FOCUSED FEASIBILITY STUDY

Olympic Water & Sewer, Inc. Site
781 Walker Way
Port Ludlow, Washington
VCP Identification No. SW1311

Prepared for: Olympic Property Group and Pope Resources, LP

Project No. 130046-001-02 • September 24, 2013 Agency Review Draft

Aspect CONSULTING

earth + water

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Acronyms

AGI	Applied Geotechnology, Inc.
Aspect	Aspect Consulting, LLC
bgs	below ground surface
BTEX	benzene, toluene, ethylbenzene, and xylenes
COC	constituents of concern
DCA	disproportionate cost analysis
DPE	dual-phase extraction
Ecology	Washington State Department of Ecology
FS	feasibility study
FFS	Focused Feasibility Study
mg/m^3	milligrams per cubic meter
mg/kg	milligrams per kilogram
µg/L	micrograms per liter
MNA	monitored natural attenuation
MTCA	Model Toxics Control Act
NAPL	nonaqueous-phase liquid
NFA	No Further Action
NPV	net present value
OPG	Olympic Property Group and Pope Resources, LP
OWSI	Olympic Water & Sewer, Inc. Site
PID	photoionization detector
RAOs	Remedial action objectives
RI	Remedial Investigation
SLR	SLR International Corporation
SVE	soil vapor extraction

TEE	Terrestrial Ecological Evaluation
TPH	total petroleum hydrocarbons
UST	underground storage tank
VCP	Voluntary Cleanup Program
WAC	Washington Administrative Code

1 Introduction

Aspect Consulting, LLC (Aspect) has prepared this Focused Feasibility Study (FFS) on behalf of Olympic Property Group and Pope Resources, LP (OPG) for the Olympic Water & Sewer, Inc. (OWSI) property located at 781 Walker Way in Port Ludlow, Washington (herein referred to as the Site) (Figure 1). This FFS incorporates the results of the previous investigations, the completed soil cleanup action, and soil vapor extraction (SVE) and SVE with groundwater pumping (DPE) pilot test activities completed by others, identifies and evaluates technically feasible cleanup action alternatives, and provides the basis for recommendation of the preferred final cleanup action for the Site. This FFS has been prepared in accordance with the Washington State Model Toxics Control Act Cleanup Regulation (MTCA), as established in Chapter 173-340 of the Washington Administrative Code (WAC) 173-340. The following subsections present the purpose and objectives of the FFS as well as an overview of this report organization.

1.1 Purpose and Objectives

Previous subsurface investigations and impacted soil excavation activities completed by others confirmed the release of gasoline-range total petroleum hydrocarbons to soil and groundwater at the Site from three former gasoline underground storage tanks (USTs) that were permanently decommissioned by removal in September 1990. Collectively, the completed UST decommissioning and soil removal activities, subsurface investigations, SVE and DPE pilot testing, and terrestrial ecological evaluation (TEE) meet the remedial investigation (RI) requirements of WAC 173-340-350. Details regarding the RI activities completed at the Site are provided in the following documents and are referenced throughout this report:

- *Hydrocarbon Contamination Assessment and Underground Storage Tank Removal, Port Ludlow Water District, Port Ludlow, Washington,* dated March 4, 1991, prepared by Applied Geotechnology, Inc. (AGI) (UST Removal Report; AGI, 1991).
- *Well 17 Site Contamination, Initial Findings, and Recommendations,* dated April 26, 2009, prepared by Robinson Noble & Saltbush, Inc. (Robinson Noble) (Initial Findings Report; Robinson Noble, 2009);
- *Site Characterization Report, Olympic Water & Sewer, Inc. Property, 781 Walker Way, Port Ludlow, Washington,* dated December 17, 2010, prepared by SLR International Corporation (SLR) (Site Characterization Report; SLR, 2010);
- *Additional Investigation Report, Olympic Water & Sewer, Inc. Property, 781 Walker Way, Port Ludlow, Washington,* dated August 2, 2011, prepared by SLR (Additional Investigation Report; SLR, 2011); and

- *Soil Vapor Extraction Pilot Test Report, Olympic Water & Sewer, Inc. Facility, 781 Walker Way, Port Ludlow, Washington,* dated May 8, 2012, prepared by SLR (SVE Pilot Test Report; SLR, 2012).

Based on the results of the RI activities, the Site has been sufficiently characterized to support the development and evaluation of technically feasible cleanup alternatives in accordance with WAC 173-340-360 through 173-340-390.

A traditional feasibility study (FS) typically includes an extensive development, screening, and evaluation process for numerous remedial alternatives. However, given the high frequency of sites with gasoline-impacted soil and groundwater, the range of applicable and effective remedial technologies is relatively well defined. In addition, Site-specific conditions preclude many potential remediation alternatives from application at the Site. Therefore, an FFS is considered sufficient for this Site.

The specific objectives of this FFS are to:

- Provide a summary of completed remedial investigation, cleanup activities and current site conditions, and present a concise Site conceptual model.
- Present a detailed analysis and feasibility evaluation of the completed SVE/groundwater pumping pilot test;
- Present the results of the completed soil vapor pathway evaluation;
- Identify and evaluate technically feasible cleanup action alternatives; and
- Present a recommendation for a final cleanup action for the Site in accordance with WAC 173-340-350(8).

The final cleanup action will be conducted independently under the Washington State Department of Ecology (Ecology) Voluntary Cleanup Program (VCP) with the objective to obtain a No Further Action (NFA) determination for the Site. The Site has been enrolled in the Ecology VCP and has been assigned VCP Identification No. SW1311.

1.2 Organization

This report has been organized into the following sections:

- **Section 2 – Summary of Site Conditions** provides a summary of Site conditions including location and description, environmental setting, and geology and hydrogeology. This section also details recent soil vapor sampling work completed by Aspect.
- **Section 3 – Conceptual Site Model** provides a summary of the conceptual site model including a discussion of the constituents of concern (COCs), affected media, sources and inferred extent of soil and groundwater impacts, potential receptors and exposure assessment, and contaminant fate and transport mechanisms for the Site. This section also presents the simplified Terrestrial Ecological Evaluation (TEE) completed for the Site.
- **Section 4 – Basis for Additional Remedial Action** presents the objectives and standards by which evaluation of additional remedial action(s), beyond those already completed at the Site, will be measured.

- **Section 5 – Focused Feasibility Study** presents a screening of potential remedial technologies, the retained cleanup action alternatives, and an evaluation of those alternatives.
- **Section 6 – Summary of Preferred Cleanup Action** provides a summary of the recommended cleanup action alternative for implementation at the Site.
- **Section 7 – References** provides a list of the source materials referenced in this report.

2 Summary of Site Conditions

This section provides a summary of Site conditions including Site location and description, environmental setting, geology and hydrogeology. It also details the recent soil vapor sampling work completed by Aspect.

2.1 Site Location and Description

The Site is located in Section 8, Township 28 North, Range 1 East in Port Ludlow, Washington (Figure 1). Identified as Jefferson County Parcel No. 821084004, the Site consists of an approximately 2.2-acre parcel of land located approximately ½-mile northwest of the Port Ludlow bay. The Site is located at the southwest corner of the intersection of Walker Way and Rainer Lane (Figure 2). Properties adjacent to the south, west, and east, beyond Rainier Lane are developed with single-family residences (Jefferson County, 2013). Properties to the north, across Walker Way, are developed with a mini-storage facility and single-family residences.

The parcel is partially developed with an OWSI operations and maintenance facility, which consists of an approximate ½-acre area that includes an office/shop/garage building (garage building), a public water supply well (i.e., Well #2) and associated pump house building, and a storage trailer (Figure 2). The ground surface within the developed portion of the Site is primarily unpaved, except for a narrow asphalt driveway that runs down the center of the OWSI facility from Walker Way to approximately the storage trailer. Areas surrounding the facility are undeveloped and covered with dense vegetation. The OWSI facility has been in operation since first development in 1968, following the installation of the water supply Well #2 (Figure 2) (SLR, 2011). Additional details regarding water supply Well #2 are provided in the following sections of this report.

2.2 Environmental Setting

This subsection provides a summary of the environmental setting of the Site. The information presented here has been obtained from a review of national, state, and local records and previous environmental work completed at the Site by others.

2.2.1 Land-Use

According to Jefferson County Assessor's Office, the property land use code is 4800–Utilities, non-public (Jefferson County, 2013). The land use code for properties adjacent to the south and west is 1100–Houses, single units, non-farm. According to the Jefferson County Assessor's Office, properties adjacent to the south, west, and east, beyond Rainier Lane are zoned MPR-Single Family. Properties to the north, across Walker Way, are zoned Rural Residential. However, the Site is used for commercial purposes by OWSI as an operations and maintenance facility, including water supply Well #2. The current and future land use for the Site is and will likely remain commercial.

2.2.2 Topography

The ground surface elevation proximate to the northern property boundary of the Site is approximately 290 feet above mean sea level (Google Earth, 2013). The ground surface of the OWSI facility slopes gently toward the southwest (Figure 2). Areas surrounding the facility are undeveloped and covered with dense vegetation. A densely vegetated gulley, containing an intermittent seasonal stream, is located to the west of the OWSI facility.

2.3 Geology, Hydrogeology, and Groundwater Use

2.3.1 Geology

Based on the results of multiple investigations completed to date at the Site, Site soils consist of dense glacial advance outwash (sand, gravel, and silt units) with interbedded lacustrine silts to the maximum depth drilled (approximately 60 feet [below ground surface] bgs). Specifically, thin surficial gravel fill is underlain by a sand (silty to gravelly) to gravel unit that is approximately 29 to 43 feet thick. Beneath the central and southern parts of the property, a 5- to 10-foot-thick sandy silt to silt is interbedded within the sand to gravel unit. The sand to gravel unit is underlain by clayey to gravelly silt that is 15 to more than 23 feet thick. At the northern and central parts of the OWSI facility, the clayey to gravelly silt unit is overlain by a silty sand that is up to 11 feet thick. In the central part of the OWSI facility (at MW-1 and MW-2), the top of the clayey to gravelly silt occurs at an elevation of approximately 251 feet above the NAVD 88 datum, while at the northern, southern, and eastern parts of the facility (at MW-4, MW-3, and MW-5, respectively), the clayey to gravelly silt occurs at higher elevations (approximately 260 to 263 feet above the NAVD 88 datum). At MW-2, MW-3, and MW-4, a gravelly sand to sand and gravel that is approximately 5 to 7.5 feet thick is interbedded within the clayey to gravelly silt unit (SLR, 2010). At MW-1, the clayey to gravelly silt unit is underlain by silty sand that extends beyond the bottom of the boring. According to the driller's log for the water supply well (Well #2) located in the northern part of the property, a thick sequence of clay and cemented sand occurs from approximately 49 to 215 feet bgs (SLR, 2010).

2.3.2 Hydrogeology

Shallow groundwater at the Site occurs under perched conditions within the glacial advance outwash and lacustrine deposits at depths above approximately 60 bgs. Deeper regional water-bearing units are present beneath a thick aquitard comprised of clay and cemented silty sand. These deep water-bearing units at Well #2 occur at depths of between 215 and 245 feet bgs, or over at least 150 feet below the top of the aquitard and base of the perched units.

In early April 2011, the depths to perched groundwater in the Site monitoring wells and SVE points ranged from 19.80 to 36.98 feet below the tops of the well casings, and the groundwater elevations ranged from 256.89 to 275.85 feet above the NAVD 88 datum (Table 1). At wells MW-1 through MW-4, the groundwater elevations in April 2011 were 3.32 to 5.68 feet higher than in October 2010, and from June 2010 to April 2011, the groundwater fluctuations in the wells ranged from 3.81 to 5.68 feet. The higher

groundwater elevations in April 2011 likely reflect seasonal recharge from infiltration of precipitation during the autumn and winter months.

Shallow groundwater beneath the Site occurs within the sand to gravel unit, and is perched on top of the underlying clayey to gravelly silt unit (see Figure 5 of the Additional Investigation Report; SLR, 2011). During periods of seasonal recharge, groundwater appears to collect above the silt and overlying silty sand units. In areas where the silty sands and silts are present at higher elevations, the groundwater elevations are higher. For example, groundwater elevations were 266.35 feet at MW-3, 273.19 feet at SVE-1, 273.38 at MW-4, and 274.07 feet at SVE-2 (see Figure 4 of the Additional Investigation Report; SLR, 2011). This groundwater is hydraulically continuous with the deeper perched groundwater intercepted by wells MW-1 and MW-2. The horizontal hydraulic conductivity of the sand to gravel unit is expected to be significantly (i.e., orders of magnitude) greater than the vertical hydraulic conductivity of the underlying silt and silty sand. Therefore, groundwater accumulating above the 265-foot elevation is expected to primarily flow laterally toward the gravels encountered at MW-2, or toward the intermittent stream in the gulley where stream sampling was completed in April 2011.

The groundwater flow within the perched zone appears to be controlled by the geometry of the clayey to gravelly silt, with flow converging into the low point of the top of the silt unit (SLR, 2010). As described above, the elevation of the silt unit is about 10 feet lower in the central part of the OWSI facility than at the northern, southern, and eastern parts of the facility. This interpretation is consistent with the high petroleum hydrocarbon concentrations occurring in the groundwater at wells MW-1 and MW-2 (SLR, 2011). Based on the known clayey to gravelly silt geometry and the area of petroleum hydrocarbon-impacted groundwater, there appears to be a flow component to the south-southwest (SLR, 2011). Perched groundwater appears to discharge to the intermittent stream at locations near the southern end of the property.

2.3.3 Groundwater Use

Well records obtained by SLR from Ecology and OWSI identified 12 water supply wells located within a ½-mile radius of the property (SLR, 2010). Approximate locations for the water supply wells are shown on Figure 7 of the Site Characterization Report (SLR, 2010). Copies of the water supply well completion logs and a table prepared by SLR that presents the well completion details are included as Appendix A. According to the well records, groundwater from the water supply wells, including Well #2 located at the Site, is used for domestic purposes. Shallow perched groundwater at the Site is not used for drinking purposes (SLR, 2011).

Water supply Well #2 is screened at depths ranging from 214 to 245 feet bgs. All of the identified water supply wells in the vicinity of the Site are completed (i.e., screened or open casing) at depths ranging between 157 and 377 feet bgs. The soil descriptions on the well logs consistently note that a thick sequence of clay and cemented silty sand aquitard units occur above the deep groundwater-bearing zones. Groundwater flow directions in the deeper regional aquifer have been inferred to flow from the upland areas toward Port Ludlow, indicating that the water supply wells are located hydraulically up- or cross-gradient of the Site (EES, 1994).

Based on the presence of the thick aquitard and the inferred deep groundwater flow direction, shallow impacted perched groundwater beneath the Site is not considered a risk to water quality in the deep groundwater-bearing zones (SLR, 2010). The lack of detectable petroleum hydrocarbons in water samples collected from Well #2 in the 1990, 2009, and 2010 further supports this conclusion (SLR, 2010).

2.4 Soil Vapor Pathway Evaluation

Aspect completed an evaluation of the soil vapor pathway at the Site in June 2013. The purpose of the evaluation was to assess if concentrations of gasoline constituents exceeding the screening levels provided in Ecology's *Draft Guidance for Evaluating Soil Vapor Intrusion in Washington State* (Ecology, 2009) were present in soil vapor beneath the slab of the garage building. Aspect installed soil vapor points SV-1 and SV-2 at the Site on June 20, 2013 (Figure 3). Soil vapor samples were collected from vapor points VP-1 and VP-2 on June 21, 2013, in accordance with the Standard Operating Procedure provided in Appendix B.

As noted in Section 2.2.1, the current and future land use for the Site is and will likely remain commercial. The vapor sample analytical results were therefore evaluated for a commercial land use scenario (Table 2). No exceedances of screening levels were recorded in soil vapor, and therefore no further evaluation of the soil vapor pathway is considered warranted given the current and future Site land use. A copy of the soil vapor laboratory analytical report is provided in Appendix C.

2.5 Sufficiency of Remedial Investigation Activities

As previously noted in Section 1.1, the results of the UST decommissioning activities, completed soil cleanup action, subsurface investigations, and pilot test activities completed at the Site constitute a complete RI in general accordance with WAC 173-340-350. The complete RI activities are considered sufficient to support the development and evaluation of technically feasible cleanup alternatives in accordance with WAC 173-340-360 through 173-340-390. Details regarding the RI activities completed at the Site are provided in documents referenced in Section 1.1. The conceptual site model, based on the results of the RI activities completed by others and the soil vapor pathway evaluation recently completed by Aspect, is presented in the following section.

3 Conceptual Site Model

This section provides a summary of the conceptual site model including a discussion of the COCs, affected media, sources and inferred extent of soil and groundwater impacts, potential receptors and exposure assessment, and contaminant fate and transport mechanisms for the Site. This section also presents the simplified TEE completed for the Site.

3.1 Constituents of Concern

The COCs identified for the Site are based on the historical use of gasoline USTs at the Site and the results of the RI activities. Based on the available data, the following COCs have been identified for the Site:

- Gasoline-range total petroleum hydrocarbons (TPH); and
- The gasoline constituents benzene, toluene, ethyl-benzene, and total xylenes (BTEX).

3.2 Affected Media

Concentrations of one or more of the COCs have been confirmed in soil and/or groundwater at the Site. Therefore, soil and groundwater have been identified as affected media of concern for the Site. Based on the lack of detectable concentrations of COCs in surface water samples collected from the intermittent seasonal stream located west of the OWSI facility, surface water will not be retained as a media of concern (SLR, 2011). In addition, based on the results of the soil vapor evaluation recently completed by Aspect, indoor air will not be retained as a media of concern. Potential receptors and exposure pathways are summarized in Section 3.4.

3.3 Sources and Extent of Impacts

A source area is the location where a release has occurred at the Site. Based on the available data, the sources of the COCs in the affected media are the 1,000-gallon UST formerly located beneath the floor of the garage building and the 2,000-gallon UST formerly located along the west side of the garage building (SLR, 2011). As previously noted, these USTs were permanently decommissioned by removal in September 1990. Given the similar contents of these former USTs (i.e., gasoline) and the proximity of these two source areas relative to each other, the two source areas will be treated as a single source area for the purposes of evaluating technically feasible remedial alternatives.

The extent of soil and groundwater impacts at the Site is identified as areas where COCs in the affected media have come to be located. A description of the extent of soil and groundwater impacts at the Site is presented below.

3.3.1 Soil

Following removal of the USTs, a cleanup action consisting of excavation of gasoline-impacted soil was completed to the extent practicable in 1990 (SLR, 2011). To prevent structural damage to the garage building, residual gasoline-impacted soil was left in-place at the base of the 1,000-gallon UST excavation (SLR, 2011). Residual gasoline-impacted soil at that location is expected to occur from below approximately 10 feet bgs to the perched groundwater table between approximately 20 to 41 feet bgs (SLR, 2011).

Concentrations of gasoline-range TPH exceeding the MTCA Method A cleanup level of 30 milligrams per kilogram (mg/kg) were detected in soil samples collected at depths greater than 20 feet bgs at SVE-2 and MW-1B (Table 3). Similarly, concentrations of benzene exceeding the MTCA Method A cleanup level of 0.03mg/kg were also detected in the soil sample collected at 24.5 to 25 feet bgs at MW-1B (Table 3).

Based on the results of the RI activities, the area of impacted soil is estimated to extend beyond the western, eastern, and southern ends of the garage building and covers an area of approximately 3,140 square feet (see Figure 7 of the Additional Investigation Report; SLR, 2011). The extent of soil impacts at the Site has been sufficiently characterized to support the development and evaluation of technically feasible cleanup alternatives in accordance with WAC 173-340-360 through 173-340-390.

3.3.2 Groundwater

Concentrations of gasoline-range TPH exceeding the MTCA Method A cleanup level of 800 micrograms per liter (µg/L) have been detected during multiple sampling events at MW-1, MW-2, SVE-1 and SVE-2 (Table 4). In addition, concentrations of one or more BTEX constituents exceeding MTCA cleanup levels have historically been detected in shallow perched groundwater samples collected at MW-1, MW-2, MW-4, and SVE-1.

The estimated area of the hydrocarbon-impacted shallow perched groundwater is depicted on Figure 4 of the Additional Investigation Report (SLR, 2011). The impacted groundwater is inferred to extend beyond the western fence line of the OWSI facility, but not as far west as the intermittent stream. The area west of the fence line to the intermittent stream is inaccessible.

The groundwater flow within the shallow perched zone appears to be controlled by the geometry of the clayey to gravelly silt, with flow converging into the low point of the top of the silt unit (SLR, 2010). Based on the known clayey to gravelly silt geometry and the area of petroleum hydrocarbon-impacted groundwater, there appears to be a flow component to the south-southwest (SLR, 2011). It is likely that the perched groundwater discharges to the intermittent stream, at locations near the southern end of the property, during periods of seasonal recharge. In addition, based on the presence of petroleum hydrocarbons at MW-4 and MW-5, there is a limited component of impacted groundwater migration, likely seasonally, to the north and east (SLR, 2011).

As discussed in Section 2.3.3, based on the presence of the thick clay and cemented silty sand aquitard between the perched and regional water-bearing units, and the inferred deep groundwater flow direction, it is unlikely that hydrocarbon-impacted shallow perched groundwater beneath the property could affect water quality in the deep groundwater-bearing zones (SLR, 2010). This conclusion is supported by the lack of

detectable petroleum hydrocarbons in water samples collected from Well #2 in the 1990, 2009, and 2010 (SLR, 2010). The extent of shallow groundwater impacts at the Site has been sufficiently characterized to support the development and evaluation of technically feasible cleanup alternatives in accordance with WAC 173-340-360 through 173-340-390.

3.4 Potential Receptors and Exposure Assessment

The two primary exposures associated with the presence of COCs at the Site are human health and terrestrial ecological risk. The nature and extent of concentrations of COCs in soil and groundwater determines the potential exposure scenarios for human health and terrestrial ecological effects.

Potential exposure pathways that may affect human health include soil, groundwater, surface water, and vapor intrusion. The following subsections present a description of each potential exposure pathway.

3.4.1 Soil Exposure Pathways

Two potential soil exposure pathways, direct-contact and soil-leaching to groundwater, have been identified for the Site. A discussion of each of the soil exposure pathways is presented below:

- **Direct-contact pathway:** The direct-contact pathway considers both dermal contact with and ingestion of soil from beneath the Site, to a maximum depth of 15 feet bgs. As previously noted, following removal of the USTs in 1990, an cleanup action consisting of excavation of gasoline-impacted soil was completed to the extent practicable in 1990 (SLR, 2011). However, to prevent structural damage to the garage building, residual gasoline-impacted soil was left in-place beneath the former location of the 1,000-gallon UST (SLR, 2011). Residual gasoline-impacted soil at that location is expected to occur from below approximately 10 feet bgs to the perched groundwater table at approximately 20 to 41 feet bgs (SLR, 2011). Although direct-contact with this shallow soil is considered unlikely, this exposure pathway will be considered during evaluation of potential remedial technologies and development of potential cleanup action alternatives.
- **Soil-leaching to groundwater pathway:** The soil-leaching to groundwater pathway requires consideration of the highest beneficial use of groundwater at the Site in accordance with WAC 173-340-357(3)(d). As described in Section 2.3.3, Ecology and OWSI well records identified 12 water supply wells located within a ½-mile radius of the property (see Figure 7 of the Site Characterization Report; SLR, 2010). However, given the geology and hydrogeology of the Site (i.e., the presence of the thick clay and cemented silty sand aquitard and the inferred deep groundwater flow direction), it is considered highly unlikely that residual concentrations of COCs in soil could affect water quality in the deep groundwater-bearing zones. Only the soil-leaching to the shallow perched groundwater-bearing zone pathway will be considered during evaluation of potential remedial technologies and development of potential cleanup action alternatives.

3.4.2 Shallow Perched Groundwater Exposure Pathway

This pathway includes ingestion of and dermal contact with groundwater from the shallow perched aquifer at the Site. As described in Section 2.3.3, Ecology and OWSI well records identified 12 water supply wells located within a ½-mile radius of the property (See Figure 7 of the Site Characterization Report; SLR, 2010). Although the shallow perched groundwater has been impacted by COCs, it is not used for drinking purposes (SLR, 2011). In addition, given the geology and hydrogeology of the Site (i.e., the presence of a thick clay and cemented sand aquitard), it is considered unlikely that the COCs could migrate from the shallow perched aquifer to the deeper regional aquifer.

Given that the existing and any potential future water supply wells at the Site target production zones at depths ranging from 215 to 245 feet bgs, it is unlikely that the shallow perched groundwater would be used for drinking water purposes in the foreseeable future (SLR, 2011). However, for the purpose of this FFS, it is assumed that the perched groundwater may be used for drinking water purposes by future residents. Therefore, exposure via ingestion and dermal contact with groundwater from the shallow perched aquifer will be considered during evaluation of potential remedial technologies and development of potential cleanup action alternatives.

3.4.3 Surface Water Exposure Pathway

Shallow perched groundwater appears to migrate southwest towards the gulley with an intermittent stream (SLR, 2011). However, concentrations of COCs have not been detected in water samples collected from the stream. Since the shallow groundwater likely discharges to the stream during periods of seasonal recharge, it appears that natural attenuation processes are reducing the hydrocarbon concentrations before groundwater discharges to the stream. The lack of detectable hydrocarbon concentrations in the stream suggests that it is unlikely that human receptors, terrestrial receptors, or aquatic organisms could have significant exposure to COCs present in the shallow groundwater. As a result, this exposure pathway is considered incomplete.

3.4.4 Vapor Intrusion Pathway

As noted in Section 2.4, an evaluation of the soil vapor pathway was completed in June 2013. Based on the results of the evaluation, no further evaluation of this pathway is warranted given the current and expected future Site land use.

3.5 Contaminant Fate and Transport

Released gasoline constituents can exist in the environment in four different phases: adsorbed to soil, dissolved in water, as vapors, and as separate nonaqueous-phase liquid (NAPL) or residual product. To date, no evidence of NAPL has been detected in the subsurface at the Site (SLR, 2011). The primary processes influencing transport of petroleum constituents in the subsurface include:

- Migration as NAPL both vertically due to gravity and laterally along less permeable soil;
- Leaching from soil to groundwater;
- Volatilization from soil or groundwater to air;
- Advection and dispersion in groundwater; and
- Natural degradation.

These potential fate and transport processes are further discussed below.

After a release from a UST, NAPL flows into the shallow soils near the tank. After saturating the soil, a portion of the NAPL can migrate downward and laterally through the vadose zone, and may reach the groundwater table, where it would float on the fluctuating groundwater. As the groundwater table rises and falls, a smear zone of residual hydrocarbons can form in the soil within the zone of groundwater fluctuation. A portion of the product can migrate with groundwater flow and based on solubility, the product also dissolves in the groundwater. However, there is no evidence that NAPL has migrated to the groundwater beneath the Site, and there is no current evidence of NAPL in the soil (SLR, 2011).

Much of the developed portion of the OWSI property is covered with gravel, and as rain falls on the ground surface and infiltrates into the subsurface, residual COCs in soil can dissolve in the water and percolate through the soils. Some of the COCs eventually reach the groundwater. Partitioning from soil to water is determined, in part, by the solubility of a particular hydrocarbon. Once dissolved in groundwater, COCs may be transported by diffusion and advection away from the source area.

Horizontal migration with groundwater (i.e., advection) is expected to be significantly more extensive at the OWSI property than vertical migration (SLR, 2011). The top of the impacted perched groundwater occurs at depths between approximately 20 to 41 feet bgs.

Dispersion, retardation, and biodegradation act to reduce the dissolved petroleum hydrocarbon concentrations as groundwater migrates from the source area. A growing body of evidence suggests that in most systems, biodecay is a significant loss mechanism for many petroleum constituents such as benzene. The intermittent stream is located over 200 feet southwest of the contaminant source area and based on topography and water levels, the perched groundwater discharges to the stream during periods of seasonal recharge. Based on the lack of detectable petroleum hydrocarbons in the stream sample, it appears that the concentrations in the groundwater have degraded sufficiently prior to discharge such that petroleum hydrocarbons are not detectable in the surface water (SLR, 2011).

The primary beneficial use aquifer in the vicinity of the Site occurs at depths of approximately 215 to 245 feet bgs beneath the Site. Given the geology and hydrogeology of the Site (i.e., the presence of the clay and cemented silty sand aquitard and the inferred deep groundwater flow direction), it is considered highly unlikely that residual concentrations of COCs in soil could affect water quality in the deep groundwater-bearing zones. None of the data collected during the RI suggests that COCs have or will migrate to deeper groundwater that is currently being used as a drinking water source.

3.6 Terrestrial Ecological Evaluation

A TEE is intended to assess potential risk to terrestrial plants and/or animals that live entirely or primarily on affected land. A simplified TEE is required under MTCA to assess potential ecological risk posed by the COC at the Site and to determine whether a more detailed investigation of potential ecological risk is required. Aspect completed a preliminary TEE for the Site in accordance with WAC 173-340-7491. A copy of the completed Ecology VCP TEE Form is provided as Appendix D. The Site qualifies for a TEE exclusion under WAC 173-340-7491(1)(a) (*All soil contamination is, or will be, at least 6 feet below the surface (or alternative depth if approved by Ecology), and institutional controls are used to manage remaining contamination.*). No further evaluation of potential threats to terrestrial plants or animals from the Site is considered warranted.

4 Basis for Additional Remedial Action

As previously noted, following removal of the USTs in 1990, a cleanup action consisting of excavation of gasoline-impacted soil was completed to the extent practicable in 1990 (SLR, 2011). This section presents the objectives and standards by which evaluation of additional remedial action(s), beyond those already completed at the Site, will be measured.

4.1 Remedial Action Objectives

Remedial action objectives (RAOs) established for the Site are intended to comply with applicable environmental regulations and protect human health and the environment. The Site-specific RAOs include the following:

- Protection from direct-contact and ingestion of petroleum-impacted soil;
- Protection from direct-contact and ingestion of petroleum-impacted shallow perched groundwater;
- Protection of drinking water in the deep groundwater-bearing zone; and
- Protection of surface water for beneficial use.

