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2008 Additional Site Investigation and Groundwater Monitoring Report

Former Unocal Edmonds Bulk Fuel Terminal (Lower Yard)

11720 Unoco Road

Edmonds, Washington 98020

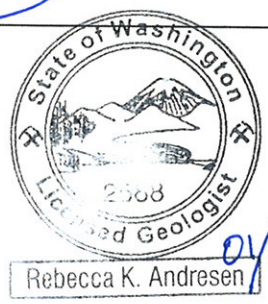
January 18, 2010

ARCADIS

David Rasar
Scientist II

Scott Zorn
Project Geologist

Rebecca Andresen, P.G.
Principal Geologist



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Former Unocal Edmonds Bulk Fuel Terminal (Lower Yard)

Prepared for:
Chevron Environmental Management Company

Prepared by:
ARCADIS
2300 Eastlake Avenue East
Suite 200
Seattle, Washington 98102
Tel 206.352.5254
Fax 206.325.8218

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Acronyms

amsl	above mean sea level
bgs	below ground surface
btoc	below top of casing
CUL	soil cleanup level
EIMS	Washington State Department of Ecology Environmental Information Management System
IHS	Indicator Hazardous Substances
LNAPL	light non-aqueous phase liquid
mg/kg	milligrams per kilogram
µg/L	micrograms per liter
OTAK	OTAK Surveying
cPAH	carcinogenic polynuclear aromatic hydrocarbons
POC	point of compliance
REL	soil remediation level
Report	*2008 Additional Site Investigation and Groundwater Monitoring Report*
SAP	*Sampling and Analysis Plan*
TPH	total petroleum hydrocarbons
TPH-G	gasoline-range hydrocarbons
TPH-D	diesel-range hydrocarbons

USEPA	United States Environmental Protection Agency
WSDOT	Washington State Department of Transportation

1. Introduction

On behalf of Chevron Environmental Management Company (Chevron), ARCADIS is pleased to submit this *2008 Additional Site Investigation and Groundwater Monitoring Report* (Report) for investigation and groundwater monitoring activities completed at the Lower Yard of the Former Unocal Edmonds Bulk Fuel Terminal located at 11720 Unoco Road, Edmonds, Washington (Site). The site location is shown on **Figure 1**. This Report presents a summary and evaluation of soil sample results from additional investigation activities conducted in accordance with the requirements of Agreed Order No. DE 4460 and as described in *Evaluation of Lower Yard Phase I Data and Work Plan for Additional Site Investigation,* submitted to DOE on May 30, 2008. Although it was not required for inclusion with this Report, a summary of the first two rounds of groundwater monitoring data collected post-remedial excavation activities has been included. Site layout is shown on **Figure 2**.

2. Site Description

The Lower Yard is approximately 22 acres in area, lying east-southeast of the BNSF Railway Company property, south of the Edmonds Marsh (also known as the Union Oil Marsh) and a drainage ditch (Willow Creek), and north of the Upper Yard (**Figure 2**). At its nearest point (the southwest corner of the Lower Yard), the Lower Yard boundary is approximately 160 feet from the Puget Sound shoreline. Two detention basins (DB-1 and DB-2) are located along the north and northeast boundary of the site. DB-1 borders Edmonds Marsh and Willow Creek, and acts as a retention pond for overflow from DB-2 during storm events. DB-2 serves as a collection area from which site stormwater is discharged into Willow Creek.

The surface soils within the southeast, north, and south portions of the Lower Yard currently consist of compacted backfill material graded toward a stormwater collection system. Surface soil is covered with hydroseed as an erosion control measure. The southwest area of the Lower Yard is covered in 6-inch minus quarry spalls and graded to direct surface water toward the center of the site and into the stormwater system. The stormwater system, consisting of 12 on-site storm drains, collects runoff water and discharges it directly into DB-2 via gravity flow. From DB-2, stormwater is discharged into Willow Creek under Industrial Stormwater General Permit No. SO3-002953C, and excess stormwater is stored in DB-1 during large storm events. A Washington State Department of Transportation- (WSDOT-) owned, 72-inch concrete stormwater line crosses beneath the Lower Yard and out to Puget Sound, at a reported depth of 9 to 12 feet bgs to the top of the pipe (**Figure 2**). This line was installed between 1972 and 1975 and is the main stormwater drainage structure for State Route 104.

Previous structures in the Lower Yard included petroleum storage and transfer equipment (aboveground tanks and piping), two truck loading racks, several office buildings, a railcar loading/unloading station, an air-blown asphalt plant, and an asphalt packaging warehouse.

2.1 History

Unocal operated the Terminal from 1923 to 1991. Fuel was brought to the Lower Yard on ships, pumped to the storage tanks in the Upper Yard, and loaded from the tanks into rail cars and trucks for delivery to customers. An asphalt plant operated at the Lower Yard from 1953 to the late 1970s.

From August to November 2001, Unocal conducted an interim action in the Lower Yard to remove light non-aqueous phase liquid (LNAPL) and petroleum-impacted soil from four areas of the Lower Yard. The 2001 interim action mainly consisted of the excavation of a total of 9,199 cubic yards of petroleum-impacted soil from four excavation areas and the extraction of 76,237 gallons of LNAPL and groundwater (approximately 2,524 gallons of LNAPL) from open excavations (MFA, 2002).

