of contaminated soil removed and treated offsite – 2002; east property removal action – 1996; groundwater recovery wells – 1999; groundwater intercept system – 2002; east property remedial action – 2002; in situ chemical oxidation for shallow soil and groundwater – ongoing
ROD	☐	
RD/RA	☐	
NFA	☒	Conditional (industrial use only) for eastern 23 acres of property, 2003 UST decommissioning, Bell Terminal, 2001

DEQ Portland Harbor Site Ranking (Tier 1, 2, or 3): 2

4. SITE OWNER HISTORY

[Primary Source: DEQ 2004, 1999; Landau Associates 1993, 2004]

Owner/Occupant	Type of Operation	Years
Northwest Terminal Co. (owner) Time Oil Co. (operator)	Petroleum products handling and storage	1943-present
Koppers Company	Wood treatment products storage and formulation	1967 to 1982
Crosby & Overton	Waste oil storage	1974 to 1989

5. PROPERTY DESCRIPTION

The Time Oil Northwest Terminal is a former bulk petroleum storage and transfer facility owned by Northwest Terminal Co. and operated by Time Oil Co. (Time Oil) since 1943. Time Oil ceased operations at the Terminal on October 31, 2001. The facility is located in the industrialized Rivergate area of north Portland, Oregon. The Terminal is bordered to the east and south by heavy industrial complexes, to the north by heavy industrial property and Port of Portland undeveloped property, and to the west by the Willamette River. The Terminal is approximately 52 acres in size and is generally flat with an average land surface elevation of about 28 ft above mean sea level (MSL). The Terminal is enclosed by a terminal-wide chain link fence and access is through the main gate at the termination of Time Oil Road. Current and historical land use for the Terminal and the adjacent properties is primarily industrial [heavy industrial (IH)].

Within the Terminal, there are several features that are distinguished by historical operations [see Supplemental Figure 2-1 from Landau Associates (2004)]:

- Main Terminal and Bell Terminal tank farms, including 21 aboveground storage tanks (ASTs) in the Main Terminal tank farm area and 10 ASTs in the Bell Terminal tank farm area. The storage tanks range from 3,000 to 80,000 barrels in size. Historically, the tanks stored various petroleum products, including gasoline, diesel and ethanol. Currently, all tanks are empty except for one in the main tank farm area, which is used to store wastewater prior to treatment at the onsite wastewater treatment system.

- Former ASTs used for storage of aviation gasoline (two) and butane storage (one). The tanks are currently empty.
- Former petroleum transfer and receipt facilities, including above and below ground piping, product receipt facilities via rail, truck, and vessel, and product distribution facilities via truck and rail (three loading racks), and via marine vessels (a 380-ft dock in the Willamette River). None of these facilities are still in use.
- The wastewater treatment system (WWTS) used to treat Terminal stormwater runoff for the industrial portions of the Terminal, investigation wastewater (e.g., development and purge water from monitoring and recovery wells), and remediation wastewater (e.g., groundwater from the groundwater interim action system) before discharge to the sanitary sewer line along Time Oil Road under permit with the City of Portland. Stormwater routed to the WWTS originates from former industrial areas of the main part of the Terminal.
- Storm drain lines consisting of the main line running east-west along the length of the Terminal about 160 ft north of the southern property boundary. Stormwater from the Terminal entrance area, the low topographic area east of the rail spur, and the undeveloped eastern portion of the property is collected into the main storm drain line for discharge into the Willamette River. In the fall of 2002, a groundwater intercept system was installed within the east-west trending storm drain to capture groundwater infiltrating into the concrete storm drain line.
- Subsurface utilities consisting of thousands of feet of pipeline underlying the facility and adjacent areas, including public utilities (e.g., electrical and water) and private utilities (e.g., hydrant lines). All product lines were flushed and cleaned upon cessation of operations at the Terminal.
- Entrance, former office, warehouses, and equipment maintenance area.

The Terminal leased a small submerged area from the Oregon Department of State Lands in 1993. An L-shaped area at the end of the loading dock was used for containment boom storage between June and August of 1993.

6. CURRENT SITE USE

All terminal operations ceased on October 31, 2001. Current site use is solely for oversight and compliance monitoring for the groundwater recovery system and wastewater treatment system. The pre-2001 facilities are still present, but have been decommissioned. Demolition of the terminal is planned.

7. SITE USE HISTORY

Prior to development of the property by Time Oil Co in 1943, the property was undeveloped river floodplain, as shown in historical aerial photographs. The photographs do not show any indication of surface water bodies on the property prior to development. It is assumed that dredged fill material was placed into this area around the turn of the 20th century, based on the similar practices along the river, but there is no documentation of the specific dates of this activity. The Main tank farm was initially constructed in 1943. From 1943 to 2001, the Terminal was operated by Time Oil as the Northwest Terminal petroleum products facility. During this period, the Terminal was used for the receipt, storage, and distribution of petroleum and petroleum-related products. Petroleum products were received and distributed at the Terminal via rail, truck, and marine vessel (a 380-ft dock in the Willamette River). Historically, Time Oil leased tank space to Crosby & Overton for storage of waste oils, and, from 1967 to 1982, the Koppers Company leased tanks and property at the Terminal for the formulation and blending of PCP-containing wood treatment products.

8. CURRENT AND HISTORIC SOURCES AND COPCS

The understanding of historic and current potential upland and overwater sources at the site is summarized in Table 1. Site features are shown on Supplemental Figure 2-1 (Landau Associates 2004) in Attachment A. A conceptual site model for the terminal is shown on Supplemental Figure 8-1 (Landau Associates 2004; Attachment A). The following sections provide a brief overview of the potential sources and COPCs at the site requiring additional discussion.

8.1. Uplands

Five areas of the terminal are considered to be historic sources for contaminants in soil only or in soil and groundwater. These areas include:

Former pentachlorophenol mixing area where specialty wood treating products containing PCP in various formulations (typically with petroleum based carriers) were blended and stored for offsite shipment. The former PCP mixing area is located in the approximate center of the Terminal, and includes the former PCP warehouse and the area south of the warehouse (formerly occupied by various mixing and storage tanks, which were removed by 1982). Approximately 4000 tons of soil were removed from the PCP mixing area in 1989 and stockpiled as described below. During a soil removal action in fall 2002, a total of 9,695 tons of soil, including the stockpile and about 5,700 additional tons of PCP-impacted soil excavated from the mixing area, were removed for offsite incineration and disposal. Residual concentrations of PCP remain in soil in this area at depths below 13 ft BGS (the approximate water table). Releases to the soil in this area resulted in groundwater contamination in the upper and lower alluvial water-bearing zones.

Bulk petroleum storage terminals, Main Terminal and Bell Terminal tank farms, which include 21 aboveground storage tanks (ASTs) in the Main Terminal tank farm area, 10 ASTs in the Bell Terminal tank farm area and associated petroleum transfer, receipt, and related facilities. The storage tanks range from 3,000 to 80,000 barrels in size. Currently, all tanks are empty except for one in the main tank farm area, which is used to store wastewater prior to treatment at the onsite wastewater treatment system. Releases in the Main Terminal have resulted in groundwater contamination at levels of concern in the upper and lower alluvial water-bearing zones. Releases in the Bell Terminal have resulted in groundwater contamination at levels of concern in the upper zone only.

Former Crosby & Overton tank area located directly south of the former PCP mixing area where waste oils were previously stored in two ASTs. The tanks have since been removed from this area. During a soil removal action in fall 2002 (in conjunction with the former PCP mixing area), 819 tons of polychlorinated biphenyl (PCB) and carcinogenic polycyclic aromatic hydrocarbon (cPAH)-impacted soil were excavated from this area for offsite thermal treatment and disposal. Contaminated soil within this area was removed to levels below the cleanup action level of 1 mg/kg and groundwater was not impacted by soil concentrations in this area. Therefore, this area is not a historic or current source of contamination via groundwater to the river (Landau Associates 2003a).

Former soil stockpile area where approximately 4,000 tons of soil that was excavated from the former PCP mixing area in 1989 or was transferred from the eastern portion of the property during interim removal actions in 1996-1997 was temporarily located. The stockpile was located southwest of the former PCP mixing area and north of an inactive soil treatment area. The former stockpile was removed and incinerated and disposed offsite during soil removal actions conducted in fall, 2002. No current source remains in this area. Because the soil stockpile was in a managed area (lined, bermed, and covered), this area is not a historic or current source of contamination to the river (Landau Associates 2003a).

East Property consisting of approximately 23 acres of undeveloped land located in the eastern portion of the facility is an inactive and currently and historically undeveloped area. In 1996-97, over ninety 55-gallon drums and approximately 500 tons of soil and debris consisting of PCP-related wastes that originated from PCP formulation activities conducted within the former PCP mixing area were removed and disposed offsite. In 2002, a remedial action for the East Property resulted in the removal and disposal of 1,732 tons of cPAH-impacted soil mainly resulting from historic road oiling. Groundwater concentrations demonstrated that the soil to groundwater pathway had been effectively eliminated and that there is not a current or historical threat to ecological receptors in the river (Landau Associates 2003b). A conditional (industrial use only) No-Further-Action (NFA) determination for the East Property was granted to Time Oil by DEQ on November 24, 2003 (DEQ 2003).

8.2. Overwater Activities

☒ Yes ☐ No

A dock extends approximately 380-ft into the Willamette River from the terminal. During the period of Terminal operation between 1943 to 2001, the dock was used for the mooring of tanker ships while transferring petroleum products to pipelines located on the dock. No overwater spills or releases have been documented or reported during overwater activities. The dock is currently not in use.

Placeholder: Information about the owner having and exercising a statutory right to an overwater facility.

8.3. Spills

Known or documented spills at the Time Oil Northwest Terminal were obtained from Time Oil or DEQ records. These spills are summarized below.

Date	Material(s) Released	Volume Spilled (gallons)	Spill Surface (gravel, asphalt, sewer)	Action Taken (yes/no)
1975	Diesel	unknown	Soil in bermed area	Yes – free product recovery and soil removal
1990	Ethanol	~500 gallons	Soil in bermed area	Yes - Product and groundwater recovery
1994	Unleaded Gasoline	1300 gallons	Soil in bermed area	Yes – Product recovery and long-term groundwater monitoring
1999	Ethanol	2,479 gallons (suspected)	Subsurface soil	Yes - Installed recovery well and conducted groundwater monitoring; no product ever observed

9. PHYSICAL SITE SETTING

Numerous subsurface investigations have been completed at the Time Oil Northwest Terminal since the late 1980s. Explorations include test pits, soil and direct-push borings, monitoring wells, groundwater recovery wells (vertical and horizontal), and *in situ* chemical oxidation (ISCO) injection wells. Currently, there are 35 upper zone monitoring wells, 32 lower zone monitoring wells, two upper zone recovery wells (one vertical, one horizontal), one lower zone recovery well (vertical), and 8 ISCO injection wells. The following information on the geologic and hydrogeologic conceptual site model is summarized from the Phase III RI report (Landau Associates 2004). Well locations are shown on Supplemental Figure 2-1 (Landau Associates 2004) of Attachment A.

9.1. Geology

Results from the subsurface borings indicate that the general site stratigraphy from the ground surface downward consists of the following:

- Fine to medium sand (fill and shallow alluvium) – (upper groundwater zone)
- Silt/Sandy silt – (confining unit)
- Fine to medium sand/silty sand with multiple discontinuous interlayers of silt – (lower groundwater zone)
- Fine to medium sand – (deep sand unit)

The stratigraphy at the site is depicted in the cross sections on Figure 2 and Figures 6-4 and 6-8 (Landau Associates 2004) of Attachment A.

9.2. Hydrogeology

Based on similar geologic soil types and hydrogeologic characteristics, four principal near-surface hydrogeologic units have been identified at the Terminal. In descending order from ground surface, these units include: 1) an upper zone, 2) a confining unit, 3) a lower zone, and 4) a deep sand unit. As described in the following sections, depending on the continuity of the confining unit, the hydrogeologic units can act as distinct aquifer units with unconfined conditions in the upper zone and confined to semi-confined characteristics in the lower zone, or act as a single unconfined aquifer (beyond the extent of the confining unit).

Upper Zone: The upper zone is an unconfined alluvial aquifer that is discontinuous in areas where the underlying confining unit is absent (e.g., toward the Willamette River). The top of the upper zone is defined by the shallow water table and, therefore, varies based on seasonal fluctuations. The base of the upper zone ranges from 10 to 20 ft bgs. The average saturated thickness of the upper zone varies from less than about 1 ft along the confining unit boundary to slightly less than 15 ft at wells located in the Main Terminal tank farm area. The variability in the upper zone water levels and, thus, the saturated thickness of the zone, generally is characterized by seasonal high water levels in the winter and spring and seasonal low water levels in the summer and fall. Currently, there are 45 shallow wells and well points (including eight ISCO monitoring wells and two recovery wells) at the Terminal installed within the upper zone.

Confining Unit: The confining unit is comprised mainly of silt and appears to act as a confining or semi-confining layer for the lower zone. The silt unit consists of material that is characteristic of natural river overbank deposits, is heterogeneous, and varies in thickness across the site from less than 1 ft to about 30 ft. The confining unit is thickest in the eastern portion of the Main Terminal and the Bell Terminal, and thins as it extends westward in the Main Terminal and as it extends southward in the Bell Terminal. In the western portion of the Main Terminal, as the confining unit becomes thinner, it eventually becomes discontinuous layers of silt and no longer acts as a confining unit between the upper and lower zones. The approximate boundary of the extent of the continuous confining unit is shown on Figures 3 and 4. Where present, the uppermost boundary of the confining layer is encountered at about 16 to 20 ft bgs (8 to 13 ft elevation, MSL). Where the silt layer is not present along the western portion of the Main Terminal, the upper zone does not exist and the lower zone acts as a single unconfined groundwater zone.

Lower Zone: The lower zone occurs in interlayered river channel and overbank deposits. This material is characterized by gray, fine to medium, sand to silty sand with multiple discontinuous interlayers of silt up to 6 ft thick. In areas where the overlying confining unit is present, the lower zone generally displays semi-confined to confined aquifer characteristics. In areas where

the confining unit is absent (i.e., western portion of the Main Terminal), the lower zone appears to act as a single, unconfined aquifer. Where both water-bearing zones are present, the lower zone does not appear to be hydraulically connected with the upper zone, except along the edge of the confining unit over most of the Terminal and downgradient of the PCP mixing area, where the upper and lower zones appear to be interconnected based on the presence of PCP in both zones historically. The lower zone ranges in thickness from about 15 to 40 ft, depending on the continuity of underlying silt layers. Where the underlying silt layers are continuous, they likely separate the lower zone from a deeper sand unit. Where the silt layers are discontinuous, the lower zone is likely in hydraulic connection with the deeper sand unit. Currently, there are 32 deep wells (including one recovery well) at the Terminal installed within the lower zone.

Deep Sand Unit: The deep sand unit is encountered at about 60 to 65 ft BGS. The unit is differentiated from the overlying sand and silt of the lower zone because it predominantly consists of fine to medium sand with low silt content. In most areas, the deep sand unit is separated from the lower zone by thin silt layers. The deep sand unit extends to at least 100 ft BGS, but the extent of the unit and its hydrogeologic characteristics could not be evaluated, based on data collected to date at the Terminal. Currently, there are no monitoring wells installed in the deep sand unit at the Terminal. One deep sand unit well previously located in the former PCP mixing area was abandoned prior to soil removal activities in this area in 2002. No COIs were detected in this well in multiple sampling events prior to well abandonment.

The hydrogeologic units have the following general characteristics:

Upper Zone – Alluvial Aquifer	
No. of Monitoring Wells	45 (inc. 8 injection wells, and 2 recovery wells)
Groundwater Flow Direction	West/southwest toward the Willamette River
Horizontal Gradient	0.007 to 0.012 linear feet per foot
Hydraulic Conductivity (K)	40 – 160 ft/day
Transmissivity (T)	180 – 520 ft^2/day
Average Linear Groundwater Velocity (effective porosity = 0.3)	0.9 – 6.4 ft/day

Lower Zone – Alluvial Aquifer	
No. of Monitoring Wells	32 (inc. 1 recovery well)
Groundwater Flow Direction	West/southwest toward the Willamette River
Horizontal Gradient	0.0002 – 0.004 linear feet per foot
Hydraulic Conductivity (K)	25 – 130 ft/day
Transmissivity (T)	2,100 - 7,000 ft^2/day
Average Linear Groundwater Velocity (effective porosity = 0.3)	0.02 to 1.7 ft/day

Groundwater in the upper zone is most likely recharged by direct infiltration from precipitation. Lower zone groundwater appears to be recharged primarily from the upper zone and from subsurface flow from the north and east. Groundwater from both water-bearing zones generally discharges to the Willamette River. Groundwater in the lower zone is recharged by the Willamette River during periods of high river flow in response to short-term increases in river stage. Groundwater levels in the lower zone are impacted by diurnal and seasonal fluctuations in river stage. Groundwater levels in the upper zone do not appear to be impacted by changes in river stage.

10. NATURE AND EXTENT (*Current Understanding*)

Significant historical environmental activities or events include the following:

- 1975 – A diesel spill was documented in the Main Tank Farm area. Remediation activities included recovery of free liquids, excavation and offsite disposal of visibly impacted soil, and backfill with clean soil.
- Approximately 1973 – During construction at the adjacent Premier Edible Oils (PEO) facility, a contractor demolished an in-service pipeline running between the Bell Terminal and a dock off of the PEO facility, resulting in a release of product. Product from the pipeline was released on the PEO facility; no information is available as to whether product was released at the Bell Terminal.
- 1984 – DEQ Site Inspection
- 1984 - Environmental investigations began.
- 1985 – 288 yd^3 of PCP-contaminated soil from the former PCP mixing area were removed and disposed at Arlington.
- 1985 – Received letter from EPA advising that commercial facilities would no longer accept PCP-containing waste.
- 1985-1990 – Time Oil and/or its consultants installed 16 monitoring wells and 7 well points (the well points and 6 of these monitoring wells have since been abandoned).
- 1989 – Approximately 4,000 tons of soil were excavated from the former wood treatment product formulation and blending facility area and placed into a bermed, lined, and covered stockpile as an interim source control measure. The excavated area was backfilled with clean soil. Attempts to biologically treat the soil were unsuccessful at the cleanup level required.
- 1990 – A pipeline release of ethanol was reported in the loading rack area just west of the terminal office. Remedial actions included soil excavation and land farming, soil vapor extraction, and groundwater recovery.
- 1994 – In response to an unleaded gasoline spill in the Main Tank Farm area, product was recovered, 4 monitoring wells/vapor extraction wells were installed, and a vapor extraction pilot test was conducted.
- 1996 – Voluntary Cleanup Program (VCP) agreement between DEQ and Time Oil executed.
- 1996 – RI/FS under the VCP initiated. Over 50 monitoring wells were installed in the upper and lower groundwater zones and numerous direct-push, CPT explorations, and test pits were used to assess the nature and extent of soil and groundwater contamination at the Terminal.
- 1996-97 - Approximately 90 drums, a small stockpile containing PCP-impacted materials, and isolated areas of PCP-impacted soil were removed from the east property; the drums were decontaminated and recycled offsite, solid PCP material was disposed offsite, and PCP-impacted soil was added to the soil stockpile.
- 1999 - A suspected pipeline release of ethanol was reported near the southern edge of the former PCP mixing area. A recovery well was installed near the release but product was never observed. Several monitoring wells were sampled for about 2 years after the time of the release.
- 1999-2000 – Three recovery wells were installed to treat PCP-impacted groundwater in the upper and lower zones for a groundwater interim action. Recovery from the lower zone well and horizontal upper zone well is ongoing.
- 2002 – The soil stockpile was removed and about 5,700 tons of PCP-impacted soil were

excavated from the former PCP mixing area for treatment and disposal at an incineration facility in Alberta, Canada. The warehouse used for wood treatment product mixing activities was decontaminated and demolished for recycling and offsite disposal. About 819 tons of cPAH-impacted soil was removed from the former Crosby & Overton tank area for treatment and disposal offsite. Approximately 1,732 tons of cPAH-impacted soil was removed from the east property for offsite treatment and disposal. Approximately 90 tons of mixed asbestos-containing material were removed from the east property and disposed offsite.

- 2002 – Use of *in situ* chemical oxidation (ISCO) was assessed for remediation of shallow PCP-impacted soil and groundwater using a bench-scale study and pilot test.
- 2002-03 – An additional 22 wells were installed in the tank farm areas for the RI and 9 wells were installed in and downgradient of the former PCP mixing area for use during ISCO injection events; five wells were abandoned.
- 2003 – Time Oil granted conditional (industrial use only) NFA for east property. The four wells on the east property were abandoned.
- 2004 – RI completed. Risk assessment initiated. Full-scale use of the ISCO technique as an interim remedial action is planned for implementation in summer 2004.

10.1. Soil

10.1.1. Upland Soil Investigations

☒ Yes ☐ No

The nature and extent of contamination in soil is based on information presented in the Phase III RI report. The referenced areas are shown on Supplemental Figure 2-1 (Landau Associates 2004) of Attachment A. Well locations are shown on Supplemental Figure 2-6 (Landau Associates 2004) of Attachment A. Summary information on soil concentrations following the removal actions on the property (see Section 11.2) are provided in Supplemental Table 1 of Attachment A. (*Placeholder: To be provided at a later date.*)

- Petroleum hydrocarbons and constituents commonly associated with petroleum products [i.e., PAHs and volatile organic compounds (VOCs)] were detected in soil in the unsaturated zone within the Main Terminal and Bell Terminal tank farm areas. The highest concentrations were detected at the capillary fringe depth within each tank farm area.
- The presence of non-aqueous phase liquid (NAPL) was observed in soil during drilling at well LW-27S located in the central portion of the Main Terminal tank farm area at a depth of 22.5 ft below ground surface (BGS). Slight to heavy sheens were observed on soil at several locations within the Main Terminal tank farm and the Bell Terminal tank farm areas. These sheens were observed in soil at depths ranging between 3.5 to 34 ft BGS in the Main Terminal tank farm and at depths ranging from 12.5 to 19.5 ft BGS in the Bell Terminal tank farm area.
- Along the portion of the Terminal that is bounded to the west by the Willamette River and its shoreline (i.e., the western boundary of the Main Terminal tank farm), diesel-range and motor oil-range petroleum hydrocarbons were detected in the upper 1.5 ft of soil at concentrations up to 438 mg/kg and 308 mg/kg, respectively. Within the capillary fringe, diesel-range and gasoline-range petroleum hydrocarbons were detected in the soil at two locations: LW-24D and LW-35D. The maximum gasoline-range and diesel-range petroleum hydrocarbons (12.7 mg/kg and 44.3

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mg/kg, respectively) at this depth occurred at LW-35D located in the northwest corner of the Main Terminal. Detectable concentrations of PAHs were also reported for soil collected from the capillary fringe depth interval at three locations along the western property boundary in the Main Terminal, including location LW-35D.

- In the Bell Terminal, the highest concentrations of contaminants in soil occur west of the tank farm near where the east-west trending pipeline formerly existed but was demolished by Schnitzer in the mid-1970s while still in use and containing product. Diesel-range and gasoline-range petroleum hydrocarbons were found at the capillary fringe depth at this location at concentrations of 12,700 mg/kg and 8,750 mg/kg, respectively. Other elevated concentrations of TPH were observed at the capillary fringe depth along the western property boundary of the Bell Terminal and appear to be related to activities in this area when used by operators of the adjacent Schnitzer property. Within the central portion of the Bell Terminal, gasoline-range and diesel-range petroleum hydrocarbon concentrations appear to have originated from different sources than those along the western property boundary because of the decreases in concentrations between the two areas. The TPH concentrations within the central portion of the tank farm are likely a result of minor, incidental releases related to operations within the Bell Terminal.

- Soil with elevated concentrations of diesel-range and gasoline-range petroleum hydrocarbons, PAHs, VOCs, and metals is found in the loading rack/entrance area of the Main Terminal at the capillary fringe. Elevated concentrations of diesel-range and gasoline-range petroleum hydrocarbons were also detected at the same depth interval.

- Within the Phase II study area, PCP concentrations ranging from nondetected to 180 mg/kg remain in soil at depths at and greater than about 13 ft BGS. This soil was not excavated during the removal action performed in the former PCP mixing area due to limitations in excavating soil below the water table and the plan to use *in situ* chemical oxidation (ISCO) to remediate soil and groundwater at this depth. Other constituents (diesel-range, motor oil-range, and gasoline-range TPH, PAHs, VOCs, and metals) are present in the surface soil and at depths at or deeper than the capillary fringe.

10.1.2. Riverbank Samples ☐ Yes ☒ No

10.1.3. Summary

Placeholder.

10.2. Groundwater

10.2.1. Groundwater Investigations ☒ Yes ☐ No

Time Oil has collected groundwater samples at the terminal since the mid-1980's. Since March 1997, groundwater samples have been collected on a quarterly basis as part of RI activities. The most recent groundwater data set discussed herein is from the October 2003 quarterly groundwater monitoring event. Groundwater sampling locations for the Phase III RI are shown on Supplemental Figure 2-6 (Landau Associates 2004) of Attachment A.

10.2.2. NAPL (Historic & Current) ☒ Yes ☐ No

- LNAPL has been observed in the upper zone groundwater in the Main Terminal tank farm area at monitoring wells N, P, Q on a semi-regular basis since installation

in 1994 and direct push monitoring point GW8-1 when drilled in 2001. LNAPL was also observed at wells LW-21S and LW-27S during the February 2004 groundwater monitoring event. The thickness of LNAPL present at these locations varies over time and between locations. The thicknesses range from 0.01 to 1.2 ft.

- No LNAPL was observed on upper zone groundwater in the Bell Terminal.
- Occasional observations of LNAPL have also been recorded for upper zone groundwater monitoring wells associated with the former PCP mixing area between November 2000 and October 2003. These wells include OX-2S, LW-8S, and LW-11S and piezometer PZ-2. LNAPL thicknesses at these locations since the soil removal action have ranged from 0.04 to 0.37 foot. Based on chemical characteristics, the LNAPL occurring in this area appears to be related to activities performed in the former PCP mixing area and not related to LNAPL observed in the Main Terminal tank farm area. LNAPL presence is also related to seasonal groundwater fluctuations.
- No NAPL has been reported for the lower zone groundwater at the Terminal.

10.2.3. Dissolved Contaminant Plumes ☒ Yes ☐ No

Dissolved contaminant plumes in upper and lower zone groundwater beneath the Terminal are typically associated with gasoline and diesel releases in the tank farm areas and releases within the former PCP mixing area. Plume characterization is complete with submittal of the Phase III RI; however, groundwater concentrations will continue to be monitored on a quarterly basis through 2004 (Landau Associates 2004).

Plume Characterization Status ☐ Complete ☐ Incomplete

Placeholder.

Plume Extent

Previous groundwater monitoring data have focused on areas of the site impacted by activities in the former PCP mixing area. The RI for the other areas of the terminal was recently completed in early 2004. Therefore, this plume extent discussion focuses on the areas and contaminants of concern associated with the former PCP mixing area. The discussion below under current plume data includes results from other parts of the terminal and for other constituents based on the October 2003 data.

Upper Zone:

Historically and currently, PCP in the upper zone is limited to a narrow plume that extends from the former PCP mixing area downgradient about 450 ft to the south/southwest. PCP concentrations in the upper zone are most elevated within and just downgradient of the former PCP mixing area, the identified source area for PCP. PCP appears to have migrated in a downgradient direction toward the south-southwest. In May 1999, PCP concentrations were observed at a maximum concentration to date of 23,000 µg/L at well LW-11S, but there were only slight increases at well LW-4S, the most downgradient well where there have been consistent low level PCP detections. PCP has not migrated in the upper zone farther downgradient to the south than well LW-13S, as indicated by nondetected concentrations in upper zone wells near the south property boundary (LW-10S, when saturated); however, low level PCP concentrations in lower zone wells on the western extent of the confining unit were detected during the four sampling events in 2003, as discussed below.

Lower Zone:

Historically and currently, PCP in the lower zone consists of several discrete areas of contamination rather than a contiguous plume. Historically, the discrete areas were mainly located within and downgradient of the former PCP mixing area, in proximity to well LW-11D, and in an area including wells LW-4D and RW-2, approximately 450 ft downgradient and to the south/southwest of the former PCP mixing area. The historically highest PCP concentrations in groundwater in the lower zone occurred at well LW-4D (18,000 ppb in October 1997) and decreased significantly at this location, such that since spring 1999, PCP concentrations have been mostly nondetect. These reductions in PCP concentrations are likely related to operation of nearby groundwater recovery well (RW-2; see Section 11.2). Recently, (since November 2002) on an intermittent basis, low level PCP concentrations (generally less than 1 µg/L) have also been detected in wells LW-6D located between LW-4D and the river, and LW-10D located at the southern property boundary. These detections are not observed on a consistent basis, which may be related to dilution of groundwater by river water at the groundwater-surface water interface, (particularly in the lower zone where the river stage influence is greatest), natural attenuation processes (e.g., adsorption, biodegradation, etc.), or seasonal variability.

Min/Max Detections (Current situation)

The October 2003 minimum and maximum groundwater plume detections at the site for both the upper and lower zones include:

Analyte	Minimum	Maximum	Detection Limits (Units)
Total Petroleum Hydrocarbons (TPH)			
TPH-Diesel	260	5,800	250 µg/L
TPH-Gasoline	350	24,000	250 µg/L
Volatile Organic Compounds (VOCs)			
Benzene	1.5	1,600	1.0 µg/L
Toluene	1.2	72	1.0 µg/L
Ethylbenzene	2.6	940	1.0 µg/L
Total Xylenes	1.0	3,170	1.0 µg/L
Semivolatile Organic Compounds (SVOCs)			
Naphthalene	1.3	190	0.1 µg/L
PCP	0.58	2,100	0.5 µg/L

Current Plume Data

Plume maps showing the extent of impacted groundwater for petroleum constituents (TPH-diesel and TPH-gasoline), VOCs (benzene), and PCP are shown on Figures 3 and 4 for the upper and lower zones, respectively, based on concentration contours maps presented in the Phase III RI (Landau Associates 2004). Terminal-wide sampling of groundwater is currently being conducted on a semi-annual basis; sampling of groundwater in areas previously associated with the petroleum operations at the terminal are being sampled on a quarterly basis. Groundwater interim action wells and water from

the groundwater intercept system in the storm drain are sampled at least on a quarterly basis. A summary of the current plume data is provided for each zone below.

The nature and extent of contamination in groundwater is evaluated by areas, as described above for the soil evaluation, and by groundwater zones.

Upper Zone:

- Diesel-range and gasoline-range petroleum hydrocarbons are present throughout the upper zone groundwater in the Main Terminal tank farm area at concentrations ranging from nondetect to 24 mg/L. Constituents typically associated with diesel-range and gasoline-range petroleum hydrocarbons (i.e., PAHs and VOCs) are also present in the upper zone groundwater in the Main Terminal tank farm area but these plumes are not as widespread as the TPH plumes. Metals were detected in the upper zone groundwater throughout the Main Terminal tank farm area at concentrations typically less than site-specific background concentrations (Landau Associates 1999).
- Concentrations of petroleum hydrocarbons present in the upper zone groundwater in the Bell Terminal tank farm indicates that there are three likely sources of contamination in the Bell Terminal: 1) near the location of a rupture along the western portion of the east-west trending pipeline where Schnitzer demolished the pipeline while still in use and containing product, 2) along the western property boundary south of the pipeline resulting from activities by operators of the adjacent Schnitzer property, and 3) the central portion of the Bell Terminal, likely resulting from minor, incidental releases related to Terminal operations. The maximum concentration of petroleum hydrocarbons in upper zone groundwater in the Bell Terminal (796 mg/L for diesel-range hydrocarbons) was found near the western property boundary. Within the central portion of the Bell Terminal, gasoline-range and diesel-range petroleum hydrocarbon concentrations appear to have originated from different sources than those along the western property boundary because of the decreases in concentrations between the two areas and resulting discontinuity between the plumes (Landau Associates 2004). Constituents associated with diesel-range and gasoline-range petroleum hydrocarbons (i.e., PAHs and VOCs) are also present in the upper zone groundwater in the Bell Terminal; however, the areas of impacted groundwater appear to be smaller than the areas of TPH-impacted groundwater.
- The gasoline-range TPH and VOC plumes present in upper zone groundwater in the Main Terminal tank farm area also include the western portion of the loading rack/entrance area.
- No VOCs or PAHs were detected in upper zone groundwater directly to the east and upgradient of the former operating portions of the Terminal.
- The only significant plume of contamination in upper zone groundwater associated with the former PCP mixing area is PCP. Based on the fourth quarter 2003 groundwater data, PCP concentrations range from 0.61 µg/L to 2,100 µg/L and extend approximately 350 ft downgradient from the PCP mixing area. However, historical PCP concentrations within the upper zone have been as high as 23,000 µg/L at well LW-11S.

- Concentrations of diesel-range and gasoline-range petroleum hydrocarbons and VOCs downgradient of the former PCP mixing area are likely related to the presence of PCP carrier oils (e.g. mineral spirits) as LNAPL and partitioning of these constituents into groundwater. The distribution of detected petroleum hydrocarbon concentrations in this area is consistent with the intermittent presence of LNAPL observed in well LW-11S and the recent occurrence of LNAPL at OX-2S and elevated PCP concentrations in groundwater.

- Separate plumes of diesel-range and gasoline-range petroleum hydrocarbons and VOCs are observed in the upper zone groundwater within and downgradient of the former PCP mixing area. These concentrations do not appear to originate from the tank farm areas and are likely related to the presence of PCP carrier oils (e.g., mineral spirits) as light non-aqueous phase liquid (LNAPL) and to the partitioning of these constituents into groundwater.

Lower Zone:

- Diesel-range and gasoline-range petroleum hydrocarbons, PAHs, VOCs, and metals are present in the lower zone groundwater along the western portion of the Main Terminal tank farm where the confining unit is discontinuous or not present and the upper and lower groundwater zones converge; however, concentrations are typically significantly less than those detected in the upper zone groundwater in these areas. Within the western portion of the Main Terminal tank farm, where the confining unit is present, fewer occurrences of contaminants in the lower zone groundwater are observed.

- PCP is detected in the lower zone groundwater within and downgradient of the former PCP mixing area at concentrations less than 1 µg/L. This distribution of PCP concentrations in lower zone groundwater in this area reflects downgradient movement from a historically high PCP concentration area and the influence of recovery well RW-2. Detections of diesel-range petroleum hydrocarbons are observed in the lower zone groundwater in these areas at concentrations up to 3.1 mg/L.

- Except for diesel-range petroleum hydrocarbons and metals, contaminants are not present in the lower zone groundwater in the Bell Terminal tank farm area. A low level concentration of diesel-range petroleum hydrocarbons (0.35 mg/L) was observed at well LW-32D and metals (chromium, copper, nickel, and zinc) were observed at three lower zone monitoring well locations at concentrations ranging from 0.004 to 0.01 mg/L.

- Metals concentrations in the lower zone are typically greater than upper zone and are unlikely related to operations at the Terminal (Landau Associates 2004).

Preferential Pathways

The east-west trending storm drain that discharges to the Willamette River and backfill associated with its construction appear to affect groundwater flow and contaminant transport in the upper zone (Attachment A; Supplemental Figures 2-1 and 2-6). The presence of the storm drain may partly explain the southerly components of upper zone groundwater flow in the Terminal area as groundwater flows toward the zone of higher hydraulic conductivity. The storm drain does not appear to fully penetrate the confining unit (where present) and thus is not thought to provide a vertical pathway for groundwater flow and contaminant transport to deeper aquifers. Groundwater samples collected from manholes in the storm drain and at the storm drain outfall in the river indicate that,

historically, the storm drain was acting as a preferential pathway for upper zone groundwater to the river. In October 2002, the stormwater intercept system was installed to eliminate the potential for upper zone groundwater to migrate through the storm drain to the river.

Other subsurface utilities include thousands of feet of pipeline underlying the facility and adjacent areas, including public utilities (e.g., electrical and water) and private utilities (e.g., hydrant lines). As-built utility drawings maintained by Time Oil indicate that none of these subsurface utilities intersect shallow groundwater and therefore, do not represent preferential pathways at the property.

Downgradient Plume Monitoring Points

Seven lower zone monitoring wells at the top of the riverbank represent the most downgradient monitoring points between the terminal and the Willamette River. All but two of these wells were installed in fall 2003 and the first sampling event was in October 2003; therefore the data presented below are for this one sampling event.

Analyte	Minimum	Maximum	Detection Limits (Units)
Total Petroleum Hydrocarbons (TPH)			
TPH-Diesel	1.1	3.1	0.25 mg/L
TPH-Gasoline	0.43	0.92	0.25 mg/L
Volatile Organic Compounds (VOCs)			
Benzene	2.9	40	1.0 µg/L
Toluene	1.2	1.6	1.0 µg/L
Ethylbenzene	ND	ND	1.0 µg/L
Total Xylenes	1.2	1.6	1.0 µg/L
Semivolatile Organic Compounds (SVOCs)			
Naphthalene	ND	ND	0.1 µg/L
PCP	1.1	1.1	0.51 µg/L

Visual Seep Sample Data ☐ Yes ☒ No

No seeps have been observed along the riverbank at the terminal.

Nearshore Porewater Data ☐ Yes ☒ No

Placeholder.

Groundwater Plume Temporal Trend

- Upper zone PCP concentrations within the mixing area source area have decreased significantly since first measured in 1991. This decrease may reflect the removal of contaminant source material during the 1989 soil excavation within the former PCP mixing area, as well as natural attenuation of the PCP (through adsorption, biodegradation, etc.) or downgradient movement past these monitoring points.
- Continuing decrease of PCP concentrations in the upper zone since 2002 is likely related to the removal of the majority of the remaining contaminated soil during the soil removal in the former PCP mixing area and from use of the ISCO technique during pilot testing.

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- Since October 2000, recovery well RW-2 has been recovering PCP-impacted groundwater from the lower zone. RW-2 has been generally effective in containing PCP-contaminated groundwater migration.

The intermittent nature of LNAPL occurrences at LW-11S appears to be related to seasonal groundwater fluctuations, such that residual LNAPL is released to the groundwater under low water table conditions.

10.2.4. Summary

The most critical exposure pathway at the Terminal is migration of contaminants via groundwater to the Willamette River. Even though impacts from discharge of groundwater from the Terminal are expected to be minimal because of dilution and other processes at the groundwater-surface water interface, there is a potential for impacted groundwater to affect sediment or surface water quality. Also, historically, the storm drain acted as a preferential pathway for migration of contaminants to the river from upper zone groundwater in the area of the PCP plume.

In the Main Terminal tank farm area, contaminants are present in the upper and lower zone groundwater. Concentrations of selected contaminants in upper zone and lower zone groundwater indicate that lateral migration in the downgradient groundwater direction has occurred (Figures 3 and 4). However, contamination of the lower zone groundwater is typically found only at downgradient monitoring locations in the western portion of the Main Terminal tank farm where a silt layer separating the upper and lower zones does not exist or is discontinuous. In this portion of the Main Terminal tank farm area, only a single unconfined groundwater zone exists. In the eastern portion of the Main Terminal tank farm, where a silt layer separating the upper and lower groundwater zones does exist, contaminant concentrations in the lower zone groundwater are typically low and are primarily detected near where the silt layer pinches out or becomes discontinuous. This suggests that the silt layer over much of the western portion of the Main Terminal tank farm area provides a natural geologic/hydrogeologic boundary between the upper zone groundwater and the lower zone groundwater, limiting the vertical migration of contaminants over this portion of the Main Terminal tank farm area, or that the characteristic of the contaminant does not lend itself to vertical migration.

In the Bell Terminal tank farm area, contaminants are present in the upper zone groundwater, but are not detected or detected at low concentrations in the lower zone groundwater. The minimal presence of contaminants in the lower zone groundwater indicates that the silt layer is acting as an impermeable boundary and the two groundwater zones are not interconnected in this area.

10.3. Surface Water

10.3.1. Surface Water Investigation ☐ Yes ☒ No

10.3.2. General or Individual Stormwater Permit (Current or Past) ☒ Yes ☐ No

Permit Type	File Number	Start Date	Outfalls	Parameters/Frequency
1200-T	109186	8/13/96	River	Oil & Grease; pH; total Phosphorus; COD; TOC; metals (As, Cd, Cr, Cu, Pb, Hg, Ni, Zn); TSS
1200-Z	109186	11/6/97	River	Oil & Grease; total copper, lead, zinc; pH; TSS
1200-C (east property only)	109737	11/16/01		Turbidity

Do other non-stormwater wastes discharge to the system? ☐ Yes ☒ No

The stormwater system at the Northwest Terminal consists of a 15-inch-diameter concrete storm drain line running east-west along the length of the Terminal about 160 ft north of the southern property boundary, four manholes, and a single outfall to the Willamette River (Attachment A; Supplemental Figures 2-1 and 2-6; Landau Associates 2004). Stormwater from the Terminal entrance area, the low topographic area east of the rail spur, and the undeveloped eastern portion of the property is collected into the main storm drain line for discharge into the river. In the fall of 2002, a groundwater intercept system was installed within the east-west trending storm drain to capture groundwater infiltrating into the concrete storm drain line between the two stormwater manholes located closest to the river, as described in Section 11.2.

10.3.3. Stormwater Data ☒ Yes ☐ No

Stormwater data were collected from the groundwater intercept system that is located in a catch basin in the east-west trending storm drain. Stormwater data collected between September 2001 and August 2002 at the catch basin closest to the river contained PCP concentrations ranging from 0.7 to 190 µg/L. Petroleum compounds (TPH -diesel, -gasoline, -mineral spirits, -kerosene, -lube oil) ranged from nondetect to 0.3 mg/L. The groundwater intercept system in the storm drain began operation in October 2002. Stormwater samples continue to be analyzed as influent into the onsite wastewater treatment system; however, these concentrations represent groundwater captured by the intercept system and do not reach the river outfall. When accessible during low river flow periods, stormwater will also be collected from the river outfall.

10.3.4. Catch Basin Solids Data ☐ Yes ☒ No

Catch basin solids have not been sampled.

10.3.5. Wastewater Permit ☒ Yes ☐ No

Permit Type	Permit No.	Start Date	Outfalls	Volumes	Parameters/Frequency
POTW	400-121	2/15/96	Sanitary sewer	None specified	PCP, BETX, pH

10.3.6. Wastewater Data ☒ Yes ☐ No

Wastewater effluent samples are collected from the onsite wastewater treatment system in accordance with the permit requirements. Wastewater effluent concentrations typically

meet the maximum allowable limit for PCP at 40 µg/L. Wastewater effluent is discharged to the city sanitary sewer along Time Oil Rd.

10.3.7. Summary

Historically, there was a potential for impacted groundwater to reach the river through the storm drain. Currently, there is little to no potential for contaminated groundwater to reach the river through the storm drain due to operation of the groundwater intercept system (Landau Associates 2004). Wastewater treated at the onsite wastewater treatment system is discharged to the POTW under a permit with the City of Portland.

10.4. Sediment

10.4.1. River Sediment Data ☒ Yes ☐ No

Two sediment investigations have taken place in the vicinity of the terminal since 1997:

- Portland Harbor Sediment Investigation (Weston 1998)
- LWG Round 1 Sediment Sampling (Integral in prep.).

Time Oil has collected no site-specific sediment data. Table 2 summarizes the results from these investigations.

10.4.2. Summary

See Final CSM update.

11. CLEANUP HISTORY AND SOURCE CONTROL MEASURES

11.1. Soil Cleanup/Source Control

In 1985, 288 yd^3 of PCP-contaminated soil from the former PCP mixing area were removed and disposed at Arlington. In 1989, approximately 4,000 tons of soil was excavated from the former PCP mixing area and placed into a bermed, lined, and covered stockpile adjacent to the area. The excavated area was backfilled with clean soil. In 1996-97, isolated areas of PCP-impacted soil were removed from the east property; the soil was added to the soil stockpile. In 2002, the soil stockpile was removed and an additional approximately 5,700 tons of PCP-impacted soil was excavated from the former PCP mixing area for treatment and disposal at an incineration facility in Alberta, Canada. The warehouse used for wood treatment product mixing activities was decontaminated and demolished for recycling/disposal offsite. About 819 tons of cPAH-impacted soil from removed from the former Crosby & Overton tank area for treatment and disposal offsite. Approximately 1,732 tons of cPAH-impacted soil was removed from the east property for offsite treatment and disposal. Approximately 90 tons of mixed asbestos-containing material were removed from the east property and disposed offsite. Other soil removals have been associated with the cleanup of isolated petroleum product releases, as documented in earlier sections.

11.2. Groundwater Cleanup/Source Control

In 1999-2000, a groundwater interim action system was implemented to treat PCP-impacted groundwater in the upper and lower zones. The system consists of two groundwater extraction wells, a horizontal well (HRW-1) in the upper zone and a vertical well (RW-2) in the lower zone, and a groundwater intercept system in the east-west trending storm drain at the manhole closest to the Willamette River (SDM-1). Recovery well locations and the storm drain are shown on Supplemental Figure 2-6 (Landau Associates 2004) in Attachment A.

Pumping within the lower zone from recovery well RW-2 began in October 2000. Since startup of recovery well RW-2, with the exception of periodic shutdowns for system maintenance, groundwater has been extracted continuously from the lower zone. Through December 2003, approximately 12.4 million gallons of water has been removed from the lower zone at RW-2.

Pumping of HRW-1 is limited to the wetter months of the year (i.e., December through May). Through December 2003, approximately 310,000 gallons of groundwater have been removed from HRW-1 since startup. Due to the inability to operate HRW-1 during the drier months from June through November and the potential for upper zone groundwater to infiltrate into the storm drain line, a groundwater intercept system was installed in the storm drain line in October, 2002, at the manhole (SDM-1) located closest to the point of discharge to the Willamette River [see Supplemental Figure 2-6 from Landau Associates (2004)]. The system consists of an 8-inch diameter polyethylene pipe routed through the 15-inch storm drain line from manhole SDM-1A through manhole SDM-1. Stormwater from the east property and Terminal office area is routed through the 8-inch liner pipe and discharged to the river. Potentially impacted groundwater entering the storm drain pipe between manholes SDM-1A and SDM-1 is routed through the annulus between the pipes and is collected in manhole SDM-1. The intercepted water is pumped from the manhole to Tank 16804 for processing by the onsite wastewater treatment plant. Through December 2003, approximately 790,000 gallons of groundwater has been intercepted from the storm drain line.

Operation of the groundwater interim action system is ongoing.

To further facilitate the remediation of PCP contamination in the groundwater and soil at the Terminal, use of the *in situ* chemical oxidation (ISCO) technique was assessed during a bench scale laboratory study and a pilot study conducted within and downgradient of the former PCP mixing area in September 2002. Results from the testing indicated that the pilot study was successful in reducing the concentration of PCP in soil and groundwater. Full-scale implementation of ISCO as an interim remedial action treatment of PCP-impacted soil and groundwater in the upper zone within the boundaries of the PCP plume is planned for summer 2004, pending DEQ approval.

11.3. Other

In 1996-97, approximately 90 drums associated with the former PCP mixing area operations and a small stockpile containing PCP-impacted materials was removed from the east property. The drums were decontaminated and recycled offsite. Solid PCP material was segregated from impacted soil and disposed offsite. The impacted soil was added to the soil stockpile. In 2002, approximately 90 tons of mixed asbestos-containing material were removed from the east property and disposed offsite.

11.4. Potential for Recontamination from Upland Sources

The groundwater interim actions described above adequately contain PCP-contaminated groundwater, and implementation of the proposed ISCO interim action should reduce residual PCP concentrations in soil that may be a source of contamination to groundwater. Time Oil is reviewing the results of the Phase III RI (Landau Associates 2004) to determine whether additional source control evaluation at other areas of the Terminal may be appropriate.

12. BIBLIOGRAPHY / INFORMATION SOURCES

References cited:

DEQ. 2003. Letter: Conditional No Further Action Determination, East Property, Time Oil Co. Northwest Terminal, ECSI #170. From Terry Hosaka, Oregon Department of Environmental Quality, to Kevin Murphy, Time Oil Co. November 24.

DEQ. 1999. DEQ Strategy Recommendation – Time Oil Northwest Terminal. Site Assessment Program, Oregon Department of Environmental Quality, Portland, OR.

DEQ. 2004. DEQ Site Summary Report – Details for Site ID 170. DEQ Environmental Cleanup Site (ECSI) Database. Accessed August 2004. http://www.deq.state.or.us/wmc/ecsi/ecsidetail.asp?seqnbr=170

GSI. 2003. Portland Harbor RI/FS: Upland Groundwater Data Review Report, River Mile 2-11, Lower Willamette River. Prepared for the Lower Willamette Group, Portland, OR. Groundwater Solutions, Inc., Portland, OR.

Integral. In preparation. Round 1 Site Characterization Report. Prepared for Lower Willamette Group, Portland, OR. Integral Consulting, Inc., Mercer Island, WA.

Integral and DEA. In preparation. Lower Willamette River February 2004 Multibeam Bathymetric Survey Report. Draft. Prepared for Lower Willamette Group, Portland, OR. Prepared by Integral Consulting, Inc., Mercer Island, WA, and David Evans and Associates, Inc., Portland, OR.

Integral, Windward, Kennedy/Jenks, Anchor Environmental, and Groundwater Solutions. 2004. Portland Harbor RI/FS Programmatic Work Plan. Prepared for the Lower Willamette Group, Portland, OR. Integral Consulting, Inc., Mercer Island, WA.

Landau Associates. 1993. Site Characteristics Report, Former PCP Mixing Area, Northwest Terminal, Portland, Oregon. August 30.

Landau Associates. 1999. Phase I and II Contaminants of Potential Concern (COPC) Screening Report. Time Oil Northwest Terminal. September 10, Attachment 1.

Landau Associates. 2003a. Removal Actions Completion Report, Phases I/II RI Areas. Time Oil Northwest Terminal. November 10.

Landau Associates. 2003b. Soil Remedial Action Completion Report, East Property. Time Oil Northwest Terminal. February 10.

Landau Associates. 2004. Phase III Remedial Investigation Report. Time Oil Northwest Terminal. April 30.

Weston. 1998. Portland Harbor Sediment Investigation Report, Multnomah County, OR. Report No. 04000-019-036-AACE. Prepared for the U.S. Environmental Protection Agency and Oregon Department of Environmental Quality, Portland, OR. Roy F. Weston, Inc., Seattle, WA.

Figures:

Figure 1. Site Features
Figure 2. Cross Section
Figure 3. Extent of Impacted Groundwater – Upper Zone (Landau Associates 2004)
Figure 4. Extent of Impacted Groundwater – Lower Zone (Landau Associates 2004)

Tables:

Table 1. Potential Sources
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Supplemental Figures

Figure 2-1. Site map (Landau Associates 2004)
Figure 2-6. Groundwater Monitoring Locations and Interim Action Locations (Landau Associates 2004)
Figure 6-4. Geologic/Hydrogeologic Cross Sections (Landau Associates 2004)
Figure 6-8. Geologic/Hydrogeologic Cross Sections (Landau Associates 2004)
Figure 8-1. Conceptual Site Model (Landau Associates 2004)

Supplemental Table:

Table 1. Summary of Soil Concentrations, Post- Soil Removal Actions (will be provided at a later date)

FIGURES

Figure 1. Site Features
Figure 2. Cross Section
Figure 3. Extent of Impacted Groundwater – Upper Zone (Landau Associates 2004)
Figure 4. Extent of Impacted Groundwater – Lower Zone (Landau Associates 2004)

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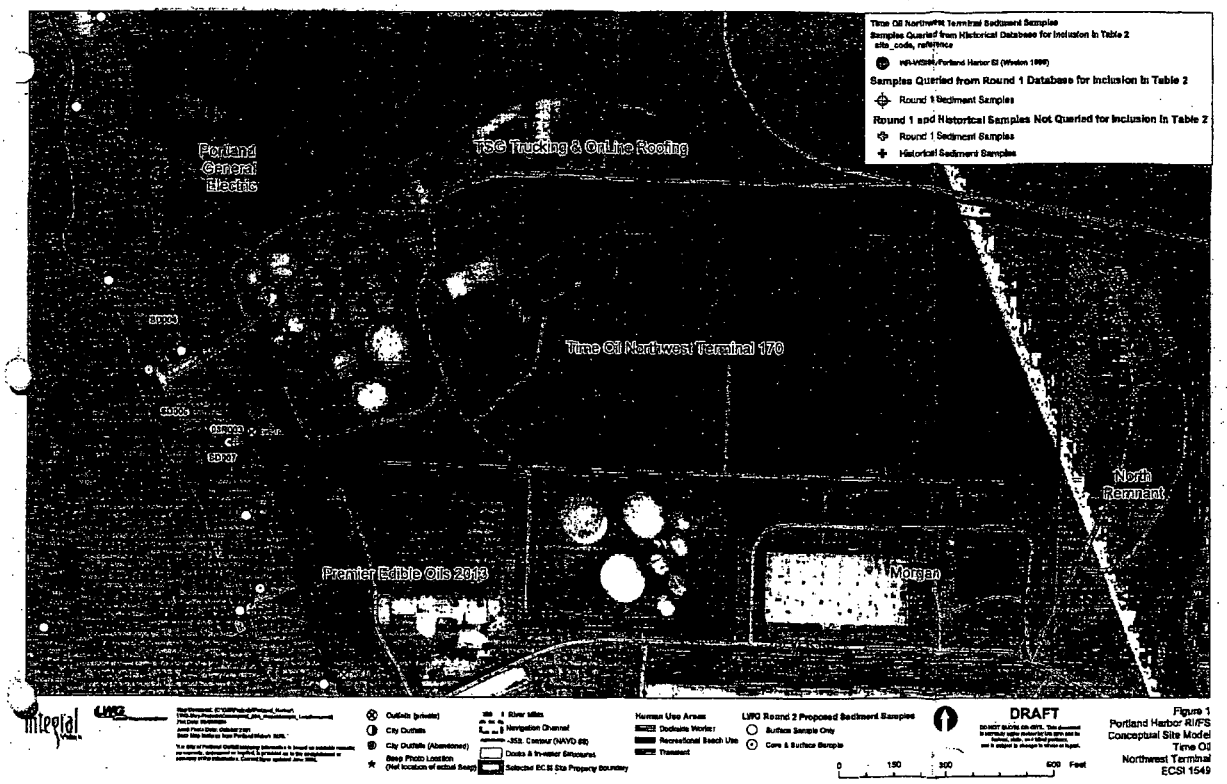
and is subject to change is whole or part.



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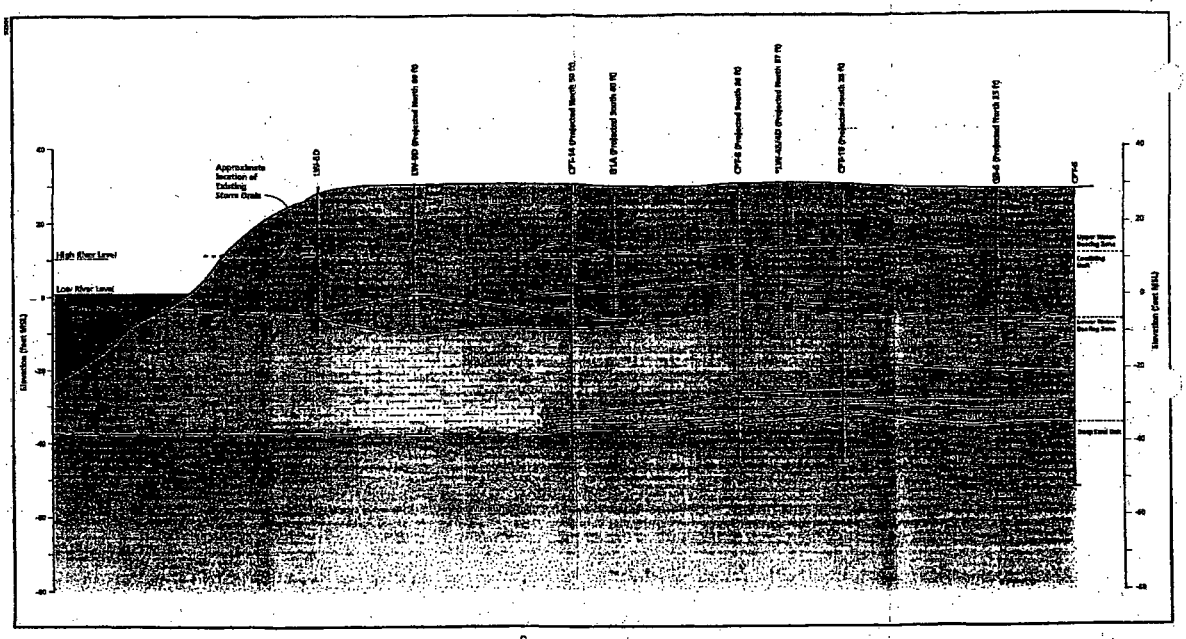

LWG
Lower Willamette Group

Groundwater Solutions Inc.

LEGEND

0 50 100
HORIZONTAL SCALE IN FEET
VERTICAL EXAGGERATION = 10X

Scale and elevations are approximate.

References: LAL 2001 Remedial Investigation, Time Oil Northwest Terminal, Portland, Oregon.

Note: Samples at CPT boring locations were obtained from a separate push-probe boring.
* DW-4S/4D are two nested wells with separate screened intervals.

DW-4D
- Boring/Well ID
- Surface elevation along profile
- Groundwater level
- Boring/Well, Projected
- Well Screen
- Bottom of boring/well

- Silt
- Silty Sand
- Fine to Medium Sand

Pleistocene Flood Deposits and Recent Alluvium - Undifferentiated sand and silt

Figu
Portland Harbor R.
Hydrogeologic Cross Section
Time Oil Northwest Terminal
GROUNDWATER SOLUTIONS, INC.

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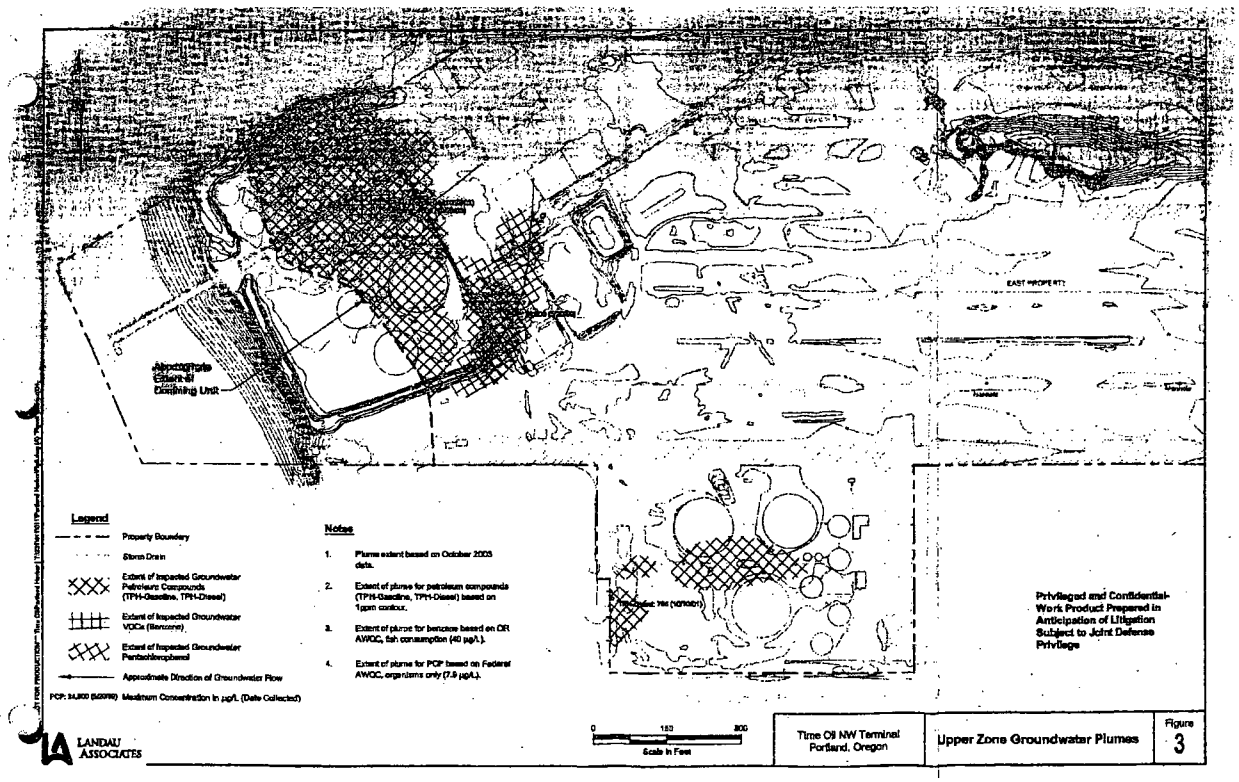

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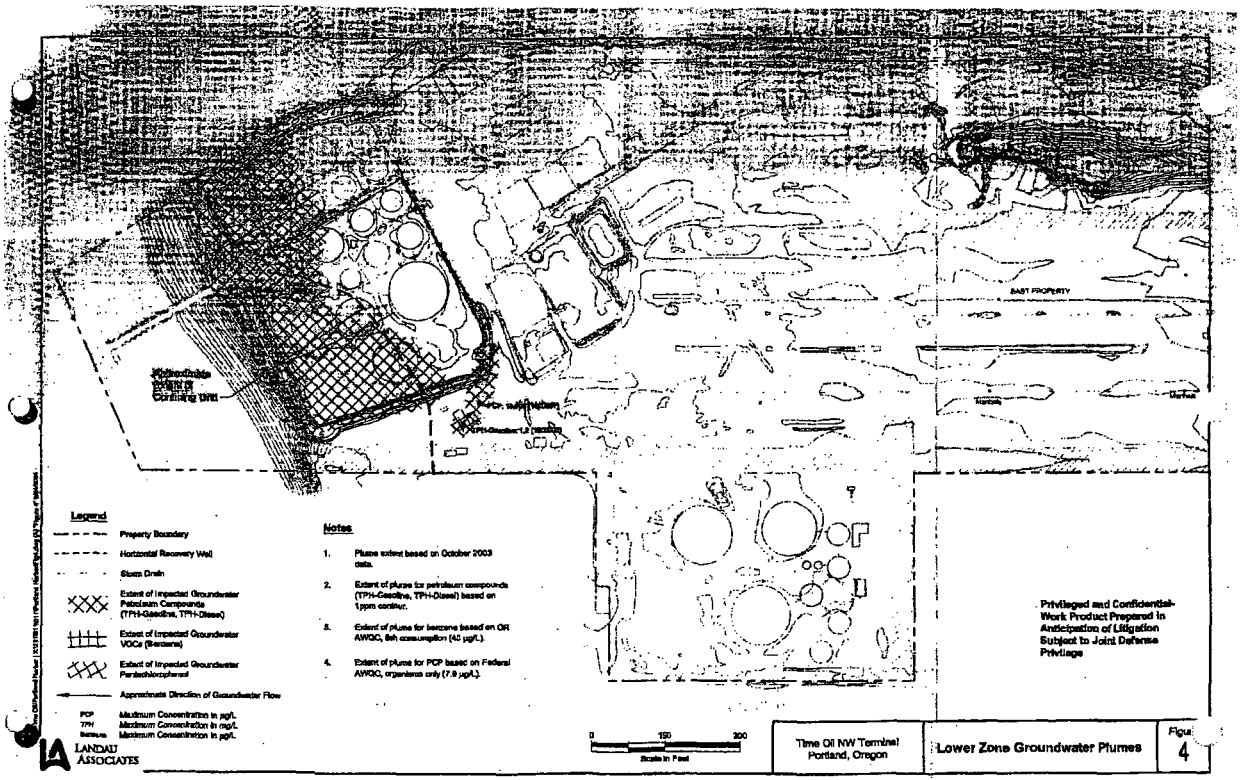

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TABLES

Table 1. Potential Sources
Table 2. Queried Sediment Chemistry Data

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Time Oil Northwest Terminal ECSI #170
Table 1. Potential Sources and Transport Pathways Assessment

Last Updated: September 17, 2004

Potential Sources	Media Impacted					COIs																		Potential Complete Pathway				
						TPH			VOCs																			
Description of Potential Source	Surface Soil	Subsurface Soil	Groundwater	Catch Basin Solids	River Sediment	Gasoline-Range	Diesel - Range	Heavier - Range	Petroleum-Related (e.g. BTEX)	VOCs	Chlorinated VOCs	SVOCs	PAHs	Phthalates	Phenolics	Metals	PCBs	Herbicides and Pesticides	Dioxins/Furans	Butyltins	Pentachlorophenol	*[Others - List]*	*[Others - List]*	Overland Transport	Groundwater	Direct Discharge - Overwater	Direct Discharge - Storm/Wastewater	Riverbank Erosion
Upland Areas																												
Former wood treatment formulation and storage area	✓	✓	✓		?	✓	✓	✓	✓			✓	✓	✓	✓	✓			✓		✓				✓			
Former Main Terminal tank farm	✓	✓	✓		?	✓	✓	✓	✓			✓	✓			✓									✓			
Former Bell Terminal tank farm	✓	✓	✓			✓	✓	✓	✓			✓	✓	✓		✓									✓			
Overwater Areas																												
Dock Operations					?	?	?	?	?			?	?			?										?		
Other Areas/Other Issues																												

Notes:
[1] All information provided in this table is referenced in the site summaries. If information is not available or inconclusive, a "?" may be used, as appropriate. No new information is provided in this table.
✓ = Source, COI are present or current or historic pathway is determined to be complete or potentially complete.
? = There is not enough information to determine if source or COI is present or if pathway is complete.
Blank = Source, COI and historic and current pathways have been investigated and shown to be not present or incomplete.