4.2 Cleanup Standards

As defined in WAC 173-340-700, cleanup standards for the Site include establishing cleanup levels and points of compliance at which those cleanup levels will be attained. The following presents a discussion of the preliminary cleanup levels and points of compliance for the Site.

4.2.1 Preliminary Cleanup Levels

Based on the exposure pathways described above (i.e., dermal contact with and/or ingestion of soil and/or shallow perched groundwater), recommended cleanup levels for the Site are MTCA Method A cleanup levels for soil and groundwater. Evaluation of additional remedial action(s), beyond the remedial actions completed to date, will address achievement of these recommended cleanup levels.

4.2.2 Points of Compliance

The points of compliance are defined in WAC 173-340-200 as the locations where cleanup levels established in accordance with WAC 173-340-720 through WAC 173-340-760 will be attained to meet the requirements of MTCA. Once the cleanup levels have been attained at the defined points of compliance, the Site is no longer considered to be a threat to human health or the environment. Standard points of compliance which address potential receptors via the exposure pathways that are complete are presented below:

- **Soil for protection from direct-contact:** Ground surface to a depth of 15 feet bgs; and
- **Shallow perched groundwater for protection of drinking water and surface water:** Within the perched aquifer extending vertically from the uppermost level of the saturated zone to the lowest depth potentially affected.

If it is not practicable to meet cleanup levels at the standard points of compliance discussed above within a reasonable restoration time frame, a conditional point of compliance for soil and/or groundwater may be established. Final points of compliance for the Site will be subject to Ecology approval.

5 Focused Feasibility Study

This section presents a screening of potential remedial technologies, the retained cleanup action alternatives, and an evaluation of those alternatives.

The purpose of the FFS is to screen cleanup alternatives and eliminate those that are not technically feasible, those whose costs are clearly disproportionate under WAC 173-340-360(3)(e), or those that will substantially affect the ability of the existing tenant to utilize the Site. In addition, the purpose of the FFS is to evaluate the most-advantageous remediation technologies using bench- and pilot-scale testing, where applicable, to recommend a final cleanup action for the Site in conformance with WAC 173-340-360 through 173-340-390. This FFS is intended to provide sufficient information to enable selection of a final cleanup action. As previously noted, the final cleanup action will be conducted independently under the Ecology VCP with the objective to obtain an NFA determination for the Site.

5.1 Potential Remedial Technologies

Aspect identified and evaluated potential remediation technologies for the Site with respect to the cleanup requirements set forth in MTCA and the RAOs and Cleanup Standards presented in Section 4. Potential remedial technologies for addressing the residual soil and groundwater impacts at the Site include the following:

- **Institutional Controls:** Measures to limit or prohibit activities that may interfere with the integrity of a cleanup action or result in exposure to hazardous substances (i.e., limitations on the use of the property or resources such as an environmental covenant or maintenance requirements for engineering controls).
- **Engineering Controls:** Containment and/or treatment systems that are designed and constructed to prevent or limit the movement of, or the exposure to, hazardous substances (i.e., asphalt or concrete paving/capping).
- **Monitored Natural Attenuation (MNA):** Monitoring the removal of contaminants by natural processes (i.e., biodegradation).
- **Soil Vapor Extraction:** Extracting and treating contaminated soil vapor. Pilot testing of this technology was completed.
- **Air Sparging:** Injecting air into contaminated groundwater to volatilize contaminants. This technology is often implemented in conjunction with SVE.
- **Enhanced Aerobic Biodegradation:** Injecting an oxygen source and, if necessary, bacteria to stimulate microbial biodegradation of contaminants.
- **In Situ Chemical Oxidation:** Injecting or mixing an oxidant, such as potassium permanganate or sodium persulfate, into the soil which reacts with and destroys contaminants.
- **Dual-Phase Extraction (DPE):** Extracting and treating impacted groundwater and vapor**.** Pilot testing of this technology was completed.

- **Soil Excavation:** Removal of impacted soil, followed by off-site disposal. This technology was implemented to the extent practical for cleanup of impacted soils during UST removal.

Each of these potential remedial technologies has been applied at sites with similar conditions and chemical occurrences. Appendix E provides a general description of each technology and their general applicability to comparable sites.

5.1.1 Screening of Potential Remedial Technologies

Preliminary screening of the potential remedial technologies based on effectiveness, implementability, and comparative costs is shown in Table 5. The following potential remedial technologies were retained for development as potential cleanup action alternatives:

- **Institutional and Engineering Controls**
- **Monitored Natural Attenuation**
- ***In Situ* Chemical Oxidation**
- **Soil Excavation**

These remediation technologies which passed the initial screening were combined into remedial alternatives and further evaluated in Section 5.3.

The following potential remedial technologies were not retained for development as potential cleanup action alternatives:

- **Air Sparging –** Air sparging was not retained for further development as a remedial alternative. The perched aquifer complexity and low aquifer permeability, coupled with the transient nature of perched groundwater, would make the implementability of air sparging and the recovery of sparged vapors problematic at the Site.
- **Enhanced Aerobic Biodegradation** – Enhanced Aerobic Biodegradation was not retained for further development as a remedial alternative primarily because similar to air sparging, the perched aquifer complexity and low aquifer permeability are considered critical factors that would make this technology difficult to implement, and of likely limited effectiveness.
- **Soil Vapor Extraction** – An SVE pilot test was conducted at the Site between December 2011 and January 2012 (SLR, 2012). An evaluation of SVE pilot testing performance is included in Section 5.1.2 below. The evaluation confirms that SVE is not a viable technology for remediation of impacted soil, and therefore SVE was not retained for consideration.
- **Dual-Phase Extraction** – A DPE test was completed in conjunction with the SVE pilot test between December 2011 and January 2012 (SLR, 2012). An evaluation of the DPE pilot testing performance is included in Section 5.1.2 below. The evaluation confirms that the addition of groundwater extraction did not significantly improve SVE mass recovery, and groundwater recovery rates were very low. As such, DPE is not considered a viable technology for

remediation of impacted soil and groundwater, and therefore was not retained for consideration.

5.1.2 Evaluation of SVE and DPE Pilot Test Data

A series of four SVE tests were conducted by SLR using a standard SVE system, with and without simultaneous removal of groundwater (DPE), between December 12, 2011 and January 5, 2012. A complete summary of the testing can be found in SLR's report included in Appendix F. These tests were designed to evaluate SVE and DPE as potential remedial options for removing gasoline constituents from soil and groundwater. Both laboratory samples and photoionization detector **(**PID) readings were collected over the course of the testing. PID readings are affected by many factors, and therefore cannot confidently be used as a surrogate for actual gasoline-range TPH vapor concentrations. The laboratory analytical results were therefore used in evaluating SVE performance and mass removal rates.

Soil vapor samples were collected during all four tests and were analyzed for a suite of hydrocarbons including gasoline-range TPH by Northwest Method NWTPH-Gx. Test 1 was conducted at well SVE-1 without the removal of groundwater, and resulted in a relatively low concentration of gasoline-range TPH in extracted vapor (i.e., 47 milligrams per cubic meter [mg/m^3] after 6 hours of operation). Test 3 was conducted on a combination of MW-1 and MW-2, and confirmed that the MW-1 is not suitable for SVE.

The results from Tests 2 and 4 both indicate that pumping groundwater while extracting vapor (i.e., DPE) from SVE-1 modestly improved removal of gasoline-range TPH. DPE resulted in a lower water table, with a resulting increase in the removed volatile gasoline constituents. The concentration of gasoline-range TPH in the vapor sample collected from the blower influent line after 9 hours of DPE operation was 1,900 mg/m^3.

During Test 4, two effluent samples were collected from the blower influent line. The first was collected after 7 days of continuous DPE and had a gasoline-range TPH concentration of 30 mg/m^3. The second sample was collected 2 days after the DPE system was restarted following a 4-day inadvertent shut-down. This second sample had a measured gasoline-range TPH concentration of 180 mg/m^3, which indicates that some "rebound" of volatile compounds likely occurred in the subsurface during the 4-day shutdown.

The SVE/DPE removal rate trend for the period from Test 2 through Test 4 was evaluated using the gasoline-range TPH concentrations from effluent samples and the respective airflows measured at the time of sampling. Due to the intermittent nature of the testing, mass recovery was evaluated relative to the duration of sampling time from individual test startups, as this provided the best assessment of how a continuously operating system would perform.

Figure 4 provides a plot of measured effluent removal rates, using the duration of sampling time from individual test startups (as opposed to a synchronous analysis). The data collected from the SVE/DPE pilot tests indicate a relatively low starting mass removal rate of approximately 3 pounds per day, with a subsequent logarithmic decay in mass removal rate to very low recovery (0.14 pounds per day) after 7 days of operation. This type of decay is typical of SVE systems, which is one reason why high initial removal rates are a key to successful implementation of SVE. Based on evaluation of the

SVE/DPE test performance, SVE and DPE were not retained as viable remedial technologies.

5.2 Potential Cleanup Action Alternatives

As detailed in the Site UST Removal Report (AGI, 1991), following removal of the USTs in 1990, a cleanup action consisting of excavation of gasoline-impacted soil was completed to the extent practicable. Each of the cleanup action alternatives developed for the Site include this soil cleanup action as the initial component.

Four retained cleanup action alternatives were fully evaluated for comparison with MTCA criteria (WAC 173-340-350(8)). The four cleanup action alternatives are as follows:

- Alternative 1 – Completed Soil Removal and No Additional Action;
- Alternative 2 – Completed Soil Removal and MNA with Environmental Covenant with Institutional Controls;
- Alternative 3 – Completed Soil Removal and *In Situ* Chemical Oxidation; and
- Alternative 4 – Completed Soil Removal and Excavation and Off-Site Disposal.

A description of each of these cleanup action alternatives and corresponding evaluation, based on the cleanup requirements set forth in MTCA, are provided in the following subsection.

5.3 Evaluation of Potential Cleanup Action Alternatives

This FFS considers the requirements under WAC 173-340-350, Site-specific conditions, and the criteria defined in WAC 173-340-360 for screening of potentially feasible remedial alternatives for the Site. A cleanup action alternative must satisfy the following threshold criteria, as specified in WAC 173-340-360(2):

- Protect human health and the environment;
- Comply with cleanup standards;
- Comply with applicable state and federal laws; and
- Provide for compliance monitoring.

These criteria represent the minimum standards for an acceptable cleanup action alternative. In addition to meeting the threshold criteria, cleanup action alternatives under MTCA will also:

- Use permanent solutions to the maximum extent practicable;
- Provide for a reasonable restoration timeframe, and
- Consider public concerns.

Evaluation of each of the cleanup action alternatives is provided below. FFS-level cost estimates for each alternative were calculated in accordance with U.S. Environmental Protection Agency (EPA) cost estimating guidance and professional experience with

similar projects (EPA, 2000). The cost for Alternative 2 was calculated as net present value (NPV) assuming a discount rate of 4 percent for a 15-year period. If long-term monitoring were to extend past this period, the NPV costs for monitoring after 15 years would be negligible. Cost estimate details and assumptions are provided in Tables 6 through 8.

5.3.1 Alternative 1 – Completed Soil Removal and No Additional Action

This alternative includes no additional action beyond the soil cleanup action completed in 1990. Though not implementable from a regulatory perspective, this alternative has zero cost and provides a baseline against which to compare other alternatives.

5.3.2 Alternative 2 – Completed Soil Removal and MNA with Environmental Covenant with Institutional Controls

This alternative includes MNA with an environmental covenant. Specifically, this alternative would include:

- The soil removal action completed in 1990 which significantly reduced the mass of COCs in the proximal source area.
- MNA to reduce concentrations of COCs in soil and shallow groundwater through biodegradation, volatilization, and other naturally occurring processes.
- An environmental covenant (filed with the property deed) incorporating institutional controls to prevent exposure to residual concentrations of COCs in soil or shallow perched groundwater, and a groundwater monitoring plan to document the progress on MNA in reducing COC concentrations.

This alternative highly implementable and economical, poses very little short-term risk, and is minimally disruptive to the operations of the OWSI facility. The potential for human exposure through direct-contact or ingestion of soil with residual concentrations of COCs under this alternative is prevented through institutional controls and restrictions on excavation or subsurface penetration established in the environmental covenant

The potential for human exposure through direct-contact or ingestion of COCs in shallow groundwater is prevented under this alternative through a restriction on shallow groundwater use in the environmental covenant, even though shallow perched water-bearing zone is not currently used for drinking water, and is a not expected to be a future source. The MNA component of this alternative provides for monitoring of the natural degradation of dissolved phase COCs in shallow perched groundwater.

This cleanup alternative would likely eventually achieve the proposed cleanup levels for the Site, complies with applicable State and Federal laws, provides for performance and compliance monitoring, and considers public concerns. This cleanup alternative would also eventually result in a permanent solution. Based on Aspect's previous experience on similar sites, groundwater monitoring to assess the progress of MNA on reducing dissolved concentrations of COCs in groundwater would be required over an extended period of time. At achievement of groundwater compliance, soil confirmation sampling would also likely be required.

The estimated cost of this alternative is $130,000 (Table 6). Restoration time frame is estimated at 15 years.

5.3.3 Alternative 3 – Completed Soil Removal and *In Situ* Chemical Oxidation

This alternative includes the following components:

- *In situ* chemical oxidation to reduce concentrations of COCs in shallow soil and perched groundwater to below MTCA Method A cleanup levels.

The *in situ* chemical oxidation component is estimated to include injection of a chemical oxidant at up to 20 permanent injection wells spaced approximately 15 feet apart to treat up to a 20-feet-thick zone of impacted soil within the mapped area of impacts. Seven separate injection events are scoped in this alternative. Injection-point spacing is an estimation based on Regenesis documentation.

The *in situ* chemical oxidation technology will require bench-scale and/or pilot testing to evaluate its potential effectiveness, select the appropriate oxidant, and design an injection program. Based on a preliminary estimate of the total mass of TPH in soil (approximately 880 pounds), approximately 28,000 pounds of RegenOx, a chemical oxidant supplied by Regenesis will be required over the seven injection events. Periodic post-injection protection groundwater monitoring would also be required to confirm that groundwater quality achieves compliance with MTCA Method A cleanup levels.

Assuming successful bench scale testing, this cleanup alternative would likely achieve the proposed cleanup levels for the Site. It complies with applicable State and Federal laws, provides for performance and compliance monitoring, and considers public concerns. This cleanup alternative would also eventually result in a permanent solution. Based on Aspect's previous experience on similar sites, groundwater monitoring to assess the progress of *in situ* chemical oxidation on reducing dissolved concentrations of COCs in groundwater would be required over an approximate 5-year period.

The estimated cost of this alternative is $650,000 (Table 7). Restoration time frame is estimated at 5 years.

5.3.4 Alternative 4 – Completed Soil Removal and Excavation and Off-Site Disposal

This alternative includes soil excavation to address residual concentrations of COCs in soil above the shallow perched groundwater-bearing zone, and follow-up groundwater monitoring to confirm that MNA reduces residual concentrations of COCs in shallow groundwater to below MTCA Method A cleanup levels. The excavation component of this alternative would require demolition of the existing garage building, excavation and off-Site disposal of residual gasoline-impacted soil, and construction of a new garage building.

As noted in Section 3.3.1, residual gasoline-impacted soil is expected to occur beneath the garage building from below approximately 10 feet bgs to the perched groundwater table at depths ranging from approximately 20 to 41 feet bgs (SLR, 2011). Based on the results of the RI activities, the estimated area of impacted soil covers an area of

approximately 3,140 square feet (see Figure 7 of the Additional Investigation Report; SLR, 2011). This alternative includes excavation of approximately 12,000 bank cubic yards of soil, including overburden and gasoline-impacted soil. Scoping of this alternative assumes the excavation can be completed by sloping, and without shoring. Shoring would add significantly to both the complexity and cost of implementation.

During excavation, overburden would be stockpiled, tested, and reused as backfill. Gasoline-impacted soil with COC concentrations above MTCA Method A cleanup levels would be transported off-site for disposal at a permitted landfill. Periodic post-excavation groundwater monitoring would also be required to confirm that shallow perched groundwater quality achieves compliance with MTCA Method A cleanup levels.

This cleanup alternative would likely achieve the proposed cleanup levels for the Site. It complies with applicable State and Federal laws, provides for performance and compliance monitoring, and considers public concerns. This cleanup alternative would also eventually result in a permanent solution. Based on Aspect's previous experience on similar sites, groundwater monitoring to assess post-excavation attenuation of residual COCs in groundwater would be required over an approximate 3-year period.

The estimated cost of this alternative is $1,250,000 (Table 8). Restoration time frame is estimated at 4 years.

5.4 Disproportionate Cost Analysis

A disproportionate cost analysis (DCA) was completed in accordance with WAC 173-340-360. The DCA provides a means to balance the cost to benefit associated with an alternative and allows for elimination of alternatives for which the incremental costs are disproportionate relative to the benefits. The DCA for the retained four alternatives is presented in Table 9. Figure 5 provides a graphical presentation of the cost to overall alternative ranking (e.g.: benefit) comparison for each of the four alternatives. The criteria used to qualitatively evaluate potentially applicable cleanup alternatives in the DCA were derived from WAC 173-340-360(3)(f). These criteria, which were assigned weighting factors in Table 9 in accordance with applicable Ecology guidance, include:

- **Protectiveness:** Overall protectiveness of human health and the environment, including the degree to which existing risks are reduced, the time required to reduce risk at the Site and attain cleanup standards, on-Site risks resulting from implementing the alternative, and the improvement of overall environmental quality.
- **Permanence:** The degree to which the alternative permanently reduces the toxicity, mobility, or volume of hazardous substances, including the adequacy of the alternative in destroying the hazardous substances, the reduction or elimination of hazardous substance releases and sources of releases, the degree of irreversibility of the waste treatment process, and the characteristics and quantity of treatment residuals generated.
- **Long-term effectiveness:** Long-term effectiveness includes the degree of certainty that the alternative will be successful, the reliability of the alternative during the period of time that hazardous substances are expected to remain on the

Site at concentrations that exceed cleanup levels, and the magnitude of residual risk with the alternative in place.

- **Management of short-term risks:** The risk to human health and the environment associated with the alternative during construction and implementation, and the effectiveness of measures that will be taken to manage such risks.
- **Technical and administrative implementability:** Ability to be implemented, including consideration of whether the alternative is technically feasible, administrative and regulatory requirements, permitting, scheduling, size, complexity, monitoring requirements, and access.
- **Consideration of public concerns:** Whether the community has concerns regarding the alternative and, if so, the extent to which the alternative addresses those concerns. This process involves concerns from individuals, community groups, local governments, federal and state agencies, or any other organization that may have an interest in or knowledge of the Site.
- **Cost:** The cost to implement the alternative, including the cost of construction, the net present value of any long-term costs, and Ecology oversight costs. Long-term costs include operation and maintenance, monitoring, and reporting costs.

The Site DCA documented in Table 9 and Figure 5 assigns each alternative an overall MTCA benefit ranking on a scale of 1 to 10, with 1 representing the lowest protectiveness, permanence, effectiveness, risk, implementability, and greatest level of public concern. The evaluated alternatives for the Site are ranked as follows:

- **Alternative 1 – Completed Soil Removal and No Additional Action**: This alternative was assigned an overall MTCA benefit ranking value of 4.7. The estimated cost of implementation is $0;
- **Alternative 2 – Completed Soil Removal and MNA with Environmental Covenant with Institutional Controls:** This alternative was assigned an overall MTCA benefit ranking value of 7.1. The estimated cost of implementation is $130,000;
- **Alternative 3 – Completed Soil Removal and *In-Situ* Chemical Oxidation**: This alternative was assigned an overall MTCA benefit ranking value of 7.2. The estimated cost of implementation is $650,000; and
- **Alternative 4 – Completed Soil Removal and Excavation with Off-Site Disposal**: This alternative was assigned an overall MTCA benefit ranking value of 7.5. The estimated cost of implementation is $1,250,000.

As shown on Figure 5, Alternatives 2, 3 and 4 have essentially comparable benefit rankings. Alternative 3 provides a nominal net 1% incremental benefit over Alternative 2, and Alternative 4 provides a nominal net benefit of 4% over Alternative 2. Despite these limited incremental benefits, the costs to implement Alternatives 3 and 4 range from approximately 6 times (Alternative 3) to ten times (Alternative 4) the cost for implementation of Alternative 2. Based on the comparable protectiveness and effectiveness provided by Alternative 2, and disproportionate cost of the nominal incremental benefits provided by either Alternatives 3 or 4, Alternative 2 is identified as the preferred alternative.

6 Summary of Preferred Cleanup Action

The preferred cleanup action alternative for the Site is Cleanup Alternative 2 – Completed Soil Removal and MNA with Environmental Covenant with Institutional Controls. This cleanup action would be conducted independently under the Ecology VCP with the long-term objective of obtaining an NFA determination for the Site.

Alternative 2, as the recommended cleanup action for this Site, would include the specific elements detailed below.

- **Institutional Controls:** These would be incorporated into an environmental covenant filed with the deed on the property. The covenant would restrict certain activities that could cause exposure to impacted soils or groundwater, or result in unacceptable mobilization of subsurface COCs. Non-commercial land uses would also be prohibited by the covenant unless and until a new analysis of remedial alternatives is prepared and Ecology approves additional cleanup actions designed to protect public health and the environmental under non-commercial land use scenarios.
- **COC Monitoring Program:** The covenant would include a groundwater sampling plan addressing implementation of an MNA groundwater sampling program to document the progress of natural attenuation of residual COCs. The groundwater sampling plan would include sampling of the selected existing wells on an annual basis, with analysis for TPH as gasoline and BTEX compounds. After groundwater compliance is achieved, the covenant would also likely include a requirement for confirmation of COC attenuation in soil as a prerequisite to removal of the environmental covenant and issuance of an NFA letter.

Based on the results of the DCA, the recommended cleanup action alternative for the Site is Cleanup Alternative 2 – Completed Soil Removal and MNA with Environmental Covenant with Institutional Controls.

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Limitations

Work for this project was performed for OPG (Client), and this report was prepared in accordance with generally accepted professional practices for the nature and conditions of work completed in the same or similar localities, at the time the work was performed. This report does not represent a legal opinion. No other warranty, expressed or implied, is made.

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TABLES

Table 1 - Summary of Groundwater Elevation Data

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Olympic Water and Sewer, Inc. Site
781 Walker Way, Port Ludlow, Washington

Well Number	Top of Casing Elevation[a] (feet)	Date Measured	Depth to Groundwater[b] (feet)	Groundwater Elevation (feet)
MW-1	294.02	06/14/10	41.33	252.69
		10/20/10	40.30	253.72
		04/08/11	36.98	257.04
MW-2	293.79	06/14/10	39.63	254.16
		10/20/10	40.71	253.08
		04/08/11	36.90	256.89
MW-3	289.37	06/14/10	25.19	264.18
		10/20/10	28.70	260.67
		04/08/11	23.02	266.35
MW-4	295.33	06/14/10	23.92	271.41
		10/20/10	26.67	268.66
		04/08/11	21.95	273.38
MW-5[c]	299.40	04/08/11	23.55	275.85
SVE-1	294.41	04/08/11	21.22	273.19
SVE-2	293.87	04/08/11	19.80	274.07

Notes:

[a]Top of casing elevations were surveyed relative to the NAVD 88 datum.

[b]Depth to groundwater measured in feet below top of PVC casing.

[c]The top of the casing of MW-5 is 2.92 feet above the ground surface. All of the other wells and the soil vapor extraction points are flush-grade completions.

Table 2 - Summary of June 21, 2013 Sub-Slab Soil Vapor Sampling Results

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Olympic Water and Sewer, Inc. Site
781 Walker Way, Port Ludlow, Washington

Sample ID	Analyte Group	Analyte	Carcinogen(C) or Non-Carcinogen(NC)	Units	Result	Result with Leakage Correction	Flag	Reporting Limit	MTCA Method B Indoor Air CUL	Site-Specific Commercial Land Use Sub-Slab Soil Vapor Screening Level [4,5]
VP-1-062113	APH	C_5 - C_8 Aliphatic Hydrocarbons[1,2]	NC	µg/m3	110	110.02		28	2,700	59,063
		C_9 - C_{12} Aliphatic Hydrocarbons[1,3]	NC	µg/m3	2,100	2100.38		14	140	3,063
		C_9 - C_{10} Aromatic Hydrocarbons	NC	µg/m3	42	42.01		3.5	180	3,938
	TO-15	Methyl tert-Butyl Ether	C	µg/m3			ND	0.70	9.6	960
		n-Hexane	NC	µg/m3			ND	0.70	320	7,000
		1,2-Dichloroethane	C	µg/m3			ND	0.70	0.096	9.6
		Benzene	C	µg/m3			ND	0.70	0.32	32.0
		Toluene	NC	µg/m3	9.8	9.80		0.70	2,200	48,125
		1,2-Dibromoethane (EDB)	C	µg/m3			ND	0.70	0.01	1.1
		Ethylbenzene	NC	µg/m3	3.2	3.20		0.70	460	10,063
		m,p-Xylenes	NC	µg/m3	15	15.00		1.4	46	1,006
		o-Xylene	NC	µg/m3	4.4	4.40		0.70	46	1,006
		1,3,5-Trimethylbenzene	NC	µg/m3	2.4	2.40		0.70	2.7	59
		1,2,4-Trimethylbenzene	NC	µg/m3	7.7	7.70		0.70	2.7	59
		Naphthalene	NC	µg/m3	1.2	1.20		0.70	1.4	31
	Tracer	Helium		ppmV	180			28	-	-
VP-2-062113	APH	C_5 - C_8 Aliphatic Hydrocarbons[1,2]	NC	µg/m3	100			27	2,700	59,063
		C_9 - C_{12} Aliphatic Hydrocarbons[1,3]	NC	µg/m3	790			14	140	3,063
		C_9 - C_{10} Aromatic Hydrocarbons	NC	µg/m3	16			3.4	180	3,938
	TO-15	Methyl tert-Butyl Ether	C	µg/m3			ND	0.68	9.6	960
		n-Hexane	NC	µg/m3			ND	0.68	320	7,000
		1,2-Dichloroethane	C	µg/m3			ND	0.68	0.10	9.6
		Benzene	C	µg/m3			ND	0.68	0.32	32.0
		Toluene	NC	µg/m3	12			0.68	2,200	48,125
		1,2-Dibromoethane (EDB)	C	µg/m3			ND	0.68	0.01	1.1
		Ethylbenzene	NC	µg/m3	10			0.68	460	10,063
		m,p-Xylenes	NC	µg/m3	45			1.4	46	1,006
		o-Xylene	NC	µg/m3	28			0.68	46	1,006
		1,3,5-Trimethylbenzene	NC	µg/m3	1.60			0.68	2.7	59
		1,2,4-Trimethylbenzene	NC	µg/m3	3.5			0.68	2.7	59
		Naphthalene	NC	µg/m3			ND	0.68	1.4	31
	Tracer	Helium		ppmV			ND	27	-	-

Notes:
Significant non-petroleum related peaks are subtracted from the APH hydrocarbon range areas when present.
[1]Hydrocarbon Range data from total ion chromatogram excluding any internal/tuning standards eluting in that range.
[2]C_5-C_8 Aliphatic Hydrocarbons exclude the concentration of Target APH analytes eluting in that range.
[3]C_9-C_{12} Aliphatic Hydrocarbons exclude concentration of Target APH Analytes eluting in that range and concentration of C_9-C_{10} Aromatic Hydrocarbons.
[4]Conservative cross-slab attenuation factor of 10, per Ecology's *Draft Guidance for Evaluating Soil Vapor Intrusion in Washington State* (2009).
[5]Site-specific correction for adult worker exposure scenario, calculated in accordance with WAC 173-340-750 and Ecology's *Draft Guidance for Evaluating Soil Vapor Intrusion in Washington State* (2009).

Table 3 - Summary of Soil Analytical Data

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Olympic Water and Sewer, Inc. Site
781 Walker Way, Port Ludlow, Washington

Soil Boring Number	Sample Name	Date Collected	Approximate Sample Depth (feet)	Analytical Results (mg/kg)						
				Benzene[a]	Toluene[a]	Ethylbenzene[a]	Total Xylenes[a]	Naphthalene[a]	Gasoline-range TPH[b]	Lead[c]
MTCA Method A Cleanup Levels[d]				**0.03**	**7**	**6**	**9**	**5**	**30**	**250**
SVE-1	SVE1-14	04/04/11	14 to 14.3	<0.02	0.04	<0.02	0.074	NA	<2.0	
SVE-2	SVE2-20	04/04/11	20 to 20.5	<0.02	0.64	0.55	1.50	NA	**110**	
SB-1	SB1-35	04/04/11	35 to 35.5	<0.02	<0.02	<0.02	<0.06	NA	<2.0	
MW-5	MW5-25	04/06/11	25 to 25.5	<0.02	<0.02	<0.02	<0.06	NA	<2.0	
MW-1B	MW1-24.5-25	04/14/10	24.5 to 25	**0.49**	5.70	1.20	6.70	0.58	**140**	1.11
MW-1	MW-1-40	06/08/10	40 to 40.3	<0.03	<0.05	<0.05	<0.15	<0.05	<2	NA
MW-1	MW1-55	06/08/10	55 to 55.5	<0.03	<0.05	<0.05	<0.15	<0.05	<2	NA
MW-2	MW2-40	06/09/10	40 to 40.3	**.21**[e]	0.062	0.11	0.066	<0.05	2.90	NA
MW-2	MW2-55.5	06/09/10	55.5 to 55.8	**.21**[e]	<0.05	<0.05	<0.15	<0.05	<2	NA
MW-3	MW-3-30.5	06/09/10	30.5 to 30.9	<0.03	<0.05	<0.05	<0.15	<0.05	<2	NA
MW-3	MW3-45.5	06/10/10	45.5 to 45.9	0.036[f]	<0.05	<0.05	<0.15	<0.05	<2	NA
MW-4	MW4-31	06/10/10	30.5 to 31	<0.03	<0.05	<0.05	<0.15	<0.05	<2	NA
MW-4	MW4-55	06/11/10	55 to 55.5	<0.03	<0.05	<0.05	<0.15	<0.05	<2	NA

Notes:
mg/kg = milligrams per kilogram (ppm).
Values in **bold** exceed the soil cleanup levels.
NA = Not analyzed.
TPH = Total Petroleum Hydrocarbons

[a]Benzene, toluene, ethylbenzene, total xylenes (BTEX), and naphthalene by EPA Method 8021B.