From August through December 2003, Unocal conducted a second interim action in the southwest Lower Yard area and in DB-1. The 2003 interim action consisted of the excavation of 39,130 tons of petroleum-impacted soil and sediment, and the extraction of approximately 1,861,520 gallons of groundwater from DB-1 and the southwest Lower Yard area.

In July 2007, Unocal entered into an Agreed Order with the Washington Department of Ecology (DOE) to conduct a third interim action (Interim Action) in the Lower Yard. Specific objectives of the Interim Action included the removal of petroleum-impacted soil that was in excess of the soil remediation levels (RELs) and soil cleanup levels (CULs) established for this site, removal of LNAPL, extraction of groundwater that is in contact with LNAPL, and removal of arsenic-impacted soil that was in excess of the CULs within the Lower Yard. A soil REL was established for total petroleum hydrocarbons (TPH) at 2,975 milligrams per kilogram (mg/kg), and soil CULs were established for carcinogenic polynuclear aromatic hydrocarbons (cPAHs) at 0.14 mg/kg, benzene at 18 mg/kg, and arsenic-impacted soil at 20 mg/kg. From July 2007 to April 2008, approximately 130,000 tons of petroleum-impacted soil and approximately 9,743 gallons of LNAPL were removed from the Lower Yard as part of Phase I of the Interim Action. A draft report documenting the Phase I activities was submitted to DOE on January 8, 2009.

Phase II of the Interim Action, which was conducted from July through October 2008, included excavation of approximately 450 linear feet of sediment from Willow Creek, as well as removal of an estimated 8,000 tons of petroleum-impacted soil remaining from excavation areas B1, B7, B8 and B9. A report documenting Phase II Interim Action activities will be submitted in April 2009, in accordance with the approved schedule in the Agreed Order.

2.2 Geology

The majority of the Lower Yard consists of clean imported backfill material from a DOE approved source, from the 2007-2008 (Phase I and Phase II) interim actions. The fill is

found within the excavated areas (**Figure 2**) to a depth of 8 to 12 feet below ground surface (bgs) and is comprised of very fine to medium sand, trace silt, and coarse gravel. Backfill in the saturated zone (approximately 8 to 15 feet bgs) is comprised of clean coarse gravels.

Prior to excavation, subsurface materials encountered during the 2007 through 2008 Phase I Interim Action consisted of silty sands with gravel and sandy silts with gravel. A clean sand formation of very fine to medium sand with fine gravel was encountered between 8 to 15 feet bgs, and contained organic material, such as beach debris, wood, and seashells. Excavation areas throughout the Lower Yard encountered a native layer approximately 6 to 12 inches thick composed of sandy silt with large amounts of peat, wood debris, and decomposing vegetation. This layer was encountered at depths of 8 to 14 feet bgs and is considered to be representative of the former marsh that was located at the site before development in the early 1900's.

3. 2007 through 2008 Phase I Interim Action Excavation Results

The main excavation areas of the 2007 through 2008 Phase I Interim Action (B11, A2, and B20) extended south and southwest to the lower portion of Unoco Road. A Washington State Department of Transportation- (WSDOT-) owned, 72-inch concrete stormwater line crosses beneath the Lower Yard and out to Puget Sound, at a reported depth of 9 to 12 feet bgs at the top of the pipe. (**Figure 2**). This line was installed between 1972 and 1975 and is the main stormwater drainage structure for State Route 104. Prior to excavation, the WSDOT stormwater line was located by GeoMarkout Corporation of Pocatello, Idaho. Phase I excavations adjacent to the WSDOT line began 10 feet to the north of the centerline of the stormwater line. Excavations then progressed away from the stormwater line at a 2:1 slope.

As part of the Phase I Interim Action activities, seventeen sidewall soil samples were collected along the south walls of excavation areas B11, A2, and B20, in the direction/closest proximity to the WSDOT line. Five of these 17 soil samples contained concentrations of Indicator Hazardous Substances (IHSs) exceeding site CULs and/or RELs (**Figure 3**). Four soil samples exceeded the site TPH REL of 2,975 mg/kg, with concentrations ranging from 3,060 mg/kg to 15,700 mg/kg. Two soil samples exceeded the site CUL for cPAHs of 0.14 mg/kg, with concentrations of 0.159 mg/kg to 0.166 mg/kg. Eleven excavation floor soil samples were collected adjacent to the 17 sidewall soil samples; none contained IHS concentrations exceeding site CULs or RELs. Analytical data for soil samples collected in this area are presented in the draft *Phase I Remedial Implementation As-Built Report,* Table 4 (ARCADIS, 2009).

Due to the proximity of the WSDOT line, the sidewalls containing impacted material were not over-excavated. The length of the southern excavation limit was demarcated with a 20 thousandths of an inch (20-mil) thick plastic sheeting from ground surface to 7.5 feet above mean sea level (amsl), or approximately six inches to one foot below the groundwater surface. The excavation was then backfilled and compacted. The approximate location of the plastic sheeting is shown on **Figure 3**. The depth and location of the plastic sheeting is depicted on **Figures 9 and 10**.