UST Underground storage tank
AST Above-ground storage tank
TPH Total petroleum hydrocarbons
VOCs Volatile organic compounds
SVOCs Semivolatile organic compounds
PAHs Polycyclic aromatic hydrocarbons
BTEX Benzene, toluene, ethylbenzene, and xylenes
PCBs Polychorinated biphenols

SCHN00303540

LWG

Lower Willamette Group

[illegible]	[illegible]	3	0	0							1.9 U	3.8 UJ	11.4	3.8	U	3.8 U
[illegible]	[illegible]	2	0	0							3.8 U	19 UJ	11.4	3.8	U	3.8 U
[illegible]	[illegible]	2	0	0							3.8 U	19 UJ	11.4	3.8	U	3.8 U
[illegible]	[illegible]	2	1	50	5.6	5.6	5.6	5.6	5.6	5.6	5.6	19 UJ	13.4	5.6		5.6
[illegible]	[illegible]	2	1	50	7.87	7.87	7.87	7.87	7.87	7.87	7.87	19 UJ	13.3	7.87		7.87
[illegible]	[illegible]	2	0	0							7.6 U	37 UJ	22.3	7.6	U	7.6 U
[illegible]	Aroclor 1221 (ug/kg)	2	0	0							3.8 U	19 UJ	11.4	3.8	U	3.8 U
[illegible]	Polychlorinated biphenyls (ug/kg)	2	1	50	13.5	13.5	13.5	13.5	13.5	13.5	13.5	37 UJ	25.3	13.5		13.5
surface	Dieldrin (ug/kg)	1	0	0							5.6 UJ	5.6 UJ	5.6	5.6	UJ	5.6 UJ
surface	Endrin (ug/g)	1	0	0							0.06 U	0.06 UJ	0.06	0.06	U	0.06 U
surface	Endrin aldehyde (ug/kg)	1	0	0							5.6 U	5.6 U	5.6	5.6	U	5.6 U
surface	Endrin ketone (ug/g)	1	0	0							0.06 U	0.06 U	0.06	0.06	U	0.06 U
surface	Heptachlor (ug/kg)	1	1	100	16	16	16	16	16	16	16	16	16	16		16
surface	Heptachlor (ug/l)	1	0	0							0.02 U	0.02 U	0.02	0.02	U	0.02 U
surface	Heptachlor epoxide (ug/kg)	1	0	0							5.6 U	5.6 U	5.6	5.6	U	5.6 U
surface	Toxaphene (ug/l)	1	0	0							0.02 U	0.02 U	0.02	0.02	U	0.02 U
surface	Total solids (percent)	1	1	100	69.4	69.4	69.4	69.4	69.4	69.4	69.4	69.4	69.4	69.4		69.4
surface	Total organic carbon (percent)	4	4	100	0.89	12	3.76	1.06	1.1	0.89	12	3.76	1.06			1.1
surface	2,3,7,8-Tetrachlorodibenzo-p-dioxin (ng/kg)	1	0	0						0.107 UJ	0.107 UJ	0.107	0.107	0.107	UJ	0.107 UJ
surface	Tetrachlorodibenzo-p-dioxin (ng/kg)	1	1	100	1.25 NJ	1.25 NJ	1.25	1.25 NJ	1.25 NJ	1.25 NJ	1.25 NJ	1.25	1.25	1.25	NJ	1.25 NJ
surface	1,2,3,7,8-Pentachlorodibenzo-p-dioxin (ng/kg)	1	1	100	0.334 NJ	0.334 NJ	0.334	0.334 NJ	0.334 NJ	0.334 NJ	0.334 NJ	0.334	0.334	0.334	NJ	0.334 NJ
surface	Pentachlorodibenzo-p-dioxin (ng/kg)	1	1	100	0.749 NJ	0.749 NJ	0.749	0.749 NJ	0.749 NJ	0.749 NJ	0.749 NJ	0.749	0.749	0.749	NJ	0.749 NJ
surface	1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin (ng/kg)	1	1	100	0.539 NJ	0.539 NJ	0.539	0.539 NJ	0.539 NJ	0.539 NJ	0.539 NJ	0.539	0.539	0.539	NJ	0.539 NJ
surface	1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin (ng/kg)	1	1	100	2.31 NJ	2.31 NJ	2.31	2.31 NJ	2.31 NJ	2.31 NJ	2.31 NJ	2.31	2.31	2.31	NJ	2.31 NJ
surface	1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin (ng/kg)	1	1	100	1.55 NJ	1.55 NJ	1.55	1.55 NJ	1.55 NJ	1.55 NJ	1.55 NJ	1.55	1.55	1.55	NJ	1.55 NJ
surface	Hexachlorodibenzo-p-dioxin (ng/kg)	1	1	100	14.2 NJ	14.2 NJ	14.2	14.2 NJ	14.2 NJ	14.2 NJ	14.2 NJ	14.2	14.2	14.2	NJ	14.2 NJ
surface	1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin (ng/kg)	1	1	100	60.7 NJ	60.7 NJ	60.7	60.7 NJ	60.7 NJ	60.7 NJ	60.7 NJ	60.7	60.7	60.7	NJ	60.7 NJ
surface	Heptachlorodibenzo-p-dioxin (ng/kg)	1	1	100	115 NJ	115 NJ	115	115 NJ	115 NJ	115 NJ	115 NJ	115	115	115	NJ	115 NJ
surface	Octachlorodibenzo-p-dioxin (ng/kg)	1	1	100	482 NJ	482 NJ	482	482 NJ	482 NJ	482 NJ	482 NJ	482	482	482	NJ	482 NJ
surface	2,3,7,8-Tetrachlorodibenzofuran (ng/kg)	1	1	100	0.304	0.304	0.304	0.304	0.304	0.304	0.304	0.304	0.304	0.304		0.304
surface	Tetrachlorodibenzofuran (ng/kg)	1	1	100	2.14 NJ	2.14 NJ	2.14	2.14 NJ	2.14 NJ	2.14 NJ	2.14 NJ	2.14	2.14	2.14	NJ	2.14 NJ
surface	1,2,3,7,8-Pentachlorodibenzofuran (ng/kg)	1	1	100	0.252 NJ	0.252 NJ	0.252	0.252 NJ	0.252 NJ	0.252 NJ	0.252 NJ	0.252	0.252	0.252	NJ	0.252 NJ
surface	2,3,4,7,8-Pentachlorodibenzofuran (ng/kg)	1	1	100	0.275 NJ	0.275 NJ	0.275	0.275 NJ	0.275 NJ	0.275 NJ	0.275 NJ	0.275	0.275	0.275	NJ	0.275 NJ
surface	Pentachlorodibenzofuran (ng/kg)	1	1	100	5.76 NJ	5.76 NJ	5.76	5.76 NJ	5.76 NJ	5.76 NJ	5.76 NJ	5.76	5.76	5.76	NJ	5.76 NJ
surface	1,2,3,4,7,8-Hexachlorodibenzofuran (ng/kg)	1	1	100	0.902 NJ	0.902 NJ	0.902	0.902 NJ	0.902 NJ	0.902 NJ	0.902 NJ	0.902	0.902	0.902	NJ	0.902 NJ
surface	1,2,3,6,7,8-Hexachlorodibenzofuran (ng/kg)	1	1	100	0.451 NJ	0.451 NJ	0.451	0.451 NJ	0.451 NJ	0.451 NJ	0.451 NJ	0.451	0.451	0.451	NJ	0.451 NJ
surface	1,2,3,7,8,9-Hexachlorodibenzofuran (ng/kg)	1	0	0						0.1 U	0.1 U	0.1	0.1	0.1	U	0.1 U
surface	2,3,4,6,7,8-Hexachlorodibenzofuran (ng/kg)	1	1	100	0.32 NJ	0.32 NJ	0.32	0.32 NJ	0.32 NJ	0.32 NJ	0.32 NJ	0.32	0.32	0.32	NJ	0.32 NJ
surface	Hexachlorodibenzofuran (ng/kg)	1	1	100	14.4 NJ	14.4 NJ	14.4	14.4 NJ	14.4 NJ	14.4 NJ	14.4 NJ	14.4	14.4	14.4	NJ	14.4 NJ
surface	1,2,3,4,6,7,8-Heptachlorodibenzofuran (ng/kg)	1	1	100	11.6 NJ	11.6 NJ	11.6	11.6 NJ	11.6 NJ	11.6 NJ	11.6 NJ	11.6	11.6	11.6	NJ	11.6 NJ
surface	1,2,3,4,7,8,9-Heptachlorodibenzofuran (ng/kg)	1	1	100	0.724 NJ	0.724 NJ	0.724	0.724 NJ	0.724 NJ	0.724 NJ	0.724 NJ	0.724	0.724	0.724	NJ	0.724 NJ
surface	Heptachlorodibenzofuran (ng/kg)	1	1	100	38.2 NJ	38.2 NJ	38.2	38.2 NJ	38.2 NJ	38.2 NJ	38.2 NJ	38.2	38.2	38.2	NJ	38.2 NJ
surface	Octachlorodibenzofuran (ng/kg)	1	1	100	35.6 NJ	35.6 NJ	35.6	35.6 NJ	35.6 NJ	35.6 NJ	35.6 NJ	35.6	35.6	35.6	NJ	35.6 NJ
surface	Gravel (percent)	2	2	100	0.15	1.86	1.01	0.15	0.15	0.15	1.86	1.01	0.15			0.15
surface	Sand (percent)	3	3	100	21.19	82.29	43.6	27.82	27.82	21.19	82.29	43.6	27.82			27.82
surface	Very coarse sand (percent)	1	1	100	0.683	0.683	0.683	0.683	0.683	0.683	0.683	0.683	0.683			0.683
surface	Coarse sand (percent)	1	1	100	8.06	8.06	8.06	8.06	8.06	8.06	8.06	8.06	8.06			8.06
surface	Medium sand (percent)	1	1	100	41.8	41.8	41.8	41.8	41.8	41.8	41.8	41.8	41.8			41.8
surface	Fine sand (percent)	1	1	100	26.8	26.8	26.8	26.8	26.8	26.8	26.8	26.8	26.8			26.8
surface	Very fine sand (percent)	1	1	100	8.17	8.17	8.17	8.17	8.17	8.17	8.17	8.17	8.17			8.17
surface	Fines (percent)	3	3	100	17.56	72.18	54	72.18	72.18	17.56	72.18	54	72.18			72.18

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Table 2. Quartel Sediment Chemistry Data

Surface or Subsurface	Analyte	Number of Samples	Number Detected	% Detected	Detected Concentrations Minimum	Maximum	Mean	Median	95th	Detected and Nondetected Concentrations Minimum	Maximum	Mean	Median	95th
surface	Silt (percent)	3	3	100	15.27	67.31	48.4	62.53	62.53	15.27	67.31	48.4	62.53	62.53
surface	Coarse silt (percent)	1	1	100	3.91	3.91	3.91	3.91	3.91	3.91	3.91	3.91	3.91	3.91
surface	Medium silt (percent)	1	1	100	2.77	2.77	2.77	2.77	2.77	2.77	2.77	2.77	2.77	2.77
surface	Fine silt (percent)	1	1	100	1.69	1.69	1.69	1.69	1.69	1.69	1.69	1.69	1.69	1.69
surface	Very fine silt (percent)	1	1	100	1.47	1.47	1.47	1.47	1.47	1.47	1.47	1.47	1.47	1.47
surface	Clay (percent)	3	3	100	2.29	11.5	7.81	9.65	9.65	2.29	11.5	7.81	9.65	9.65
surface	6-9 Phi clay (percent)	1	1	100	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02
surface	9-10 Phi clay (percent)	1	1	100	0.843	0.843	0.843	0.843	0.843	0.843	0.843	0.843	0.843	0.843
surface	>10 Phi clay (percent)	1	1	100	0.897	0.897	0.897	0.897	0.897	0.897	0.897	0.897	0.897	0.897
surface	Dalapon (ug/kg)	1	0	0						16 U	16 U	16	16 U	16 U
surface	Dicamba (ug/kg)	1	0	0						3.1 U	3.1 U	3.1	3.1 U	3.1 U
surface	MCPA (ug/kg)	1	0	0						3200 U	3200 U	3200	3200 U	3200 U
surface	Dichloroprop (ug/kg)	1	0	0						6.2 U	6.2 U	6.2	6.2 U	6.2 U
surface	2,4-D (ug/kg)	1	0	0						6.3 U	6.3 U	6.3	6.3 U	6.3 U
surface	Silvex (ug/kg)	1	0	0						1.7 U	1.7 U	1.7	1.7 U	1.7 U
surface	2,4,5-T (ug/kg)	1	0	0						1.6 U	1.6 U	1.6	1.6 U	1.6 U
surface	2,4-DB (ug/kg)	1	0	0						31 U	31 U	31	31 U	31 U
surface	Dinoseb (ug/kg)	1	0	0						3.1 U	3.1 U	3.1	3.1 U	3.1 U
surface	MCPP (ug/kg)	1	0	0						3300 U	3300 U	3300	3300 U	3300 U
surface	Aluminum (mg/kg)	4	4	100	20500	42700	31700	21500	42100	20500	42700	31700	21500	42100
surface	Aluminum (mg/l)	1	1	100	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
surface	Antimony (mg/kg)	4	4	100	0.3 J	10 J	5.83	4 J	9 J	0.3 J	10 J	5.83	4 J	9 J
surface	Antimony (mg/l)	1	0	0						0.05 U	0.05 U	0.05	0.05 U	0.05 U
surface	Arsenic (mg/kg)	4	2	50	4.43	5	4.72	4.43	4.43	4.43	5 U	4.86	5	5 U
surface	Arsenic (mg/l)	1	0	0						0.001 U	0.001 U	0.001	0.001 U	0.001 U
surface	Cadmium (mg/kg)	4	4	100	0.108	0.4	0.252	0.2	0.3	0.108	0.4	0.252	0.2	0.3
surface	Cadmium (mg/l)	1	0	0						0.002 U	0.002 U	0.002	0.002 U	0.002 U
surface	Chromium (mg/kg)	4	4	100	20	39.1	30.4	23.8	38.9	20	39.1	30.4	23.8	38.9
surface	Chromium (mg/l)	1	0	0						0.005 U	0.005 U	0.005	0.005 U	0.005 U
surface	Copper (mg/kg)	4	4	100	21.2	45.7	32.9	21.5	43	21.2	45.7	32.9	21.5	43
surface	Copper (mg/l)	1	0	0						0.002 U	0.002 U	0.002	0.002 U	0.002 U
surface	Lead (mg/kg)	4	4	100	9	12.2	10.6	9	12	9	12.2	10.6	9	12
surface	Lead (mg/l)	1	0	0						0.001 U	0.001 U	0.001	0.001 U	0.001 U
surface	Manganese (mg/kg)	3	3	100	389	764	626	725	725	389	764	626	725	725
surface	Manganese (mg/l)	1	1	100	4.59	4.59	4.59	4.59	4.59	4.59	4.59	4.59	4.59	4.59
surface	Mercury (mg/kg)	4	3	75	0.02	0.08	0.05	0.05	0.05	0.02	0.08	0.0525	0.05	0.08 U
surface	Mercury (mg/l)	1	0	0						0.0001 U	0.0001 U	0.0001	0.0001 U	0.0001 U
surface	Nickel (mg/kg)	4	4	100	18.7	30	25.2	23	29	18.7	30	25.2	23	29
surface	Nickel (mg/l)	1	0	0						0.01 U	0.01 U	0.01	0.01 U	0.01 U
surface	Selenium (mg/kg)	4	0	0						0.3 U	5 U	3.68	4 U	5 U
surface	Selenium (mg/l)	1	0	0						0.001 U	0.001 U	0.001	0.001 U	0.001 U
surface	Silver (mg/kg)	4	3	75	0.3	0.5	0.4	0.4	0.4	0.03 U	0.5	0.308	0.3	0.4
surface	Silver (mg/l)	1	0	0						0.0002 U	0.0002 U	0.0002	0.0002 U	0.0002 U
surface	Thallium (mg/kg)	3	3	100	5	6	5.67	6	6	5	6	5.67	6	6
surface	Thallium (mg/l)	1	0	0						0.001 U	0.001 U	0.001	0.001 U	0.001 U
surface	Zinc (mg/kg)	4	4	100	70.3	107	87.2	78.2	93.2	70.3	107	87.2	78.2	93.2
surface	Zinc (mg/l)	1	1	100	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004
surface	Barium (mg/kg)	3	3	100	125	200	172	190	190	125	200	172	190	190
surface	Barium (mg/l)	1	1	100	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
surface	Beryllium (mg/kg)	3	3	100	0.4	0.7	0.6	0.7	0.7	0.4	0.7	0.6	0.7	0.7
surface	Beryllium (mg/l)	1	0	0						0.001 U	0.001 U	0.001	0.001 U	0.001 U

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Table 2. Queried Sediment Chemistry Data

Surface or Subsurface	Analyte	Number of Samples	Number Detected	% Detected	Detected Concentrations Minimum	Maximum	Mean	Median	95th	Detected and Nondetected Concentrations Minimum	Maximum	Mean	Median	95th
surface	Calcium (mg/kg)	3	3	100	5770	8670	7830	8850	8850	5770	8670	7830	8850	8850
surface	Calcium (mg/l)	1	1	100	52.2	52.2	52.2	52.2	52.2	52.2	52.2	52.2	52.2	52.2
surface	Cobalt (mg/kg)	3	3	100	12.7	18.9	16.8	16.8	18.8	12.7	18.9	16.8	16.8	18.8
surface	Cobalt (mg/l)	1	0	0						0.003 U	0.003 U	0.003	0.003	U 0.003 U
surface	Iron (mg/kg)	3	3	100	31300	43500	39000	42300	42300	31300	43500	39000	42300	42300
surface	Iron (mg/l)	1	1	100	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69
surface	Magnesium (mg/kg)	3	3	100	4200	7310	6250	7240	7240	4200	7310	6250	7240	7240
surface	Magnesium (mg/l)	1	1	100	18.1	18.1	18.1	18.1	18.1	18.1	18.1	18.1	18.1	18.1
surface	Potassium (mg/kg)	3	3	100	840	1520	1280	1470	1470	840	1520	1280	1470	1470
surface	Potassium (mg/l)	1	1	100	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9
surface	Sodium (mg/kg)	3	3	100	870	1330	1140	1230	1230	870	1330	1140	1230	1230
surface	Sodium (mg/l)	1	1	100	16.3	16.3	16.3	16.3	16.3	16.3	16.3	16.3	16.3	16.3
surface	Titanium (mg/kg)	1	1	100	1410	1410	1410	1410	1410	1410	1410	1410	1410	1410
surface	Vanadium (mg/kg)	3	3	100	70	107	94.7	107	107	70	107	94.7	107	107
surface	Vanadium (mg/l)	1	0	0						0.003 U	0.003 U	0.003	0.003	U 0.003 U
surface	2-Methylnaphthalene (ug/kg)	4	0	0						19 U	20 U	19.3	19	U 19 U
surface	Acenaphthene (ug/kg)	4	2	50	21	21	21	21	21	19 U	21	20	19	U 21
surface	Acenaphthylene (ug/kg)	4	1	25	20.5	20.5	20.5	20.5	20.5	19 U	20.5	19.8	19	U 20 U
surface	Anthracene (ug/kg)	4	3	75	24	32.5	29.2	31	31	19 U	32.5	26.6	24	31
surface	Fluorene (ug/kg)	4	2	50	22	26	24	22	22	19 U	26	21.5	19	U 22
surface	Naphthalene (ug/kg)	4	1	25	29	29	29	29	29	19 U	29	21.5	19	U 19 U
surface	Phenanthrene (ug/kg)	4	4	100	100	190	130	109	120	100	190	130	109	120
surface	Low Molecular Weight PAH (ug/kg)	4	4	100	147 A	223 A	187	162	214 A	147 A	223 A	187	162	214 A
surface	Dibenz(a,h)anthracene (ug/kg)	4	2	50	24.2 J	27	25.6	24.2 J	24.2 J	19 U	27	22.3	19	U 24.2 J
surface	Benz(a)anthracene (ug/kg)	4	4	100	53	99.5 J	78.9	77	86	53	99.5 J	78.9	77	86
surface	Benzo(a)pyrene (ug/kg)	4	4	100	69	113 J	95.5	100	110	69	113 J	95.5	100	110
surface	Benzo(b)fluoranthene (ug/kg)	4	4	100	60	120	88.9	79.5 J	98	60	120	88.9	79.5	J 98
surface	Benzo(g,h,i)perylene (ug/kg)	4	4	100	37	130 J	71.5	59 J	60	37	130 J	71.5	59	J 60
surface	Benzo(k)fluoranthene (ug/kg)	4	4	100	61	94	78.5	77	81.8 J	61	94	78.5	77	81.8 J
surface	Chrysene (ug/kg)	4	4	100	72	161 J	121	120	130	72	161 J	121	120	130
surface	Fluoranthene (ug/kg)	4	4	100	160	340	221	183	200	160	340	221	183	200
surface	Indeno(1,2,3-cd)pyrene (ug/kg)	4	4	100	35	94.5 J	63.7	54	71	35	94.5 J	63.7	54	71
surface	Pyrene (ug/kg)	4	4	100	120	320	218	170	253	120	320	218	170	253
surface	Benzo(b+k)fluoranthene (ug/kg)	3	3	100	121 A	214 A	189	173 A	173 A	121 A	214 A	189	173	A 173 A
surface	High Molecular Weight PAH (ug/kg)	4	4	100	657 A	1254 A	1050	1057 A	1230 J	657 A	1254 A	1050	1057	A 1230 J
surface	Polycyclic Aromatic Hydrocarbons (ug/kg)	3	3	100	804 A	1468 A	1180	1280 A	1280 A	804 A	1468 A	1180	1280	A 1280 A
surface	2-Chlorobiphenyl (ng/kg)	1	1	100	1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.95
surface	3-Chlorobiphenyl (ng/kg)	1	1	100	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25
surface	4-Chlorobiphenyl (ng/kg)	1	1	100	2.22	2.22	2.22	2.22	2.22	2.22	2.22	2.22	2.22	2.22
surface	2,2'-Dichlorobiphenyl (ng/kg)	1	1	100	5.86	5.86	5.86	5.86	5.86	5.86	5.86	5.86	5.86	5.86
surface	2,3-Dichlorobiphenyl (ng/kg)	1	1	100	0.209	0.209	0.209	0.209	0.209	0.209	0.209	0.209	0.209	0.209
surface	2,3'-Dichlorobiphenyl (ng/kg)	1	1	100	3.07	3.07	3.07	3.07	3.07	3.07	3.07	3.07	3.07	3.07
surface	2,4-Dichlorobiphenyl (ng/kg)	1	0	0						0.696 U	0.696 U	0.696	0.696	U 0.696 U
surface	2,4'-Dichlorobiphenyl (ng/kg)	1	1	100	12.9	12.9	12.9	12.9	12.9	12.9	12.9	12.9	12.9	12.9
surface	2,5-Dichlorobiphenyl (ng/kg)	1	1	100	0.885	0.885	0.885	0.885	0.885	0.885	0.885	0.885	0.885	0.885
surface	2,6-Dichlorobiphenyl (ng/kg)	1	1	100	0.351	0.351	0.351	0.351	0.351	0.351	0.351	0.351	0.351	0.351
surface	3,3'-Dichlorobiphenyl (ng/kg)	1	1	100	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7
surface	3,4-Dichlorobiphenyl (ng/kg)	1	1	100	1.86 CJ	1.86 CJ	1.86	1.86 CJ	1.86 CJ	1.86 CJ	1.86 CJ	1.86	1.86	CJ 1.86 CJ
surface	3,4'-Dichlorobiphenyl (ng/kg)	1	0	0						C12	C12	C12		C12 C12
surface	3,5-Dichlorobiphenyl (ng/kg)	1	0	0						0.174 U	0.174 U	0.174	0.174	U 0.174 U
surface	4,4'-Dichlorobiphenyl (ng/kg)	1	1	100	17.2	17.2	17.2	17.2	17.2	17.2	17.2	17.2	17.2	17.2

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Table 2. Quartel Sediment Chemistry Data

Surface or Subsurface	Analyte	Number of Samples	Number Detected	% Detected	Detected Concentrations Minimum	Maximum	Mean	Median	95th	Detected and Nondetected Concentrations Minimum	Maximum	Mean	Median	95th
surface	2,2',3-Trichlorobiphenyl (ng/kg)	1	1	100	11.3	11.3	11.3	11.3	11.3	11.3	11.3	11.3	11.3	11.3
surface	2,2',4-Trichlorobiphenyl (ng/kg)	1	1	100	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5
surface	2,2',5-Trichlorobiphenyl (ng/kg)	1	1	100	25.5 CJ	25.5 CJ	25.5	25.5 CJ	25.5 CJ	25.5 CJ	25.5 CJ	25.5	25.5 CJ	25.5 CJ
surface	2,2',6-Trichlorobiphenyl (ng/kg)	1	1	100	7.68	7.68	7.68	7.68	7.68	7.68	7.68	7.68	7.68	7.68
surface	2,3,3'-Trichlorobiphenyl (ng/kg)	1	1	100	63.2 CJ	63.2 CJ	63.2	63.2 CJ	63.2 CJ	63.2 CJ	63.2 CJ	63.2	63.2 CJ	63.2 CJ
surface	2,3,4-Trichlorobiphenyl (ng/kg)	1	1	100	25.5 CJ	25.5 CJ	25.5	25.5 CJ	25.5 CJ	25.5 CJ	25.5 CJ	25.5	25.5 CJ	25.5 CJ
surface	2,3,4'-Trichlorobiphenyl (ng/kg)	1	1	100	17.7	17.7	17.7	17.7	17.7	17.7	17.7	17.7	17.7	17.7
surface	2,3,5-Trichlorobiphenyl (ng/kg)	1	0	0						0.144 U	0.144 U	0.144	0.144 U	0.144 U
surface	2,3,6-Trichlorobiphenyl (ng/kg)	1	1	100	0.458	0.458	0.458	0.458	0.458	0.458	0.458	0.458	0.458	0.458
surface	2,3',4-Trichlorobiphenyl (ng/kg)	1	1	100	4.77	4.77	4.77	4.77	4.77	4.77	4.77	4.77	4.77	4.77
surface	2,3',5-Trichlorobiphenyl (ng/kg)	1	1	100	9.55 CJ	9.55 CJ	9.55	9.55 CJ	9.55 CJ	9.55 CJ	9.55 CJ	9.55	9.55 CJ	9.55 CJ
surface	2,3',6-Trichlorobiphenyl (ng/kg)	1	1	100	3.41	3.41	3.41	3.41	3.41	3.41	3.41	3.41	3.41	3.41
surface	2,4,4'-Trichlorobiphenyl (ng/kg)	1	0	0						C20	C20	C20	C20	C20
surface	2,4,5-Trichlorobiphenyl (ng/kg)	1	0	0						C26	C26	C26	C26	C26
surface	2,4,6-Trichlorobiphenyl (ng/kg)	1	0	0						C18	C18	C18	C18	C18
surface	2,4',5-Trichlorobiphenyl (ng/kg)	1	1	100	49.2	49.2	49.2	49.2	49.2	49.2	49.2	49.2	49.2	49.2
surface	2,4',6-Trichlorobiphenyl (ng/kg)	1	1	100	11.6	11.6	11.6	11.6	11.6	11.6	11.6	11.6	11.6	11.6
surface	2,3',4'-Trichlorobiphenyl (ng/kg)	1	0	0						C21	C21	C21	C21	C21
surface	2,3',5'-Trichlorobiphenyl (ng/kg)	1	1	100	0.283	0.283	0.283	0.283	0.283	0.283	0.283	0.283	0.283	0.283
surface	3,3',4-Trichlorobiphenyl (ng/kg)	1	1	100	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08
surface	3,3',5-Trichlorobiphenyl (ng/kg)	1	0	0						0.196 U	0.196 U	0.196	0.196 U	0.196 U
surface	3,4,4'-Trichlorobiphenyl (ng/kg)	1	1	100	20.9	20.9	20.9	20.9	20.9	20.9	20.9	20.9	20.9	20.9
surface	3,4,5-Trichlorobiphenyl (ng/kg)	1	0	0						0.218 U	0.218 U	0.218	0.218 U	0.218 U
surface	3,4',5-Trichlorobiphenyl (ng/kg)	1	1	100	0.404 K	0.404 K	0.404	0.404 K	0.404 K	0.404 K	0.404 K	0.404	0.404 K	0.404 K
surface	2,2',3,3'-Tetrachlorobiphenyl (ng/kg)	1	1	100	47.4 CJ	47.4 CJ	47.4	47.4 CJ	47.4 CJ	47.4 CJ	47.4 CJ	47.4	47.4 CJ	47.4 CJ
surface	2,2',3,4-Tetrachlorobiphenyl (ng/kg)	1	0	0						C40	C40	C40	C40	C40
surface	2,2',3,4'-Tetrachlorobiphenyl (ng/kg)	1	1	100	22.6	22.6	22.6	22.6	22.6	22.6	22.6	22.6	22.6	22.6
surface	2,2',3,5-Tetrachlorobiphenyl (ng/kg)	1	1	100	3.51	3.51	3.51	3.51	3.51	3.51	3.51	3.51	3.51	3.51
surface	2,2',3,6'-Tetrachlorobiphenyl (ng/kg)	1	1	100	95.1 CJ	95.1 CJ	95.1	95.1 CJ	95.1 CJ	95.1 CJ	95.1 CJ	95.1	95.1 CJ	95.1 CJ
surface	2,2',3,6-Tetrachlorobiphenyl (ng/kg)	1	1	100	18 CJ	18 CJ	18	18 CJ	18 CJ	18 CJ	18 CJ	18	18 CJ	18 CJ
surface	2,2',3,6'-Tetrachlorobiphenyl (ng/kg)	1	1	100	5.56	5.56	5.56	5.56	5.56	5.56	5.56	5.56	5.56	5.56
surface	2,2',4,4'-Tetrachlorobiphenyl (ng/kg)	1	0	0						C44	C44	C44	C44	C44
surface	2,2',4,5-Tetrachlorobiphenyl (ng/kg)	1	1	100	14.7	14.7	14.7	14.7	14.7	14.7	14.7	14.7	14.7	14.7
surface	2,2',4,5'-Tetrachlorobiphenyl (ng/kg)	1	1	100	60.3 CJ	60.3 CJ	60.3	60.3 CJ	60.3 CJ	60.3 CJ	60.3 CJ	60.3	60.3 CJ	60.3 CJ
surface	2,2',4,6-Tetrachlorobiphenyl (ng/kg)	1	1	100	16.5 CJ	16.5 CJ	16.5	16.5 CJ	16.5 CJ	16.5 CJ	16.5 CJ	16.5	16.5 CJ	16.5 CJ
surface	2,2',4,6'-Tetrachlorobiphenyl (ng/kg)	1	0	0						C45	C45	C45	C45	C45
surface	2,2',5,5'-Tetrachlorobiphenyl (ng/kg)	1	1	100	134	134	134	134	134	134	134	134	134	134
surface	2,2',5,6'-Tetrachlorobiphenyl (ng/kg)	1	0	0						C50	C50	C50	C50	C50
surface	2,2',6,6'-Tetrachlorobiphenyl (ng/kg)	1	1	100	1.24	1.24	1.24	1.24	1.24	1.24	1.24	1.24	1.24	1.24
surface	2,3,3',4-Tetrachlorobiphenyl (ng/kg)	1	1	100	1.38	1.38	1.38	1.38	1.38	1.38	1.38	1.38	1.38	1.38
surface	2,3,3',4'-Tetrachlorobiphenyl (ng/kg)	1	1	100	30.8	30.8	30.8	30.8	30.8	30.8	30.8	30.8	30.8	30.8
surface	2,3,3',5-Tetrachlorobiphenyl (ng/kg)	1	0	0						0.717 U	0.717 U	0.717	0.717 U	0.717 U
surface	2,3,3',5'-Tetrachlorobiphenyl (ng/kg)	1	0	0						0.77 U	0.77 U	0.77	0.77 U	0.77 U
surface	2,3,3',6-Tetrachlorobiphenyl (ng/kg)	1	1	100	8.84 CJ	8.84 CJ	8.84	8.84 CJ	8.84 CJ	8.84 CJ	8.84 CJ	8.84	8.84 CJ	8.84 CJ
surface	2,3,4,4'-Tetrachlorobiphenyl (ng/kg)	1	1	100	13.3	13.3	13.3	13.3	13.3	13.3	13.3	13.3	13.3	13.3
surface	2,3,4,5-Tetrachlorobiphenyl (ng/kg)	1	1	100	152 CJ	152 CJ	152	152 CJ	152 CJ	152 CJ	152 CJ	152	152 CJ	152 CJ
surface	2,3,4,6-Tetrachlorobiphenyl (ng/kg)	1	0	0						C59	C59	C59	C59	C59
surface	2,3,4',5-Tetrachlorobiphenyl (ng/kg)	1	1	100	2.99	2.99	2.99	2.99	2.99	2.99	2.99	2.99	2.99	2.99
surface	2,3,4',6-Tetrachlorobiphenyl (ng/kg)	1	1	100	40.7	40.7	40.7	40.7	40.7	40.7	40.7	40.7	40.7	40.7
surface	2,3,5,6-Tetrachlorobiphenyl (ng/kg)	1	0	0						C44	C44	C44	C44	C44
surface	2,3',4,4'-Tetrachlorobiphenyl (ng/kg)	1	1	100	78.8	78.8	78.8	78.8	78.8	78.8	78.8	78.8	78.8	78.8

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Table 2. Queried Sediment Chemistry Data

Surface or Subsurface	Analyte	Number of Samples	Number Detected	% Detected	Detected Concentrations Minimum	Maximum	Mean	Median	95th	Detected and Nondetected Concentrations Minimum	Maximum	Mean	Median	95th
surface	2,3',4,5-Tetrachlorobiphenyl (ng/kg)	1	1	100	2.46	2.46	2.46	2.46	2.46	2.46	2.46	2.46	2.46	2.46
surface	2,3',4,5'-Tetrachlorobiphenyl (ng/kg)	1	1	100	0.778	0.778	0.778	0.778	0.778	0.778	0.778	0.778	0.778	0.778
surface	2,3',4,6-Tetrachlorobiphenyl (ng/kg)	1	0	0						C49	C49	C49	C49	C49
surface	2,3',4',5-Tetrachlorobiphenyl (ng/kg)	1	0	0						C61	C61	C61	C61	C61
surface	2,3',4',6-Tetrachlorobiphenyl (ng/kg)	1	0	0						C40	C40	C40	C40	C40
surface	2,3',5,5'-Tetrachlorobiphenyl (ng/kg)	1	1	100	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12
surface	2,3',5',6-Tetrachlorobiphenyl (ng/kg)	1	0	0						0.645 U	0.645 U	0.645	0.645 U	0.645 U
surface	2,4,4',5-Tetrachlorobiphenyl (ng/kg)	1	0	0						C61	C61	C61	C61	C61
surface	2,4,4',6-Tetrachlorobiphenyl (ng/kg)	1	0	0						C59	C59	C59	C59	C59
surface	2,3',4',6'-Tetrachlorobiphenyl (ng/kg)	1	0	0						C61	C61	C61	C61	C61
surface	3,3',4,4'-Tetrachlorobiphenyl (ng/kg)	1	1	100	7.72	7.72	7.72	7.72	7.72	7.72	7.72	7.72	7.72	7.72
surface	3,3',4,5-Tetrachlorobiphenyl (ng/kg)	1	0	0						0.203 U	0.203 U	0.203	0.203 U	0.203 U
surface	3,3',4,5'-Tetrachlorobiphenyl (ng/kg)	1	1	100	2.33	2.33	2.33	2.33	2.33	2.33	2.33	2.33	2.33	2.33
surface	3,3',5,5'-Tetrachlorobiphenyl (ng/kg)	1	0	0						0.61 U	0.61 U	0.61	0.61 U	0.61 U
surface	3,4,4',5-Tetrachlorobiphenyl (ng/kg)	1	1	100	0.274	0.274	0.274	0.274	0.274	0.274	0.274	0.274	0.274	0.274
surface	2,2',3,3',4-Pentachlorobiphenyl (ng/kg)	1	1	100	27.2	27.2	27.2	27.2	27.2	27.2	27.2	27.2	27.2	27.2
surface	2,2',3,3',5-Pentachlorobiphenyl (ng/kg)	1	1	100	142 CJ	142 CJ	142	142 CJ	142 CJ	142 CJ	142 CJ	142	142	142 CJ
surface	2,2',3,3',6-Pentachlorobiphenyl (ng/kg)	1	1	100	71.7	71.7	71.7	71.7	71.7	71.7	71.7	71.7	71.7	71.7
surface	2,2',3,4,4'-Pentachlorobiphenyl (ng/kg)	1	1	100	41.1 CJ	41.1 CJ	41.1	41.1 CJ	41.1 CJ	41.1 CJ	41.1 CJ	41.1	41.1	41.1 CJ
surface	2,2',3,4,5-Pentachlorobiphenyl (ng/kg)	1	1	100	167 CJ	167 CJ	167	167 CJ	167 CJ	167 CJ	167 CJ	167	167	167 CJ
surface	2,2',3,4,5'-Pentachlorobiphenyl (ng/kg)	1	0	0						C88	C88	C88	C88	C88
surface	2,2',3,4,6-Pentachlorobiphenyl (ng/kg)	1	1	100	43.2 CJ	43.2 CJ	43.2	43.2 CJ	43.2 CJ	43.2 CJ	43.2 CJ	43.2	43.2	43.2 CJ
surface	2,2',3,4,6'-Pentachlorobiphenyl (ng/kg)	1	1	100	2.36	2.36	2.36	2.36	2.36	2.36	2.36	2.36	2.36	2.36
surface	2,2',3,4',5-Pentachlorobiphenyl (ng/kg)	1	1	100	312 CJ	312 CJ	312	312 CJ	312 CJ	312 CJ	312 CJ	312	312	312 CJ
surface	2,2',3,4',6-Pentachlorobiphenyl (ng/kg)	1	0	0						C88	C88	C88	C88	C88
surface	2,2',3,5,6'-Pentachlorobiphenyl (ng/kg)	1	1	100	58.9	58.9	58.9	58.9	58.9	58.9	58.9	58.9	58.9	58.9
surface	2,2',3,6,6-Pentachlorobiphenyl (ng/kg)	1	1	100	305 CJ	305 CJ	305	305 CJ	305 CJ	305 CJ	305 CJ	305	305	305 CJ
surface	2,2',3,5,6'-Pentachlorobiphenyl (ng/kg)	1	1	100	1.52	1.52	1.52	1.52	1.52	1.52	1.52	1.52	1.52	1.52
surface	2,2',3,5',6-Pentachlorobiphenyl (ng/kg)	1	0	0						C93	C93	C93	C93	C93
surface	2,2',3,6,6'-Pentachlorobiphenyl (ng/kg)	1	1	100	1.96	1.96	1.96	1.96	1.96	1.96	1.96	1.96	1.96	1.96
surface	2,2',3,4',5'-Pentachlorobiphenyl (ng/kg)	1	0	0						C86	C86	C86	C86	C86
surface	2,2',3,4',6'-Pentachlorobiphenyl (ng/kg)	1	0	0						C93	C93	C93	C93	C93
surface	2,2',4,4',5-Pentachlorobiphenyl (ng/kg)	1	0	0						C83	C83	C83	C83	C83
surface	2,2',4,4',6-Pentachlorobiphenyl (ng/kg)	1	0	0						C93	C93	C93	C93	C93
surface	2,2',4,5,5'-Pentachlorobiphenyl (ng/kg)	1	0	0						C90	C90	C90	C90	C90
surface	2,2',4,5,6'-Pentachlorobiphenyl (ng/kg)	1	0	0						C93	C93	C93	C93	C93
surface	2,2',4,5',6-Pentachlorobiphenyl (ng/kg)	1	1	100	3.27	3.27	3.27	3.27	3.27	3.27	3.27	3.27	3.27	3.27
surface	2,2',4,6,6'-Pentachlorobiphenyl (ng/kg)	1	1	100	0.176	0.176	0.176	0.176	0.176	0.176	0.176	0.176	0.176	0.176
surface	2,3,3',4,4'-Pentachlorobiphenyl (ng/kg)	1	1	100	81.5	81.5	81.5	81.5	81.5	81.5	81.5	81.5	81.5	81.5
surface	2,3,3',4,5-Pentachlorobiphenyl (ng/kg)	1	0	0						0.368 U	0.368 U	0.368	0.368 U	0.368 U
surface	2,3,3',4',5-Pentachlorobiphenyl (ng/kg)	1	1	100	8.93 CJ	8.93 CJ	8.93	8.93 CJ	8.93 CJ	8.93 CJ	8.93 CJ	8.93	8.93 CJ	8.93 CJ
surface	2,3,3',4,5'-Pentachlorobiphenyl (ng/kg)	1	0	0						C86	C86	C86	C86	C86
surface	2,3,3',4,6-Pentachlorobiphenyl (ng/kg)	1	1	100	14	14	14	14	14	14	14	14	14	14
surface	2,3,3',4',5-Pentachlorobiphenyl (ng/kg)	1	1	100	378 CJ	378 CJ	378	378 CJ	378 CJ	378 CJ	378 CJ	378	378	378 CJ
surface	2,3,3',5,5'-Pentachlorobiphenyl (ng/kg)	1	0	0						0.329 U	0.329 U	0.329	0.329	0.329 U
surface	2,3,3',5,6-Pentachlorobiphenyl (ng/kg)	1	0	0						0.218 U	0.218 U	0.218	0.218	0.218 U
surface	2,3,3',5',6-Pentachlorobiphenyl (ng/kg)	1	0	0						C90	C90	C90	C90	C90
surface	2,3,4,4',5-Pentachlorobiphenyl (ng/kg)	1	1	100	3.92	3.92	3.92	3.92	3.92	3.92	3.92	3.92	3.92	3.92
surface	2,3,4,4',6-Pentachlorobiphenyl (ng/kg)	1	0	0						C110	C110	C110	C110	C110
surface	2,3,4,5,5-Pentachlorobiphenyl (ng/kg)	1	0	0						C85	C85	C85	C85	C85
surface	2,3,4',5,6-Pentachlorobiphenyl (ng/kg)	1	0	0						C85	C85	C85	C85	C85

SCHN00303545

Table 2. Queried Sediment Chemistry Data

Surface or Subsurface	Analyte	Number of Samples	Number Detected	% Detected	Detected Concentrations Minimum	Maximum	Mean	Median	95th	Detected and Nondetected Concentrations Minimum	Maximum	Mean	Median	95th
surface	2,3',4,4',5-Pentachlorobiphenyl (ng/kg)	1	1	100	206	206	206	206	206	206	206	206	206	206
surface	2,3',4,4',6-Pentachlorobiphenyl (ng/kg)	1	0	0						C86	C86	C86	C86	C86
surface	2,3',4,5,6'-Pentachlorobiphenyl (ng/kg)	1	1	100	0.973	0.973	0.973	0.973	0.973	0.973	0.973	0.973	0.973	0.973
surface	2,3',4,5',6-Pentachlorobiphenyl (ng/kg)	1	0	0						0.415 U	0.415 U	0.415	0.415 U	0.415 U
surface	2,3,3',4',5-Pentachlorobiphenyl (ng/kg)	1	1	100	3.05	3.05	3.05	3.05	3.05	3.05	3.05	3.05	3.05	3.05
surface	2,3',4,4',5'-Pentachlorobiphenyl (ng/kg)	1	1	100	4.16	4.16	4.16	4.16	4.16	4.16	4.16	4.16	4.16	4.16
surface	2,3',4',5,5'-Pentachlorobiphenyl (ng/kg)	1	0	0						C107	C107	C107	C107	C107
surface	2,3',4',5',6-Pentachlorobiphenyl (ng/kg)	1	0	0						C86	C86	C86	C86	C86
surface	3,3',4,4',5-Pentachlorobiphenyl (ng/kg)	1	1	100	0.858	0.858	0.858	0.858	0.858	0.858	0.858	0.858	0.858	0.858
surface	3,3',4,5,5'-Pentachlorobiphenyl (ng/kg)	1	1	100	0.581 K	0.581 K	0.581	0.581 K	0.581 K	0.581 K	0.581 K	0.581	0.581 K	0.581 K
surface	2,2',3,3',4,4'-Hexachlorobiphenyl (ng/kg)	1	1	100	83.1 CJ	83.1 CJ	83.1	83.1 CJ	83.1 CJ	83.1 CJ	83.1 CJ	83.1	83.1 CJ	83.1 CJ
surface	2,2',3,3',4,5-Hexachlorobiphenyl (ng/kg)	1	1	100	688 CJ	688 CJ	688	688 CJ	688 CJ	688 CJ	688 CJ	688	688 CJ	688 CJ
surface	2,2',3,3',4,5'-Hexachlorobiphenyl (ng/kg)	1	1	100	38.7	38.7	38.7	38.7	38.7	38.7	38.7	38.7	38.7	38.7
surface	2,2',3,3',4,6-Hexachlorobiphenyl (ng/kg)	1	1	100	7.21	7.21	7.21	7.21	7.21	7.21	7.21	7.21	7.21	7.21
surface	2,2',3,3',4,6'-Hexachlorobiphenyl (ng/kg)	1	1	100	230	230	230	230	230	230	230	230	230	230
surface	2,2',3,3',5,5'-Hexachlorobiphenyl (ng/kg)	1	1	100	10.6	10.6	10.6	10.6	10.6	10.6	10.6	10.6	10.6	10.6
surface	2,2',3,3',5,6-Hexachlorobiphenyl (ng/kg)	1	1	100	34.8 CJ	34.8 CJ	34.8	34.8 CJ	34.8 CJ	34.8 CJ	34.8 CJ	34.8	34.8 CJ	34.8 CJ
surface	2,2',3,3',5,6'-Hexachlorobiphenyl (ng/kg)	1	1	100	310 CJ	310 CJ	310	310 CJ	310 CJ	310 CJ	310 CJ	310	310 CJ	310 CJ
surface	2,2',3,3',6,6'-Hexachlorobiphenyl (ng/kg)	1	1	100	100	100	100	100	100	100	100	100	100	100
surface	2,2',3,4,4',5-Hexachlorobiphenyl (ng/kg)	1	1	100	17.4	17.4	17.4	17.4	17.4	17.4	17.4	17.4	17.4	17.4
surface	2,2',3,4,4',5'-Hexachlorobiphenyl (ng/kg)	1	0	0						C129	C129	C129	C129	C129
surface	2,2',3,4,4',6-Hexachlorobiphenyl (ng/kg)	1	1	100	8.38 CJ	8.38 CJ	8.38	8.38 CJ	8.38 CJ	8.38 CJ	8.38 CJ	8.38	8.38 CJ	8.38 CJ
surface	2,2',3,4,4',6'-Hexachlorobiphenyl (ng/kg)	1	0	0						C139	C139	C139	C139	C139
surface	2,2',3,4,5,5'-Hexachlorobiphenyl (ng/kg)	1	1	100	151	151	151	151	151	151	151	151	151	151
surface	2,2',3,4,5,6-Hexachlorobiphenyl (ng/kg)	1	0	0						0.699 U	0.699 U	0.699	0.699	0.699 U
surface	2,2',3,4,5,6'-Hexachlorobiphenyl (ng/kg)	1	0	0						C134	C134	C134	C134	C134
surface	2,2',3,4,6',5-Hexachlorobiphenyl (ng/kg)	1	1	100	42.3	42.3	42.3	42.3	42.3	42.3	42.3	42.3	42.3	42.3
surface	2,2',3,4,6,6'-Hexachlorobiphenyl (ng/kg)	1	0	0						0.354 U	0.354 U	0.354	0.354	0.354 U
surface	2,2',3,4',5,5'-Hexachlorobiphenyl (ng/kg)	1	1	100	132 D	132 D	132	132 D	132 D	132 D	132 D	132	132	132 D
surface	2,2',3,4',5,6-Hexachlorobiphenyl (ng/kg)	1	1	100	846 CJ	846 CJ	846	846 CJ	846 CJ	846 CJ	846 CJ	846	846	846 CJ
surface	2,2',3,4',5,6'-Hexachlorobiphenyl (ng/kg)	1	1	100	1.16	1.16	1.16	1.16	1.16	1.16	1.16	1.16	1.16	1.16
surface	2,2',3,4',5',6-Hexachlorobiphenyl (ng/kg)	1	0	0						C147	C147	C147	C147	C147
surface	2,2',3,4',6,6'-Hexachlorobiphenyl (ng/kg)	1	1	100	0.872	0.872	0.872	0.872	0.872	0.872	0.872	0.872	0.872	0.872
surface	2,2',3,5,5',6-Hexachlorobiphenyl (ng/kg)	1	0	0						C135	C135	C135	C135	C135
surface	2,2',3,5,6,6'-Hexachlorobiphenyl (ng/kg)	1	1	100	0.504	0.504	0.504	0.504	0.504	0.504	0.504	0.504	0.504	0.504
surface	2,2',4,4',5,5'-Hexachlorobiphenyl (ng/kg)	1	1	100	844 CJ	844 CJ	844	844 CJ	844 CJ	844 CJ	844 CJ	844	844	844 CJ
surface	2,2',4,4',5,6'-Hexachlorobiphenyl (ng/kg)	1	0	0						C135	C135	C135	C135	C135
surface	2,2',4,4',6,6'-Hexachlorobiphenyl (ng/kg)	1	0	0						0.122 U	0.122 U	0.122	0.122	0.122 U
surface	2,3,3',4,4',5-Hexachlorobiphenyl (ng/kg)	1	1	100	43.9	43.9	43.9	43.9	43.9	43.9	43.9	43.9	43.9	43.9
surface	2,3,3',4,4',5'-Hexachlorobiphenyl (ng/kg)	1	1	100	10.1	10.1	10.1	10.1	10.1	10.1	10.1	10.1	10.1	10.1
surface	2,3,3',4,4',6-Hexachlorobiphenyl (ng/kg)	1	1	100	66	66	66	66	66	66	66	66	66	66
surface	2,3,3',4,5,5'-Hexachlorobiphenyl (ng/kg)	1	1	100	7.51	7.51	7.51	7.51	7.51	7.51	7.51	7.51	7.51	7.51
surface	2,3,3',4,5,6-Hexachlorobiphenyl (ng/kg)	1	0	0						C129	C129	C129	C129	C129
surface	2,3,3',4,5',6-Hexachlorobiphenyl (ng/kg)	1	0	0						0.46 U	0.46 U	0.46	0.46	0.46 U
surface	2,3,3',4',5,6'-Hexachlorobiphenyl (ng/kg)	1	1	100	1.37 K	1.37 K	1.37	1.37 K	1.37 K	1.37 K	1.37 K	1.37	1.37	1.37 K
surface	2,3,3',4',5,6-Hexachlorobiphenyl (ng/kg)	1	0	0						C129	C129	C129	C129	C129
surface	2,3,3',4',5',6-Hexachlorobiphenyl (ng/kg)	1	1	100	53.8	53.8	53.8	53.8	53.8	53.8	53.8	53.8	53.8	53.8
surface	2,3,3',5',6,6'-Hexachlorobiphenyl (ng/kg)	1	0	0						0.524 U	0.524 U	0.524	0.524	0.524 U
surface	2,3,4,4',5,6-Hexachlorobiphenyl (ng/kg)	1	0	0						C128	C128	C128	C128	C128
surface	2,3',4,4',5,5'-Hexachlorobiphenyl (ng/kg)	1	1	100	21.8	21.8	21.8	21.8	21.8	21.8	21.8	21.8	21.8	21.8
surface	2,3',4,4',5',6-Hexachlorobiphenyl (ng/kg)	1	0	0						C153	C153	C153	C153	C153

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Table 2. Queried Sediment Chemistry Data

Surface or Subsurface	Analyte	Number of Samples	Number Detected	% Detected	Detected Concentrations Minimum	Maximum	Mean	Median	95th	Detected and Nondetected Concentrations Minimum	Maximum	Mean	Median	95th
surface	3,3',4,4',5,5'-Hexachlorobiphenyl (ng/kg)	1	0	0						0.207 U	0.207 U	0.207	0.207 U	0.207 U
surface	2,2',3,3',4,4',5-Heptachlorobiphenyl (ng/kg)	1	1	100	231	231	231	231	231	231	231	231	231	231
surface	2,2',3,3',4,4',5-Heptachlorobiphenyl (ng/kg)	1	1	100	79.5 CJ	79.5 CJ	79.5	79.5 CJ	79.5 CJ	79.5 CJ	79.5 CJ	79.5	79.5 CJ	79.5 CJ
surface	2,2',3,3',4,5,5'-Heptachlorobiphenyl (ng/kg)	1	1	100	43.4	43.4	43.4	43.4	43.4	43.4	43.4	43.4	43.4	43.4
surface	2,2',3,3',4,5,6-Heptachlorobiphenyl (ng/kg)	1	0	0						C171	C171	C171	C171	C171
surface	2,2',3,3',4,5,6'-Heptachlorobiphenyl (ng/kg)	1	1	100	284	284	284	284	284	284	284	284	284	284
surface	2,2',3,3',4,6',6-Heptachlorobiphenyl (ng/kg)	1	1	100	11.4	11.4	11.4	11.4	11.4	11.4	11.4	11.4	11.4	11.4
surface	2,2',3,3',4,6,6'-Heptachlorobiphenyl (ng/kg)	1	1	100	36.3	36.3	36.3	36.3	36.3	36.3	36.3	36.3	36.3	36.3
surface	2,2',3,3',4,5',6'-Heptachlorobiphenyl (ng/kg)	1	1	100	154	154	154	154	154	154	154	154	154	154
surface	2,2',3,3',5,5',6-Heptachlorobiphenyl (ng/kg)	1	1	100	52.5	52.5	52.5	52.5	52.5	52.5	52.5	52.5	52.5	52.5
surface	2,2',3,3',5,6,6'-Heptachlorobiphenyl (ng/kg)	1	1	100	113	113	113	113	113	113	113	113	113	113
surface	2,2',3,4,4',5,5'-Heptachlorobiphenyl (ng/kg)	1	1	100	539 CJ	539 CJ	539	539 CJ	539 CJ	539 CJ	539 CJ	539	539 CJ	539 CJ
surface	2,2',3,4,4',5,6-Heptachlorobiphenyl (ng/kg)	1	1	100	1.53	1.53	1.53	1.53	1.53	1.53	1.53	1.53	1.53	1.53
surface	2,2',3,4,4',6,6'-Heptachlorobiphenyl (ng/kg)	1	1	100	1.27	1.27	1.27	1.27	1.27	1.27	1.27	1.27	1.27	1.27
surface	2,2',3,4,4',5',6-Heptachlorobiphenyl (ng/kg)	1	1	100	188 CJ	188 CJ	188	188 CJ	188 CJ	188 CJ	188 CJ	188	188 CJ	188 CJ
surface	2,2',3,4,4',6,6'-Heptachlorobiphenyl (ng/kg)	1	0	0						0.32 U	0.32 U	0.32	0.32 U	0.32 U
surface	2,2',3,4,5,5',6-Heptachlorobiphenyl (ng/kg)	1	0	0						C183	C183	C183	C183	C183
surface	2,2',3,4,5,6,6'-Heptachlorobiphenyl (ng/kg)	1	0	0						0.308 U	0.308 U	0.308	0.308 U	0.308 U
surface	2,2',3,4',5,5',6-Heptachlorobiphenyl (ng/kg)	1	1	100	323 D	323 D	323	323 D	323 D	323 D	323 D	323	323 D	323 D
surface	2,2',3,4',5,6,6'-Heptachlorobiphenyl (ng/kg)	1	0	0						0.322 U	0.322 U	0.322	0.322 U	0.322 U
surface	2,3,3',4,4',5,5'-Heptachlorobiphenyl (ng/kg)	1	1	100	7.84	7.84	7.84	7.84	7.84	7.84	7.84	7.84	7.84	7.84
surface	2,3,3',4,4',5,6-Heptachlorobiphenyl (ng/kg)	1	1	100	45.7	45.7	45.7	45.7	45.7	45.7	45.7	45.7	45.7	45.7
surface	2,3,3',4,4',5',6-Heptachlorobiphenyl (ng/kg)	1	1	100	10.1	10.1	10.1	10.1	10.1	10.1	10.1	10.1	10.1	10.1
surface	2,3,3',4,5,5',6-Heptachlorobiphenyl (ng/kg)	1	0	0						0.288 U	0.288 U	0.288	0.288 U	0.288 U
surface	2,3,3',4',5,5',6-Heptachlorobiphenyl (ng/kg)	1	0	0						C180	C180	C180	C180	C180
surface	2,2',3,3',4,4',5,5'-Octachlorobiphenyl (ng/kg)	1	1	100	95.7	95.7	95.7	95.7	95.7	95.7	95.7	95.7	95.7	95.7
surface	2,2',3,3',4,4',5,6-Octachlorobiphenyl (ng/kg)	1	1	100	41.8	41.8	41.8	41.8	41.8	41.8	41.8	41.8	41.8	41.8
surface	2,2',3,3',4,4',5,6'-Octachlorobiphenyl (ng/kg)	1	1	100	64.5	64.5	64.5	64.5	64.5	64.5	64.5	64.5	64.5	64.5
surface	2,2',3,3',4,4',5,6'-Octachlorobiphenyl (ng/kg)	1	1	100	24.3 CJ	24.3 CJ	24.3	24.3 CJ	24.3 CJ	24.3 CJ	24.3 CJ	24.3	24.3 CJ	24.3 CJ
surface	2,2',3',4,4,5,5'-Octachlorobiphenyl (ng/kg)	1	1	100	129 CJ	129 CJ	129	129 CJ	129 CJ	129 CJ	129 CJ	129	129 CJ	129 CJ
surface	2,2',3,3',4,5,6'-Octachlorobiphenyl (ng/kg)	1	0	0						C198	C198	C198	C198	C198
surface	2,2',3,3',4,5,6,6'-Octachlorobiphenyl (ng/kg)	1	0	0						C197	C197	C197	C197	C197
surface	2,2',3,3',4,6',6,6'-Octachlorobiphenyl (ng/kg)	1	1	100	16.9	16.9	16.9	16.9	16.9	16.9	16.9	16.9	16.9	16.9
surface	2,2',3,3',5,5',6,6'-Octachlorobiphenyl (ng/kg)	1	1	100	23.1	23.1	23.1	23.1	23.1	23.1	23.1	23.1	23.1	23.1
surface	2,2',3,4,4',5,6',6-Octachlorobiphenyl (ng/kg)	1	1	100	81.3	81.3	81.3	81.3	81.3	81.3	81.3	81.3	81.3	81.3
surface	2,2',3,4,4',5,6,6'-Octachlorobiphenyl (ng/kg)	1	0	0						0.28 U	0.28 U	0.28	0.28 U	0.28 U
surface	2,3,3',4,4',5,5',6-Octachlorobiphenyl (ng/kg)	1	1	100	5.21	5.21	5.21	5.21	5.21	5.21	5.21	5.21	5.21	5.21
surface	2,2',3,3',4,4',5,6',6-Nonachlorobiphenyl (ng/kg)	1	1	100	45	45	45	45	45	45	45	45	45	45
surface	2,2',3,3',4,4',5,6,6'-Nonachlorobiphenyl (ng/kg)	1	1	100	5.72	5.72	5.72	5.72	5.72	5.72	5.72	5.72	5.72	5.72
surface	2,2',3,3',4,5,5',6,6'-Nonachlorobiphenyl (ng/kg)	1	1	100	17.4	17.4	17.4	17.4	17.4	17.4	17.4	17.4	17.4	17.4
surface	2,2',3,3',4,4',5,5',6,6'-Decachlorobiphenyl (ng/kg)	1	1	100	42.1	42.1	42.1	42.1	42.1	42.1	42.1	42.1	42.1	42.1
surface	2,4'-DDD (ug/kg)	1	0	0						0.39 U	0.39 U	0.39	0.39 U	0.39 U
surface	2,4'-DDE (ug/kg)	1	0	0						0.4 U	0.4 U	0.4	0.4 U	0.4 U
surface	2,4'-DDT (ug/kg)	1	0	0						0.38 U	0.38 U	0.38	0.38 U	0.38 U
surface	4,4'-DDD (ug/kg)	2	2	100	0.947	1.1 J	1.02	0.947	0.947	0.947	1.1 J	1.02	0.947	0.947
surface	4,4'-DDE (ug/kg)	2	2	100	0.84 J	0.85	0.845	0.84 J	0.84 J	0.84 J	0.85	0.845	0.84 J	0.84 J
surface	4,4'-DDT (ug/kg)	2	2	100	1 J	2.4	1.7	1 J	1 J	1 J	2.4	1.7	1 J	1 J
surface	Total of 3 isomers: pp-DDT,-DDD,-DDE (ug/kg)	2	2	100	2.94 A	4.2	3.57	2.94 A	2.94 A	2.94 A	4.2	3.57	2.94 A	2.94 A
surface	Aldrin (ug/kg)	2	0	0						0.19 U	0.94 UJ	0.565	0.19 U	0.19 U
surface	alpha-Hexachlorocyclohexane (ug/kg)	2	0	0						0.19 U	0.94 UJ	0.565	0.19 U	0.19 U
surface	beta-Hexachlorocyclohexane (ug/kg)	2	0	0						0.2 U	0.94 UJ	0.57	0.2 U	0.2 U

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Table 2. Queried Sediment Chemistry Data

Surface or Subsurface	Analyte	Number of Samples	Number Detected	% Detected	Detected Concentrations Minimum	Maximum	Mean	Median	95th	Detected and Nondetected Concentrations Minimum	Maximum	Mean	Median		95th
surface	delta-Hexachlorocyclohexane (ug/kg)	2	0	0						0.19 U	0.94 UJ	0.565	0.19	U	0.19 U
surface	gamma-Hexachlorocyclohexane (ug/kg)	2	0	0						0.19 U	0.94 UJ	0.565	0.19	U	0.19 U
surface	cis-Chlordane (ug/kg)	2	0	0						0.19 U	0.94 UJ	0.565	0.19	U	0.19 U
surface	trans-Chlordane (ug/kg)	1	0	0						0.19 U	0.19 U	0.19	0.19	U	0.19 U
surface	Oxychlordane (ug/kg)	1	0	0						0.38 U	0.38 U	0.38	0.38	U	0.38 U
surface	cis-Nonachlor (ug/kg)	1	0	0						0.38 U	0.38 U	0.38	0.38	U	0.38 U
surface	trans-Nonachlor (ug/kg)	1	0	0						0.38 U	0.38 U	0.38	0.38	U	0.38 U
surface	Dieldrin (ug/kg)	2	0	0						0.38 U	1.9 UJ	1.14	0.38	U	0.38 U
surface	alpha-Endosulfan (ug/kg)	2	0	0						0.19 U	0.94 UJ	0.565	0.19	U	0.19 U
surface	beta-Endosulfan (ug/kg)	2	0	0						0.38 U	1.9 UJ	1.14	0.38	U	0.38 U
surface	Endosulfan sulfate (ug/kg)	2	0	0						0.38 U	1.9 UJ	1.14	0.38	U	0.38 U
surface	Endrin (ug/kg)	2	0	0						0.38 U	1.9 UJ	1.14	0.38	U	0.38 U
surface	Endrin aldehyde (ug/kg)	2	0	0						0.38 U	1.9 UJ	1.14	0.38	U	0.38 U
surface	Endrin ketone (ug/kg)	2	0	0						0.4 U	1.9 UJ	1.15	0.4	U	0.4 U
surface	Heptachlor (ug/kg)	2	0	0						0.19 U	0.94 UJ	0.565	0.19	U	0.19 U
surface	Heptachlor epoxide (ug/kg)	2	0	0						0.19 U	0.94 UJ	0.565	0.19	U	0.19 U
surface	Methoxychlor (ug/kg)	2	0	0						1.9 U	9.4 UJ	5.65	1.9	U	1.9 U
surface	Mirex (ug/kg)	1	0	0						0.38 U	0.38 U	0.38	0.38	U	0.38 U
surface	Toxaphene (ug/kg)	2	0	0						19 U	94 UJ	56.5	19	U	19 U
surface	gamma-Chlordane (ug/kg)	1	0	0						0.94 UJ	0.94 UJ	0.94	0.94	UJ	0.94 UJ
surface	2,3,4,6-Tetrachlorophenol (ug/kg)	1	0	0						97 U	97 U	97	97	U	97 U
surface	2,4,5-Trichlorophenol (ug/kg)	4	0	0						94 U	99 U	96.5	96	U	97 U
surface	2,4,6-Trichlorophenol (ug/kg)	4	0	0						94 U	99 U	96.5	96	U	97 U
surface	2,4-Dichlorophenol (ug/kg)	4	0	0						56 U	60 U	57.8	57	U	58 U
surface	2,4-Dimethylphenol (ug/kg)	4	0	0						19 U	58 U	29	19	U	20 U
surface	2,4-Dinitrophenol (ug/kg)	4	0	0						190 UJ	200 UJ	193	190	UJ	190 U
surface	2-Chlorophenol (ug/kg)	4	0	0						19 U	20 U	19.3	19	U	19 U
surface	2-Methylphenol (ug/kg)	4	0	0						19 U	20 U	19.3	19	U	19 U
surface	2-Nitrophenol (ug/kg)	4	0	0						94 U	99 U	96.5	96	U	97 U
surface	4,6-Dinitro-2-methylphenol (ug/kg)	4	0	0						190 UJ	200 U	193	190	UJ	190 U
surface	4-Chloro-3-methylphenol (ug/kg)	4	0	0						37 U	40 U	38.5	38	U	39 U
surface	4-Methylphenol (ug/kg)	4	0	0						19 U	20 U	19.3	19	U	19 U
surface	4-Nitrophenol (ug/kg)	4	0	0						94 U	99 U	96.5	96	U	97 U
surface	Pentachlorophenol (ug/kg)	4	0	0						89 U	99 UJ	79.5	94	UJ	96 UJ
surface	Phenol (ug/kg)	4	0	0						19 U	38 U	24.3	19	U	20 U
surface	2,3,4,5-Tetrachlorophenol (ug/kg)	1	0	0						97 U	97 U	97	97	U	97 U
surface	2,3,5,6-Tetrachlorophenol (ug/kg)	1	0	0						97 U	97 U	97	97	U	97 U
surface	Dimethyl phthalate (ug/kg)	4	0	0						19 U	20 U	19.3	19	U	19 U
surface	Diethyl phthalate (ug/kg)	4	0	0						19 U	20 U	19.3	19	U	19 U
surface	Dibutyl phthalate (ug/kg)	4	0	0						19 UJ	20 UJ	19.3	19	UJ	19 U
surface	Butylbenzyl phthalate (ug/kg)	4	1	25	54.8	54.8	54.8	54.8	54.8	19 U	54.8	28.2	19	U	20 U
surface	Di-n-octyl phthalate (ug/kg)	4	0	0						19 U	20 U	19.3	19	U	19 U
surface	Bis(2-ethylhexyl) phthalate (ug/kg)	4	1	25	320	320	320	320	320	38 U	320	129	45	UJ	110 UJ
surface	Azobenzene (ug/kg)	1	0	0						19 U	19 U	19	19	U	19 U
surface	Bis(2-chloro-1-methylethyl) ether (ug/kg)	4	0	0						19 UJ	20 U	19.3	19	UJ	19 U
surface	2,4-Dinitrotoluene (ug/kg)	4	0	0						94 U	99 U	96.5	96	U	97 U
surface	2,6-Dinitrotoluene (ug/kg)	4	0	0						94 U	99 U	96.5	96	U	97 U
surface	2-Chloronaphthalene (ug/kg)	4	0	0						19 U	20 U	19.3	19	U	19 U
surface	2-Nitroaniline (ug/kg)	4	0	0						94 U	99 U	96.5	96	U	97 U
surface	3,3'-Dichlorobenzidine (ug/kg)	4	0	0						94 U	99 U	96.5	96	U	97 U
surface	3-Nitroaniline (ug/kg)	4	0	0						110 UJ	120 U	115	110	UJ	120 U

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Table 2. Queried Sediment Chemistry Data

Surface or Subsurface	Analyte	Number of Samples	Number Detected	% Detected	Detected Concentrations Minimum	Maximum	Mean	Median	95th	Detected and Nondetected Concentrations Minimum	Maximum	Mean	Median	95th
surface	4-Bromophenyl phenyl ether (ug/kg)	4	0	0						19 U	20 U	19.3	19 U	19 U
surface	4-Chloroaniline (ug/kg)	4	0	0						55 U	60 U	57.8	57 U	58 U
surface	4-Chlorophenyl phenyl ether (ug/kg)	4	0	0						19 U	20 U	19.3	19 U	19 U
surface	4-Nitroaniline (ug/kg)	4	0	0						94 UJ	99 U	96.5	95 UJ	97 U
surface	Aniline (ug/kg)	1	0	0						19 U	19 U	19	19 U	19 U
surface	Benzoic acid (ug/kg)	4	0	0						190 U	200 U	193	190 U	190 U
surface	Benzyl alcohol (ug/kg)	4	0	0						19 UJ	97 U	38.6	19 UJ	20 UJ
surface	Bis(2-chloroethoxy) methane (ug/kg)	4	0	0						19 U	20 U	19.3	19 U	19 U
surface	Bis(2-chloroethyl) ether (ug/kg)	4	0	0						37 U	40 U	38.6	38 U	39 U
surface	Carbazole (ug/kg)	4	3	75	11.4	33 J	25.1	31 J	31 J	11.4	33 J	23.8	18 UJ	31 J
surface	Dibenzofuran (ug/kg)	4	0	0						6.8 U	20 U	16	18 U	19 U
surface	Hexachlorobenzene (ug/kg)	4	0	0						0.19 U	20 U	14.6	19 U	19 U
surface	Hexachlorobutadiene (ug/kg)	4	0	0						0.22 U	20 U	14.6	19 U	19 U
surface	Hexachlorocyclopentadiene (ug/kg)	4	0	0						94 UJ	99 UJ	96.5	96 UJ	97 U
surface	Hexachloroethane (ug/kg)	4	0	0						5.6 U	20 U	16	19 U	19 U
surface	Isophorone (ug/kg)	4	0	0						19 U	20 U	19.3	19 U	19 U
surface	Nitrobenzene (ug/kg)	4	0	0						19 U	20 U	19.3	19 U	19 U
surface	N-Nitrosodimethylamine (ug/kg)	1	0	0						97 U	97 U	97	97 U	97 U
surface	N-Nitrosodipropylamine (ug/kg)	4	0	0						37 U	40 UJ	38.6	38 U	39 U
surface	N-Nitrosodiphenylamine (ug/kg)	4	0	0						19 U	20 U	19.3	19 U	19 U
surface	1,2-Dichlorobenzene (ug/kg)	4	0	0						19 U	20 U	19.3	19 U	19 U
surface	1,3-Dichlorobenzene (ug/kg)	4	0	0						19 U	20 U	19.3	19 U	19 U
surface	1,4-Dichlorobenzene (ug/kg)	4	0	0						19 U	20 U	19.3	19 U	19 U
surface	1,2,4-Trichlorobenzene (ug/kg)	4	0	0						19 U	20 U	19.3	19 U	19 U
subsurface	Total organic carbon (percent)	1	1	100	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3
subsurface	Gravel (percent)	1	1	100	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24
subsurface	Sand (percent)	1	1	100	23.27	23.27	23.3	23.27	23.27	23.27	23.27	23.3	23.27	23.27
subsurface	Fines (percent)	1	1	100	76.49	76.49	76.5	76.49	76.49	76.49	76.49	76.5	76.49	76.49
subsurface	Silt (percent)	1	1	100	58.61	58.61	58.6	58.61	58.61	58.61	58.61	58.6	58.61	58.61
subsurface	Clay (percent)	1	1	100	17.88	17.88	17.9	17.88	17.88	17.88	17.88	17.9	17.88	17.88
subsurface	Aluminum (mg/kg)	1	1	100	41300	41300	41300	41300	41300	41300	41300	41300	41300	41300
subsurface	Antimony (mg/kg)	1	0	0						4 UJ	4 UJ	4	4 UJ	4 UJ
subsurface	Arsenic (mg/kg)	1	1	100	5	5	5	5	5	5	5	5	5	5
subsurface	Cadmium (mg/kg)	1	1	100	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
subsurface	Chromium (mg/kg)	1	1	100	39.3	39.3	39.3	39.3	39.3	39.3	39.3	39.3	39.3	39.3
subsurface	Copper (mg/kg)	1	1	100	50.5	50.5	50.5	50.5	50.5	50.5	50.5	50.5	50.5	50.5
subsurface	Lead (mg/kg)	1	1	100	34	34	34	34	34	34	34	34	34	34
subsurface	Manganese (mg/kg)	1	1	100	545	545	545	545	545	545	545	545	545	545
subsurface	Mercury (mg/kg)	1	1	100	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34
subsurface	Nickel (mg/kg)	1	1	100	31.5	31.5	31.5	31.5	31.5	31.5	31.5	31.5	31.5	31.5
subsurface	Selenium (mg/kg)	1	1	100	11	11	11	11	11	11	11	11	11	11
subsurface	Silver (mg/kg)	1	1	100	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4
subsurface	Thallium (mg/kg)	1	1	100	5	5	5	5	5	5	5	5	5	5
subsurface	Zinc (mg/kg)	1	1	100	196	196	196	196	196	196	196	196	196	196
subsurface	Barium (mg/kg)	1	1	100	191	191	191	191	191	191	191	191	191	191
subsurface	Beryllium (mg/kg)	1	1	100	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63
subsurface	Calcium (mg/kg)	1	1	100	8720	8720	8720	8720	8720	8720	8720	8720	8720	8720
subsurface	Cobalt (mg/kg)	1	1	100	17.4	17.4	17.4	17.4	17.4	17.4	17.4	17.4	17.4	17.4
subsurface	Iron (mg/kg)	1	1	100	41400	41400	41400	41400	41400	41400	41400	41400	41400	41400
subsurface	Magnesium (mg/kg)	1	1	100	7060	7060	7060	7060	7060	7060	7060	7060	7060	7060
subsurface	Potassium (mg/kg)	1	1	100	1400	1400	1400	1400	1400	1400	1400	1400	1400	1400

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Table 2. Queried Sediment Chemistry Data

Surface or Subsurface	Analyte	Number of Samples	Number Detected	% Detected	Detected Concentrations Minimum	Maximum	Mean	Median	95th	Detected and Nondetected Concentrations Minimum	Maximum	Mean	Median	95th
subsurface	Sodium (mg/kg)	1	1	100	1230 J	1230 J	1230	1230 J	1230 J	1230 J	1230 J	1230	1230 J	1230 J
subsurface	Vanadium (mg/kg)	1	1	100	103	103	103	103	103	103	103	103	103	103
subsurface	2-Methylnaphthalene (ug/kg)	1	1	100	360	360	360	360	360	360	360	360	360	360
subsurface	Acenaphthene (ug/kg)	1	1	100	600	600	600	600	600	600	600	600	600	600
subsurface	Acenaphthylene (ug/kg)	1	1	100	71	71	71	71	71	71	71	71	71	71
subsurface	Anthracene (ug/kg)	1	1	100	360	360	360	360	360	360	360	360	360	360
subsurface	Fluorene (ug/kg)	1	1	100	360	360	360	360	360	360	360	360	360	360
subsurface	Naphthalene (ug/kg)	1	1	100	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
subsurface	Phenanthrene (ug/kg)	1	1	100	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500
subsurface	Low Molecular Weight PAH (ug/kg)	1	1	100	3891 A	3891 A	3890	3891 A	3891 A	3891 A	3891 A	3890	3891 A	3891 A
subsurface	Dibenz(a,h)anthracene (ug/kg)	1	1	100	150	150	150	150	150	150	150	150	150	150
subsurface	Benz(a)anthracene (ug/kg)	1	1	100	600	600	600	600	600	600	600	600	600	600
subsurface	Benzo(a)pyrene (ug/kg)	1	1	100	770	770	770	770	770	770	770	770	770	770
subsurface	Benzo(b)fluoranthene (ug/kg)	1	1	100	620	620	620	620	620	620	620	620	620	620
subsurface	Benzo(g,h,i)perylene (ug/kg)	1	1	100	770	770	770	770	770	770	770	770	770	770
subsurface	Benzo(k)fluoranthene (ug/kg)	1	1	100	410	410	410	410	410	410	410	410	410	410
subsurface	Chrysene (ug/kg)	1	1	100	800	800	800	800	800	800	800	800	800	800
subsurface	Fluoranthene (ug/kg)	1	1	100	1400	1400	1400	1400	1400	1400	1400	1400	1400	1400
subsurface	Indeno(1,2,3-cd)pyrene (ug/kg)	1	1	100	540	540	540	540	540	540	540	540	540	540
subsurface	Pyrene (ug/kg)	1	1	100	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
subsurface	Benzo(b+k)fluoranthene (ug/kg)	1	1	100	1030 A	1030 A	1030	1030 A	1030 A	1930 A	1030 A	1030	1030 A	1330 A
subsurface	High Molecular Weight PAH (ug/kg)	1	1	100	8060 A	8060 A	8060	8060 A	8060 A	8060 A	8060 A	8060	8060 A	8060 A
subsurface	Polycyclic Aromatic Hydrocarbons (ug/kg)	1	1	100	11951 A	11951 A	12000	11951 A	11951 A	11951 A	11951 A	12000	11951 A	11951 A
subsurface	2,4,5-Trichlorophenol (ug/kg)	1	0	0						98 U	98 U	98	98 U	98 U
subsurface	2,4,6-Trichlorophenol (ug/kg)	1	0	0						98 U	98 U	98	98 U	98 U
subsurface	2,4-Dichlorophenol (ug/kg)	1	0	0						59 U	59 U	59	59 U	59 U
subsurface	2,4-Dimethylphenol (ug/kg)	1	0	0						20 U	20 U	20	20 U	20 U
subsurface	2,4-Dinitrophenol (ug/kg)	1	0	0						200 UJ	200 UJ	200	200 UJ	200 UJ
subsurface	2-Chlorophenol (ug/kg)	1	0	0						20 U	20 U	20	20 U	20 U
subsurface	2-Methylphenol (ug/kg)	1	0	0						20 U	20 U	20	20 U	20 U
subsurface	2-Nitrophenol (ug/kg)	1	0	0						98 U	98 U	98	98 U	98 U
subsurface	4,6-Dinitro-2-methylphenol (ug/kg)	1	0	0						200 UJ	200 UJ	200	200 UJ	200 UJ
subsurface	4-Chloro-3-methylphenol (ug/kg)	1	0	0						39 U	39 U	39	39 U	39 U
subsurface	4-Methylphenol (ug/kg)	1	1	100	240	240	240	240	240	240	240	240	240	240
subsurface	4-Nitrophenol (ug/kg)	1	0	0						98 U	98 U	98	98 U	98 U
subsurface	Pentachlorophenol (ug/kg)	1	0	0						98 UJ	98 UJ	98	98 UJ	98 UJ
subsurface	Phenol (ug/kg)	1	0	0						20 U	20 U	20	20 U	20 U
subsurface	Dimethyl phthalate (ug/kg)	1	0	0						20 U	20 U	20	20 U	20 U
subsurface	Diethyl phthalate (ug/kg)	1	0	0						20 U	20 U	20	20 U	20 U
subsurface	Dibutyl phthalate (ug/kg)	1	0	0						20 U	20 U	20	20 U	20 U
subsurface	Butylbenzyl phthalate (ug/kg)	1	0	0						20 U	20 U	20	20 U	20 U
subsurface	Di-n-octyl phthalate (ug/kg)	1	0	0						20 U	20 U	20	20 U	20 U
subsurface	Bis(2-ethylhexyl) phthalate (ug/kg)	1	1	100	37	37	37	37	37	37	37	37	37	37
subsurface	Bis(2-chloro-1-methylethyl) ether (ug/kg)	1	0	0						20 U	20 U	20	20 U	20 U
subsurface	2,4-Dinitrotoluene (ug/kg)	1	0	0						98 U	98 U	98	98 U	98 U
subsurface	2,6-Dinitrotoluene (ug/kg)	1	0	0						98 U	98 U	98	98 U	98 U
subsurface	2-Chloronaphthalene (ug/kg)	1	0	0						20 U	20 U	20	20 U	20 U
subsurface	2-Nitroaniline (ug/kg)	1	0	0						98 U	98 U	98	98 U	98 U
subsurface	3,3'-Dichlorobenzidine (ug/kg)	1	0	0						98 U	98 U	98	98 U	98 U
subsurface	3-Nitroaniline (ug/kg)	1	0	0						120 UJ	120 UJ	120	120 UJ	120 UJ
subsurface	4-Bromophenyl phenyl ether (ug/kg)	1	0	0						20 U	20 U	20	20 U	20 U

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Table 2. Queried Sediment Chemistry Data

Surface or Subsurface	Analyte	Number of Samples	Number Detected	% Detected	Detected Concentrations Minimum	Maximum	Mean	Median	95th	Detected and Nondetected Concentrations Minimum	Maximum	Mean	Median	95th
subsurface	4-Chloroaniline (ug/kg)	1	0	0						59 U	59 U	59	59 U	59 U
subsurface	4-Chlorophenyl phenyl ether (ug/kg)	1	0	0						20 U	20 U	20	20 U	20 U
subsurface	4-Nitroaniline (ug/kg)	1	0	0						98 UJ	98 UJ	98	98 UJ	98 UJ
subsurface	Benzoic acid (ug/kg)	1	0	0						200 U	200 U	200	200 U	200 U
subsurface	Benzyl alcohol (ug/kg)	1	0	0						20 UJ	20 UJ	20	20 UJ	20 UJ
subsurface	Bis(2-chloroethoxy) methane (ug/kg)	1	0	0						20 U	20 U	20	20 U	20 U
subsurface	Bis(2-chloroethyl) ether (ug/kg)	1	0	0						39 U	39 U	39	39 U	39 U
subsurface	Carbazole (ug/kg)	1	1	100	73 J	73 J	73	73 J	73 J	73 J	73 J	73	73 J	73 J
subsurface	Dibenzofuran (ug/kg)	1	1	100	150	150	150	150	150	150	150	150	150	150
subsurface	Hexachlorobenzene (ug/kg)	1	0	0						20 U	20 U	20	20 U	20 U
subsurface	Hexachlorobutadiene (ug/kg)	1	0	0						20 U	20 U	20	20 U	20 U
subsurface	Hexachlorocyclopentadiene (ug/kg)	1	0	0						98 UJ	98 UJ	98	98 UJ	98 UJ
subsurface	Hexachloroethane (ug/kg)	1	0	0						20 U	20 U	20	20 U	20 U
subsurface	Isophorone (ug/kg)	1	0	0						20 U	20 U	20	20 U	20 U
subsurface	Nitrobenzene (ug/kg)	1	0	0						20 U	20 U	20	20 U	20 U
subsurface	N-Nitrosodipropylamine (ug/kg)	1	0	0						39 U	39 U	39	39 U	39 U
subsurface	N-Nitrosodiphenylamine (ug/kg)	1	0	0						20 UJ	20 UJ	20	20 UJ	20 UJ
subsurface	1,2-Dichlorobenzene (ug/kg)	1	0	0						20 U	20 U	20	20 U	20 U
subsurface	1,3-Dichlorobenzene (ug/kg)	1	0	0						20 U	20 U	20	20 U	20 U
subsurface	1,4-Dichlorobenzene (ug/kg)	1	0	0						20 U	20 U	20	20 U	20 U
subsurface	1,2,4-Trichlorobenzene (ug/kg)	1	0	0						20 U	20 U	20	20 U	20 U

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SUPPLEMENTAL FIGURES

Figure 2-1. Site map (Landau Associates 2004)
Figure 2-6. Groundwater Monitoring Locations and Interim Action Locations (Landau Associates 2004)
Figure 6-4. Geologic/Hydrogeologic Cross Sections (Landau Associates 2004)
Figure 6-8. Geologic/Hydrogeologic Cross Sections (Landau Associates 2004)
Figure 8-1. Conceptual Site Model (Landau Associates 2004)

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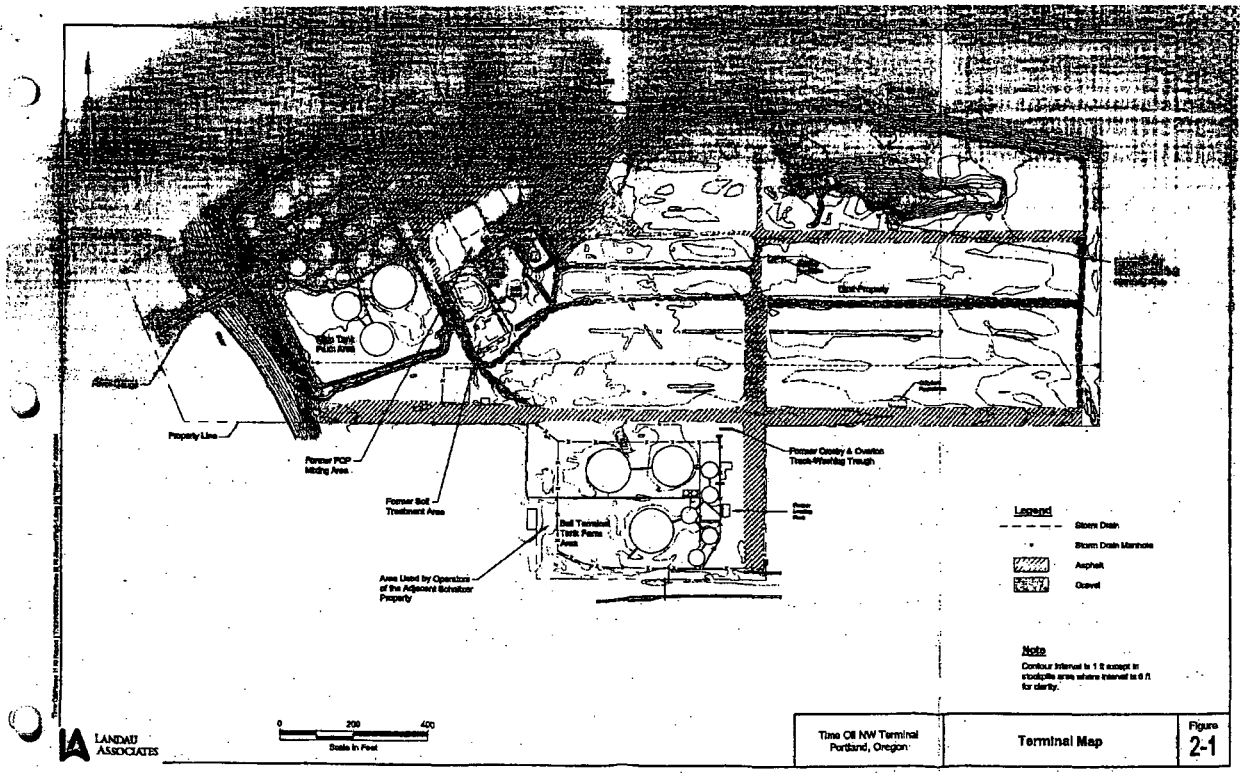

Time Oil NW Terminal
Portland, Oregon

Terminal Map

Figure 2-1

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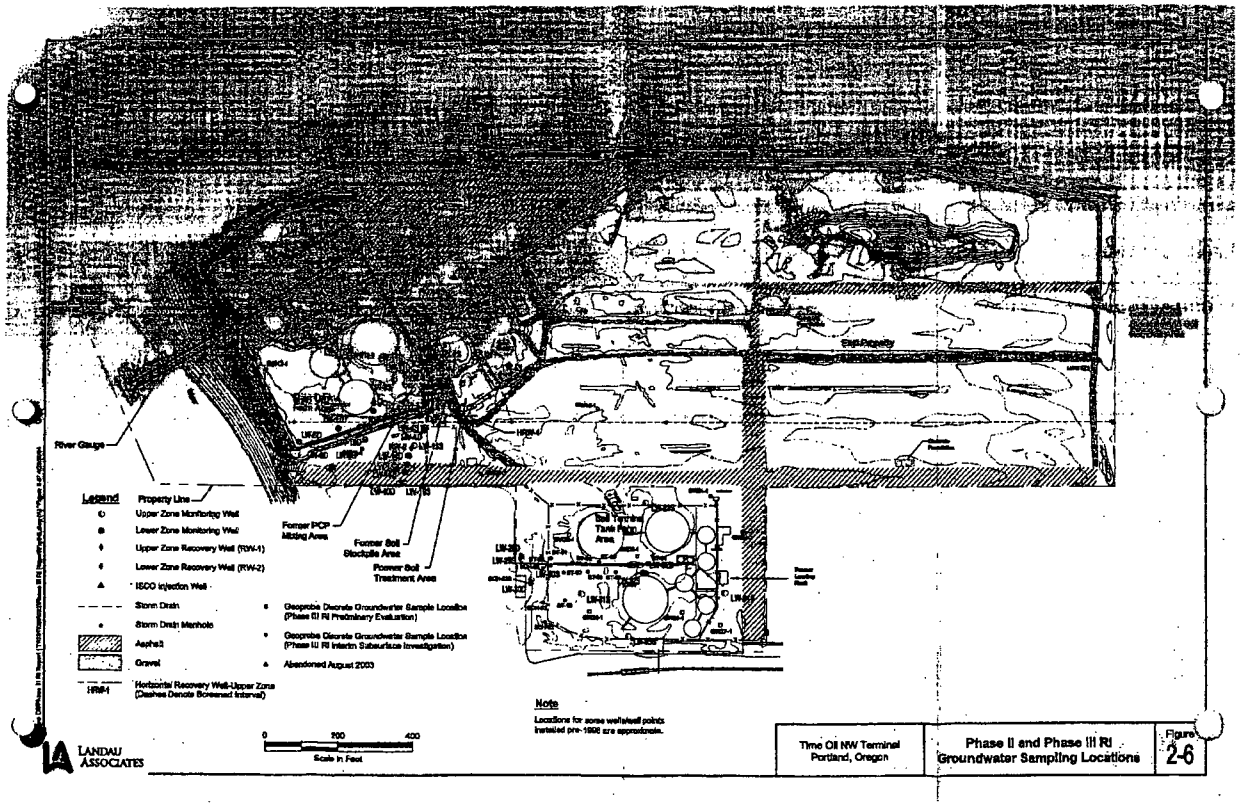

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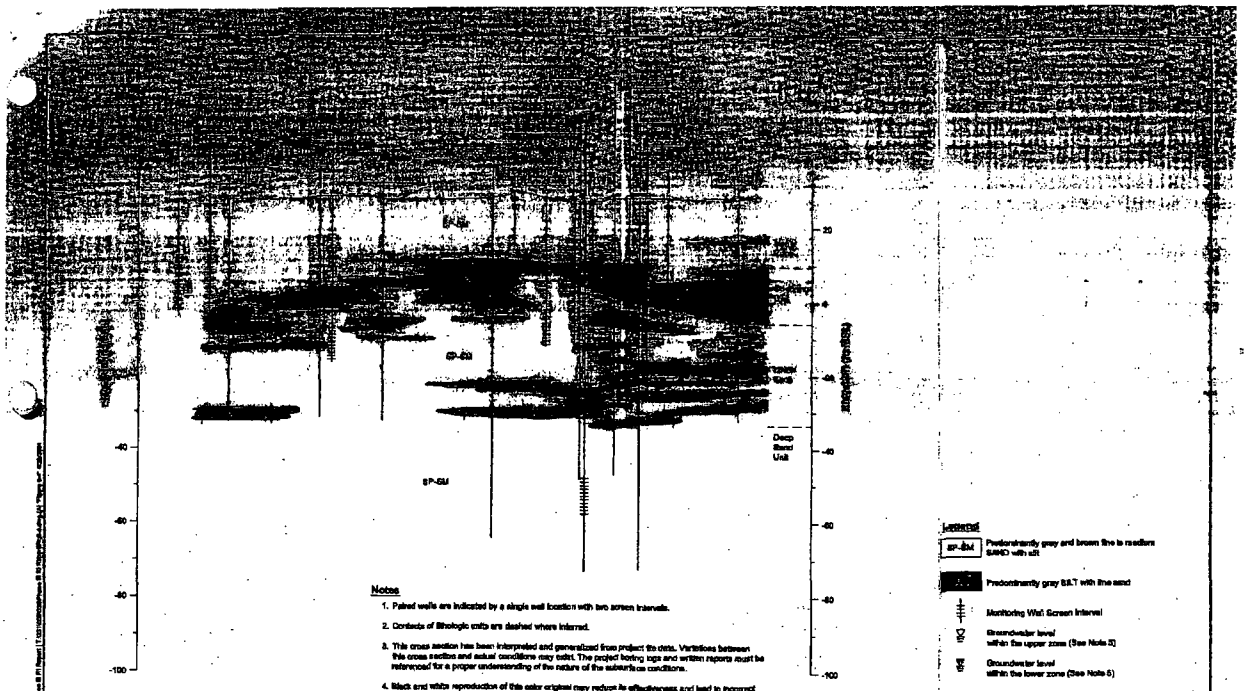

Notes

1. Paired wells are indicated by a single well location with two screen intervals.
2. Contacts of lithologic units are dashed where inferred.
3. This cross section has been interpreted and generalized from project file data. Variations between this cross section and actual conditions may exist. The project boring logs and written reports must be referenced for a proper understanding of the nature of the subsurface conditions.
4. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.
5. Groundwater levels at the CPT/II explorations are estimates based on pore dissipation tests. Groundwater levels at the CPT/II and ST-01 through ST-10 explorations were measured between July 8 and July 10, 2002. Groundwater levels at all existing phase II wells were measured on August 25, 2002. Groundwater levels at all new phase III wells were measured at time of installation in September 2003.