[b]Gasoline-range TPH by Northwest Method NWTPH-Gx or 8260c.

[c]Lead by EPA Method 200.8.

[d]Chapter 173-340 WAC, Model Toxics Control Act (MTCA) Cleanup Regulation, Method A Cleanup Levels. Amended 2007.

[e]The benzene concentration in this sample likely reflects dissolved benzene in pore water rather than benzene adsorbed to the soil.

All data from this table is from *Site Characterization Report, Olympic Water & Sewer, Inc. Property, 781 Walker Way, Port Ludlow, Washington* dated December 17, 2010 prepared by SLR and *Additional Investigation Report, Olympic Water & Sewer, Inc. Property, 781 Walker Way, Port Ludlow, Washington* dated August 2, 2011, prepared by SLR.

Table 4 - Summary of Groundwater Analytical Data

DRAFT

Olympic Water and Sewer, Inc. Site
781 Walker Way, Port Ludlow, Washington

Well Number	Date Collected		Analytical Results (µg/L)								
		Gasoline-range TPH[a]	Benzene[b]	Toluene[b]	Ethylbenzene[b]	Total Xylenes[b]	Naphthalene[b]	MTBE[b]	EDC[b]	EDB[c]	Total Lead[d]
MTCA Method A Cleanup Levels[e]		**800**	**5**	**1,000**	**700**	**1,000**	**160[f]**	**20**	**5**	**0.01**	**15**
MW-1	06/14/10	**990**	**110**	45	1.10	186	<1	<1	<1	<0.01	<1
	10/20/10	**1,900**	**520**	140	110	221	15	NA	NA	NA	NA
	04/07/11	**3,000**	**530**	82	160	120	NA	NA	NA	NA	NA
MW-2	06/14/10	**8,400**	**2,100**	620	**960**	650	100	<1	<1	<0.01	<1
	10/20/10	**3,900**	**1,300**	290	430	530	35	NA	NA	NA	NA
	04/07/11	**5,600**	**500**	730	160	410	NA	NA	NA	NA	NA
MW-3	06/14/10	<100	0.36	<1	<1	<3	<1	<1	<1	<0.01	<1
	10/20/10	<100	<0.35	<1	<1	<3	<1	NA	NA	NA	NA
	04/07/11	<100	<1	<1	<1	<3	NA	NA	NA	NA	NA
MW-4	06/14/10	<100	<0.35	<1	<1	<3	<1	<1	<1	<0.01	<1
	10/20/10	<100	<0.35	<1	<1	<3	<1	NA	NA	NA	NA
	04/08/11	380	**5.30**	75	13	47	NA	NA	NA	NA	NA
MW-5	04/08/11	220	3.40	43	7.80	25	NA	NA	NA	NA	NA
SVE-1	04/07/11	**34,000**	**550**	**5,700**	**850**	**3,300**	NA	NA	NA	NA	NA
SVE-2	04/07/11	**2,000**	5.0	14	18	35	NA	NA	NA	NA	NA

Notes:

µg/L = micrograms per liter (ppb).

Values shaded and in **bold** exceed the groundwater cleanup levels.

NA = Not analyzed.

[a]Gasoline-range TPH by Northwest Method NWTPH-Gx or 8260c..

[b]Benzene, toluene, ethylbenzene, and total xylenes (BTEX), naphthalene, methyl tertiary butyl ether (MTBE), and 1,2-dichloroethane (EDC) by EPA Method 8260C, or BTEX

[c]1,2-dibromoethane (EDB) by EPA Method 8011 Modified.

[d]Total lead by EPA Method 200.8.

[e]Chapter 173-340 WAC, Model Toxics Control Act (MTCA) Cleanup Regulation, Method A Cleanup Levels. Amended 2007.

[f]The cleanup level is the total value for naphthalene, 1-methyl naphthalene, and 2-methyl naphthalene.

Data from this table is from *Site Characterization Report, Olympic Water & Sewer, Inc. Property, 781 Walker Way, Port Ludlow, Washington* dated December 17, 2010 prepared by SLR and *Additional Investigation Report, Olympic Water & Sewer, Inc. Property, 781 Walker Way, Port Ludlow, Washington* dated August 2, 2011, prepared by SLR.

Table 5 - Preliminary Screening of Remedial Technologies

DRAFT

Olympic Water and Sewer, Inc. Site
781 Walker Way, Port Ludlow, Washington

Remedial Technology	Effectiveness	Implementability	Comparative Cost	Screening Result
Institutional Controls	low	high	low	Retained
Engineering Controls	low	high	low	Retained
Monitored Natural Attenuation	medium	high	low	Retained
Soil Vapor Extraction and Dual-Phase Extraction	low	low	medium	Not Retained
Air Sparging	low	medium	medium	Not Retained
Enhanced Aerobic Biodegradation	low	low	medium	Not Retained
In-Situ Chemical Oxidation	medium	medium	medium	Retained
Soil Excavation	high	low	high	Retained

Table 6 - Alternative 2 Cost Estimate - Completed Soil Removal and MNA with Environmental Covenant with Institutional Controls

Olympic Water and Sewer, Inc. Site
781 Walker Way, Port Ludlow, Washington

Site:	Olympic Water and Sewer, Inc.
Remedial Action Description:	Completed Soil Removal and MNA with Environmental Covenant with Institutional Controls
Key Assumptions:	Annual groundwater and surface water monitoring required Future costs are adjusted to present value using a discount rate of 4 percent Environmental covenant required for soil and shallow groundwater

Item	Quantity	Unit	Unit Cost	Est. Cost	Notes
Professional Services					
project management	20%		$ 75,592	$ 15,118	Planning and reporting
remedial design	1	ls	$ 3,500	$ 3,500	Develop monitoring plan
environmental covenant	1	ls	$ 10,000	$ 10,000	Covenant for soil and shallow groundwater
Subtotal				*$ 28,618*	
Monitoring					
Groundwater for 15 years	15	ea	$ 5,000	$ 55,592	5 shallow wells, Well #2, and 1 surface water sample per event
confirmation soil sampling	1	ls	$ 20,000	$ 20,000	upon completion of active remediatior
Subtotal				*$ 75,592*	
Contingency	25%			$ 26,053	25% scope and restoration time frame contingency
Total Estimated Cost				**$ 130,000**	(rounded to the nearest $10,000)

Notes:
ea = each
ls = lump sum

Table 7 - Alternative 3 Cost Estimate - Completed Soil Removal and *In Situ* Chemical Oxidation

Olympic Water and Sewer, Inc. Site
781 Walker Way, Port Ludlow, Washington

Site:	Olympic Water and Sewer, Inc.
Remedial Action Description:	Completed Soil Removal and *In Situ* Chemical Oxidation
Key Assumptions:	Average TPH-gas concentration in soil = 125 mg/kg Area of impacts = 3,200 sq ft Treatment thickness = 20 ft Average soil density = 110 lb/cu ft Oxidant requirements estimated using: *Principles of Chemical Oxidation Technology, Design and Application Manual, V.3.0* (Regenesis, 2010)

Item	Quantity	Unit	Unit Cost	Est. Cost	Notes
Professional Services					
project mgmt	6%		$ 387,400	$ 23,244	percentage of capital and monitoring costs
remedial design	12%		$ 295,400	$ 35,448	percentage of capital costs
construction mgmt	8%		$ 295,400	$ 23,632	percentage of capital costs
Subtotal				*$ 82,324*	
ISCO Pilot Test					
install injection wells	3	ea	$ 8,000	$ 24,000	
injection event	2	day	$ 2,500	$ 5,000	
Regen-Ox amendment	600	lb	$ 1.50	$ 900	assumes 200 lbs per injection well
Subtotal				*$ 29,900*	
***In Situ* Chemical Oxidation**					
install injection wells	17	ea	$ 8,000	$ 136,000	
injection events	7	week	$ 12,500	$ 87,500	7 events (20 wells total, inject 5 wells per day)
Regen-Ox Amendment	28000	lb	$ 1.50	$ 42,000	estimated using Regenesis design guidelines
Subtotal				*$ 265,500*	
Monitoring					
quarterly groundwater sampling	5	yr	$ 12,000	$ 60,000	5 wells quarterly to monitor performance and confirmation
confirmation soil sampling	1	ls	$ 20,000	$ 20,000	upon completion of active remediation
well abandonment	1	ls	$ 12,000	$ 12,000	
Subtotal				*$ 92,000*	
Tax	9.5%			$ 28,063	Washington Sales Tax (applied to capital costs)
Contingency	30%			$ 149,336	25% scope and restoration time frame contingency
Total Estimated Cost				**$ 650,000**	(rounded to the nearest $10,000)

Notes:
ea = each
lb = pound
ls = lump sum
yr = year

Table 8 - Alternative 4 Cost Estimate - Completed Soil Removal and Excavation and Off-Site Disposal

DRAFT

Olympic Water and Sewer, Inc. Site
781 Walker Way, Port Ludlow, Washington

Site:	Olympic Water and Sewer, Inc.
Remedial Action Description:	Completed Soil Removal and Excavation and Off-Site Disposal
Cost Estimate Accuracy:	Feasibility Level (+50/-30 percent)
Key Assumptions:	4,225 square foot area (65 feet by 65 feet) excavated to 40 foot depth 3/4:1 (H:V) sloped excavation, no shoring required Area of impacted soil = 3,200 sq ft Overburden average thickness = 15 feet Impacted zone thickness = 25 ft Average soil density = 110 lb/cu ft Clean overburden and soil from sloping excavation reused for backfill Costs for tree restoration are not included

Item	Quantity	Unit	Unit Cost	Total Cost	Notes
Professional Services					
project mgmt	6%		$ 773,738	$ 46,424	percentage of capital and monitoring costs
remedial design	6%		$ 705,738	$ 42,344	permitting, planning, geotechnical engineering
construction mgmt	4%		$ 705,738	$ 28,230	percentage of capital costs
Subtotal				*$ 116,998*	
Soil Excavation					
mobilization/demobilization	1	ls	$ 10,000	$ 10,000	recent project experience
building demo and disposal	26680	cf	$ 0.40	$ 10,672	RSMeans for building demo/recent project experience [1]
tree removal	0.1	acre	$ 10,430	$ 1,043	RSMeans for clearing and grubbing up to 12" trees [1]
decommission/replace monitoring wells	3	ea	$ 7,500	$ 22,500	MW-1, MW-2, MW-5
excavation/loading/stockpiling	12037	bcy	$ 4	$ 48,148	RSMeans for bulk excavation and loading [1]
PCS hauling and disposal	6455	ton	$ 50	$ 322,743	Local current pricing
dewatering during excavation	1	ls	$ 10,000	$ 10,000	estimate for pumps, storage, labor
impacted water disposal	5000	gal	$ 0.40	$ 2,000	Local current pricing
purchase and import clean backfill	7000	ton	$ 10	$ 70,000	Local current pricing
place and compact clean backfill	15046	bcy	$ 5	$ 75,231	RSMeans for backfill plus compaction [1]
replace building	1334	sf	$ 100	$ 133,400	engineer estimate
Subtotal				$ 705,738	
Monitoring					
quarterly groundwater sampling	3	yr	$ 12,000	$ 36,000	5 wells quarterly to monitor performance and confirmation
confirmation soil sampling	1	ls	$ 20,000	$ 20,000	
well abandonment	1	ls	$ 12,000	$ 12,000	
Subtotal				*$ 68,000*	
Tax	9.5%			$ 67,045	Washington Sales Tax (applied to capital costs)
Contingency	30%			$ 287,334	Volume and implementation contingency
Total Estimated Cost				**$ 1,250,000**	(rounded to the nearest $10,000)

Notes:

[1] Unit cost estimates from rsmeansonline.com
acre = acres
bcy = bank cubic yard
ea = each
gal = gallons
ls = lump sum
sf = square foot
yr = year

Table 9 - Summary of Alternatives Evaluation

Olympic Water and Sewer, Inc. Site
781 Walker Way, Port Ludlow, Washington

Alternative Number	Alternative 1	Alternative 2	Alternative 3	Alternative 4
Description	No Additional Action	Completed Soil Removal and MNA with Environmental Covenant with Institutional Controls	Completed Soil Removal and In Situ Chemical Oxidation	Completed Soil Removal and Excavation and Off-Site Disposal
Overall Alternative Ranking	4.7	7.1	7.2	7.5
Compliance with MTCA Threshold Criteria				
Protection of Human Health and the Environment	Potentially not, since it includes no covenant to prevent exposure to soil or groundwater	Yes – Alternative will protect human health and the environment.	Yes – Alternative will protect human health and the environment.	Yes – Alternative will protect human health and the environment.
Compliance with Cleanup Standards	Long restoration time since no active measures are used for soil of groundwater not complying with cleanup standards.	Yes – However, long restoration time since no active measures are used for soils not complying with cleanup standards.	Yes – Active remedial measures are used for soils not complying with cleanup standards.	Yes – Active remedial measures are used for soils not complying with cleanup standards.
Compliance with Applicable State and Federal Laws	No – Alternative includes no monitoring or environmental covenant.	Yes – Alternative complies with applicable laws.	Yes – Alternative complies with applicable laws.	Yes – Alternative complies with applicable laws.
Provision for Compliance Monitoring	None	Yes – Alternative includes provisions for compliance monitoring.	Yes – Alternative includes provisions for compliance monitoring.	Yes – Alternative includes provisions for compliance monitoring.
Restoration Time Frame	Potentially greater than 15 years	Potentially greater than 15 years	Minimum of 4 years	Minimum of 3 years
Evaluation Criteria				
Protectiveness (30% Weighted Factor):	2 Potentially not protective of exposure pathways.	8 Protective of exposure pathways through use of institutional controls/environmental covenant.	8 Protective of exposure pathways, some risk since the technology untested at the Site.	9 Highest degree of assurance for protection of identified exposure pathways.
Permanence (20% Weighted Factor):	5 Natural attenuation will reduce the volume and concentration of residual impacted soil and groundwater over an extended restoration time frame.	5 Natural attenuation will reduce the volume and concentration of residual impacted soil and groundwater over an extended restoration time frame.	7 Volume and concentration of residual impacted soil and groundwater is reduced; technology less certain than Alternative 4 because it is unproven at the Site.	9 Highest degree of assurance for reduction short term reduction in volume and concentration of residual impacted soil and groundwater.
Long-Term Effectiveness (20% Weighted Factor):	4 Relies on natural attenuation to reduce the volume and concentration of residual impacted soil and groundwater over an extended restoration time frame.	6 Relies on natural attenuation to reduce the volume and concentration of residual impacted soil and groundwater over an extended restoration time frame. Exposures prevented through institutional controls/environmental covenant.	7 Destroys petroleum compounds in soil and groundwater. Some implementation risk since technology is untested at the Site.	9 Soil removal coupled with groundwater natural attenuation is a proven effective remedial approach at petroleum sites.
Short-Term Risk Management (10% Weighted Factor):	9 No short term risk, since alternative involves no construction.	9 No short term risk, since alternative involves no construction.	7 This alternative poses a moderate amount of risk from drilling and construction activities.	5 This alternative poses the highest risk short term from heavy construction activities, excavation work, and truck traffic.
Implementability (10% Weighted Factor):	10 High implementability.	9 High implementability. Requires recording of covenant, and implementation of monitoring program and institutional controls.	6 Requires drilling wells inside building, drilling is limited by very dense soils, application is untested at the Site.	3 Implementation is complicated by need to demolish building, management of deep unshored excavation, limitations on equipment, truck, and overburden staging, and construction of a new building.
Public Concerns (10% Weighted Factor):	4 Likely concerns over lack of monitoring or institutional controls.	7 Potential concerns over extended restoration time frame.	7 Potential concerns over moderate disruption and inconvenience to local residents.	4 Likely significant concerns over disruption, noise, and inconvenience to local residents.
Cost	$0	$130,000	$650,000	$1,250,000

Notes:
For each evaluation criterion, technologies are ranked on a scale of 1 to 10, with 1 representing the lowest protectiveness, permanence, effectiveness, risk and implementability, or greatest level of public concern.

FIGURES

0 2,000 4,000

Feet

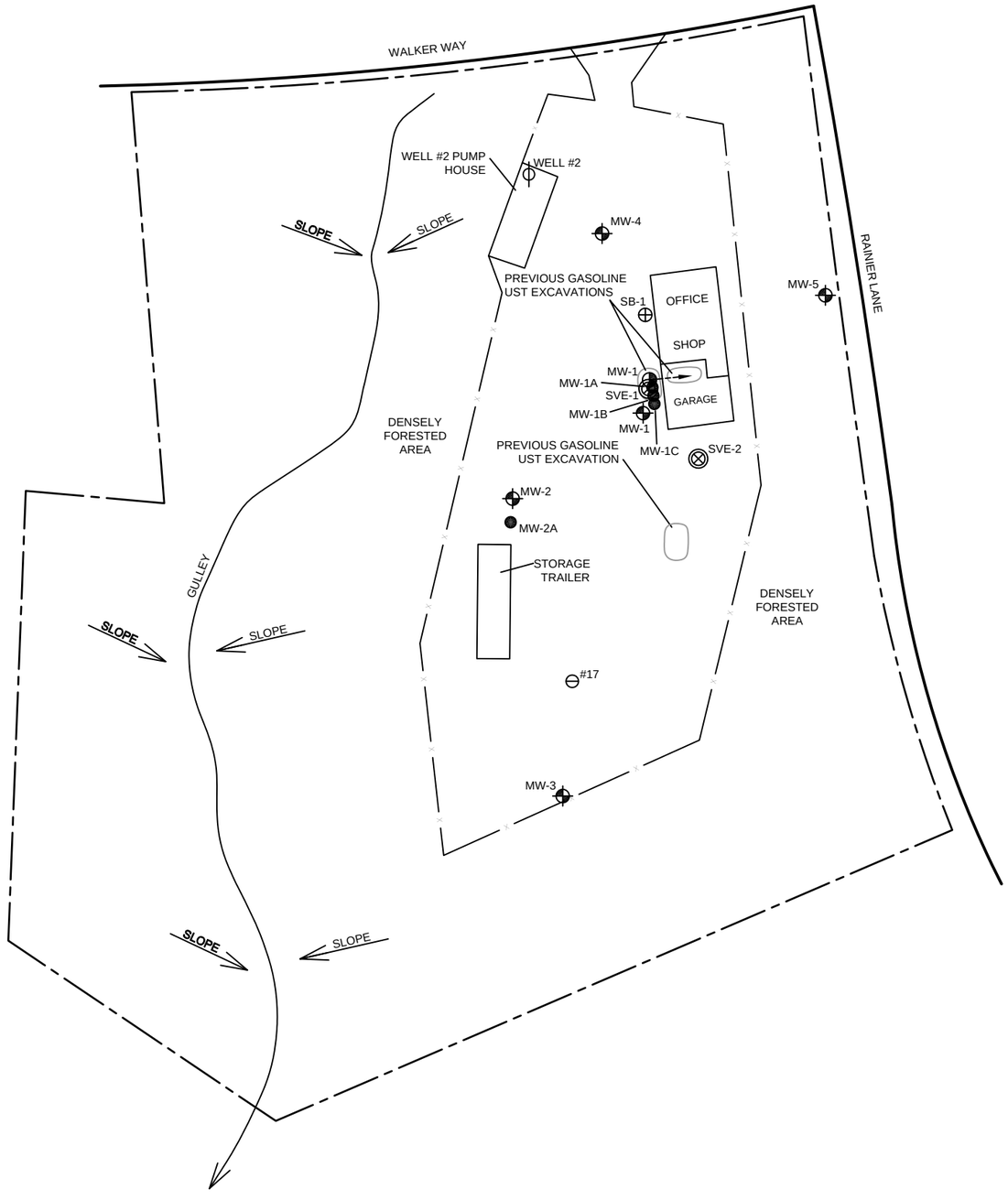
DRAFT

Site Location Map

Olympic Water & Sewer, Inc. Focused Feasibility Study
Port Ludlow, Washington

Aspect CONSULTING	AUG-2013	BY: BTC/SCC	FIGURE NO. 1
	PROJECT NO. 130046	REV BY: ---	

GIS Path: Q:\Olympic Property Group\130046 Port Ludlow\2013-08 FFS\GIS\Site Location Map.mxd || Coordinate System: NAD 1983 StatePlane Washington North FIPS 4601 Feet || Date Saved: 8/13/2013 || User: scudd || Print Date: 8/13/2013



LEGEND

- PROPERTY BOUNDARY
- SB-1 — APPROXIMATE 2011 SOIL BORING LOCATION AND DESIGNATION
- SVE-1 — PROPOSED SOIL VAPOR EXTRACTION POINT LOCATION AND DESIGNATION
- MW-1 — GROUNDWATER MONITORING WELL LOCATION AND DESIGNATION
- MW-2A — APPROXIMATE SOIL BORING LOCATION AND DESIGNATION
- #17 — EXISTING CASING LOCATION AND DESIGNATION
- WELL #2 — EXISTING WATER SUPPLY WELL LOCATION AND DESIGNATION
- MW-1 — PREVIOUS ANGLE BORING LOCATION, DESIGNATION, AND DIRECTION FROM VERTICAL
- FENCE

THIS DRAWING IS FOR CONCEPTUAL PURPOSES ONLY. ACTUAL LOCATIONS MAY VARY AND NOT ALL STRUCTURES ARE SHOWN.

BASE MAP PROVIDED BY SLR, FROM *ADDITIONAL INVESTIGATION REPORT* , DATED MAY 12, 2011.

SCALE: 1" = 50'
WHEN PLOTTED AT 11" x 17" PAGE SIZE
0 50 100 150'

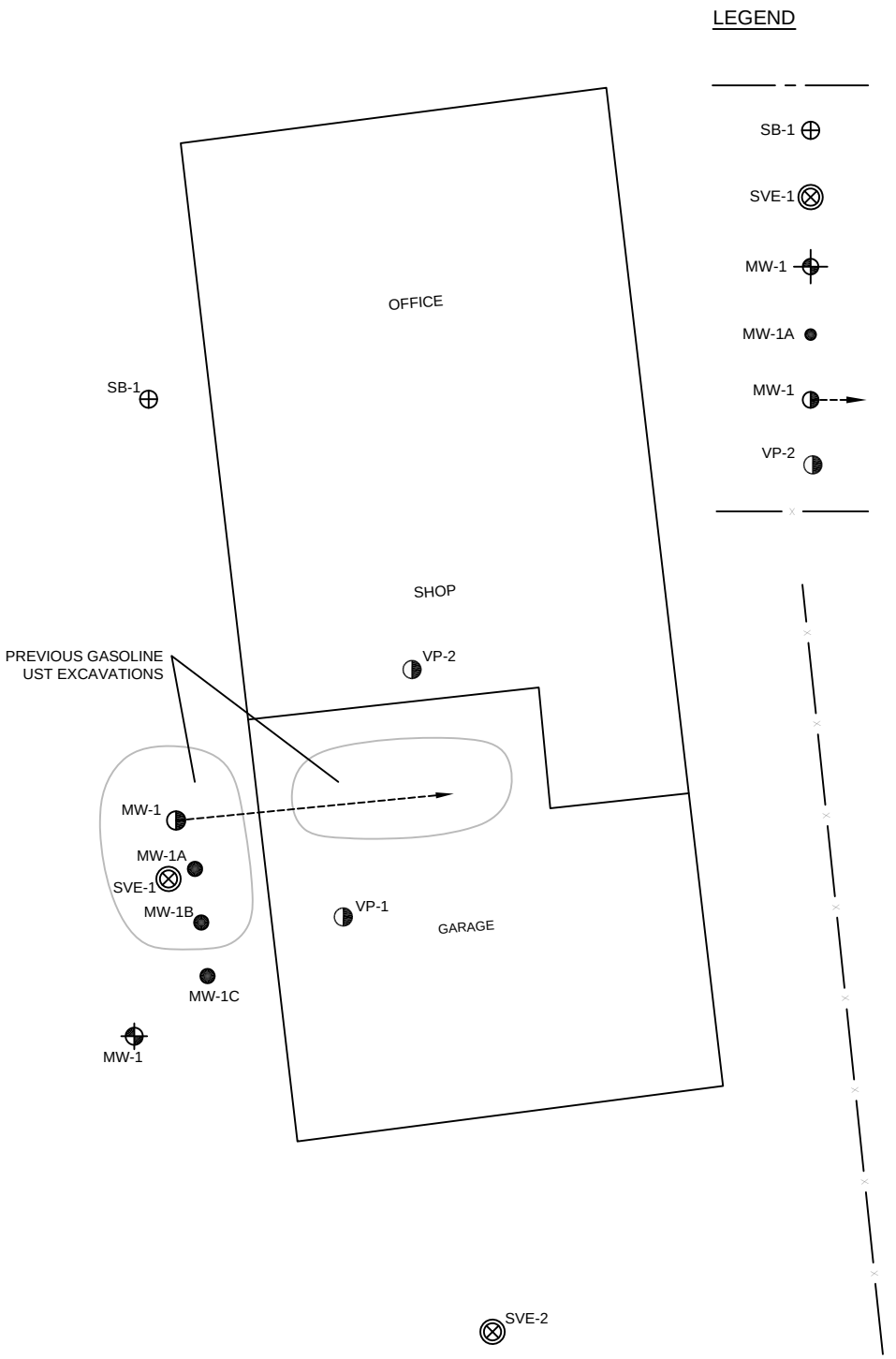
DRAFT

Site Plan

Olympic Water & Sewer, Inc. Focused Feasibility Study
Port Ludlow, Washington

Aspect CONSULTING	AUG-2013	BY: BTC/SCC	FIGURE NO. 2
	PROJECT NO. 130046	REV BY: -	

CAD Path: Q:\Olympic Property Group\130046 Port Ludlow\2013-08 FFS\130046-02.dwg SITE PLAN - 3 || Coordinate System: NAD 1983 State Plane Washington North FIPS 4601 Feet || Date Saved: Aug 13, 2013 4:02pm || User: scudd



LEGEND

- PROPERTY BOUNDARY
- SB-1 — APPROXIMATE 2011 SOIL BORING LOCATION AND DESIGNATION
- SVE-1 — SOIL VAPOR EXTRACTION POINT LOCATION AND DESIGNATION
- MW-1 — GROUNDWATER MONITORING WELL LOCATION AND DESIGNATION
- MW-1A — APPROXIMATE SOIL BORING LOCATION AND DESIGNATION
- MW-1 — PREVIOUS ANGLE BORING LOCATION, DESIGNATION, AND DIRECTION FROM VERTICAL
- VP-2 — SUB-SLAB SAMPLING LOCATION
- FENCE

N

SCALE 1" = 10'
WHEN PLOTTED ON 8 1/2 x 11

0 5 10 20

Detail Map Showing Sub-slab Sampling Locations

Olympic Water & Sewer, Inc. Focused Feasibility Study
Port Ludlow, Washington

THIS DRAWING IS FOR CONCEPTUAL PURPOSES ONLY. ACTUAL LOCATIONS MAY VARY AND NOT ALL STRUCTURES ARE SHOWN.

BASE MAP PROVIDED BY SLR, FROM *ADDITIONAL INVESTIGATION REPORT* , DATED MAY 12, 2011.