4. Additional Soil Delineation

As outlined in *Evaluation of Lower Yard Phase I Data and Work Plan for Additional Site Investigation* (ARCADIS, 2008), the purpose of this additional investigation was to:

- collect data to evaluate the nature and extent of petroleum impacts in soils to the south and southwest of the WSDOT stormwater line
- identify the lateral extent of petroleum impacts in the area of the Former Railroad Trestle
- investigate the source of LNAPL observed on groundwater in monitoring well MW-129
- address possible impacts along the south berm of DB-1
- investigate potential petroleum-impacted soil beneath the footprint of the former asphalt warehouse, as shown in **Figure 2**

Twenty-four soil borings were advanced in the Lower Yard to further delineate each of these areas. Boring locations are presented on **Figure 4**.

This additional site investigation included 14 soil borings (SB-65 through SB-75, SB-80, SB-87 and SB-88) completed to the south and southwest of the WSDOT line to delineate potential impacts remaining after Phase I excavations overlying and adjacent to the storm sewer were completed.

Additional soil assessment was also conducted in the Former Railroad Trestle Area, located to the south/southwest of the 2003 southwest Lower Yard excavation area in the most southwestern portion of the Lower Yard, as shown on **Figure 2**. During Phase I confirmation soil boring activities in April 2008, soil samples were collected in this area that contained TPH concentrations greater than the TPH REL. Historical data also show soil samples collected to the west of this area contain concentrations of TPH exceeding the site REL. Two borings (SB-85 and SB-86) were completed via hand auger to investigate and delineate impacts in this area.

Additional investigation in the area of monitoring well MW-129 was conducted due to the historical presence of LNAPL on groundwater, typically measured and recorded as

a thin film of less than or equal to 0.01 feet. Three soil borings (SB-78, SB-79 and SB-81) were advanced surrounding MW-129 to investigate the source of LNAPL.

In addition to the 15 soil borings described in the 2008 work plan, three additional borings (SB-82 through SB-84) were completed along the southern berm of DB-1 and two additional soil borings (SB-76 and SB-77) were completed within the footprint of the former asphalt warehouse (between MW-129 area and excavation area A1), in response to DOE's June 20, 2008 comments. The boring locations in this area were constrained due to the presence of the onsite water treatment system used during Interim Actions, which covered a portion of the former asphalt warehouse footprint.

Soil borings advanced along the alignment of the WSDOT stormwater line were checked for the presence of subsurface structures by removing soil using a vacuum truck to between 6 and 8 feet bgs, with the exception of those borings located in upper Unoco Road. Soil borings advanced in upper Unoco Road, the Former Asphalt Warehouse Area, and well MW-129 areas were not checked in the same manner for subsurface structures prior to drilling based on the results of geophysical testing conducted prior to Phase I implementation. Soil borings SB-82 through SB-86 were advanced to depth using a hand auger.

Eighteen-inch-long split-spoon samples were collected every 2 vertical feet to the total depth explored. For soil borings SB-71, SB-72, and SB-76 through SB-80, split-spoon samples were first collected from depths of 1 to 2 feet bgs. In soil borings SB-65 through SB-70, SB-73 through SB-75, SB-87, and SB-88, split-spoon samples were first collected at depths of 6 to 8 feet bgs. In soil borings that were checked for subsurface structures using the vacuum truck, soil samples collected at depths between ground surface and 7.0 feet bgs were collected using a hand auger during borehole clearance activities.

Field screening was conducted on each sample interval using a photoionization detector. Boring logs were prepared by an ARCADIS field geologist and are included in **Appendix A**. Soil samples were classified using the Unified Soil Classification System. In addition, select soil samples were submitted for analytical laboratory analysis. Samples were submitted to a state-certified laboratory (TestAmerica located in Bothell, Washington) and were analyzed for the following:

- benzene, toluene, ethylbenzene, and total xylenes (BTEX) by United States Environmental Protection Agency (USEPA) Method 8021B;

- gasoline-range hydrocarbons (TPH-G) by USEPA Method NWTPH-Gx;
- diesel and heavy oil-range hydrocarbons (TPH-D and TPH-O)(after silica gel cleanup)TPH-D) by USEPA Method NWTPH-Dx; and
- carcinogenic polynuclear aromatic hydrocarbons (cPAHs by USEPA Method 8270 SIM.

The soil analytical results are summarized in **Table 1** and on **Figure 5.** Laboratory data reports are included in **Appendix B**.

Analytical data presented in this Report can be located within the DOE Environmental Information Management System (EIMS), under the User Study ID: Unocal02. EIMS is a searchable database and can be accessed through the DOE website (www.ecy.wa.gov). Sample location coordinates are also presented in EIMS using the World Geodetic System.

4.1 Washington State Department of Transportation Stormwater Line

Of the soil samples collected from 14 soil borings completed along the south and southwest side of the WSDOT stormwater line, soil samples from five borings contained concentrations of IHSs that exceeded site RELs and/or CULs (**Figure 6**). Specifically, soil samples from soil borings SB-65, SB-66, SB-68, SB-69, and SB-80 exceeded the REL for TPH and the CUL for cPAHs. Concentrations of TPH ranged from 3,720 mg/kg in sample SB-69-6.0 to 16,900 mg/kg in sample SB-65-6.5. Concentrations of cPAHs ranged from 0.165 mg/kg in sample SB-68-4.0 to 1.01 mg/kg in sample SB-65-6.5. Sample SB-65-6.5 also exceeded the REL for benzene with a concentration of 35.8 mg/kg. Soil samples from borings SB-67, SB-70 through SB-75, SB-87, and SB-88 did not contain concentrations of IHSs exceeding site RELs or CULs. Analytical data are presented in **Table 1** and on **Figure 5**.