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Time Oil NW Terminal Portland, Oregon	Cross Section C-C'	Figure 6-4

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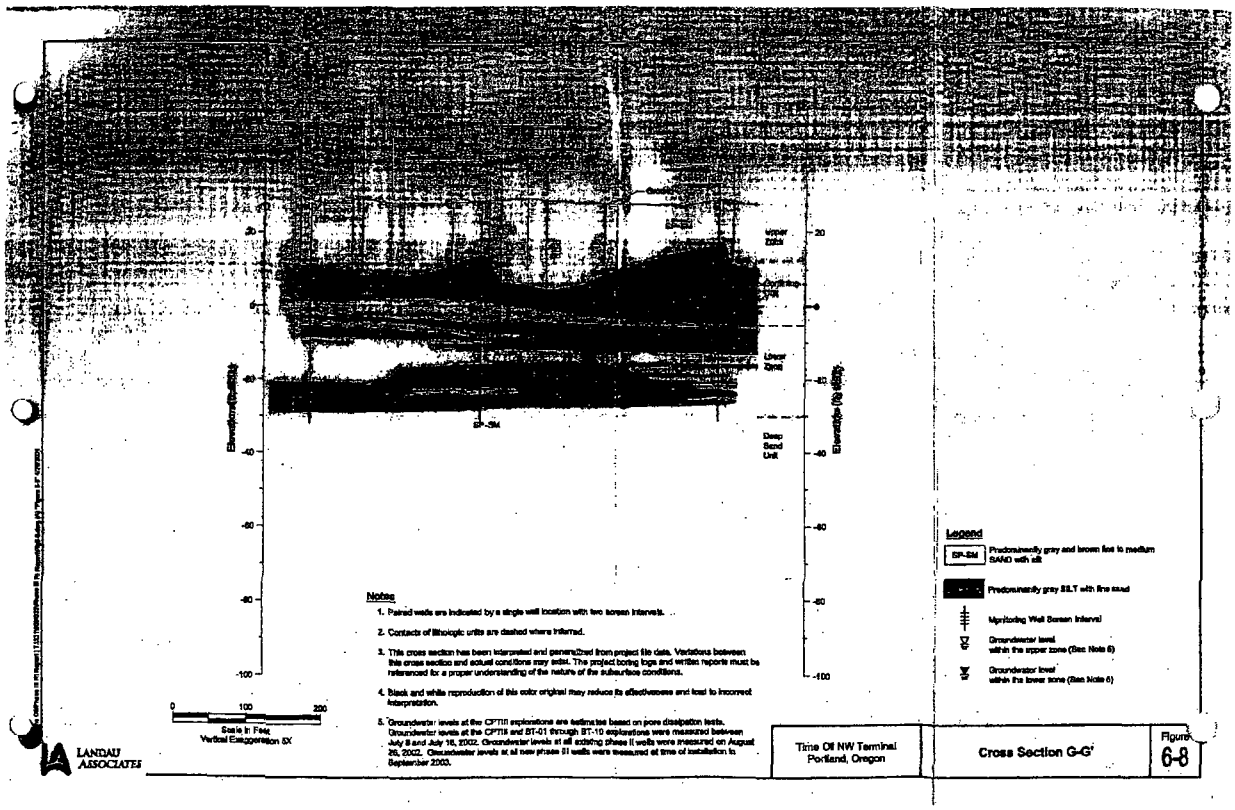

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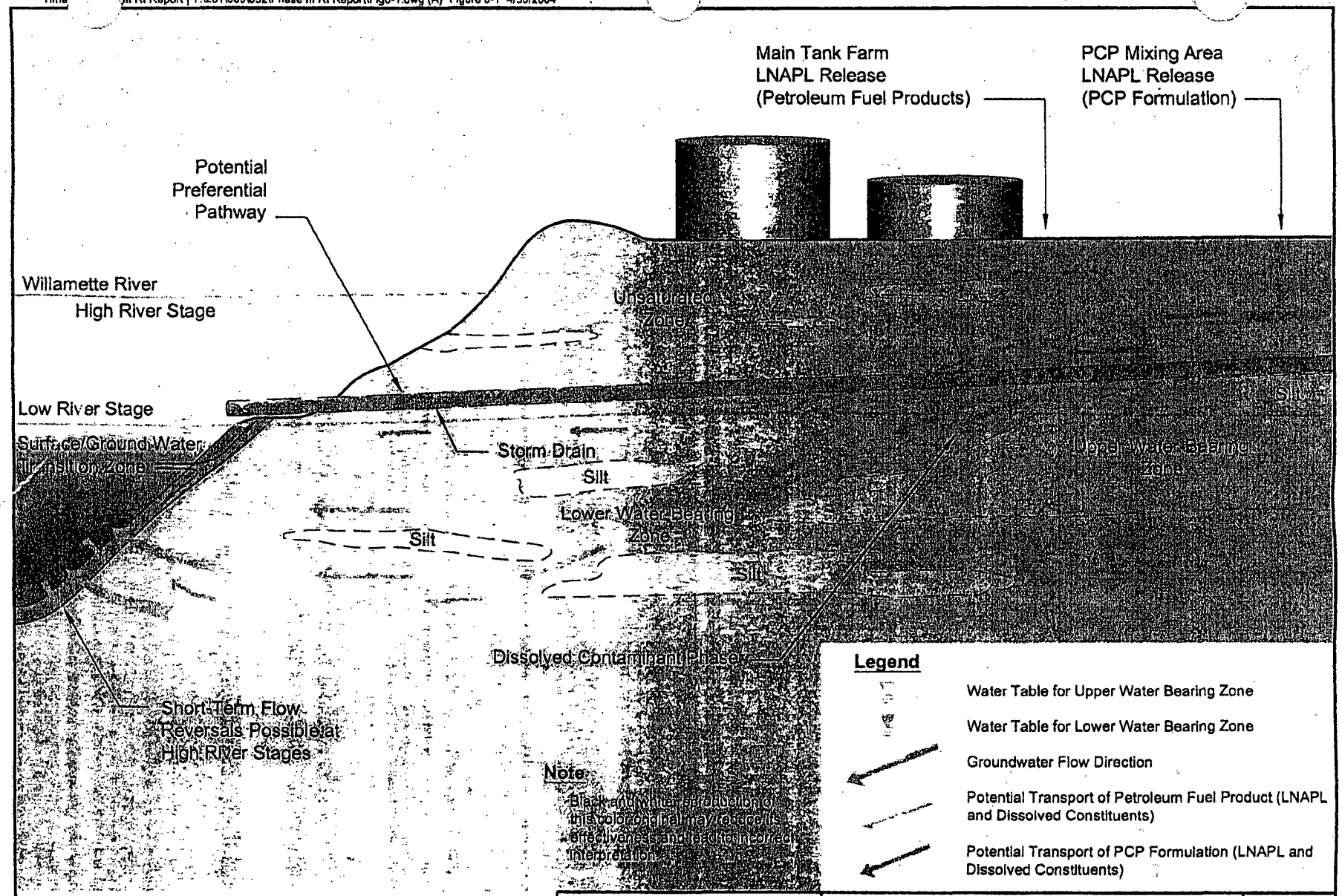

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Not to Scale

Time Oil NW Terminal
Portland, Oregon

Conceptual Site Model

Figure
8-1

SCHN00303558

SUPPLEMENTAL TABLES

Table 1. Summary of Soil Concentrations, Post- Soil Removal Actions
(will be provided at a later date)

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Time Oil : corr

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NORTHWEST REGION

November 18, 2004

Oregon Department of Environmental Quality
2020 SW Fourth Avenue, Suite 400
Portland, Oregon 97201-4987

Attn: Mr. Tom Roick

RE: RESPONSE TO DEQ COMMENTS
PHASE III REMEDIAL INVESTIGATION REPORT
TIME OIL NORTHWEST TERMINAL

Dear Tom:

On behalf of Time Oil Co. (Time Oil), this letter provides responses to comments from the Oregon Department of Environmental Quality (DEQ) regarding the *Phase III Remedial Investigation (RI) Report* (dated April 30, 2004), which was prepared by Landau Associates for Time Oil. DEQ's comments, which are documented in their letter to Time Oil dated September 20, 2004, are provided below along with the corresponding responses. These responses reflect actions for preparation and finalization of the Phase III RI report agreed upon with DEQ in our meeting on September 14, 2004 and later discussions regarding the installation of additional monitoring wells at the Northwest Terminal. In these discussions, it was agreed that the final Phase III RI report would include the results of soil and groundwater sampling being conducted for 12 additional monitoring wells being installed at the terminal in October and November 2004.

DEQ General Comments

A. ***DEQ Comment:*** *The RI needs to provide the reader (e.g., U.S. Environmental Protection Agency, tribes, other interested parties) with an understanding of the nature and extent of contamination and the basis for the findings and conclusions in the report. While it is impracticable to reproduce all previous work in the RI report, the report needs to explain to the reader each step and the rationale used in completing the RI, and provide clear references to previous documents. Reproducing some of the information and figures presented in the RI Work Plan and Interim Subsurface Investigations submittal is necessary to provide a comprehensive RI report.*

Response: More context for the phased investigation approach will be included in Sections 5 and 7. These discussions will outline the decision process for selecting soil sample locations and depths for each phase. Additionally, the rationale for selection of the Phase III groundwater sampling locations will be included. The number of soil and groundwater samples on which the evaluation and conclusions are based will also be discussed and presented in a table in the report. Specific references to previous reports and technical memoranda will be included in Section 2.2. Also, see our responses to specific comments #12 and #13.

B. ***DEQ Comment:*** *The RI is based on only one round of results from the new Phase III groundwater monitoring wells. According to the schedule presented in Section 10, the results for the May 2004 sampling event, and groundwater elevation measurements for August 2004 should be available to incorporate into the final RI report.*

Response: In addition to the information presented in the draft RI report, groundwater monitoring results for the four quarterly sampling events conducted in 2004 will be incorporated into the final report. The fourth quarter 2004 sampling event will include groundwater monitoring results for the 12 additional wells installed along the shoreline, in the Main Tank Farm, and the Bell Terminal Tank Farm in October and November 2004.

C. ***DEQ Comment:*** *The RI should provide a summary of the potential for historic or current releases to impact sediments or surface water of the Willamette River. Areas of concern are: 1) historic loading activities at the dock and potential for spills to sediments or surface water; 2) Phase II groundwater impacts to the storm drain with discharge to the River [IRAM already in place]; 3) petroleum hydrocarbon impacts to groundwater in the Main Tank Farm; and, 4) petroleum hydrocarbon impacts to groundwater at the Bell Terminal. In-water sediment sampling by the Lower Willamette Group will provide some data to assess potential sediment impacts. The need for any source control measures, in addition to those already conducted or in progress, should be evaluated as a follow-up to the upland Phase III RI work.*

Response: A subsection will be added to Section 2 of the report that describes any regulatory non-compliance (e.g., spills, permit violations; see responses to specific comments #2 and #3). For DEQ's listed areas of concern: 1) A discussion of known historic loading dock activities will be added to Section 2.1. 2) Data for samples collected from the groundwater intercept system installed in the storm drain and at the river outfall will be included in the final document; data collected prior to 2004 were included in the draft report. 3) Analytical results from the four new wells installed along the shoreline of the Willamette River will be evaluated to assess the potential for petroleum hydrocarbon impacts to sediment and surface water via discharge of groundwater to the river. 4) Analytical results from the four new wells installed at the Bell Terminal will be used to assess the potential for impacts to groundwater quality and downgradient migration of petroleum hydrocarbons. The analytical results for the sediment samples currently being collected during Round 2 of the RI for the Portland Harbor Superfund project will be evaluated as they become available in 2005; but it is unlikely that the data will be available in time for inclusion in the final Phase III RI report. An assessment of the need for any additional source control measures at the terminal is ongoing. A section, entitled "Potential Sources and Contaminant Transport Pathways to the River," will be added to identify known potential sources and provide the rationale to demonstrate that the potential source areas have been addressed.

Specific Comments

1. ***DEQ Comment:*** *Executive Summary. This section should be revised based on the comments on the main text as appropriate.*

   Response: The executive summary will be revised to reflect other changes in the main text of the report.

2. ***DEQ Comment:*** *Section 2. Page 2-1. A section should be added to the report that describes the facilities regulatory compliance history with all applicable rules and regul ations.*

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Response: Information regarding permits (e.g., NPDES) and environmental regulatory compliance [e.g., Spill Prevention Control Plans (SPCC)] will be added to Section 2.0 the report.

3. ***DEQ Comment:*** *Section 2.1. Page 2-1. This section states that the terminal was used for the receipt, storage, and distribution of petroleum and petroleum related products. The RI report should summarize historical information from the Phase III RI Work Plan, but provide a more detailed history of the Main Tank Farm and Bell Terminal activities. For example, the following information should be included:*
   - *Summary of over water (loading dock) activities;*
   - *Size, age, contents (current and historical), and construction (foundations) of the various on-site tanks;*
   - *Procedures for receipt and transfer of products should be further discussed (i.e., filling/transfer areas);*
   - *Any documented spills or releases (e.g., include historic ethanol spills);*
   - *A description of what is known about how operators of the adjacent Schnitzer property "used" the 80 foot wide strip of land at the Bell Terminal western property boundary;*
   - *A summary of what is known about releases associated with Schnitzer's removal of the pipeline to the Bell Terminal; and*
   - *Spill prevention and control plans in place during site operations.*

   Response: Specific information regarding the receipt, storage, and distribution of petroleum and petroleum related products will be added to Section 2.1 of the report as requested. This will include the specific items listed above and a description of secondary containment structures for the tank farms. With respect to the 80 ft strip of land at the Bell Terminal western property boundary, the data suggest that groundwater concentrations observed in this area originate from a different source than the concentrations observed in groundwater beneath the Bell Terminal tank farm area. An additional monitoring well (LW-43S) was installed in October 2004 to confirm the presence of separate source areas. Data from this well will be included and discussed in the final Phase III RI report.

4. ***DEQ Comment:*** *Section 2.2.2.7. Page 2-14. Please note that fluorene should be fluorine.*

   Response: Correction noted and the text will be changed.

5. ***DEQ Comment:*** *Section 2.2.3.1. Page 2-15. The RI report should provide the basis and rationale for the grid system (i.e., how was the grid developed, how soil samples were collected and composited). While this information is referenced, it would be helpful for the reader to restate the rationale and provide figures (e.g., Figure B-1 of the Phase III RI Work Plan showing grid versus biased sampling areas, and Figure 17 of the Phase III RI – Interim Subsurface Investigation Technical Memorandum).*

   Response: More information will be added regarding the basis and rationale for the grid system as originally provided in the Phase III RI work plan. Figure 3 from the Preliminary Evaluation report, which shows the actual grid sample locations, will be added to the report instead of Figure B-1. Figure B-1 of the Phase III RI work plan shows only the proposed locations. Figure 17 of the Phase III RI Interim Subsurface Investigation Technical Memorandum also shows proposed locations. The actual locations were provided on Figure 2-7 of the draft Phase III RI report. This figure will be included in the final RI report.

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6. ***DEQ Comment:*** *Section 2.2.3.1. Page 2-15. Paragraph 1. This section states that 23 temporary well points were located within the Phase III study area. The logs for these borings should be included in the report, the tabulated data referenced, and the results posted on an appropriate figure.*

   Response: Text will be added to clarify that subsurface soil information obtained at the grid soil sample locations near each temporary well point location during the preliminary evaluation was used to select the installation depth for each of the 23 temporary well points. Soil samples were not specifically collected for lithological or analytical purposes at the temporary well point locations; therefore, soil boring logs were not generated. A soil boring log for at least one of the borings located in each random sampling grid has been generated and will be included in the final Phase III RI report. The groundwater sampling results for the temporary well points are presented in Table D-1, Appendix D of the Phase III RI report. The results are posted on Figures 7-33 through Figures 7-37.

7. ***DEQ Comment:*** *Section 2.2.3.1. Page 2-15. Paragraph 2. Time Oil must address the potential for Bell Terminal releases to impact the downgradient Schnitzer property. In order to accurately characterize the nature and extent of Bell Terminal contamination, off-site data from the adjacent Schnitzer investigation should be included in the RI report and shown on appropriate figures. A discussion of the split sample results should be provided.*

   Response: Data being collected from the four additional wells installed at the Bell Terminal will be included in the discussion of the groundwater impacts in the Bell Terminal and the potential for downgradient migration onto the Schnitzer property. Also, available analytical results for soil and groundwater collected at the Schnitzer property will be added to Figures 7-33 through 7-34 of the report. A discussion of the potential for the concentrations observed in soil and groundwater from the Bell Terminal to impact groundwater on the Schnitzer property will be included in Section 7 of the report. A discussion of the split sample results is included with the overall results discussion in Sections 7 and 8; however, the results for both sets of split samples (i.e., Schnitzer's samples and Time Oil's samples) will also be summarized in tabular format and included in the report.

8. ***DEQ Comment:*** *Section 3.0. Page 3-1. Available historical maps (e.g., 1850's, 1890's, 1912, etc.) and aerial photographs or references to those provided in previous reports (e.g., Phase III RI Work Plan) should be reviewed and discussed in terms of site features, topography, and geomorphology.*

   Response: The historical maps and aerial photographs available from the Oregon Historical Society and aerial photographs that are referenced in previous reports will be reviewed and text will be added to Section 3.0 of the report that discusses changes in site features, topography, and geomorphology over time.

9. ***DEQ Comment:*** *Section 3.4. Page 3-4. A more detailed description of stormwater drainage should be provided (e.g., an update to that described in the February 9, 2001 Phase II RI Report, response to comment 2 and comment 9). Include a figure specific to the storm water drain lines, historic and existing catch basins, and piping to the wastewater treatment system. This section should also include general characteristics and the hydrology of the Willamette River (e.g., bathymetry, river dimensions, flow, depositional environment*

   Response: An update to the information provided in the Phase II RI report on the storm drain system will be provided in Section 2.1 of the Phase III RI report. We will incorporate this information and the information provided in the response to comments for the Phase II RI into a new section in Section 3.4, titled "Storm Drain System" and provide a figure showing the current and historical (to the extent known) configuration of the system. The general characteristics and hydrology of the

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Willamette River are provided in the Programmatic RI/FS work Plan (LWG 2004) and will be referenced in Section 3.4.

10. ***DEQ Comment:*** *Section 4.1. Figure 4-1. Figures 7-34 and 7-38 suggest that the extent of groundwater contamination has not been defined to the north. Therefore, the locality of the facility (LOF) may extend beyond the Time Oil property boundary to the north (the Port of Portland mitigation wetlands). Additionally, apparent releases at the Bell Terminal could migrate downgradient and impact the adjacent Schnitzer property. The LOF should be considered an approximation at these property boundaries until contaminant plumes and the extent of potential downgradient migration are more clearly defined.*

    Response: We accept the comment. The data from the new monitoring wells will be used to assess the LOF boundary for the final RI report.

11. ***DEQ Comment:*** *Section 4.3. Page 4-3. This section should include the details provided in Landau's February 9, 2001 Response to DEQ's comments, Phase II RI Report, comment #6. Also note (comment 10 above) that it is not clear the Port of Portland mitigation wetlands is outside of the groundwater LOF. Additionally, this section should mention the beneficial uses of Willamette River surface water.*

    Response: Landau's February 9, 2001 response to DEQ's comment #6 regarding the Phase II RI Report will be incorporated into Section 4.3 of the final report. The results from the initial groundwater sampling of the three new wells installed along the northern portion of the Main Terminal tank farm will be included in the final report and evaluated to better define the LOF in this area. The beneficial uses of the Willamette River surface water, as designated by rule OAR 340-041, Table 1, will be included in Section 4.3 of the final report.

12. ***DEQ Comment:*** *Section 5.1. Page 5-1. In order for the investigation strategy to be more transparent to the reader, this section should provide additional information regarding the soil investigation. The grid sampling approach should be presented in greater detail including how soil sample locations and depths were selected. Provide boring logs for all phase III drilled and hand-dug soil borings. A table would be helpful summarizing the boring, field screening results, samples collected and analyses performed.*

    Response: As previously indicated in the response to comment #5, the rationale for the grid sampling approach will be presented in greater detail including how the soil sample locations and depths were selected. Additionally, more context from the phased investigation approach will be added including a discussion of the decision process for selecting soil sample locations and depths for each phase of the investigation. Boring logs for all Phase III borings, except for the hand-augered borings, were provided with the Phase III RI report (Volume II) or in previous deliverables to DEQ. The omission of the logs for the hand-augered borings in the draft report was an oversight. These logs will be included in the final Phase III RI report. Additionally, a table summarizing all of the Phase III explorations will be added to the appendices. As agreed upon with DEQ in our meeting, this table will include the samples collected (if any) for laboratory analysis at each exploration, total depth of boring and sample depth, field screening results for these samples, the laboratory analyses performed for each sample, and a reference to a document (if any) where a boring log was previously reported.

13. ***DEQ Comment:*** *Section 5.2. Page 5-3. This section should introduce existing monitoring wells and data available from those wells and how that data was used to locate the Phase III wells.*

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Response: The rationale for selecting the Phase III groundwater sampling locations was presented in the Phase III RI work plan, the Preliminary Investigation technical memorandum, and the Interim Subsurface Investigation technical memorandum and will be included in Section 5.2. The rationale for locating the new monitoring wells installed along the northern portion of the Main Terminal tank farm, along the Willamette River shoreline, and in the Bell Terminal tank farm will also be included in this section.

14. ***DEQ Comment:*** *Section 6.1. Page 6-1. Numerous borings have been completed on-site. A table listing the boring number, total, depth, observations, and a detailed reference to the location of the boring log should be provided.*

Response: As discussed in our response to comment #12, a table summarizing the borings and explorations conducted to date will be included in the appendices of the report. The table will include the total depth of each exploration and a reference to the location of the boring log. Field screening results (specifically photoionization detector readings) will be provided for samples submitted for laboratory analysis. Observations of NAPL, sheen, and odors were provided in Table 7-1 of the draft Phase III RI report. This table will be updated, as needed, to include any observations of NAPL, sheen, and odor encountered during installation of the new groundwater monitoring wells.

15. ***DEQ Comment:*** *Section 6.1. Page 6-1. Discuss whether available historic maps and aerial photographs indicate geomorphologic or manmade features that could have an effect on contaminant transport (e.g., preferential pathways).*

Response: As discussed in our response to comment #8, available historical maps and aerial photographs from the Oregon Historical Society and aerial photographs referenced in previous reports will be evaluated to identify any changes in geomorphologic or manmade features that could have an effect on contaminant transport. A discussion of the results of this evaluation will be included in Section 6.1 of the final report.

16. ***DEQ Comment:*** *Section 7.0 and Figures 7-1 through 7-32. The RI should demonstrate whether the nature and extent (horizontal and vertical distribution) of hazardous substances released from the facility have been adequately characterized using available information on source locations, physical site data (groundwater flow data, topography, preferential pathways), and chemical analysis.*

It is difficult to tell from the data presentation in Section 7 and the figures if the extent of contamination has been determined. While the colored dots presented on the figures give the reader a general idea of the level of contamination, it would be more helpful if the actual concentration was posted on the figures, and contours estimated so that the reader can readily identify areas of contamination above various screening levels. The concentration ranges currently presented on some of the figures do not allow the reader to identify areas potentially above risk-based concentrations. The extent of contamination should be shown by contouring available concentration data, allowing areas that have been impacted to be defined, the extent to be estimated, the adequacy of the sampling locations to be evaluated, and potential data gaps to be identified. Data could also be presented in cross-sectional view. The report should comment on whether the grid-based composite sampling approach should be followed-up with additional biased samples to define the extent of contamination in areas where contamination was detected.

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Response: As agreed to in our meeting, a preliminary soil screening level will be identified for each of the eight constituents plotted on Figures 7-1 through 7-33. Concentrations that exceed the preliminary screening levels will be posted at the appropriate sample location. The soil data for each depth interval will be contoured to illustrate the concentrations that exceed the applicable screening level for each constituent. Concentrations of those constituents presented in Figures 7-1 through 7-33 will be presented on selected cross-sections, with only one constituent presented on a single cross-section.

17. ***DEQ Comment:*** *Section 7.2. Page 7-1. A general description and introduction to available groundwater monitoring data would be helpful to the reader. For example, an introduction to all available groundwater quality data and groundwater concentration trends in selected wells would help the reader interpret the 1st quarter of Phase III groundwater monitoring data.*

Response: A summary of available groundwater quality data was provided in Table 2-1 of the draft Phase III RI report. This table summarizes samples collected at each well and the analyses performed since quarterly monitoring began in 1997. This table will be updated for the final report to provide the analyses performed on samples collected during the quarterly monitoring events during 2004, including those conducted at the newly installed wells in the Main Terminal tank farm, along the Willamette River shoreline, and the Bell Terminal tank farm area. Plots of concentration vs. time will be provided for selected constituents and selected wells for discussion of contaminant trends over time.

18. ***DEQ Comment:*** *Section 7.2.2. Page 7-11. It would be helpful if representative groundwater concentrations were presented in cross-sectional view*

Response: Results for selected constituents for the most recent (fourth quarter 2004) groundwater monitoring event will be presented in cross-sectional view along with the soil results.

19. ***DEQ Comment:*** *Section 7.2.2.1. Page 7-12. Bell Terminal. The data collected by Schnitzer on and in the area of the Bell Terminal should be included and discussed in this section.*

Response: See response to comment #7.

20. ***DEQ Comment:*** *Section 7.3. Page 7-16. Please provide a figure identifying borings and wells where sheens or non-aqueous phase liquid (NAPL) were observed. The extent of NAPL should be estimated.*

Response: Locations where NAPL has been historically and currently observed will be shown on Figures 7-33 through 7-37. Additionally, Table 7-1 of the draft Phase III RI report summarizes the locations and depths where sheen and/or odor were noted in soil. Table 7-2 summarizes the locations where LNAPL was observed and measured in groundwater. These tables will be updated to include information regarding NAPL collected during the 2004 groundwater monitoring events, and information regarding NAPL sheen and/or odor collected during installation of new wells in the Main Terminal tank farm, the Bell Terminal tank farm, and along the shoreline of the Willamette River.

21. ***DEQ Comment:*** *Section 8.2. Page 8-1. Metals concentrations detected in groundwater should be evaluated to determine if they may be related to reducing conditions resulting from the presence and degradation of petroleum product in the subsurface.*

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Response: Dissolved oxygen concentrations will be compared with metals concentrations in groundwater at upgradient locations and within the tank farms areas to evaluate the potential that reducing conditions are affecting lower zone metals concentrations due to the presence and degradation of petroleum constituents.

22. ***DEQ Comment:*** *Section 8.3.3. Page 8-11. Discuss PAH concentrations in soil as they relate to the former tank foundati ons. Are existing tank foundations a potential source of contamination to soil immediately underneath the tanks?*

Response: As indicated in response to comment #3, available information on tank construction will be provided in the final report. Whether the tank foundations provide a potential source of contamination to soil underneath the tanks will be addressed in the revised report.

23. ***DEQ Comment:*** *Figure 2-6. Note that GW8-1 is not labeled on Figure 2-6.*

Response: Comment noted; the change will be made to the figure.

24. ***DEQ Comment:*** *Figures 6-2 through 6-13.*
    - *Is there a reason why GW borings are not included on cross-sections?*
    - *Selected cross-sections should show the extent of petroleum contamination based on sheen or NAPL. Can show NAPL.*
    - *Selected cross-sections should show the extent of site contamination by posting groundwater grab sample or monitoring well data.*

Response: As mentioned in our response to comment #6, soil borings for the temporary well points (GW-1 through GW-23) are not included in the cross-sections because subsurface soil samples were not collected at these locations. Observations of NAPL and sheen on groundwater will be included on the cross-sections where data are available.

Groundwater analytical results will be posted on selected cross-sections as described in our response to comment #18.

25. ***DEQ Comment:*** *Figure 6-15. This figure should include the location of wells located on the Schnitzer property near the Bell Terminal.*

Response: The well locations will be included on the figure using currently available information.

26. ***DEQ Comment:*** *Figure 6-18. The contours on this figure indicate the presence of a northwest-southeast trending groundwater trough on-site. It is unclear if this is the result of tidal fluctuations in the lower groundwater zone. The figure should include contours between the shoreline wells and the river gauge. The interpretation of this figure should be presented in the text of the RI and any special considerations noted on the figure. Figures showing "representative" groundwater flow conditions should be presented in the RI report.*

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Response: A discussion of the influences of the river on groundwater flow is included in Section 6.4.1. This discussion will be expanded to include an evaluation of the groundwater elevations collected at the newly installed monitoring wells, particularly those installed along the shoreline of the Willamette River, and to provide information collected on mean groundwater flow during aquifer testing activities for the Phase II RI. Additionally, a new figure which provides lower zone groundwater elevation contours for the fourth quarter 2004 groundwater monitoring event will be included in the final report.

27. ***DEQ Comment:*** *Appendices C and D. Do outlined values represent exceedances of screening levels?*

Response: The outlined values represent exceedances of screening levels. The meaning of the outlined values is footnoted on the last page of each table.

28. ***DEQ Comment:*** *Appendices D and E. The cover page titles for these appendices are incorrect.*

Response: The cover page titles will be corrected.

* * * * * * *

We hope that these responses provide you with the information you need to approve finalization of the Phase III RI report. Please call us if you have any questions.

LANDAU ASSOCIATES, INC.

for Terry McDonald

Rebekah Brooks
Project Manager

Stacy J. Pischer

Stacy J. Pischer, L.G.
Senior Project Geologist

RB/SJP/tam

cc: Mark Chandler, Time Oil Co.
Patty Dost, Schwabe Williamson & Wyatt

SCHN00303589

Time Oil : Comm

SCHWABE, WILLIAMSON & WYATT, P.C.

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DEPT OF ENVIRONMENTAL QUALITY
NORTHWEST REGION

MARTHA O. PAGEL
Direct Line: Portland 503.796.2872;
Salem 503.399.7712
E-Mail: mpagel@schwabe.com

November 4, 2004

Juno Pandian
Manager, Enforcement Section
Oregon Water Resources Department
725 Summer St. NE, Suite A
Salem, OR 97301-1271

Re: Request for Reconsideration -- Special Standards for Cascade Drilling Inc., Michael Niermeyer #10024; Start Card Nos. 172301-172303

Dear Juno:

I am writing on behalf of Time Oil Co. and Cascade Drilling Inc., to request reconsideration of the Final Order issued October 28, 2004, to Cascade Drilling Inc., relating to the above-referenced Start Cards. The Final Order denies a request for special well construction standards made by Mr. Niermeyer in connection with a project on Time Oil property adjacent to the Willamette River in Portland. Time Oil is the affected landowner and Cascade Drilling Inc. is the well construction contractor. The project relates to voluntary environmental clean-up efforts, under the supervision of the Oregon Department of Environmental Quality.

Special construction standards were requested by Cascade Drilling to address site-specific and alternative technology issues. The project involves construction of a total of 12 monitoring wells on the site. Four of the wells are to be constructed on the beach, and require use of a "track" rig. A total of ten of the 12 wells can be constructed using the track rig, without the need for special standards. However, approval of special standards would be required to complete the remaining two wells because the track rig cannot accommodate the larger auger that would be needed to meet standard construction specifications. (Start Card Numbers 172301 and 127302.) Cascade Drilling has previous experience in obtaining special standards under such circumstances.

At this point, Cascade Drilling is not able to provide a "rubber tire" rig, capable of meeting standard construction requirements, within the scheduled timeframe for completing the wells; the required equipment will not be available until after Thanksgiving. The resulting delay will make it impossible for Time Oil to meet a data collection/reporting schedule that has been set out by DEQ. At the same time, we understand that the requested alternative drilling method will not compromise the resource and will provide the same level of protection as would be afforded under the standard rule provisions. Mr. Niermeyer advises that the proposed

alternative would use 10.25-inch inside diameter (ID) augers to the top of a confining layer at approximately 20 feet, which is the zone expected to be most contaminated. This will provide a larger diameter seal than the 6-inch ID required in OAR 690-240-0100(7). In addition, the 4.25-inch ID augers that would be used for the lower portion of the hole will create a hole with an approximately 9-inch ID that would be grouted to provide the seal. This requires a variance from standard requirements that specify the auger's ID be 4 inches larger than the nominal casing diameter. However, the proposed seal would, in fact, be larger than that required in a similar hole constructed using rotary methods, where the hole diameter would be only 6 inches rather than 9 inches. Thus, in the most contaminated portion of the hole – the top 20 feet – the seal will be greater than that required under standard regulations. In the lower portion of the hole, the seal will also be larger than is required using rotary technology, without special standards, and will be sufficient to protect the resource.

In reviewing the applicable well construction rule (690-240-0006), it is clear that special standards can be approved to address either site-specific conditions or "alternative technologies or methods" not addressed in the rules. We are requesting that the Water Resources Department consider this alternative technology criterion to authorize special standards in this case. I understand the department typically focuses its analysis of a special standards request only upon the physical site conditions; however, the rule seems to provide full discretion for approval of special standards to accommodate alternative technology, alone.

In this case, site specific conditions require the use of the track rig for constructing key wells, and the track rig is sufficient to construct all but two of the wells without the need for special conditions. The project is currently underway on-site, with all other staging in place. The special condition for two wells would allow the project to be completed in a timely manner, with recognition that the project as a whole has site conditions that require the use of the track rig, and that alternative methods for construction of the two wells will adequately protect the resource.

As you know, DEQ has expressed strong support for the request for special standards because, in their view, it will not compromise the resource, and is desirable from the standpoint of allowing the project to stay on schedule. At the same time, we believe approval of special standards offers a reasonable and practical solution that is consistent with WRD discretion under the rules. We therefore ask your assistance in providing a prompt reply to this reconsideration request. The drilling rig is on site now, and the company expects to complete work on the other 10 wells by the end of the week.

Thank you, in advance, for any help you can provide. Please let me know if you have questions or need any additional information.

Sincerely,

Martha O. Pagel

Martha O. Pagel

MOP:mca

/89360/82295/MOP/1243861.1

cc: Mark Chandler, Time Oil Co.
Rebekah Brooks, Landau Associates, Inc.
Michael (Bruce) Niermeyer, Cascade Drilling Inc.
Rodney G. Struck, R.G., DEQ
Thomas E. Roick, DEQ ✓
Kris Byrd, WRD

Projects Rpt.

LANDAU ASSOCIATES

October 7, 2005

Mr. Tom Roick
Oregon Department of Environmental Quality
2020 SW Fourth Avenue, Suite 400
Portland, OR 97201-4987

RE: TIME OIL NORTHWEST TERMINAL
PORTLAND, OREGON

Dear Mr. Roick:

On behalf of Time Oil, attached is the July, August, and September 2005 quarterly report for Time Oil Northwest Terminal RI/FS.

LANDAU ASSOCIATES, INC.

Rebekah Brooks
Project Manager

RB/tam
10/7/05 \\Edmdata\wproc\231\TRANSMIT.FAX\Quarterly Rpt_Ltr.doc
Enclosure

cc: Mr. Mark Chandler, Time Oil Co.
Ms. Patricia Dost, Schwabe Williamson & Wyatt
Mr. Mike Tischuk, Beazer East, Inc.

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NORTHWEST REGION

QUARTERLY REPORT TO DEQ
TIME OIL - NORTHWEST TERMINAL
July through September, 2005

SUMMARY OF WORK PERFORMED

- Prepared and submitted the April – September 2005 quarterly report to DEQ.
- Continued operation of the groundwater interim action in the lower zone at RW-2 at an average flow rate of 7.4 gpm.
- Continued operation of groundwater recovery in the upper zone at the groundwater intercept system at the east-west trending storm drain line (SDM-1) at an average flow rate of 1.0 gpm.
- Conducted intermittent operation of groundwater recovery in the upper zone from horizontal recovery well (HRW-1) at an average flow rate of 0.01 gpm. Due to low groundwater elevation conditions, no groundwater was recovered from HRW-1 in August or September 2005.
- A total of approximately 21.99 million gallons of groundwater have been treated and discharged from the interim action system, with a total of about 0.80 million gallons treated during this quarter.
- Continued review of the system operations performance for the groundwater interim action system at RW-2 and HRW-1, the groundwater intercept system at SDM-1, and the onsite wastewater treatment plant (WWTP).
- Collected effluent samples from the WWTP throughout the quarter to evaluate the treatment system efficiency. Laboratory analysis of the effluent samples collected indicated that the system was operating within the established permit limitations.
- Updated the Storm Water Pollution Control Plan for the Terminal and provided to the Water Quality Division of DEQ.
- Conducted the third quarter 2005 groundwater monitoring event, August 15-23, 2005. Received final approval from DEQ for the February 2, 2004 revised sampling frequency proposal in a letter from Tom Roick, dated July 26, 2005.
- Measured natural attenuation parameters (e.g., pre-purge, down-hole, dissolved oxygen and oxidation reduction potential measurements) monthly during the third quarter 2005 for use in preparation of a source control evaluation approach.
- Completed preparation of the *First Quarter 2005 Groundwater Monitoring and Groundwater Interim Action Status Report*, and submitted to DEQ.
- Prepared the *Second Quarter 2005 Groundwater Monitoring and Groundwater Interim Action Report.*
- Began receiving the third quarter 2005 (August 2005) groundwater monitoring data.
- Submitted the final Phase III RI report to DEQ.

SCHN00303921

- Continued passive product recovery in wells LW-21S and LW-27S using passive bailers. The product is temporarily being stored in a 55-gallon drum in a designated location at the terminal pending disposal. Product socks were not reinstalled at any of the wells in the Main Tank Farm area during the third quarter 2005 monitoring event, because product was not observed at any of the other wells. The spent product socks are being temporarily stored in a 55-gallon drum in a designated location at the terminal pending disposal.

- Continued preparation of a work plan for performance of the terminal-wide human health and ecological risk assessments. The work plan is expected to be submitted to DEQ in November 2005.

- Provided DEQ with an outline for a source control evaluation at the Terminal for discussion in our July 20, 2005 meeting.

- Met with DEQ on July 20, 2005, on the approach for a source control evaluation for the Terminal and a proposal for conducting a monitored natural attenuation evaluation as part of the source control evaluation.

- Prepared a proposal for conducting a monitored natural attenuation evaluation as part of a source control evaluation approach for the Terminal and submitted to DEQ.

RESULTS COLLECTED

- Influent/effluent samples from the WWTP for July, August, and September 2005. The analytical results from the sampling events indicated that the WWTP was operating within the established permit limits. The data results will be presented in the *Third Quarter 2005 Groundwater Monitoring and Groundwater Interim Action Status Report.*

- A portion of the final groundwater data for the third quarter 2005 groundwater sampling events. Data results will be presented in the *Third Quarter 2005 Groundwater Monitoring and Groundwater Interim Action Status Report.*

PROBLEMS ENCOUNTERED AND STEPS TO RESOLVE

- The pump at SDM-1 stopped operating on June 6, 2005. The pump was replaced and the new pump was operating as of July 7. The delay was caused by first trying to repair the existing pump and then assessing whether it was under warranty. To prevent a lapse in system operation in the future, 2 new pumps were purchased. One pump was installed at SDM-1 and the second pump serves as a backup. Flowmeter readings from August 23 and September 1 indicate no flow in that period, but it is likely due to lack of rain rather than a problem with the pump.

- A water leak in the pipeline leading from Tank 16804 to the wastewater treatment system was discovered by Time Oil personnel on July 5, 2005. A contractor was hired to uncover and repair the pipeline on July 6, 2005. The soil was sampled around the pipeline for TPH constituents (BTEX, TPH-G, and TPH-Dx) and PCP. PCP, BTEX, and TPH-G concentrations were nondetect and the TPH-Dx (diesel-range and motor-oil range) concentrations were less than the Oregon DEQ RBCs. Based on these results, the soil was used to backfill the trench around the pipeline.

WORK TO BE PERFORMED NEXT QUARTER

- Prepare and submit quarterly report to DEQ.
- Continue implementation of the groundwater interim action in the lower zone at RW-2. Continue to operate the groundwater intercept system at the storm drain (SDM-1). Continue groundwater treatment and discharge to POTW. Continue review of the system operations performance for the groundwater interim action system at RW-2, HRW-1, SDM-1 and the onsite wastewater treatment system.
- Continue to monitor the effluent from the WWTP.
- Complete preparation of the *Second Quarter 2005 Groundwater Monitoring and Groundwater Interim Action Report* and submit to DEQ.
- Prepare the *Third Quarter 2005 Groundwater Monitoring and Groundwater Interim Action Report.*
- Continue passive product recovery in wells in the Main Tank Farm Area, as appropriate.
- Provide a technical memorandum to DEQ requesting a reduction in monitoring frequency requirements for future quarterly groundwater monitoring events.
- Conduct the fourth quarter 2005 groundwater monitoring event in November 2005. We will attempt to sample the wells on the Port of Portland to define the locality of facility at the north side of the Terminal property, if water levels have risen sufficiently and if access is approved by the Port.
- Complete preparation of the risk assessment work plan and submit to DEQ.
- Respond to DEQ's comments on the final Phase III RI report and receive approval of the report from DEQ.
- Receive approval from DEQ on the monitored natural attenuation evaluation proposal to be conducted as part of the source control evaluation at the Terminal. Begin implementation of the monitored natural attenuation evaluation.
- Continue monthly measurements of natural attenuation parameters through December 2005.

Gradient
CORPORATION

April 13, 2006

Mr. Mike Romero
Oregon Department of Environmental Quality
Northwest Region
2020 Southwest Fourth Avenue, Suite 400
Portland, OR 97201

Subject: Schnitzer/Premier Edible Oils (PEO) Site – Quarterly Report

Dear Mike:

On behalf of Schnitzer Investment Corp. (SIC), Gradient Corporation is submitting this Quarterly Report for the Premier Edible Oils (PEO) Site, as required by Section II, H of the Voluntary Agreement for Upland Remedial Investigation/Feasibility Study and Source Control Measures between SIC and the Oregon Department of Environmental Quality (DEQ). This Quarterly Report summarizes activities conducted during the time period quarter; describes activities planned for the next quarter; and discusses problems encountered during the quarter, if any, and actions taken to resolve those problems.

Summary of Project Activities

Between January 1 and March 31, 2006, SIC and its consultants, Gradient Corporation and URS, completed the following work at the PEO site:

- Completed review of draft Conceptual Site Model (CSM) for the PEO site that was prepared by the Lower Willamette Group (LWG). On March 10, 2006, submitted SIC comments to correct the numerous erroneous and/or misleading statements in the draft CSM regarding contaminant sources and distribution for the PEO site. The comments memorandum (*Comments on the Lower Willamette Group's Draft Conceptual Site Model for the Premier Edible Oils Site*, dated March 1, 2006) was prepared on behalf of SIC by Gradient Corporation in collaboration with URS Corporation. On March 10, SIC's environmental counsel submitted a report discussing sources for the residual contamination at the PEO site (*White Paper – Contaminant Sources at the Premier Edible Oils Site (ECSI #2013) Located Within The Portland Harbor Superfund Site*, dated March 6, 2006), and requested that Time Oil be named as a responsible party at the PEO site.
- Ongoing communications with DEQ regarding next steps for evaluating PEO property and inter-relationships between PEO site evaluations and investigations conducted by Time Oil on the adjacent Bell Terminal property. As DEQ is aware, obtaining a timely approval of SIC's proposed *Work Plan for Additional Characterization of the Premier Edible Oils Property* and achieving further progress on the activities proposed in the Work Plan has been slowed by several changes in the DEQ project manager assignment for the PEO site.
- Ongoing review of remedial investigation efforts at Time Oil's Northwest Terminal to determine implications for evaluations of PEO property.

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- Continued review of selected sediment data from the LWG Round 2 field sampling program and evaluation of implications of data for assessing conditions in the vicinity of the PEO site.

Activities to be Conducted Next Quarter

The following activities are planned for the PEO site between April 1 and June 30, 2006:

- Continue communications with DEQ regarding proposed future efforts at PEO site and ongoing Time Oil activities on Bell Terminal site. As data become available, obtain additional information from DEQ regarding Time Oil's ongoing investigations and Bell Terminal site features.
- Continue working with DEQ to follow up on SIC's June 17, 2005 letter response to DEQ comments, to finalize the *Work Plan for Additional Characterization of the Premier Edible Oils Property*, and to initiate additional efforts.
- Continue working with DEQ during transition to new DEQ project management, including setting up a meeting to discuss outstanding issues for the PEO site.
- Continue evaluation of Time Oil's investigative data for the Bell Terminal site in light of proposed and ongoing data collection, including assessing implications of available data for potential impacts on PEO site from Time Oil site and assessing need for additional recommendations regarding further sampling on the Bell Terminal site.
- Continue reviewing statements made regarding the PEO site in documentation prepared by the LWG and correcting errors presented in such documentation.
- Continue reviewing data from the LWG field sampling program as data become available.

Issues to be Resolved/Recommended Actions

None.

Please contact me if you have any questions regarding this report or any of the completed or proposed activities.

Sincerely,

Catherine Petito Boyce, S.M.
Principal Scientist

cc: J. Brown/James C. Brown & Associates
D. Coberley/URS
J. Jakubiak/SIC
T. Zelenka/SIC

SCHN00304170

Oregon
Theodore Kulongoski, Governor

Department of Environmental Quality
Northwest Region Portland Office
2020 SW 4th Avenue, Suite 400
Portland, OR 97201-4987
(503) 229-5263
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May 10, 2006

Mr. Jim Jakubiak
Schnitzer Investment Corp.
P.O. Box 10047
Portland, Oregon 97296-0047

Re: Schnitzer/Premier Edible Oils (PEO) Remedial Investigation and Portland Harbor Source Control Evaluation, ECSI # 2013

Dear Mr. Jakubiak

The DEQ project team has reviewed the site file, the March 2005 *Work Plan for Additional Characterization of the Premier Edible Oils Property* and the subsequent comments and project correspondence between Gradient and DEQ that have transpired since the 2005 workplan was submitted. The purpose of this letter is to summarize DEQ's expectations regarding the remaining workplan-related issues at the Former Premier Edible Oils site. It will also serve as our response to both the June 17, 2005 and November 3, 2005 letters to DEQ from Gradient Corporation. DEQ understands that a revised workplan and implementation schedule will be submitted by Schnitzer Investment Corporation (SIC) after the resolution of these outstanding issues. DEQ appreciates SIC's continued commitment to complete the Remedial Investigation and Source Control Evaluation at the former Premier Edible Oils site.

It is important to note that the finalized Portland Harbor Joint Source Control Strategy (JSCS) was released by DEQ and EPA in December 2005. The JSCS recommends an approach for completing source control evaluations at Portland Harbor upland sites and provides screening levels for contaminants that have complete pathways to the Willamette River. DEQ is actively implementing the JSCS at all Portland Harbor upland sites and will use it as guidance for the source control evaluation at the former PEO site. DEQ requests that SIC and Gradient review the JSCS and determine if the currently proposed workplan will provide the information necessary to prepare a complete source control evaluation report for the site. The JSCS is available at http://www.deq.state.or.us/nwr/PortlandHarbor/JSCS.htm.

This letter follows the comment numbering structure of the response to comments presented in the June 17, 2005 and responds to each of Gradient's responses. Comments 3, 5 and 9 were also discussed in the October 27, 2005 email from DEQ and the November 5, 2005 letter from Gradient and are considered to be the outstanding workplan-related issues.

Comment #1 – Section 2.2.1 Source Control Evaluation and NAPL Characterization – Southern PEO site
DEQ acknowledges SIC's agreement to collect a groundwater sample from the new well.

Comment #2 – Section 2.2.2 Soil Boring Installation

DEQ acknowledges SIC's agreement to install the requested three additional borings. It is not clear, however, if SIC is agreeing to complete the soil borings as monitoring wells if significant petroleum contamination is noted during the installation as requested in DEQ's May 26, 2005 comments on the workplan. If petroleum contamination is present along the beach, permanent monitoring wells will be necessary to adequately determine the potential current and future impact to the Willamette River. DEQ stands firm behind its request for the borings to be completed as monitor wells if significant contamination is detected.

Comment #3 – Section 2.2.4 Product Physical and Chemical Property Measurements

SIC may conduct product finger printing analysis if samples can be collected from the Bell Terminal. SIC and Gradient can coordinate these efforts with Time Oil.

Comment #4 – Section 2.2.5 Supplemental Sewer Flow Characterization

DEQ understands that SIC will collect and evaluate all relevant information for characterizing the storm sewer system. DEQ recommends that SIC and Gradient refer to the storm water pathway section and Appendix D of the JSCS to further define what information DEQ considers relevant.

Comment #5 – Section 2.2.6 Additional Source Control Evaluations

It remains DEQ's expectation that 3 to 5 shallow borings be advanced down gradient and riverward of the NAPL plume in the southern portion of the site. This effort will help to define the nature and extent of contamination on site and is within the scope of the Agreement as stated in the October 27th, 2005 email. The borings will also help to ensure that a complete source control evaluation is conducted at the site. The borings should be located based on the additional information requested in DEQ's May 26, 2005 comment (i.e., a map and cross-sections).

DEQ acknowledges SIC's concerns regarding the timing of this investigative effort expressed in both the June 1, 2005 and November 3, 2005 letters. DEQ agrees that a more complete review of the analytical and lithologic data collected as part of the 2005 workplan and all the existing LWG off-shore data (note that this area has been dredged in the past and access issues have hindered the off-shore sediment sampling efforts) will provide a stronger technical foundation on which to scope these riverward subsurface soil/sediment and groundwater samples. DEQ will allow SIC to follow a phased approach for characterizing this potential NAPL discharge area provided that SIC prepares a scope of work outline and schedule for analyzing the required data, preparing the required NAPL plume maps and cross-sections, and for installing the riverward borings. The outline should strive to collect information that can also be used in the evaluation of future source control measures and NAPL recovery alternatives. The schedule for outline completion shall be incorporated into the schedule presented in the November 3, 2005 letter from Gradient. All data reviewed in the evaluation should be compared to all the relevant Screening Level Values listed in Table 3.1 of the JSCS. This phased approach will provide an efficient approach to determine what source control measures may be necessary at the site and whether an EE/CA like effort is necessary prior to implementation of source control measures.

Comment #6 – Section 2.3.1 Technical Considerations in Collecting and Interpreting TPH Data
DEQ acknowledges SIC's acceptance of DEQ's comment.

Comment #7 – Section 2.3.2 Monitoring Well installation – Central PEO Site
DEQ agrees that a monitor well will be installed at the PB-6 location and a monitor well will be installed at the location of boring PB-9 if TPH is observed during the field screening efforts. If not already planned, please ensure that sheen testing is included in the soil boring field screening protocol for all proposed borings.

Comment #8 – Section 2.3.3 Soil boring Installation – Central PEO Site
DEQ understands that SIC will analyze the soil samples for the full suite of VOC analytes.

Comment #9 – Section 2.3.4 Coordinated Sampling with Time Oil
DEQ has requested that Time Oil conduct an additional round of sampling in the Bell Terminal area to be coordinated with SIC's sampling event at the former Premier Oil site. Please coordinate sampling activities directly with Time Oil as appropriate. If necessary, DEQ can assist in this effort.

Comment #10 - Section 2.4 Supplemental Site-Wide Hydrogeologic Characterization
DEQ understands that slug and bail-down tests proposed in the work plan will not be conducted during these field investigations.

During the May 3, 2006 site visit, the following new issues were identified and should be incorporated into the project as suggested.

- The slag identified along the southern portion of the site needs to be incorporated into the site conceptual model and its extent delineated. Additional groundwater sampling parameters for metals may need to be incorporated into the workplan to assess any impact the slag may or may not be having on the groundwater at the site.
- The drums of IDW being stored at various locations on site need to profiled and disposed of properly. Please provide the waste characterization and disposal information to DEQ when this is complete.
- The rusty pipe access points we observed in the east central portion of the property near the former AST locations and the soil piles in the SE portion of site need to be identified on a site map. An explanation of what they are, if soil sampling of the soil pile is necessary and the rationale used to determine this needs to be included in the next phase of reporting. A plan to do this is can be included in the revised scope of work.

During the May 3rd meeting, DEQ and Schnitzer agreed that Schnitzer would submit the revised workplan within 60 days of the receipt of this letter. The general schedule for the work plan finalization, implementation and report preparation presented in the November 3,

2005 is adequate for the remainder of the tasks to be completed. Please contact me at (503) 229-5563 if you have any questions regarding this letter.

Sincerely,

Michael Romero
Cleanup and Lower Willamette Section

Cc: Cathy Petito Boyce, Gradient Corporation
Jim Brown, Jim Brown Associates
Mavis Kent, Jim Anderson, DEQ

Agency Review
Risk Assessment Work Plan
Time Oil Northwest Terminal
Portland, Oregon

December 28, 2005

Prepared for

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LIST OF ACRONYMS

ADD	Average Daily Dose
ARL	Acceptable Risk Level
AST	Aboveground Storage Tank
ATSDR	Agency for Toxic Substance and Disease Registry
BAF	Bioaccumulation Factor
BGS	Below Ground Surface
BTF	Biotransfer Factors
CEEM	Conceptual Ecological Exposure Model
CEM	Conceptual Exposure Model
CESARS	Chemical Evaluation Search and Retrieval System
COI	Contaminant of Interest
COPC	Contaminant of Potential Concern
COPEC	Contaminant of Potential Ecological Concern
cPAH	Carcinogenic Polycyclic Aromatic Hydrocarbon
CRBG	Columbia River Basalt Group
CSM	Conceptual Site Model
DEQ	Oregon Department of Environmental Quality
D_{HR}	Home Range Diameter
EC	Environmental Concentration
EDD	Estimated Daily Dose
EPA	U.S. Environmental Protection Agency
EPC	Exposure Point Concentration
ERA	Ecological Risk Assessment
ERBSC	Ecological Risk-Based Screening Concentration
ERfC	Ecological Reference Concentration
ERfD	Ecological Reference Dose
ESA	Endangered Species Act
ETCL	Ecological Target Cleanup Level
HHRA	Human Health Risk Assessment
IRIS	Integrated Risk Information System
ISCO	*In Situ* Chemical Oxidation
LADD	Lifetime Average Daily Dose

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LC_{50}	Lethal Concentration for 50 Percent of the Population
LD_{50}	Lethal Dose for 50 Percent of the Population
LOAEL	Lowest Observed Adverse Effect Level
LOEL	Lowest Observed Effect Level
MSL	Mean Sea Level
NFA	No Further Action
NOAEL	No Observed Adverse Effect Level
NOEL	No Observed Effect Level
OAR	Oregon Administrative Rule
OHM/TADS	Oil and Hazardous Materials/Technical Assistance Data System
ONHIC	Oregon National Heritage Information Center
PCB	Polychlorinated Biphenyl
PCP	Pentachlorophenol
PRG	Preliminary Remediation Goal
RBC	Risk-Based Concentration
RI	Remedial Investigation
RTECS	Registry of Toxic Effects of Chemical Substances
SLV	Screening Level Value
TBD	Toxicity Benchmark Dose
TUF	Temporal Use Factor
UCL	Upper Confidence Limit
UF	Uncertainty Factor
USFWS	U.S. Fish and Wildlife Service
VCP	Voluntary Cleanup Program
WWTS	Wastewater Treatment System

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1.0 INTRODUCTION

This document presents a work plan for a human health and ecological risk assessment for the Time Oil Co. (Time Oil) Northwest Terminal (Terminal or site) in Portland, Oregon. This work plan has been prepared to present the methods that will be used in evaluating site conditions relative to the potential risk posed to human and ecological receptors from environmentally impacted media in the uplands portion of the site. The risk assessment will be based on knowledge of the Terminal obtained through previous environmental investigations, with emphasis placed on the information presented in the final *Phase III Remedial Investigation Report* (Phase III RI, Landau Associates 2005). The risk calculation methods that will be used are prescribed by Oregon Department of Environmental Quality (DEQ) guidance documents (DEQ 2000, 2001).

This work plan also presents a conceptual site model (CSM) for the Terminal that identifies sources of contamination at the site, potential contaminant migration and transport pathways, and potential receptor populations and exposure pathways. The CSM was developed based on information obtained during previous site investigation activities at the Terminal (Landau Associates 1993, 1997, 2001, 2004) and information presented in the site summary for the CSM report for Portland Harbor (Integral Consulting, Inc. and Groundwater Solutions, Inc. 2004).

This work plan is organized into four sections and one appendix as follows:

- Section 1.0 presents an overview of the planned risk assessment for the Terminal, including a description of the Terminal, the local geology and hydrogeology, and the CSM.
- Section 2.0 describes the environmental investigations performed to date, identifies the data that will be used in conducting the human health and ecological risk assessments, and describes the status of data gaps.
- Section 3.0 describes how the data will be screened to identify contaminants that will be evaluated in the risk assessment process.
- Section 4.0 describes the methods that will be used in conducting the human health risk assessment, and presents the mathematical models and input parameters that will be used to evaluate site risk. This section also discusses how the uncertainty associated with the risk evaluation will be addressed and how risk-based concentrations will be developed.
- Section 5.0 describes the methods that will be used in conducting the ecological risk assessment, and presents the mathematical models and input parameters that will be used to evaluate site risk. This section also discusses how the uncertainty associated with the risk evaluation will be addressed and how ecologically protective risk-based concentrations will be developed.
- Appendix A includes the completed Level I Ecological Scoping Evaluation for the site, which is summarized in Section 5.0.

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1.1 TERMINAL DESCRIPTION

Time Oil's Northwest Terminal is described in detail in the final Phase III RI report (Landau Associates 2005). A brief overview is included here for context.

The Terminal is a former bulk petroleum storage and transfer facility currently owned by Time Oil. Time Oil ceased operations at the Terminal on October 31, 2001. From 1943 to 2001, the Terminal was operated by Time Oil as the Northwest Terminal petroleum products facility. Since operations began, the Terminal was used for the receipt, storage, and distribution of petroleum and petroleum-related products. Historically, Time Oil also leased tank space to Crosby & Overton for storage of waste oils, and Koppers Company Inc., n/k/a Beazer East, Inc., (Koppers) entered into an agreement with Time Oil which provided that Time Oil would formulate Koppers' pentachlorophenol (PCP)-containing wood treating products. Koppers owned tanks at the Terminal used for the formulation and blending of PCP-containing wood treatment products and owned all raw materials, products and wastes associated with the operation.

The site is located in Township 2 North, Range 1 West, Sections 34 and 35, in the industrialized Rivergate area of north Portland, Oregon (Figure 1). The Terminal is bordered to the east and south by heavy industrial complexes, to the north by heavy industrial property and Port of Portland undeveloped property, and to the west by the Willamette River. The Terminal is approximately 52 acres in size and is generally flat with an average land surface elevation of about 28 ft above mean sea level (MSL). The Terminal is enclosed by a terminal-wide chain link fence and access is through the main gate at the termination of Time Oil Road. Within the Terminal, there are several features that are distinguished by their historical uses, as shown on Figure 2.

1.2 GEOLOGY AND HYDROGEOLOGY

The Terminal is located on sand fill within the floodplain of the Willamette River. Prior to development of waterfront facilities, this region was characterized by alluvial river deposits consisting of sand and silt deposited by a series of braided channels, lowlands, and marshes. Specifically at the site, historical aerial photographs indicate that the area consisted of river floodplain and overbank deposits with no apparent historical river channels present. The Willamette River channel has historically been dredged to facilitate transport and moorage of shipping vessels for various industries along the riverfront. It is likely that shallow soil at the Terminal consists partly of historically dredged fill material that was placed in the upland areas. Geologic units at the Terminal, inferred from regional geologic information, consist of the undifferentiated Columbia River Basalt Group (CRBG), Sandy River Mudstone, the Troutdale Formation, alluvium, and imported fill, in order of decreasing age and depth.

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Four principal near-surface hydrogeologic units have been identified at the Terminal. In descending order from ground surface, these units include: 1) an upper water-bearing zone, comprised predominantly of shallow fill (10- to 20-ft thick, with less than 1- to 15-ft saturated thickness); 2) a silt confining unit (1- to 30-ft thick); 3) a lower water-bearing zone, comprised predominantly of native alluvium consisting of silty sand and sand interlayers (1- to 40-ft thick); and 4) a deep sand unit (greater than 40-ft thick). Depending on the continuity of the confining unit, the hydrogeologic units can act as distinct aquifer units with unconfined conditions in the upper zone and confined to semiconfined characteristics in the lower zone, or act as a single unconfined aquifer in the area beyond the extent of the confining unit to the west, toward the Willamette River. The hydrogeologic units are described in detail in the Phase III RI report.

1.3 CONCEPTUAL SITE MODEL

A complete pathway from the source of chemicals to human or ecological receptors is necessary for potential risk to be realized. Required elements for a complete exposure pathway include:

- A source of potentially toxic chemicals (i.e., primary sources, such as contents of tanks, or a secondary source, such as contaminated soil)
- A mechanism of chemical release to the environment (i.e., spillage to the ground)
- A mechanism of retention in, or transport to, an exposure medium (i.e., adsorption to soil, or leaching from soil to shallow subsurface groundwater)
- A point of contact between receptor and exposure medium (i.e., a person with uncovered skin working in the presence of contaminated soil or groundwater)
- An intake route for the receptor (i.e., a person handling contaminated soil with bare hands).

A CSM is a working hypothesis of how site-related contaminants might migrate through the environment to potential exposure media. It describes what is known about sources and the receiving environment, and is the basis for identifying the processes by which receptors may come to be exposed to contaminants in conceptual exposure models (CEMs) for human and ecological receptors.

The CEMs presented in this section describe contaminant sources, potential release mechanisms, transport pathways based on information obtained during previous environmental investigations at the Terminal, secondary source and exposure media, and potential exposure pathways to human and ecological receptors.

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1.3.1 CONTAMINANT SOURCES AND POTENTIAL RELEASE MECHANISMS

This section identifies confirmed and potential sources of environmental impacts at the Terminal. These sources have been described in detail in previous documents, and are summarized here for reference. The locations of confirmed and potential source areas are shown on Figure 2. A schematic of the CSM for the Terminal is provided on Figure 3. The CEMs for human and ecological risk are provided on Figures 4 and 5, respectively. As described below, soil removal actions have removed source material from areas including the former PCP mixing area, the former Crosby & Overton area, the former soil stockpile area, and the East Property. These actions effectively removed the potential exposure route for facility-related contaminants via surface soil in these areas. Based upon confirmation sampling data, there is no complete exposure pathway from surface soil in these interim removal areas, and surface soil exposures will not be considered for the human health and ecological risk assessments in these areas. Additional considerations for the East Property are also provided below.

1.3.1.1 Petroleum-Related Operations

Twenty-one aboveground storage tanks (ASTs) are located in the Main Terminal tank farm area. These ASTs historically provided storage for various petroleum products. All of the Main Terminal tank farm area tanks are currently empty, except for tank 16804, which stores groundwater recovered by the interim action recovery wells prior to treatment at the onsite wastewater treatment system. Product lines in this area have been flushed and cleaned. Based on data presented in the Phase III RI report, historical handling and storage of petroleum products in the Main Terminal tank farm area appear to have resulted in chemical releases to surface and/or subsurface soil and subsequent migration to groundwater. The Terminal historically received and distributed petroleum products via rail, truck, and marine vessel. Loading racks and docks are no longer in use, and all associated aboveground and underground distribution pipes have been flushed and cleaned. Historical use of onsite product receiving and distribution facilities onsite could have resulted in chemical releases to surface soil and/or subsurface soil. Two ASTs formerly used for storage of aviation gasoline and one AST formerly used for butane storage are located southeast of the Terminal office. Historical use of these ASTs could have resulted in petroleum releases to surface soil.

Ten ASTs are located in the Bell Terminal tank farm area. These ASTs historically provided storage for various petroleum products and are currently empty. Product lines in this area have been flushed and cleaned. Based on data presented in the Phase III RI report, historical handling and storage of petroleum products in the Bell Terminal tank farm area appear to have resulted in chemical releases to surface and/or subsurface soil; however, no past releases in the Bell Terminal tank farm area have been

documented. Within the central portion of the Bell Terminal Tank Farm area, gasoline- and diesel-range petroleum hydrocarbon concentrations present in soil appear to have originated from different sources than those along the western property boundary because of the decreases in concentrations between the two areas. The TPH concentrations within the central portion of the tank farm are likely a result of minor, incidental releases related to operations within the Bell Terminal Tank Farm area. The source of TPH concentrations outside the operational area of the Bell Terminal Tank Farm near the western property boundary is unknown. Groundwater data collected within the Bell Terminal Tank Farm area and on the adjacent former PEO property suggest the presence of three commingled petroleum hydrocarbon plumes within this area: 1) one originating in the central portion of the Bell Terminal Tank Farm area near the east-west trending pipeline, 2) one originating along the western property boundary outside the walls of the tank farm, and 3) one originating on the eastern portion of the former PEO property where significant petroleum releases are known to have occurred, such as in the area where the former diesel ASTs were located. Even though it is likely that the plume originating from the central portion of the Bell Terminal commingles with the plume originating near the western property boundary, and that both of these plumes commingle with other contamination originating on the former PEO property in the area where the former diesel ASTs were located, it is unlikely that the elevated concentrations observed near the western property boundary or on the former PEO property originate from the Bell Terminal tank farm operations. This conclusion is based on the significant increase in both soil and groundwater concentrations for petroleum constituents across the western property boundary and on the former PEO property. Also, product has consistently been observed with thicknesses up to about 6 ft in wells on the eastern portion of the former PEO property (well MW-4) between 2001 and 2003, but no product has ever been observed within the Bell Terminal Tank Farm area. This contaminant distribution supports the presence of different sources than in the Bell Terminal Tank Farm area. Additional data are needed on the adjacent property to further characterize the nature and extent of contamination from activities along the western property boundary of the Bell Terminal or on the adjacent property.

1.3.1.2 PCP-Related Operations

Koppers used a portion of the site, identified as the former PCP mixing area and warehouse, for blending and storing specialty wood treating products containing PCP from 1967 to 1984. Historical activities in this area resulted in chemical releases to surface soil. Known soil contamination in this area at depths above the water table, approximately 13 ft below ground surface (BGS), was excavated for offsite treatment and disposal during an interim removal action (Landau Associates 2003). An interim action, using the *in situ* chemical oxidation (ISCO) technology, is currently ongoing to address environmental impacts from this operation to shallow groundwater and soil within the zone of

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groundwater fluctuation. In addition, shallow groundwater impacted by PCP entering the east-west trending storm drain is being captured by a storm drain intercept system installed in 2000, and a horizontal recovery well is being operated under seasonal high groundwater conditions. In the lower zone, since 2000, a vertical recovery well captures downgradient migration of PCP-impacted groundwater. Captured groundwater is treated at the onsite wastewater treatment system and discharged into the POTW under a permit with the City of Portland.

Soil excavated from the former PCP mixing area in 1989 and from the East Property during interim removal actions in 1996 and 1997 (see below) was temporarily stockpiled in an area south of the former PCP mixing area. Stockpiled soil was placed on top of a plastic liner to limit contact with the existing ground surface and was covered with plastic to limit stormwater runoff. The stockpile and any residual impacted soil below the stockpile was removed in 2002 as part of the soil removal action described above (Landau Associates 2003). Following soil removal, soil within the footprint of the former stockpile was tested and found to be unimpacted.

1.3.1.3 Other Miscellaneous Historical Uses

The former Crosby & Overton tank area historically contained two ASTs used for waste oil storage. Based on data in the Phase III RI report, storage and handling of chemicals in this area, including petroleum hydrocarbons, carcinogenic polycyclic aromatic hydrocarbons (cPAH), and polychlorinated biphenyls (PCBs), appear to have resulted in chemical releases to surface soil. ASTs in this area have been removed and all associated piping has been flushed and cleaned. Known soil contamination in this area was addressed by interim removal actions in 1987, 1989 (Landau Associates 2001), and 2002 (Landau Associates 2003). Groundwater was not adversely impacted by operations in this area.

A remedial action for the eastern 23 acres (East Property) of the Northwest Terminal resulted in a conditional (industrial use only) no further action (NFA) determination from DEQ (DEQ 2003). As part of this determination, DEQ found that because drinking water is not a current or reasonably likely future beneficial use of shallow groundwater at the site, contaminants historically detected in groundwater on the East Property are below concentrations of concern for human health, and do not pose a threat to ecological receptors in the Willamette River located over 1000 ft to the west (DEQ 2003). Therefore, the East Property has been excluded from the risk evaluations.

1.3.2 Potential Contaminant Fate and Transport

The primary fate and transport mechanisms that are likely to occur at the Terminal include transport and degradation.

Transport mechanisms at the site, which have the potential to impact media that human and ecological receptors could be exposed to, include the following:

- **Disturbance and Air Transport Of Surface Soil.** This pathway is associated with the disturbance of surface soil, through human activity or wind erosion, and subsequent airborne transport of particulates. The transported particulates could be inhaled by human and ecological receptors or redeposited downwind.

- **Leaching to Groundwater from Surface and Subsurface Soil.** This pathway is associated with chemical constituents that are sorbed on upland soil and that dissolve or otherwise desorb into water passing through the soil (i.e., infiltrating water from the surface, migrating groundwater). The extent to which leaching occurs is a function of the amount of water passing through the soil, properties of the individual chemical constituents, and physical and chemical properties of the soil and water. Leaching is a reversible process, in that chemicals leached to groundwater can re-sorb onto soil farther along the flow path.

- **Transport of Volatile Contaminants to Ambient Air from Groundwater.** This pathway is associated with the volatilization and migration of volatile contaminants in shallow groundwater through the unsaturated zone to the ground surface, where these contaminants could impact ambient air. The resulting vapor phase contaminants could be inhaled by human and ecological receptors.