DRAFT

Aspect CONSULTING

AUG-2013	BY: BTC/SCC	FIGURE NO. 3
PROJECT NO. 130046	REV BY: -	

Testing Data Summary					
Sample	Date	Days of continuous SVE operation with groundwater removal	SVE Airflow Rate in Standard Cubic feet/minute	Laboratory Result for GRO in mg/meter^3	GRO Removal Rate (lbs/day)
Test2-Sample2	12/13/2011	0.375	18	1900	3.07
Test4-Sample2	1/5/2012	2	75	180	1.21
Test4-Sample1	12/29/2011	7	53	30	0.14

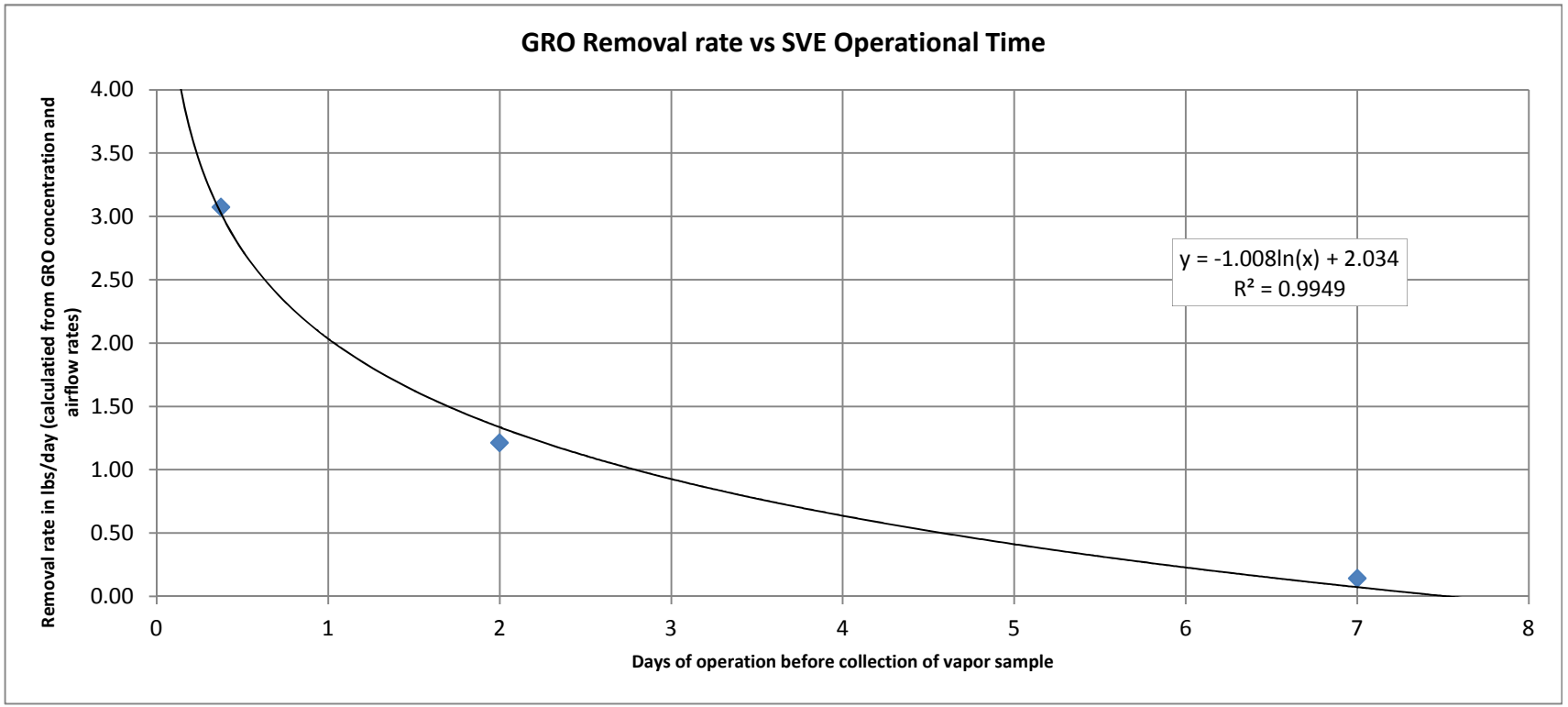
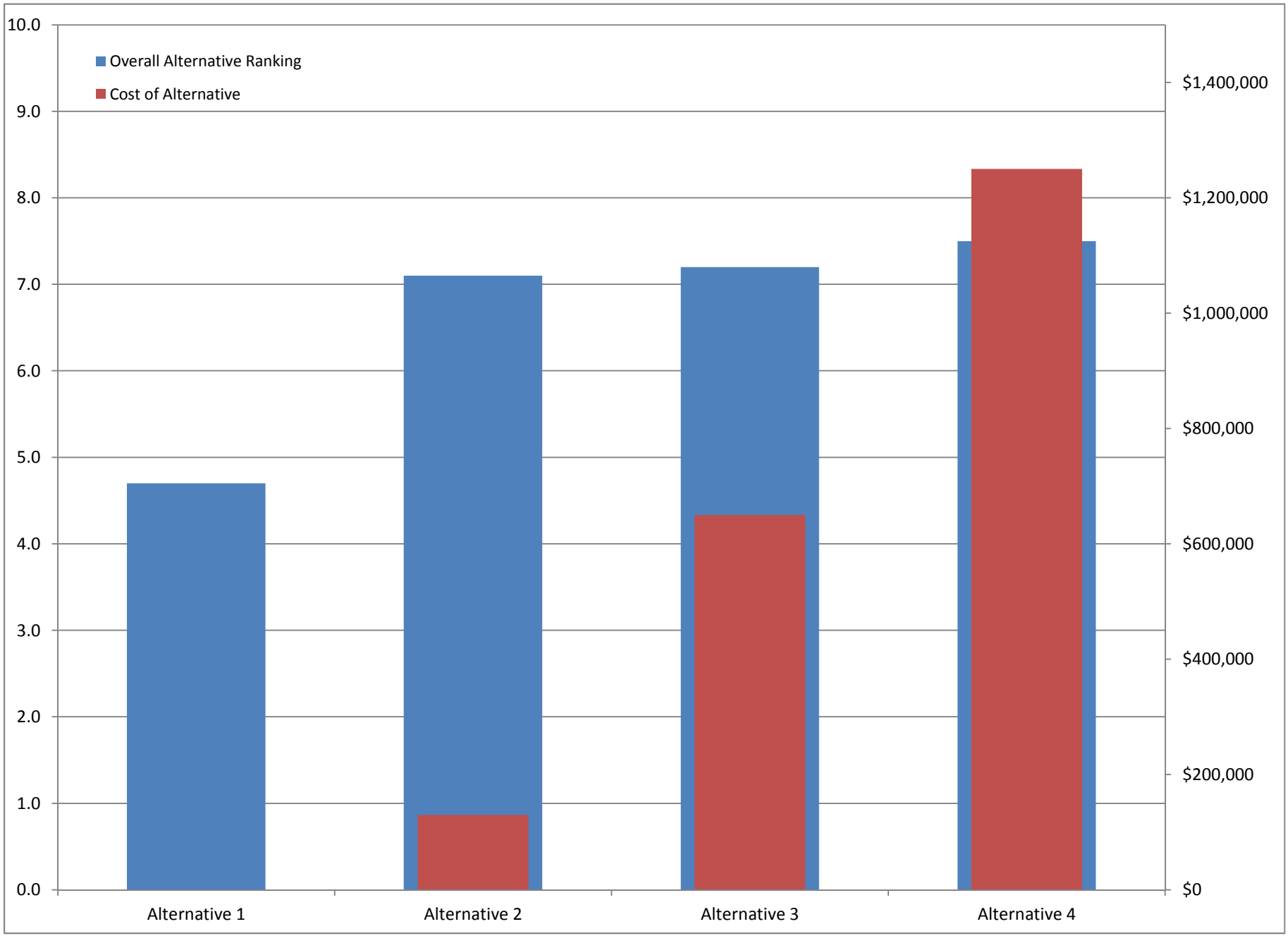


Figure 4 - Analysis of Mass Removal Rate versus Time -SVE Pilot Testing with Groundwater Extraction (DPE, Test 4)



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8/22/2013
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Figure 5 - Disproportionate Cost Analysis Summary
Olympic Water and Sewer, Inc. Site

APPENDIX A

Water Production Well Logs

Table C-1
Water Well Supply Well Construction Details
Olympic Water and Sewer, Inc. Property
Port Ludlow, Washington

SLR Designated Number	Quarter	Quarter	Section	Township	Range	Well Owner's Name (at time of installation)	Well Use	Total Depth (ft. bgs)	Casing Depth (ft. bgs)	Screen Depth (ft. bgs)	Open (ft. bgs)	StaticWater Level (ft. bgs)	Producing Formation
1	NW	SE	8	28N	1E	Blaine Shaffer	Domestic	208	0-203	203-208	NA	108	Sand and Gravel
2	SW	SE	8	28N	1E	Pope & Talbot Development, Inc.	Domestic	245	0-214; 224-240	214-224; 240-245	-	69.5	Sand and Gravel
3	SE	NE	8	28N	1E	Pope & Talbot Development, Inc.	Domestic	257	241-257	0-241	-	144.5	Sand and Gravel
4	SE	SW	8	28N	1E	Pope & Talbot Development, Inc.	Domestic	546	0-315.5; 329.7-361.3	315.5-329.7; 361.3-377.1	-	158.9	Sand and Gravel; Pebble Conglomerate
5	NW	SE	8	28N	1E	Richard Werner	Domestic	157	0-157	None	157	118	Gravel
6	NW	SE	8	28N	1E	Ross Witter	Domestic	176	0-176	None	176	136	Sand and Gravel
7	NW	SE	8	28N	1E	Ross Witter	Domestic	178	0-178	None	178	133	Sand and Gravel
8	NE	SW	8	28N	1E	Ruth Altis	Domestic	211.5	0-211.5	None	211.5	191	Sandy Clay and Gravel
9	NE	SW	8	28N	1E	Chris Baschab	Domestic	276	0-270	270-276	-	226.5	Sand and Gravel
10	NE	SW	8	28N	1E	Frank Woodruff	Domestic	193	0-193	None	193	114	Gravel
11	S 1/2	NE	8	28N	1E	R.T. Moran	Domestic	290	0-285	285-290	-	201	Sand and Gravel
12	NW	SE	8	28N	1E	John Werner	Domestic	205	NA	NA	NA	142.65	NA

Notes:
The well construction details in this table are based on Washington Department of Ecology or Olympic Water & Sewer, Inc. records.
NA= Information not available.

File original and first copy with Department of Ecology

Second Copy - Owner's Copy
Third Copy - Driller's Copy 176868

WATER WELL REPORT

STATE OF WASHINGTON

(1)

Start Card No. WE03667
UNIQUE WELL I.D. # AGS283
Water Rights Permit No.

(1) OWNER: Name: BLAINE SHAFFER **Address:** 425 SHINE RD., PORT LUDLOW, WA 98365

(2) LOCATION OF WELL: County: JEFFERSON NW 1/4 of the SE 1/4, Sec. 8, Twnsp 28 N, R. 1 E W.M.

(2a)STREET ADDRESS OF WELL (or nearest address 804 WALKER WAY, PORT LUDLOW, WA 98365

(3) PROPOSED USE: ☒ Domestic ☐ Test well ☐ Irrigation ☐ Municipal ☐ Industrial ☐ Dewater ☐ Other

(4) TYPE OF WORK: Owner's number of well(if more than one): 1
☐ Abandoned ☒ New well **Method:** ☐ Dug ☐ Bored ☐ Deepened ☒ Cable ☐ Driven ☐ Reconditioned ☐ Rotary ☐ Jetted

(5) DIMENSIONS: Diameter of well: 6 inches
Drilled 208 feet Depth of completed well 208 feet

(6) CONSTRUCTION DETAILS:
Casing Installed: 6 in. diam. from 0 ft. to 203 ft.
☒ Welded in. diam. from ft. to ft.
☐ Liner installed in. diam. from ft. to ft.
☐ Threaded in. diam. from ft. to ft.

Perforations: Were perforations made?: ☐ Yes
Perforator type:
Size of perforation: in. by: in.
Perforations from: ft. to ft.
Perforations from: ft. to ft.

Screens: ☒ Screens installed
Manufacturer's name: Johnson
Type: Telescoping
Diam. 6 in. slot size .016 from 203 ft. to 208 ft.
Diam. in. slot size from ft. to ft.

Gravel: ☐ Yes Size of gravel: in.
Gravel Placed from: ft. to ft.

Surface seal: ☒ Yes To what depth?: 18 ft.
Material used in seal: Bentonite
Did any strata contain unusable water ☐ Yes
Type of water: Depth of strata: ft.
Method of sealing strata:

(7) PUMP: Manufacturer's name: Goulds
Type: Submersible HP: 1

(8) WATER LEVELS Land-surface elevation above mean sea-level: 310 ft.
Static level: 108 ft. below top of well Date: 6/21/2005
Artestian pressure: PSI Date:
Artesian water is controlled by:

(9) WELL TESTS Drawdown is amount water level is lowered below static level.
Was a pump test made? ☒ Yes, by: Don Lofall
Yield: 15 GPM with 15 ft. drawdown after 1.5 hrs
Yield: GPM with ft. drawdown after hrs

Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)

Time	Water level	Time	Water level	Time	Water level
10 min.	108'				

Date of test: 6/21/2005
Bailer test: 20 GPM with 28 ft. drawdown after hrs.
Air test: GPM with stem set at ft. for hrs.
Artesian flow: GPM Date:
Temp. of water: deg. Was a chemical analysis made? ☒ Yes

(10) WELL LOG or ABANDONMENT PROCEDURE DESCRIPTION

Formation: Describe by color, character, size of material and structure, and show thickness of aquifers and the kind and nature of the material in each stratum penetrated, with at least on entry for each change of formation.

MATERIAL	FROM	TO
BROWN HARDPAN	0'	67'
BROWN SAND & GRAVEL	67'	102'
GRAY HARDPAN	102'	108'
BROWN CLAY	108'	125'
BLUE CLAY	125'	144'
BROWN CLAY	144'	189'
GRAY SAND W/B	189'	192'
BROWN CLAY	192'	199'
GRAY SAND & GRAVEL W/B	199'	?

RECEIVED
AUG 05 2005
DEPT OF ECOLOGY

Work started: 6/13/2005 Work completed: 6/20/2005

WELL CONSTRUCTOR CERTIFICATION:
I constructed and / or accept responsibility for construction of this well, and to the compliance with all Washington well construction standards. Materials used and the information reported above are true to my best knowledge and belief.

Contractor: LOFALL WELL DRILLING

Address: 180 NW Lofall Rd, Poulsbo, WA 98370

Signed: Raymond L Bourg (Well Driller) License # 1463

Contractor's Registration No: LOFALWD124C5 Date: 7/12/2005

(2)

STATE OF WASHINGTON
DEPARTMENT OF CONSERVATION
DIVISION OF WATER RESOURCES

WELL SCHEDULE No. 28/1E-8Q1

Date 8-21, 1975

Record by A. Williamson

Source

1. Location: State of WASHINGTON
   County Jefferson
   Area
   Map
   SW¼SE¼ sec. 8 T. 28 N., R. 1 (E.) W.

DIAGRAM OF SECTION

Details

#2

2. Owner or Tenant: Port Ludlow Devel. (His No.)
   Address Popt. Talbot
3. Driller Address
4. Land-surface datum: 300 ft. above below msl
   Topography
5. Type: Dug (Drilled) Driven Depth: Rept. feet
   Bored Jetted Meas. feet
   Date , 19
6. Casing: Diam. 8" to in. ft. Type
   Depth ft. Finish
7. Chief aquifer(s) from ft. to ft.
8. Water level: Rept. Meas. 295 ft. 7-21, 1975 above below L.S.
   69.72 which is 5 ft. above below datum
9. Pump: Type Sub-1 Capacity Size gal. min.
   Driven by 20 horsepower
10. Yield: Flow gal. min. Pump 160 gal. min. Meas. (Rept.) Est.
    Drawdown 42.5 ft. after hours pumping gal. min.
    Adequacy, permanence
11. Use: Dom. Stock. PS. Ind. Irr. Obs.
12. Quality: Sample No. , 19 Temp. °F.
    Taste, color, hardness, sanitation, etc.
13. Other data: Log Water levels Draft Pump test Analyses

Turn up

POPE AND TALBOT DEVELOPMENT INC.

PORT LUDLOW REGION

(2)

Well Data Summary

REFERENCE NO. 10

LOCATION: T 28 R 1E Sec. 8 1/4 1/4 KQ | B VER. CODE

LAND SURFACE ELEVATION 300 | B VER. CODE DEPTH 245 DATE DRILLED 1968

WELL OWNER: POPE TALBOT DEVELOPMENT, INC.

OWNER'S DESIGNATION (WELL 2, N) USE

INFORMATION SOURCE R+N 01-82 DRILLING METHOD CABLE

DRILLED BY STOICAN CASING SIZE (S) 10 Sec.

COMPLETION MODE SCREEN COMPLETION ZONE (S) 214-224 240-245

YIELD 15.8 | A VER. CODE SPECIFIC CAPACITY 3.0 | A VER. CODE

SWL 67.2 | B VER. CODE DATE 11/1968

AQUIFER TRANSMISSIVITY 15,000 | B VER.CODE

STORAGE COEFFICIENT | VER.CODE

1/4 1/4 KQ

OTHER WATER BEARING ZONES PENETRATED

MAJOR AQUICLUDES PENETRATED

POST CONSTRUCTION SWL MEASUREMENTS WITH DATES 67.0 | B VER. CODE 11/71

69.2 | B VER. CODE 8/21/75 | VER. CODE | VER. CODE

DETAILED SUPPLEMENTARY FILES

PUMP TEST DATA FILE

GEOLOGIC LOG SEE BACK

WATER CHEMISTRY

REMARKS 11/71 Q/s = 4.0 @ 1 HRS AND 160 gpm.

11/71 TEMP 49½, pH = 7.4, HARD = 70, Fe = 0.3, H_2S = SLIGHT.

Mn = .16

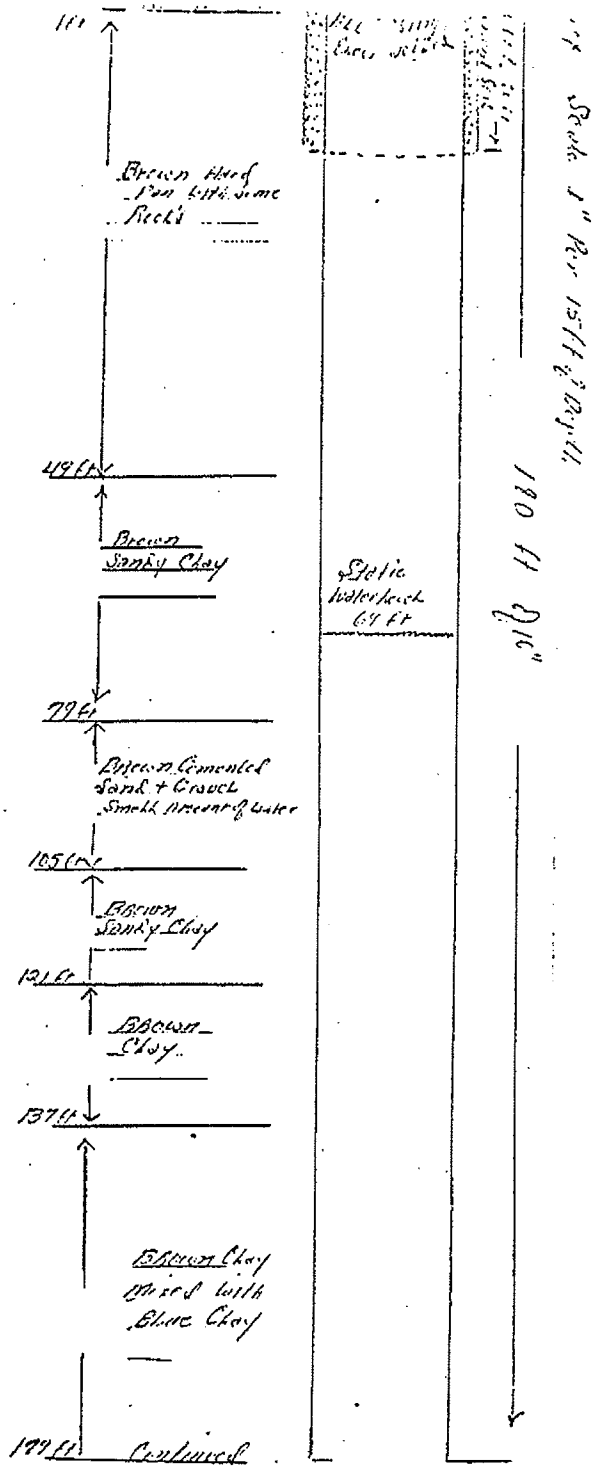
781 Walker Way

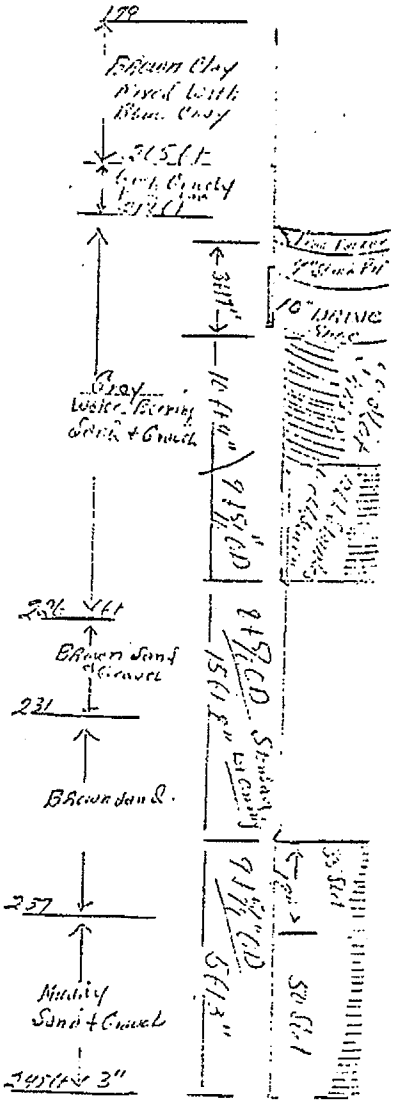
☐ REVIEW

☐ FIELD SCHEDULE

RECORD BY. MCS

ROBINSON & NOBLE, INC.





Total Depth Top of Gravel
Total Depth Top of Gravel
Date Completed May
Legend & Screen

WELL #2

③

Appl. 10445
Per. 9874

STATE OF WASHINGTON
DEPARTMENT OF CONSERVATION
DIVISION OF WATER RESOURCES

WELL LOG

Record by: Driller

Source: Driller's record

Location: State of WASHINGTON

County: Jefferson

Area:

Map:

NW¼ SE¼ NE¼ sec. 8 T. 28 N., R. 1 E.

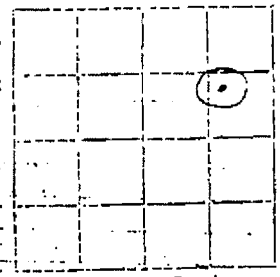


Diagram of Section

File number

Drilling Co. L.R. Gaudio

Address: Tacoma, Washington

Method of Drilling: .... Date: .... 19....

Owner: Pope & Talbot Development Inc.

Address: 113 Dexter Ave. MN Seattle, WA 98109

Land surface, datum .... ft. above / below

SWL: 144.5 Date: Nov. 18, 1968 Dims: 8" x 257'

CORRELATION	MATERIAL	From (feet)	To (feet)
	(Transcribe driller's terminology literally but paraphrase as necessary, in parentheses. If material water-bearing, so state and record static level if reported. Give depths in feet below land-surface datum unless otherwise indicated. Correlate with stratigraphic column, if feasible. Following log of materials, list all casings, perforations, screens, etc.)		
	Community domestic supply		
	hardpan	0	34
	clay, sand, gravel	34	39
	hardpan	39	48
	clay, sand	48	57
	hardpan	57	80
	sand, gravel, some clay binder		
	small amount of water 80-82	80	128
	clay, silt & sandy wet peat	128	142
	clay, silt	142	162
	clay, gravel some sand	162	186
	clay, some gravel & peat	186	214
	sand, gravel & water	214	223
	sand, some gravel, clay layer	223	235
	sand, gravel, cemented layer	235	245
	water		

Turn up

Sheet .... of .... sheets

3

WELL LOG.—Continued No...../.....

Correlation	Material	From (feet)	To (feet)
	Depth forward	———	
	sand, gravel water	245	255
	clay, blue grey	255	257
	Casing: 8" from 0' to 241'		
	Screen: cook strainless		
	8" slot size 10 from 241' to 246'		
	8" slot size 80 from 246' to 257'		
	Surface Seal: concrete 1'		
	Pump test: 88 gpm with 39' DD after 1 hrs		
	Pump: Gould, submersible 20 HP		

S. F. No. 7449—OS—12-65.

PORT LUDLOW REGION

(3)

Well Data Summary

REFERENCE NO. 9

LOCATION: T 28 R 1E Sec. 8 1/4 1/4 H1 | B VER. CODE

LAND SURFACE ELEVATION 380 | B VER. CODE DEPTH 257 DATE DRILLED 1968

WELL OWNER: POPE AND TALBOT DEVELOPMENT INC

OWNER'S DESIGNATION WELL 3, N USE

INFORMATION SOURCE R+N 01-82 DRILLING METHOD CABLE

DRILLED BY GAUDIO CASING SIZE (S) 8 Sec.

COMPLETION MODE SCREEN COMPLETION ZONE (S) 241-257

YIELD 88 | A VER. CODE SPECIFIC CAPACITY 2.3 | A VER. CODE

SWL 144.5 | B VER. CODE DATE 11/18/68

AQUIFER TRANSMISSIVITY 6000 | B VER.CODE 11/1971

STORAGE COEFFICIENT | VER.CODE

1/4 1/4 H

OTHER WATER BEARING ZONES PENETRATED

MAJOR AQUICLUDES PENETRATED

POST CONSTRUCTION SWL MEASUREMENTS WITH DATES 152 | B VER. CODE 11/71

156.5 | B VER. CODE 8/21/75 | VER. CODE | VER. CODE

DETAILED SUPPLEMENTARY FILES

PUMP TEST DATA FILE R+N FILE

GEOLOGIC LOG SEE BACK

WATER CHEMISTRY TEMP = 51°F, pH = 7.5, HARD = 102, Cl = 6, Fe = 0.4, H_2S ODOR STRONG

REMARKS 11/71 Q/s = 2.0 @ 107 gpm @ 1 HR.

11/71 Fe = 0.1, H_2S = SLIGHT, Mn = .13

11/68 Cl = 6

Talbot Way

☐ REVIEW

☐ FIELD SCHEDULE

RECORD BY: MBS

ROBINSON & NOBLE, INC.

WELL No. 3 PORT LUDLOW

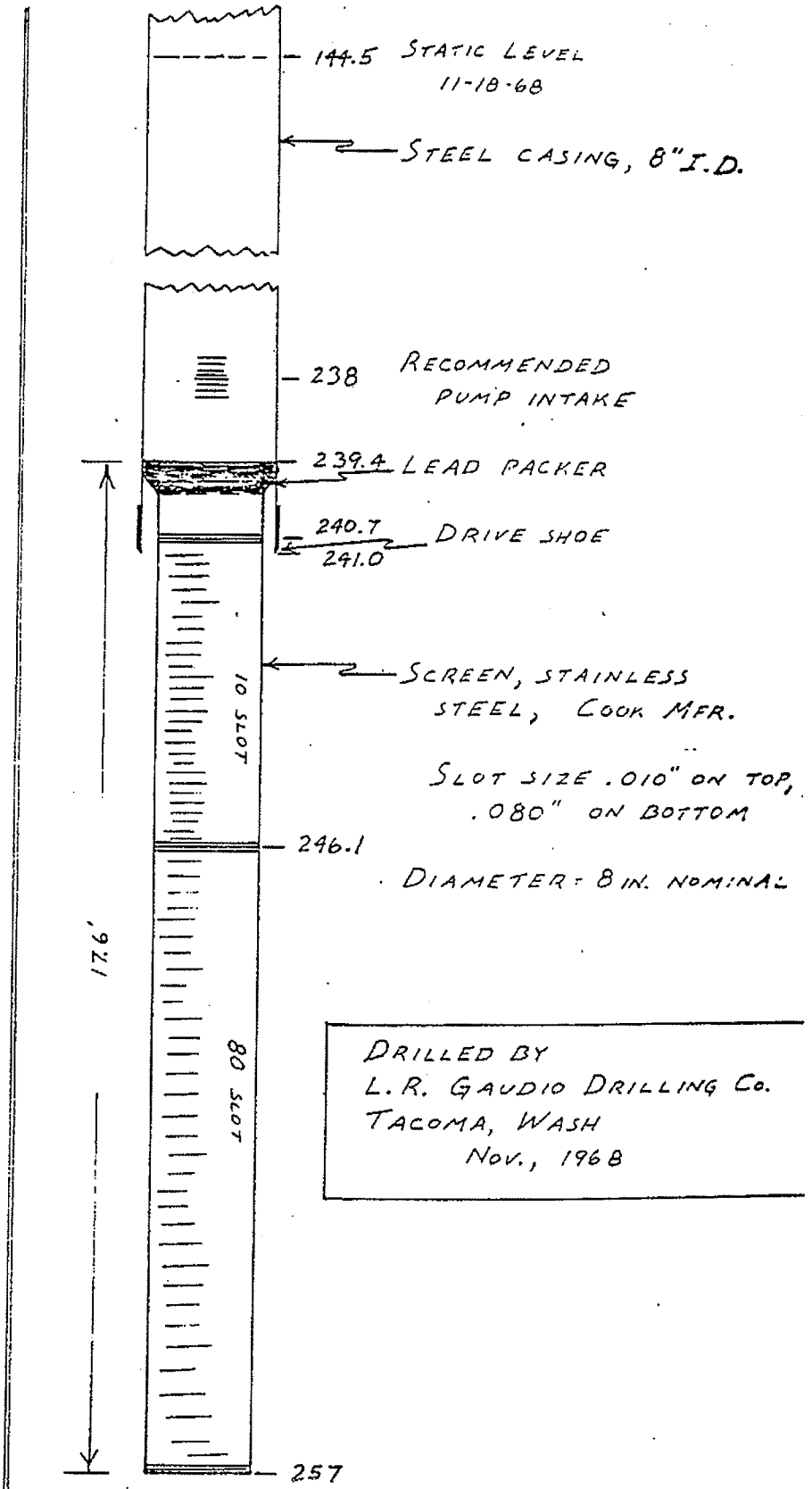
3

DRILLER'S LOG 1"=30'

DEPTHS ARE FEET BELOW LAND SURFACE

0	HARDPAN
34	CLAY, SAND, GRAVEL
39	HARDPAN
48	CLAY, SAND
57	HARDPAN
80	SAND, GRAVEL, SOME CLAY BINDER. SMALL AMT. WATER NOTED 80-82
128	CLAY, SILTY & SANDY PEATY 138-142
142	CLAY, SILTY, BROWN-GREEN
162	CLAY, GRAY - SOME SAND
186	CLAY, SOME GRAVEL & PEAT. BROWN-GREEN
214	SAND & GRAVEL - WATER
223	SAND, SOME GRAVEL, CLAY LAYERS
235	SAND, GRAVEL, WATER - CEMENTED LAYERS
245	SAND, GRAVEL, WATER
255	
257	CLAY, BLUE-GRAY

CONSTRUCTION DETAILS 1"=3'



DRILLED BY
L. R. GAUDIO DRILLING Co.
TACOMA, WASH
NOV., 1968

POPE & TALBOT, INC
SEATTLE. WASH.