Total depth explored in the borings located along the WSDOT stormwater line ranged from 14.5 feet bgs in soil borings SB-80 and SB-88 to 24.5 feet bgs in soil boring SB-71. Soil samples exceeding RELs or CULs were collected between 4.0 feet bgs (SB-68-4.0) and 8.0 feet bgs (SB-65-8.0), which are depths within the expected zone of seasonal groundwater fluctuation.

Based on results from Phase I Interim Action excavation confirmation soil sample analytical results and analytical results from the 14 soil borings completed during the

additional assessment, vertical and horizontal delineation of impacts along the WSDOT line has been completed. Excavation confirmation soil samples that contained concentrations of IHSs in excess of site CULs and RELs were collected from depths between ground surface and 8 feet bgs. In each case, a sample was collected below the impacted sample with analytical results indicating IHS concentrations were less than CULs and RELs. Therefore, the horizontal and vertical extent is defined by excavations completed during the Phase I Interim Action and soil analytical results from soil borings SB-67, SB-70 through SB-74, and SB-87. It is estimated that approximately 4,691 cubic yards of impacted soil remain in place above and in the vicinity of the WSDOT stormwater line. This calculation is based on the areas of impact as shown on **Figure 6** being excavated to a depth of 12 feet bgs, with 2 to 1 slopes on all sidewalls. A maximum depth of 12 feet bgs was used based on the deepest boring sample with IHS concentrations exceeding site CULs (SB-65-8.0) and the next deepest sample with concentrations less than site CULs (SB-65-16.0). An excavation depth of 12 feet bgs is half way between the sample with soil exceedences and the sample without exceedences. The remaining impacted soil in the vicinity of the WSDOT line will be addressed in the final corrective action plan.

Cross sections of this area, including sample locations and depths, are included as **Figures 7 through 10**.

4.2 Former Railroad Trestle Area

The Former Railroad Trestle Area is located in the southwestern corner of the Lower Yard. Three soil samples from previous site investigations collected in this area contained concentrations of TPH exceeding the site REL. To complete the delineation of the lateral extent of petroleum-impacted soils, two soil borings were completed as part of the Additional Site Investigation to the southwest of the Former Railroad Trestle Area. Soil borings SB-85 and SB-86 were completed to 9 feet bgs using a hand auger. Based on data collected in 2003 and 2008, two sets of analytical samples were collected from each boring at depths that corresponded with known impacts. Soil samples SB-85-5.5, SB-85-7.5, SB-86-4.5, and SB-86-6.5 did not contain concentrations of site IHSs exceeding site RELs or CULs. Analytical data are presented in **Table 1** and on **Figure 5**. Data collected from the Additional Site Investigation and previous investigations have completed delineation of the horizontal and vertical extent of petroleum-impacted soil in this area.

Subsequent to the Additional Site Investigation and based on the preliminary data collected during this assessment, ARCADIS completed an additional excavation in this

area during Phase II Interim Action. The excavation included the removal of approximately 7,850 tons of soil from the Former Railroad Trestle Area, including the impacted material exceeding RELs or CULs identified by Phase I confirmation boring activities. Following completion of excavation activities, confirmation soil samples were collected from the excavation floor and sidewalls for analytical testing. Analytical results on the confirmation soil samples did not contain concentrations of IHSs exceeding applicable RELs or CULs, and the excavation was backfilled in accordance with the Agreed Order. These results will be included in the pending Phase II Interim Action As-Built Report which will be submitted to DOE in April 2009.

4.3 Asphalt Warehouse Area

As described in the *Evaluation of Lower Yard Phase I Data and Work Plan for Additional Site Investigation* (ARCADIS, 2008), two soil borings were planned in the vicinity of the former asphalt warehouse to investigate the possibility of petroleum impacts.

Soil borings SB-76 and SB-77 were completed to depths of 17 feet and 14.5 feet bgs, respectively. The soil sample from SB-76, collected at 9 feet bgs, exceeded RELs and CULS for TPH and cPAHs with concentrations of 17,100 mg/kg and 0.198 mg/kg, respectively. The sample collected from boring SB-76 at 10.5 feet bgs contained a cPAH concentration of 0.190 mg/kg, greater than the site CUL. The sample from soil boring SB-77, collected at 9.5 feet bgs, exceeded the RELs and CULs for TPH and cPAHs with concentrations of 7,880 mg/kg and 0.214 mg/kg, respectively. Analytical data are presented in **Table 1** and on **Figure 5**.

Based on the preliminary results of this assessment, an additional excavation was conducted in the Asphalt Warehouse Area during Phase II remedial activities. Approximately 4,585 tons of soil were removed from the Asphalt Warehouse Area, which encompassed SB-76 and SB-77. Confirmation soil samples were collected from the excavation floor and sidewalls, and the excavation was backfilled. These results will be included in the pending Phase II Interim Action As-Built Report which will be submitted to DOE in April 2009.