Hydrogeologic data show that groundwater underlying the site discharges to the Willamette River. However, data collected from shoreline wells that are used to monitor water quality near the point of discharge to the Willamette River show that, with the exception of chromium concentrations in three of the wells and a single copper concentration, no constituent exceeded the preliminary screening levels established for the RI (Landau Associates 2005) during the November 2004 quarterly groundwater sampling event, and all constituents were less than the preliminary screening levels during the February and June 2005 events. Diesel-range petroleum hydrocarbons (TPH-diesel) were detected in three of the four shoreline wells during each event, but no published risk-based screening level value is available for TPH-diesel. All other petroleum-related constituents were not detected or were detected at concentrations below preliminary screening values for protection of human and ecological receptors. The data collected from the shoreline wells indicate that even though there is a physical groundwater transport pathway between upland areas of the terminal to the river, there is not a current complete contaminant transport pathway to the river via groundwater, any potential for future migration is being addressed in a separate Source Control Evaluation. Therefore, the groundwater to surface water exposure pathway will not be considered in the risk assessment. Groundwater concentrations from the shoreline wells will be compared to Joint Source Control Strategy (DEQ and EPA 2005) screening level values to confirm the absence of a complete groundwater to surface water contaminant transport pathway in the upcoming source control evaluation to be provided to DEQ in spring 2006. Any historical impacts to surface water and sediments

are being addressed through the risk assessment being conducted as part of the Portland Harbor RI/FS. Data from the shoreline wells will continue to be reported in quarterly groundwater reports.

1.3.3 Secondary Source and Exposure Media

This section describes environmental media with potential or confirmed impacts from contaminant sources at the Terminal. The relationship between site environmental media and the potential present and future exposure pathways for contaminant contact with human or ecological receptors, are summarized in the following subsections.

1.3.3.1 Upland Soil

Both surface and subsurface soil contain contaminants of interest (COIs) at the site, except in the areas where soil removal actions have occurred, as will be demonstrated in the risk assessment by screening procedures described in Section 3.0. Impacted surface soil at the site represents a potential source of direct contact by humans. Impacted surface soil also is a source of direct contact with and ingestion of COIs by ecological receptors that live or feed at the facility. These are complete and potentially significant pathways for current and potential future scenarios that will be considered in the risk assessment.

Impacted subsurface soil (defined as soil at depths between 3 ft and 13 ft for the purposes of this risk assessment) represents a potential source of direct human contact at the site for excavation workers. Although there are not any current activities or plans at the site for the excavation work, this is a complete and potentially significant pathway for possible future scenarios that will be considered in the risk assessment. Because ecological receptors are considered to inhabit soil depths of less than 3 ft BGS, there is an incomplete pathway for exposure of ecological receptors to subsurface soil. Therefore, this pathway will not be considered in the risk assessment.

1.3.3.2 Groundwater

Upper zone groundwater and, to a lesser degree, lower zone groundwater have been shown to contain COIs at the site. Based on the beneficial water use determination summarized in the Phase III RI report (Landau Associates 2005) and the NFA determination for the East Property (DEQ 2003), the current and likely future beneficial use of groundwater in surrounding areas is primarily industrial with some use for irrigation of ornamental vegetation (i.e., not food crops) and does not include use as drinking water. However, irrigation does not occur in direct proximity to the site, and groundwater flow patterns at the site are not impacted by pumping for irrigation, therefore, exposure to groundwater via irrigation is

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not considered a significant pathway. Groundwater at the Terminal is not currently used for any purposes; any potential future groundwater use at the terminal will be limited to industrial use. In potential future scenarios, human receptors could be exposed to chemicals in lower zone groundwater by dermal contact with groundwater used for industrial purposes, which is considered to be a complete and potentially significant pathway and will be considered in the risk assessment. There is insufficient yield of upper zone groundwater to facilitate its use for industrial purposes. In potential future scenarios, excavation workers could come into contact with upper zone groundwater exposed in open trenches. Ecological receptors are not expected to be exposed to groundwater at the Terminal and, therefore, this exposure pathway will not be considered in the ecological risk assessment.

1.3.3.3 Ambient Air

Volatile contaminants have been detected in upper zone groundwater at the Terminal. These contaminants have the potential to separate into soil gas at the surface of the groundwater table and then migrate to the ground surface and volatilize into ambient air. This pathway will be considered as complete and potentially significant for current and potential future scenarios in the risk assessment, although it may be determined that the potential risks associated with inhalation of impacted ambient air are insignificant in comparison to other exposure pathways at the Terminal.

1.3.3.4 Indoor Air

Volatile contaminants have been detected in upper zone groundwater at the Terminal. These contaminants have the potential to separate into soil gas at the surface of the groundwater table and then migrate to the ground surface and volatilize into indoor air. This pathway will be considered as complete and potentially significant in the risk assessment for potential future land use scenarios that could include indoor industrial activities, although it may be determined that the potential risks associated with inhalation of impacted indoor air are insignificant in comparison to other exposure pathways at the Terminal.

1.3.3.5 Willamette River Surface Water and Sediment

Groundwater samples collected from shoreline monitoring wells represent water quality conditions in shallow groundwater near the discharge point to the Willamette River. Data from samples collected in November 2004, February 2005 and June 2005 show that, with the exception of two metals in the first sampling event only, groundwater discharging to the Willamette River does not contain COIs above screening levels, and there is no complete contaminant pathway to the river, therefore, exposure to

surface water and sediment in the river will not be considered in the risk assessment. The potential for future migration of site COIs to surface water or sediment will be addressed in a separate Source Control Evaluation. Any historical impacts to Willamette River surface water and sediment quality are being addressed in the Portland Harbor RI/FS.

1.3.4 POTENTIAL RECEPTORS AND EXPOSURE SCENARIOS

Potential receptors are those human or ecological groups that, by virtue of their activities at a site (now or in the future) could be exposed to impacted environmental media. This section presents a summary of potential receptors identified for the site and surrounding area. Potential human receptors have been identified based on our understanding of current and potential future land use at the site and in the surrounding area from the results of land use and beneficial water use surveys completed for the site and summarized in the Phase III RI report (Landau Associates 2005). Ecological receptors have been identified based on a survey of ecological conditions at the terminal.

Three exposure scenarios for human receptors account for likely current or potential future contact with site COIs. These exposure scenarios are:

- Onsite Industrial Worker: The onsite industrial worker may work in an indoor or outdoor setting and is assumed to be involved in onsite occupational activities 250 days per year for up to 25 years.
- Onsite Construction Worker: The onsite construction worker is assumed to be involved in outdoor construction activities with a greater opportunity for direct contact with the upper 3 ft of soil. The construction worker is assumed to be engaged in work at the site for 250 days per year for up to one year.
- Onsite Excavation Worker: The onsite excavation worker is assumed to have a high level of contact with soil and potentially with upper zone groundwater in trenches extending to 13 ft BGS.

In addition to these human exposure scenarios, ecological exposure scenarios involving terrestrial and/or semi-aquatic receptors are possible based on both current and potential future site conditions. This section presents a preliminary evaluation of present and potential future exposure scenarios for the human and ecological receptors identified for the site, by environmental medium.

1.3.4.1 Upland Soil

The onsite industrial worker, onsite construction worker, and onsite excavation worker may contact contaminants in surface soil through incidental ingestion, dermal contact, and inhalation of airborne particulate matter. Only the onsite excavation worker could contact contaminants in subsurface

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soil; this would occur through future excavation activities that are expected to be limited to the soil within 13 ft of the surface.

Terrestrial and semi-aquatic animals are expected to come in contact only with surface soil; this contact could occur during burrowing or at the ground surface (dermal contact, incidental ingestion, and inhalation of airborne particulate matter). Ecological receptor exposure is expected to be limited to the upper 3 ft of soil. Terrestrial and semi-aquatic predators could also be exposed to COIs through ingestion of prey that inhabit contaminated surface soil. Terrestrial plants also could come in contact with surface soil contamination, primarily via uptake through their root systems.

1.3.4.2 Groundwater

As described in Section 1.3.3.2, neither drinking nor irrigation are current or reasonably likely future beneficial uses of groundwater at the Terminal. Furthermore, there are no groundwater seeps in the riverbank; therefore, direct exposure to groundwater is only possible when groundwater is pumped from the subsurface for specific purposes.

If future site activities involve the use of groundwater for industrial purposes, the onsite industrial worker could be exposed to impacted lower zone groundwater through dermal contact; incidental ingestion and inhalation of airborne water particles are considered potentially complete but insignificant pathways for exposure to industrial process water. The onsite excavation worker could be exposed to impacted upper zone groundwater in subsurface excavations through dermal contact; however, incidental ingestion and inhalation of airborne water particles are considered potentially complete but insignificant pathways for excavation worker exposure. The onsite construction worker is not expected to be exposed to groundwater.

1.3.4.3 Ambient Air

The onsite industrial worker, onsite construction worker, and onsite excavation worker may uptake vapor phase contaminants through the inhalation of impacted ambient air. As described in Section 1.3.3.3, ambient air could be impacted by the volatilization of COIs in upper zone groundwater.

1.3.4.4 Indoor Air

Although indoor air impacts are not a concern under the existing site configuration, the site may be redeveloped in the future. A future onsite industrial worker may uptake vapor phase contaminants through the inhalation of impacted indoor air. As described in Section 1.3.3.4, indoor air could be impacted by the volatilization of COIs in upper zone groundwater.

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1.3.5 SUMMARY

Figure 4 summarizes the CEM for human risk and Figure 5 summarizes the CEM for ecological risk. These figures identify known or suspected sources of contamination at the site, known or suspected contaminant release mechanisms and migration pathways, potential receptor populations, and potential exposure pathways.

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2.0 ENVIRONMENTAL DATA

This section describes the environmental investigations performed to date, identifies the data that will be used in conducting the baseline human health and ecological risk assessments, and describes the status of data gaps.

2.1 PREVIOUS INVESTIGATIONS

Beginning in 1984, a series of environmental investigations were conducted to evaluate the potential for soil and groundwater contamination due to former operations at the Terminal. These investigations included a site inspection by DEQ in 1984, several soil investigations in the former PCP mixing area between 1984 and 1994, removal of the Crosby & Overton truck-washing trough in 1986, test pit explorations near the Crosby & Overton truck-washing trough in 1989, and a groundwater and soil investigation in 1994 in response to an unleaded gasoline spill. These investigations are described in the Phase III RI report.

In addition to the soil and groundwater investigations conducted between 1984 and 1994, a phased RI was conducted at the Terminal from 1996 through 2004, including ongoing quarterly groundwater monitoring continuing to the present under a Voluntary Cleanup Program (VCP) agreement between Time Oil and DEQ. The Phase I RI focused on the former stockpile area, and the Phase II RI focused on the former PCP mixing area and the former Crosby & Overton area. The Phase III RI focused on areas of the Terminal where no extensive soil or groundwater investigations had previously been performed, including the former Main Terminal and Bell Terminal tank farm areas, the former loading racks, and other historical operational portions of the Terminal. Some additional investigations and a soil remedial action were also performed for the East Property, which is not an area of consideration for the risk assessment and is, therefore, not considered part of the Terminal, or site, for the purposes of this document as described above. Some interim removal actions, including removal of the stockpile and impacted soil from the former PCP mixing/warehouse areas and soil from the Crosby & Overton area, were also completed in 2002. A more complete description of environmental data collected to date, including data representative of residual soil concentrations remaining at the conclusion of the soil removal actions and contaminated soil that has already been removed, is presented in the Phase III RI report and the removal action completion report (Landau Associates 2003).

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2.2 RISK ASSESSMENT DATA SET

This section describes the data set collected during environmental investigations at the Terminal that will be the basis for evaluating potential risks to human and ecological receptors. Special approaches to handling environmental data for risk assessment purposes are also described.

2.2.1 DATA SET DESCRIPTION

The data set compiled in the Phase III RI report (Landau Associates 2005) presents data representative of existing site conditions. Soil samples collected throughout the Phase II and Phase III RIs, that are representative of soil remaining at the Terminal following the completed interim remedial or removal actions, are presented in the Phase III RI report and comprise the data set to be used for soil characterization in the risk assessment. Except for the excavation worker scenario, which involves exposure to soil from ground surface to 13 ft BGS, all other human and ecological receptors are potentially exposed only to surface soil from ground surface to 3 ft BGS, as specified in DEQ guidance. Soil data will be evaluated in two data sets for risk assessment purposes: surface soil will include all applicable data from 0 to 3 ft BGS, and surface and subsurface soil will include all applicable data from 0 to 13 ft BGS (the approximate water table).

The nature and extent of contamination present in groundwater at the Terminal was evaluated based on chemical results for groundwater samples collected from temporary borings during the Phase III preliminary evaluation, the Phase III interim subsurface investigation, the October-November 2004 well installation, and also the most recent year of quarterly groundwater monitoring data (fourth quarter 2004 through third quarter 2005); the most recent year of groundwater monitoring data will be used for those wells that have been discontinued from the quarterly monitoring program. Groundwater data will be evaluated in two data sets for risk assessment purposes, "upper zone groundwater" and "lower zone groundwater." In areas closer to the river beyond the confining unit boundary where only one unconfined groundwater zone exists, groundwater data will be considered representative of lower zone groundwater, because of the similarity with lower zone groundwater elevations.

2.2.2 DATA SET HANDLING

Data sets used for risk assessment purposes are subject to statistical evaluation. Data handling techniques used to facilitate such statistical evaluations in a manner that is reasonable, and also maintains a conservative nature (i.e., tendency to err on the side of overestimating potential risks), are described below.

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Due to limitations in the accuracy of available chemical analysis equipment, laboratories typically cannot determine whether a chemical is absent from a sample, but they can confirm that it is not present above some threshold concentration, called the laboratory reporting limit, at which the chemical analysis equipment is considered reliable. Deterministic risk assessment procedures require that some discrete concentration be used for each sample to estimate average exposure point concentrations (EPCs) for chemicals that are retained as contaminants of potential concern (COPCs). Samples with concentrations not detected at the reporting limit will be handled in accordance with guidance developed by the U.S. Environmental Protection Agency (EPA 1989). Generally, if a chemical is not detected above the reporting limit in some samples from the site, but is detected in other samples, then those samples in which the chemical is not detected will be assigned a "proxy" concentration of one-half the value of the reporting limit for use in the calculation of EPCs. These proxy values will not have any bearing on the screening process described in Section 3.0. For data sets with a lognormal distribution, which is characteristic of most environmental data sets, assuming a proxy concentration of one-half the value of the reporting limit will provide a conservative estimate of the actual average concentration of nondetect samples.

Blind field duplicate samples are often collected during environmental investigations for the purposes of evaluating data quality. To avoid a statistical bias toward concentrations from sample locations where duplicate samples were collected (i.e., effectively counting these sample locations twice in comparison to other sample locations), only a single chemical concentration from the original sample or its duplicate will be retained for use in data evaluation. The selected concentration will be the maximum detected concentration for detected chemicals, or one-half the value of the lowest achieved reporting limit for nondetected chemicals. In cases where a chemical is not detected, this approach allows the use of the most sensitive analytical run to estimate the concentration below the reporting limit. In cases where a chemical is detected and there is some variability in the reported concentration, this approach conservatively assumes that the actual concentration is the highest of the two concentrations.

2.3 DATA GAPS

Surface soil, subsurface soil, and groundwater have been adequately characterized for risk assessment purposes based on the data presented in the Phase III RI report. The installation and quarterly sampling of shoreline wells to monitor groundwater quality near the point of discharge to the Willamette River have filled what was previously a data gap at the Terminal. The only remaining data gaps include definition of the locality of facility at the north property boundary and assessment of the mobility of the product observed in monitoring wells in the Main Terminal tank farm area. Time Oil has obtained permission from the Port of Portland for sampling two wells located within 300 ft of the north property

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boundary to determine whether any groundwater contamination from the Terminal extends north of the property boundary. The wells were dry during the second quarter 2005 groundwater monitoring event in June 2005 and the fourth quarter 2005 event in November 2005. Time Oil will make a final attempt to sample the wells during the first quarter event in February 2006. If the wells are still dry during this next event, Time Oil will make a recommendation to DEQ on a methodology for determining the locality of facility in this area. Also, Time Oil is preparing a source control evaluation document that will provide information on the mobility of the product and whether remediation is necessary to address potential product migration, and if so, the remedial options. We expect this document to be submitted to DEQ in the spring 2006.

3.0 DATA SCREENING

The potential exposures and risk(s) from contaminants at the Terminal will be assessed based on the data set described in Section 2.2. Constituents that are detected in less than 5 percent of the samples, or are detected with a maximum concentration that is less than site-specific background levels established for metals (Landau Associates 1999), are considered to have *de minimus* risk to human health and the environment and will be screened out of the risk assessment process (DEQ 2000). Constituents that are considered essential nutrients for human or ecological receptors (e.g., calcium, iron, magnesium, etc.) will not be retained for consideration in the risk assessment. All remaining constituents that are not rejected during data validation, are detected in at least 5 percent of the samples collected from a given environmental medium, and that are above background levels will be included in the database used in the human health and ecological risk assessments. Reporting limits for chemicals that were not detected, but considered to be reasonably likely to be present at the site, will be reviewed to verify that elevated reporting limits have not masked the potential presence of site contaminants. The resulting data set will constitute the COIs in all environmental media at the site.

A COPC/COPEC screening report was previously prepared for the Terminal based on Phase I and II investigations (Landau Associates 1999). The Phase III RI investigation and interim actions conducted at the Terminal since the COPC/COPEC screening report was prepared have resulted in significant changes to the data set that defines the nature and extent of contamination; therefore, the COPC/COPEC screening activities that will be performed as part of this risk assessment will supersede those presented in the previous report.

Data screening to identify COPCs for human health or COPECs for ecological receptors are discussed in Sections 4.0 and 5.0, respectively.

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4.0 HUMAN HEALTH RISK ASSESSMENT

A baseline human health risk assessment will be performed to estimate current and potential future risk to human health at the site using deterministic techniques outlined in DEQ cleanup regulations and guidance [Oregon Administrative Rule (OAR) 340-122-0084, DEQ 2000]. The following sections describe how site data will be used in evaluating human health risk based on our current understanding of the site, potential receptor populations, and exposure pathways. In addition, methods that will be used to quantify exposure and estimate risk are presented, and factors that will be qualitatively evaluated in assessing the uncertainty associated with the risk estimates are summarized.

4.1 CONTAMINANTS OF POTENTIAL CONCERN AND EXPOSURE POINT CONCENTRATIONS

As per DEQ (2000) guidance, the site data will be further refined after the screening process described in Section 3.0, to identify a subset of contaminants, the COPCs, that will be the focus of the baseline human health risk assessment. This screening for COPCs will eliminate from further consideration any contaminants with concentrations so low relative to risk-based criteria that the contaminants do not merit further evaluation. DEQ's risk-based concentrations (RBCs, DEQ 2003) and U.S. Environmental Protection Agency (EPA) Region 9 Preliminary Remediation Goals for industrial sites (PRGs, EPA 2002) will be used as the basis for screening COIs by risk to human health. The screening process will be conducted separately for COIs detected in onsite groundwater and soil. However, exposures to the same COI through multiple environmental media via multiple exposure pathways will also be evaluated. COIs at concentrations below these risk-based screening levels will not be evaluated further in the baseline human health risk assessment and the remaining constituents will be designated as COPCs and will be evaluated in subsequent steps in the risk assessments.

If a contaminant is a COPC in one medium and is detected in multiple media, the COPC will be retained in each medium to ensure consideration of potential exposures via multiple pathways. If a risk-based screening level is not available for a given COI, the COI will be identified as a COPC and discussed in the uncertainty analysis.

After COPCs have been identified for each environmental medium, a statistical evaluation will be conducted for each of the following data sets:

- Surface soil
- Surface and subsurface soil

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- Upper zone groundwater
- Lower zone groundwater.

The purpose of the statistical evaluation will be to identify a representative concentration, the EPC, of each COPC in each data set for use in evaluating chemical intake and risk through the relevant exposure scenarios and pathways identified in the exposure assessment. For each COPC in each data set, DEQ regulations require that both the arithmetic mean (central tendency) concentration and the 90 percent upper confidence limit (UCL), referred to as the plausible upper bound) be estimated for a given set of chemical concentration data. Calculations for contaminant intake by exposure pathway and risk estimates will be made using both resulting exposure concentrations in order to represent the required range of risks posed by the site.

4.2 EXPOSURE ASSESSMENT

Exposure assessment is the process of measuring or estimating the intensity, frequency, and duration of exposure. The exposure assessment step in the baseline human health risk assessment process involves identification of potential receptor populations and exposure pathways that could bring the receptors in contact with contamination at the site. The risk assessment process evaluates only complete exposure pathways. As noted in Section 1.3, in order for a human exposure pathway to be complete, each of the following elements must exist:

- A source and mechanism for chemical release
- An environmental transport medium (e.g., air, water, soil)
- A point of potential human contact with the medium
- A human exposure route at the point of contact (e.g., inhalation, ingestion, dermal contact).

For the purposes of this assessment, the environmental media through which exposure to the COPCs may occur is soil (surface and subsurface) and groundwater. Exposure to impacted soil could occur via incidental ingestion, dermal contact, and inhalation of suspended particulates. Exposure to impacted groundwater could occur via incidental ingestion, dermal contact, and inhalation of volatilized constituents. The diffusion/flux model described in DEQ guidance (DEQ 1999) was used to model contaminant migration from shallow groundwater to outdoor air (Figure 6). The Johnson and Ettinger model (Figure 7, DEQ 1999) was used to model indoor air concentrations.

The following sections present an evaluation of exposure pathways currently identified for each of the site receptor populations, exposure equations that will be used to calculate chemical intake for each of the pathways, and exposure parameters that will be used in calculating chemical intake.

4.2.1 ONSITE INDUSTRIAL WORKER

The Terminal is currently an inactive facility; however, future industrial workers using the site could be responsible for a variety of duties. The onsite industrial worker could potentially become exposed to contaminated soil and groundwater through direct contact pathways during occupational activities. The specific pathways include:

- Surface soil (0 to 3 ft BGS): dermal contact, incidental ingestion, and inhalation of suspended soil particulates
- Lower zone groundwater as process water: dermal contact
- Ambient air: inhalation of chemicals that have volatilized out of upper zone groundwater
- Indoor air: inhalation of chemicals that have volatilized out of upper zone groundwater.

For the purposes of this risk assessment, the onsite industrial worker population will be adult and assumed to work primarily in the upland areas of the Terminal. Industrial workers could potentially come into dermal contact with lower zone groundwater if used as industrial process water; however, groundwater at the Terminal has not been historically used for such purposes. Intake of contaminants will be modeled by assuming that the industrial worker performs tasks in relatively close proximity to each medium, with intake occurring through dermal contact and incidental ingestion of surface soil, dermal contact with lower zone groundwater used as industrial process water, and inhalation of ambient or indoor air impacted by volatile COIs in upper zone groundwater. The equations that will be used to calculate exposure to contaminants in soil, groundwater, and ambient or indoor air through each of the exposure pathways are shown on Figures 8 through 12, the exposure parameters used in the calculations are presented in Table 1.

4.2.2 ONSITE CONSTRUCTION WORKER

There is currently no ongoing construction activity at the Terminal. However, future site uses (i.e., Terminal demolition or redevelopment of the site) may require consideration of the construction worker scenario. Construction worker activities could potentially expose construction workers to contaminants in surface soil (dermal contact, incidental ingestion, and inhalation of particulates) and ambient air (inhalation).

For the purposes of this risk assessment, the model will assume that the receptor population is adult working in close proximity to the soil, with chemical intake occurring through dermal contact and incidental ingestion of soil and through inhalation of suspended particulate matter. The equations that

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will be used to calculate exposure to contaminants in surface soil through dermal contact, incidental ingestion and/or inhalation of suspended soil particulates are shown on Figures 8 through 10. The equation to calculate exposure to contaminants in ambient air via inhalation is shown on Figure 12. Exposure parameters used in these calculations are presented in Table 1.

4.2.3 ONSITE EXCAVATION WORKER

There is currently no ongoing excavation activity at the Terminal. However, future site uses (i.e., Terminal demolition or redevelopment of the site) may require consideration of the excavation worker scenario. Movement of earthen material could potentially expose excavation workers to contaminants in surface and subsurface soil (dermal contact, incidental ingestion, and inhalation of particulates); shallow groundwater (dermal contact); and ambient air (inhalation).

For the purposes of this risk assessment, the model will assume that the receptor population is adult working in close proximity to the soil, with chemical intake occurring through dermal contact and incidental ingestion of soil and through inhalation of suspended particulate matter. It is also assumed that the excavation worker could come into dermal contact with shallow groundwater. The equations that will be used to calculate exposure to contaminants in surface and subsurface soil through dermal contact, incidental ingestion and/or inhalation of suspended soil particulates are shown on Figures 8 through 10. The equation to calculate exposure to contaminants in shallow groundwater via dermal contact is shown on Figure 11. The equation to calculate exposure to contaminants in ambient air via inhalation is shown on Figure 12. Exposure parameters used in these calculations are presented in Table 1.

4.3 DOSE-RESPONSE ASSESSMENT

The purpose of the dose-response assessment is to weigh available evidence regarding the potential for COPCs to cause adverse health effects in exposed individuals and to provide, where possible, an estimate of the relationship between the extent of exposure to a compound and the increased likelihood or severity of the adverse effect.

The bulk of knowledge about the dose-response relationship is based on data collected from animal studies and theoretical precepts about what might occur in humans. Mathematical models are used to estimate the potential human response at levels far below those tested in animals. These models contain several limitations that will be considered when the risk estimates are evaluated. Most of the COIs preliminarily identified for the site have toxicity criteria available for the dose-response assessment, and include both noncarcinogenic and carcinogenic compounds. For those COPCs for which toxicity

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criteria are not available to conduct a quantitative risk estimate, a qualitative evaluation of the risk will be presented.

The EPA online Integrated Risk Information System (IRIS, EPA 2004) will be accessed to identify toxicity criteria for the site COPCs. Reference dose values will be identified to evaluate noncarcinogenic health effects, and cancer potency factors will be identified to evaluate carcinogenic health risks. In some cases, both reference dose values and potency factors may be available for some compounds. In these cases, both noncarcinogenic and carcinogenic health effects will be evaluated. Information concerning the basis of the toxicity criteria used and their associated uncertainty will be presented in the baseline risk assessment report, as recommended by EPA guidance (EPA 1989).

4.4 RISK CHARACTERIZATION

The risk characterization will provide a quantitative and qualitative summary of the health risks posed to individuals by exposure to the COPCs in environmental media at the site. The risk characterization will address both noncarcinogenic and carcinogenic health effects.

Potential noncarcinogenic adverse health effects will be evaluated by comparing the predicted chemical intake values to reference dose values obtained from the EPA IRIS database. In order to evaluate the general acceptability of a particular dose relative to a reference dose value, a hazard quotient value is calculated, which is the ratio of the calculated average daily dose (ADD) to the reference dose value:

$$\text{Hazard Quotient} = \text{ADD}/\text{Reference Dose}$$

A hazard quotient less than or equal to 1 indicates that the predicted exposure would not pose an unacceptable level of noncarcinogenic health risk (EPA 1989). To account for the additive effects of individual chemicals for a given exposure pathway that could potentially act upon the same organs or result in the same physiological endpoint, additive effects are addressed by calculating a hazard index, which is the sum of all individual hazard quotients for a given pathway.

Carcinogenic risks are defined in terms of the probability of an individual developing cancer as the result of exposure to a given chemical at a given concentration. The incremental probability of developing cancer (i.e., the theoretical excess cancer risk) is that risk attributed to exposure to the COPCs present at the site. For each applicable COPC, the theoretical excess cancer risk is based on the lifetime average daily dose (LADD), which is defined as the total incremental dose of a chemical received as a

result of the exposure averaged over a lifetime. Once the LADD has been calculated, the cancer risk is calculated as follows:

Estimated Cancer Risk = LADD x Potency Factor

As with hazard quotients, the estimated cancer risks for each chemical and exposure route will be summed to estimate the total excess cancer risk for the exposed individual per exposure pathway (EPA 1989).

4.5 UNCERTAINTY ANALYSIS

An uncertainty analysis will be conducted for the baseline human health risk assessment to examine the sources and magnitude(s) of potential uncertainty associated with the risk estimates. Sources of uncertainty include the data available for the site investigations, receptor population and exposure pathway identification, exposure parameter selection, and toxicity criteria used to characterize risk. Each of these potential sources of uncertainty will be evaluated qualitatively to determine the likely degree of uncertainty associated with the risk estimates, and whether the uncertainty has likely led to over- or under-estimates of risk.

4.6 BASELINE HUMAN HEALTH RISK ASSESSMENT – CONCLUSIONS AND RECOMMENDATIONS

The conclusions of the baseline human health risk assessment (HHRA), including acceptable risk levels for exposure of COPCs to human receptors at the terminal, and any recommendations for additional assessment of risk to human receptors will be provided in a baseline HHRA report, as described in Section 6.0.

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5.0 ECOLOGICAL RISK ASSESSMENT

An ecological risk assessment (ERA) will be performed to address current and potential future risks posed to ecological receptors at the site. As described in Sections 1.3.1 and 1.3.2 of this Work Plan, the ERA will focus on the western portion of the site and will specifically exclude the formerly remediated East Property and surface water and sediment within the Willamette River. As also described earlier, exposure of ecological receptors to COIs in surficial soil is not expected in areas where soil removal actions previously occurred within the former PCP mixing area and the former Crosby & Overton area.

The ERA will be conducted in accordance with OAR 340-122 and DEQ guidance for conducting Level II and III ERAs (DEQ 2000, 2001). Generally, ERAs conducted to meet Oregon DEQ guidelines are based on an EPA framework (EPA 1998). This framework follows a stepwise process that first includes problem formulation to determine the focus and scope of the assessment, followed by an exposure assessment, toxicity assessment, and risk characterization.

In accordance with DEQ guidance, a Level I Ecological Scoping Assessment was conducted based on an April 2005 site visit and is presented in Appendix A. The results of the Level I assessment indicate that terrestrial ecological habitat at the terminal is limited in quality and size because of the presence of the tank farms, buildings, predominantly gravel or dirt surfaces, and the overall lack of vegetation. However, the presence of COIs in media at the terminal could provide an exposure pathway to terrestrial ecological receptors (mainly through surficial soil). Therefore, potential ecological receptors and potentially complete exposure pathways exist within the locality of the facility and a Level II Screening ERA should be conducted.

As defined by DEQ guidance, the Level II Screening ERA is essentially a preliminary problem formulation that will determine the presence of contaminants of potential ecological concern (COPECs) at the Terminal, if any, and the ecological receptor groups likely to be exposed to these COPECs. The results of the Level II Screening ERA will be reported to DEQ with recommendations regarding the need for additional ecological assessment. If further ecological assessment is deemed necessary, species-specific and site-specific ecological risks will be calculated using one of two approaches. The first approach would be to calculate ecological target cleanup levels (ETCLs) based on individual-level risks for indicator species. This approach is a DEQ-accepted method that is somewhat conservative (i.e., more likely to predict risks when none actually exist) and is defined in a previous version of the DEQ Level II guidance (1999). The second approach is the current DEQ Level III baseline ERA method, as defined in the DEQ Level III guidance, which examines population-level risks for indicator species. The number of COPECs, the receptor groups of most concern, and the level of risks predicted during the Level II

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Screening ERA will be considered in the decision to proceed with a Level II individual-level ERA or a Level III population-level ERA. The overall process will allow for informed, stepwise decision-making in order to focus each subsequent and more complex level of ecological assessment on the most important ecological issues for the site. The following sections present the procedures to be followed for the Level II Screening ERA, a Level II species-specific individual-level ERA (if required), and a Level III baseline population-level ERA (if required).

5.1 LEVEL II SCREENING ASSESSMENT

This section documents the steps necessary to conduct the Level II screening assessment for the ERA. The Level II screening assessment will build on the information collected during the Level I scoping process and will initiate the problem formulation process for the ERA for the Terminal. The scope of an ERA is defined through problem formulation, during which the physical and contaminant characteristics of the site are described, including the important ecological habitats, plants, and wildlife that exist there. Along with the results of previously completed investigations and knowledge of the site, this information is used to identify the COIs (i.e., contaminants likely to be present at the site), the ecological receptors of concern (i.e., assessment species), and the COPECs. This information will also be used to incorporate ecological exposure information into the preliminary conceptual site model (Section 1.3) and to develop information needed for the ecological exposure model (CEEM) required for the Level III assessment, if necessary. The ecological exposure information will include the expected fate and transport of chemicals at the site, the potential exposure media, and exposure pathways for ecological receptors of potential concern. Specifically, the problem formulation will include:

- a site description
- a summary of the results of previous investigations
- description of the ecosystem components at the site
- selection of assessment species for the site
- a summary of complete ecological exposure pathways
- selection of the COPECs
- a summary of potential ecological effects of the COPECs
- presentation of the ecological exposure information for the preliminary CSM
- presentation of candidate assessment endpoints and measures based on the COPECs for the site and potentially effected ecological receptors.

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The site description, previous investigation summary, and preliminary conceptual site model are provided earlier in this work plan. Information to be used for preliminary problem formulation and identification of COPECs is provided below, including the current understanding of the ecological conditions at the Terminal. As described below, the preliminary problem formulation will conclude with identification of candidate assessment endpoints and measures that become the focus of the remainder of the ERA. Preliminary problem formulation will also provide for a qualitative understanding and ranking of which COPECs are of the most importance and in which media. The preliminary problem formulation information will be updated as part of the Level II COPEC determination and may be further modified or updated during the Level II ETCL calculation or Level III ERA, in accordance with the level of detail required by the selected approach, if determined necessary.

5.1.1 ECOSYSTEM COMPONENTS

The site encompasses terrestrial environments and borders riverine environments. This section summarizes and focuses the characteristics of the terrestrial environment that are relevant to the ERA. The riverine environment is being assessed as part of the Portland Harbor RI/FS.

5.1.1.1 Terrestrial Environment

The Terminal is dominated by two areas of ASTs known as the former Main and Bell Terminal tank farms. The former Main Terminal tank farm area is within a bermed area approximately 30 ft above the shoreline of the Willamette River in the northwest area of the site. Immediately east of the former Main Terminal tank farm area are the truck loading/unloading area and associated office and warehouse buildings. A few additional ASTs and the existing wastewater treatment system (WWTS) are also present near this Main Terminal complex. The former Bell Terminal tank farm area is several hundred feet south of the former Main Terminal tank farm area and several hundred feet east of the river, and is separated from the river by the Premier Edible Oils site currently owned by Schnitzer Steel Inc. The ASTs at the former Main and Bell Terminal tank farms are close together and surrounded by dirt berms designed for spill containment. Within the berms the ground is predominantly bare dirt with very little to no natural vegetation. Most of the area between the former Main Terminal tank farm area, the office and warehouse buildings, and the WWTS is either paved or covered with gravel. The areas where former soil removal actions occurred in the former PCP mixing area, the former Crosby & Overton tank area, and the former soil stockpile area are covered with sand and gravel fill. The area between the former Main Terminal complex and the former Bell Terminal tank farm area is mowed weedy vegetation or bare dirt surface. Therefore, the terrestrial habitat at the site currently provides little habitat for ecological receptors. A

limited number of small terrestrial mammals (e.g., deer, mice), terrestrial invertebrates, and/or reptiles (e.g., garter snakes) may inhabit the mowed grassy area between the tank farms.

5.1.1.2 Riverine Environment

As described earlier in this work plan, there is no complete exposure pathway to the Willamette River. Therefore, ecological receptors in the riverine environment will be considered only insomuch as their normal activities would result in potential exposure to upland surface soil (i.e., semi-aquatic receptors with terrestrial foraging habits may be evaluated, but fully aquatic receptors will not). Aquatic receptors are being evaluated as part of the Portland Harbor RI/FS.

5.1.1.3 Sensitive Environments

No sensitive environments exist on the site. The Willamette River, located adjacent to the site, is a sensitive habitat as defined by OAR 340-122-045, due to the critical habitat designation for the federally listed Chinook salmon and steelhead and is being evaluated for the Portland Harbor RI/FS. While some restored wetlands are present north of the Terminal, the zoning and land use surrounding the site are industrial.

5.1.1.4 Sensitive Species

A sensitive species search via the Oregon Natural Heritage Information Center (ONHIC) has not yet been conducted. This search will be conducted and the results incorporated into the ERA. Evaluation of sensitive species for the ERA will be limited to terrestrial and possibly semi-aquatic receptors exposed to contaminants in terrestrial habitats. Currently available information on sensitive species is provided below.

Bald eagles have nested along the Willamette River upstream and downstream from the site. Due to successful recovery efforts, U.S. Fish and Wildlife Service (USFWS) recently proposed that the bald eagle be removed from the federal list of endangered and threatened wildlife in the lower 48 states under the Endangered Species Act (ESA). While the public comment period on the ruling to de-list closed in October 1999 and the de-listing was expected to have been completed within a year of the end of the public comment period (CH2M Hill 1999), the de-listing has not occurred to date.

State-listed terrestrial and semi-aquatic threatened, endangered, and sensitive-critical species in Multnomah County, Oregon include birds (i.e., bald eagle and peregrine falcon), bats, frogs, turtles, and snails. Given the general lack of suitable habitat, the birds and other protected species are unlikely to

inhabit the Terminal or the site vicinity. There are no known rare, threatened, or endangered plant species at the Terminal.

5.1.1.5 Potential Ecological Receptor Types

For the purposes of this ERA, terrestrial plants, invertebrates, and wildlife are those species that forage on terrestrial plants, terrestrial invertebrates, and terrestrial wildlife (e.g., herbivorous, invertivorous, omnivorous, or carnivorous amphibians, reptiles, bird, or mammals) and, thus, are most likely to be exposed to site-related contamination in surface soil. Semi-aquatic wildlife are those species that live in the terrestrial environment, but obtain a significant portion of their diet from the aquatic environments, or vice versa, and may be exposed to site-related contamination in surface soil. Aquatic plants, invertebrates, fish, and wildlife are those species that obtain their sustenance from the aquatic environment and, thus, are unlikely to be exposed to site-related contamination in soil or groundwater at the Terminal. Representative terrestrial and semi-aquatic ecological receptors that are known or likely to be found at or adjacent to the site are listed in Tables 2 and 3, respectively. The receptor types (or functional groups) these species represent are summarized in Table 4. Some of these ecological receptors may be resident at the site while others may use the site on a seasonal basis, or as a resting or staging area along migration routes. These species were used to define the ecological functional groups of species at the site and to select the representative assessment communities and species that are evaluated in the ERA, as described in the next section. The functional grouping is described in the next section.

5.1.2 Selection of Assessment Communities and Assessment Species

In ERAs, it is impractical to address each individual species that may inhabit a given site. Therefore, similarly exposed species are classified into functional groups based primarily on their foraging habits, and then assessment communities or assessment species are chosen to represent these functional groups. Subsequently, predicted risk for one assessment community or assessment species is considered representative of risk to the other species within the represented functional groups.

The Time Oil Northwest Terminal functional groups were developed from site-specific species lists by grouping species by taxonomic class (e.g., birds, mammals, amphibians, etc.), foraging strategy (e.g., terrestrial or semi-aquatic), and trophic level (e.g., primary producer, herbivore, invertivore/detritivore, or carnivore/piscivore). Because different species of plants and invertebrates can be very numerous, these lower trophic level species are often combined according to DEQ guidance and assessed as communities because of their very similar exposure routes. In addition, toxicity data for plants and invertebrates are most often representative of groups of species. These combinations of lower

trophic level species are termed assessment communities because they may represent numerous types of species. An assessment community may represent one or more functional groups. During the functional grouping process, semi-aquatic species were grouped into terrestrial or aquatic foraging strategies based on their expected primary foraging habits while they are present at the site. For example, raccoons were considered to be part of the terrestrial food web, because they are expected to forage primarily on terrestrial berries, seeds, and invertebrates that are common along the river, but not on aquatic prey items such as crawdads, which are uncommon or absent in the near-shore areas of the river where raccoons could wade. Preliminary functional groups selected for this ERA are presented in Table 5. This list was used to develop the terrestrial food web diagrams shown on Figure 13.

A representative assessment species was also selected to represent each of the upper trophic level functional groups, based primarily on the species within each functional group that would be expected to receive the highest exposure to contaminants at the site. Primary factors related to exposure potential that were considered included:

- body size
- population density and extent of home range
- foraging approach of the species
- contaminated media at the site
- ecological niche(s) represented by a species.

Other factors that influenced the selection of some assessment species included:

- sensitivity of the receptor to the site-related contaminants
- availability of exposure and toxicity data
- societal value/regulatory status of the species
- position of the species within the food web.

The selected assessment communities and species, and the functional groups they represent, are listed in Table 5. The rationale for selection of each assessment community and species is presented below.

5.1.2.1 Assessment Communities and Exposure Pathways

Terrestrial Plants

The terrestrial plant community is defined as all plants that obtain nutrients primarily from soil (including soil pore water). The primary production of these plants provides a foundation for the

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terrestrial food web. Negative impacts to primary production are likely to result in decreased abundance of soil invertebrates and upper trophic level species due to a lack of food and cover. A reduced diversity of particularly sensitive plant species may also result in similar detrimental effects to some upper trophic level species if plants that are a preferred food for particular herbivores are extirpated (made regionally extinct) from the site due to their exposure to contaminants in soil. Because plant toxicity data are not available for most wild plant species, these plant species were assessed as a community by applying the available toxicity data across all species at the site. This broad application assumes that the mechanism of toxic action is similar between plant species. The principal exposure pathway for terrestrial plants to contaminants at the site is via uptake from soil and soil pore water.

Terrestrial Invertebrates

The terrestrial invertebrate community is defined as all invertebrates that obtain nutrients primarily from soil or on the soil surface. The abundance and diversity of such invertebrates is similar in importance to that of plants because invertebrates are also a primary food source within the terrestrial food web. Declining numbers or types of terrestrial invertebrates may result in decreased abundance and/or diversity of insectivores. This, in turn, may result in lower diversity of upper trophic level wildlife because fewer numbers or types of insectivores means fewer food items for carnivores that prey on the insectivores. Thus, the dependent carnivores may starve or leave the site in search of their preferred food items. The principal exposure pathways for terrestrial invertebrates to COPECs at the site is via ingestion of and dermal contact with soil.

5.1.2.2 Assessment Species and Exposure Pathways

The assessment species and the functional groups they represent for the Terminal are summarized in Table 5. In some cases, one assessment species was considered to be representative of several functional groups. This was the case when a particular assessment species could be chosen that was similar to, but likely to be more highly exposed or sensitive to, contaminants than species in the other represented functional groups. Thus, using an assessment species approach protects other species in different functional groups and allows the number of assessment species to be reduced. The rationale for the selection of assessment species for multiple functional groups is described in the following sections.

Terrestrial Avian Invertivores

The American robin was chosen as an assessment species because it is likely to be the most exposed representative of the terrestrial invertivore functional group. The robin is small, has a high food

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intake rate for its weight, and would be susceptible to chemical exposure via ingestion of contaminated terrestrial invertebrates and incidental ingestion of soil. No perennial surface water is present at the site and therefore, exposure to contaminated drinking water is not considered a significant exposure pathway. Robins are present onsite during the spring and summer months (and potentially all year), have limited home ranges, and have adequate exposure and toxicological data.

The robin was considered to be representative of the potential exposure and effects for several other functional groups, including terrestrial avian herbivores, terrestrial avian omnivores, and terrestrial avian carnivores. The exposure of invertivores is usually higher than that of herbivores or omnivores, because plants generally take up contaminants to a lesser extent than invertebrates. For this reason, the robin will also represent terrestrial avian herbivores and omnivores. The robin is also a more conservative representative of terrestrial avian carnivores than a red-tailed hawk (the other choice for this site) because of its smaller body and home range, each of which increase the potential for exposure to chemicals at the site. Additional considerations that support this substitute include the fact that fewer hawks would be expected to inhabit the site because their home ranges extend farther, hawks would not be solely exposed to contaminants at the site as robins may be, and because methods of assessing toxicity are nearly identical for the robin and hawk.

Terrestrial Mammalian Invertivores

The masked shrew was chosen as a mammalian assessment species because it has a high potential for chemical exposure, it (or other similar shrew species) is a resident at the site, it is a prey species for avian and mammalian carnivores, and it has adequate toxicological and exposure data. The masked shrew is very small, is known to have a high food intake rate for its weight, and is potentially exposed to contaminants in surface soil via ingestion of contaminated invertebrates and incidental ingestion of soil. Shrews obtain most of their water requirements from their prey and there is no perennial surface water onsite, therefore, contaminant exposure via drinking water is considered negligible for the shrew and will not be assessed.

Similar to the robin, the shrew was considered representative of several functional groups, including terrestrial mammalian herbivores and terrestrial mammalian omnivores. The shrew is a conservative representative of terrestrial mammalian omnivores and herbivores because chemicals are most often expected to bioaccumulate to a greater extent in invertebrates than in plants. In addition, the shrew is the smallest terrestrial mammal at the site, so its food intake to weight ratio (i.e., exposure) is expected to be greater than any other small mammal.

The shrew is also a conservative representative of nutria and muskrat that are most frequently classified as aquatic mammalian herbivores. Because there is limited or no aquatic vegetation in the

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vicinity of the Terminal, aquatic mammalian herbivores such as nutria are most likely eating terrestrial vegetation or must swim to offsite areas where aquatic vegetation is present. Given either of these scenarios and the rationale that invertivores are more susceptible to contaminant exposure than herbivores, the shrew is a conservative representative of the nutria and muskrat that may inhabit the site.

Terrestrial Reptilian Carnivores

Garter snakes may inhabit the terrestrial environment at the site. Currently, exposure and toxicity data are inadequate to assess the potential risks for reptiles. Thus, although the garter snake is identified as an assessment species, its potential risks are only considered qualitatively, compared to risks predicted for other assessment species.

5.1.2.3 Summary of Assessment Communities and Species

The above-noted assessment species and the functional groups they represent are presented in Table 5. Of these, only the garter snake will be assessed in a purely qualitative manner, due to the lack of exposure and toxicity data for this species. The exposure pathways to be assessed for each of these receptors is presented in Table 6 and Figure 5.

5.1.3 Environmental Concentrations

The environmental concentrations (ECs) are concentrations of COIs in each exposure medium that are used to select the COPECs. As such, they are estimates of the environmental concentration to which ecological receptors are exposed over a relevant spatial area defined by their habitat. The ECs will be calculated as follows:

- For plants and soil invertebrates (assessment communities) that are immobile or nearly immobile, the maximum detected concentration of each COI in soil will be used as the EC.
- For terrestrial wildlife (assessment species: robin and shrew) consuming soil, vegetation, or prey, the 90UCL of each COI in soil will be the preferred EC. If fewer than 10 samples are available, the maximum detected concentration will be used as the EC. The data distribution will be tested for normality and lognormality and the 90UCL will be calculated appropriately for the distribution. If the data are neither normally nor lognormally distributed, the 90UCL will be calculated using the Z-statistic.

The ECs and calculation methods used in the ERA will be presented in the Level II ERA – Screening Assessment Report (see Section 6.0).

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5.1.4 CONTAMINANTS OF POTENTIAL ECOLOGICAL CONCERN

The COPECs determined during the Level II screening ERA will be applicable to all potential additional ERA evaluations conducted for the site. The screening procedures generally consider the frequency of detection, whether the chemicals are essential nutrients, background or reference chemical concentrations, ecological risk-based screening concentrations (ERBSCs), and bioaccumulation potential. In this manner, contaminants that are not expected to significantly contribute to risk are eliminated from the ERA data set. The frequency of detection and background screening procedures are described in Section 3.0. The COIs identified based on the procedures described in Section 3.0 will be subjected to the ecological risk-based and bioaccumulation screening procedures described in the following sections to select COPECs for the Terminal.

5.1.4.1 Risk-Based Screening

According to DEQ guidance, the risk-based screening steps eliminate COIs that are not detected at the site above ERBSCs. This screening will include comparison of maximum detected concentrations (for immobile species) or the 90 percent UCL concentrations (for mobile species) of each COI in each direct exposure medium to DEQ's risk-based Screening Level Values (SLVs; DEQ 2001), as described in Section 5.1.3. For COIs without corresponding SLVs, chemical-specific SLVs from other COIs will be used as surrogate values (based on similarity in chemical structure) where appropriate, or other ERBSCs will be selected from the literature, as available. For surface soil, the only ecological exposure medium at the site, these alternate ERBSCs may include Dutch soil screening values (DMHSPE 2001) and ecological soil screening levels developed by EPA (EPA 2003), or others. The SLVs and other ERBSCs used in this screening step for surface soil will be tabulated in the Level II ERA – Screening Assessment Report.

A COI will be retained as a COPEC in surface soil if it exceeds an SLV or other ERBSC by a factor of more than 5. The screening calculations will be tabulated for surface soil and presented in the Level II ERA – Screening Assessment Report.

5.1.4.2 Additional Screening Procedures

Three additional screening steps will be conducted. First, the bioaccumulation potential of the COIs will be assessed. Organic chemicals with a Log K_{ow} between 3 and 8 will be considered to have the potential to bioaccumulate. The bioaccumulative metals in surface soil will be selected in coordination with DEQ. The COIs listed as having the potential to bioaccumulate will be included in the ERA for further assessment.

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Second, the maximum detection limit for each of these COIs will be compared to the chemical-specific SLV or other pertinent ERBSC to verify that the analytical methods were sensitive enough to detect a potential impact (if the detection limit exceeds the SLV, the COI generally is retained as a COPEC).

Finally, following DEQ guidance (DEQ 2001), the chemical-specific ratios of each COI concentration to its corresponding SLV or ERBSC (i.e., the COI risk ratios) will be summed to calculate a medium-specific risk ratio and then the contribution of each COI to the medium-specific risk ratio will be calculated. Those COIs that, according to DEQ guidance, contributed excessively to the medium-specific risk ratio will be retained as COPECs. The site COPECs for surface soil, identified per the above steps, will be presented in the Level II ERA – Screening Assessment Report.

5.1.5 Preliminary Ecological Effects Assessment

The COPECs developed per Section 5.1.4 will be grouped by type (i.e., metals, PAHs, chlorinated hydrocarbons, organochlorine compounds, etc.) and the general mode of action or known toxic effects to wildlife will be discussed qualitatively. This general description of potential ecological effects will be used to highlight the types of COPECs that may be more likely to effect particular types of ecological receptors (i.e., plants, terrestrial invertebrates, mammals, birds, or herpetiles). If necessary, additional receptors may be added to the ERA to assess particular ecological effects that may result due to particular COPECs at the Terminal.

5.1.6 Preliminary Conceptual Site Model – Ecological Exposures

The preliminary CSM presented in Section 1.3.5 above will be modified, as necessary, to accommodate findings of the preliminary problem formulation.

5.1.7 Candidate Assessment Endpoints

Assessment endpoints are written descriptions of the environmental characteristics of concern at a given site (EPA 1998). Generally, they represent ecological aspects that should be assessed in order to assure protection of the environment and allow informed site-specific risk management decisions. Developing assessment endpoints is an integral part of problem formulation because these endpoints link risk assessment results to risk-management actions. Primary considerations for selecting assessment endpoints will include ecological relevance, policy goals, societal/cultural values, and susceptibility to the environmental stressor (i.e., the site contaminant, EPA 1998). The selection of assessment endpoints also depends on:

- the species present at the site and their interaction
- types of contaminated media at the site
- complete ecological exposure pathways
- types of contaminants present.

Generally, the assessment endpoints for the Terminal will be selected to be indicative of toxic effects to receptor populations. Because no terrestrial or semi-aquatic threatened or endangered species have been identified as inhabiting the site, assessment at the individual level will not be required. At least one assessment endpoint will be selected for each identified assessment community and species. For each endpoint, assessment measures will be defined that describe how the endpoint will be evaluated.

5.1.8 LEVEL II SCREENING ASSESSMENT - CONCLUSIONS AND RECOMMENDATIONS

Through the procedures described above, an ecological description of the site and an understanding of whether COPECs at the site may pose a risk to ecological receptors will be determined. If evaluations conducted for the Level II ERA – Screening Assessment indicate that the site is highly unlikely to pose a potential risk to ecological receptors, then no additional ERA evaluations will be conducted and the ERA will be complete. If it is determined that additional ecological assessment is necessary to better assess the potential for ecological risk to receptors due to exposure to COPECs at the Terminal, species potentially at risk and the identified COPECs will become the focus of a Level II ETCL calculation or Level III baseline ERA, whichever is determined to be most appropriate, as described in the following sections. The results of the Level II COPEC determination and recommendations for further assessment will be presented to DEQ in a Level II ERA – Screening Report as described in Section 6.0.

5.2 LEVEL II SPECIES-SPECIFIC ECOLOGICAL TARGET CLEANUP LEVELS

Based on the results of the Level II Screening Assessment, a recommendation will be made regarding whether to perform further Level II species-specific individual-level ecological assessment or to complete a Level III baseline population-level ERA. This decision will be based primarily on the number and types of COPECs and assessment species that are potentially at risk resulting from historical activities at the Terminal. This section describes the methods that would be used for determining Level II ETCLs if this method is used. Most of the preliminary problem formulation completed during the determination of COPECs will be considered adequate for the individual-level risk determination. However, representative indicator or assessment species will be selected from the bird and mammal receptor groups for which

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risks were predicted during the Level II Screening Assessment. Then, the determination of ETCLs protective of these individual assessment species would include exposure assessment, toxicity assessment, and risk characterization.

5.2.1 EXPOSURE ASSESSMENT

Generally, exposure assessment involves mathematically expressing the exposure of assessment species (i.e., developing site-specific exposure models for assessment species) and identifying species-specific and chemical-specific exposure parameters. The EPCs from the Level II Screening Assessment and selected exposure parameters are then used within the exposure equations to calculate the estimated daily dose (EDD) of COPECs for each of the assessment species.

5.2.1.1 Exposure Models

The exposure media, assessment species, and significant exposure pathways selected during the problem formulation define the exposure models required to calculate an estimated daily intake of the COPECs. For all assessment species, the estimated daily intake can generally be expressed as:

$$EDD_{total} = \frac{EDI_{soil} + EDI_{food}}{BW} \qquad \text{(Equation 5-1)}$$

where:

EDD_{total} = Total estimated daily dose of COPECs for the assessment species [mg/kg body weight (bw) per day]
EDI_{soil} = Estimated daily intake of COPECs from incidental ingestion of soil (mg COPEC per day)
EDI_{food} = Estimated daily intake of COPECs from ingestion of food/prey items (mg COPEC per day)
BW = Body weight of the assessment species (kg).

This equation is modified to be species-specific by mathematically expressing the estimated daily intake of COPECs via food and soil for a particular species. The species-specific equation for robins and shrews is:

$$EDD_t = \frac{[(BAF \times IR_e)+IR_s] \times EPC_s \times DC_f \times SUF}{BW} \qquad \text{(Equation 5-2)}$$

where:

EDD_t = Estimated total daily dose (mg/kg-bw per day)
EPC_s = Exposure point concentration of COPEC in soil (mg/kg)
BAF = Soil-to-earthworm bioaccumulation factor (kg soil/kg worm)
DC_f = Percent of diet comprised of selected food items (unitless)
IR_e = Ingestion rate of earthworms by the assessment species (kg/day)
IR_s = Incidental soil ingestion rate by the assessment species (kg/day)

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SUF = Site use factor for the assessment species, comprised of areal and seasonal partitioning of the use of the site by the assessment species (unitless).

BW = Body weight of the assessment species (kg).

Given that the calculation of risk for assessment species is the ratio of the total estimated daily dose of a COPEC to the ecological reference dose (ERfD) calculated as:

$$TQ_{species} = \frac{EDD_t}{ERfD} \qquad \text{(Equation 5-3)}$$

where:

$TQ_{species}$ = Toxicity quotient for a particular COPEC, assessment species, and exposure medium (unitless).

EDD_t = The total estimated daily dose of a given COPEC by an assessment species from a particular exposure medium (mg COPEC/kg body weight per day)

ERfD = The ecological reference dose for a given COPEC and assessment species (mg COPEC/kg body weight per day).

Then by setting the TQ to 1 and combining equations 5-2 and 5-3, the ETCL (a.k.a. the EPC at which the TQ=1) for the robin and shrew can be calculated as:

$$ETCL_{species} = \frac{ERfD \times BW}{[IR_s + (BAF \times IR_a)] \times DC_e \times SUF} \qquad \text{(Equation 5-4)}$$

The resulting ETCLs would then be reported. The following sections define the required species-specific and chemical-specific exposure parameters.

5.2.1.2 Species-Specific Exposure Parameters

The species-specific parameters required for equation 5-4 include:

- total dietary intake (kg dw/day)
- plant matter intake (kg dw/day)
- animal matter intake (kg dw/day)
- incidental soil ingestion (kg dw/day)
- Dietary composition of selected food items (%)
- body weight (kg)
- home range (acres)
- migration factor (%)

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Various sources in the scientific literature will be reviewed for information on these species-specific parameters. The Wildlife Exposure Factors Handbook (EPA 1993) will be the preferred source for these exposure parameters. If particular exposure parameters are not reported in the handbook, other literature will be used to obtain the necessary exposure factors. In general, average values found in or calculated from the literature will be used for each exposure parameter. Any variations from this approach will be noted in a Level II species-specific ERA document.

5.2.1.3 Chemical-Specific Exposure Parameters

In order to calculate the COPEC concentrations in each medium (including prey items), the following chemical-specific exposure parameters may be required:

- soil-to-biota bioaccumulation factors (BAFs)
- dose-to-tissue biotransfer factors (BTFs)

Bioaccumulation is the adsorption of chemicals into tissue via all exposure routes (e.g., direct absorption, inhalation, or ingestion). The BAF is a measure of the transfer and accumulation of COPECs from a medium (e.g., surface soil) into the tissue of a receptor that resides in the soil or forages on invertebrates or other soil-dependent prey items (excluding plants). For example, an earthworm BAF is the ratio of chemical in worm tissue to that found in the surrounding soil (mg chemical/kg tissue per mg chemical/kg soil = kg soil/kg tissue). Earthworm BAFs for inorganic chemicals and PCBs will consist of median values provided by Sample et al. (1998). The BAFs for other organic chemicals will be estimated from the lipid content of soil invertebrates (2 percent) and an average site-specific surface soil organic carbon content, using the following predictive BAF model (Menzie et al. 1992):

BAF = Earthworm Lipid Content / (0.66 x Fraction Organic Carbon in Soil) Equation 5-5

BTFs are ratios of the concentrations of chemicals in food items to the concentrations in receptor tissues. These will be obtained, as necessary, from various species-specific and chemical-specific peer-reviewed literature.

5.2.2 TOXICITY ASSESSMENT

The toxicity data to be used in the Level II species-specific calculations include toxicity benchmark doses (TBDs) selected from appropriate references for the COPECs. The TBDs representative of the lowest observed adverse effect level (LOAEL) or no observed adverse effect level (NOAEL) may be used directly as ecological reference doses (ERfDs) or otherwise are converted to

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ERfDs representative of LOAELs or NOAELs as appropriate, using uncertainty factors that are defined by DEQ (2001). The TBDs selected for this ERA, and the process to convert TBDs to ERfDs, will be described in the ERA report.

The principal data sources for TBDs will be:

- EPA's Ecological Soil Screening Level reports (EPA 2003)
- Summary reviews of available toxicity data (Sample et al. 1996; Oak Ridge National Laboratories' On-line Ecotoxicological Databases)
- Peer-reviewed literature sources (journal articles and scientific publications)
- EPA's IRIS
- Chemical-specific Toxicological Profiles produced by Agency for Toxic Substances and Disease Registry (ATSDR)
- The National Institute of Occupational Safety and Health Registry of Toxic Effects of Chemical substances (RTECS)

Oral dose studies will be the only sources used for the selection of TBDs. Some of the toxicity studies from these sources provide toxicity information in the form of a food or drinking water concentration (i.e., mg chemical/kg food or mg chemical/L water). In this case, the food or drinking water concentration will be transformed to a dose (mg chemical/kg body weight per day). This conversion requires knowledge of the amount of food eaten per day by the test species and its body weight. Preferably, this information was obtained from the text in which the toxicity information was found. However, such information was not always provided. In this event, daily food ingestion rates and body weights for the test species will be obtained from other sources (e.g., EPA 1988, 1993, or Dunning 1993) and used to convert the chemical content of a food item into a TBD. For this conversion, it will be assumed that the effective dose of a chemical is 100 percent of the ingested dose (i.e., 100 percent bioavailability was assumed). When possible, mean ingestion rate or body weight values will be used or calculated, but discrete values will be used in the absence of a mean or the data to calculate one. An attempt also will be made to only use ingestion rate and body weight parameters for the same species as used in the pertinent toxicity study, but this is not always possible and parameters for similar species will be substituted as required.

When possible, a chronic NOAEL will be selected as the TBD for protected species and a LOAEL will be selected as the TBD for other species. In the absence of a LOAEL or NOAEL, a no-observed-effect-level (NOEL), lowest-observed-effect-level (LOEL), or other toxicity endpoint will be selected and converted to NOAELs or LOAELs using uncertainty factors. The actual effects threshold is likely to fall between the NOAEL or LOAEL, but these two values were substituted as the threshold

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doses for this ERA because most often it is not possible to predict the actual effects threshold from the available literature.

Data for chronic toxicity will be chosen when available, however, subchronic and/or acute data will be used if chronic data are unavailable, and converted to chronic data using uncertainty factors. If no TBD can be obtained or calculated for a particular chemical and/or indicator species and a TBD for a surrogate chemical cannot be applied, that contaminant will not be evaluated quantitatively for that species.

For many chemicals there will be several toxicity studies identified in various sources. Most often, the different studies investigated provide data regarding different toxicological endpoints. The process of selecting an appropriate TBD requires an assessment of the appropriateness of the various endpoints. In general, data indicative of overt health effects to individual organisms that results in population level effects will be preferred. These may include reproductive effects, survival, or mortality. Other less adverse effects endpoints, such as changes in organ weight or subtle physiological effects, will be used only in the absence of the preferred endpoints. Preference for particular endpoints will be established as follows.

- **Primary Significance** – Reproductive effects such as decreased fertility, teratogenicity, and developmental/fetal mortality, which could impact the species population; survival, which could impact population numbers in future generations; and severe histopathological effects such as necrosis of or serious damage to organs such as the liver, kidneys, brain/central nervous system, and lungs, which could impact primary body functions and result in mortality.

- **Secondary Significance** – Alterations in function of organs and/or behavior that could result in decreased survival.

- **Tertiary Significance** – Alterations such as decreased liver size, increased chemical concentration in blood, or increased body weight that are not readily associated with decreased reproduction, reduced survival, or increased mortality.

Carcinogenic endpoints are not considered appropriate for the selection of TBDs. This is in accordance with the current understanding that cancer is not generally considered to be a threat for free-ranging wildlife species because they are relatively short-lived and cancers do not have time to develop.

Chronic LOAELs will be selected as the TBDs for non-threatened or endangered species. The actual effects threshold is likely to fall between the NOAEL or LOAEL, but these two values will be substituted as the threshold doses for this ERA because most often it is not possible to predict the actual effects threshold from the available literature.

Because toxicity data are unavailable for many species, a body weight adjustment (Sample et al. 1996, Sample and Arenal 1999) will be made as necessary to extrapolate an ERfD for an assessment species when the ERfD is available for another species in the same taxonomic class. This body weight

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extrapolation will occur according to the appropriate body weight scaling equations provided by the EPA (1993).

$$ERfD_r = TBD_t \times (BW_t / BW_r)^P \qquad \text{(Equation 5-6)}$$

where:

$ERfD_r$	=	Ecological reference dose for the robin (mg/kg-bw per day)
TBD_t	=	Toxicity Benchmark Dose for the test species (mg/kg-bw per day)
BW_t	=	Body weight of the test species (kg)
BW_r	=	Body weight of the robin (kg)
P	=	Appropriate exponent for the assessment species (unitless; EPA 1993)

5.2.3 Ecological Target Cleanup Levels

The calculated species-specific ETCLs will be presented and the lowest ETCL for each chemical and medium will be compared to chemical concentrations at sample locations across the Terminal. The sample locations with COPEC concentrations greater than the lowest ETCL will be described.

5.2.4 Hot Spots

The Oregon cleanup rules require the remedial investigation to evaluate hot spots of contamination. In soil, the acceptable hot spot concentration for exposure by ecological receptors to each individual substance is 10 times the acceptable risk level, or where COPECs are reasonably likely to migrate such that a hot spot would be created in another medium, or when COPECs are not reliably able to be contained. Sample locations that have COPEC concentrations that exceed these criteria will be described as hot spots.

5.2.5 Risk Characterization

The risk characterization will be used to present and discuss uncertainties associated with the predicted ecological risks and hot spot locations. The impact of the uncertainties on the predicted risks will be described and the likelihood of the predicted risks being realized will be discussed.

5.2.6 Level II Conclusions and Recommendations

If a Level II species-specific ERA is completed, the evaluation and its conclusions will be provided in a report to be submitted to DEQ, as described in Section 6.0. The calculated ETCLs could then be used to develop conservative remedial actions that would be protective of ecological receptors.

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5.3 LEVEL III ECOLOGICAL RISK ASSESSMENT

In accordance with DEQ (2001) guidance, if the Level III ERA is completed, it would include problem formulation, exposure assessment, toxicity assessment, and risk characterization. The problem formulation completed during the Level II COPEC screening would be incorporated into the Level III ERA with updates, as necessary given any additional information acquired during the Level III assessment. The following sections describe the procedures to be used for the exposure assessment, toxicity assessment, and risk characterization.

5.3.1 LEVEL III EXPOSURE ASSESSMENT

The exposure assessment includes mathematically expressing the methods for quantifying exposure of assessment species (i.e., site-specific exposure models), definition of the local populations of assessment communities and species, determination of exposure areas and/or habitat patches for each assessment species, definition of the relative habitat quality for each habitat patch, calculation of EPCs for exposure areas and/or habitat patches, and presentation of the exposure parameters. The EPCs and exposure parameters are then used within the exposure models to calculate the EDD of COPECs for each of the indicator species.

5.3.1.1 Exposure Dose Equations

The exposure media, indicator species, and significant exposure pathways selected during the problem formulation will be used to create the exposure models (i.e., equations) to calculate an estimated daily intake of the COPECs for each indicator species. Exposure models generally are not developed for indicator communities because potential risks to communities are assessed by direct comparison of EPCs in each medium to ERBSCs. For assessment species, an ingestion rate and body weight are included in the equation, resulting in calculation of an exposure dose, as follows:

Equation 6-7

$$D_j = \sum_{i=1}^{d}\sum_{k=1}^{q}\left[\left(\frac{IR_i \times C_{jk}}{BW}\right)\times\left(\frac{Ha_k Hq_k}{\sum_{k=1}^{q}(Ha_k Hq_k)}\right)\right]\times TUF$$

where:

D_j = Dose for a given assessment species for the jth contaminant (mg/kg body weight [bw] per day)

q = Total number of kth habitat patches within local population boundary (unitless)

d = Total number of ith media (unitless)

IR_i = Intake rate for the ith medium (kg/d or L/d)

C_{ijk} = Concentration of jth contaminant in i^{th} medium in k^{th} habitat patch (mg COPEC/kg)

BW = Body weight of the assessment species (kg)

Ha_k = Area of kth habitat patch (square meters)

Hq_k = Relative habitat quality of kth habitat patch for a given assessment species (unitless)

TUF = Temporal utilization factor (unitless).

Ingestion rates and body weights for each assessment species (i.e., species-specific exposure parameters), COPEC concentrations in each media (including prey items), local population boundaries, habitat patch size and quality, and species specific temporal use factors must be determined to support these calculations. These procedures are defined in the following sections.

5.3.1.2 Exposure Parameters

Exposure parameters are species-specific and chemical-specific measures that determine the extent of exposure for the assessment communities and species. These parameters will be the same as described above for the Level II ETCL calculation.

5.3.1.3 Exposure Point Concentrations

The EPCs for COPECs in surface soil will be the 90 percent UCL, and will be used to calculate exposure of the assessment species to COPECs. If particular exposure areas, habitat patches, or groups of habitat patches (for a given species) include a subset of all samples that were used to calculate EPCs for the Level II COPEC screening assessment, then the appropriate subset of samples will be used to re-calculate a 90 percent UCL for the particular exposure area or habitat patch(es). The same methodology as used in the Level II COPEC screening will be employed to calculate these more specific EPCs.

5.3.1.4 Local Receptor Population Boundaries

Establishing local population boundaries for assessment communities and species limits the number of individuals considered in the ERA to those likely to be exposed to site-related contamination. For sessile assessment communities (i.e., plants and terrestrial invertebrates), the local population will be all the individuals within habitat patches (determined as described in the next section). If habitat patches for these sessile receptors cannot be clearly defined, then the local population will be all individuals within areas where the receptors could be exposed to site-related COPECs.

For assessment species, the local population will include all individuals within five home-range diameters (D_{HR}) from the outer boundary of the area of site-related contamination. This will be approximated using the following equation from DEQ (2001):

$$A = \frac{100 \times HR}{\pi} \qquad \text{Equation 5-8}$$

where:

A = Areal extent of the study population (m^2)
HR = Home range area (m^2)
π = Pi (3.14)

Actual residency of transient or migratory species within the local population boundaries may be adjusted using the temporal utilization factor as described in Section 5.3.1.6 below.

5.3.1.5 Determination of Habitat Patches

Following determination of the areal extent of the study populations, the number, size, and quality of habitat patches will be determined within the local population boundaries. The different habitat types present at the Terminal will be mapped and described. The expected use of these habitats by each assessment community and species will be described with regard to the extent of each habitat (or habitats) likely to be inhabited. These areas will become the habitat patches for each receptor. Then the spatial extent of each species' habitat patch(es) will be estimated. The relative quality of the habitat patches used by each assessment community and species will also be rated as unsuitable (0), poor (0.25), average (0.5), good (0.75), or excellent (1.0) based on site surveys, professional judgment, and species requirements. The number, area, and quality of habitat patches are all factors within equation 5-7 above.

5.3.1.6 Temporal Use Factors

Some of the assessment species are expected to be transient or migratory. These species travel from place to place and are not exposed throughout the year to site-related contamination at the Terminal. For these species, a temporal use factor (TUF) will be applied to the exposure dose calculation to quantify the number of days per year the species is expected to be exposed to contaminated media at the site. Non-hibernating, non-migratory species will have a TUF of 1. Other species will have a TUF between 0 and 1.

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5.3.2 TOXICITY ASSESSMENT

The ecological toxicity assessment will provide estimates of the ERfD of each COPEC. This is the concentration, above which significant effects would be expected for the assessment species. TBDs will be selected from the literature and converted to species-specific doses (ERfDs) using uncertainty factors. The sources for the TBDs may include:

- Oak Ridge National Laboratory (Sample et al. 1996)
- ATSDR toxicity profiles
- USFWS synoptic reviews of hazards to fish, wildlife, and invertebrates
- EPA's IRIS database
- RTECS, a National Institute of Occupational Safety and Health on-line database
- Health and Safety Databank, a National Library of Medicine on-line database
- Oil and Hazardous Materials/Technical Assistance Data System (OHM/TADS), an EPA on-line database
- The Michigan Department of Natural Resources' Chemical Evaluation Search and Retrieval System (CESARS)
- Other peer-reviewed technical publications.

The toxicity endpoint for assessment species will be the lethal dose for 50 percent of the population (LD_{50}). When such values are not available, different effects levels such as NOAELs or LOAELs will be used, as available, and converted to preferred toxicity benchmark values using uncertainty factors (UFs). When more than one UF is necessary for a particular TBD, UFs will be multiplied together or applied in sequence. The UFs for converting effects levels and their application (DEQ 2001) include:

- NOAEL to LOAEL: UF = 5
- Subchronic to Chronic: UF = 10
- Acute to Chronic: UF = 33
- Chronic NOAEL to LD_{50}= 100

Data for species of the same family, order, genus, or species will be preferentially selected when available. If this is not possible, toxicity data for species within the same taxonomic class will be used and extrapolated to the assessment communities and species using uncertainty factors. No extrapolations between taxonomic classes (e.g., from birds to mammals) will be performed. The uncertainty factors will

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be applied to calculate TBDs that are considered equivalent to chronic lethal concentration for 50 percent of the population (LC_{50}) or LD_{50} values. Taxonomic extrapolations will be performed as follows:

- Different taxonomic family: UF = 2
- Different taxonomic genus: UF = 2.

The concentrations and doses of COPECs that result following application of the uncertainty factors will be the ecological reference concentrations (ERfCs) and ERfDs used in the risk calculations.

Within certain classes of chemicals (e.g., butylbenzenes, PAHs, and pesticides), toxicity values for one COPEC (i.e., surrogate chemicals) may be substituted for another COPEC when a chemical-specific toxicity value is not available for the latter COPEC. All surrogate chemical substitutions will be noted within the Level III baseline ERA report, as described in Section 6.0.

5.3.3 RISK CHARACTERIZATION

Risk characterization involves calculation, presentation, and description of the potential risks for the assessment communities and species. The risk characterization also includes discussion of the uncertainties associated with the predicted risks and of the potential for the predicted risks to represent significant population level effects at the site.

5.3.3.1 Risk Estimation

The acceptable risk level (ARL) for populations of ecological receptors is a 10 percent chance, or less, that 20 percent or more of the total local population would have an exposure greater than the ERfC or ERfD for each COPEC. Risk estimation will involve the following:

- Estimating the local population abundance of the assessment communities and species
- Estimating the probability that an individual of an endpoint species will experience an exposure in excess of the ERfC or ERfD
- Using a cumulative binomial distribution function to estimate the number of individuals likely to have a greater than 10 percent chance of being exposed at a concentration greater than the ERfC for assessment communities or the ERfD for assessment species
- Determining whether the number of exposed individuals is greater than 20 percent of the local population.

If fewer than 20 percent of the individuals within the local population of each assessment community and species are predicted to be exposed, or if there is less than a 10 percent chance of exposure above the ERfC or ERfD, then acceptable risks exist at the site.

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5.3.3.2 Local Population Abundance

The local population includes all individuals within the local population boundary and will be determined using population density estimates. These estimates will be obtained from available literature or local biologists. For assessment communities, the density of expected dominant species within each community will be used. If reliable population density estimates cannot be obtained from these sources, onsite surveys may be conducted for the assessment communities. For assessment species, if site-specific density estimates are not available, then scaling relationships will be used to estimate population density based on the species body mass (Damuth 1993; Juanes 1986).

5.3.3.3 Probability of Exposure Exceeding Toxicity Reference Values

The probability of exposure exceeding the ERfC or ERfD will be estimated using the following equation:

$$p = \phi_Z\left(\frac{x_{EXP} - \ln(EBV)}{s_{EXP}}\right) \qquad \text{Equation 5-9}$$

where:

- P = Probability of exposure (unitless)
- ϕ_Z = Cumulative distribution function of a standard normal random variable
- x_{exp} = Mean of natural logarithms of exposure (mg/kg, mg/L, or mg/kg per day)
- EBV= Point value of the calculated exposure (mg/kg, mg/L, or mg/kg per day)
- s_{exp} = Standard deviation of natural logarithms of exposure (unitless).

5.3.3.4 Acceptability of Risk

The probability that 20 percent of the individuals in a population experience an exposure greater than a toxicity reference value will be determined using the following binomial probability function:

$$b(y,n,p) = \binom{n}{y} p^y (1-p)^{n-y} \qquad \text{Equation 5-10}$$

where:

- b = Probability of 20 percent of the individuals in a population experiencing an exposure greater than the toxicity reference value
- y = 20 percent of the population

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n = The number of individuals in the local population

p = Probability of an individual experiencing an exposure greater than the toxicity reference value.

As noted above, this probability will be used to determine whether the exposure of assessment communities and species meets the ARL.

5.3.4 UNCERTAINTY ANALYSIS

An uncertainty analysis will be conducted for the baseline ERA to examine the sources and magnitude(s) of potential uncertainty associated with the risk estimates. Sources of uncertainty include the data available for the site investigations, receptor population and exposure pathway identification, exposure parameter selection, and toxicity criteria used to characterize risk. Each of these potential sources of uncertainty will be evaluated qualitatively to determine the likely degree of uncertainty associated with the risk estimates, and whether the uncertainty has likely led to over- or under-estimates of risk.

5.3.5 PREDICTED ECOLOGICAL RISKS

The effects of the uncertainties on predicted ecological risks will be described to determine whether the risk estimates need adjustment given the uncertainties. In this manner, a better understanding is provided regarding the likelihood of the predicted effects being realized in local receptor populations.

5.3.6 LEVEL III ECOLOGICAL TARGET CLEANUP LEVELS

Media-specific ETCLs will be calculated for each of the final COPECs that contribute a majority of the predicted ecological risks. Finally, to the extent possible given the sampling design, the areal extent of chemical concentrations that exceed ETCLs will be plotted to aid in the determination of any remedial action at the site.

5.3.7 LEVEL III CONCLUSIONS AND RECOMMENDATIONS

The primary goals of the baseline ERA are to document whether a potential exists for significant ecological risk at the site and to determine ETCLs. The risks will be summarized and discussed in the context of the assessment endpoints identified during completion of the problem formulation in a Level III baseline ERA report, as described in Section 6.0.