ROBINSON, ROBERTS, & ASSOC.
GROUND WATER GEOLOGISTS
TACOMA WASHINGTON

NOV. 21, 1968
J. B. Noble

POPE AND TALBOT DEVELOPMENT INC.
PORT LUDLOW REGION

4

Well Data Summary

REFERENCE NO. 8

LOCATION: T 28 R 1E Sec. 8 1/4 1/4 P VER. CODE B

LAND SURFACE ELEVATION 340 TOPO VER. CODE O DEPTH 546 DATE DRILLED 1980

WELL OWNER: POPE AND TALBOT DEVELOPMENT, INC.

OWNER'S DESIGNATION WELL 4N USE

INFORMATION SOURCE R+N 79-81 DRILLING METHOD CABLE

DRILLED BY STORY + ARMSTRONG CASING SIZE (S) 12 X 315.6 Sec. 8

COMPLETION MODE SCREEN COMPLETION ZONE (S) 315.6 - 329.7 100 + 80 SLOT
361.3 - 377.1 10 + 30 SLOT

YIELD 94 VER. CODE A SPECIFIC CAPACITY 1.7 VER. CODE A

SWL 158.9 REC. VER. CODE B DATE 4/28/80

AQUIFER TRANSMISSIVITY 3030 + 4280 VER. CODE A

STORAGE COEFFICIENT VER. CODE

1/4 1/4 P

OTHER WATER BEARING ZONES PENETRATED

MAJOR AQUICLUDES PENETRATED

POST CONSTRUCTION SWL MEASUREMENTS WITH DATES 154 VER. CODE A 5/8/80

VER. CODE VER. CODE VER. CODE

DETAILED SUPPLEMENTARY FILES

PUMP TEST DATA FILE R+N 79-81 W/ RECOVERY HYDROGRAPH

GEOLOGIC LOG SEE BACK

WATER CHEMISTRY R-N 79-81, OK

REMARKS Walden Lane (westerly "extension" of Walker Way

☐ REVIEW

☐ FIELD SCHEDULE

RECORD BY: MCS

ROBINSON & NOBLE, INC.

epartment of Ecology
econd Copy — Owner's Copy
ird Copy — Driller's Copy

WATER WELL REPORT
STATE OF WASHINGTON

Application No. .....
Permit No. ....

(4)

1) **OWNER:** Name Pope & Talbot Development, Inc. Address P.O. Box 75, Port Ludlow, WA 98365

LOCATION OF WELL: County Jefferson SE ¼ SW ¼ Sec. 8 T. 28 N., R. 1E W.M.

ng and distance from section or subdivision corner

3) **PROPOSED USE:** Domestic ☐ Industrial ☐ Municipal ☒
Irrigation ☐ Test Well ☐ Other ☐

4) **TYPE OF WORK:** Owner's number of well (if more than one).... 4N
New well ☒ Method: Dug ☐ Bored ☐
Deepened ☐ Cable ☒ Driven ☐
Reconditioned ☐ Rotary ☐ Jetted ☐

5) **DIMENSIONS:** Diameter of well 12 inches.
Drilled 546 ft. Depth of completed well 388½ ft.

6) **CONSTRUCTION DETAILS:**

Casing installed: 12 " Diam. from 0 ft. to 315½ ft.
Threaded ☐ 10 " Diam. from 329½ ft. to 361 ft.
Welded ☒ 10 " Diam. from 378 ft. to 388½ ft.

Perforations: Yes ☐ No ☒
Type of perforator used .....
SIZE of perforations ..... in. by ..... in.
..... perforations from ..... ft. to ..... ft.
..... perforations from ..... ft. to ..... ft.
..... perforations from ..... ft. to ..... ft.

Screens: Yes ☒ No ☐
Manufacturer's Name UOP Johnson
Type Pipe Size Model No. 304SS
Diam. 10" Slot size .080 from 315 ft. to 329½ ft.
Diam. 10" Slot size .080 from 361 ft. to 378 ft.

Gravel packed: Yes ☐ No ☒ Size of gravel: .....
Gravel placed from ..... ft. to ..... ft.

Surface seal: Yes ☒ No ☐ To what depth? 20 ft.
Material used in seal cement
Did any strata contain unusable water? Yes ☐ No ☒
Type of water? ..... Depth of strata .....
Method of sealing strata off .....

(7) **PUMP:** Manufacturer's Name .....
Type: ..... H.P. .....

(8) **WATER LEVELS:** Land-surface elevation above mean sea level.... 372 ft.
Static level 158.9 ft. below top of well Date 4/28/80
Artesian pressure ..... lbs. per square inch Date .....
Artesian water is controlled by ..... (Cap, valve, etc.)

(9) **WELL TESTS:** Drawdown is amount water level is lowered below static level
Was a pump test made? Yes ☒ No ☐ If yes, by whom? Robinson, Noble, Carr
Yield: 94 gal./min. with 50.6 ft. drawdown after 17.67 hrs.
" " " "
" " " "

Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)

Time	Water Level	Time	Water Level	Time	Water Level
10 min.	172.6	50	168.35	155	164.8
20 "	170.95	80	166.85	220	163.5
40 "	169.8	100	166.1		

Date of test 4/28/80 - 4/29/80
...er test ..... gal./min. with ..... ft. drawdown after ..... hrs.
Artesian flow ..... g.p.m. Date .....
Temperature of water ..... Was a chemical analysis made? Yes ☒ No ☐

(10) **WELL LOG:**

Formation: *Describe by color, character, size of material and structure, and show thickness of aquifers and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of formation.*

MATERIAL	FROM	TO
brown to gray till	0	52
brown, sandy, pebbly silt	52	131
sand and gravel	131	151
brown silty sand and gravel	151	157
gray sandy silt	157	171
gray pebbly silt	171	267
gray poorly sorted silty sand and gravel	267	269
gray pebbly silt	269	314
brown, poorly sorted medium to coarse sand and gravel	314	332
gray pebbly silt	332	360
gray sand and gravel	360	366
gray silty sand with some gravel	366	380
gray clayey silt	380	536
weathered pebble conglomerate	536	544
gray pebble conglomerate (bedrock)	544	546

RECEIVED
JUN 09 1980
DEPARTMENT OF ECOLOGY
SOUTHWEST REGIONAL OFFICE JUN 6 1980
DEPT. OF ECOLOGY

Water Rights 6/27/80

Work started 3/18 19 80 Completed 4/29 1980

WELL DRILLER'S STATEMENT:

This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

NAME Story/Armstrong Drilling
(Person, firm, or corporation) (Type or print)
Address 10711-10715 66th Ave. E.
Puyallup, WA 98371

[Signed] .....
(Well Driller)

License No. 0012 Date MAY 30 1980

(USE ADDITIONAL SHEETS IF NECESSARY)

S. F. No. 7356—OS—(Rev. 4-71).

File Original and First Copy with Department of Ecology
Second Copy — Owner's Copy
Third Copy — Driller's Copy

(5)

WATER WELL REPORT

STATE OF WASHINGTON

Application No. .....

Permit No. .....

(1) OWNER: Name Richard Werner Address 660 Werner Rd Port Ludlow

(2) LOCATION OF WELL: County Jefferson — NW¼ SE ¼ Sec 8 T 28 N., R 1 E W.M.

Bearing and distance from section or subdivision corner

(3) PROPOSED USE: Domestic ☑ Industrial ☐ Municipal ☐
Irrigation ☐ Test Well ☐ Other ☐

(4) TYPE OF WORK: Owner's number of well (if more than one) ....
New well ☑ Method: Dug ☐ Bored ☐
Deepened ☐ Cable ☑ Driven ☐
Reconditioned ☐ Rotary ☐ Jetted ☐

(5) DIMENSIONS: Diameter of well 6 inches.
Drilled 157 ft. Depth of completed well 157 ft.

(6) CONSTRUCTION DETAILS:
Casing installed: 6 " Diam. from 0 ft. to 157 ft.
Threaded ☐ ..... " Diam. from ..... ft. to ..... ft.
Welded ☑ ..... " Diam. from ..... ft. to ..... ft.

Perforations: Yes ☐ No ☑
Type of perforator used .....
SIZE of perforations ..... in. by ..... in.
..... perforations from ..... ft. to ..... ft.
..... perforations from ..... ft. to ..... ft.
..... perforations from ..... ft. to ..... ft.

Screens: Yes ☐ No ☑
Manufacturer's Name .....
Type ..... Model No .....
Diam. ..... Slot size ..... from ..... ft. to ..... ft.
Diam. ..... Slot size ..... from ..... ft. to ..... ft.

Gravel packed: Yes ☐ No ☑ Size of gravel: .....
Gravel placed from ..... ft. to ..... ft.

Surface seal: Yes ☑ No ☐ To what depth? 20 ft.
Material used in seal Bent Clay & Cement
Did any strata contain unusable water? Yes ☐ No ☑
Type of water? ..... Depth of strata .....
Method of sealing strata off .....

(7) PUMP: Manufacturer's Name .....
Type: ..... H.P. .....

(8) WATER LEVELS: Land-surface elevation above mean sea level 430 ft.
Static level 118 ft. below top of well Date 2-21-85
Artesian pressure ..... lbs. per square inch Date .....
Artesian water is controlled by ..... (Cap, valve, etc.)

(9) WELL TESTS: Drawdown is amount water level is lowered below static level
Was a pump test made? Yes ☐ No ☐ If yes, by whom? .....
Yield: ..... gal./min. with ..... ft. drawdown after ..... hrs.
" " " "
" " " "

Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)

Time	Water Level	Time	Water Level	Time	Water Level

Date of test .....
Bailer test 12 gal./min. with 10 ft. drawdown after 1½ hrs.
Artesian flow ..... g.p.m. Date .....
Temperature of water ..... Was a chemical analysis made? Yes ☐ No ☑

(10) WELL LOG:

Formation: *Describe by color, character, size of material and structure, and show thickness of aquifers and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of formation.*

MATERIAL	FROM	TO
Brn sandy Clay	0	8
Brn sandy hardpan	8	20
Brn sandy Clay	20	25
Gray sandy Clay	25	35
Gray sandy Clay & gravel HP.	35	45
Gray sandy Clay	45	55
Blue sandy Clay	55	100
gray sandy Clay	100	135
Wet gray sandy Clay	135	155
Clean sand & gravel	155	157

RECEIVED
MAR 26 1985
DEPARTMENT OF ECOLOGY

Work started 2-13 19 85 Completed 2-21 19 85

WELL DRILLER'S STATEMENT:

This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

NAME Richard Bekkevar (Person, firm, or corporation) (Type or print)

Address 2722 Hwy 101 E Sequim Wa.

[Signed] Richard Bekkevar (Well Driller)

License No. 779 Date 2-21 19 85

(USE ADDITIONAL SHEETS IF NECESSARY)

S. F. No. 7356—OS—(Rev. 4-71).

File Original and First Copy with Department of Ecology
Second Copy—Owner's Copy
Third Copy—Driller's Copy

WATER WELL REPORT

STATE OF WASHINGTON

Start Card No. 021985

Water Right Permit No. _____

(1) **OWNER:** Name Ross Witter Address 171 Embody RD. Port Ludlow, WA.

(2) **LOCATION OF WELL:** County Jefferson NW ¼ SE ¼ Sec. 6 T. 28 N., R. 1E W.M.

(2a) **STREET ADDDRESS OF WELL** (or nearest address) _____

(3) **PROPOSED USE:** ☑ Domestic ☐ Industrial ☐ Municipal ☐ ☐ Irrigation ☐ Test Well ☐ Other ☐ ☐ DeWater

(4) **TYPE OF WORK:** Owner's number of well (if more than one) _____

Abandoned ☐ New well ☑ Method: Dug ☐ Bored ☐ Deepened ☐ Cable ☑ Driven ☐ Reconditioned ☐ Rotary ☐ Jetted ☐

(5) **DIMENSIONS:** Diameter of well Six inches. Drilled 176 feet. Depth of completed well 176 ft.

(6) **CONSTRUCTION DETAILS:**

Casing Installed: Six " Diam. from +1 ft. to 176 ft.
Welded ☑ _____ " Diam. from _____ ft. to _____ ft.
Liner Installed ☐ _____ " Diam. from _____ ft. to _____ ft.
Threaded ☐

Perforations: Yes ☐ No ☑
Type of perforator used _____
SIZE of perforations _____ in. by _____ in.
_____ perforations from _____ ft. to _____ ft.
_____ perforations from _____ ft. to _____ ft.
_____ perforations from _____ ft. to _____ ft.

Screens: Yes ☐ No ☑
Manufacturer's Name _____
Type _____ Model No. _____
Diam. _____ Slot size _____ from _____ ft. to _____ ft.
Diam. _____ Slot size _____ from _____ ft. to _____ ft.

Gravel packed: Yes ☐ No ☐ Size of gravel _____
Gravel placed from _____ ft. to _____ ft.

Surface seal: Yes ☑ No ☐ To what depth? 18 ft.
Material used in seal Bentonite + clay DRillings
Did any strata contain unusable water? Yes ☐ No ☑
Type of water? _____ Depth of strata _____
Method of sealing strata off _____

(7) **PUMP:** Manufacturer's Name _____
Type: _____ H.P. _____

(8) **WATER LEVELS:** Land-surface elevation above mean sea level 300+ ft.
Static level 136 ft. below top of well Date 1-16-90
Artesian pressure _____ lbs. per square inch Date _____
Artesian water is controlled by _____ (Cap, valve, etc.)

(9) **WELL TESTS:** Drawdown is amount water level is lowered below static level
Was a pump test made? Yes ☐ No ☑ If yes, by whom? _____
Yield: _____ gal./min. with _____ ft. drawdown after _____ hrs.
" " " "
" " " "

Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)

Time	Water Level	Time	Water Level	Time	Water Level

Date of test _____
Bailer test 15 gal./min. with 15 ft. drawdown after 3½ hrs.
Airtest _____ gal./min. with stem set at _____ ft. for _____ hrs.
Artesian flow _____ g.p.m. Date _____
Temperature of water 49 Was a chemical analysis made? Yes ☐ No ☑

(10) **WELL LOG or ABANDONMENT PROCEDURE DESCRIPTION**

Formation: Describe by color, character, size of material and structure, and show thickness of aquifers and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of information.

MATERIAL	FROM	TO
clay, Sandy, GRAvely	0	10
Hardpan	10	30
clay, Sandy, GRAvely	30	60
clay, Sandy	60	130
clay, Sandy, GRAvely	130	165
Sand GRAvel + H2O	165	176

Work started 1-5 19 90 Completed 1-16 19 90

WELL CONSTRUCTOR CERTIFICATION:

I constructed and/or accept responsibility for construction of this well, and its compliance with all Washington well construction standards. Materials used and the information reported above are true to my best knowledge and belief.

NAME Maberry Well DRilling (PERSON, FIRM, OR CORPORATION) (TYPE OR PRINT)

Address Po Box 255 Quilcene, WA. 98376

(Signed) William Dwight Maberry (WELL DRILLER) License No. 1217

Contractor's Registration No. MABERWD121PJ Date 1-18 19 90

(USE ADDITIONAL SHEETS IF NECESSARY)

File Original and First Copy with Department of Ecology
Second Copy — Owner's Copy
Third Copy — Driller's Copy

(7)

WATER WELL REPORT

STATE OF WASHINGTON

Application No .....

Permit No. .....

(1) OWNER: Name Ross Witter Address Rt 1 Box 342 Chimacum 9832

(2) LOCATION OF WELL: County Jefferson NW ¼ SE ¼ Sec. 8 T. 28 N., R. 1 E W.M.

Bearing and distance from section or subdivision corner

(3) PROPOSED USE: Domestic ☑ Industrial ☐ Municipal ☐
Irrigation ☐ Test Well ☐ Other ☐

(4) TYPE OF WORK: Owner's number of well (if more than one) ....
New well ☑ Method: Dug ☐ Bored ☐
Deepened ☐ Cable ☑ Driven ☐
Reconditioned ☐ Rotary ☐ Jetted ☐

(5) DIMENSIONS: Diameter of well 6 inches.
Drilled 178 ft. Depth of completed well 178 ft.

(6) CONSTRUCTION DETAILS:
Casing installed: 6 " Diam. from 0 ft. to 178 ft.
Threaded ☐ ..." Diam. from ... ft. to ... ft.
Welded ☑ ..." Diam. from ... ft. to ... ft.

Perforations: Yes ☐ No ☑
Type of perforator used ....
SIZE of perforations ... in. by ... in.
... perforations from ... ft. to ... ft.
... perforations from ... ft. to ... ft.
... perforations from ... ft. to ... ft.

Screens: Yes ☐ No ☑
Manufacturer's Name ....
Type ... Model No ....
Diam. ... Slot size ... from ... ft. to ... ft.
Diam. ... Slot size ... from ... ft. to ... ft.

Gravel packed: Yes ☐ No ☑ Size of gravel: ....
Gravel placed from ... ft. to ... ft.

Surface seal: Yes ☑ No ☐ To what depth? 20 ft.
Material used in seal Puddle Clay Bentonite
Did any strata contain unusable water? Yes ☐ No ☑
Type of water? ... Depth of strata ....
Method of sealing strata off ....

(7) PUMP: Manufacturer's Name ....
Type: ... H.P. ....

(8) WATER LEVELS: Land-surface elevation above mean sea level .... 430 ft.
Static level 133 ft. below top of well Date 1-29-85
Artesian pressure ... lbs. per square inch Date ....
Artesian water is controlled by ... (Cap, valve, etc.)

(9) WELL TESTS: Drawdown is amount water level is lowered below static level
Was a pump test made? Yes ☐ No ☐ If yes, by whom? ....
Yield: ... gal./min. with ... ft. drawdown after ... hrs.
" " " "
" " " "

Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)

Time	Water Level	Time	Water Level	Time	Water Level

Date of test 1-29-85
Baller test 24 gal./min. with 3 ft. drawdown after 1 hrs.
Artesian flow ... g.p.m. Date ....
Temperature of water .... Was a chemical analysis made? Yes ☐ No ☑

(10) WELL LOG:

Formation: *Describe by color, character, size of material and structure, and show thickness of aquifers and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of formation.*

MATERIAL	FROM	TO
Brn sandy Clay	0	8
gray sandy Clay hardpan	8	25
gray sandy Clay	25	33
Brn sandy Clay	33	80
gray sandy Clay	80	130
Coarse gray sand & Clay	130	135
gray gravelly hardpan	135	137
gray sandy Clay	137	150
gray hard sandy Clay	150	170
Lt B. gray sandy Clay	170	178
Clean sand & gravel	178	

RECEIVED
APR 26 P1:24
DEPT OF ECOLOGY
OLYMPIA, WASH.

Work started 1-22 19 85 Completed 1-29 19 85

WELL DRILLER'S STATEMENT:

This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

NAME Richard Bekkevar (Person, firm, or corporation) (Type or print)

Address 2722 Hwy 101 E Sequim

[Signed] Richard Bekkevar (Well Driller)

License No. 779 Date 1-29- 85

(USE ADDITIONAL SHEETS IF NECESSARY)

S. F. No. 7356—OS—(Rev. 4-71).

File Original and First Copy with Department of Ecology
Second Copy — Owner's Copy
Third Copy — Driller's Copy

8

WATER WELL REPORT

STATE OF WASHINGTON

Application No. .....

Permit No. .....

(1) OWNER: Name Ruth Attis Address Rt 1 Box 594A Pt Ludlow Wa.

(2) LOCATION OF WELL: County Jefferson S.E. ¼ N.E. ¼ S.W. ¼ Sec. 8 T. 28 N., R. 1 E. W.M.

Bearing and distance from section or subdivision corner

(3) PROPOSED USE: Domestic ☑ Industrial ☐ Municipal ☐
Irrigation ☐ Test Well ☐ Other ☐

(4) TYPE OF WORK: Owner's number of well (if more than one) .....
New well ☑ Method: Dug ☐ Bored ☐
Deepened ☐ Cable ☑ Driven ☐
Reconditioned ☐ Rotary ☐ Jetted ☐

(5) DIMENSIONS: Diameter of well 6 inches.
Drilled 211½ ft. Depth of completed well 211½ ft.

(6) CONSTRUCTION DETAILS:
Casing installed: 6 " Diam. from 0 ft. to 211½ ft.
Threaded ☐ " Diam. from ..... ft. to ..... ft.
Welded ☑ " Diam. from ..... ft. to ..... ft.

Perforations: Yes ☐ No ☑
Type of perforator used .....
SIZE of perforations ..... in. by ..... in.
..... perforations from ..... ft. to ..... ft.
..... perforations from ..... ft. to ..... ft.
..... perforations from ..... ft. to ..... ft.

Screens: Yes ☐ No ☑
Manufacturer's Name .....
Type ..... Model No. .....
Diam. ..... Slot size ..... from ..... ft. to ..... ft.
Diam. ..... Slot size ..... from ..... ft. to ..... ft.

Gravel packed: Yes ☐ No ☑ Size of gravel: .....
Gravel placed from ..... ft. to ..... ft.

Surface seal: Yes ☑ No ☐ To what depth? 20 ft.
Material used in seal Bentonite & Portland Clay
Did any strata contain unusable water? Yes ☐ No ☑
Type of water? ..... Depth of strata .....
Method of sealing strata off .....

(7) PUMP: Manufacturer's Name .....
Type: ..... H.P. .....

(8) WATER LEVELS: Land-surface elevation above mean sea level .... 480 ft.
Static level 191 ft. below top of well Date 12-6-84
Artesian pressure ..... lbs. per square inch Date .....
Artesian water is controlled by ..... (Cap, valve, etc.)

(9) WELL TESTS: Drawdown is amount water level is lowered below static level
Was a pump test made? Yes ☐ No ☐ If yes, by whom? .....
Yield: ..... gal./min. with ..... ft. drawdown after ..... hrs.
" " " "
" " " "

Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)

Time	Water Level	Time	Water Level	Time	Water Level

Date of test .....
Bailer test 3 gal./min. with 15 ft. drawdown after ½ hrs.
Artesian flow ..... g.p.m. Date 12-6-84
Temperature of water ..... Was a chemical analysis made? Yes ☐ No ☑

(10) WELL LOG:

Formation: *Describe by color, character, size of material and structure, and show thickness of aquifers and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of formation.*

MATERIAL	FROM	TO
Brn Sandy Clay	0	25
Lite gray Sandy Clay	25	40
4B Fine Brn sandy Clay 4gal	40	50
fine Brn Sandy Clay	50	105
Coarse Brn sandy Clay	105	135
Brn Sandy Clay + gravel	135	145
Brn Sandy Clay	145	158
Brn sandy fine pea	168	170
Brn sandy Clay	170	200
4B Brn sandy Clay + gravel	200	211½

RECEIVED
DEC 10 '84 10:17
DEPARTMENT OF ECOLOGY
S.W. REGIONAL OFFICE

Work started 11-21, 19 84 Completed 12-6, 19 84

WELL DRILLER'S STATEMENT:

This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

NAME Richard Bekkevar (Person, firm, or corporation) (Type or print)

Address 2722 Hwy 101 E Sequim WA

[Signed] Richard Bekkevar (Well Driller)

License No. 779 Date 12-7-, 19 84

(USE ADDITIONAL SHEETS IF NECESSARY)

S. F. No. 7356—OS—(Rev. 4-71).

WATER WELL REPORT

STATE OF WASHINGTON

START CARD NO W129124

UNIQUE WELL I D # AFC 960

WATER RIGHT PERMIT NO

107757

(1) OWNER: Name Chris Baschab Address P.O. Box 65056 Port Ludlow, Wa. 98365

(2) LOCATION OF WELL: County Jefferson NE 1/4 SW 1/4 Sect 8 T 28N R 1E WM

(2a) STREET ADDRESS OF WELL (or nearest address) 231 Coursey Lane Port Ludlow

(3) PROPOSED USE: ☒ Domestic ☐ Irrigation ☐ Other ☐ Industrial ☐ DeWater ☐ Municipal ☐ Test Well

(4) TYPE OF WORK: Owner's number of well (If more than one) 1

☒ New Well ☐ Abandoned ☐ Deepened ☐ Reconditioned

Method ☐ Dug ☐ Bored ☒ Cable ☐ Driven ☐ Rotary ☐ Jetted

(5) DIMENSIONS: Diameter of well 6" inches

Drilled 275 feet Depth of completed well 276 feet

(6) CONSTRUCTION DETAILS:

Casing installed 6" diam From 0 ft To 271-10 ft

☒ Welded 5" diam From 269-1 ft To 270-10 ft

☐ Liner ☐ Threaded ____ diam From ____ ft To ____ ft

Perforations ☐ Yes ☒ No

Type perforator used

Size of perforations ____ in by ____ in

____ perforations From ____ ft To ____ ft

____ perforations From ____ ft To ____ ft

____ perforations From ____ ft To ____ ft

Screens ☒ Yes ☐ No

Manufacture's Name Johnson

Type Stainless V-Slot Model No

Diam 5" Slot size .010 From 270-10 ft To 276 ft

Diam ____ Slot size ____ From ____ ft To ____ ft

Diam ____ Slot size ____ From ____ ft To ____ ft

Gravel packed ☐ Yes ☒ No Size of gravel

Gravel placed from ____ ft To ____ ft

Surface seal ☒ Yes ☐ No To what depth? 25 ft

Material used in seal Med Chip Bentonite

Did any strata contain unusable water? ☐ Yes ☒ No

Type of water ____ Depth of strata ____ ft

Method of sealing strata off

(7) PUMP: Manufacture's Name

Type ____ H P

(8) WATER LEVELS: Land surface elevation above sea level 430 ft

Static level 226-5 ft below top of well Date May 15, 2001

Artesian pressure ____ lbs per square inch Date

Artesian water is controled by ____ (Cap, valve, etc)

(9) WELL TEST: Drawdown is amount water level is lowered below static level

Was a pump test made? ☐ Yes ☒ No If yes, by whom?

Yield ____ gal /min with ____ ft drawdown after ____ hrs

Yield ____ gal /min with ____ ft drawdown after ____ hrs

Yield ____ gal /min with ____ ft drawdown after ____ hrs

Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)

Time	Water Level	Time	Water Level	Time	Water Level

Date of test

Bailer test 3 gal /min with 44-7 ft drawdown after 2 hrs

Airtest ____ gal /min with stem set at ____ ft for ____ hrs

Artesian flow ____ gal /min Date May 11, 2001

Temp of water ____ Was a chemical analysis made? ☐ Yes ☒ No

(10) WELL LOG or ABANDONMENT PROCEDURE DESCRIPTION

Formation Describe by color, character, size of material and structure, and show thickness of aquifers and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of information

MATERIAL	FROM	TO
Brown hard clay, gravel	0	35
Gray cemented gravel	35	45
Brown packed sand & clay	45	56
Brown very fine sand, packed, dry	56	69
Brown sandy clay	69	75
Brown silty clay	75	102
Brown very fine sand, loose, dry	102	137
Brown packed sand & small gravel	137	151
Brown tight sand, small gravel, seepage	151	162
Brown sandy clay, dry	162	177
Light gray sandy clay, firm	177	189
Brown sandy clay, firm	189	201
Blue clay	201	212
Blue sandy clay	212	217
Blue sandy firm clay, stratified, seepage	217	224
Blue sandy clay	224	230
Blue silty clay	230	246
Blue fine sand, stratified, dirty	246	250
Light brown sandy clay	250	260
Light brown sandy, gravely clay	260	266
Brown med & coarse sand, W/B	266	271
Brown med & coarse sand, pea gravel, W/B	271	275
Brown tight gravel, clay, no flow	275	
Well Yield Note Well has intermittent yields down to 3 gpm from a average yield of 10 plus gpm do to high pumping rate of Pope Resource well located aprox. 900 feet from this well.		

RECEIVED

DEC 14 2001

Washington State Department of Ecology

Worked started Mar 28, 2001 Completed May 15, 2001

WELL CONSTRUCTOR CERTIFICATION:

I constructed and/or accept responsibility for construction of this well, and its compliance with all Washington well construction standards Materials used and the information reported above are true to my best knowledge and belief

NAME Charlie's Drilling (Person, Firm, or Corporation)

Address P.O. Box 127 Port Hadlock, WA. 98339

(Signed) Charlie Shuck (Well Driller) License No. 0458

Contractor's Registration No. CHARLD*066 OO

Date May 16, 2001

File Original and First Copy with Department of Ecology
Second Copy — Owner's Copy
Third Copy — Driller's Copy

(10)

WATER WELL REPORT

STATE OF WASHINGTON

Application No. .....

Permit No. .....

(1) OWNER: Name FRANK L WOODRUFF Address 1213 S.E. WILLOW, LACEY, WN 98503

(2) LOCATION OF WELL: County THURSTON — NE ¼ SW ¼ Sec. 8 T. 18 N., R. 1 E. W.M.

Bearing and distance from section or subdivision corner 8L

(3) PROPOSED USE: Domestic [X] Industrial [ ] Municipal [ ]
Irrigation [ ] Test Well [ ] Other [ ]

(4) TYPE OF WORK: Owner's number of well (if more than one) .....
New well [X] Method: Dug [ ] Bored [ ]
Deepened [ ] Cable [ ] Driven [ ]
Reconditioned [ ] Rotary [X] Jetted [ ]

(5) DIMENSIONS: Diameter of well 6 inches.
Drilled 192 ft. Depth of completed well 192 ft.

(6) CONSTRUCTION DETAILS:

Casing installed: 6 " Diam. from +1 ft. to 192 ft.
Threaded [ ] ..... " Diam. from ..... ft. to ..... ft.
Welded [X] ..... " Diam. from ..... ft. to ..... ft.

Perforations: Yes [ ] No [X]
Type of perforator used .....
SIZE of perforations ..... in. by ..... in.
..... perforations from ..... ft. to ..... ft.
..... perforations from ..... ft. to ..... ft.
..... perforations from ..... ft. to ..... ft.

Screens: Yes [ ] No [X]
Manufacturer's Name .....
Type ..... Model No. .....
Diam. ..... Slot size ..... from ..... ft. to ..... ft.
Diam. ..... Slot size ..... from ..... ft. to ..... ft.