4.4 Well MW-129 Area

Due to uncertainties related to the source of film of LNAPL film on groundwater historically present in well MW-129, three soil borings (SB-78, SB-79 and SB-81) were advanced in the vicinity of well MW-129 for the collection of soil samples. The three

soil borings were completed southwest, north (between DB-1 and MW-129), and northeast of MW-129 (**Figure 4**).

Soil borings SB-78, SB-79, and SB-81 were completed using a hollow-stem auger drill rig to depths of 15 feet bgs, 13.5 feet bgs, and 16 feet bgs, respectively. Of the three soil borings, a single sample from one (SB-79) contained IHSs in excess of site RELs and CULs. Sample SB-79-8.5, collected at a depth of 8.5 feet bgs in soil boring SB-79, exceeded the site RELs and CULs, with concentrations of TPH and cPAHs at 3,960 mg/kg and 0.276 mg/kg, respectively. Samples collected from depths of 5 feet, 10 feet, and 11.5 feet bgs in soil boring SB-79 did not contain concentrations of IHSs greater than applicable RELs.

Field observations were made at the time of boring SB-78 installation indicating the presence of LNAPL on the plastic bag used to describe the soil collected at 10 feet bgs. Based on this observation a sample from SB-78 was collected at 10 feet bgs and submitted to the laboratory for analysis. The Initial field observation was not confirmed by analytical testing which reported a TPH concentration of 35.1 mg/kg, indicating that LNAPL was not present.

Samples collected from SB-78 and SB-81 did not contain concentrations of IHSs greater than site RELs or CULs. Analytical data are presented in **Table 1** and on **Figure 5**.

Prior to Phase II Interim Action excavation activities, MW-129 was decommissioned as a contingency for the Asphalt Warehouse Area excavation extending to its location. Soil excavation activities during the Phase II Interim Action extended to include the location of soil borings SB-76, SB-77, and SB-79, and MW-129 was replaced in October 2008 during monitoring well installations. These results will be included in the pending Phase II Interim Action As-Built Report which will be submitted to DOE in April 2009.

4.5 Detention Basin No. 1 Berm

Based on comments in the DOE response letter dated June 20, 2008, three additional borings (SB-82, SB-83, and SB-84) were completed along the southeastern berm of DB-1. The soil borings were completed using a hand auger to depths of 9 feet, 8.5 feet, and 8 feet bgs, respectively. Two samples per soil boring were submitted for laboratory analysis. Samples from these borings did not contain concentrations of

IHSs above site RELs or CULs. Analytical data are presented in **Table 1** and on **Figure 5**.

Based on the results of soil samples collected on the DB-1 berm, no additional work was performed in this area during the Phase II Interim Action.

5. Groundwater Monitoring

In accordance with the Agreed Order, the site has implemented a groundwater monitoring program following completion of Phase I and II of the Interim Action excavation activities. The purpose of the monitoring program is to evaluate if remaining on-site soil concentrations will cause an exceedance of CULs at points of compliance (POCs), and to understand if remaining hydrocarbon concentrations in groundwater will naturally attenuate to below the groundwater CULs at POCs.

The sampling program consists of 12 rounds of groundwater sampling. Sampling began in October 2008. Samples will be collected every two months until August 2010[1]. Samples are collected from 40 on-site wells. Of these 40 wells, 21 wells are POC wells for monitoring groundwater quality conditions along the perimeter of the site. Twenty-one wells are located in three on-site groundwater flow paths for monitoring groundwater quality and parameters indicating the possible biodegradation of dissolved-phase hydrocarbon constituents. The flow paths are triangle-shaped with the wide end of the triangle being downgradient. The groundwater sampling from the wells within the flow paths will provide the data to utilize Ecology's Data Analysis Tool Package A (Modules 1, 2, and 3) (Ecology, 2005). The sampling results (IHS concentrations) and the groundwater monitoring data from the wells within the flow paths will be used in Module 1 to evaluate if the plume is shrinking, expanding or stable. Eight on-site wells and one off-site well (MW-151, MW-125, MW-122, MW-131, MW-E, MW-13U, MW-203, MW-134X, and MW-301) are not part of the sampling program, but are gauged for groundwater elevations during monitoring events. Groundwater flow paths and well locations are shown on **Figure 11**.

Groundwater cleanup levels for the site have been established based on the protection of surface water. The groundwater CULs, as outlined in the Interim Action Report Workplan, are as follows:

- benzene: 51 micrograms per liter (µg/L)
- total cPAHs: 0.018 µg/L (adjusted for toxicity)

[1] This comment describes the initial sampling program as described in the Interim Action Report. Chevron proposed changes to the sampling program in December 2009.

- total TPH (eastern side of site): 506 µg/L
- total TPH (western side of site): 706 µg/L

At the completion of the two-year monitoring program, statistical analysis will be utilized in conjunction with additional evaluation in order to determine the final cleanup action.

5.1 Monitoring Well Installation

From October 8 to October 14, 2008, ARCADIS supervised the installation of 29 on-site monitoring wells. Twenty of the monitoring wells are located within three designated groundwater flow paths, as outlined in the Agreed Order. Five of the wells (MW-500, MW-501, MW-510, MW-518 and MW-524) are POC wells, and four of the wells (MW-149R, MW-8R, MW-139R, and MW-129R) are replacements for POC wells abandoned and removed during remedial activities.