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6.0 RISK ASSESSMENT DELIVERABLES

The deliverables to be submitted to DEQ for review and comment for the human health and ecological risk assessments are described in the following sections. It is anticipated that the risk assessment reporting will be completed in 2006.

6.1 BASELINE HUMAN HEALTH RISK ASSESSMENT REPORT

The baseline HHRA report will include identification of COPCs and the results of EPC calculation for human receptors, as well as provide the results of the exposure assessment, dose-response assessment, risk characterization, and uncertainty analysis. The results of the baseline HHRA will be used to define acceptable risk levels for human receptors for development of remedial alternatives for the Terminal, as part of the feasibility study.

6.2 LEVEL II ECOLOGICAL RISK ASSESSMENT – SCREENING ASSESSMENT REPORT

The Level II ERA – Screening Assessment Report will include identification of COPECs and exposure pathways for ecological receptors, an ecological description of the site, as well as the uncertainties associated with each identified risk and the assumptions made in the assessment. This information will be used to make recommendations as to whether COPECs at the site pose a risk to ecological receptors and whether additional ecological assessment is required. Recommendations will include one of the following: 1) no further evaluation, 2) performance of a Level II species-specific individual-level ERA, or 3) performance of a baseline ERA.

6.3 LEVEL II SPECIES-SPECIFIC ECOLOGICAL RISK ASSESSMENT

If completed, the Level II species-specific ERA report will provide the results of the Level II species-specific exposure assessment, toxicity assessment, and risk characterization, as well as EPCs, assumptions used in the ERA, and uncertainties associated with the assessment. The Level II ETCLs will also be reported to allow development of conservative remedial alternatives for protection of ecological receptors.

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6.4 LEVEL III BASELINE ECOLOGICAL RISK ASSESSMENT (IF REQUIRED)

The Level III baseline ERA report will provide the results of the Level III ERA baseline exposure assessment, toxicity assessment, and risk characterization, as well as EPC values, assumptions used in the evaluations, and the uncertainties analysis. The report will also provide a description of which, if any, COPECs are likely to require remediation for the protection of ecological receptors.

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7.0 USE OF THIS REPORT

This risk assessment work plan has been prepared by Landau Associates for the exclusive use of Time Oil Co. for specific application to the Northwest Terminal. Services for this project were conducted in accordance with the Environmental Services Contract between Time Oil Co. and Landau Associates, Inc. Landau Associates has performed our services in accordance with generally accepted engineering and consulting standards for environmental work in effect at the time and locality services were performed. The reuse of information, conclusions, and recommendations provided herein by Time Oil Co. or others in connection with any site other than the Northwest Terminal without Landau Associates written permission shall be at the sole risk of Time Oil Co. and without liability to Landau Associates.

This document was prepared under the supervision and direction of the following key staff.

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8.0 REFERENCES

CH2M Hill. 1999. *Biological Assessment, Ross Island Sand & Gravel Company Removal/Fill Permit Renewal.* Prepared for the U.S. Army Corps of Engineers, Portland District. November.

Damuth, J. 1993. Cope's rule, the island rule, and scaling of mammalian population density. *Nature.* 365:748-750.

DEQ. 1999. *Portland Harbor Sediment Management Plan: Appendix G.* Oregon Department of Environmental Quality.

DEQ. 2000. *Guidance for the Conduct of Deterministic Human Health Risk Assessments.* Oregon Department of Environmental Quality, Waste Management & Cleanup Division, Cleanup Policy & Program Development Section. May.

DEQ. 2001. *Guidance for Ecological Risk Assessment.* Oregon Department of Environmental Quality, Waste Management and Cleanup Division, Cleanup Policy and Program Development Section. Portland, Oregon. Final. April 1998. Updated. November 2001.

DEQ. 2003. *Risk-Based Decision Making for the Remediation of Petroleum-Contaminated Sites.* Oregon Department of Environmental Quality, Land Quality Division, Environmental Cleanup and Tanks Program. September 22.

DEQ and EPA. 2005. Portland Harbor Joint Source Control Strategy. Interim Final. Oregon Department of Environmental Quality and U.S. Environmental Protection Agency. September.

DMHSPE. 2001. *Technical Evaluation of the Intervention Values for Soil/Sediment and Groundwater, Human and Ecotoxicological Risk Assessment and Derivation of Risk Limits for Soil, Aquatic Sediment and Groundwater.* Dutch Ministry of Housing Special Development Planning and the Environment, Bilthoven, The Netherlands. RIVM Report 711701023. February.

Dunning, J.B., Jr. 1993. *CRC Handbook of Avian Body Masses.* CRC Press, Boca Raton, Florida.

EPA. 1989. *Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part A).* EPA/540/1-89/002. United States Environmental Protection Agency, Office of Emergency and Remedial Response, Washington DC.

EPA. 1993. *Wildlife Exposure Factors Handbook. Volumes I and II.* U.S. Environmental Protection Agency, Office of Research and Development. Washington, DC. EPA/600/R-93/187a. December.

EPA. 1998. *Final Guidelines for Ecological Risk Assessment.* U.S. Environmental Protection Agency, Risk Assessment Forum. Washington, DC. EPA/630/R 95/002F. April.

EPA. 2002. *EPA Region 9 Preliminary Remediation Goals.* Online document available at URL: http://www.epa.gov/region09/waste/sfund/prg/whatsnew.htm. October 1.

EPA. 2003. *Ecological Soil Screening Level Guidance.* Office of Solid Waste and Emergency Response U.S. Environmental Protection Agency. Washington D.C. November.

EPA. 2004. *Integrated Risk Information System.* Online searchable database available at URL: http://www.epa.gov/iris/. Frequent updates.

Integral Consulting, Inc., and Groundwater Solutions, Inc. 2004. *Draft Conceptual Model Update, Portland Harbor Superfund Project.* Prepared for the Lower Willamette Group. September 17.

Juanes, F. 1986. Population density and body size in birds. *American Naturalist.* 128:921-929.

Landau Associates. 1993. *Site Characterization Report, Former PCP Mixing Area, Northwest Terminal Facility.* August 30.

Landau Associates. 1997. *Phase I Remedial Investigation Report, Time Oil Northwest Terminal.* April 25.

Landau Associates. 1999. *Phase I and II Constituents of Potential Concern Screening Report, Time Oil Northwest Terminal.* September 10.

Landau Associates. 2001. *Phase II Remedial Investigation Report, Time Oil Northwest Terminal, Portland, Oregon. Vol. I and II.* February 9.

Landau Associates. 2003. *Removal Actions Completion Report, Phases I/II RI Areas, Time Oil Northwest Terminal, Portland, Oregon.* November 10.

Landau Associates. 2004. *Draft Phase III Remedial Investigation Report, Time Oil Northwest Terminal, Portland, Oregon. Vol. I and II.* April 30.

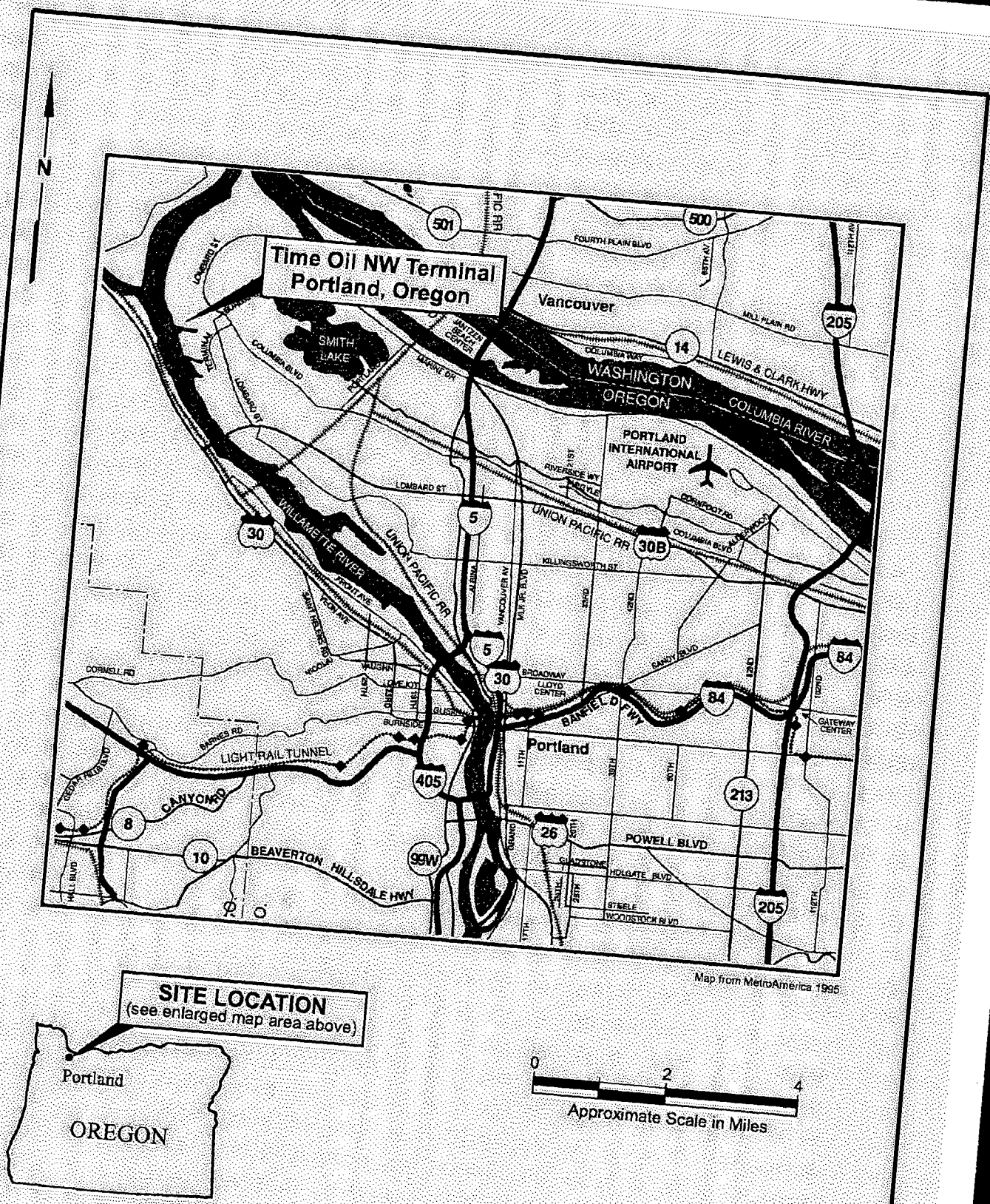
Landau Associates. 2005. *Phase III Remedial Investigation Report,* Time Oil Northwest Terminal, Portland, Oregon. Volumes I (report) and II (appendices). Prepared for Time Oil Co., Seattle, Washington. July 19.

Menzie, C.A., D.E. Burmaster, J.S. Freshman, and C.A. Callahan. 1992. "Assessment of Methods for Estimating Ecological Risk in the Terrestrial Component: A Case Study at the Baird and McGuire Superfund Site in Holbrook, Massachusetts." *Environ. Toxicol. Chem.* 11:245-260.

Sample, B.E. and C.A. Arenal. 1999. Allometric Models for Interspecies Extrapolation of Wildlife Toxicity Data. Bull. Environ. Contam. Toxicol. 62:653-663.

Sample, B.E., J.J. Beauchamp, R.A. Efroymson, G.W. Suter II. 1998. *Development and Validation of Bioaccumulation Models for Small Mammals.* Lockheed Martin Energy Systems, Inc., Oak Ridge National Laboratory. Oak Ridge, Tennessee. ES/ER/TM-219. February.

Sample, B.E., D.M. Opresko, and G.W. Suter II. 1996. *Toxicological Benchmarks for Wildlife: 1996 Revision.* Risk Assessment Program, Health Sciences Research Division. Oak Ridge, Tennessee. ES/ER/TM 86/R3. June.



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Time Oil NW Terminal Portland, Oregon	Vicinity Map	Figure 1

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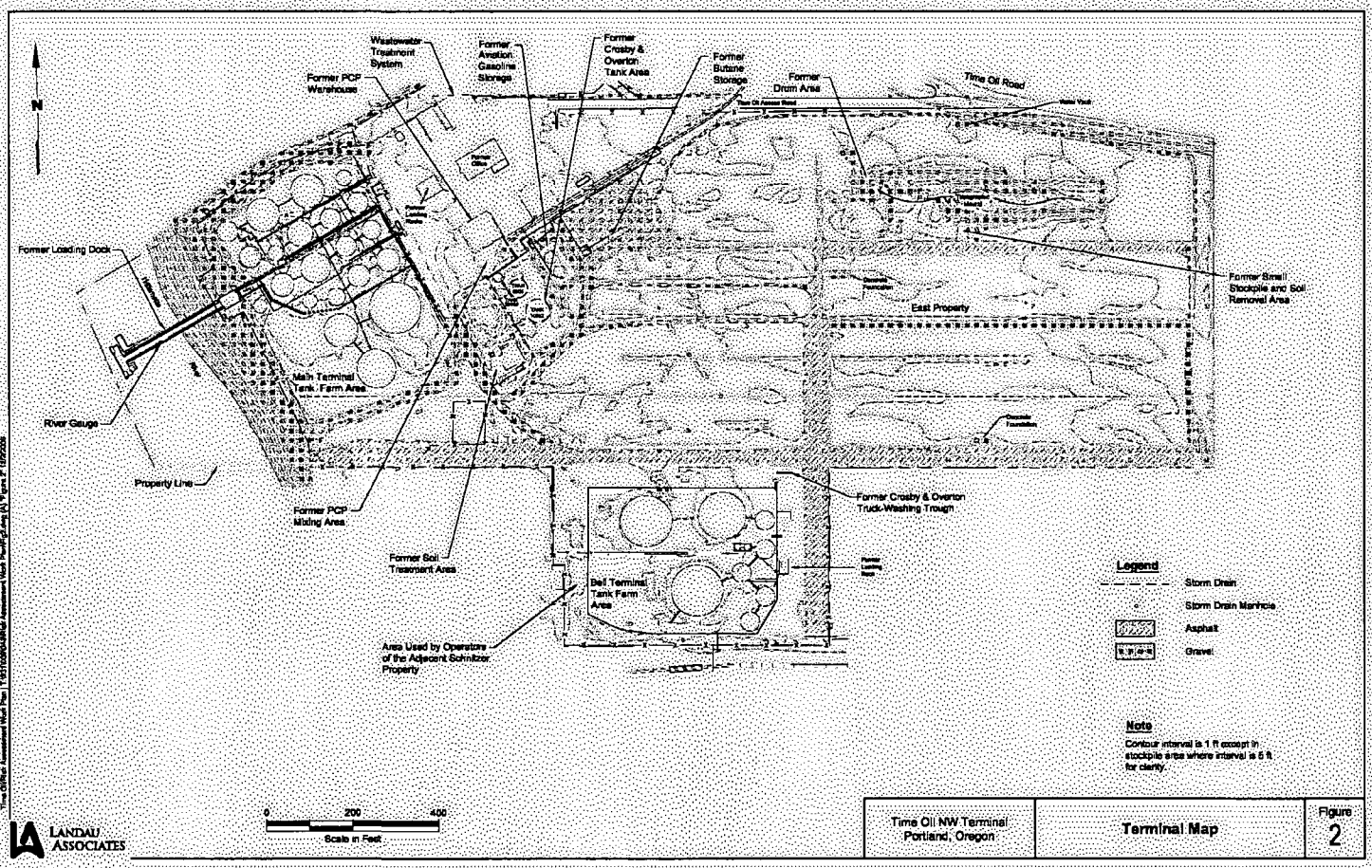

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Time Oil NW Terminal Portland, Oregon	Terminal Map	Figure 2

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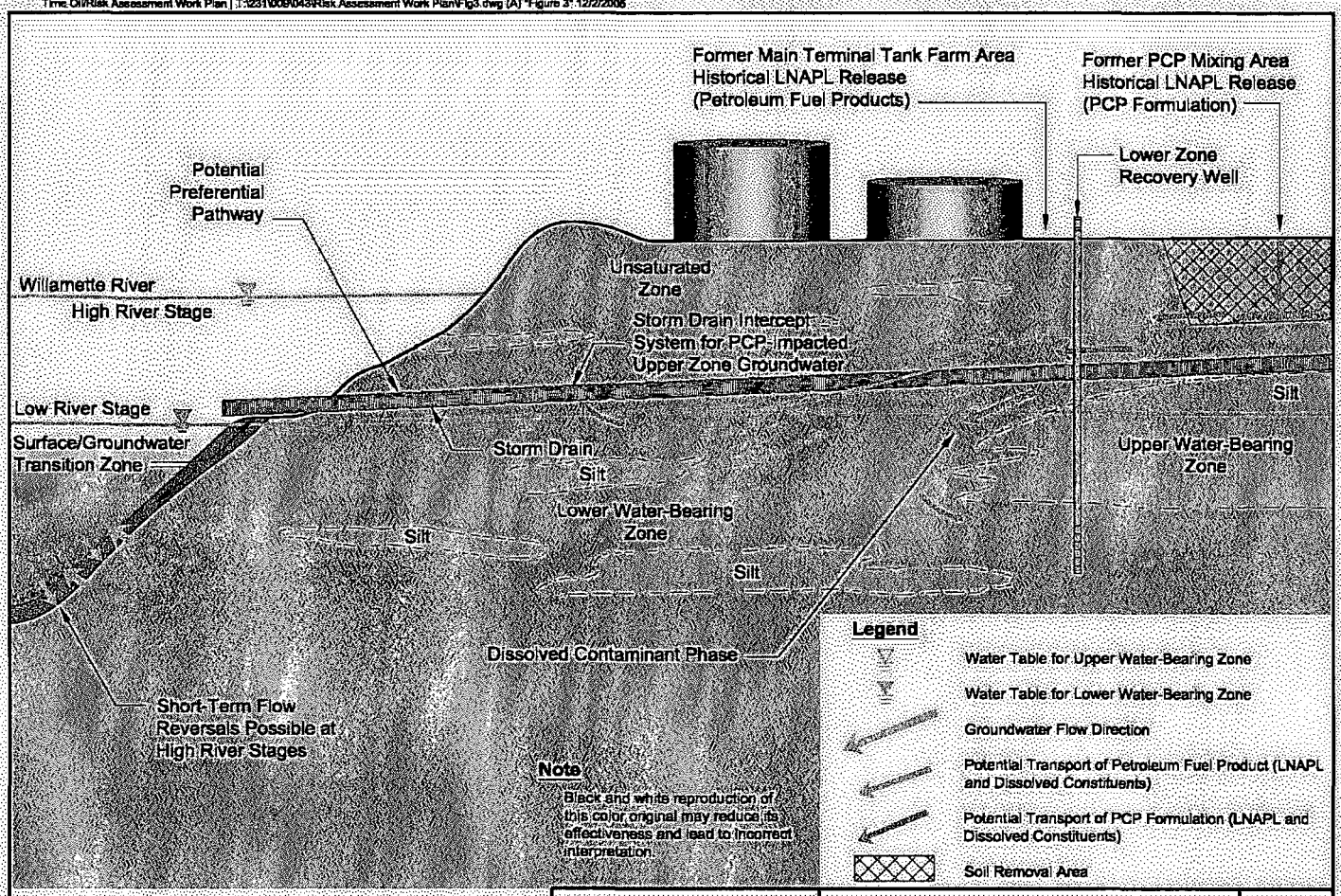

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Not to Scale	Time Oil NW Terminal Portland, Oregon	Conceptual Site Model	Figure 3

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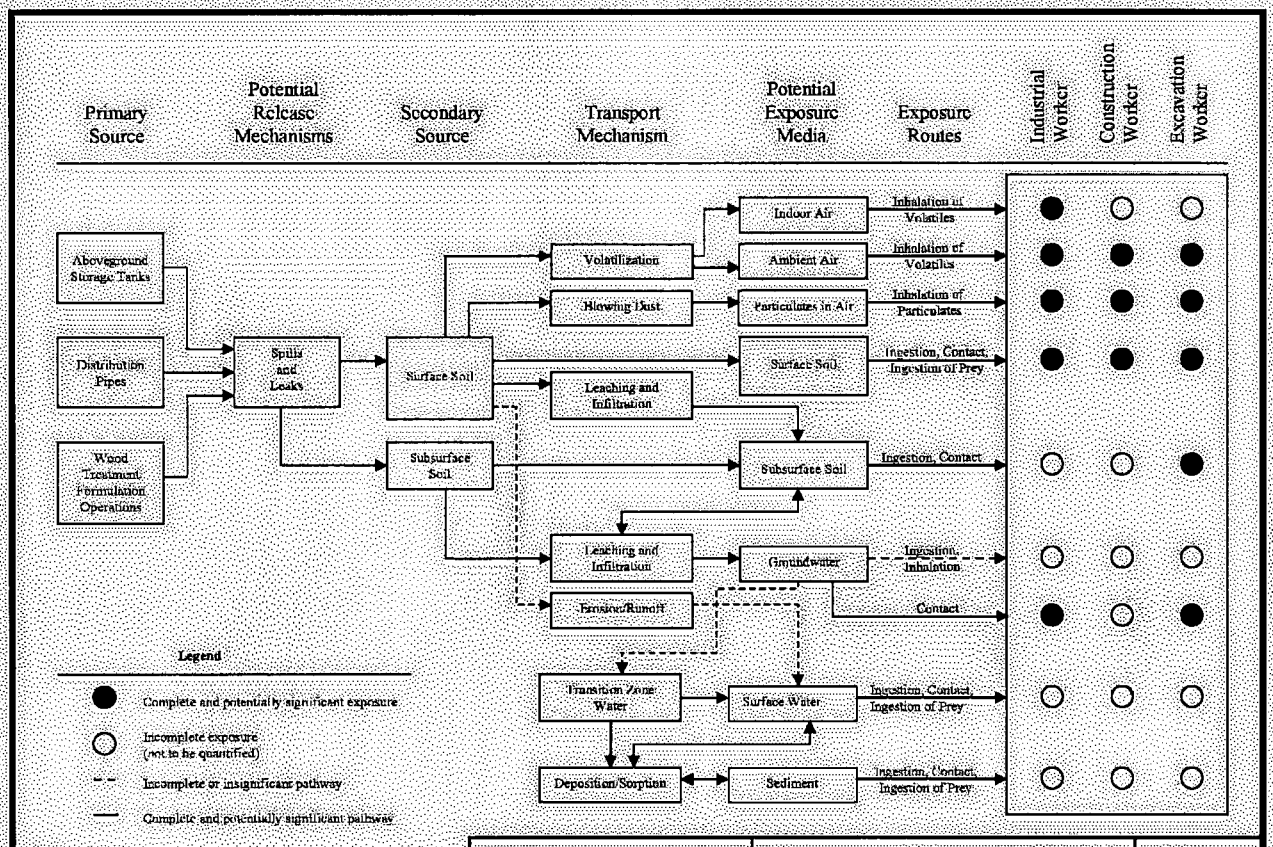

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Time Oil NW Terminal
Portland, Oregon

Conceptual Exposure Model for Human Risk

Figure 4

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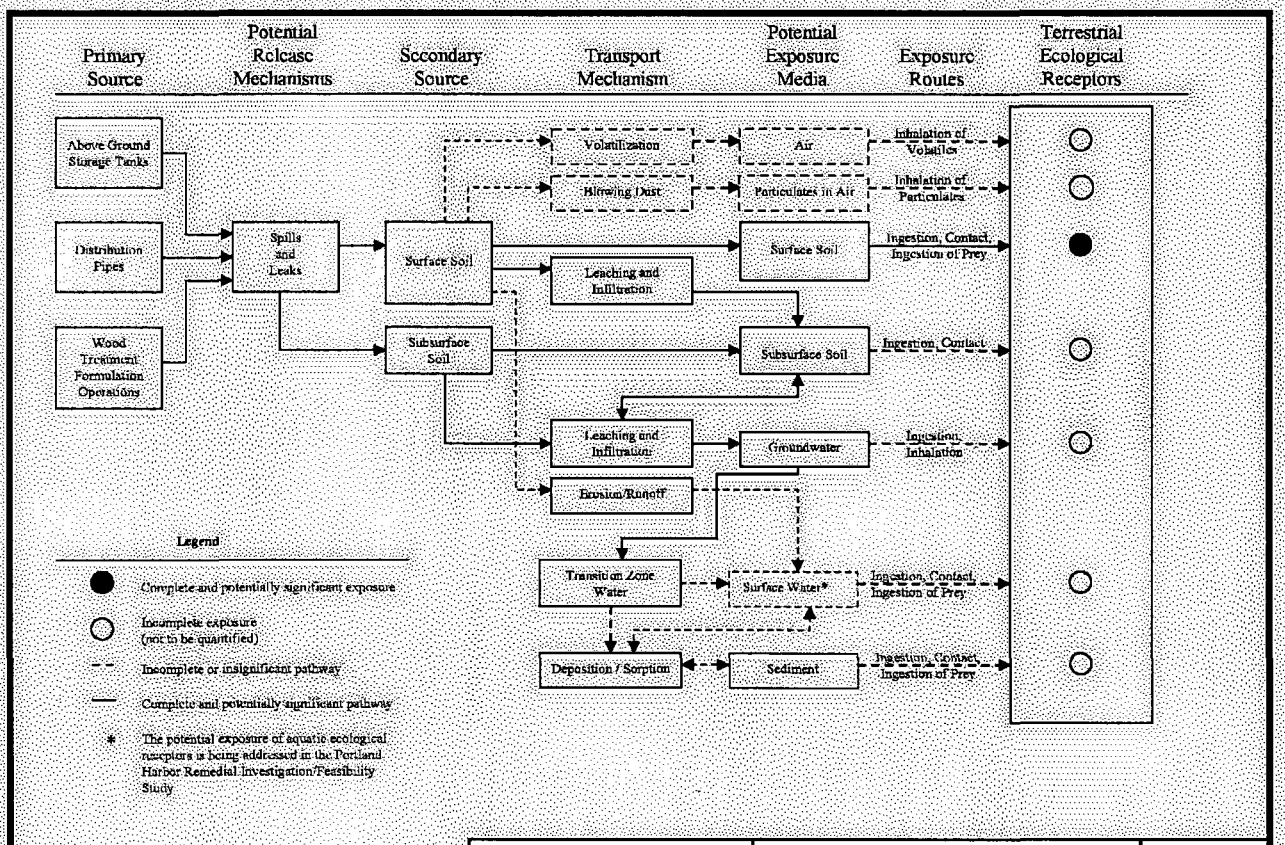

Time Oil NW Terminal
Portland, Oregon

Conceptual Exposure Model for Ecological Risk

Figure 5

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Contaminant Concentration in Air

$$C_a = C_w \cdot VF_{wo} \cdot F_w$$

Volatilization Factor

$$VF_{wo} = \frac{D_T eff \cdot H \cdot \left(10^3 \frac{g}{kg}\right) \cdot \left(10^3 \frac{L}{m^3}\right)}{(Q/C) \cdot L_w \cdot \left(10^2 \frac{cm}{m}\right)}$$

Diffusion Coefficients

$$D_T eff = \frac{L_w}{\left(\frac{L_v}{D_v eff}\right) + \left(\frac{L_{cap}}{D_{cap} eff}\right)}$$

$$D_v eff = \frac{D_{air} \cdot n_a^{10/3} \cdot H + D_w \cdot n_w^{10/3}}{H \cdot n^2}$$

$$D_{cap} eff = \frac{D_{air} \cdot n_{acap}^{10/3} \cdot H + D_w \cdot n_{wcap}^{10/3}}{H \cdot n^2}$$

Where:

C_a	=	Contaminant concentration in air (mg/m^3)
C_w	=	Contaminant concentration in water (mg/L)
VF_{wo}	=	Volatilization factor for groundwater to ambient air pathway (L/m^3)
$D_T eff$	=	Total effective diffusion coefficient (cm^2/s)
H	=	Henry's Law constant (unitless)
Q/C	=	Inverse of mean concentration at center of source area (g/m^2-s / kg/m^3)
L_w	=	Depth to groundwater (cm)
L_v	=	Thickness of vadose zone (cm)
L_{cap}	=	Thickness of capillary fringe (cm)
$D_v eff$	=	Effective diffusion coefficient of vadose zone (cm^2/s)
$D_{cap} eff$	=	Effective diffusion coefficient of capillary fringe (cm^2/s)
D_{air}	=	Diffusion coefficient in air (cm^2/s)
D_w	=	Diffusion coefficient in water (cm^2/s)
n	=	Total soil porosity (unitless)
n_a	=	Air-filled porosity (unitless)
n_w	=	Water-filled porosity (unitless)
n_{acap}	=	Air-filled porosity in capillary fringe (unitless)
n_{wcap}	=	Water-filled porosity in capillary fringe (unitless)

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Time Oil NW Terminal Portland, Oregon	**Diffusion/Flux Model – Upper Zone Groundwater to Ambient Air**	Figure 6

Contaminant Concentration in Air

$$C_a = C_w \cdot VF_{wi}$$

Volatilization Factor

$$VF_{wi} = \frac{H \cdot \left[\dfrac{D_T eff \cdot \left(86400 \dfrac{s}{d}\right)}{L_B \cdot ER \cdot L_w}\right] \cdot \left(10^3 \dfrac{L}{m^3}\right)}{1 + \left[\dfrac{D_T eff \cdot \left(86400 \dfrac{s}{d}\right)}{L_B \cdot ER \cdot L_w}\right] + \left[\dfrac{D_T eff \cdot L_{crk}}{D_v eff \cdot L_w \cdot f_{crk}}\right]}$$

Diffusion Coefficients

$$D_T eff = \frac{L_w}{\left(\dfrac{L_v}{D_v eff}\right) + \left(\dfrac{L_{cap}}{D_{cap} eff}\right)}$$

$$D_v eff = \frac{D_{air} \cdot n_a^{10/3} \cdot H + D_w \cdot n_w^{10/3}}{H \cdot n^2}$$

$$D_{cap} eff = \frac{D_{air} \cdot n_{acap}^{10/3} \cdot H + D_w \cdot n_{wcap}^{10/3}}{H \cdot n^2}$$

Where:

C_a = Contaminant concentration in air (mg/m^3)
C_w = Contaminant concentration in water (mg/L)
VF_{wi} = Volatilization factor for groundwater to indoor air pathway (L/m^3)
$D_T$eff = Total effective diffusion coefficient (cm^2/s)
H = Henry's Law constant (unitless)
Q/C = Inverse of mean concentration at center of source area (g/m^2-s / kg/m^3)
L_w = Depth to groundwater (cm)
L_v = Thickness of vadose zone (cm)
L_{cap} = Thickness of capillary fringe (cm)
L_B = Height of building (cm)
L_{crk} = Thickness of foundation crack (cm)
f_{crk} = Fraction of foundation available for transport (unitless)
ER = Building air exchange rate (1/day)
$D_v$eff = Effective diffusion coefficient of vadose zone (cm^2/s)
D_{cap}eff = Effective diffusion coefficient of capillary fringe (cm^2/s)
D_{air} = Diffusion coefficient in air (cm^2/s)
D_w = Diffusion coefficient in water (cm^2/s)
n = Total soil porosity (unitless)
n_a = Air-filled porosity (unitless)
n_w = Water-filled porosity (unitless)
n_{acap} = Air-filled porosity in capillary fringe (unitless)
n_{wcap} = Water-filled porosity in capillary fringe (unitless)

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Time Oil NW Terminal Portland, Oregon	**Johnson-Ettinger Model – Upper Zone Groundwater to Indoor Air**	Figure 7

Carcinogens

$$ADD_{dc} = \frac{DA_{soil} \cdot SA \cdot EF_{evd} \cdot EF_{dy} \cdot ED}{BW \cdot AT_c}$$

Noncarcinogens

$$ADD_{dc} = \frac{DA_{soil} \cdot SA \cdot EF_{evd} \cdot EF_{dy} \cdot ED}{BW \cdot AT_n}$$

Dose Absorbed per Unit Area per Water Contact Event

$$DA_{soil} = C_s \cdot AF \cdot DAF \cdot CF_{km}$$

Where:

ADD_{dc} = Absorbed daily dose from contact with soil (mg/[kg·d])

DA_{soil} = Absorbed dose per soil contact event (mg/cm^2·event)

SA = Exposed skin surface area (cm^2)

EF_{evd} = Event frequency (events/d)

EF_{dy} = Exposure frequency (d/yr)

ED = Exposure duration (yr)

BW = Body weight (kg)

AT_c = Averaging time, carcinogens (d)

AT_n = Averaging time, noncarcinogens (d)

C_s = Contaminant concentration in soil (mg/kg)

AF = Soil-to-skin adherence factor (mg/cm^2·event)

DAF = Dermal absorption factor (unitless)

CF_{km} = Conversion factor (10^{-6} kg/mg)

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Time Oil NW Terminal Portland, Oregon	**Exposure Model – Dermal Contact with Soil**	Figure 8

Carcinogens

$$ADD_{si} = \frac{C_s \cdot IRS \cdot CF_{km} \cdot EF_{dy} \cdot ED}{BW \cdot AT_c}$$

Noncarcinogens

$$ADD_{si} = \frac{C_s \cdot IRS \cdot CF_{km} \cdot EF_{dy} \cdot ED}{BW \cdot AT_n}$$

Where:

ADD_{si} = Average daily dose from incidental soil ingestion (mg/[kg·d])
C_s = Contaminant concentration in soil (mg/kg)
IRS = Incidental soil ingestion rate (mg/d)
CF_{km} = Conversion factor (10^{-6} kg/mg)
EF_{dy} = Exposure frequency (d/yr)
ED = Exposure duration (yr)
BW = Body weight (kg)
AT_c = Averaging time, carcinogens (d)
AT_n = Averaging time, noncarcinogens (d)

[Source: DEQ 2000]

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Time Oil NW Terminal Portland, Oregon	**Exposure Model – Ingestion of Soil**	Figure 9

Carcinogens

$$ADD_{ip} = \frac{PM_{10} \cdot IRA \cdot \left(EF_{evd} \cdot t_{event} / CF_{hd}\right) \cdot EF_{dy} \cdot ED}{BW \cdot AT_c}$$

Noncarcinogens

$$ADD_{ip} = \frac{PM_{10} \cdot IRA \cdot \left(EF_{evd} \cdot t_{event} / CF_{hd}\right) \cdot EF_{dy} \cdot ED}{BW \cdot AT_n}$$

$$PM_{10} = \left(\frac{C_s}{PEF}\right) \cdot F_s$$

Where:

ADD_{ip} = Average daily dose from inhalation of particulates (mg/[kg·d])

PM_{10} = Concentration of respirable particulates in air (mg/m^3)

IRA = Inhalation rate (m^3/d)

EF_{evd} = Event frequency (events/d)

t_{event} = Exposure time (hr/event)

CF_{hd} = Conversion factor (24 hr/d)

EF_{dy} = Exposure frequency (d/yr)

ED = Exposure duration (yr)

BW = Body weight (kg)

AT_c = Averaging time, carcinogens (d)

AT_n = Averaging time, noncarcinogens (d)

C_s = Contaminant concentration in soil (mg/kg)

PEF = Particulate emission factor (1.32 x 10^9 m^3/kg)

F_s = Fraction of soil contaminated (unitless)

[Source: DEQ 2000]

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LANDAU ASSOCIATES

Time Oil NW Terminal Portland, Oregon	**Exposure Model – Inhalation of Soil Particulates**	Figure 10

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Carcinogens

$$ADD_{sd} = \frac{DA_{water} \cdot SA \cdot EF_{evd} \cdot EF_{dy} \cdot ED}{BW \cdot AT_c}$$

Noncarcinogens

$$ADD_{sd} = \frac{DA_{water} \cdot SA \cdot EF_{evd} \cdot EF_{dy} \cdot ED}{BW \cdot AT_n}$$

Dose Absorbed per Unit Area per Water Contact Event

$$DA_{water} = 2 \cdot K_p \cdot (C_w \cdot CF_{cl}) \cdot \sqrt{\frac{6 \cdot \tau \cdot t_{event}}{\pi}}, \text{ for } t_{event} < t^*$$

$$DA_{water} = K_p \cdot (C_w \cdot CF_{cl}) \cdot \left[\frac{t_{event}}{1+B} + 2\tau \cdot \left(\frac{1+3B}{1+B}\right)\right], \text{ for } t_{event} > t^*$$

Where:

ADD_{sd} = Absorbed daily dose from contact with water (mg/[kg·d])
DA_{water} = Dose absorbed per unit area per water contact event (mg/cm^2·event)
SA = Exposed skin surface area (cm^2)
EF_{evd} = Event frequency (events/d)
EF_{dy} = Exposure frequency (d/yr)
ED = Exposure duration (yr)
BW = Body weight (kg)
AT_c = Averaging time, carcinogens (d)
AT_n = Averaging time, noncarcinogens (d)
K_p = Dermal permeability coefficient (cm/hr)
C_w = Contaminant concentration in water (mg/L)
CF_{cl} = Conversion factor (10^{-3} L/cm^3)
τ = Lag time (hr/event)
t_{event} = Exposure time (hr/event)
t^* = Time to reach steady-state (hr)
B = Relative contribution of permeability coefficients (unitless)

[Source: DEQ 2000]

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LANDAU ASSOCIATES

Time Oil NW Terminal
Portland, Oregon

Exposure Model – Dermal Contact with Water

Figure 11

SCHN00304247

Carcinogens

$$ADD_a = \frac{C_a \cdot IRA \cdot (EF_{hd} / CF_{hd}) \cdot EF_{dy} \cdot ED}{BW \cdot AT_c}$$

Noncarcinogens

$$ADD_a = \frac{C_w \cdot IRA \cdot (EF_{hd} / CF_{hd}) \cdot EF_{dy} \cdot ED}{BW \cdot AT_n}$$

$$C_a = [C_w \cdot VF_w \cdot F_w]$$

Where:

ADD_a	=	Average daily dose from inhalation of ambient or indoor air (mg/[kg·d])
C_a	=	Contaminant concentration in air (mg/m^3)
IRA	=	Inhalation rate (m^3/d)
EF_{hd}	=	Exposure frequency (hr/d)
CF_{hd}	=	Conversion factor (24 hr/d)
EF_{dy}	=	Exposure frequency (d/yr)
ED	=	Exposure duration (yr)
BW	=	Body weight (kg)
AT_c	=	Averaging time, carcinogens (d)
C_w	=	Contaminant concentration in water (mg/L)
AT_n	=	Averaging time, noncarcinogens (d)
VF_w	=	Volatilization factor for water (L/m^3)
F_w	=	Fraction of water contaminated (unitless)

[Source: DEQ 2000]

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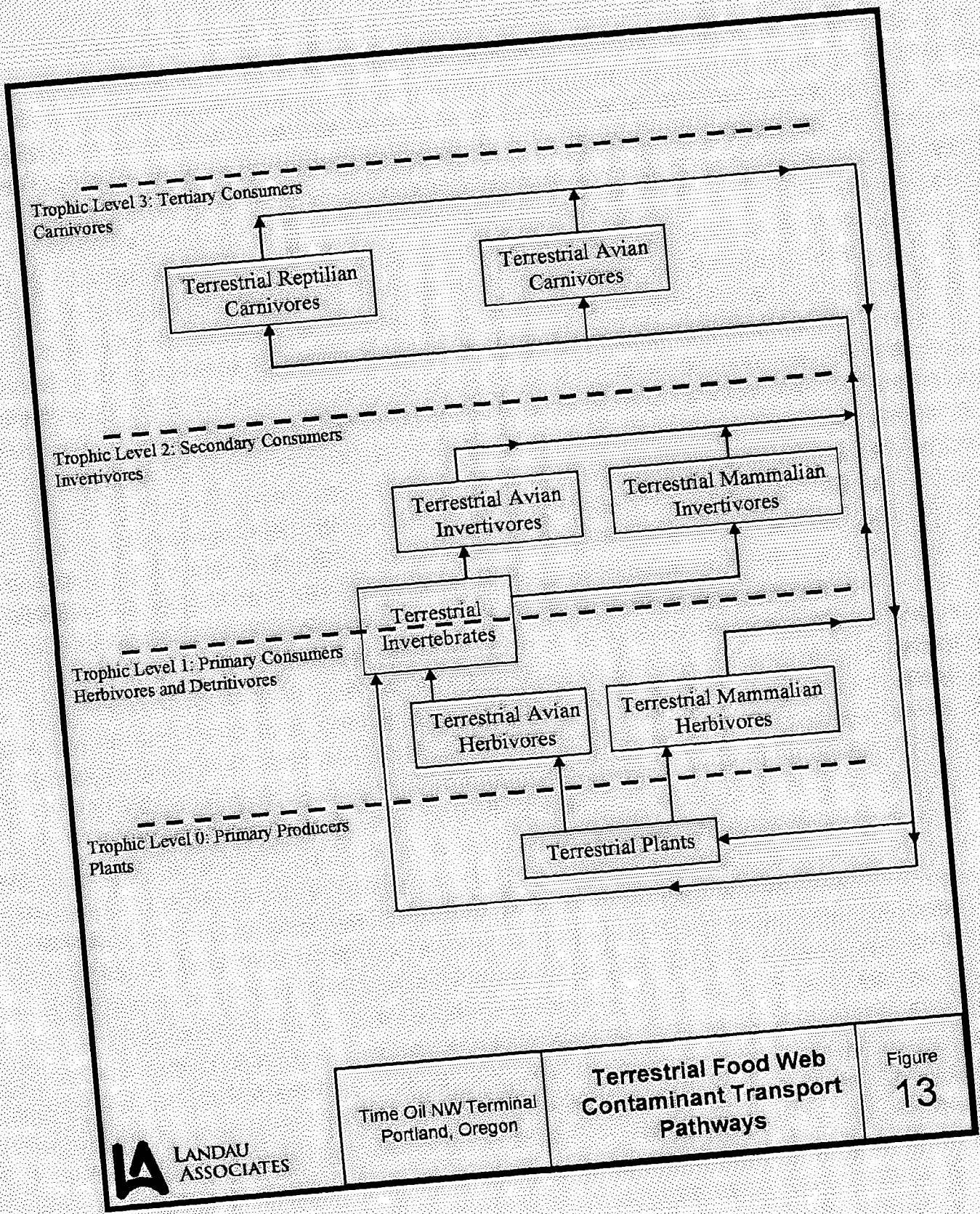
Time Oil NW Terminal Portland, Oregon	**Exposure Model – Inhalation of Ambient or Indoor Air**	Figure 12

SCHN00304248



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Time Oil NW Terminal
Portland, Oregon

Terrestrial Food Web Contaminant Transport Pathways

Figure 13

SCHN00304249

TABLE 1
HUMAN EXPOSURE FACTORS
TIME OIL NORTHWEST TERMINAL

Exposure Factor (Symbol)	Units	Industrial Worker Adult				Construction Worker Adult				Excavation Worker Adult			
		CTE		RME		CTE		RME		CTE		RME	
Body Weight (BW)	kg	70	(a)	70	(a)	70	(b)	70	(b)	70	(a)	70	(a)
Incidental soil/sed ingestion rate (IRS)	mg/d	50	(a)	100	(a)	100	(b)	480	(b)	100	(a)	480	(a)
Water ingestion rate (IRW)	L/d	–		–		–		–		–		–	
Exposed Surface Area (SA)													
Soil Contact	cm^2	3200	(a)	4100	(a)	3200	(b)	4100	(b)	3200	(a)	4100	(a)
Water	cm^2	3200	(c,d)	4100	(c,d)	5200	(b)	7000	(b)	5200	(a,e)	7000	(a,e)
Inhalation rate (IRA)	m^3/d	20	(f)	20	(f)	20	(b)	20	(b)	20	(f)	20	(f)
Soil/sed to skin adherence factor (AF_s)	mg/cm^2-even	0.08	(a)	0.08	(a)	0.3	(b)	1	(b)	0.3	(a)	1	(a)
Exposure frequency (EF_{hd})	hr/d	8	(h)	8	(h)	8	(h)	8	(h)	8	(h)	8	(h)
Exposure frequency (EF_d)	d/yr	250	(a)	250	(a)	250	(i)	250	(i)	9	(a)	9	(a)
Event frequency (EF_{evd})	events/d	1	(h)	1	(h)	2	(i)	2	(i)	2	(a)	2	(a)
Event time, water (t_{event})	hr/event	2	(d,h)	2	(d,h)	–		–		2	(a,e)	2	(a,e)
Event time, air (t_{event})	hr/event	8	(h)	8	(h)	8	(h)	8	(h)	8	(h)	8	(h)
Exposure duration (ED)	yr	6	(a)	25	(a)	0.5	(b)	1	(b)	0.5	(a)	1	(a)
Averaging time, carcinogens (AT_c)	d	25550	(a)	25550	(a)	25550	(b)	25550	(b)	25550	(a)	25550	(a)
Averaging time, noncarcinogens (AT_n)	d	2190	(a)	9125	(a)	180	(b)	365	(b)	180	(a)	365	(a)
Fraction of soil contaminated (F_s)	unitless	1	(a)	1	(a)	1	(b)	1	(b)	1	(a)	1	(a)
Fraction of water contaminated (F_w)	unitless	1	(a,d)	1	(a,d)	–		–		1	(a,e)	1	(a,e)
Dermal absorption factor (DAF)	unitless	chem-specific		chem-specific		chem-specific		chem-specific		chem-specific		chem-specific	
Dermal permeability coefficient (K_p)	cm/hr	chem-specific		chem-specific		chem-specific		chem-specific		chem-specific		chem-specific	
Lag time (τ)	hr/event	chem-specific		chem-specific		chem-specific		chem-specific		chem-specific		chem-specific	
Time to reach steady state (t^*)	hr	chem-specific		chem-specific		chem-specific		chem-specific		chem-specific		chem-specific	
Relative contribution of Ks (B)	unitless	chem-specific		chem-specific		chem-specific		chem-specific		chem-specific		chem-specific	
Particulate emission factor (PEF)	m^3/kg	1.32E+09	(a)	1.32E+09	(a)	1.32E+09	(a)	1.32E+09	(a)	1.32E+09	(a)	1.32E+09	(a)
Fraction of organic carbon in soil (f_{oc})	unitless	0.006	(a)	0.006	(a)	0.006	(a)	0.006	(a)	0.006	(a)	0.006	(a)

– Exposure factor not presented because the associated pathway is inapplicable or insignificant for the scenario shown.

(a) DEQ 2000, Guidance for Conduct of Deterministic Human Health Risk Assessments.
(b) Construction worker exposure factor assumed to be the same as that identified for excavation workers.
(c) Surface area for industrial worker exposure to process water assumed to include heads, hands, and forearms (DEQ 2000).
(d) Exposure to groundwater as process water only.
(e) Exposure to shallow groundwater only.
(f) DEQ 2002, recommendation in letter date October 7, 2002 regarding the risk assessment approach.
(h) Based on best professional judgment.
(i) DEQ 2003, Risk-Based Decision Making for the Remediation of Petroleum-Contaminated Sites.

TABLE 2
POTENTIAL TERRESTRIAL ECOLOGICAL RECEPTORS
TIME OIL NORTHWEST TERMINAL

Common Name	Scientific Name	Common Name	Scientific Name	Common Name	Scientific Name
Plants					
Abronia	*Abronia sp.*	European Teasel	*Dipsacus fullonum*	Heartweed	*Polygonum persicaria*
Vine Maple	*Acer circinatum*	Fireweed	*Epilobium augustifolium*	Fern	*Polypodium sp.*
Big Leaf Maple	*Acer macrophyllum*	Watson's willow-herb	*Epilobium watsonii*	Sword-fern	*Polystichum munitum*
Cultivated Maple	*Acer sp.*	Horsetail	*Equisetum telmateia*	Black Cottonwood	*Populus trichocarpa*
Bentgrass	*Agrostis sp.*	Thyme-leaf Spurge	*Euphorbia serpyllifolia*	Cottonwood (tree/seedling)	*Populus trichocarpa*
Tumbleweed Amaranth	*Amaranthus graecizans*	Oregon Ash	*Fraxinus latifolia*	Oak	*Quercus sp.*
Serviceberry	*Amelanchier alnifolia*	Bedstraw	*Galium sp.*	Wild Rose	*Rosa sp.*
False Indigo	*Amorpha fruticosa*	Goldenweed	*Haplopappus sp.*	Himalayan Blackberry	*Rubus discolor*
Water Birch	*Betula occidentalis*	English Ivy	*Hedera helix*	Trailing Blackberry	*Rubus ursinus*
Nodding Beggar-tick	*Bidens cernua*	Velvet Grass	*Holcus lanatus*	Curly Dock	*Rumex crispus*
Three-lobed Beggar-tick	*Bidens tripartita*	Creambush Oceanspray	*Holodiscus discolor*	Willow	*Salix sp.*
Sedge	*Carex sp.*	Klamath Weed	*Hypericum perforatum*	Russian Thistle	*Salsola kali*
Common Centaury	*Centaurium umbellatum*	Peavine (Introduced)	*Lathyrus sp.*	Skullcap	*Scutellaria sp.*
Hornwort	*Ceratophyllum demersum*	Spanish-clover	*Lotus purshiana*	Black Nightshade	*Solanum nigrum*
Redbud	*Cercis occidentalis*	No common name	*Lythrum portula*	Western Goldenrod	*Solidago occidentalis*
Lambsquarter	*Chenopodium album*	Mallow	*Malva sp.*	Bittersweet Nightshade	*Solanum dulcamara*
Mexican Tea Wormseed	*Chenopodium ambrosoides*	Alfalfa	*Medicago sativa*	Saltmarsh Sandspurry	*Spergularia marina*
Jerusalem-oak	*Chenopodium botrys*	White Sweet-clover	*Melilotus alba*	Snowberry	*Symphoricarpus albus*
Glaucous Goosefoot	*Chenopodium glaucum*	Beebalm	*Melissa officinalis*	Common Tansy	*Tanacetum vulgare*
Chickory	*Cichorium intybus*	Indian Plum	*Oemleria cerasiformis*	Common Dandelion	*Taraxacum officinale*
Western Clematis	*Clematis ligusticifolia*	Common Evening-primrose	*Oenothera strigosa*	Poison Oak	*Toxicodendron pubescens*
Red Osier Dogwood	*Cornus sericea*	Marjoram	*Origanum sp.*	Moss	Unidentified
Creek Dogwood	*Cornus stolonifera*	Reed Canary Grass	*Phalaris arundinacea*	Stinging Nettle	*Urtica dioica*
Scot's Broom	*Cytisus scoparius*	English Plantain	*Plantago lanceolata*	Mullein	*Verbascum sp.*
Bleeding Heart	*Dicentra spectabilis*	Kentucky Bluegrass	*Poa pratensis*	Oregon Viburnum	*Viburnum ellipticum*
Crabgrass	*Digitalis sp.*	Willow Weed	*Polygonum lapathifolium*		
Birds					
American Robin	*Turdus migratorius*	Common Raven	*Corvus corax*	Northern Flicker	*Colaptes auratus*
Belted Kingfisher	*Megaceryle alcyon*	Dark-eyed Junco	*Junco Hyemalis*	Prairie Falcon	*Falco mexicanus*
Blackcapped Chickadee	*Parus atricapillus*	American Goldfinch	*Carduelis tristis*	Purple Finch	*Carpodacus purpureus*
Brown Creepers	*Certhia familiaris*	House Finch	*Carpodacus mexicanus*	Red Breasted Nuthatch	*Sitta canadensis*
Brownheaded Cowbird	*Molothrus ater*	House Sparrow	*Passer domesticus*	Redtail Hawk	*Buteo jamaicensis*
Bushtit	*Psaltriparus minimus*	Hummingbird	*Various spp.*	Rufous-sided Towhee	*Pipilo erthrophthalmus*
California Quail	*Callipepla californica*	Mourning Dove	*Zenaida macroura*	Winter Wren	*Troglodytes troglodytes*
Cedar Waxwing	*Bombycilla cedrorum*				
Mammals					
Feral Domestic Cat	*Felis domestica*	Masked shrew	*Sorex cinerius*	Raccoon	*Procyon lotor*
Deer mouse	*Peromyscus maniculatus*	Mink	*Mustela vison*	Beaver	*Castor canadensis*
Reptiles					
Garter Snake	*Thamnophis sp.*				

TABLE 3
POTENTIAL SEMI-AQUATIC ECOLOGICAL RECEPTORS
TIME OIL NORTHWEST TERMINAL

Common Name	Scientific Name
Birds	
Mallard Duck	*Anas platyrhynchos*
Great Basin Canada Goose	*Branta canadensis*
Mammals	
Raccoon	*Procyon lotor*
River Otter	*Lutra canadensis*
Mink	*Mustela viscon*

TABLE 4
ECOLOGICAL RECEPTOR FUNCTIONAL GROUPS
AND REPRESENTATIVE INDICATOR SPECIES
TIME OIL NORTHWEST TERMINAL

Functional Group	Potential Assessment Communities/Species
Terrestrial Plants	Terrestrial Plants
Terrestrial Invertebrates	Terrestrial Invertebrates
Terrestrial Avian Herbivores	Dark-Eyed Junco
	Mourning Dove
	Canada Goose
	California Quail
Terrestrial Mammalian Herbivores	Meadow Vole
	Beaver
	Deer
	Nutria (a)
	Muskrat (a)
Terrestrial Avian Omnivores	Fox Sparrow
Terrestrial Mammalian Omnivores	Raccoon
	Deer Mouse
Terrestrial Avian Invertivores	American Robin
Terrestrial Mammalian Invertivores	Masked Shrew
Terrestrial Avian Carnivores	Pygmy Owl
	Great Horned Owl
Terrestrial Reptilian Carnivores	Garter Snake

(a) While the nutria and muskrat are most often classified as aquatic mammalian herbivores, as described in the work plan, there is no aquatic vegetation in the vicinity of the Terminal. Thus, at this site, these ecological receptors could only be eating terrestrial vegetation.

TABLE 5
SELECTED INDICATOR COMMUNITIES, INDICATOR SPECIES AND ECOLOGICAL RECEPTOR FUNCTIONAL GROUPS
TIME OIL NORTHWEST TERMINAL

Selected Assessment Communities/Species	Represented Functional Groups
Terrestrial plants	Terrestrial Plants
Terrestrial Invertebrates	Terrestrial Invertebrates
American Robin	Terrestrial Avian Herbivores
	Terrestrial Avian Omnivores
	Terrestrial Avian Invertivores
	Terrestrial Avian Carnivores
Masked Shrew	Terrestrial Mammalian Herbivores
	Terrestrial Mammalian Omnivores
	Terrestrial Mammalian Invertivores
Garter Snake	Terrestrial Reptilian Carnivores

TABLE 6
EXPOSURE MEDIA FOR THE SELECTED INDICATOR COMMUNITIES AND SPECIES
TIME OIL NORTHWEST TERMINAL

Indicator Communities/Species	Uptake From Soil	Uptake From Surface Water	Uptake From River Sediment	Incidental Soil Ingestion	Surface Water Ingestion	Incidental River Sediment Ingestion	Prey Ingestion	Maternal Transfer
Terrestrial Plants	X							
Terrestrial Invertebrates	X							
American Robin				X			X (a)	
Masked Shrew				X			X (a)	
Garter Snake*				O			O (b)	

X = Primary exposure route will be addressed quantitatively in the ecological risk assessment.
O = Primary exposure route will be addressed qualitatively in the ecological risk assessment.
* = Assessed qualitatively in the ecological risk assessment due to a lack of exposure and toxicity data.
(a) Preys on terrestrial invertebrates.
(b) Preys on amphibians and terrestrial invertebrates.

APPENDIX A

Level I Ecological Scoping Evaluation

Ecological Scoping Checklist

Site Name	Time Oil Northwest Terminal
Date of Site Visit	4/05
Site Location	Portland, Oregon
Site Visit Conducted by	Rone Brewer, Sound Ecological Endeavors

Part ❶

CONTAMINANTS OF INTEREST Types, Classes, Or Specific Hazardous Substances‡ Known Or Suspected	Onsite	Adjacent to or In locality of the facility †
Metals	X	
PAHs	X	
Petroleum Hydrocarbons	X	
Pentachlorophenol	X	

‡ As defined by OAR 340-122-115(34) † As defined by OAR 340-122-115(38)

Part ❷

OBSERVED CHEMICAL IMPACTS ASSOCIATED WITH THE SITE	Finding
Onsite vegetation (None, Limited, Extensive)	L
Vegetation in the locality of the site (None, Limited, Extensive)	N
Onsite wildlife such as macroinvertebrates, reptiles, amphibians, birds, mammals, other (None, Limited, Extensive)	N
Wildlife such as macroinvertebrates, reptiles, amphibians, birds, mammals, other in the locality of the site (None, Limited, Extensive)	N
Other readily observable impacts (None, Discuss below)	D
Discussion: The property is predominantly covered by aboveground storage tanks, buildings, asphalt roadways, and gravel. These and other physical impacts to vegetation have occurred since the site was developed. The current areas of vegetation have been repeatedly disturbed over the years and include mowed grassy and weedy species.	

ATTACHMENT 1
Ecological Scoping Checklist (cont'd)
Part ❸

SPECIFIC EVALUATION OF ECOLOGICAL RECEPTORS / HABITAT	Finding
Terrestrial – Wooded	
Percentage of site that is wooded	<5
Dominant vegetation type (Evergreen, Deciduous, Mixed)	D
Prominent tree size at breast height, i.e., four feet (<6", 6" to 12", >12")	6" to 12"
Evidence / observation of wildlife (Macroinvertebrates, Reptiles, Amphibians, Birds, Mammals, Other)	B, Ma
Terrestrial – Scrub/Shrub/Grasses	
Percentage of site that is scrub/shrub/grass	35
Dominant vegetation type (Scrub, Shrub, Grasses, Other)	Grass/ Shrub
Prominent height of vegetation (<2', 2' to 5', >5')	2' to 5'
Density of vegetation (Dense, Patchy, Sparse)	P to D
Evidence / observation of wildlife (MacroInvertebrates, Reptiles, Amphibians, Birds, Mammals, Other)	B, M
Terrestrial – Ruderal	
Percentage of site that is ruderal	60
Dominant vegetation type (Landscaped, Agriculture, Bare ground)	B
Height of dominant vegetation (0', >0' to <2', 2' to 5', >5')	<2'
Density of vegetation (Dense, Patchy, Sparse)	S
Evidence / observation of wildlife (Macroinvertebrates, Reptiles, Amphibians, Birds, Mammals, Other)	B
Aquatic - Non-flowing (lentic)	
Percentage of site that is covered by lakes or ponds	0
Type of water bodies (Lakes, Ponds, Vernal pools, Impoundments, Lagoon, Reservoir, Canal)	NA
Size (acres), average depth (feet), trophic status of water bodies	NA
Source water (River, Stream, Groundwater, Industrial discharge, Surface water runoff)	NA
Water discharge point (None, River, Stream, Groundwater, Wetlands impoundment)	NA
Nature of bottom (Muddy, Rocky, Sand, Concrete, Other)	NA
Vegetation present (Submerged, Emergent, Floating)	NA
Obvious wetlands present (Yes / No)	NA
Evidence / observation of wildlife (Macroinvertebrates, Reptiles, Amphibians, Birds, Mammals, Other)	NA
Aquatic - Flowing (lotic)	
Percentage of site that is covered by rivers, streams (brooks, creeks), intermittent streams, dry wash, arroyo, ditches, or channel waterway	0
Type of water bodies (Rivers, Streams, Intermittent Streams, Dry Wash, Arroyo, Ditches, Channel waterway)	Willamette River addressed in the Portland Harbor RI/FS
Size (acres), average depth (feet), approximate flow rate (cfs) of water bodies	NA

SCHN00304258

SPECIFIC EVALUATION OF ECOLOGICAL RECEPTORS / HABITAT	Finding
Bank environment (cover: Vegetated, Bare / slope: Steep, Gradual / height (in feet))	NA
Source water (River, Stream, Groundwater, Industrial discharge, Surface water runoff)	NA
Tidal influence (Yes / No)	NA
Water discharge point (None, River, Stream, Groundwater, Wetlands impoundment)	NA
Nature of bottom (Muddy, Rocky, Sand, Concrete, Other)	NA
Vegetation present (Submerged, Emergent, Floating)	NA
Obvious wetlands present (Yes / No)	NA
Evidence / observation of wildlife (Macroinvertebrates, Reptiles, Amphibians, Birds, Mammals, Other)	
Aquatic – Wetlands	
Obvious or designated wetlands present (Yes / No)	N
Wetlands suspected at site is/has (Adjacent to water body, in Floodplain, Standing water, Dark wet soils, Mud cracks, Debris line, Water marks)	NA
Vegetation present (Submerged, Emergent, Scrub/shrub, Wooded)	NA
Size (acres) and depth (feet) of suspected wetlands	NA
Source water (River, Stream, Groundwater, Industrial discharge, Surface water runoff)	NA
Water discharge point (None, River, Stream, Groundwater, Impoundment)	NA
Tidal influence (Yes / No)	NA
Evidence / observation of wildlife (Macroinvertebrates, Reptiles, Amphibians, Birds, Mammals, Other)	

Photographic documentation is provided in Attachment D2

Part ❹

ECOLOGICALLY IMPORTANT SPECIES / HABITATS OBSERVED
None observed. On-site terrestrial habitats minimal in quality and size. Anadromous fish, resident fish (e.g., sculpins), fish-eating birds, and other aquatic species are likely within Willamette River adjacent to the site, but are not considered in this ERA as are being investigated as part of the Portland Harbor Remedial Investigation/Feasibility Study (RI/FS).

ATTACHMENT 2
Evaluation of Receptor-Pathway Interactions

EVALUATION OF RECEPTOR-PATHWAY INTERACTIONS	Y	N	U
Are hazardous substances present or potentially present in surface waters?		X	
AND			
Are ecologically important species or habitats present?		X	
AND			
Could hazardous substances reach these receptors via surface water?		X	
When answering the above questions, consider the following: • Known or suspected presence of hazardous substances in surface waters. • Ability of hazardous substances to migrate to surface waters. • Terrestrial organisms may be dermally exposed to water-borne contaminants as a result of wading or swimming in contaminated waters. Aquatic receptors may be exposed through osmotic exchange, respiration or ventilation of surface waters. • Contaminants may be taken-up by terrestrial plants whose roots are in contact with surface waters. • Terrestrial receptors may ingest water-borne contaminants if contaminated surface waters are used as a drinking water source.			
Are hazardous substances present or potentially present in groundwater?	X		
AND			
Are ecologically important species or habitats present?	X		
AND			
Could hazardous substances reach these receptors via groundwater?		X	
When answering the above questions, consider the following: • Known or suspected presence of hazardous substances in groundwater. • Ability of hazardous substances to migrate to groundwater. • Potential for hazardous substances to migrate via groundwater and discharge into habitats and/or surface waters. • Contaminants may be taken-up by terrestrial and rooted aquatic plants whose roots are in contact with groundwater present within the root zone (~1m depth). • Terrestrial wildlife receptors generally will not contact groundwater unless it is discharged to the surface.			

"Y" = yes; "N" = No, "U" = Unknown (counts as a "Y")

ATTACHMENT 2
Evaluation of Receptor-Pathway Interactions (cont'd)

EVALUATION OF RECEPTOR-PATHWAY INTERACTIONS	Y	N	U
Are hazardous substances present or potentially present in sediments?		X	
AND			
Are ecologically important species or habitats present?		X	
AND			
Could hazardous substances reach these receptors via contact with sediments?		X	
When answering the above questions, consider the following: • Known or suspected presence of hazardous substances in sediment. • Ability of hazardous substances to leach or erode from surface soils and be carried into sediment via surface runoff. • Potential for contaminated groundwater to upwell through, and deposit contaminants in, sediments. • If sediments are present in an area that is only periodically inundated with water, terrestrial species may be dermally exposed during dry periods. Aquatic receptors may be directly exposed to sediments or may be exposed through osmotic exchange, respiration or ventilation of sediment pore waters. • Terrestrial plants may be exposed to sediment in an area that is only periodically inundated with water. • If sediments are present in an area that is only periodically inundated with water, terrestrial species may have direct access to sediments for the purposes of incidental ingestion. Aquatic receptors may regularly or incidentally ingest sediment while foraging.			
Are hazardous substances present or potentially present in prey or food items of ecologically important receptors?			X
AND			
Are ecologically important species or habitats present?	X		
AND			
Could hazardous substances reach these receptors via consumption of food items?	X		
When answering the above questions, consider the following: • Higher trophic level terrestrial and aquatic consumers and predators may be exposed through consumption of contaminated food sources. • In general, organic contaminants with log K_{ow} > 3.5 may accumulate in terrestrial mammals and those with a log K_{ow} > 5 may accumulate in aquatic vertebrates.			

"Y" = yes; "N" = No, "U" = Unknown (counts as a "Y")

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ATTACHMENT 2
Evaluation of Receptor-Pathway Interactions (cont'd)

EVALUATION OF RECEPTOR-PATHWAY INTERACTIONS	Y	N	U
Are hazardous substances present or potentially present in surficial soils?	X		
AND			
Are ecologically important species or habitats present?	X		
AND			
Could hazardous substances reach these receptors via incidental ingestion of or dermal contact with surficial soils?	X		
When answering the above questions, consider the following: • Known or suspected presence of hazardous substances in surficial (~1m depth) soils. • Ability of hazardous substances to migrate to surficial soils. • Significant exposure via dermal contact would generally be limited to organic contaminants which are lipophilic and can cross epidermal barriers. • Exposure of terrestrial plants to contaminants present in particulates deposited on leaf and stem surfaces by rain striking contaminated soils (i.e., rain splash). • Contaminants in bulk soil may partition into soil solution, making them available to roots. • Incidental ingestion of contaminated soil could occur while animals grub for food resident in the soil, feed on plant matter covered with contaminated soil or while grooming themselves clean of soil.			
Are hazardous substances present or potentially present in subsurface soils?	X		
AND			
Are ecologically important species or habitats present?		X	
AND			
Could hazardous substances reach these receptors via vapors or fugitive dust carried in surface air or confined in burrows?		X	
When answering the above questions, consider the following: • Volatility of the hazardous substance (volatile chemicals generally have Henry's Law constant > 10^{-5} atm-m^3/mol and molecular weight < 200 g/mol). • Exposure via inhalation is most important to organisms that burrow in contaminated soils, given the limited amounts of air present to dilute vapors and an absence of air movement to disperse gases. • Exposure via inhalation of fugitive dust is particularly applicable to ground-dwelling species that could be exposed to dust disturbed by their foraging or burrowing activities or by wind movement. • Foliar uptake of organic vapors would be limited to those contaminants with relatively high vapor pressures. • Exposure of terrestrial plants to contaminants present in particulates deposited on leaf and stem surfaces.			

"Y" = yes; "N" = No, "U" = Unknown (counts as a "Y")

SCHN00304262

TIME OIL - COMM

LANDAU ASSOCIATES

December 24, 2003

Oregon Department of Environmental Quality
Northwest Region Portland Office
2020 SW 4th Avenue, Suite 400
Portland, Oregon 97201-4987

DEPT OF ENVIRONMENTAL QUALITY
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DEC 26 2003
NORTHWEST REGION

Attn: Mr. Tom Roick

RE: RESPONSE TO DEQ COMMENTS ON THE *IN SITU* CHEMICAL OXIDATION FIELD PILOT TEST REPORT TIME OIL NORTHWEST TERMINAL

Dear Mr. Roick:

On behalf of Time Oil Co., this letter provides our response to the Oregon Department of Environmental Quality's (DEQ) comments dated October 21, 2003 regarding the results of an *in situ* chemical oxidation (ISCO) pilot study conducted for the Time Oil Northwest Terminal in Portland, Oregon. The results of the pilot study were documented in the March 26, 2003 report completed by In-Situ Oxidative Technologies (ISOTEC 2003) and submitted by Landau Associates with an accompanying cover letter to DEQ in June 2003. The pilot study included baseline groundwater sampling, the injection of Fenton's Reagent into the groundwater, and subsequent groundwater monitoring to determine the effects of the Fenton's Reagent on the primary contaminant of concern [pentachlorophenol (PCP)] identified at the site. The DEQ comments (italicized type) and our associated responses are provided below.

1. *The figures provided in the letter are difficult to interpret and are not conclusive with respect to the effectiveness of treatment. Rather than relying on a single, pre-injection sampling round, it would be helpful to establish a typical range of concentration changes over time prior to treatment through use of the well data (LW11S and RW1) back to 1999. The effectiveness of the treatment could then be gauged relative to past variable contaminant concentrations.*

   We have attached a site map (Figure 1) with the field pilot study wells clearly identified. We have also updated the historical plots (Figures 2 through 7) of groundwater elevations and PCP concentrations that were previously submitted as attachments to the cover letter accompanying the Field Pilot Test Report submission. In the referenced cover letter, it was noted that PCP concentration reductions appeared to be a trend in five monitoring wells (PZ-1, LW-11S, OX-1S, OX-3S, and OX-4S), while increased PCP concentrations were apparent in two monitoring wells (OX-2S and RW-1). As you suggested, we have updated the plots to show the most recent data available (3rd Quarter Event; August 2003) for groundwater monitoring wells and have included

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SCHN00304288

data for LW-11S and RW-1 that present the data collected from these two wells since 1999. We have also attached Table 1, which is an updated version of the PCP analytical data compiled since the initiation of the pilot study. The concentration of PCP present in PZ-1 has not been evaluated since February 2003; therefore, an updated figure was not prepared. The updated data presented on revised Figures 2 through 7 are summarized as follows:

- **Figure 2**: The concentration of PCP present in LW-11S was reported to be 1,700 micrograms per liter (µg/L) in August 2003 as compared to a concentration of 4,000 µg/L in June 2002 (prior to the pilot study injection event). The water table elevation recorded in August 2003 (14.78 ft) is comparable to the water table elevation observed in September 1999 (14.87 ft), when the corresponding PCP concentration in groundwater was reported to be 9,400 µg/L.

- **Figure 3:** The concentration of PCP present in OX-1S was reported to be 19 µg/L in August 2003 as compared to a concentration of 9,800 µg/L in June 2002. The water table elevation recorded in August 2003 (14.62 ft) is comparable to the water table elevation observed on October 3, 2002 (14.10 ft), when the corresponding PCP concentration in groundwater was reported to be 1,800 µg/L.

- **Figure 4:** The concentration of PCP present in OX-3S was reported to be 1,400 µg/L in August 2003 as compared to a concentration of 17,000 µg/L in June 2002. The water table elevation recorded in August 2003 (14.49 ft) is comparable to the water table elevation observed on October 3, 2002 (13.95 ft), when the corresponding PCP concentration in groundwater was reported to be 8,200 µg/L.

- **Figure 5:** The concentration of PCP present in OX-4S was reported to be 2,200 µg/L in August 2003 as compared to a concentration of 9,300 µg/L in June 2002. The water table elevation recorded in August 2003 (13.59 ft) is comparable to the water table elevation observed on October 3, 2002 (13.44 ft), when the corresponding PCP concentration in groundwater was reported to be 1,300 µg/L.

- **Figure 6:** The concentration of PCP present in OX-2S was reported to be 5,800 µg/L in August 2003 as compared to a concentration of 2,300 µg/L in June 2002. The water table elevation recorded in August 2003 (14.26 ft) is comparable to the water table elevation observed on October 3, 2002 (14.41 ft), when the corresponding PCP concentration was reported to be 1,600 µg/L.

- **Figure 7:** The concentration of PCP present in RW-1 was reported to be 1,400 µg/L in August 2003 as compared to a concentration of 1,700 µg/L in June 2002. The water table elevation recorded in August 2003 (13.37 ft) is comparable to the water table elevation observed in September 1999 (13.44 ft), when the corresponding PCP concentration in groundwater was reported to be 3,100 µg/L.

Based on the information presented on Figures 2 through 5, it appears that the concentration of PCP present in LW-11S, OX-1S, OX-3S, and OX-4S have decreased since the injection of Fenton's Reagent, and the PCP concentration does not appear to be solely dependent on the groundwater elevation. The data presented on Figure 6 appear to indicate that the concentration

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of PCP in OX-2S has increased since the injection of Fenton's Reagent, which may be indicative of downgradient plume migration from a PCP source area. The data presented on Figure 7 appear to indicate that the concentration of PCP in RW-1 has decreased since the injection of Fenton's Reagent; however, the concentration appears to be correlated to the groundwater table fluctuation.

2. *As noted above, it is not clear that observed decreases in pentachlorophenol (PCP) concentrations are solely the result of the injected material versus other "natural" processes, including the degree of dilution related to injected volumes.*

While it is accurate to state that "natural" processes have not been evaluated as a component of the pilot study, we believe that the effects of dilution on PCP concentrations relative to the volume of liquid injected at each injection point would have been attenuated by groundwater flux by this time. As indicated in Table 1 and on Figures 2 through 7, the PCP concentrations detected in the six groundwater monitoring wells located within the pilot study area have continued to remain appreciably lower (76.3% to 99.8%) in four of the six monitoring wells evaluated since the injection event was completed. If the decreased PCP concentrations were solely due to the effects of dilution, it would be expected that the PCP concentrations in groundwater within the pilot test area would have recovered at all of the monitoring locations as of our most recent monitoring event, which was completed in August 2003 (approximately 11 months after the injection event).

3. *The observed increase in soil PCP concentrations at OX-2S and increase in groundwater PCP concentrations in some wells but not others may indicate non-homogenous contaminant distribution and/or non-uniform delivery/treatment in the subsurface. This uncertainty should be a consideration in limiting the injection spacing for full-scale application.*

It is likely that heterogeneities exist in the subsurface that will prevent the equal distribution of Fenton's Reagent throughout the radius of influence (ROI) of each injection point. However, as stated in our response to Comment #1, we also believe that the increased PCP concentrations observed in OX-2S may be attributed to plume migration from an upgradient source area. We will plan on setting up an overlapping injection grid to attempt to get a more uniform distribution of the reagent perpendicular to the groundwater flow direction. In addition, we will plan to alter our injection point spacing and pattern, if adjustments appear warranted based on groundwater data collected in between injection events.

4. *If several full-scale injections are planned, the grid location should be staggered between events to provide better coverage (i.e., with 50-ft spacing, move the grid over 25 ft for the second round).*

See Response 3 above.

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5. *The discussion of potential by-products should be expanded to address metals, including the injected iron and potential oxidation of metals in the subsurface. While oxidized metals are often reduced with time/distance from the treatment area, we should confirm that a sensitive receptor (in the Willamette River) will not be exposed before such natural attenuation. In addition to those metals analyzed as shown on Table 1, please include selenium, which can be mobilized by oxidation, and iron, which is being added to the formation.*

   Based on the data presented in the Laboratory Treatability Study Report (ISOTEC 2002), which was submitted to the DEQ on August 28, 2002, the selenium concentration in a representative "slurry mixture" of soil and groundwater collected in the saturated zone at the site was less than 0.008 milligrams per kilogram (mg/kg) prior to the addition of the Fenton's Reagent. The concentration of dissolved phase selenium in the slurry mixture was determined to be 0.018 mg/kg following the addition of the Fenton's Reagent. The concentration of dissolved phase iron (ferrous iron) in the slurry mixture increased from 0.152 mg/kg to 54.1 mg/kg after the addition of the Fenton's Reagent during the laboratory treatability study, due to the addition of the catalyst agent that contains ferrous iron. Monitoring of selenium and iron will be proposed in a work plan to be developed for the full-scale ISCO application.

6. *Some treatment should be conducted in the spring during high groundwater conditions in order to treat contaminants in the capillary fringe.*

   We agree that the ISCO applications will likely be most effective during high groundwater conditions and we will attempt to schedule our injection events accordingly.

Further information relevant to comments 3 through 6 will be addressed in a work plan to be developed for the full-scale implementation of ISCO as an interim remedial action at the Time Oil Northwest Terminal. The work plan should be submitted to DEQ in January 2004, with the proposed full-scale implementation of ISCO tentatively scheduled for late winter or early spring of 2004 during high groundwater table conditions. Please contact us if you should have any further questions or comments regarding our intent to implement a full-scale ISCO interim remedial approach for the site. We look forward to continuing to work with you on this project.

SCHN00304291

LANDAU ASSOCIATES, INC.

Martin T Powers

Martin T. Powers, P.E.
Associate Engineer

Christopher Young for

Rebekah Brooks
Associate Hydrogeologist

MTP/ccy

cc: Kevin Murphy, Time Oil Co.
Patricia Dost, Schwabe Williamson & Wyatt
Cheryl Rath, Schwabe Williamson & Wyatt

REFERENCES

ISOTEC. 2002. *Laboratory Treatability Study Report, Time Oil Co. Northwest Terminal Site, 10350 North Time Oil Road, Portland, Oregon.* August 9.