Gravel packed: Yes [ ] No [X] Size of gravel: .....
Gravel placed from ..... ft. to ..... ft.

Surface seal: Yes [X] No [ ] To what depth? 20 ft.
Material used in seal BENTONITE + DRILLINGS
Did any strata contain unusable water? Yes [ ] No [X]
Type of water? ..... Depth of strata .....
Method of sealing strata off .....

(7) PUMP: Manufacturer's Name .....
Type: ..... H.P. .....

(8) WATER LEVELS: Land-surface elevation above mean sea level ..... 300 ft.
Static level 114 ft. below top of well Date JAN 6-1975
Artesian pressure ..... lbs. per square inch Date .....
Artesian water is controlled by ..... (Cap, valve, etc.)

(9) WELL TESTS: Drawdown is amount water level is lowered below static level
Was a pump test made? Yes [ ] No [X] If yes, by whom? .....
Yield: ..... gal./min. with ..... ft. drawdown after ..... hrs.
" " " "
" " " "

Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)

Time	Water Level	Time	Water Level	Time	Water Level

Date of test .....
Bailer test 20 gal./min. with 0 ft. drawdown after 3 hrs.
Artesian flow ..... g.p.m. Date JAN 6-1975
Temperature of water 50 Was a chemical analysis made? Yes [ ] No [ ]

(10) WELL LOG:

Formation: *Describe by color, character, size of material and structure, and show thickness of aquifers and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of formation.*

MATERIAL	FROM	TO
Rocky H.P.	0	19
Sandy H.P.	19	50
Brown Sandy Clay	50	98
Gray Gravel H.P.	98	110
Large Extra Hard Rock	110	115
Gray Sandy Clay	115	182
Brown Sand - H2O	182	187
Fine Gravel H2O	187	192
H.P.	192	?

Work started ..... 19 ..... Completed ..... 19 .....

WELL DRILLER'S STATEMENT:

This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

NAME Hood Canal Drilling Co. (Person, firm, or corporation) (Type or print)

Address RT 2, Box 693A Quilcene Wn

[Signed] M. W. Mahaney (Well Driller)

License No. 0285 Date JAN 16, 1975

(USE ADDITIONAL SHEETS IF NECESSARY)

S. F. No. 7356—OS—(Rev. 4-71).

File Original and First Copy with Department of Ecology
Second Copy — Owner's Copy
Third Copy — Driller's Copy

WATER WELL REPORT
STATE OF WASHINGTON

Application No. .....
Permit No. .....

(1) OWNER: Name R. T. Moran Address Rt. 1, Box 604-D port Ludlow, Wa. 9

(2) LOCATION OF WELL: County Jefferson Tax Lot NE ¼ Sec 8 T. 28 N., R. 1E W.M.

Bearing and distance from section or subdivision corner

(3) PROPOSED USE: Domestic ☒ Industrial ☐ Municipal ☐
Irrigation ☐ Test Well ☐ Other ☐

(4) TYPE OF WORK: Owner's number of well (if more than one) .....
New well ☒ Method: Dug ☐ Bored ☐
Deepened ☐ Cable ☒ Driven ☐
Reconditioned ☐ Rotary ☐ Jetted ☐

(5) DIMENSIONS: Diameter of well 6 inches.
Drilled 290' 10" ft. Depth of completed well 290' 10" ft.

(6) CONSTRUCTION DETAILS:
Casing installed: 6" Diam. from 0 ft. to 288 ft.
Threaded ☐ 5" Diam. from 285 ft. to 285' 8" ft.
Welded ☒ ." Diam. from ft. to ft.

Perforations: Yes ☐ No ☒
Type of perforator used .....
SIZE of perforations ..... in. by ..... in.
..... perforations from ..... ft. to ..... ft.
..... perforations from ..... ft. to ..... ft.
..... perforations from ..... ft. to ..... ft.

Screens: Yes ☒ No ☐
Manufacturer's Name Johnson
Type Stainless Steel Model No.
Diam. 5 5/8 Slot size .020 from 285' 8" ft. to 290' 10" ft.
Diam. ..... Slot size ..... from ..... ft. to ..... ft.

Gravel packed: Yes ☐ No ☒ Size of gravel: .....
Gravel placed from ..... ft. to ..... ft.

Surface seal: Yes ☒ No ☐ To what depth? 18 ft.
Material used in seal Bentonite & clay
Did any strata contain unusable water? Yes ☐ No ☒
Type of water? ..... Depth of strata .....
Method of sealing strata off .....

(7) PUMP: Manufacturer's Name .....
Type: ..... H.P. .....

(8) WATER LEVELS: Land-surface elevation above mean sea level .... ft.
Static level 20.1 ft. below top of well Date 6/30/78
Artesian pressure ..... lbs. per square inch Date .....
Artesian water is controlled by ..... (Cap, valve, etc.)

(9) WELL TESTS: Drawdown is amount water level is lowered below static level
Was a pump test made? Yes ☐ No ☒ If yes, by whom? .....
Yield: ..... gal./min. with ..... ft. drawdown after ..... hrs.
" " " "
" " " "

Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)

Time	Water Level	Time	Water Level	Time	Water Level

Date of test .....
Bailer test 5 gal./min. with 69 ft. drawdown after 5 hrs.
Artesian flow ..... g.p.m. Date .....
Temperature of water 49 Was a chemical analysis made? Yes ☐ No ☒

(10) WELL LOG:

Formation: Describe by color, character, size of material and structure, and show thickness of aquifers and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of formation.

MATERIAL	FROM	TO
Brown top soil	0	1
Brown sandy clay	1	11
Brown sandy gravely clay & large rocks	11	25
Brown clay	25	83
Brown gritty clay	83	128
Brown sandy clay	128	138
Brown sand & gravel	138	142
Brown dry gravel	142	169
Brown sandy clay	169	182
Brown fine dry sand	182	197
Brown dry large gravel & coarse sand	197	199
Greenish brown clay & wood particles	199	218
Gray clay	218	241
Greenish silty clay	241	256
Greenish brown silty sandy clay (some seepage)	256	270
Greenish brown sandy clay	270	287
Blue coarse sand & large gravel W/B Static approx. 215'	287	289
Greenish brown clay	289	291

RECEIVED
DEC - 7 1978
DEPARTMENT OF ECOLOGY
SOUTHWEST REGIONAL OFFICE

Work started 6/19 19 78 Completed 6/30 19 78

WELL DRILLER'S STATEMENT:

This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

NAME Stoican Drilling Co., Inc.
(Person, firm, or corporation) (Type or print)

Address P.O. Box 161 Sequim, Wash. 98382

[Signed] Valis Stoican President 0473
(Well Driller)

Charlie Sherk 0458 Date 7/10 19 78
License No.

Sub Contractor-Bill Weber 0535
Webers Well Drilling

(USE ADDITIONAL SHEETS IF NECESSARY)

(12)

STATE OF WASHINGTON
DEPARTMENT OF CONSERVATION
DIVISION OF WATER RESOURCES

WELL SCHEDULE No. 28/1E-2K1

Date 8-21, 1975

Record by: A. Williamson

Source

1. Location: State of WASHINGTON
County: Jefferson
Area
Map
NW¼ SE¼ sec. 8 T. 28 N., R. 1 W.
Details

DIAGRAM OF SECTION

2. Owner or Tenant: [illegible] (His No.)
Address
3. Driller: Address
4. Land-surface datum: [illegible] ft. above below
Topography:
5. Type: Dug Drilled Driven Depths Rept. 325 feet
Bored Jetted Meas. feet
Date 19 75
6. Casing: Diam. 6" to in.
ft. Type
Depth ft. Finish
7. Chief aquifer(s): from ft. to ft.
8. Water level: Rept. 10.25 ft. 8-21, 1975, above +
Meas. below
which is ? ft. above below datum
9. Pump: Type Capacity gal./min.
Driven by horsepower
10. Yield: Flow gal./min. Pump gal./min. Meas. Rept. Est.
Drawdown ft. after hours pumping gal./min.
Adequacy, permanence
11. Use: Dom. Stock. PS. Ind. Irr. Obs.
12. Quality: Sample No. 19 Temp. °F.
Taste, color, hardness, sanitation, etc.

13. Other data: Log Water levels Draft Pump test Analyses

Turn up

APPENDIX B

Field Procedures Addendum

B.1 Field Procedures Addendum

B.1.1 Sub-Slab Soil Vapor Sampling Procedures

The purpose of this Addendum is to provide field personnel with an outline of the specific information needed to collect and document representative sub-slab soil vapor samples. The recommended sub-slab soil vapor sampling technique, as presented in this Addendum, is based on the assumption that soil vapor samples should be representative of chemicals that may volatilize from the uppermost aquifer into the vadose zone.

B.1.1.1 Sampling Equipment and Materials

The following equipment and materials are necessary to properly conduct sub-slab soil vapor sampling (see Figure B-1):

- Rotary hammer drill with a 2-inch and a 1-inch carbide tipped bit.
- Extension cord and generator (if no power outlets are available).
- 3-inch (length) stainless steel (SS) screen assembly with locking cap (AMS GVP probe assembly or equivalent).
- Hose barb, stainless steel (1/4-inch).
- Teflon® tape.
- 100% Beeswax, to seal vapor port borehole annulus.
- Quick Set Concrete Patch, to seal vapor port borehole annulus.
- Air pump and appropriate connection tubing, tee fittings, valves, and flow metering device for purging and sampling vapor ports.
- 1-liter Tedlar® bags to collect purged vapors.
- Sufficient number of Summa canisters and appropriate flow controllers to collect soil vapor samples.
- Equipment required for collection of samples using Summa canisters, including appropriate wrenches and pressure gauges.
- An accurate and reliable watch that has been properly set.
- A calculator.
- Field notebook, applicable sampling analysis plan, and Chain of Custody.
- Health-and-safety equipment and supplies (e.g., personal protective equipment [PPE]) as described in the relevant site health-and-safety plan (HSP).
- Shipping package for the Summa canisters.

When leak testing is required, additional equipment and materials include:

- Leak test shroud of sufficient size to cover soil gas vapor probe and sampling train (including Summa canister).
- A soft gasket to seal the leak test shroud to the floor.
- Tracer gas (helium), supplied in a 20 cubic foot gas cylinder with flow regulator.
- Flow regulator with 1/8-inch barbed outlet and tubing to connect the helium gas cylinder to the shroud.
- MGD-2002 helium meter or equivalent.

B.1.1.2 Sampling Procedure

Preparation

- Prior to beginning, clear sampling locations for utilities, verify access agreements are in place, and obtain required permits, as appropriate.
- Install sub-slab soil vapor sampling ports as follows:
  - Drill a 2-inch borehole to a depth of approximately 3 inches.
  - Drill a 1-inch borehole through the center of the 2-inch borehole through the floor slab of the building foundation to a depth of approximately 12 inches below the surface.
  - Construct the vapor point as shown in Figure B-1 and insert such that the top of the assembly is set approximately 1/8-inch below the top of the slab.
  - Seal the vapor port by melting the beeswax with a small butane torch. Pour the beeswax from the rubber plug up to the bottom ½-inch of the 2-inch borehole.
  - Allow beeswax to solidify and harden.
  - Mix Quick Set concrete patch and apply from top of beeswax seal to within ¼-inch of the top of the slab.
- Assemble sampling train. The sampling train will be set up so that the Summa canister is in-line between the vapor port and the air pump, with a valve between the canister and the pump (see Figure B-1):
  - Verify the Summa canister number engraved on the canister matches the number listed on the certified clean tag to ensure proper decontamination of the canister was completed. Fill out the sample tag.
  - Verify the canister valve is closed tightly and remove the threaded cap at the inlet of the canister.
  - Attach the flow controller to the inlet of the canister; the flow controller will have a built in pressure gauge.
  - Connect the tubing from vapor port to inlet of a ¼-inch tee fitting.

  - Connect the Summa canister/flow controller to one outlet of the tee fitting.
  - Connect air pump to the other outlet of the tee fitting, insert a ¼-inch shutoff valve between the tee fitting and the air pump.
- Where leak testing is required, a shroud will be placed over the vapor port and the Summa canister to keep tracer gas in contact with the vapor port and fittings. The shroud consists of a plastic bin of a known volume. Two holes will be drilled near the top of the shroud; one for connection of the helium gas cylinder and one for connection of the air pump located outside the shroud. A third hole will be drilled near the base of the shroud to monitor the helium concentration inside during sampling (see Figure B-1).

B.1.1.3 Sampling Methodology

Sample Collection

- Purge the vapor port and sampling train at approximately 100 ml/min using the air pump to ensure the sample is representative of subsurface conditions. Capture purged vapor in 1-liter Tedlar® bags at the outlet of the air pump and release the vapor outdoors. Three-to-five tubing volumes should be removed. Use the following equation to calculate volume to be purged:

$$V = \pi \times r^2 \times l$$

  Where:

  V = Volume of tubing

  r = the inner radius of the tubing being used [inches]

  l = the length of the tubing being used [inches]

  $\pi = 3.14$

  (Convert to ml using 1-inch^3 = 16.387 ml to determine how long to purge port)
- If the sampling and analysis plan calls for Tedlar® bag samples to be collected for analysis, these samples will be collected at the outlet of the air pump following purging of the vapor port.
- Begin sample collection by closing the ¼-inch shutoff valve between the Summa canister and the air pump and opening the valve on the Summa canister. Immediately record the pressure on the gauge as the "initial pressure" on the tag attached to the canister.
- After sampling begins and the apparatus is verified to be operating correctly, leave the canister to fill.
- Record all sample information in the field book and/or applicable field forms including the following:
  - Canister number and sample identification,
  - Sample start date and times,
  - Location of sample (distance from walls shown on building floor plan),

  - Initial and final pressure of canister, and
  - Notes regarding leak test, if applicable.
- Return to check canisters periodically (depending on length of sample period), to ensure proper operation. It is necessary to check the canister prior to completion because the accuracy of the flow regulators can vary, causing the canisters to fill faster than expected. The final pressure at the end of sampling should be approximately -5 to -6 inches mercury (Hg). If the canister has already reached this point, sampling is complete, the canister valve should be closed, and the pressure recorded as the "final pressure" on the sample tag, the field book, and applicable field forms. Sample collection will be considered complete, regardless of final pressure, after the stated sample period has elapsed.
- Record the exact pressure of the canister and time at the end of sampling on the sample tag for that canister, in the field book, and on the applicable field forms.
- Verify that the canister valve is closed tightly, remove the flow controller, and replace the threaded cap at the top of the canister. Discard all sample tubing.
- Abandon vapor port by removing vapor screen and tubing, backfilling with glass bead, and patching with concrete.

Leak Testing

- Before purging or sampling begins, place the leak test shroud over the vapor port/Summa canister sampling apparatus. The tubing from the tee connection above the canister will pass through the wall of the shroud to connect with the air pump outside.
- Connect the helium cylinder to the leak test shroud using tubing from the flow regulator on the cylinder, through a hole in the wall of the shroud. Be sure to keep the cylinder in an upright position at all times.
- Connect the helium meter to the leak test shroud using the hole near the base.
- Use the flow regulator to slowly release helium into the leak test shroud until a predetermined concentration of helium is contained within the enclosed area. The helium concentration will be measured using the helium meter. Maintain helium concentrations throughout the sampling period by continuously bleeding cylinder gas into the shroud as needed.
- Prior to collecting the canister sample, the vapor port will be purged as described above. Purged vapor contained in the Tedlar® bags will be field screened using the helium meter to ensure that the concentration of helium inside the bags is less than 5 percent of the shroud concentration. If leakage is detected, the vapor port seal will be enhanced and connections will be inspected and tightened. This process will be repeated until no significant leakage has been demonstrated.
- After confirming no significant leakage, the ¼-inch shutoff valve between the Summa canister and the air pump will be closed and the canister valve will be opened to begin collecting the sample.

B.1.1.4 Post-Sample Collection Procedures

Label all sample containers with the following information: sample identification, date and time sample was collected, the starting and ending canister pressure, the site name, and the company name.

Include all this information in the field book plus the ending time of sample collection, and transfer pertinent information to the Chain-of-Custody record. Pack all Summa canisters in the original shipping containers, sealed with a custody seal, and send to the lab for analysis. The official holding time for this analysis is 30 days. However, attempt to get samples to the lab as soon as possible to allow lab time to conduct re-runs, dilutions, and low-level analyses, as necessary prior to sample expiration.

B.1.1.5 Analysis

The soil gas samples should be analyzed using EPA Methods TO-14 or TO-15, and when necessary/possible, low-level analysis or Selective Ion Mode (SIM) analysis to obtain the lowest achievable detection and reporting limits. Note the desired analytical methods are on the Chain-of-Custody form, and be sure analysis for helium is specified for leak-tested samples.

B.1.1.6 Decontamination

The equipment used for soil gas sampling does not require decontamination in the field. The Summa canisters will be individually cleaned and certified to 0.02 ppbv THC for the project-specific analyte list by the contract laboratory prior to shipment. Ensure that documentation of this certification is included on a tag attached to the canister and in the paperwork that accompanies the canister shipment from the lab.

B.1.1.7 Documentation

Record all field activities, environmental and building conditions, and sample documentation on the appropriate field forms and field notebook.

B.2 References

Department of Environmental Protection, 2002, Commonwealth of Massachusetts, Indoor Air Sampling and Evaluation Guide, WSC Policy #02-430, Boston, Massachusetts, April 2002.

EPRI, 2005, Reference Handbook for Site Specific Assessment of Sub-Surface Vapor Intrusion to Indoor Air, March 2005.

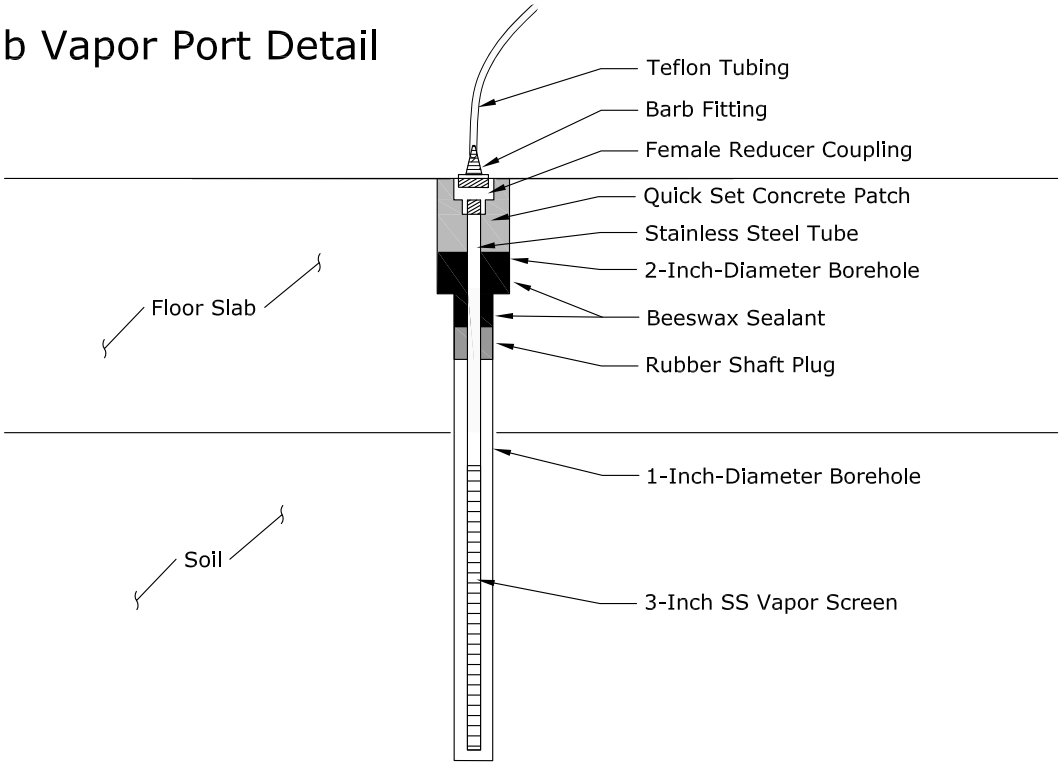
New Jersey Department of Environmental Protection, 2005, Vapor Intrusion Guidance, October 2005.

New York State Department of Health, 2006, Guidance for Evaluation Soil Vapor Intrusion in the State of New York, October 2006.

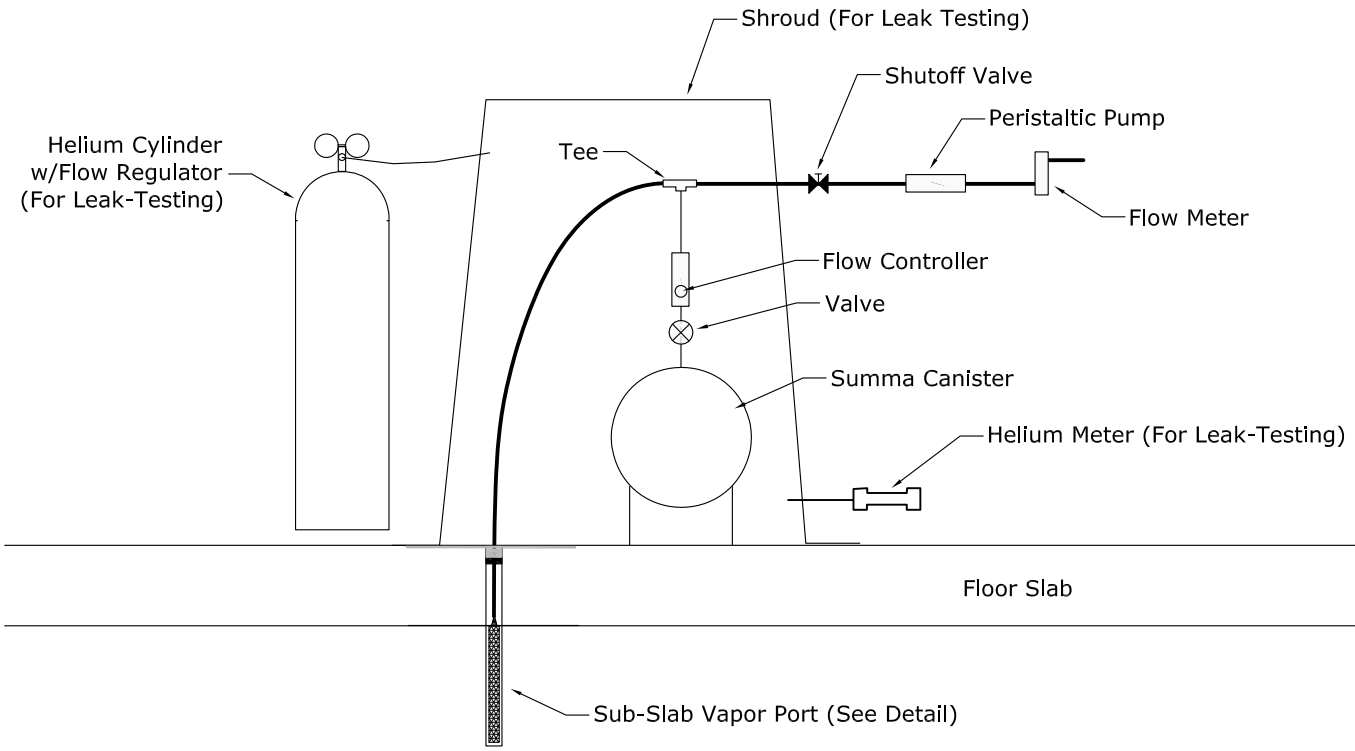
USEPA, 1999, Center for Environmental Research Information, Office of Research and Development, Compendium of Methods for Determination of Toxic Organic Compounds in Ambient Air, Second Edition, Compendium Method To-14A, Determination of Volatile Organic Compounds (VOCs) in Ambient Air Using Specially Prepared Canisters with Subsequent Analysis by Gas Chromatography, January 1999.

USEPA, 2002, Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway Form Groundwater and Soils, EPA530-F-02-052, November 2002.

Sub-Slab Vapor Port Detail



Sub-Slab Vapor Sampling Train



Aspect CONSULTING

Sub-Slab Vapor Sampling Apparatus
Standard Operating Procedures
Aspect Consulting, LLC
Seattle, Washington

DRAFT

DATE: September 2013	PROJECT NO. 130046
DESIGNED BY: EJM	
DRAWN BY: SCC	FIGURE NO. B-1
REVISED BY: EJM	

C:\Users\emarhofer\Desktop\Figure B-1.dwg 8.5x11 Portrait
Sep 24, 2013 3:53pm emarhofer

APPENDIX C

Laboratory Analytical Report

2655 Park Center Dr., Suite A
Simi Valley, CA 93065
T: +1 805 526 7161
F: +1 508 526 7270
www.alsglobal.com

LABORATORY REPORT

July 11, 2013

Greg Ferris
Aspect Consulting
401 2nd Ave. S, Suite 201
Seattle, WA 98104-3814

RE: Port Ludlow OWSI / 130046

Dear Greg:

Enclosed are the results of the samples submitted to our laboratory on June 26, 2013. For your reference, these analyses have been assigned our service request number P1302737.

All analyses were performed according to our laboratory's NELAP and DoD-ELAP-approved quality assurance program. The test results meet requirements of the current NELAP and DoD-ELAP standards, where applicable, and except as noted in the laboratory case narrative provided. For a specific list of NELAP and DoD-ELAP-accredited analytes, refer to the certifications section at www.alsglobal.com. Results are intended to be considered in their entirety and apply only to the samples analyzed and reported herein.

If you have any questions, please call me at (805) 526-7161.

Respectfully submitted,

ALS | Environmental

By Kate Aguilera at 10:58 am, Jul 11, 2013

Kate Aguilera
Project Manager

2655 Park Center Dr., Suite A
Simi Valley, CA 93065
T: +1 805 526 7161
F: +1 508 526 7270
www.alsglobal.com

Client: Aspect Consulting
Project: Port Ludlow OWSI / 130046

Service Request No: P1302737

CASE NARRATIVE

The samples were received intact under chain of custody on June 26, 2013 and were stored in accordance with the analytical method requirements. Please refer to the sample acceptance check form for additional information. The results reported herein are applicable only to the condition of the samples at the time of sample receipt.

Fixed Gases Analysis

The samples were analyzed for fixed gases (oxygen/argon, nitrogen, methane and carbon dioxide) according to modified EPA Method 3C (single injection) using a gas chromatograph equipped with a thermal conductivity detector (TCD). This method is not included on the laboratory's NELAP or AIHA-LAP scope of accreditation.

Helium Analysis

The samples were also analyzed for helium according to modified EPA Method 3C (single injection) using a gas chromatograph equipped with a thermal conductivity detector (TCD). This method is not included on the laboratory's NELAP, DoD-ELAP, or AIHA-LAP scope of accreditation.

Air-Phase Petroleum Hydrocarbons (APH) Analysis

The samples were also analyzed for total aliphatic and aromatic gasoline range hydrocarbons by gas chromatography/mass spectrometry according to the Method for the Determination of Air-Phase Petroleum Hydrocarbons (APH), Massachusetts Department of Environmental Protection, Revision 1, December, 2009. This method is not included on the laboratory's DoD-ELAP or AIHA-LAP scope of accreditation.

Significant non-petroleum related peaks (i.e. halogenated, oxygenated, terpenes, etc.) are subtracted from the hydrocarbon range areas when present. Any internal/tuning standards and target APH analytes eluting in the hydrocarbon ranges are also subtracted. Additionally, C_9-C_{10} Aromatic Hydrocarbons are excluded from the C_9-C_{12} Aliphatic Hydrocarbon range.

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Client: Aspect Consulting
Project: Port Ludlow OWSI / 130046

Service Request No: P1302737

CASE NARRATIVE

Volatile Organic Compound Analysis

The samples were also analyzed for volatile organic compounds in accordance with EPA Method TO-15 from the Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air, Second Edition (EPA/625/R-96/010b), January, 1999. The analytical system was comprised of a gas chromatograph / mass spectrometer (GC/MS) interfaced to a whole-air preconcentrator. The method was modified to include the use of helium as a diluent gas in place of zero-grade air for canister pressurization. When necessary, analytical sample volumes were adjusted by a correction factor for canisters pressurized with helium. A summary sheet has been included listing the affected samples. This method is not included on the laboratory's AIHA-LAP scope of accreditation. Any analytes flagged with an X are not included on the laboratory's NELAP or DoD-ELAP scope of accreditation.

The Summa canisters were cleaned, prior to sampling, down to the method reporting limit (MRL) reported for this project. Please note, projects which require reporting below the MRL could have results between the MRL and method detection limit (MDL) that are biased high.

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ALS Environmental – Simi Valley

Certifications, Accreditations, and Registrations

Agency	Web Site	Number
AIHA	http://www.aihaaccreditedlabs.org	101661
Arizona DHS	http://www.azdhs.gov/lab/license/env.htm	AZ0694
DoD ELAP	http://www.pjlabs.com/search-accredited-labs	L11-203
Florida DOH (NELAP)	http://www.doh.state.fl.us/lab/EnvLabCert/WaterCert.htm	E871020
Maine DHHS	http://www.maine.gov/dhhs/mecdc/environmental-health/water/dwp-services/labcert/labcert.htm	2012039
Minnesota DOH (NELAP)	http://www.health.state.mn.us/accreditation	494864
New Jersey DEP (NELAP)	http://www.nj.gov/dep/oqa/	CA009
New York DOH (NELAP)	http://www.wadsworth.org/labcert/elap/elap.html	11221
Oregon PHD (NELAP)	http://public.health.oregon.gov/LaboratoryServices/EnvironmentalLaboratoryAccreditation/Pages/index.aspx	CA200007
Pennsylvania DEP	http://www.depweb.state.pa.us/labs	68-03307 (Registration)
Texas CEQ (NELAP)	http://www.tceq.texas.gov/field/qa/env_lab_accreditation.html	T104704413-12-3
Utah DOH (NELAP)	http://www.health.utah.gov/lab/labimp/certification/index.html	CA015272012-2
Washington DOE	http://www.ecy.wa.gov/programs/eap/labs/lab-accreditation.html	C946

Analyses were performed according to our laboratory's NELAP and DoD-ELAP approved quality assurance program. A complete listing of specific NELAP and DoD-ELAP certified analytes can be found in the certifications section at www.alsglobal.com, or at the accreditation body's website.