OTAK Surveying (OTAK), a licensed surveyor from Kirkland, Washington, surveyed the existing and new monitoring well locations relative to existing site features and North American Datum 83/98 horizontal datum. OTAK also measured top-of-casing well elevations to the nearest 0.01 foot. Well installation and development details will be reported as part of the Phase II Interim Action As-Built Report in April 2009.

5.2 Groundwater Procedures

During groundwater monitoring events, 48 on-site wells and one off-site well (MW-301) are gauged with a decontaminated oil/water interface probe to determine depth to groundwater and to check for the presence of LNAPL. Prior to gauging, all well caps are removed to allow groundwater levels to equilibrate. Five staff gauges in Willow Creek are also measured. Gauging activities are conducted as close to the time of low tide as possible. After gauging, the wells to be sampled are purged via low-flow methods using peristaltic pumps with disposable polyethelene tubing. Water quality and geochemical parameters, including dissolved oxygen, oxidation-reduction potential, pH, conductivity, temperature, and dissolved ferrous iron measurements, are collected at the time of purging using a water quality meter with a flow-through cell. Groundwater is purged until the geochemical parameters stabilize to within 10 percent of their value. Parameters collected during the October 2008 and December 2008 sampling events are provided in **Appendices C and D**, respectively. Samples are collected into new, laboratory-supplied containers with proper preservatives and kept in

an iced cooler. Samples are picked up daily by a TestAmerica courier for transport to TestAmerica Laboratory, Bothell, Washington.

Groundwater samples are analyzed for the following hydrocarbon constituents:

- benzene by USEPA Method 8021B;
- TPH-G by Ecology Methods NWTPH-Gx;
- TPH-D and heavy oil-range hydrocarbons (THP-O) by Ecology Method NWTPH-Dx (after silica gel cleanup); and
- total cPAHs, including naphthalene, by USEPA Method 8270C.

Additionally, groundwater conditions at the site are being monitored to evaluate natural attenuation of hydrocarbon contaminates. To analyze these conditions, the following analyses are also performed:

- sulfate by USEPA Method 300.0;
- nitrate by USEPA Method 300.0;
- alkalinity by USEPA Method 310.0;
- dissolved methane by USEPA Method RSK 175; and
- dissolved manganese by USEPA Method 200.8.

Groundwater laboratory reports for the October 2008 and December 2008 events are included as **Appendices E and F**, respectively.

5.3 Groundwater Flow

On October 20, 2008, during low tide, ARCADIS field personnel gauged 48 on-site wells, one off-site well, and four staff gauges in Willow Creek. Depths to water ranged from 2.66 feet below top of casing (btoc) in well LM-2 to 26.58 feet btoc in well MW-134X. The presence of LNAPL was not detected in any wells. Groundwater elevations ranged from 4.21 amsl in well MW-524 to 8.55 feet amsl in well MW-134X. Water levels in Willow Creek ranged from being below staff gauge D-7 to 7.10 feet

amsl at staff gauge D-3. Water was present in the creek channel adjacent to staff gauge D-7, but the water level was below the base of the gauge. Based on gauging data, groundwater flow is to the northeast in the eastern portion of the site, to the north in the central portion of the site, and to the northwest in the western portion of the site. Water elevations in Willow Creek are higher than groundwater elevations on site. Depths to water, groundwater elevations, and times of gauging are presented in **Table 2**. October 2008 groundwater elevations and contours are presented on **Figure 12.**

During low tide on December 8, 2008, ARCADIS field personnel gauged 48 on-site wells and four staff gauges in Willow Creek. Depths to water ranged from 2.89 feet btoc in well LM-2 to 26.55 feet btoc in well MW-134X. The presence of LNAPL was not detected in any wells. Groundwater elevations ranged from 4.60 feet amsl in well MW-108 to 11.48 feet amsl in well MW-500. Water levels in Willow Creek ranged from being below staff gauge D-7 to 7.20 feet amsl at staff gauge TB. Water was present in the creek channel adjacent to staff gauge D-7, but the water level was below the base of the gauge. Groundwater elevations and flow gradients during this event remained consistent with past measurements. December groundwater elevations and contours are presented on **Figure 13.**

5.4 Analytical Results

Total TPH concentrations were calculated by summing the concentrations of gasoline, diesel, and heavy oil. If one or more of the constituents did not exceed the laboratory detection limit, half of the detection limit for each constituent was added to the detectable concentrations. To calculate Total cPAHs, the seven cPAH congener concentrations were adjusted for toxicity according to the method outlined in *Air Toxics Hot Spots Program Risk Assessment Guidelines, Part II Technical Support Document for Describing Available Cancer Potency Factors* (California Environmental Protection Agency, 2005). Duplicate samples were collected at a frequency of 10 percent, and matrix spike/matrix spike duplicate samples were collected at a frequency of 20 percent, as specified in the Agreed Order. October and December 2008 groundwater analytical results are presented in **Tables 3 through 5**, and displayed on **Figures 14 and 15**.

5.4.1 October Analytical Results

From October 21 to October 27, 2008, groundwater samples were collected from 40 on-site monitoring wells. Twenty-four samples had detectable concentrations of TPH.

Fifteen of these samples exceeded applicable TPH CULs. Of the 24 samples with detectable TPH concentrations, 19 were detected for TPH-G only.