ISOTEC. 2003. *Field Pilot Test Report, Time Oil Co. Northwest Terminal Site, 10350 North Time Oil Road, Portland, Oregon.* March 26.

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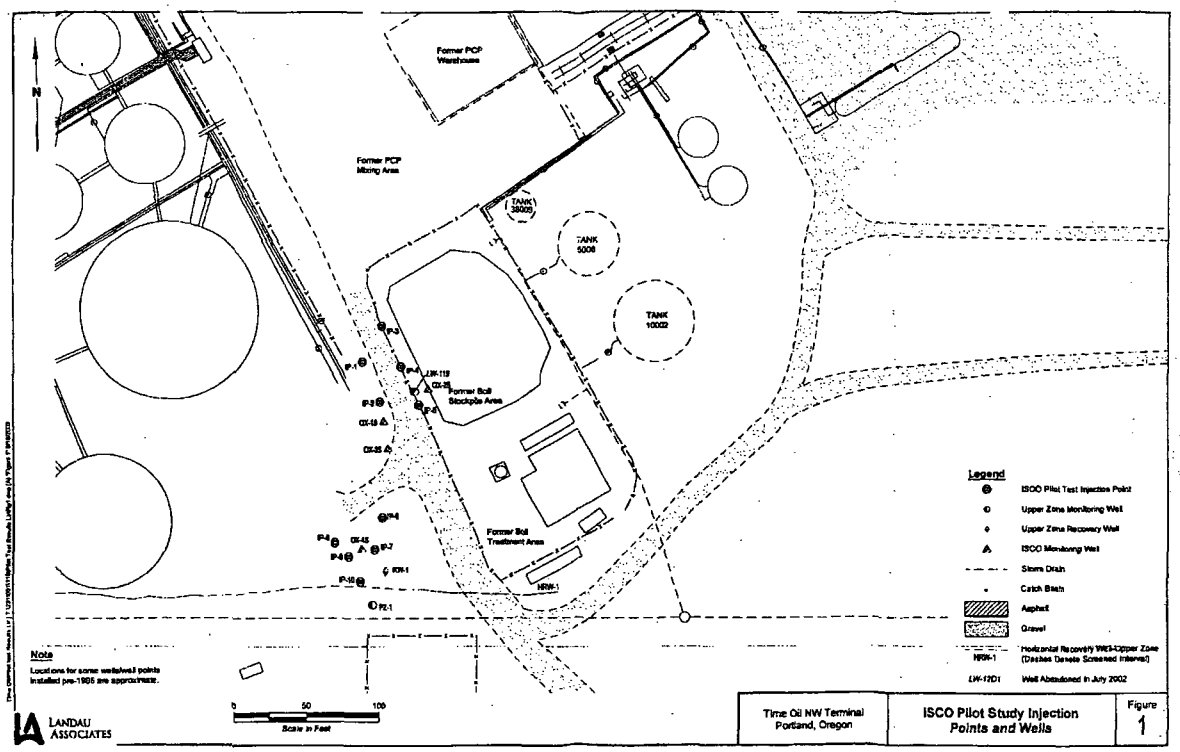

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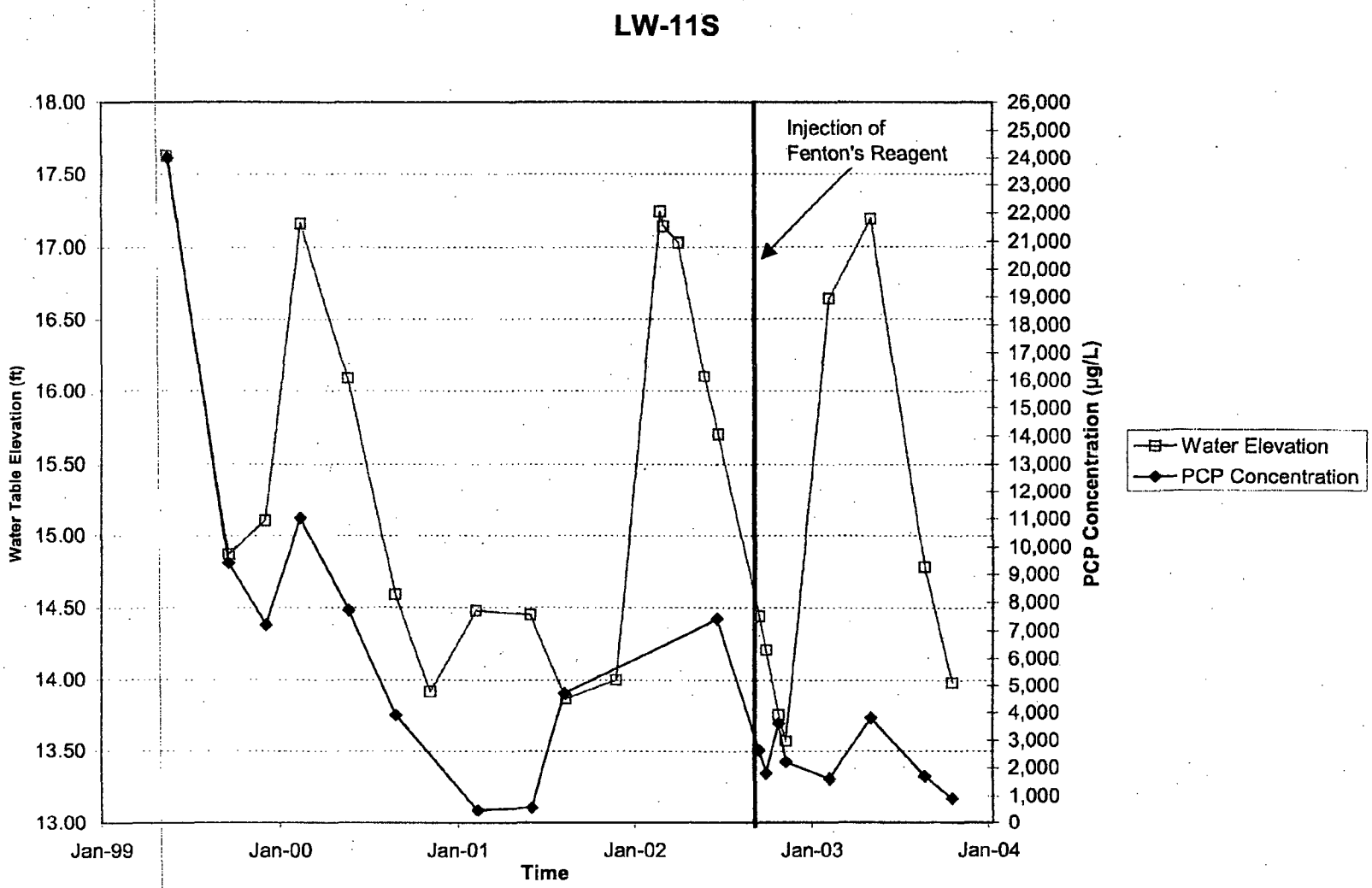

Note: Groundwater elevation without corresponding PCP concentration (e.g., December 2001 - June 2002) is indicative of the presence of LNAPL and no sample was collected for analysis.

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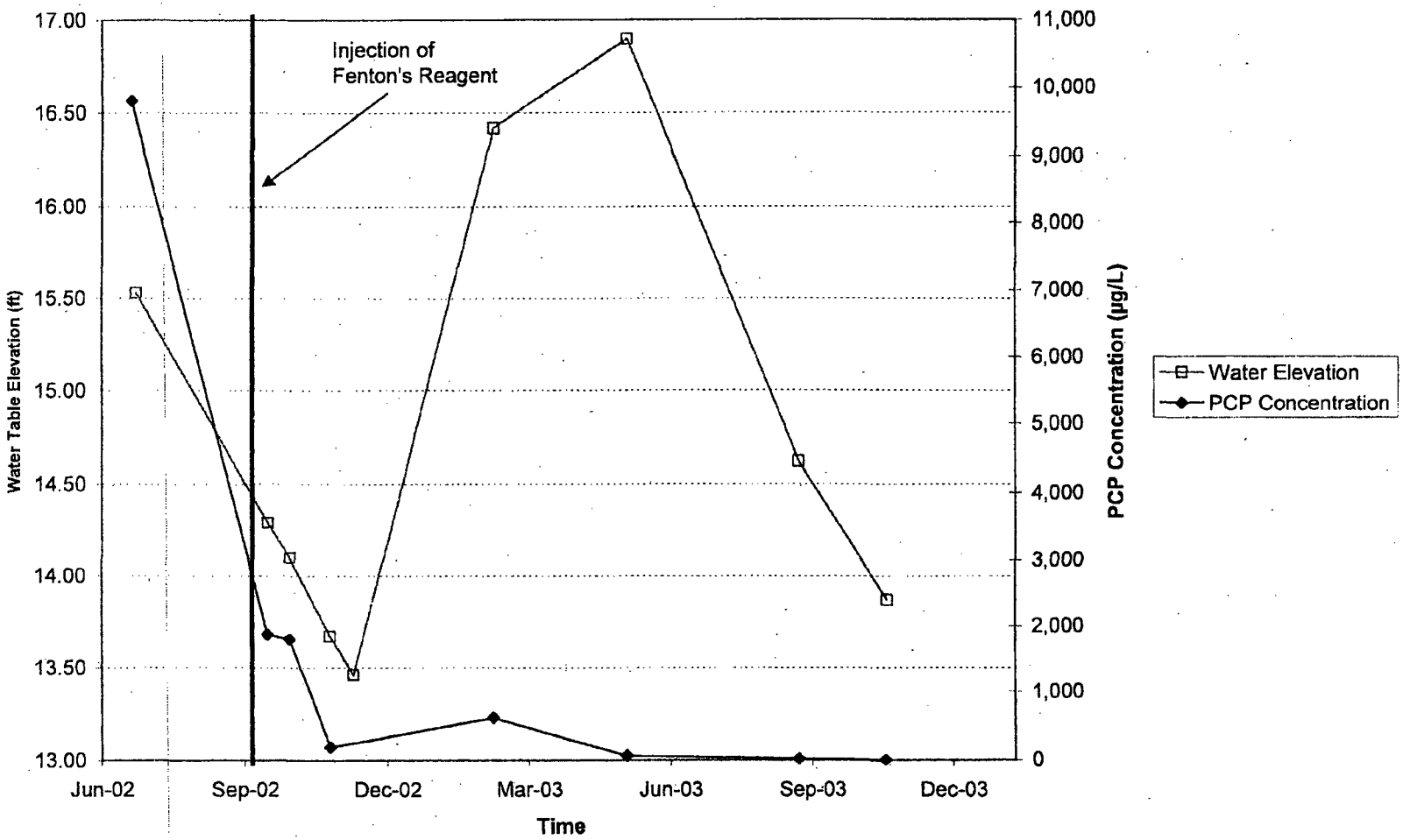
ISCO Observation Wells Time Oil Northwest Terminal Portland, Oregon	**Comparison of PCP Concentrations and Groundwater Elevation vs. Time LW-11S**	Figure 2

SCHN00304294

Source: S:\wproc\231\001\118\Pilot Test Cvr Ltr_Tb1.xls



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ISCO Observation Wells Time Oil Northwest Terminal Portland, Oregon	**Comparison of PCP Concentrations and Groundwater Elevation vs. Time OX-1S**	Figure 3

SCHN00304295

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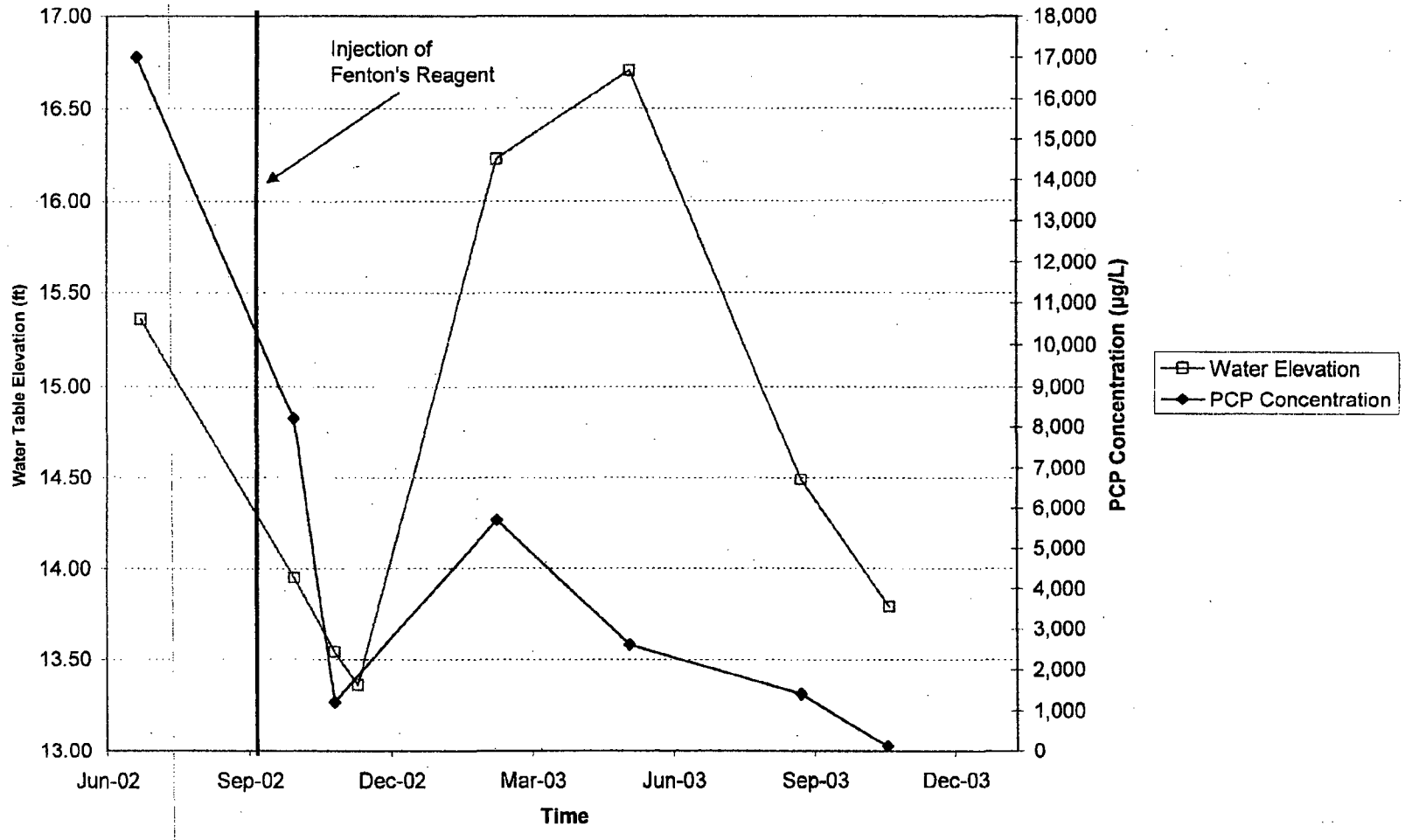

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ISCO Observation Wells Time Oil Northwest Terminal Portland, Oregon	**Comparison of PCP Concentrations and Groundwater Elevation vs. Time OX-3S**	Figure 4

SCHN00304296

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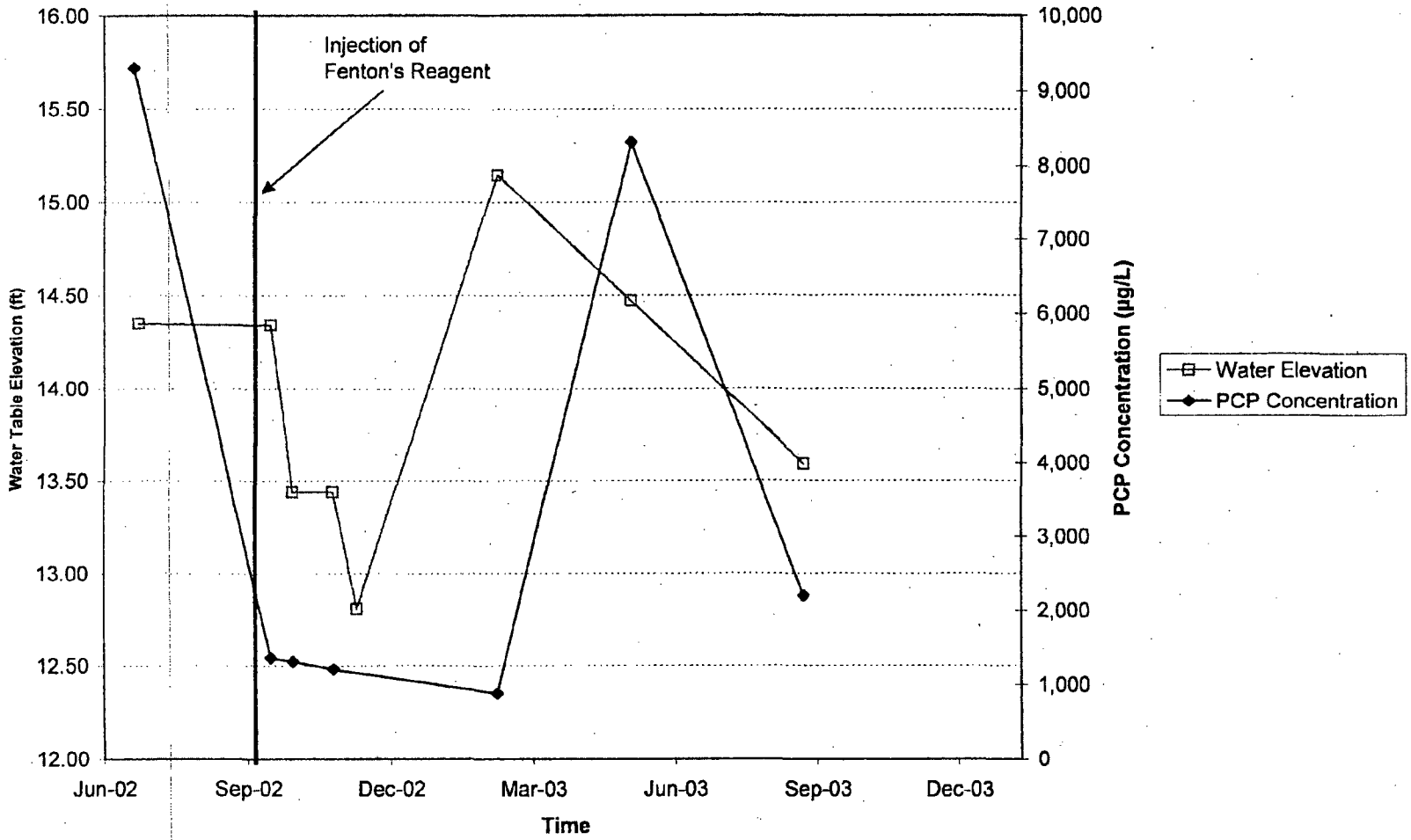

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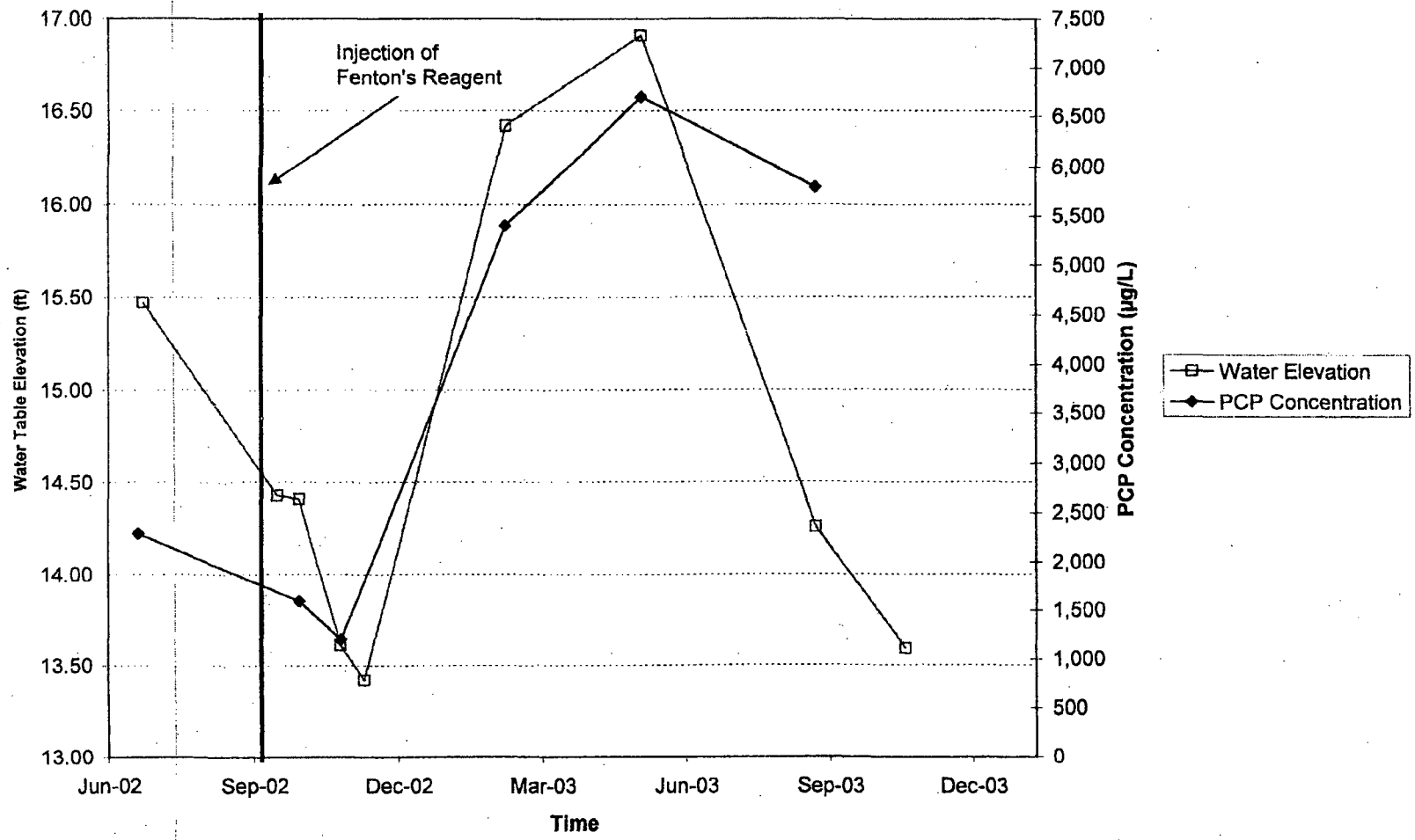
ISCO Observation Wells Time Oil Northwest Terminal Portland, Oregon	**Comparison of PCP Concentrations and Groundwater Elevation vs. Time OX-4S**	Figure 5

SCHN00304297



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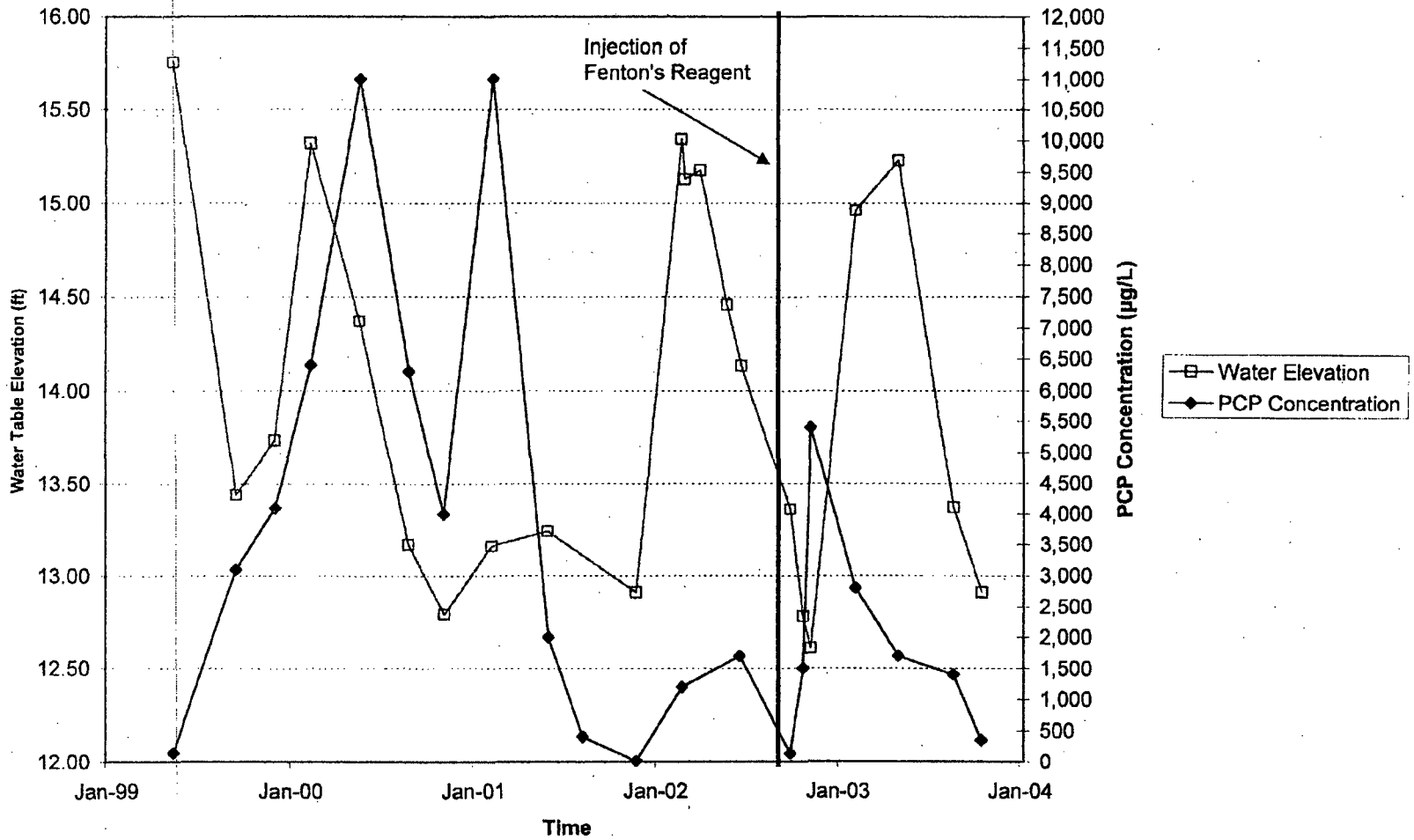
ISCO Observation Wells Time Oil Northwest Terminal Portland, Oregon	**Comparison of PCP Concentrations and Groundwater Elevation vs. Time OX-2S**	Figure 6

SCHN00304298



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ISCO Observation Wells Time Oil Northwest Terminal Portland, Oregon	**Comparison of PCP Concentrations and Groundwater Elevation vs. Time RW-1**	Figure 7

SCHN00304299

TABLE 1
ISCO PILOT TEST EVALUATION
DISSOLVED PCP CONCENTRATIONS AND WATER TABLE ELEVATIONS
TIME OIL NORTHWEST TERMINAL
PORTLAND, OREGON

Monitoring Well	Distance From Closest Injection Point	06/24/2002 Baseline (µg/L)	06/27/2002 Water Elevation (ft)	09/19/2002 Post Injection (µg/L)	09/19/2002 Water Elevation (ft)	10/03/2002 Post Injection (µg/L)	10/03/2002 Water Elevation (ft)	10/29/2002 Post Injection (µg/L)	10/29/2002 Water Elevation (ft)	11/13/2002 Post Injection (µg/L)	11/13/2002 Water Elevation (ft)	02/11/2003 Post Injection (µg/L)	02/11/2003 Water Elevation (ft)	05/8/2003 Post Injection (µg/L)	05/8/2003 Water Elevation (ft)	08/27/2003 Post Injection (µg/L)	08/27/2003 Water Elevation (ft)	Baseline vs Third Quarter 2003 (% Reduction)
RW-1	17 ft	1,700	14.13	NS	NR	140	13.36	1,500	12.78	5,400	12.61	2,800	14.96	1,700	15.23	1,400	13.37	17.65
PZ-1	38 ft	12,000	13.54	NS	NR	7,000	13.14	NS	11.87	NS	12.21	700	14.46		14.79		12.72	NS
LW-11S	9 ft	7,400	15.70	2,620	14.44	1,800	14.21	3,800	13.75	2,200	13.57	1,600	15.64	3,800	17.19	1,700	14.78	77.03
OX-1S	12 ft	9,800	15.53	1,870	14.29	1,800	14.10	200	13.67	NS	13.46	620	16.42	67	16.90	19	14.62	99.81
OX-2S	16 ft	2,300	15.47	NS	14.43	1,600	14.41	1,200	13.61	NS	13.42	5,400	16.42	6,700	16.91	5,800	14.26	-152.17
OX-3S	33 ft	17,000	15.36	NS	NR	8,200	13.95	1,200	13.54	NS	13.36	5,700	16.23	2,600	16.71	1,400	14.49	91.76
OX-4S	9 ft	9,300	14.35	1,350	14.34	1,300	13.44	1,200	13.44	NS	12.81	880	15.15	8,300	14.47	2,200	13.59	76.34

NS = Not sampled.
NR = Not recorded.

SCHN00304300

Landau Associates
Environmental and Geotechnical Services

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AUG 14 2001

NORTHWEST REGION

8/16/01 OK to Kevin Murphy on Response to Comments. TEK

August 13, 2001

Mr. Tom Roick
Oregon Department of Environmental Quality
2020 SW Fourth Avenue, Suite 400
Portland, Oregon 97201-4987

RE: RESPONSE TO DEQ COMMENTS
GROUNDWATER INTERIM ACTION STATUS REPORT – 1ST QUARTER 2001
SUPPLEMENTAL SAMPLING AND ANALYSIS PLAN – PHASE II RI
PHASE III REMEDIAL INVESTIGATION WORK PLAN
TIME OIL NORTHWEST TERMINAL

Dear Mr. Roick:

Time Oil Co. has reviewed the comments prepared by the Oregon Department of Environmental Quality (DEQ) on July 18, 2001, for the Groundwater Interim Action Status Report – 1st Quarter 2001 (dated June 11, 2001); the Supplemental Sampling and Analysis Plan – Phase II RI (dated June 18, 2001); and the Phase III Remedial Investigation (RI) Work Plan (dated June 18, 2001) prepared by Landau Associates for Time Oil Co. (Time Oil). This letter provides Time Oil's responses to DEQ's comments on these documents. The responses have been numbered to correspond to DEQ's comments.

RESPONSES:

Groundwater Interim Action Status Report – 1st Quarter 2001

A work plan for conducting a vacuum-enhanced pumping test at upper zone recovery wells, HRW-1 and RW-1, was provided to DEQ on August 1, 2001. The work plan addresses the information listed by DEQ in your comment letter. DEQ provided approval of the plan in an email, dated August 6, 2001.

Supplemental Sampling and Analysis Plan – Phase II RI

1. Soil Sampling

Time Oil agrees to collect the additional soil samples, as requested. The upper sampling depth at the four sample locations where an upper depth of 1 ft is indicated (SSS-1, SSS-2, SSS-10, and SSS-11) has been changed to 0.5 ft (Figure 1 and Table 1) to be consistent with previous data. The revised figure and table are attached to this letter. Specific responses to DEQ's bulleted comments are provided below.

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(425) 778-0907 • Fax: (425) 778-6409 • Toll Free: (800) 552-5957 • E-mail: info@landauinc.com
Seattle (Edmonds) Tacoma Portland (Lake Oswego) Spokane

100

- Sample depths of 0.5 and 5 ft have been added at locations SSS-9 and SSS-12.

- The extent of high PCP concentrations near LB-5 will be evaluated after the soil stockpile is removed from this area. There is no planned action for this area at this time.

- A sample depth of 0.5 ft has been added to location SSS-3.

- The need for additional characterization data for identification of hot spots considering the soil to groundwater pathway will be evaluated based on the results of a baseline risk assessment for the terminal, to be conducted following completion of Phase III RI activities.

2. Stormwater Sampling

- The Phase II RI report (Landau Associates, February 9, 2001) provides a detailed description of the areas where stormwater is collected by the storm drain. As described in Sections 2.1 and 3.4 of this report, stormwater from the terminal entrance area, the low topographic area east of the rail spur, and from the cover of the soil stockpile is collected into the storm drain line for discharge into the Willamette River under a NPDES permit. In addition, stormwater from the paved non-industrial areas (e.g., around the terminal office area) has discharged to the storm drain for about the past year. Any stormwater collected at the following areas is treated by the onsite bioremediation waste treatment system: 1) the valve vault on the dock, 2) the valve and pump vault next to the truck loading rack, 3) around the truck loading rack, and 4) the rail rack. Surface water runoff along the roads or old railroad beds likely flows toward the eastern side of the property. In other areas of the terminal and on the east property, precipitation infiltrates directly into the ground because of the relatively flat topographic surface.

  Currently, stormwater is collected twice a year at two compliance points along the storm drain line under the NPDES permit: one at the outlet of the pipeline from the stockpile, and one at the outlet of the pipeline from the rail spur. The analyses results since 1998 were provided to DEQ in Time Oil's letters regarding soil stockpile management, dated April 6, 2001 and July 26, 2001. Except for low concentrations of some metals, concentrations of analytes required in the permit (plus PCP since December 2000) have been below laboratory detection limits and, therefore, seasonal variability is not discernable. Because of the activities conducted within the drainage area of the storm drain, the stormwater samples will be analyzed for TPH-HCID. As an additional check, the samples will also be analyzed for PCP.

- To our knowledge, there is only one catch basin located along the east-west storm drain line. As shown on Figure 2, the catch basin is located on the east property about 40 ft south of the storm drain line. A decision on whether a sediment sample will be collected from the catch basin will be based on whether field observations indicate that the catch basin is connected to the storm drain line and whether sediment is present. If these conditions exist, the sediment will be sampled as part of the storm drain sampling effort and analyzed for PCP and PAHs.

- Stormwater sampling will be conducted twice, once in conjunction with supplemental soil sampling and Phase III activities, currently scheduled for late August-early September 2001, and once following a storm event, anticipated for winter 2002. Recent field observations have indicated that water is flowing through the storm drain even during low precipitation periods. The source of this water is unknown, but it may be reflective of input from

neighboring properties to the east (where the storm drain originates) or from groundwater entering the storm drain. As shown on Figure 2, stormwater will be collected at two locations: one at the manhole nearest the river (or at the river outfall, if exposed), and the second location will be moved from the original location shown on Figure 2 to the manhole farthest to the east on the Time Oil property. Sampling at this location will, hopefully, provide an indication of whether there is any impact to the stormwater from properties to the east. Figure 2 has been revised and is attached to this letter.

- The stormwater invert elevations and ground surface elevations will be surveyed at the sampling locations.

3. Equipment Decontamination and Waste Management (see responses to comments for the Phase III RI below).

Phase III Remedial Investigation Work Plan

General Comments:

1. No response necessary.

2. See previous response under the first bullet for Stormwater Sampling. The main tank farm is surrounded by an earth berm that has been in existence since terminal construction. Stormwater percolates in this area.

Specific Comments:

1. Section 4.1.2. Paragraph 1, Line 2. The references should be Section 2.1.1.1 and Figure B-1 of Appendix B.

2. Section 4.1.5 and Section 4.2.3. The rationale for the selected metals was based on the data collected during the Phase II RI. The current list of metals includes those metals that are known to be associated with petroleum-based materials used at the terminal. With regard to fuel additives, analysis for MTBE and ETBE will be conducted on soil from possible known gasoline-impacted areas. These areas include: 1) near the former underground storage tanks locations (sub-areas B4 and B13 on Figure 11); 2) near active and former truck and railroad car loading racks (sub-areas B3, B7, B14, and B15); and 3) in the area where a known gasoline release has occurred (in the main tank farm area near wells N, P, and Q). An evaluation of whether groundwater samples from these areas will also be analyzed for the fuel additives will be conducted following review of the soil data.

3. SAP Section 2.2.2.1. Page B-11: *Lower Monitoring Wells*. The step-down procedure will include leaving the 15-inch diameter auger in the ground and inserting the 11-inch diameter auger through it, following placement and hydration of the bentonite seal at the confining unit. The use of "O" rings between auger flights is not considered necessary, given the limited amount of time that the augers will be in the ground at each location (less than one day).

4. SAP Section 2.2.2.2. The goal of well development will be to reduce turbidity to less than 5 NTUs; however, if this standard cannot be achieved after 10 casing volumes of water have been removed, well development will be considered complete. In this case, the laboratory will be instructed to allow any suspended material to settle and use the upper, clear portion of the sample for sample extraction and analysis.

5. SAP Section 2.2.2.3. If NAPL is encountered in a well, a sample of the NAPL will be collected for chemical characterization and viscosity and density measurements, if sufficient volume of the product is recovered. The groundwater at this location will not be sampled while NAPL is present.

6. SAP Section 2.2.2.3. Page B-15. Last bullet. The text indicates that to prevent degassing during VOA sampling, a flow rate for the electric submersible pump or dedicated bladder pump will be maintained below about 100 ml/min. The flow rate is checked using a graduated cylinder and a watch with a second hand.

7. SAP Section 2.6.1. Investigation-derived waste (IDW) will be stored and managed in accordance with Time Oil's Drummed Waste Management Lesson Plan, prepared as part of the terminal operation's training manual. The plan includes procedures for drum labeling, inspection, storage, and disposal, and hazardous waste disposal and manifesting procedures. The plan is kept on file at Time Oil. With the exception of two containers retained for use in treatability studies, there is no RCRA listed IDW currently being stored at the terminal. We do not expect to generate any soil cuttings during use of the direct-push technique for soil borings in the Phase II RI source areas or during the preliminary investigation for the Phase III RI; however, there may be a minimal amount of excess soil sample remaining following sample collection. Any excess soil sample volume for samples collected in the Phase II areas will be drummed separately from those collected in the Phase III areas, but not stored separately. Drummed waste is currently stored in the designated storage area at the terminal.

8. SAP Section 2.7. GPS or taped measurement will be used to identify the sampling locations prior to sampling (+/- 5ft accuracy). Following sample collection, the GPS will be used to determine the horizontal coordinates for the direct-push sample locations within the tank farm areas. Topographic contours, based on previous surveys, will be used to estimate the ground surface elevations. A licensed surveyor will be used to determine vertical coordinates (including ground surface and monitoring well measuring point elevations) and horizontal coordinates for the Phase II supplemental soil boring locations and Phase III monitoring well locations with an accuracy of 0.1 ft and 1 ft accuracy, respectively.

* * * * * * *

We hope that these responses provide you with the information you need to approve proceeding with field work for the supplemental sampling and the Phase III preliminary investigation, currently scheduled to begin August 20, 2001. Please call Kevin Murphy or me if you have any questions.

LANDAU ASSOCIATES, INC.

By:

Rebekah Brooks
Senior Hydrogeologist

RB/skh
Enclosures
cc: Rod Struck, DEQ
Kevin Murphy, Time Oil Co.
Patty Dost, Schwabe Williamson & Wyatt

TABLE 1
SUPPLEMENTAL SAMPLING SUMMARY
PHASE II RI
TIME OIL NORTHWEST TERMINAL

Recommended Sample Location	Sample Type	Sample Depth (ft BGS)	Analytes	Analytical Methods (a)	Rationale
SSS-1	Soil	0.5	PCP	8270 SIM	Estimate whether nearby surface contamination extends below the ground surface.
	Soil	5	PCP	8270 SIM	
SSS-2	Soil	0.5	PCP	8270 SIM	Estimate the vertical and horizontal extent of PCP contamination beyond the northeast corner of the 1989 excavation.
	Soil	5	PCP	8270 SIM	
	Soil	10	PCP	8270 SIM	
	Soil	15	PCP	8270 SIM	
SSS-3	Soil	0.5	PCP	8270 SIM	Estimate the extent of contamination beyond the western end of the 1989 excavation.
	Soil	5	PCP	8270 SIM	
	Soil	10	PCP	8270 SIM	
SSS-4	Soil	15	PCP	8270 SIM	Estimate the vertical extent of the remaining contamination below and at the southwest corner of the former PCP warehouse.
	Soil	20	PCP	8270 SIM	
	Soil	25	PCP	8270 SIM	
	Soil	30	PCP	8270 SIM	
	Soil	35	PCP	8270 SIM	
	Soil	40	PCP	8270 SIM	
SSS-5	Soil	15	PCP	8270 SIM	Estimate the vertical extent of the remaining contamination below and at the southwest corner of the former PCP warehouse.
	Soil	20	PCP	8270 SIM	
	Soil	25	PCP	8270 SIM	
	Soil	30	PCP	8270 SIM	
	Soil	35	PCP	8270 SIM	
	Soil	40	PCP	8270 SIM	
SSS-6	Soil	10	PCP	8270 SIM	Estimate the vertical extent of the remaining contamination below and at the southwest corner of the former PCP warehouse.
	Soil	18	PCP	8270 SIM	
	Soil	20	PCP	8270 SIM	
	Soil	25	PCP	8270 SIM	
	Soil	30	PCP	8270 SIM	
	Soil	35	PCP	8270 SIM	
	Soil	40	PCP	8270 SIM	
SSS-7	Soil	10	PCP	8270 SIM	Estimate the vertical extent of the remaining contamination at the eastern side of the 1989 excavation.
	Soil	15	PCP	8270 SIM	
	Soil	20	PCP	8270 SIM	
	Soil	25	PCP	8270 SIM	
	Soil	30	PCP	8270 SIM	
SSS-8	Soil	5	PCP	8270 SIM	Estimate the extent to which contamination extends beyond the southeast side of the 1989 excavation.
	Soil	10	PCP	8270 SIM	
	Soil	15	PCP	8270 SIM	
SSS-9	Soil	0.5	PCP	8270 SIM	Characterize contamination in the smear zone downgradient of the source area.
	Soil	5	PCP	8270 SIM	
	Soil	10	PCP	8270 SIM	
	Soil	15	PCP	8270 SIM	
SSS-10	Soil	0.5	PCP and PAHs	8270 SIM and 8270	Estimate the vertical and horizontal extent of contamination southeast of the former PCP mixing area.
	Soil	5	PCP and PAHs	8270 SIM and 8270	
SSS-11	Soil	0.5	PCP and PAHs	8270 SIM and 8270	Estimate the vertical and horizontal extent of contamination southeast of the former PCP mixing area.
	Soil	5	PCP and PAHs	8270 SIM and 8270	
	Soil	10	PCP and PAHs	8270 SIM and 8270	
	Soil	15	PCP and PAHs	8270 SIM and 8270	
SSS-12	Soil	0.5	PCP	8270 SIM	Characterize contamination in the smear zone downgradient of the source area.
	Soil	5	PCP	8270 SIM	
	Soil	10	PCP	8270 SIM	
	Soil	15	PCP	8270 SIM	

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TABLE 1
SUPPLEMENTAL SAMPLING SUMMARY
PHASE II RI
TIME OIL NORTHWEST TERMINAL

Recommended Sample Location	Sample Type	Sample Depth (ft BGS)	Analytes	Analytical Methods (a)	Rationale
SSS-13	Soil	0.5	PCP and PAHs	8270 SIM and 8270	Estimate the vertical and horizontal extent of contamination southeast of the former PCP mixing area.
	Soil	1	PCP and PAHs	8270 SIM and 8270	
	Soil	5	PCP and PAHs	8270 SIM and 8270	
	Soil	10	PCP and PAHs	8270 SIM and 8270	
	Soil	20	PCP and PAHs	8270 SIM and 8270	
SSS-14	Soil	0.5	PCP	8270 SIM	Estimate the vertical and horizontal extent of contamination southeast of the former PCP mixing area.
	Soil	1	PCP	8270 SIM	
	Soil	5	PCP	8270 SIM	
	Soil	15	PCP	8270 SIM	
SSS-15	Soil	0.5	PCP and PAHs	8270 SIM and 8270	Estimate the vertical and horizontal extent of contamination southeast of the former PCP mixing area.
	Soil	1	PCP and PAHs	8270 SIM and 8270	
	Soil	16	PCP and PAHs	8270 SIM and 8270	
		NA	TPH	NWTPH-HCID	Evaluate stormwater quality upgradient of the upper zone PCP plume and at the eastern property boundary.
SDM-1	Stormwater	NA	PCP	8270 SIM	
		NA	TPH	NWTPH-HCID	Evaluate stormwater quality downgradient of upper zone PCP plume and groundwater interim action area.
SDM-2	Stormwater	NA	PCP	8270 SIM	

Note:
(a) Analytical methods listed are EPA SW-846 methods.

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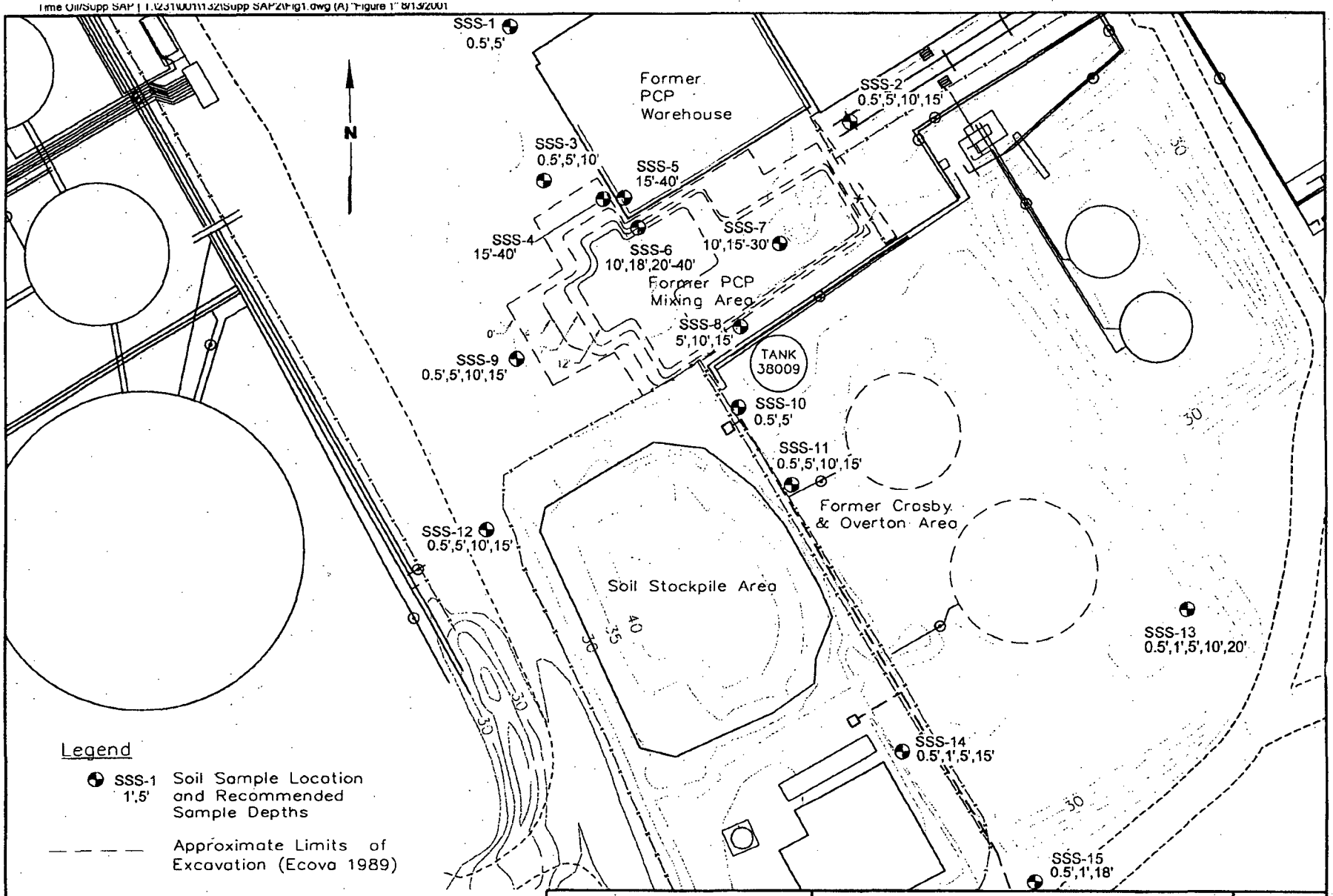
Time Oil/Supp SAP | T:\231\001\132\Supp SAP2\Fig1.dwg (A) "Figure 1" 8/13/2001



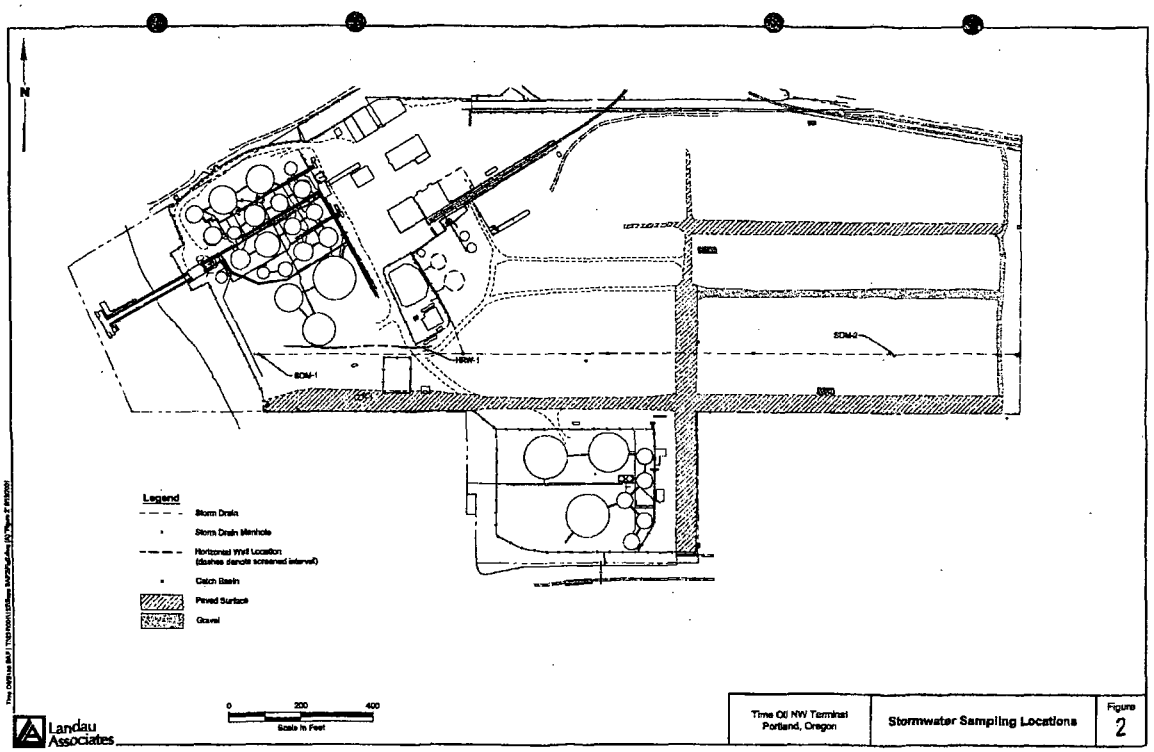
Landau Associates

Time Oil NW Terminal
Portland, Oregon

Recommended Supplemental Soil Sample Locations

Figure
1

SCHN00304307



Time Oil NW Terminal Portland, Oregon	Stormwater Sampling Locations	Figure 2

SCHN00304308

Time 0.7: comm

ROICK Tom

From: STRUCK Rodney
Sent: Monday, August 13, 2001 2:25 PM
To: ROICK Tom
Subject: FW: Response to DEQ comments

Tom,

Welcome back. I reviewed Rebecca's letter, in general, I believe that the responses adequately address our comments. Possible questions to Time & Landau include:

Comment	Question
2. Stormwater Sampling. Bullet 2. Paragraph 2	When will the storm water sampling be performed?
Phase III - Specific Comment No. 2.	How will DEQ be integrated into the decision of whether groundwater samples will be analyzed for fuel additives?

I will be in Tuesday the 14th and then out until Monday August 20th.

Rod

-----Original Message-----

From: **Rebekah Brooks** [mailto:RBrooks@landauinc.com] <mailto:[mailto:RBrooks@landauinc.com]>
Sent: Monday, August 13, 2001 12:53 PM
To: STRUCK Rodney; ROICK Tom
Cc: Terry McGourty; PDost@SCHWABE.com; kmurphy@timeoil.com
Subject: Response to DEQ comments

TEXT.htm ResponsetoDEQ_let.doc

On behalf of Time Oil, attached is a letter providing response to DEQ's comments on the Groundwater Interim Action Status Report - 1st quarter 2001, the Supplemental SAP- Phase II, and the Phase III RI Work Plan. A hard copy of the letter with the revised Table and Figures from the Supplemental SAP will follow by overnight mail.

Because of the schedule for cleanup and closure activities at the Northwest Terminal, it is very important that we begin work for the Supplemental SAP and the Phase III preliminary evaluation on August 20 (that's one week from today), if we don't want to delay the work until October. Therefore, we would appreciate your approval of these responses as soon as possible.

As indicated in the July 2001 monthly report, the 3rd quarter 2001 groundwater sampling event and setup for the pumping tests at HRW-1 and RW-1 began today.

As always, please call Kevin Murphy or me if you have any questions or concerns.

Thank you.

Rebekah Brooks
Senior Hydrogeologist
Landau Associates, Inc.
rbrooks@landauinc.com
425-778-0907 ext. 105

Time Oil: Com

STRUCK Rodney

From: STRUCK Rodney
Sent: Monday, August 06, 2001 11:24 AM
To: 'Kevin Murphy'
Cc: 'chalbert@landauinc.com'; ROICK Tom
Subject: RE: Time Oil Vacuum Enhanced Pump Test

Kevin,

I have reviewed the "*Vacuum-Enhanced Pumping Test Work Plan*" prepared for the Time Oil Northwest Terminal in Portland, Oregon as requested. The work plan is approved as written. However, the Oregon Department of Environmental
Quality's (DEQ) comments are provided below:

1) Discharge rates should be monitored overtime during the pumping test. Based on our telephone conversation today, DEQ understands periodic measurements will be made during the duration of the test.

2) The work plan indicates that the off-gas will be collected and analyzed for volatile organic compounds using EPA Method TO-14 during the pump test. It should be noted that pentachlorolphenol (PCP) is not included in the VOC analyses and is a contaminant of concern at the Time Oil facility. Therefore, if it is determined that vacuum enhanced pumping is practicable at the facility, the off-gas should be tested for PCP and other semivolatile organic compounds (SVOCs) that might be present in the off-gas. This testing can be performed as part of the proposed pumping test or in subsequent tested if determined necessary.

   Potential emissions from an enhanced extraction system should be evaluated to assess potential impacts to air quality and the need for an air quality permit (or equivalent).

3) The work plan does not clearly define the criteria for defining "sustainable yield". DEQ assumes that Time Oil will evaluate the feasibility and cost effectiveness of implementing vacuum enhanced pumping following completion of the proposed test. If it is determined that vacuum enhanced pumping is feasible on a temporary or permanent basis, DEQ should be notified and potential regulatory requirements evaluated (e.g., air quality permits).

Please give me a call if you have any questions or concerns.

Rod Struck

Oregon Department of Environmental Quality
Northwest Region
Voluntary Cleanup and Portland Harbor Section
2020 SW Fourth Avenue, Suite 400
Portland, Oregon 97201

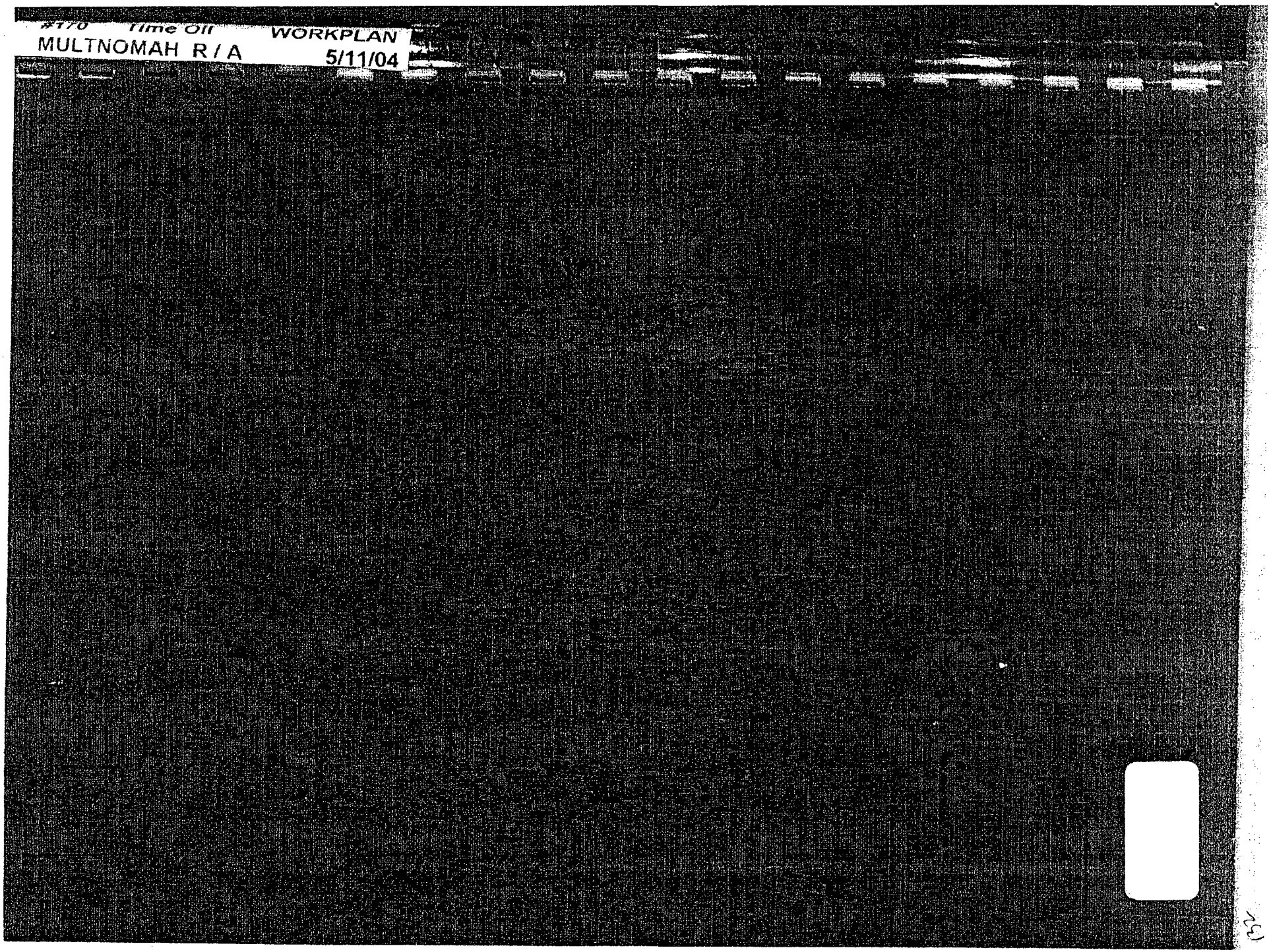
Phone: (503)229-5562
FAX: (503)229-6899

Visit DEQ's web page at: www.deq.state.or.us

-----Original Message-----
From: **Kevin Murphy [mailto:kmurphy@timeoil.com]**
Sent: Thursday, August 02, 2001 11:25 AM
To: STRUCK Rodney
Subject: Time Oil Vacuum Enhanced Pump Test

<< File: VacPumpTest_let.doc >> Rod,
I wanted to send you this electronic version in advance of the hard copy hitting your desk in hopes that you may be able to give it a quick review and OK. We are proposing a simple sustainable yield type test in

#170 Time Off WORKPLAN
MULTNOMAH R / A 5/11/04



SCHN00304311

Work Plan

LANDAU ASSOCIATES

Work Plan
In Situ Chemical Oxidation
Interim Remedial Action
Time Oil Northwest Terminal
Portland, Oregon

SCHN00304312

Work Plan
In Situ Chemical Oxidation
Interim Remedial Action
Time Oil Northwest Terminal
Portland, Oregon

May 11, 2004

Prepared for

Time Oil Co.
2737 West Commodore Way
Seattle, WA 98100-1233

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MAY 13 2004
DEPT OF ENVIRONMENTAL QUALITY
NORTHWEST REGION

LANDAU ASSOCIATES
130 2nd Avenue South
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SCHN00304313

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SCHN00304315

1.0 INTRODUCTION

This work plan presents the scope of work for implementation of an *in situ* chemical oxidation (ISCO) interim remedial action program at the Time Oil Northwest Terminal (site) in Portland, Oregon. Pentachlorophenol (PCP) has been identified as the primary contaminant of potential concern (COPC) in soil and groundwater at the site (Landau Associates 2004) and is the target compound of the proposed ISCO interim remedial action. A laboratory treatability study (ISOTEC 2002) and pilot test results (ISOTEC 2003) indicate that ISCO has proven to be successful in reducing PCP concentrations at the site in both shallow groundwater and saturated zone soil. A vicinity map is shown on Figure 1, and a site plan depicting the western portion of the site that has been impacted by PCP is shown on Figure 2. A description of the ISCO process and the objectives of this work plan are provided below. This work plan will be implemented following receipt of authorization to proceed from the Oregon Department of Environmental Quality (DEQ).

1.1 *IN SITU* CHEMICAL OXIDATION (ISCO) PROCESS DESCRIPTION

As previously presented in the work plan (Landau Associates 2002) prepared prior to the implementation of the pilot test, ISCO is the application of a chemical oxidant to the subsurface of a site with the intention of oxidizing contaminants into less toxic or non-toxic compounds. Some of the potential benefits of ISCO include:

- A fast reaction with contaminants and potential for achieving cleanup goals in a relatively short time period
- Elimination of the need to excavate soil or pump groundwater for treatment
- Elimination of the need for offsite disposal of residuals (e.g., treated groundwater or excavated soil).

The specific type of chemical oxidation that was implemented during the pilot test is based on Fenton's reagent oxidation technology as applied by In-Situ Oxidative Technologies, Inc. (ISOTEC) of Englewood, Colorado. The Fenton's reagent chemical oxidation reaction is created by the reaction of soluble iron with low concentrations of hydrogen peroxide to produce hydroxyl radicals (•OH). The hydroxyl radical is a very powerful and short-lived oxidizer that attacks the carbon double bonds of chlorinated hydrocarbons (e.g., PCP). An example chemical equation for Fenton's chemistry is shown below (where Fe^{2+} is ferrous iron, H_2O_2 is hydrogen peroxide, Fe^{3+} is ferric iron, OH^- is hydroxide ion, and •OH is the hydroxyl free radical):

$$Fe^{2+} + H_2O_2 \text{ ---> } Fe^{3+} + OH^- + \bullet OH$$

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Iron is used to catalyze the reaction. Maintaining iron in the solution is important for the process to be successful in an *in situ* application. Complexed iron, patented by ISOTEC, is used in the process to eliminate the necessity of performing the reaction under low pH conditions, as is the case with traditional Fenton's reagent chemistry. The hydrogen peroxide and dissolved iron solutions are injected into the subsurface. The reaction time is very fast, with oxidation capacity of the reagent typically being used up in a few days. As a result of the chemical reaction induced, hydrogen peroxide ultimately breaks down into water and oxygen, and the iron catalyst is oxidized and precipitates out of solution.

The dilute concentration of hydrogen peroxide used during the pilot test (about 17 percent), will be repeated for full-scale implementation. The low concentration helps to reduce the potential for significant exothermic reactions that can be associated with higher concentrations of hydrogen peroxide. ISOTEC's experience using low hydrogen peroxide concentrations and complexed iron has reportedly resulted in less than a 25°F temperature increase in field applications.

The dosage rate of Fenton's reagent injected into the groundwater during the pilot test will also be repeated for full-scale implementation. Approximately 200 gallons of 17 percent hydrogen peroxide and 200 gallons of complexed iron solution were used at each injection location during the pilot test.

1.2 OBJECTIVE OF ISCO INTERIM REMEDIAL ACTION

The objective of ISCO interim remedial action is to reduce the concentration of PCP present in shallow groundwater within the PCP source area and extent of the PCP plume in the upper zone groundwater, and to reduce the concentration of PCP in the soil located within the zone of groundwater fluctuation (i.e., smear zone). Target cleanup concentrations for PCP in groundwater have not yet been established for the site. Based on the groundwater analytical results observed since the completion of the ISCO pilot test, a decrease in dissolved-phase PCP concentration of 70 percent or more is anticipated.

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2.0 SUMMARY OF PILOT STUDY

In September of 2002, ISOTEC conducted a pilot test at the site to determine the effectiveness of ISCO to reduce PCP concentrations in upper zone groundwater and saturated zone soil at the site. A description of the pilot test and a summary of the results are provided below.

2.1 DESCRIPTION OF PILOT TEST

On September 17 and 18, 2002, ISOTEC injected reagents at ten locations (IP-1 through IP-10) across the pilot test area (Figure 3). The materials injected included 17 percent hydrogen peroxide, complexed iron solution, and tap water. The injection points were direct-push probes installed by the drilling contractor, Cascade Drilling, Inc., and consisted of 1.5-inch diameter, 3-ft long injection screens attached to the bottom of the direct-push rods. The injection points were driven to a depth of 19 to 19.5 feet below ground surface (BGS) and spaced 25 feet apart based on a 12.5- to 15-ft estimated radius of influence (ROI). The ROI was estimated based on site lithology, contaminant concentrations and ISOTEC's previous experience. The depths were chosen so that reagent could be delivered through the 3-ft screened interval to the saturated zone between the water table at approximately 16 ft BGS and a silt layer at approximately 19 ft BGS. The shallow groundwater located above the silt layer is referred to as the upper zone groundwater at the site.

On September 17, 2002, pilot test injections were conducted at IP-6, IP-7, IP-8, IP-9 and IP-10. On September 18, 2002, pilot test injections were completed at IP-1, IP-2, IP-3, IP-4 and IP-5. For each injection location, ISOTEC typically injected approximately 100 gallons of tap water followed by 100 gallons of stabilized 17 percent hydrogen peroxide (oxidizer). Following a second water flush, 100 gallons of the complexed iron solution (catalyst) was injected followed by a third water flush, 100 more gallons of oxidizer, a fourth flush, 100 more gallons of catalyst and a final flush. Injection pressures ranged from 0 to 35 psi and injection rates of fluids ranged from 2 to 6.7 gallons per minute (gpm) for nine of the ten injection points. Injection procedures for IP-8, however, had to be terminated due to injection pressures as high as 60 psi. IP-10 was installed and utilized as a replacement for IP-8, which received only a 20-gal initial flush and 3 gallons of 17 percent hydrogen peroxide prior to termination.

A more detailed description of pilot test injection methodology was presented in the summary report (ISOTEC 2003) submitted to DEQ by Landau Associates in correspondence dated June 18, 2003.

2.2 PILOT TEST RESULTS

Groundwater and saturated zone soil samples were collected by Landau Associates to evaluate the effectiveness of the pilot test. In Appendix A, Figures A-1 through A-6 present dissolved-phase PCP

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concentrations before and after the injection of Fenton's reagent for six monitoring wells. Also in Appendix A, Table A-1 summarizes soil analytical results collected in the pilot test area prior to and after the injection of Fenton's reagent. Based on the analytical data presented in Appendix A, the ISOTEC process was successful in reducing PCP concentrations in both groundwater and soil.

In comparison to analytical results from the baseline sampling event conducted prior to the pilot test injection, groundwater sampling data collected during October 22-24, 2003 indicate that PCP concentrations have decreased from 79 percent to 99.99 percent for wells in the PCP plume area. Wells sampled in October 2003 in the pilot test area include RW-1, LW-11S, OX-1S, and OX-3S. Other monitoring wells within the PCP plume area were not sampled because they were either dry (OX-4S) or contained measurable product (OX-2S). Given the previously reported dissolved-phase PCP concentrations [>5,000 micrograms/liter (µg/L)] reported for monitoring well OX-2S, and the proximity of OX-2S to monitoring well LW-11S, which formerly exhibited measurable product, the presence of product in OX-2S is not unexpected and is likely related to the lower seasonal groundwater elevation in the upper zone in comparison to previous sampling events. One shallow groundwater monitoring well (OX-5S) upgradient of the PCP plume area, and three shallow groundwater monitoring wells (OX-6S, OX-7S, and OX-8S) in the PCP plume area were installed in September 2003 (Figure 2). The new groundwater monitoring wells were initially sampled during the October 2003 sampling event. Groundwater samples collected from these wells will provide baseline data for the ISCO interim remedial action. In addition to the shallow groundwater monitoring wells, one monitoring well (OX-8D) was installed in the lower zone groundwater near OX-8S. Monitoring well OX-8D will not be used to monitor the ISCO interim remedial action effects. The soil boring logs and monitoring well construction details for OX-5S, OX-6S, OX-7S, OX-8S, and OX-8D are provided in Appendix B.

Results of the pilot test indicated that the ROI for an individual injection point was underestimated. The ROI was observed to extend from approximately 17 to 33 feet rather then the estimated 12.5 to 15 feet. As a result, the ROI anticipated for the ISCO interim remedial action program implementation will be greater than the ROI of the pilot test, as described in the pilot test summary report (ISOTEC 2003).

SCHN00304319

3.0 CURRENT CONDITIONS

A detailed description of the hydrogeologic conditions at the site is provided in the Phase III Remedial Investigation (RI) report (Landau Associates 2004). The ISCO interim remedial action is being implemented to target PCP in the upper zone groundwater. Therefore, the hydrogeologic conditions described in this section are limited to the upper zone of groundwater. The subsurface soil chemical conditions presented in this section are compilations of soil analytical data collected historically at the site, taking into consideration remedial activities (i.e., soil excavation and the ISCO pilot test) that have been completed to date. The groundwater conditions described in this section are derived from the quarterly groundwater sampling event conducted in October 2003 and the four groundwater gauging events completed in February, May, August, and October 2003.

3.1 UPPER ZONE HYDROGEOLOGIC CONDITIONS

Four principal near-surface hydrogeologic units have been identified at the terminal, based on similar geologic soil types and hydrogeologic characteristics. In descending order from ground surface, these units include an upper water-bearing zone (upper zone), a confining unit, a lower water-bearing zone (lower zone), and a deep sand unit. Depending on the continuity of the confining unit and silt layers separating the units, the hydrogeologic units can act as distinct aquifer units under unconfined conditions in the upper zone or under confined to semi-confined conditions in the lower zone, or act as a single unconfined aquifer. The ISCO interim remedial action will address the upper zone and associated confining unit described below.

Upper Zone

The upper zone at the site has the following properties:

- The upper zone is a discontinuous, unconfined aquifer in fill and river alluvial deposits, consisting predominantly of sand. Seasonal variability occurs in the upper zone water levels; therefore, the saturated thickness of the zone varies, with seasonal high water levels in the winter and spring, and seasonal low water levels in the fall.

- Horizontal groundwater flow in the upper zone within the developed area of the terminal is generally consistently to the west-southwest toward the Willamette River; however, localized changes in the flow direction to the south-southwest occur in an area near and including the former PCP mixing area. The groundwater elevation in the upper zone is subject to seasonal variation, with a typical variation of approximately 3 ft between the low water table period (fall) and the high water table period (winter and spring). Within the past twelve months, the groundwater elevation of upper zone monitoring wells was measured in February, May, August, and October 2003 (Figures 6 through 9, respectively). The groundwater flow direction in the upper zone does not appear to vary significantly seasonally.

SCHN00304320

- Average hydraulic conductivity estimates for the upper zone range from about 40 to 160 ft/day (including slug/bail test results) and the transmissivity is estimated to range from about 180 to 520 ft^2/day, assuming an average aquifer thickness of 4 ft. Groundwater velocities in the upper zone are estimated to range between about 0.7 to 7 ft/day.

Confining Unit

- A silt to sandy silt unit of variable thickness and areal extent separates the upper and lower zones across most of the terminal and appears to act as a confining or semi-confining layer for the lower zone. The silt unit consists of material that is characteristic of natural river overbank deposits, is heterogeneous, and varies in thickness across the site from less than 1 ft to about 17 ft.

- The confining layer thins and terminates west and southwest near the Willamette River and to the north of the former PCP mixing area. Thinning of the confining unit also occurs in a lenticular area south of the former PCP mixing area. As a result of the thinning of the confining unit in these areas, the upper and lower zones appear to be hydraulically connected, or the upper zone does not exist and the lower zone acts as an unconfined aquifer. Average vertical hydraulic conductivities of the confining unit have been determined to range between 0.004 to 0.007 ft/day.

3.2 SUBSURFACE SOIL CONDITIONS

PCP has been analyzed in soil samples collected during a series of subsurface soil investigations completed since 1986 and following a soil removal action completed in September through November 2002 (Landau Associates 2003). Soil analytical data presented in Figure 4 is representative of PCP concentrations present in the subsurface soil following the soil removal activities completed in September through November 2002, and the ISCO pilot test conducted in September 2002.

3.3 UPPER ZONE GROUNDWATER CONDITIONS

PCP in the upper zone groundwater extends in a narrow plume from the former PCP mixing area source area southwest to its most downgradient extent, approximately 400 ft from the source area (near LW-13S). The eastern and western boundaries and downgradient edge of the plume are defined by non-detected PCP concentrations at monitoring locations bordering the plume.

The most recent groundwater samples that were analyzed for PCP, and for which data validation has been completed, were collected on October 22-24, 2003. Based on the analytical results derived from the October 2003 sampling event (Figure 5), well OX-6S contained the highest detected concentration of PCP in the upper zone groundwater (2,100 µg/L). The groundwater analytical results from the October 2003 groundwater sampling event are presented in Figure 5.

SCHN00304321

A detailed discussion of the analytical results derived from the October 2003 groundwater sampling event was provided in the fourth quarter 2003 status report (Landau Associates 2004) submitted to DEQ.

SCHN00304322

4.0 ISCO INJECTION APPROACH

As described below, the ISCO interim remedial action will be implemented in general accordance with the recommendations from the pilot test report, and as presented in the Sampling and Analysis Plan (SAP; Appendix C). The ISCO injection events will likely occur three times during 2004, with groundwater progress sampling occurring between events to monitor effectiveness of the ISCO program and identify areas that may require focused treatment during the next injection event. The time between injection events will likely be three to four months, but this schedule may be modified based on analytical results observed. The first injection event is scheduled to take place in May or June 2004 to take advantage of high groundwater conditions.

4.1 SAFETY PROTOCOL

The ISCO interim remedial action will be performed in compliance with the site-specific health and safety plan (HASP; Landau Associates 2002). Prior to mobilization, the current HASP will be reviewed and modified, as necessary, to include appropriate procedures for handling the chemical oxidant and applicable material safety data sheets (MSDS). All personnel present onsite for the ISCO injection activities will be required to review, acknowledge, and comply with the provisions of the HASP.

4.2 INJECTION METHODOLOGY

The direct-push injection approach utilized during the pilot test will be used again for the interim remedial action. Similar to the pilot test method, each injection point will receive approximately 500 gallons of tap water, 200 gallons of 17 percent hydrogen peroxide, and 200 gallons of complexed iron solution. The spacing and depth of injection points is detailed below, however, these parameters may be adjusted based on progress sampling results between injection events and the groundwater elevation at the time the injection event is to be completed. In addition to the direct-push injection locations, additional hydrogen peroxide, complexed iron solution, and tap water may be introduced through a series of lateral injection wells that were installed during the completion of soil excavation activities in the vicinity of the former PCP warehouse and mixing area (Landau Associates 2003). The use of the lateral injection wells will be evaluated during the initial injection event. The continued use of the lateral injection wells in subsequent injection events will be dependent upon the observed effectiveness of injection fluids in entering the shallow groundwater formation and an observed reduction in dissolved-phase PCP in the upper zone.

SCHN00304323

4.2.1 BASELINE GROUNDWATER MONITORING EVENT

In preparation for the ISCO interim remedial action, and as a follow up to the soil removal activities completed in 2002, four monitoring wells (OX-5S through OX-8S) were installed in the vicinity of the former PCP warehouse and mixing area in September 2003. These four monitoring wells, and the six additional monitoring wells (RW-1, LW-11S, and OX-1S through OX-4S) previously used to monitor results of the pilot test, will be utilized to document baseline conditions prior to the injection of chemical oxidation reagents into the groundwater and to evaluate the effect of the ISCO injection program on PCP, selenium, and iron concentrations between the injection events. Sampling and analysis will be performed in accordance with the SAP (Appendix C) of this work plan. The SAP includes the full list of parameters for analyses at the monitoring wells.