Each of the certifications listed above have an explicit Scope of Accreditation that applies to specific matrices/methods/analytes; therefore, please contact the laboratory for information corresponding to a particular certification.

ALS ENVIRONMENTAL

DETAIL SUMMARY REPORT

Client: Aspect Consulting
Service Request: P1302737
Project ID: Port Ludlow OWSI / 130046

Date Received: 6/26/2013
Time Received: 09:30

Client Sample ID	Lab Code	Matrix	Date Collected	Time Collected	Container ID	Pi1 (psig)	Pf1 (psig)	3C Modified - Fxd Gases Can	3C Modified - Helium Can	MA APH 1.0 - MA VOC PH Can	TO-15 - VOC Cans
VP-1-062113	P1302737-001	Air	6/21/2013	10:00	SC00683	-1.47	3.65	X	X	X	X
VP-2-062113	P1302737-002	Air	6/21/2013	11:00	SC01531	-1.10	3.69	X	X	X	X

ALS ENVIRONMENTAL
Sample Volume Correction for Helium Pressurization for SCAN Analysis

Sample ID	Pi	Pf	Sample Volume (L)	Adjusted Volume (L)
P1302737-001	-1.47	3.65	0.901	1.00
P1302737-002	-1.10	3.69	0.905	1.00

Validation Date: 10/13/09

Template Name: MFC_GCF_backfill.xls

Columbia Analytical Services

2655 Park Center Drive, Suite A
Simi Valley, California 93065
Phone (805) 526-7161
Fax (805) 526-7270

Air - Chain of Custody Record & Analytical Service Request

Requested Turnaround Time in Business Days (Surcharges) please circle
1 Day (100%) 2 Day (75%) 3 Day (50%) 4 Day (35%) 5 Day (25%) 10 Day-Standard

CAS Project No.: P1302737

Company Name & Address (Reporting Information): Aspect Consulting

Project Name: Port Ludlow OWSI

Project Number: 130046

Project Manager: Greg Ferris

P.O. # / Billing Information: 130046-001-01

Phone: (206) 838-6580

Fax:

Email Address for Result Reporting: gferris@aspectconsulting.com

Sampler (Print & Sign): Eric Geissinger

CAS Contact:

Analysis Method

Client Sample ID	Laboratory ID Number	Date Collected	Time Collected	Canister ID (Bar code # - AC, SC, etc.)	Flow Controller ID (Bar code #- FC #)	Canister Start Pressure "Hg	Canister End Pressure "Hg/psig	Sample Volume	MA APH/TO-15 (see reporting list below)*	Modified Method: O_2, CO_2, CH_4, N_2, plus He (tracer)	Comments e.g. Actual Preservative or specific instructions
VP-1-062113	1-137	6/21/13	1000	SC00183	FCS00027	-28	-5.5	6L	X	X	Please note we used He as a tracer gas
VP-2-062113	2-1088	6/21/13	1100	SC01531	FCS00116	-29	-5.5	6L	X	X	
* C5-C8 Aliphatic Hydrocarbons											
C9-C12 Aliphatic Hydrocarbons											
C9-C10 Aromatic Hydrocarbons											
BTEX											
Naphthalene											
MTBE											
n-hexane											
1,2-dibromoethane											
1,2-dichloroethane											
1,3,5-trimethylbenzene											
1,2,4-trimethylbenzene											

MA APH/TO-15 Reporting List (call w/ questions)

Report Tier Levels - please select

Tier I - Results (Default if not specified) ____
Tier II (Results + QC Summaries) ____
Tier III (Results + QC & Calibration Summaries) ____
Tier IV (Data Validation Package) 10% Surcharge ____

EDD required Yes / No
Type: ____

Project Requirements (MRLs, QAPP)

Relinquished by: (Signature)	Date:	Time:	Received by: (Signature)	Date:	Time:
	6/24/13	1330		6/24/13	0930
Relinquished by: (Signature)	Date:	Time:	Received by: (Signature)	Date:	Time:

Cooler / Blank Temperature ____°C

ALS Environmental
Sample Acceptance Check Form

Client: Aspect Consulting Work order: P1302737

Project: Port Ludlow OWSI / 130046

Sample(s) received on: 6/26/13 Date opened: 6/26/13 by: MZAMORA

Note: This form is used for all samples received by ALS. The use of this form for custody seals is strictly meant to indicate presence/absence and not as an indication of compliance or nonconformity. Thermal preservation and pH will only be evaluated either at the request of the client and/or as required by the method/SOP.

		Yes	No	N/A
1	Were **sample containers** properly marked with client sample ID?	☒	☐	☐
2	Container(s) **supplied by ALS**?	☒	☐	☐
3	Did **sample containers** arrive in good condition?	☒	☐	☐
4	Were **chain-of-custody** papers used and filled out?	☒	☐	☐
5	Did **sample container labels** and/or tags agree with custody papers?	☒	☐	☐
6	Was **sample volume** received adequate for analysis?	☒	☐	☐
7	Are samples within specified holding times?	☒	☐	☐
8	Was proper **temperature** (thermal preservation) of cooler at receipt adhered to?	☐	☐	☒
9	Was a **trip blank** received?	☐	☒	☐
10	Were **custody seals** on outside of cooler/Box?	☐	☒	☐
	Location of seal(s)? _____ Sealing Lid?	☐	☐	☒
	Were signature and date included?	☐	☐	☒
	Were seals intact?	☐	☐	☒
	Were custody seals on outside of sample container?	☐	☒	☐
	Location of seal(s)? _____ Sealing Lid?	☐	☐	☒
	Were signature and date included?	☐	☐	☒
	Were seals intact?	☐	☐	☒
11	Do containers have appropriate **preservation**, according to method/SOP or Client specified information?	☐	☐	☒
	Is there a client indication that the submitted samples are **pH** preserved?	☐	☐	☒
	Were **VOA vials** checked for presence/absence of air bubbles?	☐	☐	☒
	Does the client/method/SOP require that the analyst check the sample pH and if necessary alter it?	☐	☐	☒
12	**Tubes:** Are the tubes capped and intact?	☐	☐	☒
	Do they contain moisture?	☐	☐	☒
13	**Badges:** Are the badges properly capped and intact?	☐	☐	☒
	Are dual bed badges separated and individually capped and intact?	☐	☐	☒

Lab Sample ID	Container Description	Required pH *	Received pH	Adjusted pH	VOA Headspace (Presence/Absence)	Receipt / Preservation Comments
P1302737-001.01	6.0 L Source Can					
P1302737-002.01	6.0 L Source Can					

Explain any discrepancies: (include lab sample ID numbers): _____

RSK - MEEPP, HCL (pH<2); RSK - CO2, (pH 5-8); Sulfur (pH>4)

ALS ENVIRONMENTAL

RESULTS OF ANALYSIS

Client: **Aspect Consulting**
Client Sample ID: **VP-1-062113**
Client Project ID: **Port Ludlow OWSI / 130046**

ALS Project ID: P1302737
ALS Sample ID: P1302737-001

Test Code: EPA Method 3C Modified
Instrument ID: HP5890 II/GC1/TCD
Analyst: Jennifer Young
Sample Type: 6.0 L Summa Canister
Test Notes:
Container ID: SC00683

Date Collected: 6/21/13
Date Received: 6/26/13
Date Analyzed: 7/1/13
Volume(s) Analyzed: 0.10 ml(s)

Initial Pressure (psig): -1.47 Final Pressure (psig): 3.65

Canister Dilution Factor: 1.39

CAS #	Compound	Result %, v/v	MRL %, v/v	Data Qualifier
7782-44-7	**Oxygen +**			
7440-37-1	**Argon**	**15.0**	0.14	
7727-37-9	**Nitrogen**	**77.4**	0.14	
74-82-8	Methane	ND	0.14	
124-38-9	**Carbon Dioxide**	**7.54**	0.14	

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.
MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.

ALS ENVIRONMENTAL

RESULTS OF ANALYSIS

Client: **Aspect Consulting**
Client Sample ID: **VP-2-062113** ALS Project ID: P1302737
Client Project ID: **Port Ludlow OWSI / 130046** ALS Sample ID: P1302737-002

Test Code: EPA Method 3C Modified Date Collected: 6/21/13
Instrument ID: HP5890 II/GC1/TCD Date Received: 6/26/13
Analyst: Jennifer Young Date Analyzed: 7/1/13
Sample Type: 6.0 L Summa Canister Volume(s) Analyzed: 0.10 ml(s)
Test Notes:
Container ID: SC01531

Initial Pressure (psig): -1.10 Final Pressure (psig): 3.69

Canister Dilution Factor: 1.35

CAS #	Compound	Result %, v/v	MRL %, v/v	Data Qualifier
7782-44-7	**Oxygen +**			
7440-37-1	**Argon**	**12.9**	0.14	
7727-37-9	**Nitrogen**	**79.3**	0.14	
74-82-8	Methane	ND	0.14	
124-38-9	**Carbon Dioxide**	**7.78**	0.14	

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.
MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.

ALS ENVIRONMENTAL

RESULTS OF ANALYSIS

Client: **Aspect Consulting**
Client Sample ID: **Method Blank** ALS Project ID: P1302737
Client Project ID: **Port Ludlow OWSI / 130046** ALS Sample ID: P130701-MB

Test Code: EPA Method 3C Modified Date Collected: NA
Instrument ID: HP5890 II/GC1/TCD Date Received: NA
Analyst: Jennifer Young Date Analyzed: 7/01/13
Sample Type: 6.0 L Summa Canister Volume(s) Analyzed: 0.10 ml(s)
Test Notes:

CAS #	Compound	Result %, v/v	MRL %, v/v	Data Qualifier
7782-44-7	Oxygen +			
7440-37-1	Argon	ND	0.10	
7727-37-9	Nitrogen	ND	0.10	
74-82-8	Methane	ND	0.10	
124-38-9	Carbon Dioxide	ND	0.10	

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.
MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.

ALS ENVIRONMENTAL

LABORATORY CONTROL SAMPLE SUMMARY

Client: **Aspect Consulting**
Client Sample ID: **Lab Control Sample** ALS Project ID: P1302737
Client Project ID: **Port Ludlow OWSI / 130046** ALS Sample ID: P130701-LCS

Test Code: EPA Method 3C Modified Date Collected: NA
Instrument ID: HP5890 II/GC1/TCD Date Received: NA
Analyst: Jennifer Young Date Analyzed: 7/01/13
Sample Type: 6.0 L Summa Canister Volume(s) Analyzed: NA ml(s)
Test Notes:

CAS #	Compound	Spike Amount ppmV	Result ppmV	% Recovery	ALS Acceptance Limits	Data Qualifier
7782-44-7	Oxygen +					
7440-37-1	Argon	50,000	**55,200**	**110**	85-111	
7727-37-9	Nitrogen	49,400	**54,500**	**110**	85-114	
74-82-8	Methane	39,500	**42,700**	**108**	90-114	
124-38-9	Carbon Dioxide	49,300	**53,000**	**108**	84-113	

ALS ENVIRONMENTAL

RESULTS OF ANALYSIS

Client: **Aspect Consulting**
Client Project ID: **Port Ludlow OWSI / 130046** ALS Project ID: P1302737

Helium

Test Code: EPA 3C Modified
Instrument ID: HP5890 II/GC8/TCD Date(s) Collected: 6/21/13
Analyst: Jennifer Young Date Received: 6/26/13
Sample Type: 6.0 L Summa Canister(s) Date Analyzed: 6/28/13
Test Notes:

Client Sample ID	ALS Sample ID	Injection Volume ml(s)	Canister Dilution Factor	Result ppmV	MRL ppmV	Data Qualifier
VP-1-062113	P1302737-001	1.00	1.10	**180**	28	
VP-2-062113	P1302737-002	1.00	1.06	ND	27	
Method Blank	P130628-MB	1.00	1.00	ND	25	

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.
MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.

ALS ENVIRONMENTAL

LABORATORY CONTROL SAMPLE SUMMARY

Client: **Aspect Consulting**
Client Sample ID: **Lab Control Sample** ALS Project ID: P1302737
Client Project ID: **Port Ludlow OWSI / 130046** ALS Sample ID: P130628-LCS

Test Code: EPA 3C Modified Date Collected: NA
Instrument ID: HP5890 II/GC8/TCD Date Received: NA
Analyst: Jennifer Young Date Analyzed: 6/28/13
Sample Type: 6.0 L Summa Canister Volume(s) Analyzed: NA ml(s)
Test Notes:

CAS #	Compound	Spike Amount ppmV	**Result ppmV**	**% Recovery**	ALS Acceptance Limits	Data Qualifier
7440-59-7	Helium	10,000	**9,620**	**96**	70-127	

ALS ENVIRONMENTAL

RESULTS OF ANALYSIS

Client: **Aspect Consulting**
Client Sample ID: **VP-1-062113** ALS Project ID: P1302737
Client Project ID: **Port Ludlow OWSI / 130046** ALS Sample ID: P1302737-001

Test Code: Massachusetts APH, Revision 1, December 2009 Date Collected: 6/21/13
Instrument ID: Tekmar AUTOCAN/Agilent 5975Binert/6890N/MS13 Date Received: 6/26/13
Analyst: Chris Cornett Date Analyzed: 7/4/13
Sample Type: 6.0 L Summa Canister Volume(s) Analyzed: 1.00 Liter(s)
Test Notes:
Container ID: SC00683

Initial Pressure (psig): -1.47 Final Pressure (psig): 3.65

Canister Dilution Factor: 1.39

Compound	Result µg/m³	MRL µg/m³	Data Qualifier
C_5 - C_8 Aliphatic Hydrocarbons[1,2]	**110**	28	
C_9 - C_{12} Aliphatic Hydrocarbons[1,3]	**2,100**	14	
C_9 - C_{10} Aromatic Hydrocarbons	**42**	3.5	

Significant non-petroleum related peaks (i.e. halogenated, oxygenated, terpenes, etc.) are subtracted from the hydrocarbon range areas when present.

[1]Hydrocarbon Range data from total ion chromatogram excluding any internal/tuning standards eluting in that range.

[2]C_5-C_8 Aliphatic Hydrocarbons exclude the concentration of Target APH analytes eluting in that range.

[3]C_9-C_{12} Aliphatic Hydrocarbons exclude concentration of Target APH Analytes eluting in that range and concentration of C_9-C_{10} Aromatic Hydrocarbons.

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.

MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.

ALS ENVIRONMENTAL

RESULTS OF ANALYSIS

Client: **Aspect Consulting**
Client Sample ID: **VP-2-062113** ALS Project ID: P1302737
Client Project ID: **Port Ludlow OWSI / 130046** ALS Sample ID: P1302737-002

Test Code: Massachusetts APH, Revision 1, December 2009 Date Collected: 6/21/13
Instrument ID: Tekmar AUTOCAN/Agilent 5975Binert/6890N/MS13 Date Received: 6/26/13
Analyst: Chris Cornett Date Analyzed: 7/4/13
Sample Type: 6.0 L Summa Canister Volume(s) Analyzed: 1.00 Liter(s)
Test Notes:
Container ID: SC01531

Initial Pressure (psig): -1.10 Final Pressure (psig): 3.69

Canister Dilution Factor: 1.35

Compound	Result µg/m³	MRL µg/m³	Data Qualifier
C_5 - C_8 Aliphatic Hydrocarbons[1,2]	**100**	27	
C_9 - C_{12} Aliphatic Hydrocarbons[1,3]	**790**	14	
C_9 - C_{10} Aromatic Hydrocarbons	**16**	3.4	

Significant non-petroleum related peaks (i.e. halogenated, oxygenated, terpenes, etc.) are subtracted from the hydrocarbon range areas when present.

[1]Hydrocarbon Range data from total ion chromatogram excluding any internal/tuning standards eluting in that range.

[2]C_5-C_8 Aliphatic Hydrocarbons exclude the concentration of Target APH analytes eluting in that range.

[3]C_9-C_{12} Aliphatic Hydrocarbons exclude concentration of Target APH Analytes eluting in that range and concentration of C_9-C_{10} Aromatic Hydrocarbons.

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.

MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.

ALS ENVIRONMENTAL

RESULTS OF ANALYSIS

Client: **Aspect Consulting**
Client Sample ID: **Method Blank** ALS Project ID: P1302737
Client Project ID: **Port Ludlow OWSI / 130046** ALS Sample ID: P130703-MB

Test Code: Massachusetts APH, Revision 1, December 2009 Date Collected: NA
Instrument ID: Tekmar AUTOCAN/Agilent 5975Binert/6890N/MS13 Date Received: NA
Analyst: Chris Cornett Date Analyzed: 7/3/13
Sample Type: 6.0 L Summa Canister Volume(s) Analyzed: 1.00 Liter(s)
Test Notes:

Compound	Result µg/m³	MRL µg/m³	Data Qualifier
C_5 - C_8 Aliphatic Hydrocarbons[1,2]	ND	20	
C_9 - C_{12} Aliphatic Hydrocarbons[1,3]	ND	10	
C_9 - C_{10} Aromatic Hydrocarbons	ND	2.5	

Significant non-petroleum related peaks (i.e. halogenated, oxygenated, terpenes, etc.) are subtracted from the hydrocarbon range areas when present.

[1]Hydrocarbon Range data from total ion chromatogram excluding any internal/tuning standards eluting in that range.

[2]C_5-C_8 Aliphatic Hydrocarbons exclude the concentration of Target APH analytes eluting in that range.

[3]C_9-C_{12} Aliphatic Hydrocarbons exclude concentration of Target APH Analytes eluting in that range and concentration of C_9-C_{10} Aromatic Hydrocarbons.

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.

MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.

ALS ENVIRONMENTAL

LABORATORY CONTROL SAMPLE SUMMARY

Client: **Aspect Consulting**
Client Sample ID: **Lab Control Sample** ALS Project ID: P1302737
Client Project ID: **Port Ludlow OWSI / 130046** ALS Sample ID: P130703-LCS

Test Code: Massachusetts APH, Revision 1, December 2009 Date Collected: NA
Instrument ID: Tekmar AUTOCAN/Agilent 5975Binert/6890N/MS13 Date Received: NA
Analyst: Chris Cornett Date Analyzed: 7/3/13
Sample Type: 6.0 L Summa Canister Volume(s) Analyzed: 0.125 Liter(s)
Test Notes:

Compound	Spike Amount µg/m³	**Result µg/m³**	**% Recovery**	ALS Acceptance Limits	**Data Qualifier**
C5 - C8 Aliphatic Hydrocarbons	202	**167**	**83**	70-130	
C9 - C12 Aliphatic Hydrocarbons	204	**184**	**90**	70-130	
C9 - C10 Aromatic Hydrocarbons	402	**366**	**91**	70-130	

ALS ENVIRONMENTAL

RESULTS OF ANALYSIS

Client: **Aspect Consulting**
Client Sample ID: **VP-1-062113** ALS Project ID: P1302737
Client Project ID: **Port Ludlow OWSI / 130046** ALS Sample ID: P1302737-001

Test Code: EPA TO-15 Modified Date Collected: 6/21/13
Instrument ID: Tekmar AUTOCAN/Agilent 5975Binert/6890N/MS13 Date Received: 6/26/13
Analyst: Chris Cornett Date Analyzed: 7/4/13
Sample Type: 6.0 L Summa Canister Volume(s) Analyzed: 1.00 Liter(s)
Test Notes:
Container ID: SC00683

Initial Pressure (psig): -1.47 Final Pressure (psig): 3.65

Canister Dilution Factor: 1.39

CAS #	Compound	Result µg/m³	MRL µg/m³	Result ppbV	MRL ppbV	Data Qualifier
1634-04-4	Methyl tert-Butyl Ether	ND	0.70	ND	0.19	
110-54-3	n-Hexane	ND	0.70	ND	0.20	
107-06-2	1,2-Dichloroethane	ND	0.70	ND	0.17	
71-43-2	Benzene	ND	0.70	ND	0.22	
108-88-3	Toluene	**9.8**	0.70	**2.6**	0.18	
106-93-4	1,2-Dibromoethane	ND	0.70	ND	0.090	
100-41-4	Ethylbenzene	**3.2**	0.70	**0.73**	0.16	
179601-23-1	m,p-Xylenes	**15**	1.4	**3.5**	0.32	
95-47-6	o-Xylene	**4.4**	0.70	**1.0**	0.16	
108-67-8	1,3,5-Trimethylbenzene	**2.4**	0.70	**0.50**	0.14	
95-63-6	1,2,4-Trimethylbenzene	**7.7**	0.70	**1.6**	0.14	
91-20-3	Naphthalene	**1.2**	0.70	**0.23**	0.13	

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.
MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.

ALS ENVIRONMENTAL

RESULTS OF ANALYSIS

Client: **Aspect Consulting**
Client Sample ID: **VP-2-062113** ALS Project ID: P1302737
Client Project ID: **Port Ludlow OWSI / 130046** ALS Sample ID: P1302737-002

Test Code: EPA TO-15 Modified Date Collected: 6/21/13
Instrument ID: Tekmar AUTOCAN/Agilent 5975Binert/6890N/MS13 Date Received: 6/26/13
Analyst: Chris Cornett Date Analyzed: 7/4/13
Sample Type: 6.0 L Summa Canister Volume(s) Analyzed: 1.00 Liter(s)
Test Notes:
Container ID: SC01531

Initial Pressure (psig): -1.10 Final Pressure (psig): 3.69

Canister Dilution Factor: 1.35

CAS #	Compound	Result µg/m³	MRL µg/m³	Result ppbV	MRL ppbV	Data Qualifier
1634-04-4	Methyl tert-Butyl Ether	ND	0.68	ND	0.19	
110-54-3	n-Hexane	ND	0.68	ND	0.19	
107-06-2	1,2-Dichloroethane	ND	0.68	ND	0.17	
71-43-2	Benzene	ND	0.68	ND	0.21	
108-88-3	Toluene	**12**	0.68	**3.2**	0.18	
106-93-4	1,2-Dibromoethane	ND	0.68	ND	0.088	
100-41-4	Ethylbenzene	**10**	0.68	**2.3**	0.16	
179601-23-1	m,p-Xylenes	**45**	1.4	**10**	0.31	
95-47-6	o-Xylene	**28**	0.68	**6.5**	0.16	
108-67-8	1,3,5-Trimethylbenzene	**1.6**	0.68	**0.33**	0.14	
95-63-6	1,2,4-Trimethylbenzene	**3.5**	0.68	**0.71**	0.14	
91-20-3	Naphthalene	ND	0.68	ND	0.13	

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.
MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.

ALS ENVIRONMENTAL

RESULTS OF ANALYSIS

Client: **Aspect Consulting**
Client Sample ID: **Method Blank** ALS Project ID: P1302737
Client Project ID: **Port Ludlow OWSI / 130046** ALS Sample ID: P130703-MB

Test Code: EPA TO-15 Modified Date Collected: NA
Instrument ID: Tekmar AUTOCAN/Agilent 5975Binert/6890N/MS13 Date Received: NA
Analyst: Chris Cornett Date Analyzed: 7/3/13
Sample Type: 6.0 L Summa Canister Volume(s) Analyzed: 1.00 Liter(s)
Test Notes:

Canister Dilution Factor: 1.00

CAS #	Compound	Result µg/m³	MRL µg/m³	Result ppbV	MRL ppbV	Data Qualifier
1634-04-4	Methyl tert-Butyl Ether	ND	0.50	ND	0.14	
110-54-3	n-Hexane	ND	0.50	ND	0.14	
107-06-2	1,2-Dichloroethane	ND	0.50	ND	0.12	
71-43-2	Benzene	ND	0.50	ND	0.16	
108-88-3	Toluene	ND	0.50	ND	0.13	
106-93-4	1,2-Dibromoethane	ND	0.50	ND	0.065	
100-41-4	Ethylbenzene	ND	0.50	ND	0.12	
179601-23-1	m,p-Xylenes	ND	1.0	ND	0.23	
95-47-6	o-Xylene	ND	0.50	ND	0.12	
108-67-8	1,3,5-Trimethylbenzene	ND	0.50	ND	0.10	
95-63-6	1,2,4-Trimethylbenzene	ND	0.50	ND	0.10	
91-20-3	Naphthalene	ND	0.50	ND	0.095	

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.
MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.

ALS ENVIRONMENTAL

SURROGATE SPIKE RECOVERY RESULTS

Client: **Aspect Consulting**
Client Project ID: **Port Ludlow OWSI / 130046** ALS Project ID: P1302737

Test Code: EPA TO-15 Modified
Instrument ID: Tekmar AUTOCAN/Agilent 5975Binert/6890N/MS13 Date(s) Collected: 6/21/13
Analyst: Chris Cornett Date(s) Received: 6/26/13
Sample Type: 6.0 L Summa Canister(s) Date(s) Analyzed: 7/3 - 7/4/13
Test Notes:

Client Sample ID	ALS Sample ID	1,2-Dichloroethane-d4 Percent Recovered	Toluene-d8 Percent Recovered	Bromofluorobenzene Percent Recovered	Acceptance Limits	Data Qualifier
Method Blank	P130703-MB	**86**	**98**	**105**	70-130	
Lab Control Sample	P130703-LCS	**83**	**95**	**106**	70-130	
VP-1-062113	P1302737-001	**85**	**96**	**109**	70-130	
VP-2-062113	P1302737-002	**85**	**97**	**109**	70-130	

Surrogate percent recovery is verified and accepted based on the on-column result.
Reported results are shown in concentration units and as a result of the calculation, may vary slightly from the on-column percent recovery.

ALS ENVIRONMENTAL

LABORATORY CONTROL SAMPLE SUMMARY

Client: **Aspect Consulting**
Client Sample ID: **Lab Control Sample** ALS Project ID: P1302737
Client Project ID: **Port Ludlow OWSI / 130046** ALS Sample ID: P130703-LCS

Test Code: EPA TO-15 Modified Date Collected: NA
Instrument ID: Tekmar AUTOCAN/Agilent 5975Binert/6890N/MS13 Date Received: NA
Analyst: Chris Cornett Date Analyzed: 7/3/13
Sample Type: 6.0 L Summa Canister Volume(s) Analyzed: 0.125 Liter(s)
Test Notes:

CAS #	Compound	Spike Amount µg/m³	Result µg/m³	% Recovery	ALS Acceptance Limits	Data Qualifier
1634-04-4	Methyl tert-Butyl Ether	204	**173**	**85**	69-120	
110-54-3	n-Hexane	206	**157**	**76**	63-115	
107-06-2	1,2-Dichloroethane	208	**161**	**77**	69-118	
71-43-2	Benzene	208	**182**	**88**	69-117	
108-88-3	Toluene	208	**195**	**94**	65-116	
106-93-4	1,2-Dibromoethane	208	**204**	**98**	69-130	
100-41-4	Ethylbenzene	206	**200**	**97**	66-119	
179601-23-1	m,p-Xylenes	412	**388**	**94**	64-118	
95-47-6	o-Xylene	200	**191**	**96**	65-120	
108-67-8	1,3,5-Trimethylbenzene	208	**203**	**98**	64-125	
95-63-6	1,2,4-Trimethylbenzene	200	**201**	**101**	64-131	
91-20-3	Naphthalene	178	**185**	**104**	56-143	

Laboratory Control Sample percent recovery is verified and accepted based on the on-column result.
Reported results are shown in concentration units and as a result of the calculation, may vary slightly.

APPENDIX D

Terrestrial Ecological Evaluation Form

Voluntary Cleanup Program

Washington State Department of Ecology
Toxics Cleanup Program

TERRESTRIAL ECOLOGICAL EVALUATION FORM

Under the Model Toxics Control Act (MTCA), a terrestrial ecological evaluation is necessary if hazardous substances are released into the soils at a Site. In the event of such a release, you must take one of the following three actions as part of your investigation and cleanup of the Site:

1. Document an exclusion from further evaluation using the criteria in WAC 173-340-7491.
2. Conduct a simplified evaluation as set forth in WAC 173-340-7492.
3. Conduct a site-specific evaluation as set forth in WAC 173-340-7493.

When requesting a written opinion under the Voluntary Cleanup Program (VCP), you must complete this form and submit it to the Department of Ecology (Ecology). The form documents the type and results of your evaluation.

Completion of this form is not sufficient to document your evaluation. You still need to document your analysis and the basis for your conclusion in your cleanup plan or report.

If you have questions about how to conduct a terrestrial ecological evaluation, please contact the Ecology site manager assigned to your Site. For additional guidance, please refer to www.ecy.wa.gov/programs/tcp/policies/terrestrial/TEEHome.htm.

Step 1: IDENTIFY HAZARDOUS WASTE SITE	
Please identify below the hazardous waste site for which you are documenting an evaluation.	
Facility/Site Name: 781 Walker Way, Port Ludlow	
Facility/Site Address: 781 Walker Way, Port Ludlow, WA 98365	
Facility/Site No:	VCP Project No.: SW1311

Step 2: IDENTIFY EVALUATOR			
Please identify below the person who conducted the evaluation and their contact information.			
Name: Brett Carp			Title: Sr. Environmental Scientist
Organization: Aspect Consulting			
Mailing address: 401 2nd Avenue South, #201			
City: Seattle		State: WA	Zip code: 98104
Phone: 206-838-5836	Fax: 206-838-5853	E-mail: bcarp@aspectconsulting.com	

Step 3: DOCUMENT EVALUATION TYPE AND RESULTS

A. Exclusion from further evaluation.

1. Does the Site qualify for an exclusion from further evaluation?

☒ Yes *If you answered **"YES,"** then answer **Question 2**.*

☐ No or Unknown *If you answered **"NO" or "UKNOWN,"** then skip to **Step 3B** of this form.*

2. What is the basis for the exclusion? *Check all that apply. Then skip to **Step 4** of this form.*

Point of Compliance: WAC 173-340-7491(1)(a)

☐ All soil contamination is, or will be,* at least 15 feet below the surface.