Concentrations of cPAHs were not reported greater than the laboratory detection limit in any of the samples collected during this sampling event. However, due to elevated laboratory detection limits during cPAH analysis of samples from monitoring wells MW-510 and MW-523, the detection levels are greater than the site cPAH CULs.

Benzene was detected in samples from 16 wells throughout the site. No samples contained benzene concentrations exceeding the site REL.

5.4.1.1 Point of Compliance Wells

During the October 2008 monitoring event, samples from five of the 19 POC wells contained concentrations of TPH that exceeded their applicable CULs. Monitoring wells MW-104, MW-500, MW-501, MW-510, and MW-518 exceeded their respective TPH CULs, with concentrations ranging from 1,110 µg/L in samples collected from monitoring well MW-104 to 8,330 µg/L in samples collected from monitoring well MW-501.

Samples collected from five POC wells contained TPH concentrations that exceeded the laboratory detection limit, but did not exceed their applicable CULs. Concentrations in these samples ranged from 418 µg/L from monitoring well MW-139R to 597 µg/L from monitoring well MW-20R. Nine POC wells did not contain concentrations of TPH above the laboratory detection limit.

Benzene was detected in five POC wells during this event, with concentrations ranging from 0.503 µg/L in samples from monitoring well MW-518 to 6.89 µg/L in samples collected from monitoring well MW-510. The CUL for benzene is 51 µg/L.

5.4.1.2 Groundwater Flow Path Wells

Samples collected from 10 flow path monitoring wells exceeded their applicable TPH CULs. Concentrations in these samples ranged from 701 µg/L in monitoring well MW-504 to 1,700 µg/L in monitoring well MW-502. Three of these wells are located in the eastern flow path, five of them are in the central flow path, and two of them are in the western flow path.

Samples collected from four flow path monitoring wells contained detectable concentrations of TPH that did not exceed site CULs. Concentrations in these samples ranged from 425 µg/L in monitoring well MW-521 to 647 µg/L in monitoring well MW-517. Seven flow path monitoring wells did not contain detectable concentrations of TPH.

Benzene was detected in samples from 10 flow path monitoring wells. Concentrations ranged from 0.702 µg/L in samples collected from monitoring well MW-513 to 7.03 µg/L in samples collected from monitoring well MW-504. None of the detected benzene concentrations exceeded the applicable CUL.

5.4.2 December Analytical Results

From December 9 to December 16, 2008, groundwater samples were collected from 40 on-site monitoring wells. Nineteen samples contained concentrations above the laboratory reporting limit for TPH. Nine of these samples contained concentrations above the applicable TPH CULs. Of the 19 samples detected for TPH, 17 were detected for TPH-G only.

The sample collected from monitoring well LM-2 was the only sample that contained concentrations of adjusted cPAHs above the laboratory detection limit, with a concentration of 0.00772 µg/L. However, due to elevated laboratory detection limits during cPAH analysis of the sample from monitoring well MW-510, the detection level is greater than the site cPAH CULs. No samples contained cPAH concentrations exceeding the site CUL of 0.018 µg/L.

Benzene was reported in concentrations exceeding the laboratory detection limit in samples from 10 wells throughout the site. No samples contained benzene concentrations exceeding the site REL.

5.4.2.1 Point of Compliance Wells

During the December 2008 monitoring event, samples from four of the 19 POC wells contained concentrations of TPH that exceeded their respective CULs. Monitoring wells MW-104, MW-147, MW-510, and MW-518 exceeded their respective TPH CULs. Concentrations ranged from 968 µg/L in samples collected from monitoring well MW-147 to 5,410 µg/L in samples collected from monitoring well MW-510.

Samples collected from three POC wells contained TPH concentrations above the laboratory detection limit, but did not exceed their respective CULs. Concentrations in these samples ranged from 425 µg/L in monitoring well MW-136 to 697 µg/L in monitoring well MW-20R. Twelve POC wells did not contain concentrations of TPH above the laboratory detection limit.

Benzene was detected in four POC wells, with concentrations ranging from 0.510 µg/L in samples collected from MW-8R to 22.2 µg/L in samples collected from monitoring well MW-20R. None of the detectable benzene concentrations exceeded the applicable CUL.

5.4.2.2 Groundwater Flow Path Wells

Samples collected from five flow path monitoring wells exceeded the applicable TPH CULs. Concentrations in these samples ranged from 562 µg/L in monitoring well MW-507 to 1,440 µg/L in monitoring well MW-502. Two of these wells are located in the eastern flow path and three of them are located in the central flow path.

Samples collected from seven flow path monitoring wells contained detectable concentrations of TPH that did not exceed site CULs. Concentrations in these samples ranged from 439 µg/L in monitoring well MW-519 to 554 µg/L in monitoring well MW-522. Nine flow path monitoring wells did not contain detectable concentrations of TPH.

Benzene was detected in six flow path wells with concentrations ranging from 0.605 µg/L in the sample collected from MW-507 to 3.77 µg/L in the sample collected from monitoring well MW-520. Detectable concentrations of benzene did not exceed the applicable CUL.