4.2.2 INJECTION LOCATIONS

The pilot test summary report recommended 50-ft spacing between injection points, with a 25-ft ROI estimated for each injection location. However, 40-ft spacing will be used for the first injection event of the full-scale ISCO implementation in order to allow for overlapping radii of influence. The reagents will be delivered at a depth of approximately 16 to 19 ft BGS. The proposed locations of the direct-push ISCO injection points (IP-1-A through IP-30-A) and lateral injection wells (MPline01, 02E, 02W, 03E, 03W, and 04) are shown on Figure 10.

The lateral injection wells are located in the vicinity of the former PCP warehouse and mixing area, which is considered to be the primary source area for PCP impacts to the subsurface. Each lateral injection well is constructed of 4-inch diameter, schedule 40 PVC pipe with solid wall risers and horizontal sections comprised of alternating sections of solid wall pipe and well screen pipe. If utilized for the introduction, it is anticipated that the Fenton's reagent fluids will be pumped into the lateral injection wells through the solid wall risers and will diffuse into the groundwater formation through the well screen pipe. The horizontal portion of each of these lateral injection wells is approximately 12 ft BGS. This method of injection will only be utilized if the horizontal portions of the injection wells are submerged in the water table or are no more than 1 ft above the water table and if this method appears to effectively deliver injected fluids into the shallow groundwater formation.

4.2.3 INJECTION OF ISCO CHEMICALS

Injection of the chemical oxidation reagents will initially be performed by a team comprised of personnel from Landau Associates, ISOTEC, and Cascade Drilling. Following the initial injection event, the subsequent injection events may be performed by Landau Associates and Cascade Drilling personnel.

SCHN00304324

4.2.3.1 Groundwater Injection Methods

Cascade Drilling will use a direct-push rig to install injection screens at the designated injection locations. ISOTEC will attach 3-ft-long injection screens to the bottom of the 1.5-inch diameter direct-push rods, allowing hydrogen peroxide, complexed iron solution, and tap water to be delivered into the 3-ft screened interval. Typically, injection screens will be driven to a depth of approximately 16 to 19 ft BGS and spaced 40 feet apart. The depths were chosen so that reagent will be delivered to the upper zone groundwater, without disturbing the silt layer (confining unit) located at varying depths from 16 to 19 ft BGS at the site. The first injection event will include approximately 30 injection points distributed over the PCP plume area.

Tap water, hydrogen peroxide (oxidizer), and a complexed iron solution (catalyst) will be pumped into the injection points using small diaphragm pumps. For each injection location, ISOTEC will inject fluids as follows (all volumes are approximate):

- 100 gallons tap water as water flush
- 100 gallons of oxidizer (17 percent hydrogen peroxide)
- 100 gallons of tap water
- 100 gallons of catalyst (complexed iron solution)
- 100 gallons of tap water
- 100 gallons of oxidizer
- 100 gallons of tap water
- 100 gallons of catalyst
- 100 gallons of tap water.

Injection pressures are expected to range from 0 to 35 psi and injection rates are expected to range from 2 to 6.7 gpm. If variations in the geologic formation cause injection pressures to exceed 40 psi or injection rates to be less than 1 gpm, adjustments will be made to the injection depth or location. Each injection event is expected to be completed within one to two weeks. A schematic depiction of the ISCO injection process is provided on Figure 11.

In addition to the vertical injection points, similar volumes of water, oxidizer, and catalyst will be introduced to the subsurface through each of the six lateral injection wells located near the former PCP warehouse and mixing area.

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4.2.3.2 Field Monitoring During Groundwater Injection

As referenced in the SAP (Appendix C), field monitoring during injection will consist of the following:

- Monitoring the groundwater temperature in upper zone monitoring wells (OX-1S through OX-8S, LW-11S, and RW-1) located within the injection area so that groundwater temperature is maintained below the level that subsurface utilities and monitoring well materials could be endangered. If the temperature rises above 100°F, injection would be temporarily discontinued until the groundwater temperature stabilizes.

- Monitoring the injection pressure to determine the formational resistance at the injection point. If the injection pressure is determined to be greater than 45 psi, the injection at that point will be terminated and the injection point will be relocated.

- Monitoring the generation of gas in the subsurface. An explosimeter will be used to monitor the condition (i.e., explosive potential and organic concentration) of vapors in the subsurface storm sewer pipeline during the injection event. If explosimeter readings indicate that the subsurface vapors in the monitoring wells or subsurface utilities exceed 20 percent of the lower explosive limit (LEL), ISCO injection activities will be ceased. Vapor extraction will be resumed after explosimeter readings indicate vapors in the subsurface are less than 20 percent of the LEL.

- Monitoring the oxidation/reduction potential of groundwater in the injection area monitoring wells (OX-1S through OX-8S, LW-11S, and RW-1) prior to and after the injections completed on a daily basis.

- If present, the depth and thickness of nonaqueous-phase liquid (NAPL) in monitoring wells located within the vicinity of the injection points will be measured.

4.2.4 POST GROUNDWATER INJECTION MONITORING

A groundwater sampling event will be performed approximately two weeks following the completion of each ISCO injection event. If practical, the injection events will be conducted on a schedule which allows for the routinely-scheduled groundwater monitoring event to serve as the post-injection groundwater monitoring event. In accordance with correspondence submitted by Landau Associates to DEQ dated February 2, 2004, the ISCO monitoring wells RW-1, LW-11S, and OX-1S through OX-8S would be routinely sampled in February and August.

Additional groundwater sampling events may be performed, as needed, to monitor the effects on groundwater induced by the ISCO injection events, specifically to monitor the potential for an increase or "rebound" of PCP concentrations. In addition to PCP, selenium and iron (ferrous iron) concentrations will be monitored during the quarterly groundwater sampling events to determine if the ISCO injections cause an unacceptable increase in concentration of these metals in groundwater. The details of the

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groundwater monitoring associated with the implementation of the ISCO interim remedial action are provided in the SAP in Appendix C.

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5.0 DISPOSITION OF WASTE MATERIAL

Several types of waste material may be generated during the completion of the ISCO pilot study. A description of the types of waste material anticipated and the proposed method of disposal follow:

- Soil cuttings will not be generated during the completion of injection point installation
- Groundwater generated during the purging of groundwater monitoring wells will be deposited to the terminal wastewater treatment system located onsite for treatment and discharge, as indicated in the SAP
- Disposable personal protective equipment (PPE) will be collected in trash bags and disposed in the existing trash dumpster onsite for disposal at the local municipal waste landfill
- Empty containers of hydrogen peroxide will be removed from the site at the conclusion of each injection event to be recycled by the supplier.

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6.0 ANALYSIS OF EFFECTIVENESS

Following completion of each ISCO injection event and follow-up monitoring, an evaluation will be performed to assess the effects of the ISCO injection program on the upper zone groundwater. The evaluation and subsequent reporting are described below.

6.1 DATA EVALUATION

The data evaluation to be performed following the ISCO injection events will include assessment and/or calculation of the following:

- PCP concentration changes and changes in PCP plume area
- PCP mass removal
- Estimated area of influence observed
- Estimated dosage rate required to meet specific mass removal goals
- Potential health and safety risks
- Formation of undesired reaction by-products (e.g., selenium and iron).

The data analysis will be performed to assess the effectiveness of the ISCO program for the PCP plume in upper zone groundwater and what modifications need to be made prior to future ISCO injection events.

6.2 REPORTING

The results of the data evaluation will be presented within the quarterly progress reports already being completed for submittal to DEQ. If it is determined that more than one injection event is advisable within a quarterly monitoring period, a technical memorandum will be submitted to DEQ to provide a rationale for the injection event prior to mobilizing to the site to complete the injection event.

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7.0 PROPOSED SCHEDULE

The first injection event is scheduled to take place in May or June 2004 to take advantage of high groundwater conditions typical during spring. Subsequent injection events and monitoring schedules will be proposed in quarterly status reports or technical memoranda submitted to DEQ. If feasible, the timing of the injection events will be coordinated to occur approximately two weeks prior to the regularly scheduled groundwater monitoring event to be completed in the second quarter of 2004.

* * * * * *

This [illegible] been prepared under the supervision and direction of the following key staff.

LANDAU ASSOCIATES, INC.

Martin T. Powers, P.E.
Senior Associate Engineer

Rebekah Brooks
Associate Hydrogeologist

MTP/RB/tam

SCHN00304330

8.0 REFERENCES

In-Situ Oxidation Technologies, Inc. (ISOTEC). 2003. *Field Pilot Test Report, Time Oil Northwest Terminal, Portland, Oregon*. March 26.

In-Site Oxidation Technologies, Inc. (ISOTEC). 2002. *Laboratory Treatability Study Report, Time Oil Northwest Terminal, Portland, Oregon.* August 9.

Landau Associates. 2004a. *Phase III Remedial Investigation Report, Time Oil Northwest Terminal, Portland, Oregon.* April 30.

Landau Associates. 2004b. *Fourth Quarter 2003 Groundwater Monitoring and Groundwater Interim Action Status Report, Time Oil Northwest Terminal, Portland, Oregon.*

Landau Associates. 2003. Removal Action Completion Report, Phases I/II RI Areas, Time Oil Northwest Terminal, Portland, Oregon. November 10.

Landau Associates. 2002. *Work Plan: In-Situ Chemical Oxidation Pilot Study, Time Oil Northwest Terminal, Portland, Oregon.* June 7.

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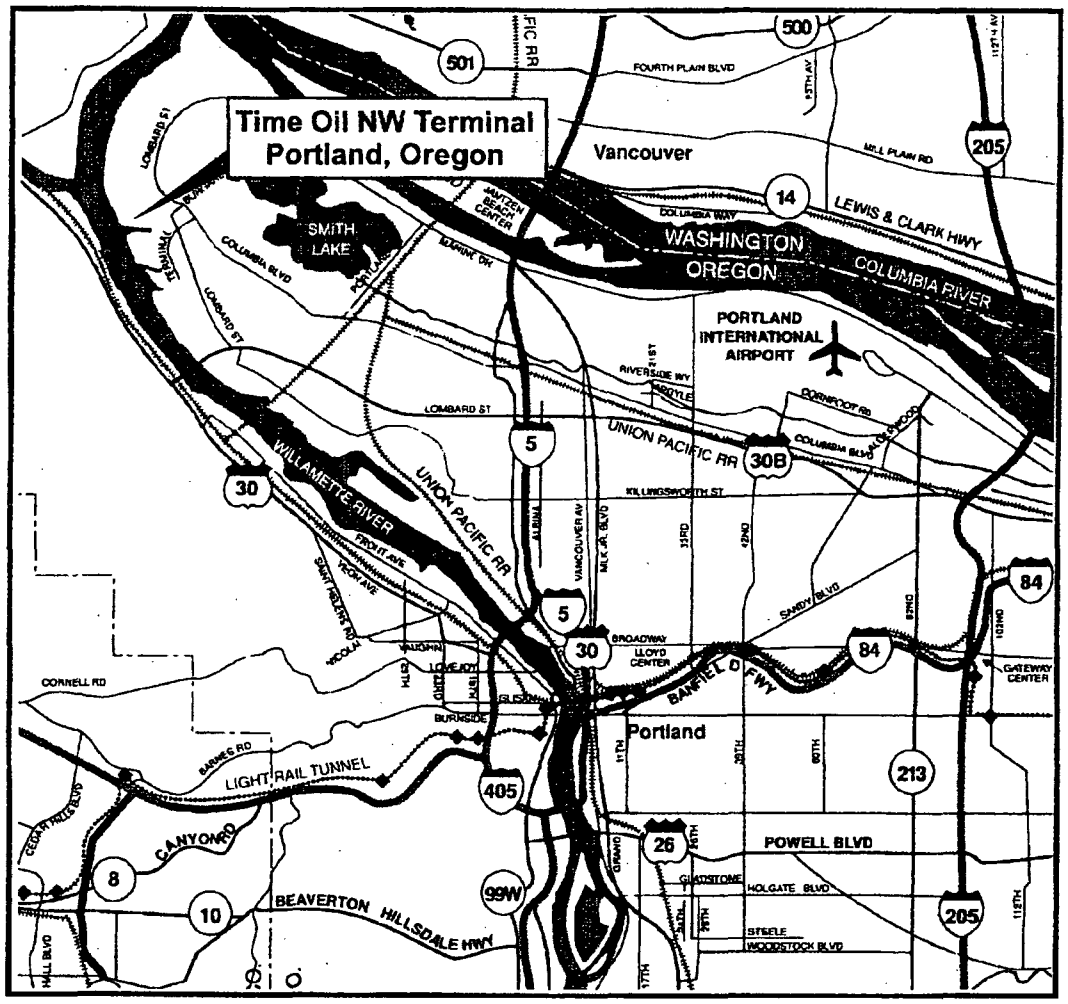
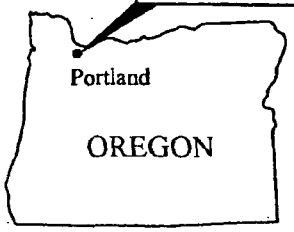


Map from MetroAmerica 1995

SITE LOCATION
(see enlarged map area above)



0 2 4
Approximate Scale in Miles

Time Oil | T:\231\001\Vicinity Map.cdr (C) 6/20/2003

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Time Oil NW Terminal Portland, Oregon	**Vicinity Map**	Figure 1

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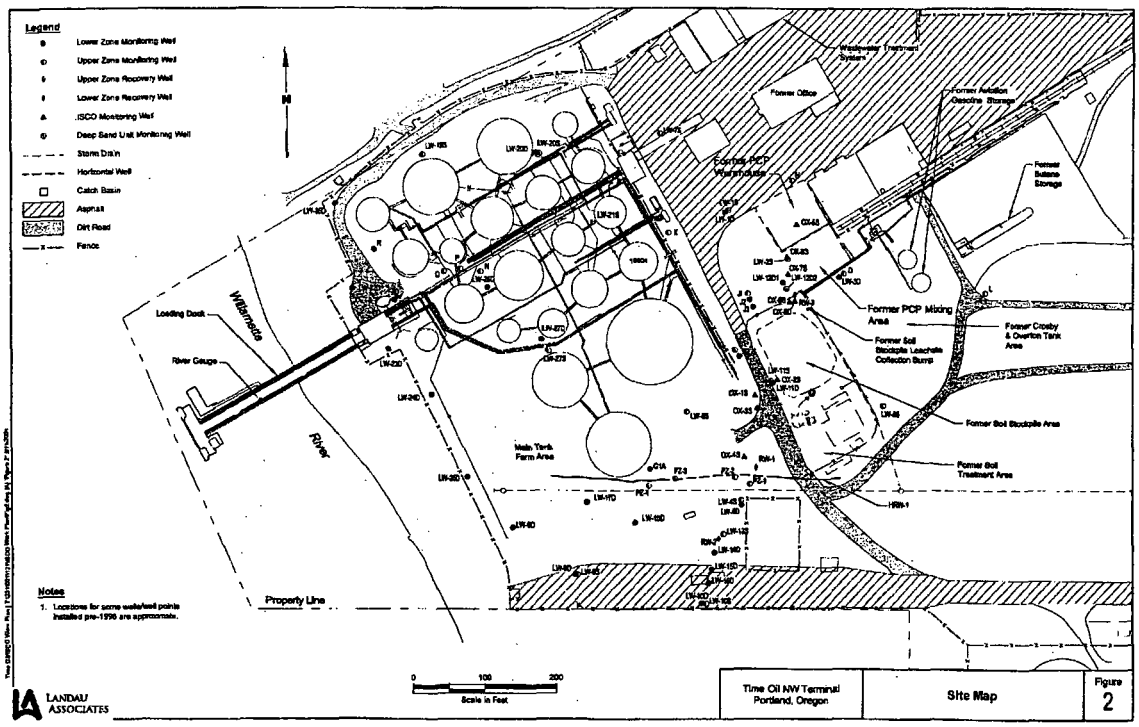

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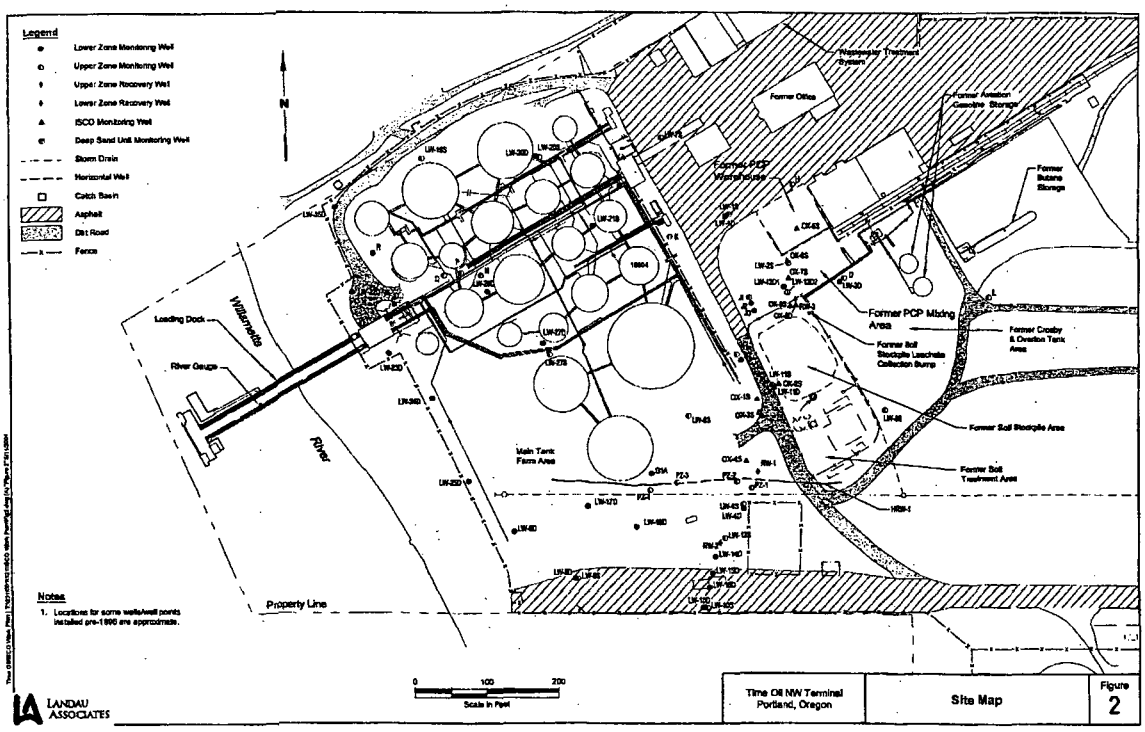

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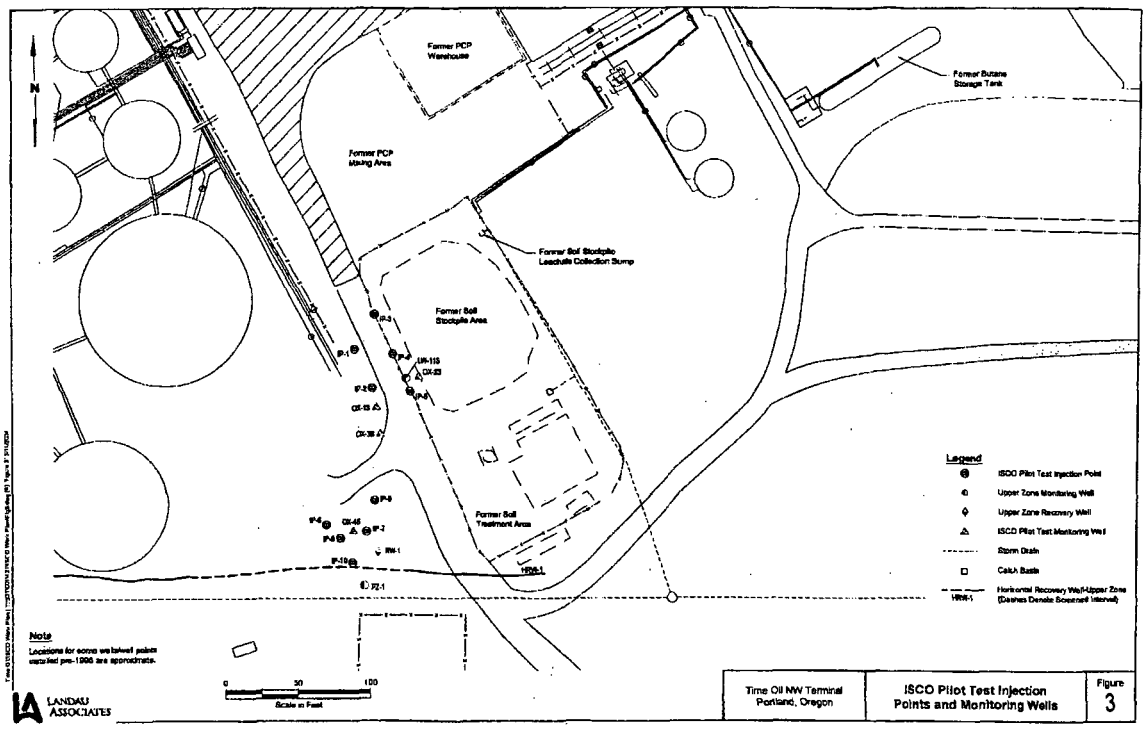

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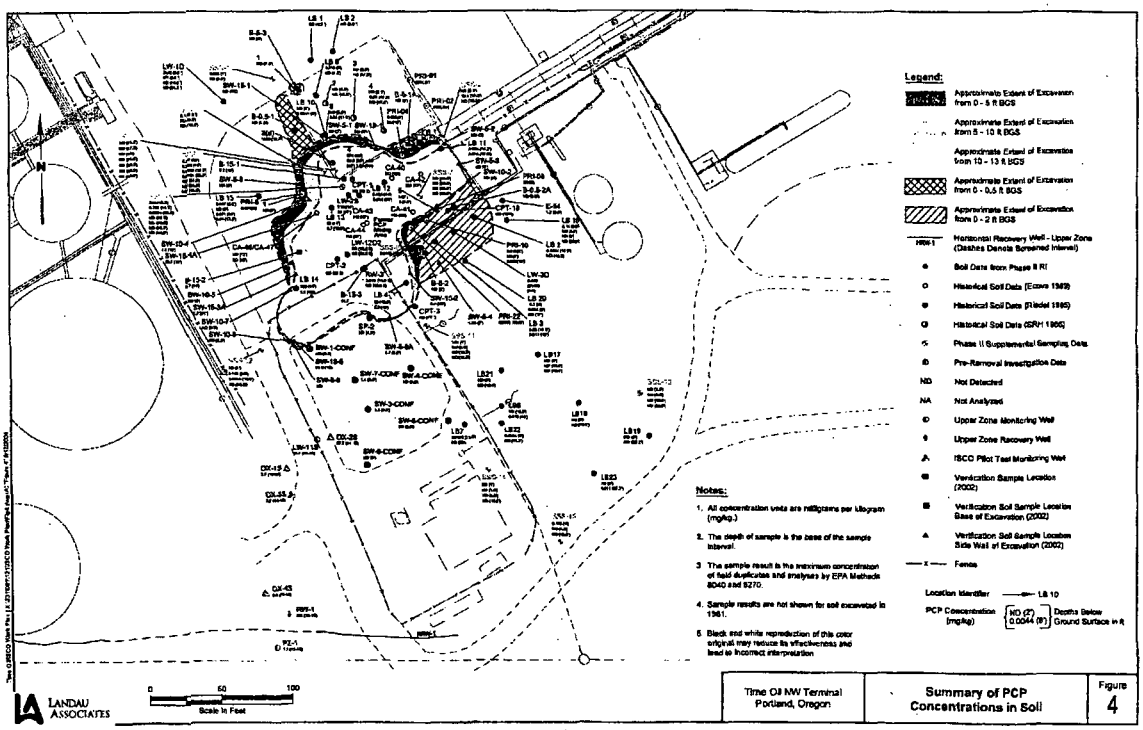

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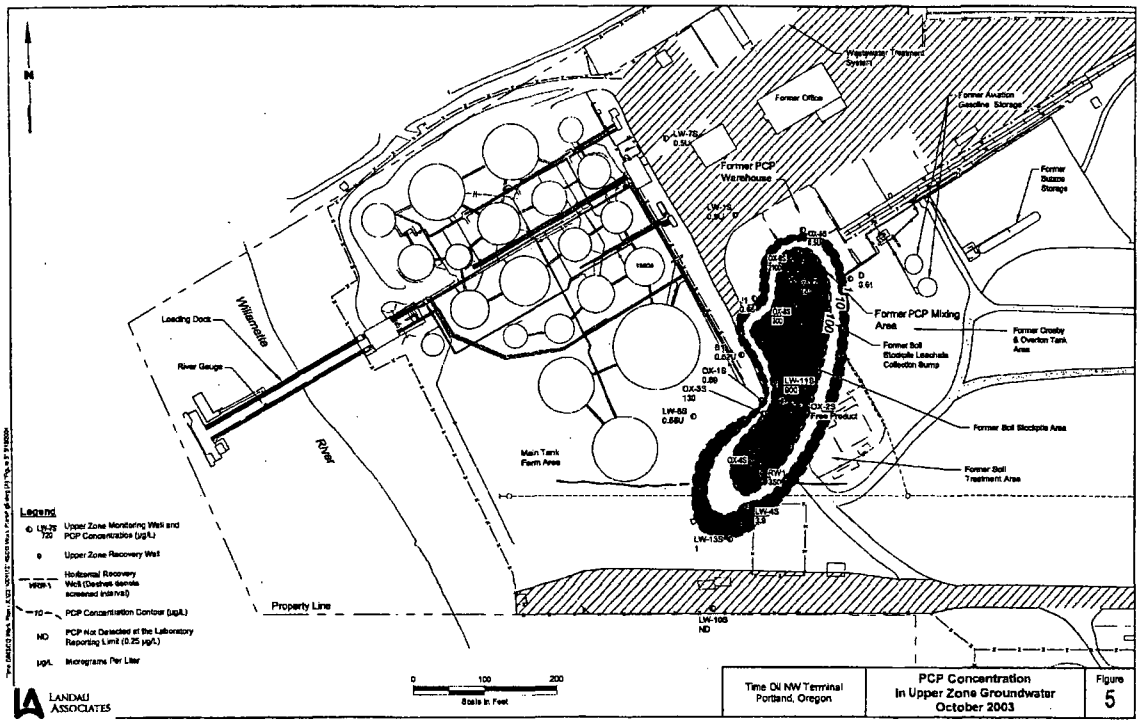

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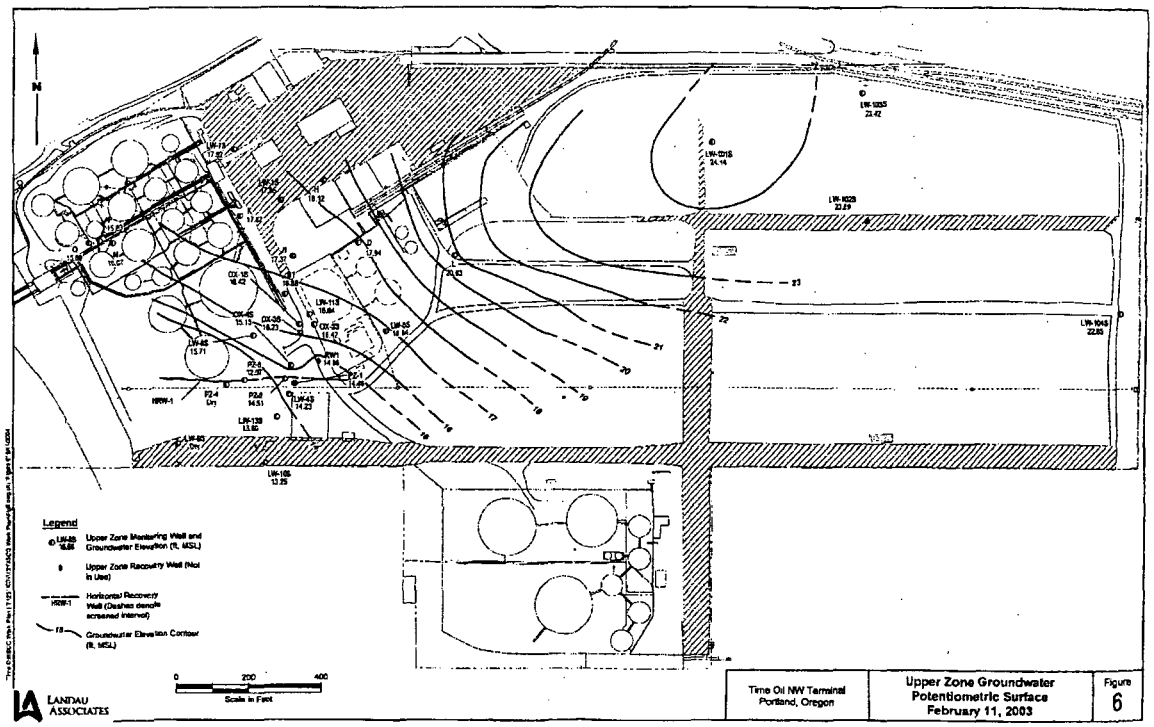
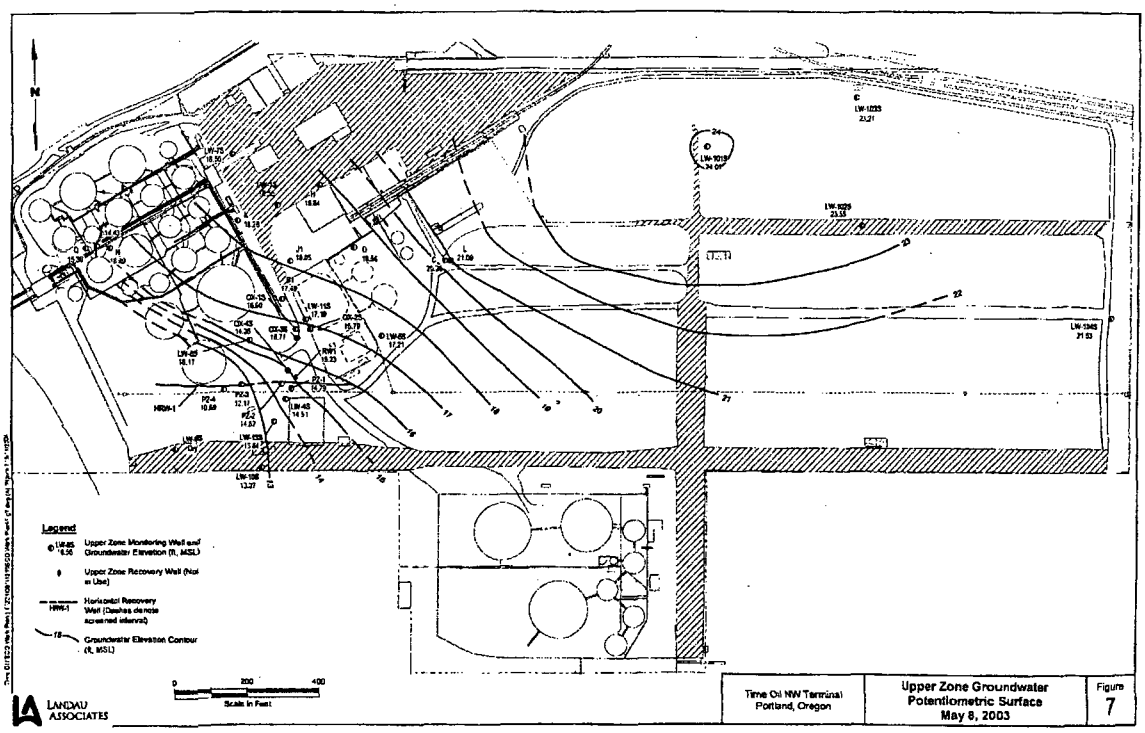


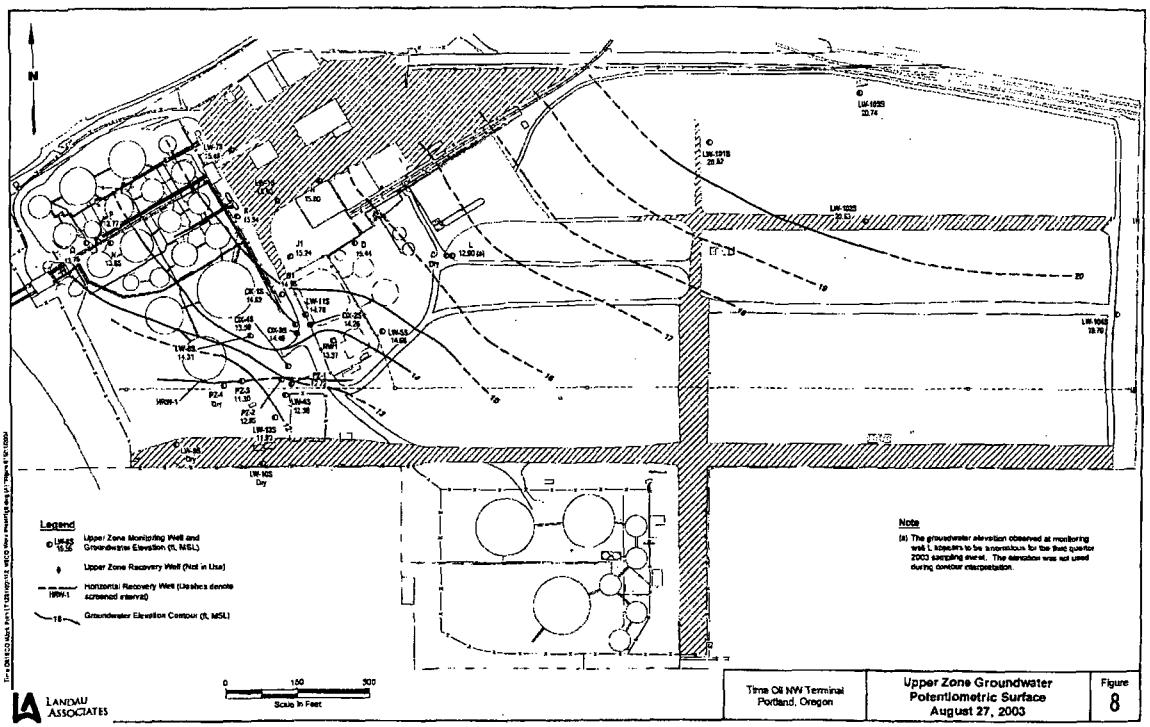
Time Oil NW Terminal Portland, Oregon	Upper Zone Groundwater Potentiometric Surface February 11, 2003	Figure 6

SCHN00304338



Time Oil NW Terminal Portland, Oregon	Upper Zone Groundwater Potentiometric Surface May 8, 2003	Figure 7

SCHN00304339



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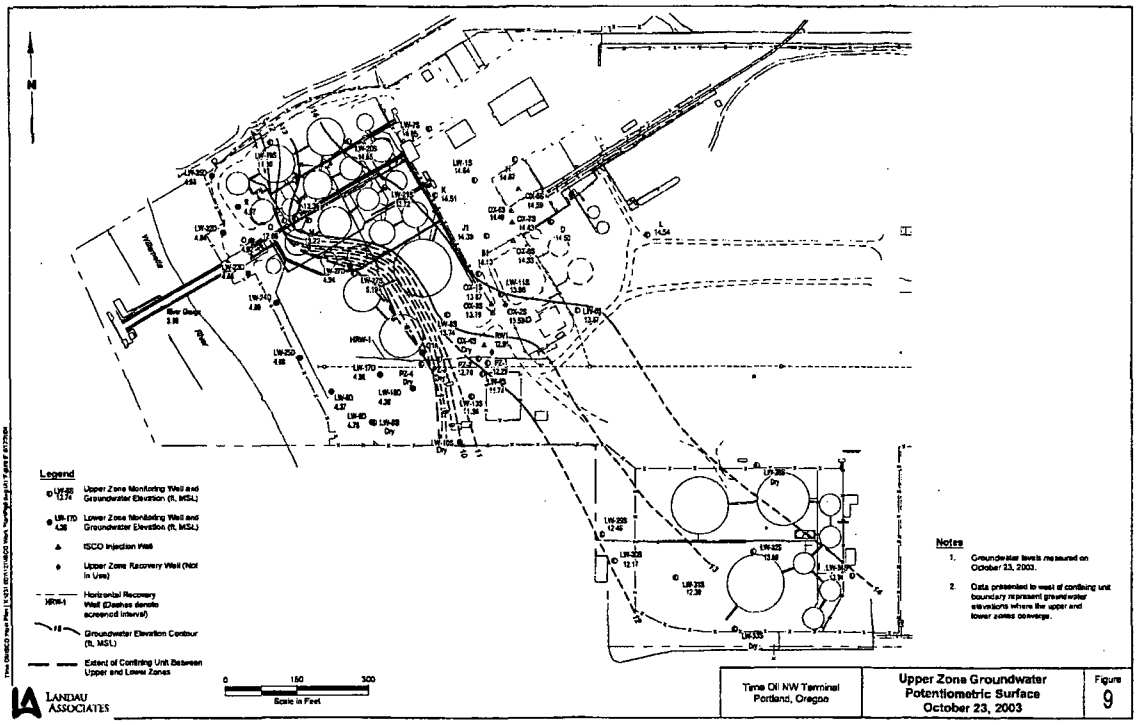
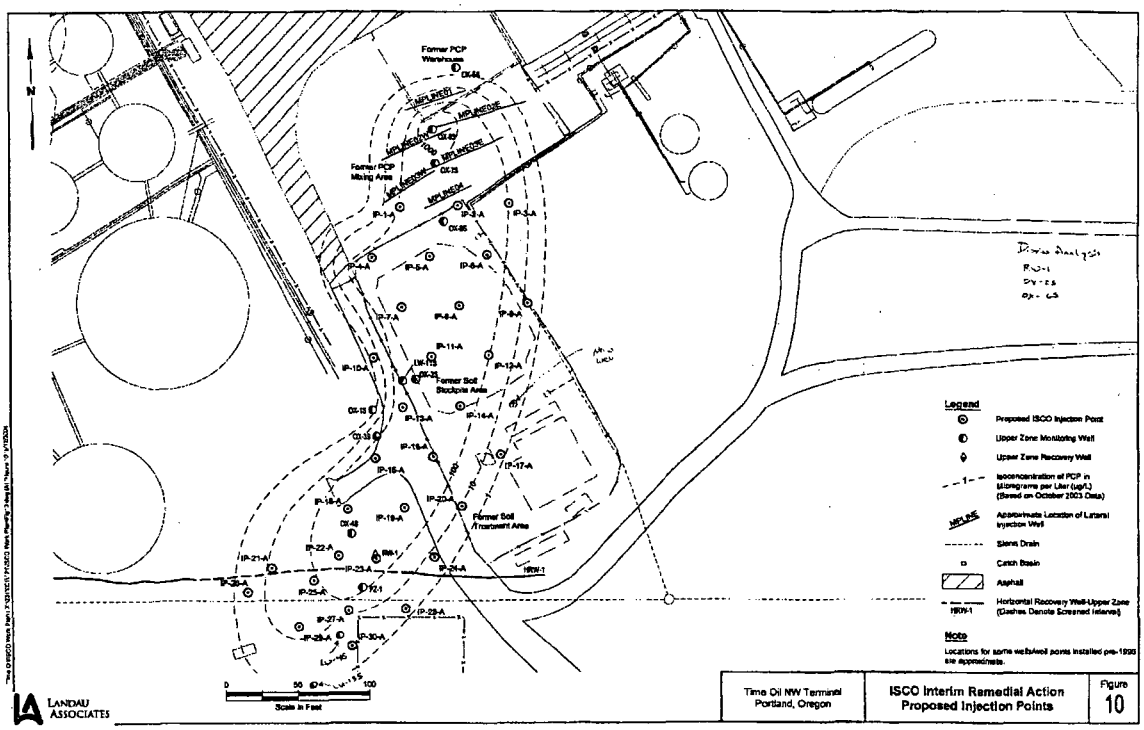


Time Oil NW Terminal Portland, Oregon	Upper Zone Groundwater Potentiometric Surface October 23, 2003	Figure 9

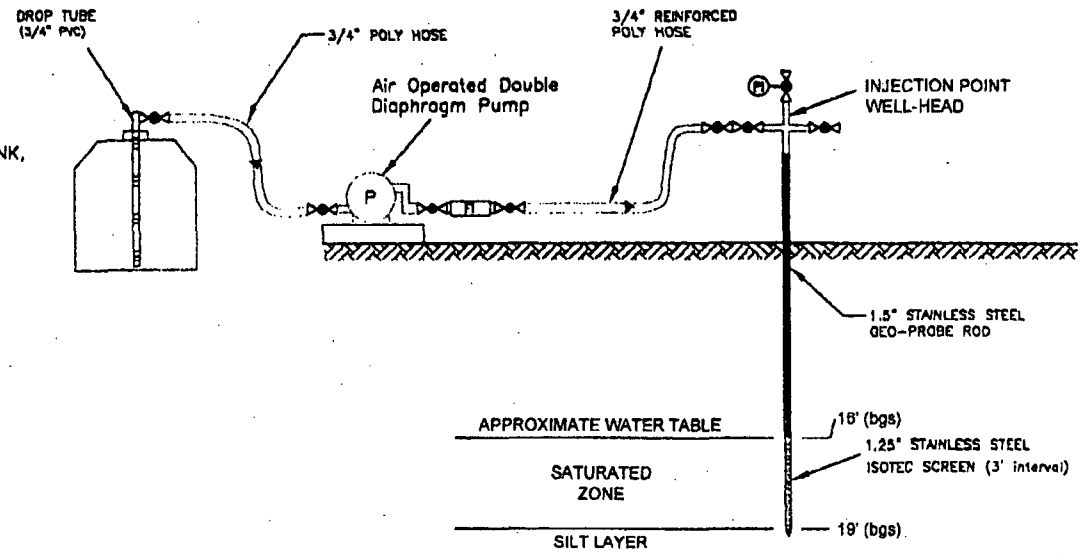
SCHN00304341



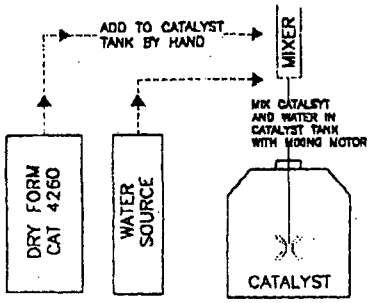
SCHN00304342

ISOTEC REAGENT INJECTION PROCEDURE

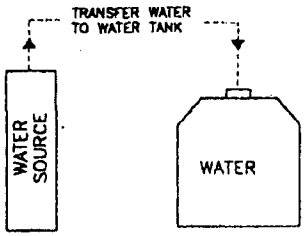
1.) DROP TUBE IS PLACED IN WATER TANK AND PUMP IS ACTIVATED.
2.) DROP TUBE THEN PLACED IN OXIDIZER TANK, CONTINUE INJECTIONS.
3.) WATER FLUSH IS INITIATED AT COMPLETION OF OXIDIZER INJECTIONS
4.) DROP TUBE IS MOVED TO CATALYST TANK, CONTINUE INJECTIONS
5.) FINAL WATER FLUSH IS COMPLETED



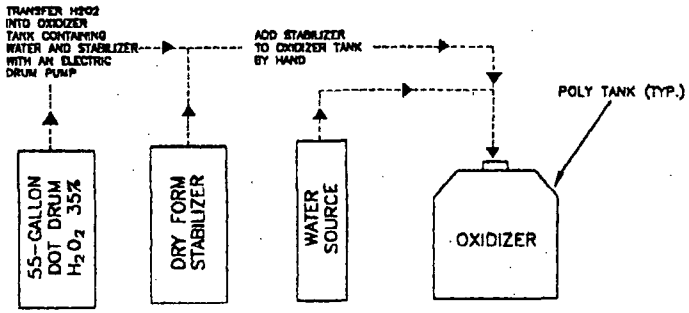
CATALYST TANK PROCEDURES



WATER TANK PROCEDURES



OXIDIZER TANK PROCEDURES



Source: In-Situ Oxidative Technologies, Inc. 2003

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Time Oil NW Terminal Portland, Oregon	**ISCO Injection Schematic Depiction**	Figure **11**

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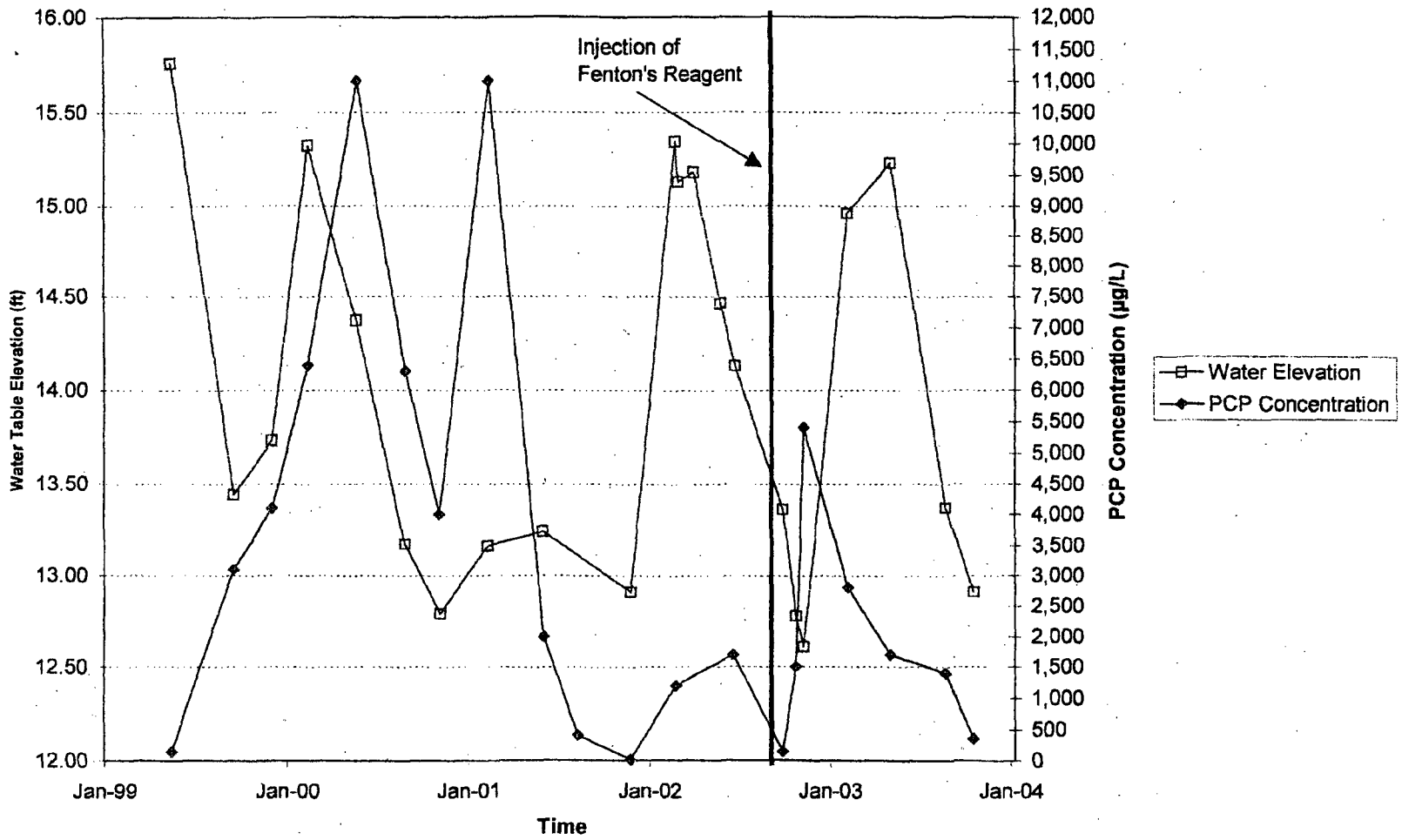
APPENDICES

SCHN00304344

APPENDIX A

Dissolved- and Adsorbed-Phase PCP Results Since Pilot Test



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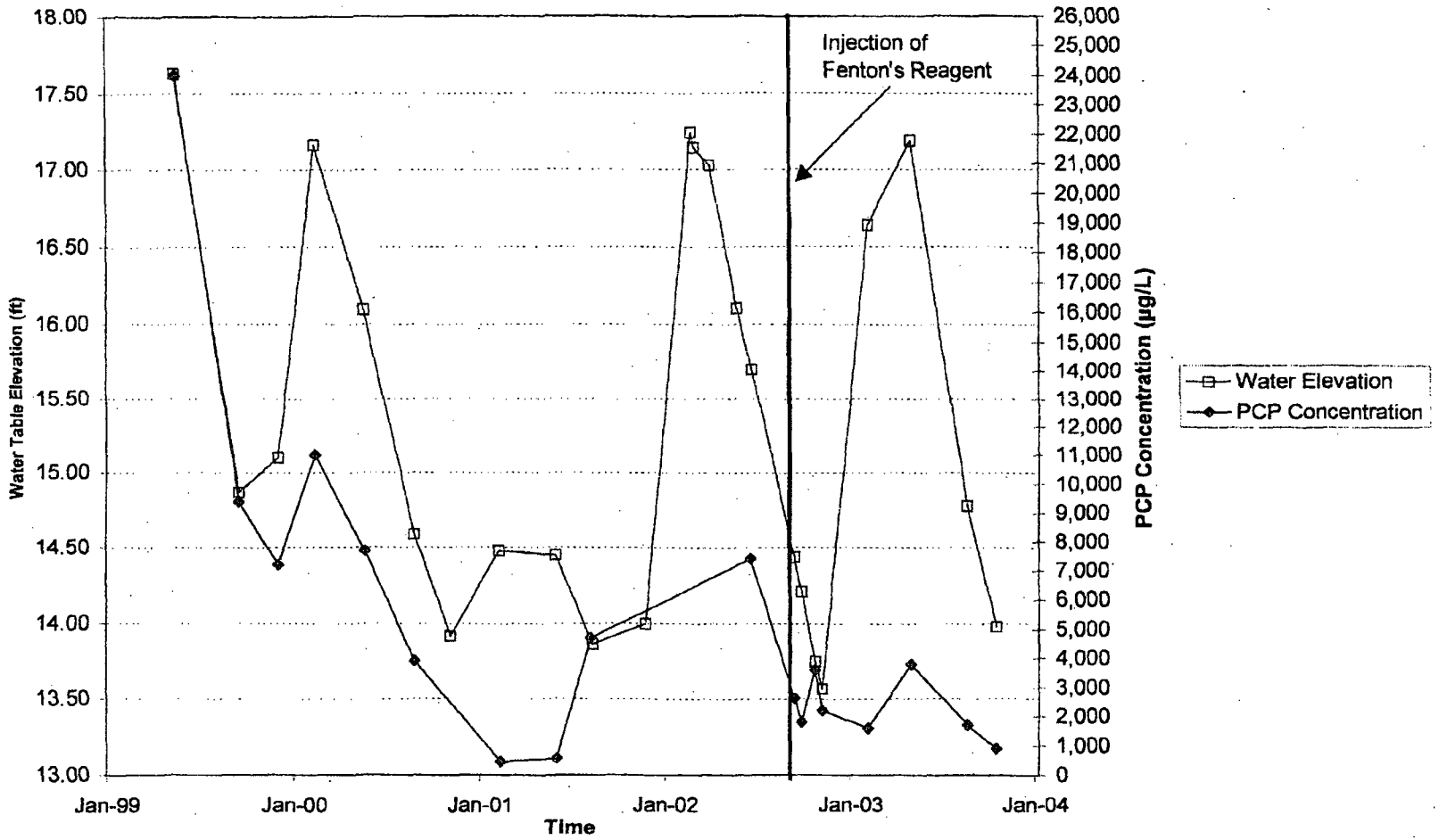
Time Oil Northwest Terminal Portland, Oregon	RW-1	Figure A-1

SCHN00304346

Source: s:\wproc\231\001\118\Pilot Test Cvr Ltr_Tb1.xls LW-11S



Note: Groundwater elevation without corresponding PCP concentration (e.g., December 2001 - June 2002) is indicative of the presence of LNAPL and no sample was collected for analysis.

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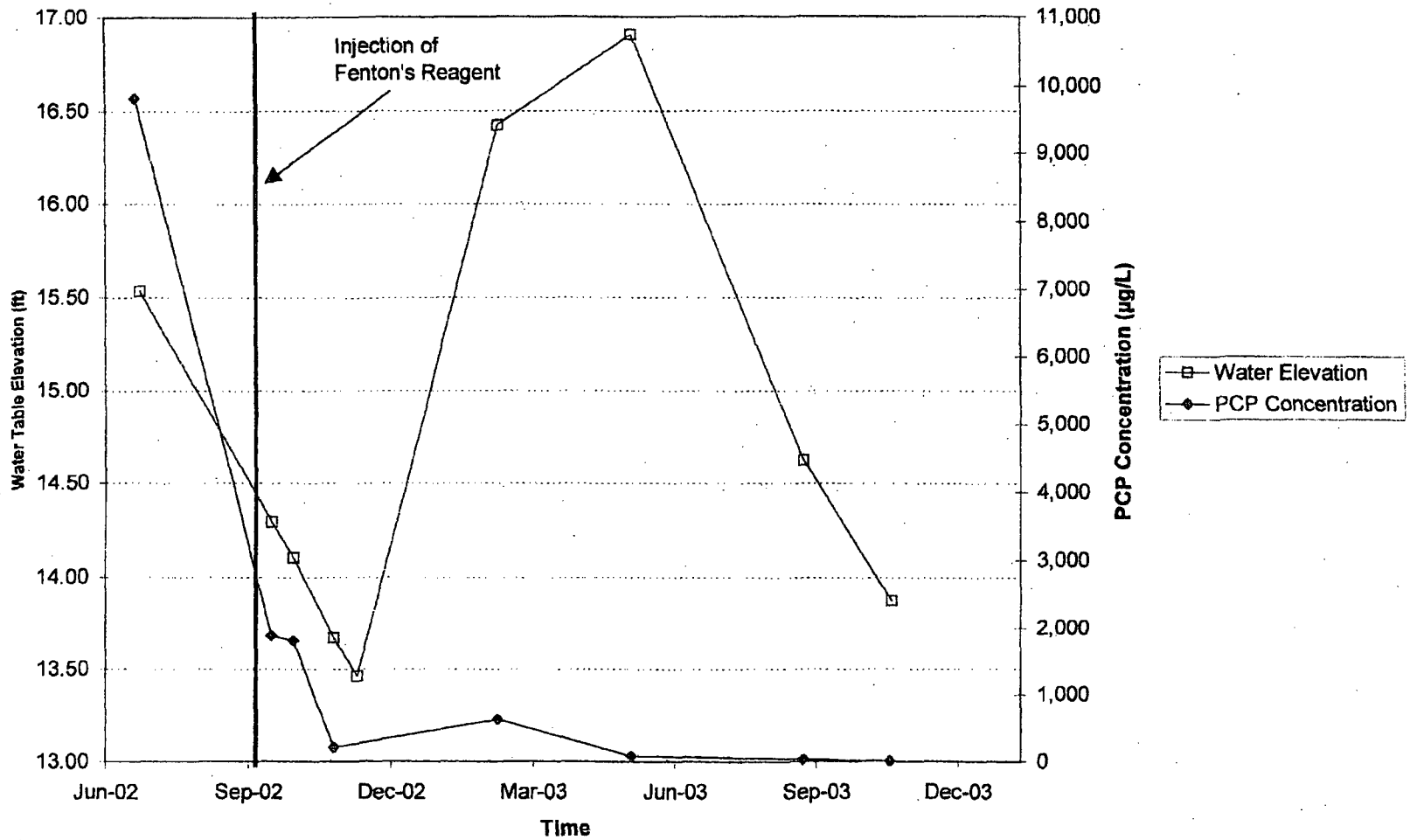
Time Oil Northwest Terminal Portland, Oregon	LW-11S	Figure A-2

SCHN00304347

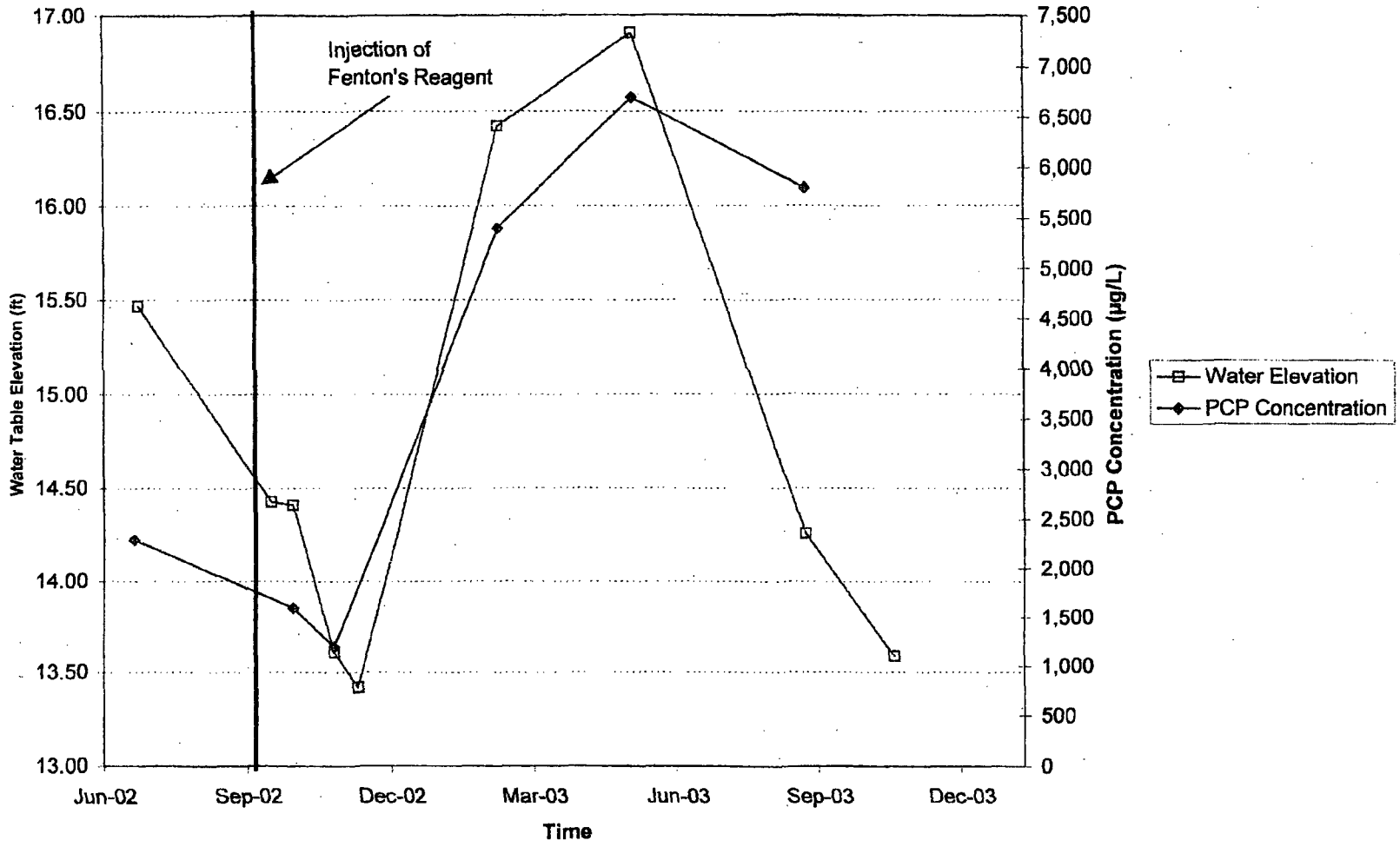


LANDAU ASSOCIATES

Time Oil Northwest Terminal Portland, Oregon	OX-1S	Figure A-3

SCHN00304348

Source: s:\wproc\231\001\118\Pilot Test Cvr Ltr_Tb1.xls OX-2S



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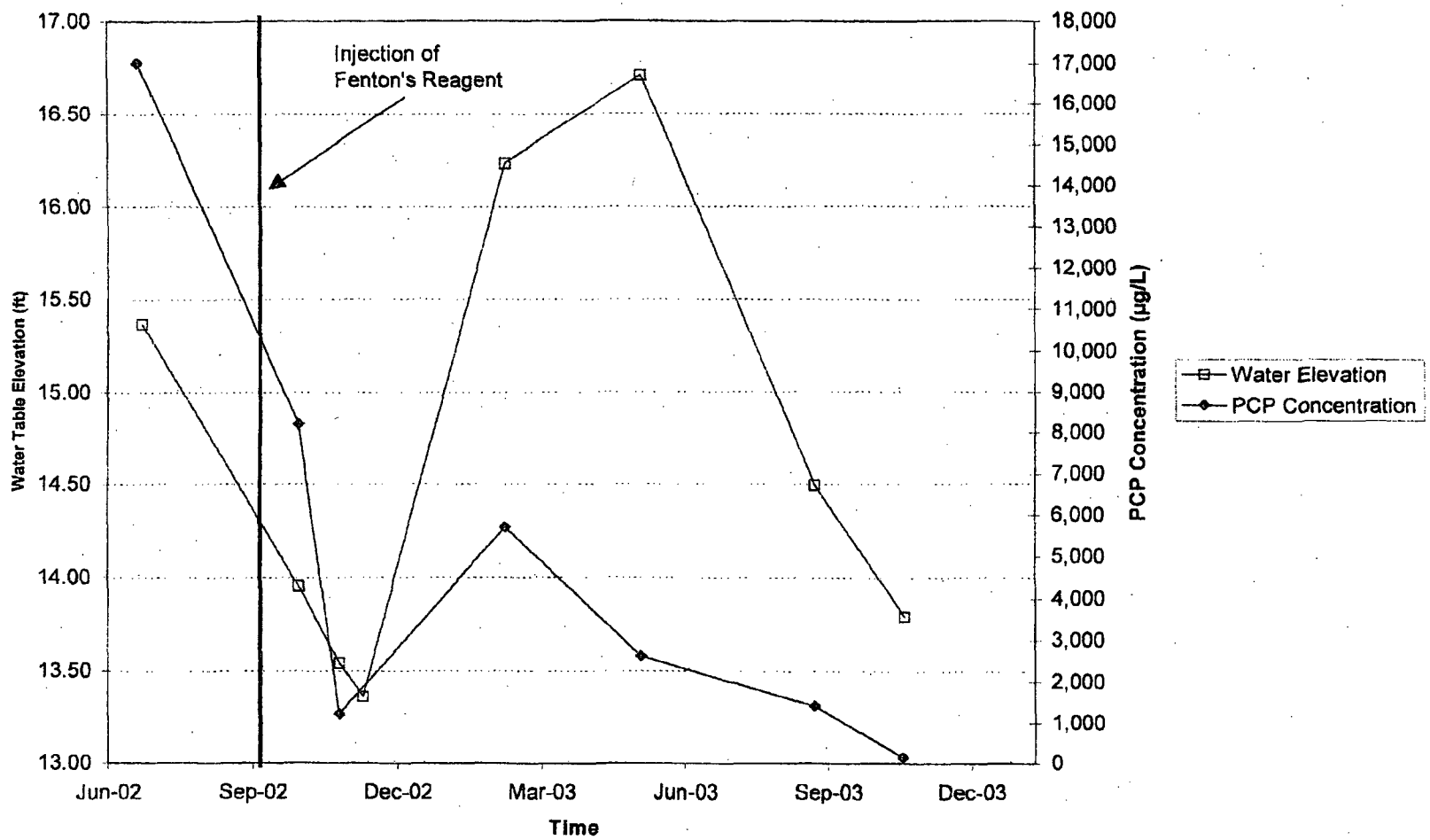
Time Oil Northwest Terminal Portland, Oregon	OX-2S	Figure A-4

SCHN00304349



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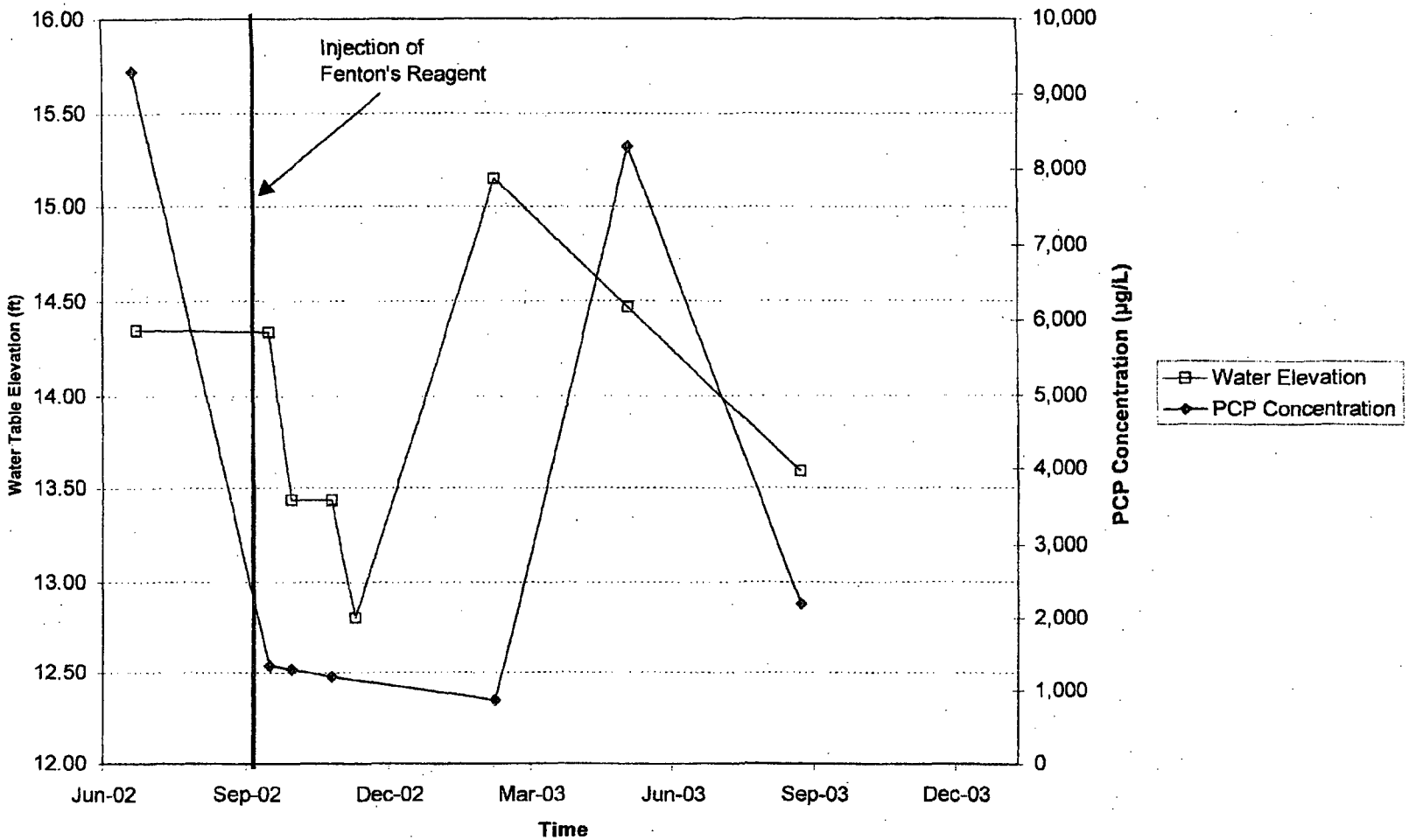
Time Oil Northwest Terminal Portland, Oregon	OX-3S	Figure A-5

SCHN00304350



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Time Oil Northwest Terminal Portland, Oregon	OX-4S	Figure A-6

SCHN00304351

TABLE A-1
ISCO PILOT TEST SOIL ANALYTICAL RESULTS
TIME OIL NORTHWEST TERMINAL

Sample Identification:	Baseline OX-1S	OX-1S	Baseline OX-2S	OX-2S	Baseline OX-3S	OX-3S	Baseline OX-4S	OX-4S	PZ-1	LW11S	RW1
Depth:	15-16	14-17	15-16	14-17	15-16	14-18	15.5-16.5	14-18	13-16	15-19	13-17
Laboratory Identification:	EM10B	0210067-05A	EM10A	0210067-04A	EM10C	0210067-03A	EM10D	0210067-01A	0210067-06A	0210067-02A	0210067-07A
Date Collected:	6/14/2002	10/8/2002	6/14/2002	10/8/2002	6/14/2002	10/8/2002	6/17/2002	10/8/2002	10/8/2002	10/8/2002	10/8/2002
CHLORINATED PHENOLS (µg/kg)											
EPA Method SW8040											
Pentachlorophenol	6000	NA	9900	NA	11000	NA	1300	NA	NA	NA	NA
2,4,6-Trichlorophenol	7.9 U	NA	7.9 U	NA	7.8 U	NA	7.9 U	NA	NA	NA	NA
2,3,6-Trichlorophenol	7.9 U	NA	7.9 U	NA	7.8 U	NA	7.9 U	NA	NA	NA	NA
2,4,5-Trichlorophenol	7.9 U	NA	7.9 U	NA	7.8 U	NA	7.9 U	NA	NA	NA	NA
2,3,4-Trichlorophenol	7.9 U	NA	8.8 U	NA	7.8 U	NA	7.9 U	NA	NA	NA	NA
2,3,5,6- and 2,3,4,6-Tetrachlorophenol	790	NA	470	NA	530	NA	53	NA	NA	NA	NA
2,3,4,5-Tetrachlorophenol	37	NA	31	NA	21	NA	10	NA	NA	NA	NA
CHLORINATED PHENOLS (µg/kg)											
EPA Method SW8270B											
2,3,4,6-Tetrachlorophenol	NA	522	NA	1990	NA	167 U	NA	167 U	167 U	543	167 U
2,4,5-Trichlorophenol	NA	333 U	NA	333 U	NA	333 U	NA	333 U	333 U	333 U	333 U
2,4,6-Trichlorophenol	NA	333 U	NA	333 U	NA	333 U	NA	333 U	333 U	333 U	333 U
2,4-Dichlorophenol	NA	200 U	NA	200 U	NA	200 U	NA	200 U	200 U	200 U	200 U
2,6-Dichlorophenol	NA	167 U	NA	167 U	NA	167 U	NA	167 U	167 U	167 U	167 U
2-Chlorophenol	NA	66.7 U	NA	66.7 U	NA	66.7 U	NA	66.7 U	66.7 U	66.7 U	66.7 U
4-Chloro-3-methylphenol	NA	133 U	NA	133	NA	133 U	NA	133 U	133 U	133	133 U
Pentachlorophenol	NA	2710	NA	37700	NA	3220	NA	415	1090	16700	333 U

U = Indicates compound was analyzed for, but not detected at the given detection limit.
NA = Not analyzed.

APPENDIX B

Soil Boring Logs and Well Construction Diagrams

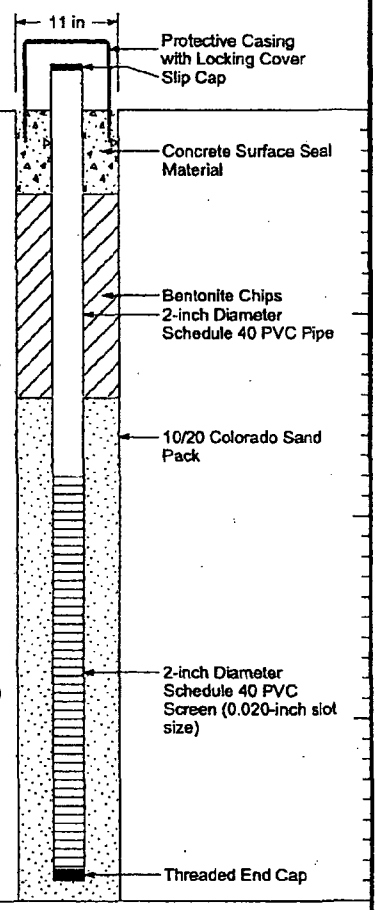
OX-5S

Drilling Method: Hollow-stem Auger
Ground Elevation (ft): 28.2 (MSL)
Drilled By: Cascade Drilling

Depth (ft)	Sample Number & Interval	Sampler Type	Blows/Foot	PID (ppm)	Graphic Symbol	USCS Symbol	Soil Profile	Water Level
0						GP	Brown, sandy GRAVEL (medium dense, moist) (no odor, no sheen)[Fill]	
5						SP	Brown, fine SAND with trace silt (medium dense, moist) (no odor, no sheen)	
10	1	a2	51	0				
	2	a2	40	0				
	3	a2	31	0				ATD
15	4	a2	47	0		SP	Gray, fine SAND with trace silt (dense, wet) (no odor, no sheen)	
	5	a2	39	0				
	6	a2	36	0		ML	Gray, sandy SILT (very stiff, moist) (no odor, no sheen)	
20								
25								
30								

Boring Completed 09/17/03
Total Depth of Boring = 19.5 ft.

Monitoring Well Detail



Monitoring Well Completed 09/17/03
Elevation at Top of Protective Casing = 31.00 ft.
Elevation at Top of Monitoring Well Casing = 30.74 ft.
Total Depth of Monitoring Well = 19.0 ft.

Notes:
1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

231001.121 4/1/04 \\EDMDATA\GINTG\INTEG\PROJECTS\231001A.GPJ WELL LOG

LANDAU ASSOCIATES

Time Oil - NW Terminal Portland, OR	Log of Monitoring Well OX-5S	Figure B-1

SCHN00304354

OX-6S

Drilling Method: Hollow-stem Auger

Ground Elevation (ft): 28.6 (MSL)

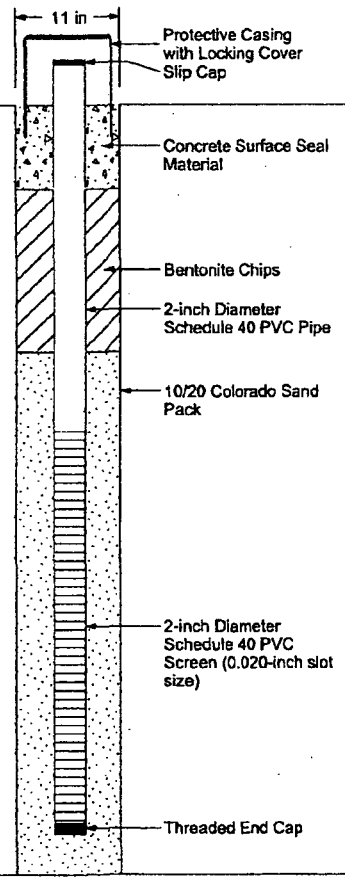
Drilled By: Cascade Drilling

Depth (ft)	Sample Number & Interval	Sampler Type	Blows/Foot	PID (ppm)	Graphic Symbol	USCS Symbol	Soil Profile
0						GP	Brown, sandy GRAVEL with trace silt (medium dense, moist) (no odor, no sheen) [Fill]
10	1	a2	50/5"	0			
						SP	Brown, fine SAND with trace silt (medium dense to dense, moist) (no odor, no sheen)
	2	a2	40	0			
	3	a2	75	0			
15	4	a2	19	22.6			Becomes wet
						SP	Gray, fine SAND with trace silt (loose, wet) (mild PCP like odor, no sheen)
	5	a2	20	0			
	6	a2	14	0		ML	Gray SILT with trace sand and roots (stiff, moist) (no odor, no sheen)

Boring Completed 09/17/03
Total Depth of Boring = 19.0 ft.

Water Level: ATD

Monitoring Well Detail



Monitoring Well Completed 09/17/03
Elevation at Top of Protective Casing = 31.29 ft.
Elevation at Top of Monitoring Well Casing = 30.92 ft.
Total Depth of Monitoring Well = 18.0 ft.

Notes:
1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

231001.121 4/1/04 \\EDMDATA\GINT\GINT6\PROJECTS\231001A.GPJ WELL LOG

LANDAU ASSOCIATES

Time Oil - NW Terminal Portland, OR	Log of Monitoring Well OX-6S	Figure B-2

SCHN00304355

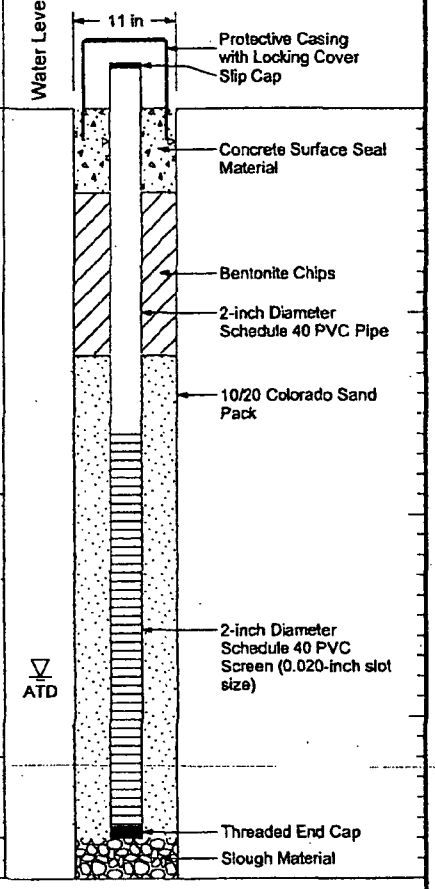
OX-7S

Drilling Method: Hollow-stem Auger
Ground Elevation (ft): 28.6 (MSL)
Drilled By: Cascade Drilling

Depth (ft)	Sample Number & Interval	Sampler Type	Blows/Foot	PID (ppm)	Graphic Symbol	USCS Symbol	Description
0						GP	Brown, sandy GRAVEL with trace silt (medium dense, moist) (no odor, no sheen) [Fill]
5							
10						SP	Brown, fine SAND with trace silt (medium dense to dense, moist) (no odor, no sheen)
	1	a2	28	0			
	2	a2	28	0			Becomes wet
	3	a2	60	0			
15	4	a2	78	0			
	5	a2	56	0		SP	Gray, fine SAND with trace silt (medium dense, wet) (mild PCP like odor, no sheen)
	6	a2	18	0		ML	Gray SILT with sand and trace roots (very stiff, moist) (no odor, no sheen)
20							
25							
30							

Boring Completed 09/18/03
Total Depth of Boring = 19.0 ft.

Monitoring Well Detail



Monitoring Well Completed 09/18/03
Elevation at Top of Protective Casing = 31.06 ft.
Elevation at Top of Monitoring Well Casing = 30.68 ft.
Total Depth of Monitoring Well = 18.0 ft.

Notes:
1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

231001.121 4/1/04 \\EDMDATA\GINT\GINT6\PROJECTS\231001A.GPJ WELL LOG

LANDAU ASSOCIATES

Time Oil - NW Terminal Portland, OR	Log of Monitoring Well OX-7S	Figure B-3

SCHN00304356

OX-8S

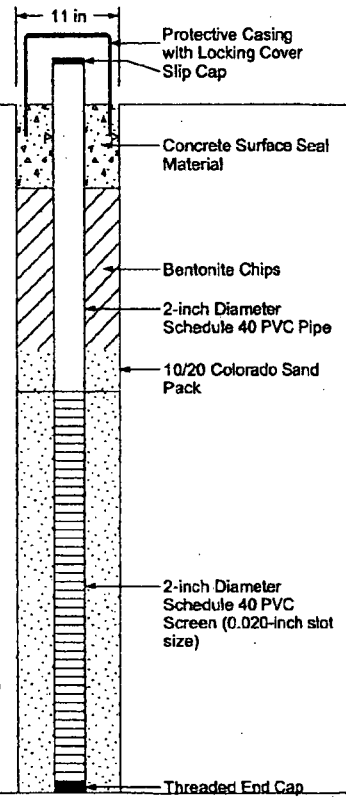
Drilling Method: Hollow-stem Auger
Ground Elevation (ft): 28.3 (MSL)
Drilled By: Cascade Drilling

Depth (ft)	Sample Number & Interval	Sampler Type	Blows/Foot	PID (ppm)	Graphic Symbol	USCS Symbol	Description
0						GP	Brown, sandy GRAVEL with trace silt (medium dense, moist) (no odor, no sheen) (Fill)
5							
10						SP	Brown, fine SAND with trace silt (medium dense, moist) (no odor, no sheen)
15	1	a2	67	201		SP	Gray, fine SAND with trace silt (medium dense, moist to wet) (strong PCP like odor, no sheen)
	2	a2	7	0			Gray silt in drive shoe
20							
25							
30							

Boring Completed 09/16/03
Total Depth of Boring = 17.0 ft.

Water Level: ATD

Monitoring Well Detail



Monitoring Well Completed 09/16/03
Elevation at Top of Protective Casing = 31.05 ft.
Elevation at Top of Monitoring Well Casing = 30.74 ft.
Total Depth of Monitoring Well = 17.0 ft.

Notes:
1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

231001.121 4/1/04 \\EDMDATA\GINT\GINT6\PROJECTS\231001A.GPJ WELL LOG

LANDAU ASSOCIATES

Time Oil - NW Terminal Portland, OR	Log of Monitoring Well OX-8S	Figure B-4

SCHN00304357

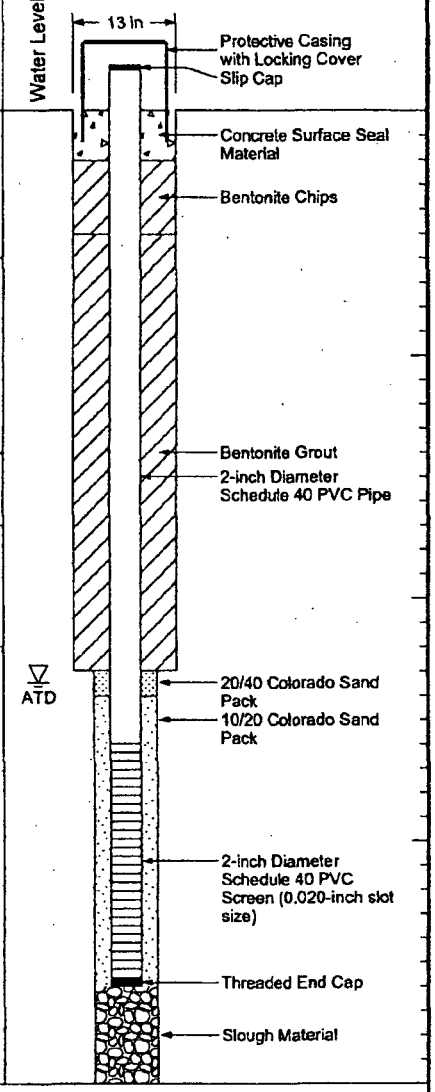
OX-8D

Drilling Method: Hollow-stem Auger
Ground Elevation (ft): 28.4 (MSL)
Drilled By: Cascade Drilling

Depth (ft)	Sample Number & Interval	Sampler Type	Blows/Foot	PID (ppm)	Graphic Symbol	USCS Symbol	Soil Profile
0						GP	Brown, sandy GRAVEL with trace silt (medium dense, moist) (no odor, no sheen) [Fill]
						SP/ SM	Brown, fine SAND with silt (medium dense, moist) (no odor, no sheen)
10	1	a2	37	4.6			
	2	a2	18	0			
	3	a2	23	19.7			Becomes wet
	4	a2	14	18.1		SP	Gray, fine SAND with silt (loose, wet) (stong PCP odor, no sheen)
	5	a2	4	2.6			
	6	a2	21	0		ML	Gray SILT with trace fine sand and wood debris (stiff, wet) (no odor, no sheen)
20	7	a2	33	0			
	8	a4		0		SP	Gray, fine SAND with trace silt (medium dense, moist) (no odor, no sheen)
	9	a4		0			with trace roots
30	10	a4		0			3-inch silt lense
	11	a4		0			3-inch silty fine SAND lense
	12	a4		0			
40							
50							

Boring Completed 09/16/03
Total Depth of Boring = 40.0 ft.

Monitoring Well Detail



Monitoring Well Completed 09/16/03
Elevation at Top of Protective Casing = 31.09 ft.
Elevation at Top of Monitoring Well Casing = 30.84 ft.
Total Depth of Monitoring Well = 36.0 ft.

Notes:
1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

231001.121 4/1/04 \\EDMDATA\GINT\GINT6\PROJECTS\231001A.GPJ WELL LOG

LANDAU ASSOCIATES

Time Oil - NW Terminal Portland, OR	Log of Monitoring Well OX-8D	Figure B-5

SCHN00304358

APPENDIX C

Sampling and Analysis Plan

SCHN00304359

Sampling and Analysis Plan
In Situ Chemical Oxidation
Interim Remedial Action
Time Oil Northwest Terminal
Portland, Oregon

May 11, 2004

Prepared for

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SCHN00304360

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SCHN00304361

1.0 INTRODUCTION

This sampling and analysis plan (SAP) describes the procedures for conducting field activities during the *in situ* chemical oxidation (ISCO) interim remedial action program to be implemented at the Time Oil Northwest Terminal (site) in Portland, Oregon. The primary objective of this SAP is to provide sampling and subsurface evaluation methodology consistent with accepted procedures such that the effectiveness of ISCO for treatment of the upper zone groundwater and soil can be accurately assessed and the interim remedial action approach can be adjusted, as appropriate. This SAP was prepared in accordance with Oregon Department of Environmental Quality (DEQ) and U.S. Environmental Protection Agency (EPA) guidance documents (DEQ 1994; EPA 1986; 1987; 1988; 1993a,b), and provides consistent field, sampling, and analytical procedures to be used during the ISCO interim remedial action plan.

SCHN00304362

2.0 FIELD INVESTIGATION PROCEDURES

This section describes the field procedures to be employed during the ISCO interim remedial action plan. Field activities during the ISCO interim remedial action plan will consist primarily of the following:

- Baseline groundwater monitoring. Within two weeks prior to the initial ISCO injection event scheduled for May or June 2004, baseline groundwater analytical samples will be collected from
  RW-1, LW-11S, and OX-1S through OX-8S. The resulting analytical data will be used to establish baseline conditions prior to the implementation of the interim remedial action plan.

- Monitoring of groundwater during the ISCO injection events for geochemical parameters.

- Collection of groundwater samples for chemical analysis approximately two weeks following ISCO injection events in order to evaluate the effectiveness of ISCO in reducing PCP concentrations in groundwater and to determine if the chemical reaction caused by the injection of Fenton's reagent compounds results in increased concentrations of ferrous iron and selenium.

Prior to initiation of any invasive subsurface activity, the locations of each proposed exploration will be checked in the field to locate all underground and aboveground utilities or other physical limitations that would prevent injection at the proposed location; the final location for each injection will be based on the findings of the field check.

2.1 BASELINE GROUNDWATER EVALUATION

Prior to the injection of ISCO reagents, a baseline groundwater sampling event will be performed to assess the quality of groundwater in the vicinity of the proposed ISCO injection points. The baseline evaluation will include groundwater sampling at monitoring wells RW-1, LW-11S, and OX-1S through OX-8S.

2.1.1 GROUNDWATER LEVEL MEASUREMENTS

Prior to withdrawal of any water from the monitoring wells for purging or sampling, the depth to groundwater and thickness of light non-aqueous phase liquid (LNAPL), if present, below the top of the well casing will be measured for documentation of groundwater elevation and for evaluation of groundwater flow. Depth to groundwater and LNAPL, if present, will be measured using a graduated water level indicator or oil-water indicator probe and recorded on a Water Level Measurement form. The water level or oil-water indicator probe will be decontaminated prior to insertion at each well in accordance with procedures described in Section 2.5.

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2.1.2 GROUNDWATER SAMPLING

Groundwater samples will be collected from the monitoring wells (RW-1, LW-11S, and OX-1S through OX-8S) located within the ISCO injection area to document groundwater conditions before and after the injection of ISCO reagents. Following the measurement of the depth to groundwater, the groundwater monitoring wells will be sampled as follows:

- Prior to purging any groundwater, the oxidation-reduction potential (ORP), dissolved oxygen, specific conductivity, and pH will be measured. The pre-purging data will be collecting using "downhole" probes. This information will be recorded on the Groundwater Sample Collection Form.

- Prior to sampling, each well will be purged using a centrifugal purge pump that is attached to dedicated purge and sample collection tubing (types of pumps used may vary depending on purge volume and depth and include a centrifugal pump, a peristaltic pump, and an electric submersible pump). Purging will continue until at least three casing volumes of water have been removed and specific conductivity and temperature have stabilized or until the well goes dry. The purge volume will be calculated based on the following formula:

  1 casing volume (gallons) = $\pi r^2 h \times 7.48$ gal/ft^3,

  where $\pi = 3.14$, r = radius of well casing in ft, h = height of water column from the bottom of the well, in feet.

- Purge data will be recorded on a Groundwater Sample Collection form including purge volume, time of commencement and termination of purging, and any observations regarding physical characteristics of the purge water and field measurements of pH, specific conductivity, temperature, ORP, dissolved oxygen, and turbidity.

- Purge and decontamination water will be initially contained in drums or a trailer-mounted tank, then transferred to the onsite water treatment system for treatment and discharge to the sanitary sewer system.

- Groundwater sampling will begin immediately following well purging except when the well purges dry. In this case, the groundwater will be allowed to recharge in the well casing to approximately 80 percent of the static level prior to sample collection. Sample data will be recorded on a Groundwater Sample Collection form, including sample number and time collected; the observed physical characteristics of the sample (e.g., color, turbidity, etc.); and field parameters (pH, specific conductivity, temperature, dissolved oxygen, and turbidity).

- Four replicate field measurements of temperature and specific conductivity will be obtained using the following procedures:

  - A 250-mL plastic beaker will be rinsed with deionized water followed by sample water.

  - The electrodes and temperature compensation probe will be rinsed with deionized water followed by sample water.

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- The beaker will be filled with sample water; the probes will be placed in the beaker until the readings are stabilized. Temperature and specific conductivity measurements will be recorded on the Groundwater Sample Collection form.

- The above step will be repeated to collect remaining replicates.

- Any problems or significant observations will be noted in the "comments" section of the Groundwater Sample Collection form.

- Groundwater samples will be collected using a peristaltic pump attached to dedicated polyethylene tubing. To prevent degassing during volatile organic analysis (VOA) sampling, a pumping rate will be maintained below about 100 mL/min. The VOA containers will be filled completely so that no head space remains. Samples will be preserved, as specified in the QAPP. Clean gloves will be worn when collecting each sample.

- Specific conductivity, ORP, dissolved oxygen, and pH meters will be calibrated according to manufacturer's specifications at the beginning of each sample day and every four hours afterward. Calibration data will be recorded in a logbook maintained for each instrument. Meter calibration will be checked when recalibrated or when meter drift is suspected, and data will be recorded in the calibration logbook. The meters will be calibrated with buffered solutions closest to known field parameters.

Groundwater sampling will be conducted in accordance with the appropriate provisions of the Quality Assurance Project Plan (QAPP) (Landau Associates 2001a). Analytical methods, containers, laboratories, sample storage and preservation, and holding times are referenced in Table C-1. The locations of the monitoring wells are provided on Figure 10 of the ISCO interim remedial action work plan.

2.1.2.1 Groundwater Analyses

Groundwater samples collected for the ISCO interim remedial action will be analyzed for the chemical analyses that are routinely used for the groundwater sampling events. The analyses completed for routine groundwater sampling events include: semivolatile organic compounds (SVOCs; EPA Method 8270); volatile organic compounds (VOCs; EPA Method 8260); six priority pollutant metals (arsenic, lead, chromium, copper, nickel, and zinc; EPA Methods 6010/7000 series); total dissolved solids (TDS; EPA Method 160.1); chloride (EPA Method 325.2); and field parameters (pH, conductivity, ORP, dissolved oxygen, turbidity, and temperature). In addition to the routine analyses included in quarterly groundwater sampling events, groundwater samples collected in conjunction with the ISCO interim remedial action will be analyzed for selenium (EPA Method 6010) and ferrous iron (SM 3500-Fe). As described in Section 2.3 of the SAP, post-injection groundwater monitoring not completed during regularly-scheduled quarterly monitoring events will be restricted to analysis of PCP (EPA Method 8270), chloride (EPA Method 325.2), selenium (EPA Method 6010), ferrous iron (EPA Method 3500-Fe),

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and field parameters (pH, specific conductivity, ORP, dissolved oxygen, turbidity, and temperature). The proper sample containers, storage, temperature, preservation, and holding times are listed in Table C-1.

2.2 GROUNDWATER MONITORING DURING ISCO INJECTION EVENTS

Groundwater will be monitored using real-time methods during the injection of the ISCO reagent. Real-time groundwater monitoring will be limited to the wells located in the vicinity of the ISCO injection points. The groundwater in the wells will be monitored prior to, during, and after the ISCO injection event for the following parameters: presence of LNAPL, pH, dissolved oxygen, temperature, ORP, and VOC vapors. Real-time groundwater monitoring data will be recorded immediately prior to the initiation of the ISCO injection and at 30-minute intervals until approximately 90 minutes after the injection event is completed.

2.3 QUALITY ASSURANCE AND QUALITY CONTROL

Analytical samples collected will follow standard quality assurance and quality control (QA/QC) procedures and procedures outlined in the QAPP (Landau Associates 2001a). Field QA/QC includes the collection of quality control samples, including blind field duplicate samples and matrix spike and matrix spike duplicate samples. Equipment rinsate blanks will not be collected. Each of these quality control samples will be collected at the rate of one in every twenty samples collected for each sample media type. The procedures for collection of the quality control samples are provided in the QAPP. Field QA/QC samples will be collected in conjunction with routing sampling events, but will not be collected for sampling events completed between the routing sampling events.

2.4 SAMPLE DOCUMENTATION, HANDLING, AND CUSTODY

Sample documentation, handling, and custody procedures to be used during the ISCO interim action plan will follow the procedures specified in the QAPP (Landau Associates 2001a). Sample containers, preservatives, and holding times for each chemical analysis to be performed in conjunction with the ISCO interim remedial action are presented in Table C-1.

2.5 EQUIPMENT DECONTAMINATION

The decontamination procedures described below are to be used by field personnel to clean drilling, sampling, and related field equipment. Deviation from these procedures will be documented in field records.

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2.5.1 MONITORING EQUIPMENT

All groundwater monitoring equipment will be cleaned using a three step process, as follows:

1. Scrub surfaces of equipment that would be in contact with the sample with brushes using an Alconox solution.
2. Rinse and scrub equipment with clean tap water.
3. Rinse equipment a final time with deionized water to remove tap water impurities.

Decontamination of the groundwater monitoring equipment will occur between collection of each sample. Decontamination of monitoring equipment that is suspected to come into contact with free-phase liquid or contains a visible sheen will include a hexane rinse (or other appropriate solvent) prior to the tap water rinse.

2.5.2 INJECTION RIGS

The injection equipment that is used downhole or that contacts material and equipment going downhole, will be cleansed by a hot water, high pressure wash before each use and at completion of the project. Potable tap water from the municipal water supply will be used as the cleansing agent.

2.6 RESIDUAL WASTE MANAGEMENT

Purge and decontamination water generated during the ISCO interim remedial action will be transferred to the terminal wastewater treatment system for treatment and discharge to the sanitary sewer system under an existing permit (No. 400.121) with the City of Portland.

SCHN00304367

3.0 REFERENCES

DEQ. 1994. *Soil Cleanup Manual (OAR 340-122-045 and 046; Implementation Guidelines for the Investigation and Cleanup of Simple Sites with Soil Contamination, Associated Guidance Documents).* Oregon Department of Environmental Quality, Waste Management and Cleanup Division. April.

EPA. 1993a. *Subsurface Characterization and Monitoring Techniques, A Desk Reference, Volume I: Solids and Groundwater,* Appendices A and B.

EPA. 1993b. *Subsurface Characterization and Monitoring Techniques, A Desk Reference, Volume II: The Vadose Zone, Field Screening, and Analytical Methods,* Appendices C and D.

EPA. 1988. *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA.* U.S. Environmental Protection Agency, Washington, D.C.

EPA. 1987. *A Compendium of Superfund Field Operation Methods.* USEPA 540/P-87/001. U.S. Environmental Protection Agency. December.

EPA. 1986. *Test Methods for Evaluating Solid Waste.* EPA/SW-846, Third Edition, with 1990 updates. U.S. Environmental Protection Agency.

Landau Associates. 1999. *Report, Phase I and II Contaminants of Potential Concern (COPC) Screening Report, Time Oil Northwest Terminal, Portland, Oregon.* Prepared for Time Oil Co. September 10.

Landau Associates 2001a. *Quality Assurance Project Plan.* Appendix C, Phase III Remedial Investigation Work Plan. June 18.

Landau Associates. 2001b. *Phase II Remedial Investigation, Time Oil Northwest Terminal, Portland, Oregon.* February 9.

TABLE C-1
ANALYTICAL SAMPLE PARAMETERS
ISCO INTERIM REMEDIAL ACTION PLAN
TIME OIL NORTHWEST TERMINAL
PORTLAND, OREGON

Monitoring Wells (a)	Matrix	Analytes	Analytical Method/Procedure	Laboratory	Sample Container	Storage Temperature & Preservation	Maximum Sample Holding Time (b)
LW-11S, RW-1S, OX-1S, OX-2S, OX-3S, OX-4S, OX-5S, OX-6S, OX-7S, OX-8S	Water	Volatile Organics (c)	EPA Method 8260	Specialty Analytical, Inc.	3 each 40-mL glass vials	HCl to pH <2 Cool to 4°C	14 days until analysis
	Water	Semivolatile organics (c)	EPA Method 8270	Specialty Analytical, Inc.	1-Liter amber glass, Teflon-lined lid	Cool to 4°C	7 days until extraction; 40 days after extraction
	Water	Priority Pollutant Metals (c)	EPA Method 6010/7000 Series	Specialty Analytical, Inc.	1-Liter high density polyethylene (HDPE)	5 ml HNO_3 Cool to 4°C	6 months until analysis
	Water	Ferrous Iron (Fe^{2+})	SM 3500-Fe	Specialty Analytical, Inc.	6 X 1-Liter wide mouth plastic	Cool to 4°C	28 days until analysis
	Water	Total Dissolved Solids (c)	EPA Method 160.1	Specialty Analytical, Inc.	1-Liter plastic	N/A	N/A
	Water	Chloride	EPA Method 325.2	Specialty Analytical, Inc.	500-mL HDPE	Cool to 4°C	28 days until analysis
	Water	Pentachlorophenol	EPA Method 8270	Specialty Analytical, Inc.	1-Liter amber glass, Teflon-lined lid	Cool to 4°C	7 days until extraction; 40 days after extraction
	Water	Selenium	EPA Method 6010	Specialty Analytical, Inc.	1-Liter HDPE	5 ml HNO_3 Cool to 4°C	6 months until analysis

(a) Groundwater samples listed will be collected during quarterly groundwater sampling events and two to three weeks after each ISCO injection event.
(b) Holding times are from date of collection unless otherwise specified.
(c) These analyses will only be completed during quarterly groundwater sampling events.

SCHN00304369

Time Oil: Amm

State of Oregon
Department of Environmental Quality — Memorandum

Date: May 24, 2004

To: Jim Anderson, Manager, NWR Portland Harbor Section

From: Tom Roick, Project Manager, NWR Lower Willamette Section

Subject: Interim Remedial Action, Source Control Decision for Time Oil Northwest Terminal ECSI # 170

Purpose

This memo summarizes DEQ's review of a proposed interim action by Time Oil Company for the Northwest Terminal site. The proposed interim action seeks to treat pentachlorophenol (PCP) contamination in groundwater at the facility pending selection of a final remedial action for the site through the remedial investigation / feasibility study (RI/FS) process. The proposal is an expansion of a currently operating groundwater pump and treat system and an in situ treatment pilot study conducted in 2002. The proposal is documented in the May 11, 2004 *Work Plan, In Situ Chemical Oxidation, Interim Remedial Action, Time Oil Northwest Terminal*, prepared by Landau Associates. The DEQ Time Oil project team has completed our review of the Work Plan and recommends approval of the proposed action. We have some comments on the Work Plan details, which Time Oil must respond to as part of the field implementation. Time Oil would like to begin the interim action in mid-June 2004.

Background

From 1943 to 2001, Time Oil operated a petroleum products storage terminal in the Rivergate industrial area of Portland at 10350 Time Oil Road (attached Figures 1 and 2). The site is adjacent to the Willamette River at river mile 3.4 in Portland Harbor. During operation, the Time Oil terminal was used for the receipt, storage, and distribution of petroleum-related products. Historically, Time Oil leased above-ground tank space to Crosby & Overton, Inc., for storage of waste oils, and to the Koppers Company for formulation of PCP wood treatment products from 1967 to 1982. The terminal ceased operations in 2001 and Time Oil is in the process of decommissioning site structures.

PCP contamination in soil and groundwater was discovered at the facility in 1985. On September 5, 1996 DEQ entered into a Voluntary Agreement with Time Oil to provide oversight of environmental investigations at the Time Oil facility. Investigations have been phased to address a PCP-contaminated soil stockpile (Phase I), PCP-mixing area soil and groundwater contamination (Phase II), and other areas of the facility including bulk petroleum storage tanks (Phase III). The proposed interim action will address Phase II, PCP-contaminated groundwater and saturated zone soil contamination.

133

SCHN00304370

typically used up in a few days. ISOTEC's process has been shown to be effective in treating a range of contaminants including petroleum hydrocarbons and chlorinated solvents. Treatment by-products are carbon dioxide, water, chloride ions, and ferric iron, which rapidly precipitates out of the groundwater.

During the pilot study reagents were injected into push-probes screened from the top of the water table at 16 feet bgs to 19 feet bgs, at ten locations downgradient of the source area (Figure 3). Groundwater and saturated zone soil samples were collected to evaluate effectiveness of the pilot treatment. While PCP was the target contaminant, contaminants of potential concern (COPCs) in the Phase II area include petroleum hydrocarbons; constituents of petroleum products, such as benzene and naphthalene; other phenols, such as tetrachlorophenol; and dioxin, a contaminant in PCP product formulations. The ISCO process was successful in reducing overall PCP concentrations as well as other contaminants of concern in both saturated zone soil and groundwater.

Interim Action Work Plan

The current proposal is full-scale implementation of the ISCO pilot study conducted previously at the site in 2002. Attached Figures 4 and 5 show the most recent site investigation data plotting PCP concentrations in soil and upper zone groundwater, respectively. Figure 6 shows groundwater flow conditions, and Figure 7 shows the proposed ISCO injection points. Approximately 30 injection points will be installed at 40-foot spacings, with some treatment overlap in the radius of influence surrounding each injection point. Lateral manifold piping previously installed in the PCP mixing area excavation may also be used, pending an evaluation of the water table elevation at the time of treatment. Groundwater recovery wells RW-2 and HRW-1 will be operational during treatment to maintain capture of the PCP plume.

Attached Table 1 lists the groundwater monitoring locations and analytical parameters proposed to evaluate effectiveness of the treatment. Although not listed on the table, total petroleum hydrocarbons will be analyzed quarterly and dioxin will be analyzed annually in selected wells as part of an on-going, Phase II monitoring program. In addition to priority pollutant metals, selenium analysis is included because naturally-occurring concentrations of this metal could mobilize under oxidizing conditions. Monitoring will be conducted to ensure that the ISCO injections do not cause an unacceptable increase in the concentrations of metals in groundwater. The reactants are short-lived in the environment, and the radius of influence of the treatment process can be readily controlled and monitored through source area and downgradient monitoring wells. The downgradient edge of the plume to be treated is approximately 350 feet from the Willamette River. No adverse impacts to groundwater are anticipated downgradient of the treatment area.

Recommendation

The potential for PCP in groundwater at the site to migrate to the Willamette River, and particularly to migrate preferentially through the on-site storm drain, is a time-critical concern.

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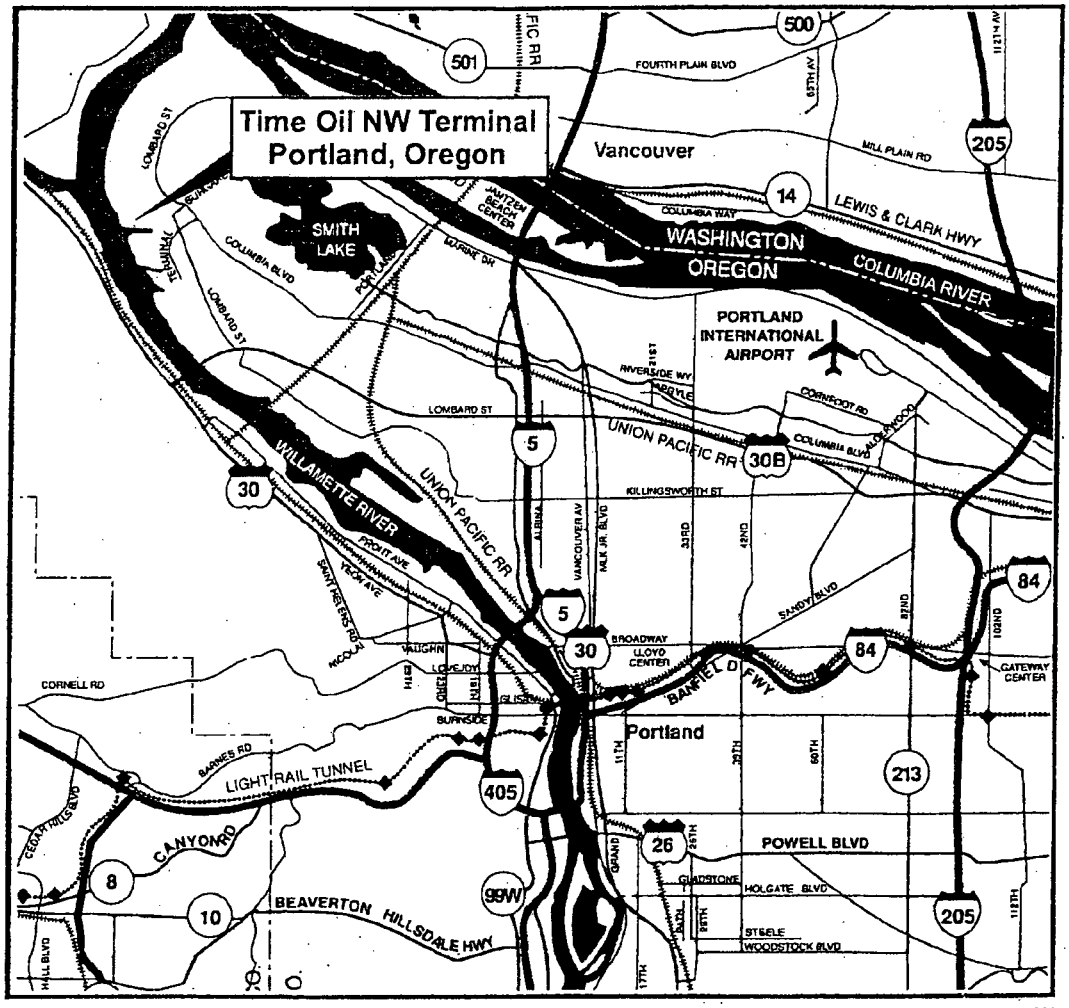
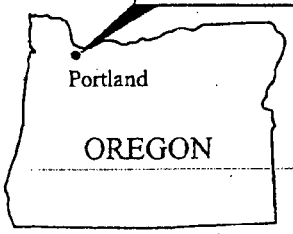


Map from MetroAmerica 1995

SITE LOCATION
(see enlarged map area above)



0 2 4
Approximate Scale in Miles

Time Oil | T:\231\001\Vicinity Map.cdr (C) 6/20/2003

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Time Oil NW Terminal Portland, Oregon	**Vicinity Map**	Figure 1

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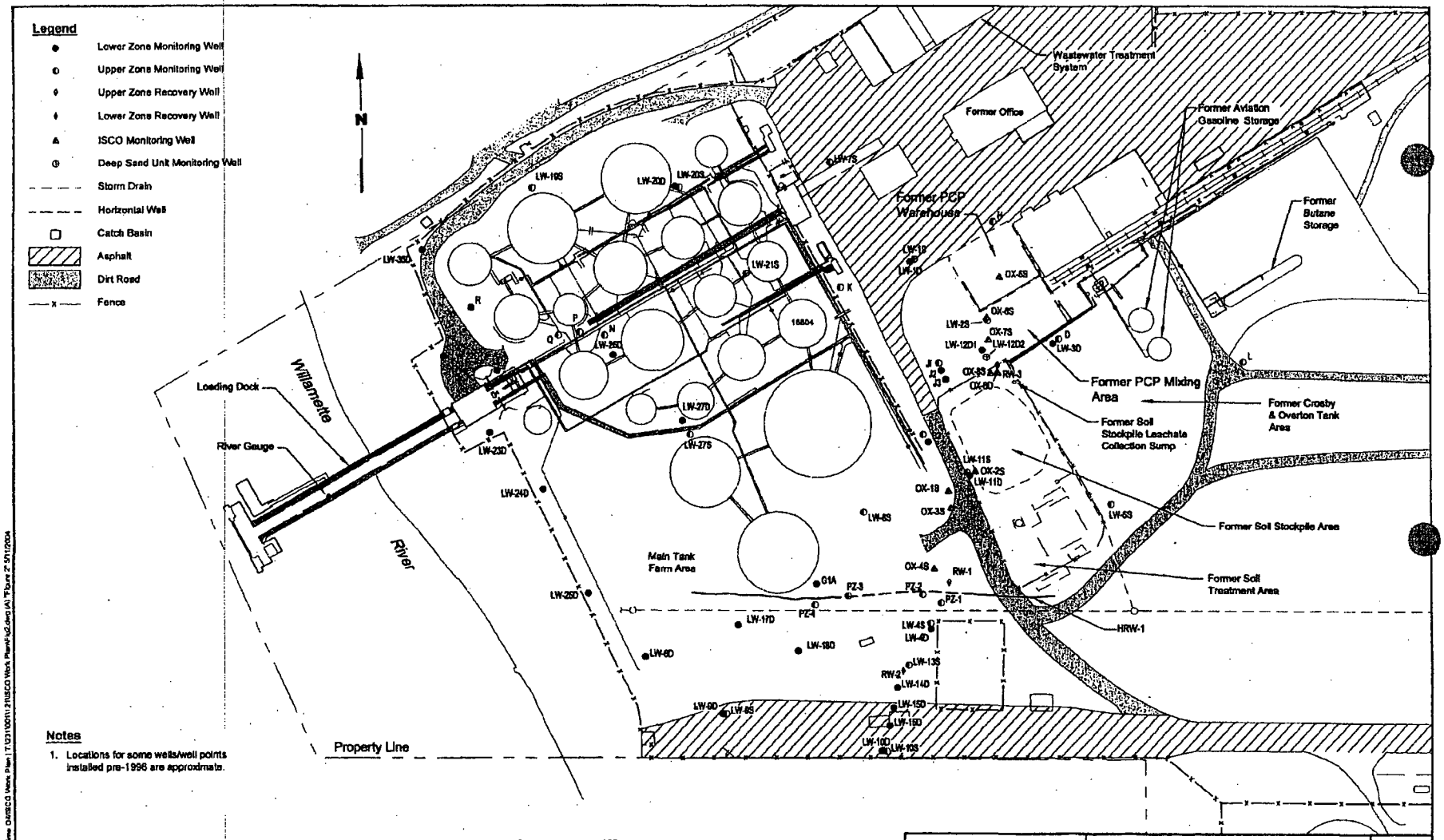

Notes

1. Locations for some wells/well points installed pre-1996 are approximate.

LANDAU ASSOCIATES

Time Oil NW Terminal Portland, Oregon	Site Map	Figure 2

Time OilISCO Work Plan\17\31\0011\21\ISCO Work Plan\fig2.dwg (A) "Figure 2" 5/11/2004

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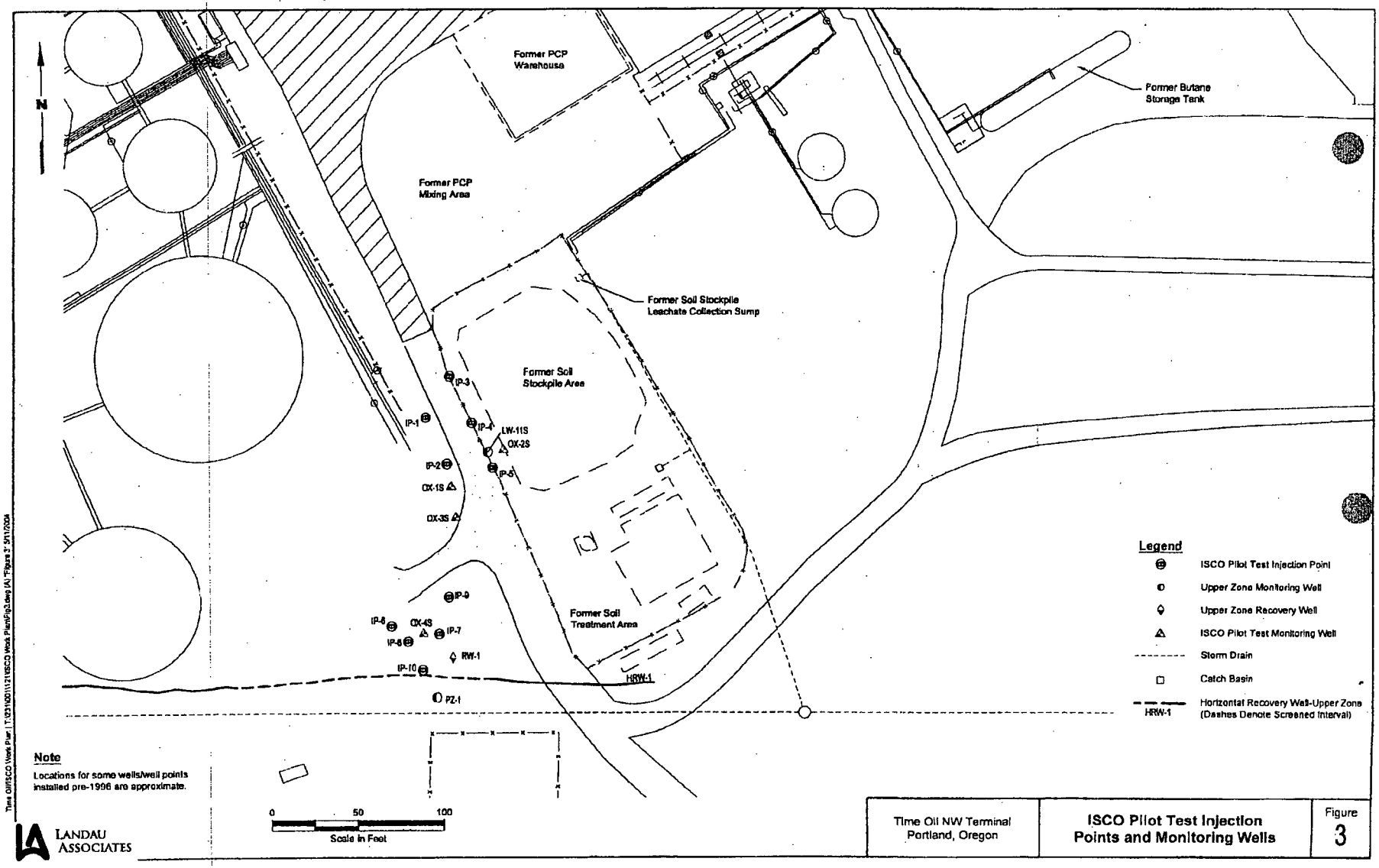

Note

Locations for some wells/well points installed pre-1996 are approximate.

LANDAU ASSOCIATES

Time Oil NW Terminal Portland, Oregon	ISCO Pilot Test Injection Points and Monitoring Wells	Figure 3

Time Oil/ISCO Work Plan | T:\231\001\11\21\ISCO Work Plan\Fig3.dwg [A] "Figure 3" 5/11/2004

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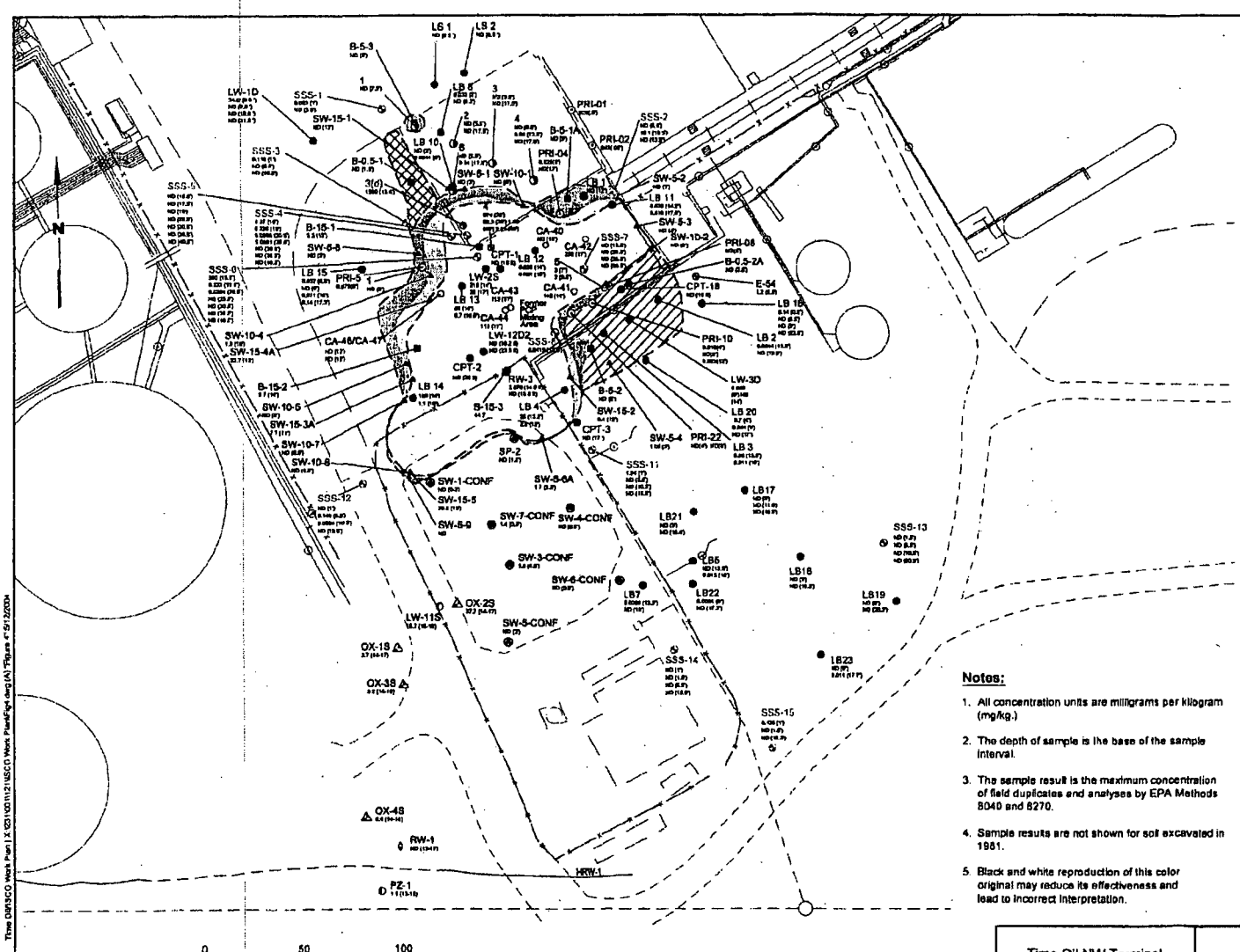

Legend:

- Approximate Extent of Excavation from 0 - 5 ft BGS
- Approximate Extent of Excavation from 5 - 10 ft BGS
- Approximate Extent of Excavation from 10 - 13 ft BGS
- Approximate Extent of Excavation from 0 - 0.5 ft BGS
- Approximate Extent of Excavation from 0 - 2 ft BGS
- HRW-1 — Horizontal Recovery Well - Upper Zone (Dashes Denote Screened Interval)
- Soil Data from Phase II RI
- Historical Soil Data (Ecova 1989)
- Historical Soil Data (Riedel 1985)
- Historical Soil Data (SRH 1986)
- Phase II Supplemental Sampling Data
- Pre-Removal Investigation Data
- ND — Not Detected
- NA — Not Analyzed
- Upper Zone Monitoring Well
- Upper Zone Recovery Well
- ISCO Pilot Test Monitoring Well
- Verification Sample Location (2002)
- Verification Soil Sample Location Base of Excavation (2002)
- Verification Soil Sample Location Side Wall of Excavation (2002)
- Fence

Location Identifier → LB 10

PCP Concentration (mg/kg): ND (2') / 0.0044 (8') — Depths Below Ground Surface in ft

Notes:

1. All concentration units are milligrams per kilogram (mg/kg.)
2. The depth of sample is the base of the sample interval.
3. The sample result is the maximum concentration of field duplicates and analyses by EPA Methods 8040 and 8270.
4. Sample results are not shown for soil excavated in 1981.
5. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.

LANDAU ASSOCIATES

Time Oil NW Terminal Portland, Oregon	Summary of PCP Concentrations in Soil	Figure 4

Time Oil/ISCO Work Plan | X:\2010\0112\ISCO Work Plan\Fig4.dwg(A)"Figure 4"5/12/2004

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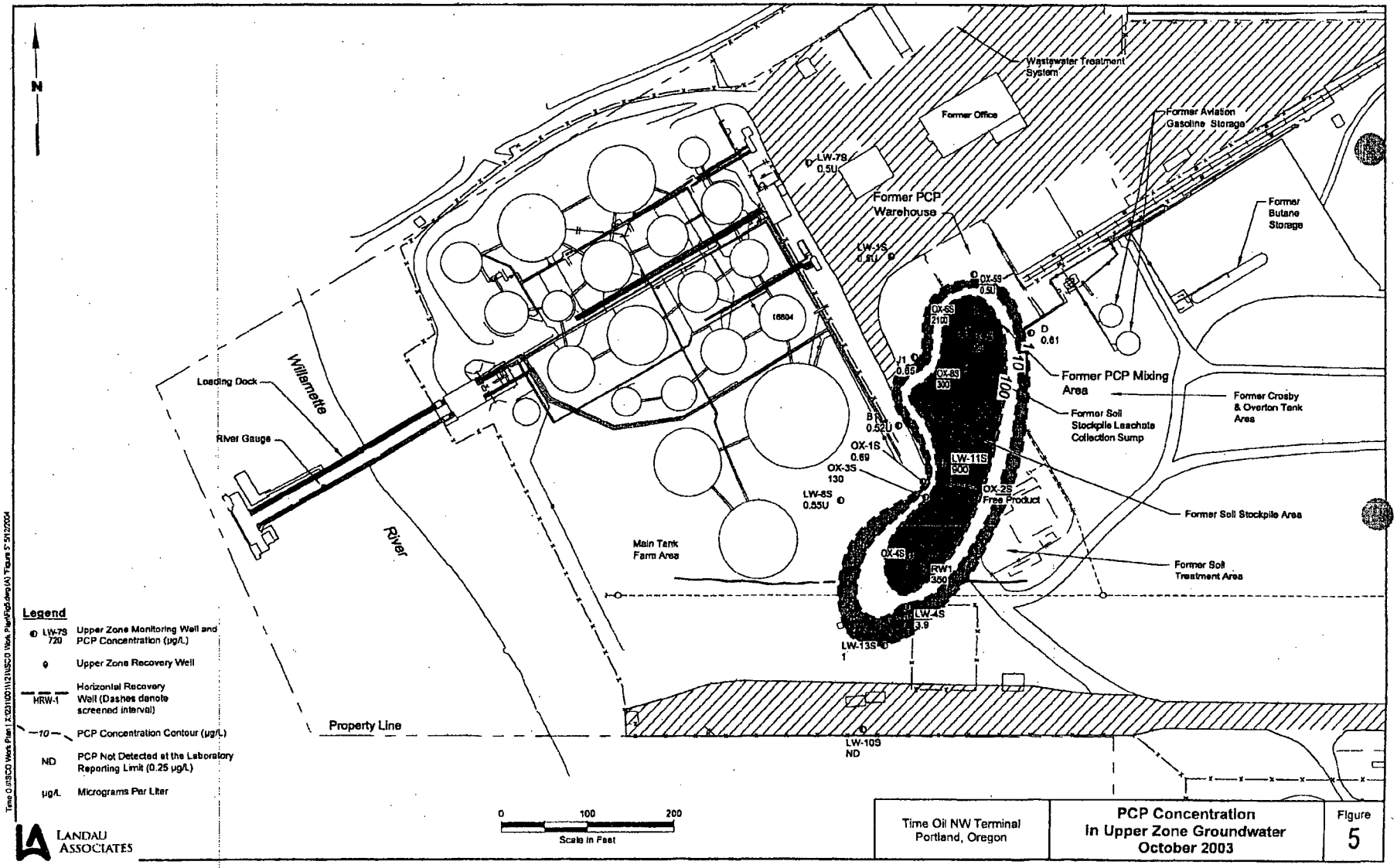
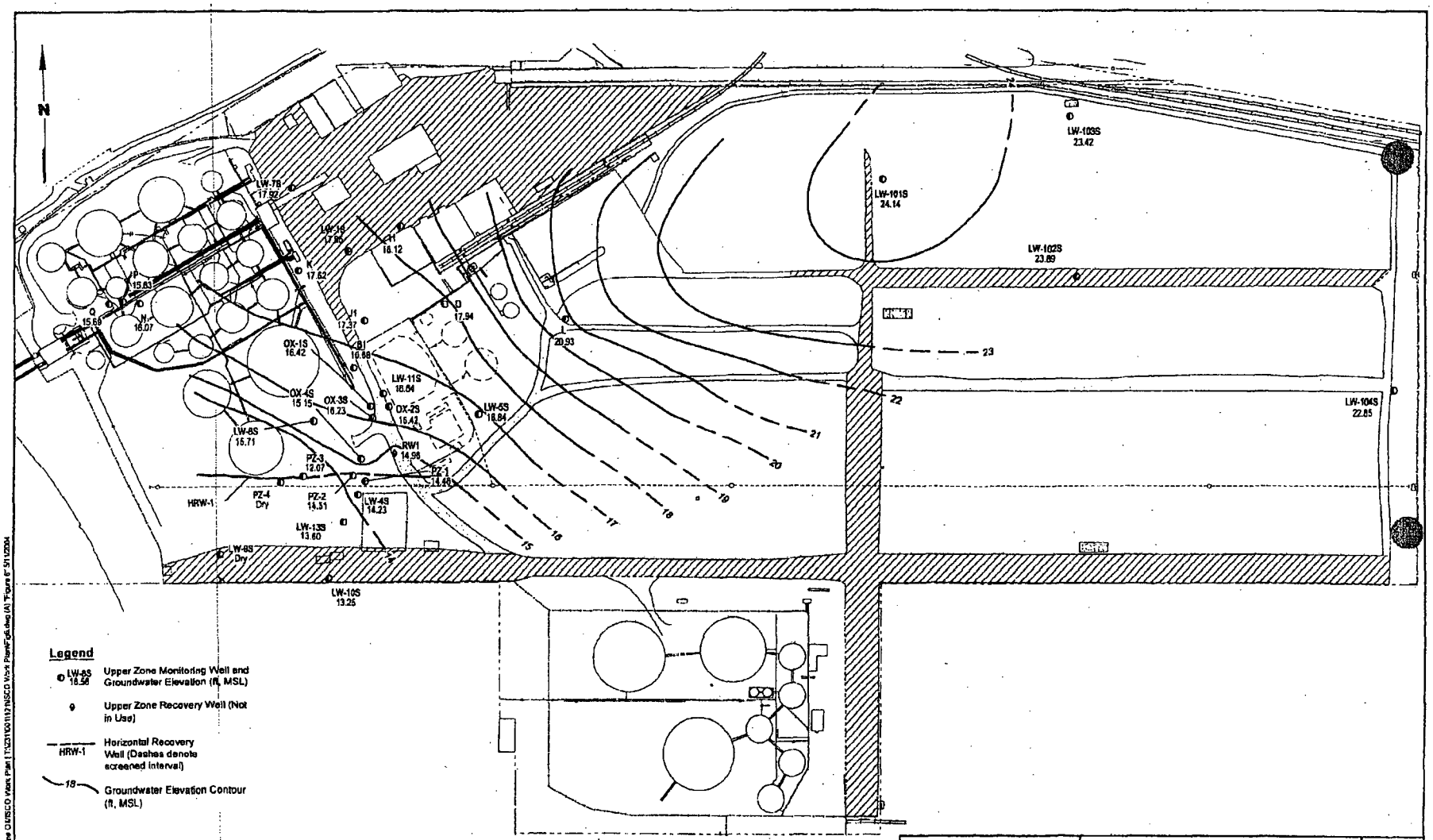


SCHN00304376



Time Oil NW Terminal Portland, Oregon	Upper Zone Groundwater Potentiometric Surface February 11, 2003	Figure 6

Time Oil/SCD Work Plan | T:\2310\01\127\SCD Work Plan\Fig6.dwg (A) "Figure 6" 5/11/2004

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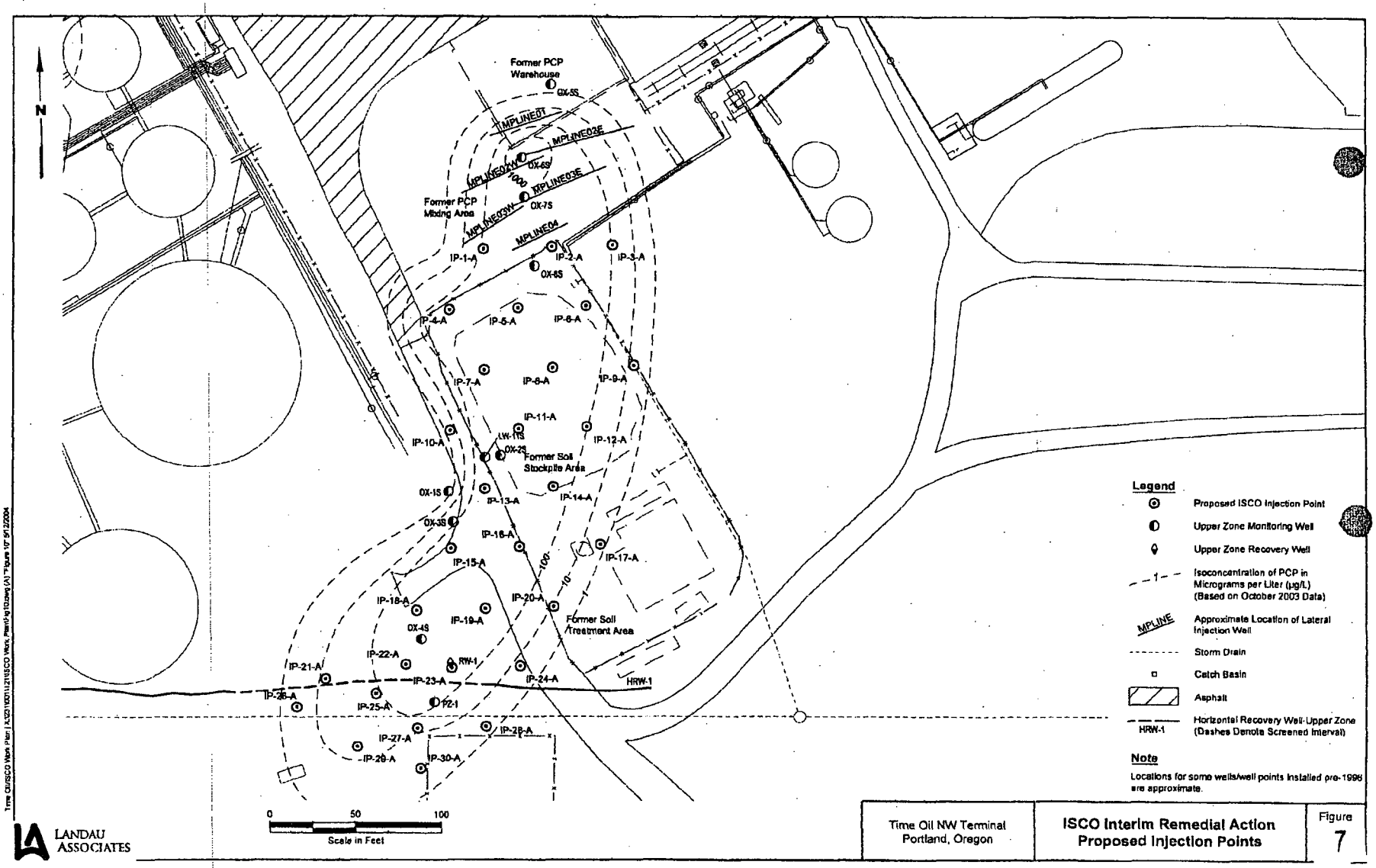

LANDAU ASSOCIATES

Time Oil NW Terminal Portland, Oregon	ISCO Interim Remedial Action Proposed Injection Points	Figure 7

Time Oil/ISCO Work Plan | X:\231\001\1\215\ISCO Work Plan\Fig10.dwg (A) "Figure 10" 5/12/2004

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TABLE 1
ANALYTICAL SAMPLE PARAMETERS
ISCO INTERIM REMEDIAL ACTION PLAN
TIME OIL NORTHWEST TERMINAL
PORTLAND, OREGON

Monitoring Wells (a)	Matrix	Analytes	Analytical Method/Procedure	Laboratory	Sample Container	Storage Temperature & Preservation	Maximum Sample Holding Time (b)
LW-11S, RW-1S, OX-1S, OX-2S, OX-3S, OX-4S, OX-5S, OX-6S, OX-7S, OX-8S	Water	Volatile Organics (c)	EPA Method 8260	Specialty Analytical, Inc.	3 each 40-mL glass vials	HCl to pH <2 Cool to 4°C	14 days until analysis
	Water	Semivolatile organics (c)	EPA Method 8270	Specialty Analytical, Inc.	1-Liter amber glass, Teflon-lined lid	Cool to 4°C	7 days until extraction; 40 days after extraction
	Water	Priority Pollutant Metals (c)	EPA Method 6010/7000 Series	Specialty Analytical, Inc.	1-Liter high density polyethylene (HDPE)	5 ml HNO_3 Cool to 4°C	6 months until analysis
	Water	Ferrous Iron (Fe^{2+})	SM 3500-Fe	Specialty Analytical, Inc.	6 X 1-Liter wide mouth plastic	Cool to 4°C	28 days until analysis
	Water	Total Dissolved Solids (c)	EPA Method 160.1	Specialty Analytical, Inc.	1-Liter plastic	N/A	N/A
	Water	Chloride	EPA Method 325.2	Specialty Analytical, Inc.	500-mL HDPE	Cool to 4°C	28 days until analysis
	Water	Pentachlorophenol	EPA Method 8270	Specialty Analytical, Inc.	1-Liter amber glass, Teflon-lined lid	Cool to 4°C	7 days until extraction; 40 days after extraction
	Water	Selenium	EPA Method 6010	Specialty Analytical, Inc.	1-Liter HDPE	5 ml HNO_3 Cool to 4°C	6 months until analysis

(a) Groundwater samples listed will be collected during quarterly groundwater sampling events and two to three weeks after each ISCO injection event.
(b) Holding times are from date of collection unless otherwise specified.
(c) These analyses will only be completed during quarterly groundwater sampling events.

SCHN00304379

Jim - Rod & Tom G. have reviewed. Let me know if you have comments and I will Finalize. Thanks!

Nice job, Tom. I have a couple of comments + questions ...., let's talk, Tom

State of Oregon

Department of Environmental Quality — Memorandum

Date: DRAFT

To: Jim Anderson, Manager, NWR Portland Harbor Section

From: Tom Roick, Project Manager, NWR Lower Willamette Section

Subject: Interim Remedial Action, Source Control Decision for Time Oil Northwest Terminal ECSI # 170

Purpose

This memo summarizes DEQ's review of a proposed interim action by Time Oil Company for the Northwest Terminal site. The proposed interim action seeks to treat pentachlorophenol (PCP) contamination in groundwater at the facility pending selection of a final remedial action for the site through the remedial investigation / feasibility study (RI/FS) process. The proposal is an expansion of a currently operating groundwater pump and treat system and an in situ treatment pilot study conducted in 2002. The proposal is documented in the May 11, 2004 *Work Plan, In Situ Chemical Oxidation, Interim Remedial Action, Time Oil Northwest Terminal*, prepared by Landau Associates. The DEQ Time Oil project team has completed our review of the Work Plan and recommends approval of the proposed action. We have some comments on the Work Plan details, which Time Oil must respond to as part of the field implementation. Time Oil would like to begin the interim action in mid-June 2004.

Background

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PCP contamination in soil and groundwater was discovered at the facility in 1985. On September 5, 1996 DEQ entered into a Voluntary Agreement with Time Oil to provide oversight of environmental investigations at the Time Oil facility. Investigations have been phased to address a ~~pentachlorophenol (PCP)~~-contaminated soil stockpile (Phase I), PCP-mixing area soil and groundwater contamination (Phase II), and other areas of the facility including bulk petroleum storage tanks (Phase III). The proposed interim action will address Phase II, PCP-contaminated groundwater and saturated zone soil contamination.

SCHN00304380

Tom, I'm curious.... are they just spoiling batches of gw? Propane gas is stored in an AST. Batched treated through the onsite treatment system, discharged to City Sewer

Phase II Interim Actions

Several interim measures have been conducted at the Time Oil facility. Cleanup activities to date in the Phase II area have included the following.

- In 1989, approximately 3,000 cubic yards of PCP-contaminated soil were excavated from the PCP-mixing area and placed into a stockpile for biological treatment. Treatment was not successful in reducing PCP concentrations to the target cleanup goal, and the soil stockpile remained on-site until removal in 2002 (see below).
- In March 2000, Time Oil began installation of a groundwater pump and treat interim action to address migration of the PCP groundwater plume. A horizontal recovery well, HRW-1, was installed in the upper groundwater zone at about 22 feet below ground surface (bgs). Pumping of groundwater from HRW-1 has been intermittent, due to low groundwater elevations and technical difficulties with the well and horizontal pump system.
- In October 2000, as part of the groundwater interim action, groundwater pumping was implemented from a recovery well, RW-2, previously installed in 1997. RW-2 is screened in the lower groundwater zone from 27 to 41 feet bgs. Over 15 million gallons of PCP-contaminated groundwater have been extracted since the beginning of pumping. The extracted groundwater is treated in an on-site biological water treatment system and discharged to the City of Portland's Columbia Wastewater Treatment Plant.
- In September 2002, a groundwater ~~water~~ recovery system was installed in the storm sewer that runs through the site to capture groundwater seeping into the drain line. The storm drain line is plugged upgradient of the PCP groundwater plume, but contains a bypass that allows storm water to flow through to its discharge point at the Willamette River. The system captures groundwater seeping into the drain line and pumps it into a holding tank for treatment through the on-site biological treatment system.
- In the fall 2002, the former PCP mixing area warehouse was demolished and the resulting materials disposed. The Phase I stockpile of PCP-contaminated soil was trucked off-site to an incinerator in Canada for disposal, along with approximately 6,400 cubic yards of PCP-contaminated soil excavated from the former PCP mixing area. Manifold piping (MPLines) was installed in the bottom of the approximately 13 foot deep soil excavation for potential future use in treating residual soil and groundwater contamination.

I don't understand. Is the recovery system recovering gw in the backfill or actually in the pipe? The text says stormwater flow thru the pipe ..., or does it enter the pipe downpipe of the PCP plume. Please explain to me. OK

ISCO Pilot Study

In September 2002, Time Oil retained In-Situ Oxidative Technologies, Inc. (ISOTEC) to conduct an *in situ* chemical oxidation (ISCO) pilot study through the use of Fenton's reagent. The treatment was intended to address PCP-contaminated groundwater and saturated zone soil downgradient of the former PCP mixing area. The Fenton's reagent reaction is created by the reaction of soluble iron with low concentrations of hydrogen peroxide to produce hydroxyl radicals (•OH). The ISOTEC process includes a proprietary food-grade reagent to help catalyze the reaction. The hydroxyl radical is a powerful and short-lived oxidizer that attacks the carbon double bonds of chlorinated hydrocarbons, such as PCP. The oxidation capacity of the reagent is

(OH⁻) ? No! • OH is a radical
OH⁻ is an ion

SCHN00304381

typically used up in a few days. ISOTEC's process has been shown to be effective in treating a range of contaminants including petroleum hydrocarbons and chlorinated solvents. Treatment by-products are carbon dioxide, water, chloride ions, and ferric iron, which rapidly precipitates out of the groundwater.

During the pilot study reagents were injected into push-probes screened from the top of the water table at 16 feet bgs to 19 feet bgs, at ten locations downgradient of the source area (Figure 3). Groundwater and saturated zone soil samples were collected to evaluate effectiveness of the pilot treatment. While PCP was the target contaminant, contaminants of potential concern (COPCs) in the Phase II area include petroleum hydrocarbons; constituents of petroleum products, such as benzene and naphthalene; other phenols, such as tetrachlorophenol; and dioxin, a contaminant in PCP product formulations. The ISCO process was successful in reducing overall PCP concentrations as well as other contaminants of concern in both saturated zone soil and groundwater.

Interim Action Work Plan

The current proposal is full-scale implementation of the ISCO pilot study conducted previously at the site in 2002. Attached Figures 4 and 5 show the most recent site investigation data plotting PCP concentrations in soil and upper zone groundwater, respectively. Figure 6 shows groundwater flow conditions, and Figure 7 shows the proposed ISCO injection points. Approximately 30 injection points will be installed at 40-foot spacings, with some treatment overlap in the radius of influence surrounding each injection point. Lateral manifold piping previously installed in the PCP mixing area excavation may also be used, pending an evaluation of the water table elevation at the time of treatment. Groundwater recovery wells RW-2 and HRW-1 will be operational during treatment to maintain capture of the PCP plume.

Tom, TPH was listed as COI, but not as an analyte in Table 1. Why? Let's talk. TPH is included in the Quarterly Monitoring events.

Attached Table 1 lists the groundwater monitoring locations and analytical parameters proposed to evaluate effectiveness of the treatment. Although not listed on the table, dioxin has been and will continue to be analyzed in selected wells as part of an on-going, Phase II annual monitoring program. In addition to priority pollutant metals, selenium analysis is included because naturally-occurring concentrations of this metal could mobilize under oxidizing conditions. Monitoring will be conducted to ensure that the ISCO injections do not cause an unacceptable increase in the concentrations of metals in groundwater. The reactants are short-lived in the environment, and the radius of influence of the treatment process can be readily controlled and monitored through source area and downgradient monitoring wells. The downgradient edge of the plume to be treated is approximately 350 feet from the Willamette River. No adverse impacts to groundwater are anticipated downgradient of the treatment area.

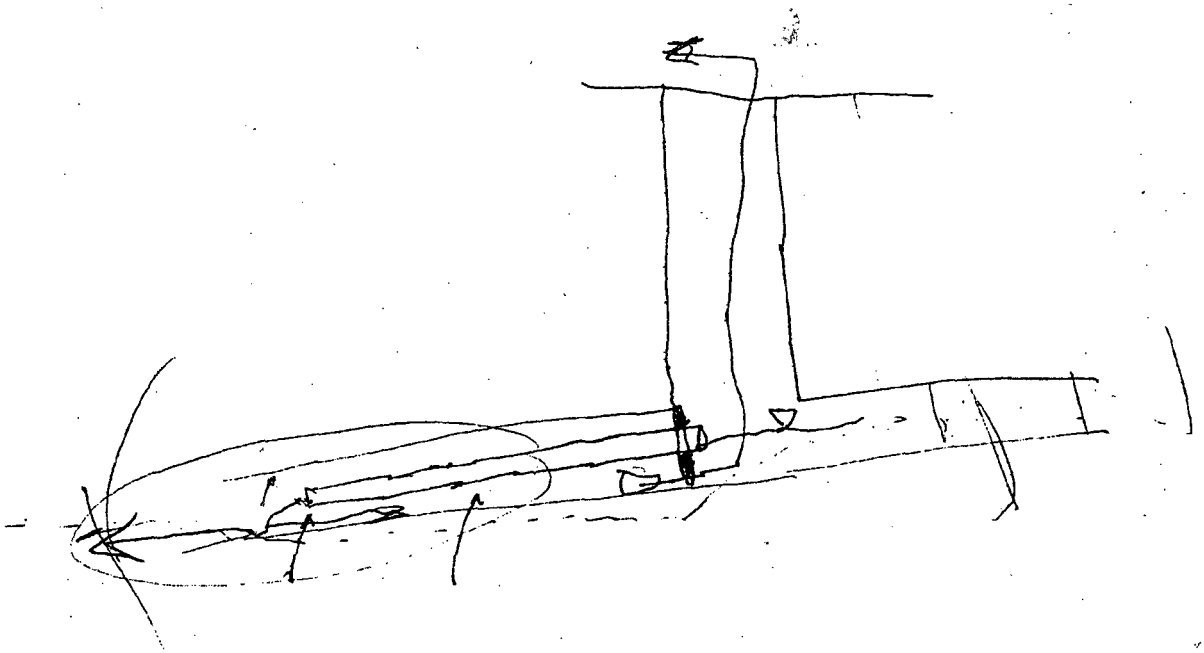
Recommendation

The potential for PCP in groundwater at the site to migrate to the Willamette River, and particularly to migrate preferentially through the on-site storm drain, is a time-critical concern. The DEQ Time Oil project team supports the use of ISCO as an interim source control action for the Time Oil site.

SCHN00304382

Concurrent with implementation of the interim remedial action, Time Oil will continue to complete the Phase II and III Remedial Investigations, baseline human health risk assessment and ecological risk assessments, and a site feasibility study. The results of these studies will be used by DEQ to select the final upland site remedy (i.e., source control decision) for the facility. DEQ will seek public comment on the recommended final upland remedy. At this time, we anticipate the final remedy will be proposed in the fall 2005.

Attachments:
Figures 1-7
Table 1



SCHN00304383

#170 Time Oil RPT
MULTNOMAH Qtrly rpt 7/8/04

SCHN00304409

Time Oil:
Quarterly Rpt.

LANDAU ASSOCIATES

July 9, 2004

Mr. Tom Roick
Oregon Department of Environmental Quality
2020 SW Fourth Avenue, Suite 400
Portland, OR 97201-4987

RECEIVED
JUL 12 2004
DEPT OF ENVIRONMENTAL QUALITY
NORTHWEST REGION

RE: TIME OIL NORTHWEST TERMINAL
PORTLAND, OREGON

Dear Mr. Roick:

On behalf of Time Oil, attached is the April through June 2004 quarterly report for Time Oil Northwest Terminal RI/FS.

LANDAU ASSOCIATES, INC.

Rebekah Brooks
Project Manager

RB/tam
7/9/04 \\Edmdata\wproc\231\TRANSMIT.FAX\Quarterly Rpt_Ltr.doc
Enclosure

cc: Mr. Walter Sprague, Time Oil Co.
Ms. Patricia Dost, Schwabe Williamson & Wyatt
Mr. Mike Tischuk, Beazer East, Inc.

SCHN00304410

QUARTERLY REPORT TO DEQ
TIME OIL - NORTHWEST TERMINAL
April through June, 2004

SUMMARY OF WORK PERFORMED

- Prepared and submitted the January - March 2004 quarterly report to DEQ.

- Continued operation of the groundwater interim action in the lower zone at RW-2 at an average flow rate of 7.7 gpm. Continued operation of groundwater recovery in the upper zone at the groundwater intercept system at the east-west trending storm drain line at an average flow rate of 2.37 gpm from May 24th through June 29th. The flow meter for the storm drain (SDM-1) was not functioning from April 1st through May 24th. HRW-1 did not operate during April 1st through April 30th because it was dry due to low water level conditions. HRW-1 operated intermittently from April 30th through June at an average rate of 0.27 gpm. A total of approximately 16.9 million gallons of groundwater have been treated and discharged from the interim action system, with a total of about 1.1 million gallons treated during this quarter.

- Continued review of the system operations performance for the groundwater interim action system at RW-2 and HRW-1, the groundwater intercept system at SDM-1, and the onsite wastewater treatment plant (WWTP). In addition, we continued to monitor the groundwater elevation in the upper zone to determine when groundwater recovery could be resumed at HRW-1. Based on the observed groundwater elevation, the pump in HRW-1 was restarted on April 30, 2004.

- Collected effluent samples from the WWTP throughout the quarter to evaluate the treatment system efficiency. On April 22, 2004 a WWTP effluent sample was collected which indicated that the concentration of pentachlorophenol (PCP) was 194 micrograms per liter (µg/L), which exceeded the permitted limit of 40 µg/L for PCP. The upset condition was reported to the City of Portland and minor changes were made to the WWTP to improve the aeration of the water prior to effluent. Subsequent effluent samples have been verified as meeting the discharge permit limits.

- Completed the *Phase III Remedial Investigation (RI)I Report* and submitted to DEQ for review on April 30, 2004.

- Began preparation of a work plan for performance of the terminal-wide human health and ecological risk assessments.

- Conducted the second quarter 2004 groundwater monitoring event June 7 through 10, 2004. Continued the sampling frequency recommended in our February 2, 2004 letter to DEQ, as approved by DEQ in an email from Tom Roick on February 3, 2004. Formal approval will occur after thorough review by DEQ.

- Completed preparation of the *Fourth Quarter 2003 Groundwater Monitoring and Groundwater Interim Action Status Report* and submitted to DEQ.

- Continued preparation of the *First Quarter 2004 Groundwater Monitoring and Groundwater Interim Action Status Report.*

- Prepared a work plan for implementation of the *in situ* chemical oxidation (ISCO) technique as an interim remedial action for upper zone soil and groundwater. Final approval of the work plan from DEQ is pending and the first full-scale ISCO event is scheduled to commence on July 12, 2004.

SCHN00304411

- Received DEQ's comments on the *ISCO Interim Remedial Action Work Plan* and submitted a response letter to DEQ on its comments. At DEQ's request, the response to comments will be incorporated into the work plan.

- Sampled the ISCO monitoring wells as part of the second quarter 2004 event to document baseline groundwater conditions prior to implementation of the interim remedial action.

- Submitted the (Underground Injection Control) UIC application for the ISCO injection event to Barbara Priest at DEQ, Water Quality. Received approval of the application from DEQ on June 18, 2004.

- Continued passive product recovery in well Q using a product sock. The product socks were removed from wells LX-2S and PZ-2 because product was not observed at these locations during the second quarter 2004 monitoring event. Continued temporary storage of the spent product socks in a 55-gallon drum in a designated location at the terminal pending disposal.

- Continued passive product recovery in well LW-21S using a passive bailer. The bailer was removed from well LW-27S because product was not observed at this location during the second quarter 2004 monitoring event. The product is temporarily being stored in a 55-gallon drum in a designated location at the terminal pending disposal.

RESULTS COLLECTED

- Influent/effluent samples from the WWTP for April through June, 2004. With the exception of the analytical result from the April 22, 2004 effluent sample, PCP and other constituent concentrations (e.g., BTEX) were less than the permitted maximum discharge limits identified in the industrial wastewater discharge permit. The data results will be presented in the *Second Quarter 2004 Groundwater Monitoring and Groundwater Interim Action Status Report.*

- Final groundwater data for the first quarter 2004 groundwater sampling event. Data results will be presented in the *First Quarter 2004 Groundwater Monitoring and Groundwater Interim Action Status Report.*

PROBLEMS ENCOUNTERED AND STEPS TO RESOLVE

- As referenced above, an effluent sample collected from the WWTP on April 22, 2004 reportedly exhibited a concentration of PCP (194 µg/L) in excess of the permitted limit (40 µg/L). Modifications were made to improve performance of the WWTP, and subsequent samples collected on May 6, May 13, May 19, May 27, June 3, June 9, and June 15, 2004 were analyzed for PCP and reported to be below the 40 µg/L discharge permit limit.

WORK TO BE PERFORMED NEXT QUARTER

- Prepare and submit quarterly report to DEQ.

- Continue implementation of the groundwater interim action in the lower zone at RW-2. Continue to operate the groundwater intercept system at the storm drain (SDM-1). Continue groundwater treatment and discharge to POTW. Continue review of the system operations performance for the

SCHN00304412

groundwater interim action system at RW-2, HRW-1, SDM-1 and the onsite wastewater treatment system.

- Continue to monitor the effluent from the WWTP.
- Complete preparation of the *First Quarter 2004 Groundwater Monitoring and Groundwater Interim Action Report* and submit to DEQ.
- Prepare the *Second Quarter 2004 Groundwater Monitoring and Groundwater Interim Action Report.*
- Conduct the third quarter 2004 groundwater monitoring event in August 2004.
- Conduct the first ISCO injection event in mid-July 2004.
- Complete preparation of the risk assessment work plan and submit to DEQ.

NEW TIME OIL PROJECT MANAGER

- Time Oil is in the process of selecting a new project manager for this site. For now, please direct correspondence and other communications to Walter Sprague, Time Oil Co., 2737 W. Commodore Way, Seattle WA; (206) 285-2400 Ext 505; wsprague@timeoil.com.

SCHN00304413