6. Data Validation

As outlined in the *Sampling and Analysis Plan* (SAP) (SLR, 2007), the laboratory submitted summary data and quality assurance information to permit independent and conclusive determination of data quality. The determination of data quality was performed using the Laboratory Data Validation Guidelines for Evaluating Inorganic Analyses (USEPA, 1994a) and the Laboratory Data Validation Functional Guidelines for Evaluating Organics Analyses (USEPA, 1994b), as guidelines for data review.

Laboratory deliverable requirements for the chemical analyses included the information outlined below:

- A cover letter for each sample batch that includes a summary of any quality control, sample, shipment, or analytical problems, and documentation of all internal decisions. Problems were outlined and final solutions documented. A copy of the signed chain of custody form for each batch of samples was included in the narrative packet.

- Sample concentrations reported on standard data sheets in proper units and the appropriate number of significant figures. For undetected values, the lower limit of detection for each compound was reported separately for each sample. Dates of sample extraction, preparation and analysis were included.

- A method blank summary.

- Surrogate percent recoveries were calculated and reported.

- Duplicate sample analytical results.

- Matrix spike/matrix spike duplicate percent recoveries, spike level, and relative percent difference.

- A list of the detection limits calculated for the laboratory instruments for all compounds.

Sample holding times were calculated by comparing the date of sample collection (shown on the chain of custody form) with the date of sample analysis. ARCADIS completed a full data quality review of laboratory deliverables, and completed separate Data Validation Reports, which are attached as **Appendix G**. Based on the ARCADIS

review of laboratory reports, the overall system performance was acceptable, and the overall data quality was within the guidelines specified in the SAP (SLR, 2007). No data were marked as unusable.

7. Management of Investigation-Derived Wastes

Soil generated during investigation activities was stored in 55-gallon steel drums and stored on site. During Phase II of the Interim Action cleanup, the contents of the soil drums were emptied into the on-site impacted soil stockpile, loaded off site with the excavation materials from Phase II Interim Action activities, and taken to Cemex (formerly Rinker) in Everett, Washington for thermal destruction.

Purge water generated during groundwater monitoring events was stored in 55-gallon polyethylene drums and kept on site. The drums were then emptied by an Emerald Services vacuum truck and taken to their Airport Way facility for recycling after every other sampling event.

8. Conclusions

During June and July, 2008, an additional soil investigation was conducted to collect data and evaluate the nature and extent of petroleum impacts in soils to the south and southwest of the WSDOT stormwater line, to identify the lateral extent of petroleum impacts in the Former Railroad Trestle Area, to investigate the source of LNAPL observed on groundwater in well MW-129, to address possible impacts along the south berm of DB-1, and to investigate potential petroleum-impacted soil beneath the footprint of the former asphalt warehouse.

Based on results from this investigation, the excavation activities for Phase II Interim Action were modified to include excavation of the Former Railroad Trestle Area and a portion the Former Asphalt Warehouse.

Based on analytical results from soil borings SB-85 and SB-86, which did not contain concentrations of IHSs exceeding site RELs and/or CULs, Phase II Interim Action excavation activities in the Former Railroad Trestle Area included only those petroleum-impacted soils encountered during Phase I Interim Action confirmation sampling.

Based on results from soil borings SB-76 and SB-77, an excavation of a portion of the Former Asphalt Warehouse Area was completed as part of Phase II. The excavation area encompassed the Former Asphalt Warehouse Area, including SB-76, SB-77, and SB-79. This excavation extended to a depth of at least 11 feet bgs in order to remove impacted soils encountered at 10.5 feet bgs in SB-76.

No additional work was conducted in the immediate vicinity of MW-129. However, MW-129 was decommissioned in place as a contingency for the Former Asphalt Warehouse Area excavation extending to its location, and was replaced during monitoring well network installations in October 2008. No additional work was conducted on the berm between DB-1 and Edmonds Marsh. A Phase II Interim Action As-Built Report, including full details of all Phase II activities will be submitted in April 2009.

In accordance with the Agreed Order and following completion of Phase I and II Interim Action remedial excavation activities, a groundwater monitoring program was implemented at the site beginning in October 2008. The purpose of the monitoring program is to understand if remaining on-site soil concentrations will be a source of free product or will cause an exceedance of CULs at points of compliance, and to

evaluate whether remaining hydrocarbon concentrations in the groundwater will naturally attenuate to below the groundwater CULs at POCs.

Conclusive trends in groundwater conditions at the site are indeterminable at this time, as only two rounds of groundwater data have been collected.

During the October 2008 monitoring event, samples from five compliance wells exceeded their site-specific TPH CULs. Two of these samples were collected from POC wells located along the perimeter of the southeast Lower Yard, and three of them are located along the north/northwest perimeter. Samples collected from 10 flow path wells exceeded TPH CULs during this event. Three of these wells are located in the eastern flow path, five of them are in the central flow path, and two of them are in the western flow path. There were no exceedances for benzene or cPAHs in any groundwater samples collected during this event.

During the December 2008 monitoring event, samples from four compliance wells exceeded their site-specific TPH CULs. POC wells with exceedances are located along the north, northeast, and southwest perimeter of the site. Five flow path wells contained samples with concentrations exceeding TPH CULs. Two of these wells are located in the eastern flow path, and three of them are located in the central flow path. There were no exceedances for benzene or cPAHs in any groundwater samples during the December 2008 monitoring event.

Groundwater monitoring events will continue to be conducted every two months, as outlined in the Interim Action Plan.

9. References

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