☒ All soil contamination is, or will be,* at least 6 feet below the surface (or alternative depth if approved by Ecology), and institutional controls are used to manage remaining contamination.

Barriers to Exposure: WAC 173-340-7491(1)(b)

☐ All contaminated soil, is or will be,* covered by physical barriers (such as buildings or paved roads) that prevent exposure to plants and wildlife, and institutional controls are used to manage remaining contamination.

Undeveloped Land: WAC 173-340-7491(1)(c)

☐ There is less than 0.25 acres of contiguous[#] undeveloped[±] land on or within 500 feet of any area of the Site and any of the following chemicals is present: chlorinated dioxins or furans, PCB mixtures, DDT, DDE, DDD, aldrin, chlordane, dieldrin, endosulfan, endrin, heptachlor, heptachlor epoxide, benzene hexachloride, toxaphene, hexachlorobenzene, pentachlorophenol, or pentachlorobenzene.

☐ For sites not containing any of the chemicals mentioned above, there is less than 1.5 acres of contiguous[#] undeveloped[±] land on or within 500 feet of any area of the Site.

Background Concentrations: WAC 173-340-7491(1)(d)

☐ Concentrations of hazardous substances in soil do not exceed natural background levels as described in WAC 173-340-200 and 173-340-709.

* An exclusion based on future land use must have a completion date for future development that is acceptable to Ecology.

[±] "Undeveloped land" is land that is not covered by building, roads, paved areas, or other barriers that would prevent wildlife from feeding on plants, earthworms, insects, or other food in or on the soil.

[#] "Contiguous" undeveloped land is an area of undeveloped land that is not divided into smaller areas of highways, extensive paving, or similar structures that are likely to reduce the potential use of the overall area by wildlife.

B. Simplified evaluation.

1. Does the Site qualify for a simplified evaluation?

☐ Yes *If you answered **"YES,"** then answer **Question 2** below.*

☐ No or Unknown *If you answered **"NO"** or **"UNKNOWN,"** then skip to **Step 3C** of this form.*

2. Did you conduct a simplified evaluation?

☐ Yes *If you answered **"YES,"** then answer **Question 3** below.*

☐ No *If you answered **"NO,"** then skip to **Step 3C** of this form.*

3. Was further evaluation necessary?

☐ Yes *If you answered **"YES,"** then answer **Question 4** below.*

☐ No *If you answered **"NO,"** then answer **Question 5** below.*

4. If further evaluation was necessary, what did you do?

☐ Used the concentrations listed in Table 749-2 as cleanup levels. *If so, then skip to **Step 4** of this form.*

☐ Conducted a site-specific evaluation. *If so, then skip to **Step 3C** of this form.*

5. If no further evaluation was necessary, what was the reason? *Check all that apply. Then skip to **Step 4** of this form.*

Exposure Analysis: WAC 173-340-7492(2)(a)

☐ Area of soil contamination at the Site is not more than 350 square feet.

☐ Current or planned land use makes wildlife exposure unlikely. Used Table 749-1.

Pathway Analysis: WAC 173-340-7492(2)(b)

☐ No potential exposure pathways from soil contamination to ecological receptors.

Contaminant Analysis: WAC 173-340-7492(2)(c)

☐ No contaminant listed in Table 749-2 is, or will be, present in the upper 15 feet at concentrations that exceed the values listed in Table 749-2.

☐ No contaminant listed in Table 749-2 is, or will be, present in the upper 6 feet (or alternative depth if approved by Ecology) at concentrations that exceed the values listed in Table 749-2, and institutional controls are used to manage remaining contamination.

☐ No contaminant listed in Table 749-2 is, or will be, present in the upper 15 feet at concentrations likely to be toxic or have the potential to bioaccumulate as determined using Ecology-approved bioassays.

☐ No contaminant listed in Table 749-2 is, or will be, present in the upper 6 feet (or alternative depth if approved by Ecology) at concentrations likely to be toxic or have the potential to bioaccumulate as determined using Ecology-approved bioassays, and institutional controls are used to manage remaining contamination.

C. Site-specific evaluation. A site-specific evaluation process consists of two parts: (1) formulating the problem, and (2) selecting the methods for addressing the identified problem. Both steps require consultation with and approval by Ecology. *See* WAC 173-340-7493(1)(c).

1. Was there a problem? *See* WAC 173-340-7493(2).

☐ Yes *If you answered **"YES,"** then answer **Question 2** below.*

☐ No *If you answered **"NO,"** then identify the reason here and then skip to **Question 5** below:*

- ☐ No issues were identified during the problem formulation step.
- ☐ While issues were identified, those issues were addressed by the cleanup actions for protecting human health.

2. What did you do to resolve the problem? *See* WAC 173-340-7493(3).

☐ Used the concentrations listed in Table 749-3 as cleanup levels. *If so, then skip to **Question 5** below.*

☐ Used one or more of the methods listed in WAC 173-340-7493(3) to evaluate and address the identified problem. *If so, then answer **Questions 3 and 4** below.*

3. If you conducted further site-specific evaluations, what methods did you use?
Check all that apply. See WAC 173-340-7493(3).

- ☐ Literature surveys.
- ☐ Soil bioassays.
- ☐ Wildlife exposure model.
- ☐ Biomarkers.
- ☐ Site-specific field studies.
- ☐ Weight of evidence.
- ☐ Other methods approved by Ecology. If so, please specify:

4. What was the result of those evaluations?

- ☐ Confirmed there was no problem.
- ☐ Confirmed there was a problem and established site-specific cleanup levels.

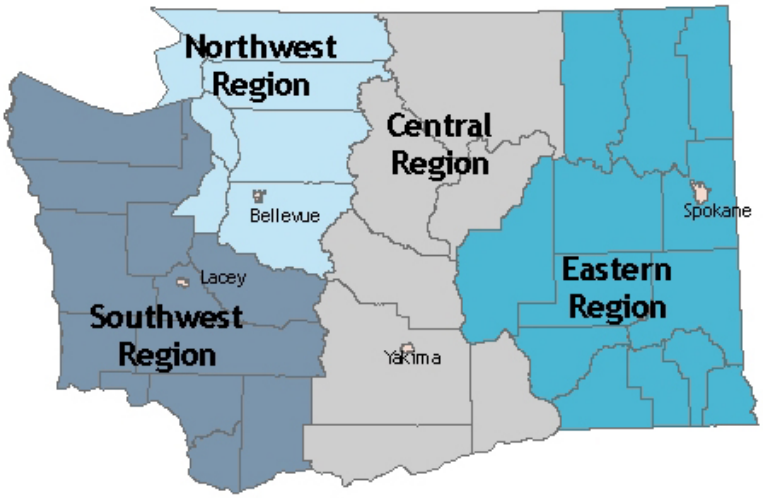
5. Have you already obtained Ecology's approval of both your problem formulation and problem resolution steps?

☐ Yes If so, please identify the Ecology staff who approved those steps:

☐ No

Step 4: SUBMITTAL

Please mail your completed form to the Ecology site manager assigned to your Site. If a site manager has not yet been assigned, please mail your completed form to the Ecology regional office for the County in which your Site is located.



Northwest Region: Attn: VCP Coordinator 3190 160th Ave. SE Bellevue, WA 98008-5452	**Central Region:** Attn: VCP Coordinator 15 W. Yakima Ave., Suite 200 Yakima, WA 98902
Southwest Region: Attn: VCP Coordinator P.O. Box 47775 Olympia, WA 98504-7775	**Eastern Region:** Attn: VCP Coordinator N. 4601 Monroe Spokane WA 99205-1295

APPENDIX E

Review of Potential Remediation Technologies for Petroleum-Impacted Sites

E.1 Institutional Controls

Institutional controls are measures to limit or prohibit activities that may interfere with the integrity of a cleanup action or result in exposure to hazardous substances. Examples of institutional controls are limitations on the use of the property or resources such as an environmental covenant or maintenance requirements for engineering controls.

Advantages

- Can be easy to implement without disrupting operations.
- Relatively low cost.

Limitations

- Does not address the destruction or remediation of COCs.
- Depending on site-specific conditions, may not be sufficient to prevent off-property migration of COCs.
- May result in restrictions on the property use.

Summary Evaluation

Because of its low cost and ease of implementation, institutional controls can be a valuable component of a remediation strategy at sites impacted with petroleum hydrocarbons.

E.2 Engineering Controls

Engineering controls means containment and/or treatment systems that are designed and constructed to prevent or limit the movement of, or the exposure to, hazardous substances. An example of an engineering control would be a physical barrier such as asphalt or concrete paving/capping.

Advantages

- Can be easy to implement without disrupting operations.
- Can be relatively low cost.

Limitations

- Does not address the destruction or remediation of COCs.
- Depending on site-specific conditions, may not be sufficient to prevent off-property migration of COCs.
- May result in restrictions on the property use.

Summary Evaluation

Because of its low cost and ease of implementation, engineering controls can be a valuable component of a remediation strategy for petroleum-impacted sites.

E.3 Monitored Natural Attenuation

Monitored natural attenuation involves the destruction of COCs in site soil and groundwater by *in situ* by natural processes, including as biodegradation by native bacteria. This technology typically involves periodic monitoring of soil, groundwater, and/or air to evaluate remediation progress and ensure continued protectiveness.

Advantages

- COCs are permanently destroyed.
- Easy to implement without disrupting operations.
- Relatively low cost.

Limitations

- Depending on site-specific conditions, remediation may take an extended time period.
- Depending on site-specific conditions, may not be sufficient to prevent off-property migration of COCs.

Summary Evaluation

Because of its low cost and ease of implementation, monitored natural attenuation can be a valuable component of a remediation strategy at petroleum-impacted sites.

E.4 Soil Vapor Extraction

Soil vapor extraction involves removal of COCs in site soils above the water table by applying a vacuum to wells and treating constituents removed in the extracted soil gas. Equipment required with this technology includes wells, piping, a vacuum blower, moisture knockout pot, and treatment equipment (e.g., activated carbon vessels). Operation requirements include electricity for the vacuum blower, natural gas for the catalytic oxidizer, disposal of generated wastes (condensate water), equipment maintenance, and air monitoring.

Advantages

- COCs are permanently destroyed.
- Relatively non-disruptive technology (will require temporary disturbance to install wells and piping).
- Area of treatment can extend underneath otherwise inaccessible facility areas.

Limitations

- Removal of COCs from low-permeability soils can be limited by the rate of diffusion through these soils.
- Not effective in groundwater or soil below the water table.

Summary Evaluation

Because of its moderate cost and ease of implementation, soil vapor extraction can be a valuable component of a remediation strategy at petroleum-impacted sites. However, this technology was pilot tested at the Site between December 2011 and January 2012 and overall performance was poor. Initial soil vapor extraction mass removal rates were relatively low, and removal rates declined rapidly over the testing period, even with the addition of groundwater extraction (dual-phase extraction).

E.5 Air Sparging

Air sparging involves removal of COCs from groundwater and saturated soil and by injecting air in wells screened below the water table. Volatile contaminants evaporate into the injected air, which is typically collected and treated by through soil vapor extraction (see E.4 above). Equipment required with this technology includes wells, piping, and an air compressor. Operation requirements include electricity for the air compressor, equipment maintenance, and air monitoring.

Advantages

- COCs are permanently removed and destroyed (if collected/treated with soil vapor extraction).
- Relatively non-disruptive technology (will require temporary disturbances to install wells and piping).
- Area of treatment can extend underneath otherwise inaccessible facility areas.

Limitations

- Heterogeneous geology may limit the rate of diffusion through low-permeability soil layers and reduce treatment effectiveness.
- Preferential pathways for subsurface air movement may still result in incomplete treatment in some areas.
- Heterogeneous soils, especially low permeability zones above the air injection level, can make recovery of sparged air problematic and can result in unpredictable subsurface migration of contaminated soil vapor.

Summary Evaluation

Because of its moderate cost and ease of implementation, air sparging can be a valuable component of a remediation strategy at petroleum-impacted sites. However, given the heterogeneous subsurface soils present at the Site, and the transient nature of perched groundwater, both the implementability of air sparging, and the recovery of sparged vapors, would be problematic at the Site.

E.6 Enhanced Aerobic Biodegradation

Enhanced aerobic biodegradation is the practice of adding oxygen (an electron acceptor) to groundwater and/or soil to increase the number and vitality of indigenous microorganisms already naturally performing biodegradation of COCs at the Site. Application is typically accomplished via injection of a liquid compound to provide oxygen to the subsurface. This process is performed in several discrete injection events and does not require continuously-operating equipment on site.

Advantages

- COCs are permanently destroyed *in situ*.
- Easy to implement without significantly disrupting operations.
- Can enhance remediation in otherwise inaccessible areas by altering groundwater conditions over a localized area.

Limitations

- Although faster than natural attenuation, remediation will likely be limited by the rate at which COCs desorb from soil. Therefore, remediation time with this technology may be a decade or more.
- Generally not effective in soil above the water table.

Summary Evaluation

Enhanced aerobic biodegradation is not typically cost-effective for source removal, but is most applicable as a polishing technology. Although faster than unassisted natural attenuation, this is typically still a slow process that can take a number of years to destroy COCs, may require multiple injection events, and is generally employed following treatment of saturated soil and groundwater by more aggressive technologies.

E.7 *In Situ* Chemical Oxidation

For chemical oxidization, a strong oxidizing chemical (e.g., ozone, Fenton's reagent, activated persulfate, permanganate) is injected into groundwater or mixed into soil to react and mineralize (i.e., convert to carbon dioxide and water) organic contaminants. Ozone is typically applied in gas form as part of air sparging; Fenton's reagent and activated persulfate are typically injected as liquid solutions into groundwater.

Advantages

- COCs are permanently destroyed *in situ.*
- May not require installation of permanent wells, piping, or equipment which may help minimize disruption to business operations.
- Potential area of influence could extend underneath inaccessible areas of the Site.

Limitations

- Generally not effective in soil above the water table.
- Low-permeability soils may not be adequately addressed.

Summary Evaluation

The success of this technology is highly dependent on the chemical oxidant physically coming into contact and reacting with COCs in soil and groundwater. The presence of heterogeneous soils and low-permeability zones can limit the ability of this technology to completely treat impacted soil and groundwater.

E.8 Dual-Phase Extraction

This approach uses soil vapor extraction in conjunction with groundwater pumping to depress the water table, which exposes shallow saturated soils to treatment by soil vapor extraction, and provides hydraulic containment and removal of COCs in site groundwater. To increase effectiveness, this technology can be applied in conjunction with air sparging to provide additional groundwater treatment. In addition to equipment required by soil vapor extraction, this technology requires either submersible pumps or a high-vacuum blower to remove water, and additional treatment equipment. Water disposal can require obtaining a sewer discharge authorization and possibly treatment prior to discharge.

Advantages

- COCs are permanently removed and destroyed.
- Provides hydraulic control of chemical migration as well as on-site treatment.
- Area of influence from pumping can extend underneath inaccessible areas.

Limitations

- Heterogeneous soils and low-permeability zones can complicate application, increase costs, and result in incomplete treatment.
- High soil permeability can result in the need to remove and treat large volumes of water to adequately depress the water table.
- Requires significant above-ground space for required equipment.
- Can have relatively high cost for water disposal.

Summary Evaluation

The presence of heterogeneous soils and low-permeability zones can limit the ability of this technology to completely treat impacted soil and groundwater. This technology was pilot tested at the Site between December 2011 and January 2012 and overall performance was poor. Water removal rates were low, consistent with the dense, low permeability glacial soil of the shallow perched aquifer. Initial mass removal rates were relatively low, and mass removal rates declined rapidly over the testing period.

E.9 Soil Excavation

This technology involves removing contaminated soils and transporting the soil to a permitted disposal facility (e.g., landfill or soil recycler). Soil can be removed by a variety of techniques; shallow soil is typically removed with an excavator, while deeper soil may be removed using overlapping augers or a shored excavation.

Advantages

- For soil that can be accessed, this is the most certain method of removing COCs from the Site.
- For shallow impacted soils, excavation coupled with off-site disposal is typically the most cost-effective active remedial measure.

Limitations

- Excavation costs increase significantly with depth and proximity to load bearing structures and buildings, particularly when shoring is required.
- Impacted soil beneath buildings and other facilities typically requires the demolition of those structures to access soil.
- Excavation is potentially disruptive, particularly when the removal is not consistent with site development plans.

Summary Evaluation

Shallow impacted soil was removed the extent practical at the Site in 1990. Removal of additional deeper impacted soil at the Site would require a deep, sloped excavation. Demolition and replacement of the existing shop/garage building would also be required.

APPENDIX F

SLR Soil Vapor Extraction Pilot Test Report (on CD)

May 8, 2012
Project 101.00433.00003

Mr. Larry Smith
Olympic Water & Sewer, Inc.
70 Breaker Lane
Port Ludlow, Washington 98635

Re: Soil Vapor Extraction Pilot Test Report, Olympic Water & Sewer, Inc. Facility, 781 Walker Way, Port Ludlow, Washington

Dear Larry:

SLR International Corporation (SLR) has prepared this report to present the results of the soil vapor extraction (SVE) pilot tests that were recently conducted at the Olympic Water & Sewer, Inc. (OWSI) facility in Port Ludlow, Washington. The purposes of the pilot tests were to: 1) assess the potential effectiveness of SVE, with and without groundwater de-watering, at remediating the volatile petroleum hydrocarbon-impacted soil, 2) evaluate if groundwater extraction can effectively de-water the shallower portion of saturated zone (above the Unit B silty sand), expose the capillary fringe above the deeper water table (above the Unit D silts), and allow SVE to remove additional petroleum hydrocarbon vapors from the shallower saturated zone and the capillary fringe, and 3) obtain the information necessary for potential future design and implementation of an SVE system, with or without groundwater recovery/treatment.

PROPERTY DESCRIPTION

The subject property, which is owned by OWSI, is located at 781 Walker Way in Port Ludlow, Washington. The location of the property is shown on Figure 1. The OWSI property is an approximate 2.2-acre parcel that is partially developed with an OWSI operation and maintenance facility. The facility consists of an approximate ½-acre area that includes an office/shop/garage building (garage building), a public water supply well (Well #2) and associated pump house building, and a storage trailer (see Figure 2). The ground surface within the facility is primarily unpaved, except for a narrow asphalt driveway that runs down the center of the facility from Walker Way to approximately the storage trailer. Within the OWSI property, the facility is surrounded on all sides by dense forest, and a gulley containing an intermittent stream is located within the forest to the west of the facility. The facility has been operating since 1968, after the installation of the water supply well. Prior to 1968, the property was undeveloped.

SUMMARY OF ENVIRONMENTAL CONDITIONS

In 1990, the three gasoline underground storage tanks (USTs) at the property were removed. A 1,000-gallon UST was located beneath the floor of the northern garage bay, a 2,000-gallon UST was located outside (west) of the northern garage bay, and a 2,000-gallon UST was located approximately 40 feet south of the garage. The approximate locations of the UST excavations are shown on Figure 2. Volatile petroleum hydrocarbon-impacted soil was only present in the 1,000-gallon tank excavation and the northern 2,000-gallon tank excavation [Applied Geotechnology, Inc. (AGI), 1991]. Excavation activities were conducted to remove the impacted soil near the tanks; however, due to structural concerns for the building, the excavation at the former 1,000-gallon tank could only be extended to a depth of approximately 10 feet below ground surface (bgs).

During subsequent environmental investigations at the property, a total of 13 soil borings were drilled and sampled. The approximate locations of the borings are shown on Figure 2. The soil sample analytical results from the 1990 gasoline UST removals (including the subsequent soil excavations) (AGI, 1991), and the field screening and soil sample analytical results from the subsurface investigations at the property (SLR, 2010; and SLR, 2011) indicate that the former northern gasoline UST area is the source of the remaining volatile petroleum hydrocarbon-impacted soil and groundwater beneath the property. The hydrocarbon-impacted soil occurs at the base of the former 1,000-gallon UST excavation (at approximately 10 feet bgs) and extends to the saturated zone above the Unit B silty sands (approximately 20 feet bgs) and may also extend to the water table above the Unit D silts (approximately 41 feet bgs) near the garage building. The estimated area of impacted soil extends beyond the western, eastern, and southern ends of the garage building and covers an area of approximately 3,140 square feet. The estimated area of the hydrocarbon-impacted soil is shown on Figure 3.

Well #2, which is located at the northern portion of the property, is screened at depths ranging from 214 to 245 feet bgs. After 40 years of operation, the yield of Well #2 was decreasing, and in 2009, OWSI decided to install a replacement well (designated Well #17) at the southern part of the facility. The planned construction of Well #17 was similar to the construction of Well #2. On April 21, 2009, during the drilling of Well #17, the driller noticed a gasoline odor emanating from the well casing at a depth of approximately 50 feet [Robinson Noble & Saltbush, Inc. (Robinson Noble), 2009]. The drilling was discontinued, and soil and groundwater samples were collected from the bottom of the casing for laboratory analysis. The analytical results showed that the groundwater sample contained gasoline-range organics (GRO) and benzene concentrations [5,530 and 948 micrograms per liter (µg/L), respectively] that exceeded the Model Toxics Control Act (MTCA) Method A groundwater cleanup levels (800 and 5 µg/L, respectively). Due to the presence of the

gasoline-impacted groundwater, the well was not completed and the casing was capped. The location of the casing for Well #17 is shown on Figure 2.

During the 2010 and 2011 subsurface investigations, five of the soil borings were completed as groundwater monitoring wells (MW-1, MW-2, MW-3, MW-4, and MW-5), and groundwater sampling events were conducted in June 2010, October 2010, and April 2011. In addition, the soil borings that were completed as SVE points (SVE-1 and SVE-2) contained shallow groundwater, and groundwater samples were collected from the SVE points in April 2011. The locations of the monitoring wells and SVE points are shown on Figure 4. The groundwater sample analytical results showed that all of the samples from MW-1 and MW-2 and the April 2011 sample from SVE-1 contained benzene and GRO concentrations (up to 2,100 and 34,000 µg/L, respectively) that exceeded the MTCA Method A cleanup levels (SLR, 2010; and SLR, 2011). The April 2011 samples from MW-4 and SVE-2 contained benzene and GRO concentrations, respectively, that exceeded the Method A cleanup levels.

Based on the groundwater sample analytical results from the 2009 drilling of Well #17 (Robinson Noble, 2009) and the 2010 and 2011 subsurface investigations (SLR, 2010; and SLR, 2011), petroleum hydrocarbon concentrations greater than the MTCA Method A groundwater cleanup levels occur near the source area (former northern gasoline UST area) and primarily extend to the south and southwest. The estimated area of the hydrocarbon-impacted groundwater is shown on Figure 4. The greatest petroleum hydrocarbon concentrations occurred in the shallow saturated zone above the Unit B silty sands beneath the western edge of the garage building (at SVE-1). Based on the presence of petroleum hydrocarbons at wells MW-4 and MW-5, there is also a limited component of impacted groundwater migration (likely above Unit B) to the north and east.

PROPERTY GEOLOGY AND HYDROGEOLOGY

The subsurface investigations indicate that the soils beneath the subject property consist of surficial gravel fill underlain by dense glacial advance outwash (sand, gravel, and silt units) with interbedded lacustrine silts to the maximum depth drilled (approximately 60 feet bgs). The distributions of subsurface soils (grouped by lithologies into Units A through E) are shown on Figure 5.

Unit A extends beneath all of the investigated portions of the property and varies from approximately 29 to 43 feet in thickness. Unit A primarily consists of very fine to fine sand or gravelly sand, and includes silty sands and a 5- to 10-foot-thick sandy silt to silt interbed beneath some portions of the property. Unit A is underlain by Unit B beneath the northeastern and eastern parts of the property (at MW-1, MW-4, MW-5, SB-1, SVE-1, and SVE-2), by Unit C beneath the central part of the property (at MW-2), and by Unit D beneath

the southern part of the property (at MW-3). Unit B consists of silty sand that is up to 11 feet thick where encountered, and is underlain by Unit D. Unit C was only encountered at MW-2, and consists of gravel with cobbles. Unit C has a maximum thickness of 12 feet and is underlain by Unit D. Unit D extends beneath all of the investigated portions of the property, consists of hard silt, clayey silt, and gravelly silt, and ranges from approximately 15 to more than 23 feet in thickness. In the central part of the OWSI facility (at MW-1 and MW-2), the top of Unit D occurs at an elevation of approximately 251 feet above the NAVD 88 datum, while at the northern and southern parts of the facility and to the east of the facility (at MW-4, MW-3, and MW-5, respectively), Unit D occurs at higher elevations (approximately 260 to 263 feet above the NAVD 88 datum). At MW-2, MW-3, MW-4, and SVE-2, Unit D contains an interbed of sand with gravel and cobbles that is approximately 5 to 7.5 feet thick. A very dense, very fine to fine silty sand that underlies Unit D at the bottom of the deepest boring at the facility (MW-1) is identified as Unit E.

According to the driller's log for the water supply well (Well #2) located in the northern part of the property (see Figure 2), a thick sequence of clays with cemented gravels extends from approximately 49 to 215 feet bgs (SLR, 2010). The deep water-bearing units at Well #2 occur at depths between 215 and 245 feet bgs.

In general, sands and gravels are significantly more permeable than silty sands, silts, sandy silts, clayey silts, and gravelly silts. Therefore, Unit A and Unit C are interpreted as being relatively permeable soils that provide preferential pathways for groundwater flow. Units B, D, and E are interpreted as being relatively impermeable soils that act as local aquitards. The uppermost clay identified in the driller's log for Well #2 is a "sandy clay" that extends from about 49 to 79 feet bgs, which is generally consistent with the depths of Units D and E. This suggests that an aquitard consisting of Unit B, Unit D, Unit E, and associated underlying fine-grained soils extends beneath the facility, has a minimum 30-foot thickness, and may locally exceed 55 feet in thickness.

On December 12, 2011, prior to start-up of the first SVE pilot test, groundwater levels were measured in all of the monitoring wells and SVE points at the facility. The depths to groundwater ranged from 25.82 to 40.69 feet below the tops of the well casings, and the groundwater elevations ranged from 253.10 to 270.14 feet above the NAVD 88 datum. The groundwater elevations at several of the wells and SVE-1 are shown on Figure 5. The groundwater table beneath the property occurs as a single, hydraulically continuous saturated zone; however, the depth and elevation of the water table vary significantly beneath the property. The water table position appears to be primarily controlled by the elevation of the uppermost laterally-extensive aquitard. Beneath the northern and eastern portions of the facility and east of the facility, the uppermost aquitard is Unit B, the aquitard elevation is about 260 to 270 feet above the NAVD 88 datum, and the water table intercepts either Unit A sands or underlying Unit B silty sand (this shallower area of the water table is monitored at

MW-4, MW-5, SVE-1, and SVE-2). Beneath the south-central and southern parts of the facility, the uppermost aquitard unit is Unit D, the aquitard elevation is typically below 260 feet, and a deeper area of the water table intercepts Unit C gravel at MW-2 and either Unit A sands or underlying Unit D silts at MW-3 (the deeper water table area). Well MW-1, in the north-central part of the facility (approximately 10 feet southwest of SVE-1), monitors the deeper water table within the aquitard units (Unit B and Unit D).

Within the shallow water table area, groundwater is expected to primarily flow laterally above the aquitard within the relatively permeable Unit A sands towards the deeper water table area. Within the deeper water table area, groundwater is expected to primarily flow laterally above the aquitard within the relatively permeable Unit C gravels. The elevations of both the aquitard and the water table beneath the deeper water table area in the central part of the facility (near MW-2) is about 9 to 15 feet lower than at the northern, southern, and eastern parts of the facility. Based on the known topography of the uppermost aquitard surface, the water table elevations, and the area of petroleum hydrocarbon-impacted groundwater (see Figure 4), there appears to be a groundwater flow component beneath the facility to the south-southwest.

SVE PILOT TESTS

From December 12, 2011 through January 5, 2012, SLR conducted four SVE pilot tests to: 1) assess the potential effectiveness of SVE, with and without groundwater de-watering, at remediating the remaining volatile petroleum hydrocarbon-impacted soil, 2) evaluate if groundwater extraction can effectively de-water the shallower portion of the saturated zone (above the Unit B silty sand), expose the capillary fringe above the deeper water table (above the Unit D silts), and allow SVE to remove additional petroleum hydrocarbon vapors from the shallower saturated zone and the capillary fringe, and 3) obtain the information necessary for potential future design and implementation of an SVE system, with or without groundwater recovery/treatment.

Prior to conducting the first three pilot tests, SLR obtained verbal authorization from the Olympic Region Clean Air Agency (ORCAA) to conduct the three shorter pilot tests without treatment of the extracted soil vapors. However, for the extended pilot test (Pilot Test #4), ORCAA required treatment of the extracted vapors prior to emission to the atmosphere.

Each pilot test consisted of connecting a 3-horsepower Rotron EN523 regenerative blower to the selected extraction point, and applying the maximum vacuum pressure created by the blower. After applying the vacuum, SLR personnel measured the flow rate of the extracted air within a 2-inch-diameter influent pipe to the blower by using an anemometer, and monitored the approximate petroleum hydrocarbon concentrations in the extracted and emitted soil vapors by using a photoionization detector (PID). During each test, SLR also measured the vacuum

pressures at the SVE points and at all of the monitoring wells with magnehelic gauges to evaluate the radius of applied vacuum influence in the subsurface. Prior to beginning and during each test, SLR measured the depths to groundwater in all of the SVE points and monitoring wells by using an electronic water level indicator. The field data collected during each test are described below and copies of the field notes that include the data are attached.

At initiation and completion of Pilot Tests #1 and #2, a sample of the extracted soil vapors was collected for laboratory analysis. During Pilot Test #3, an extracted soil vapor sample was only collected at test initiation, and during Pilot Test #4, the samples were collected after one week of operation and at completion of the test. During the initiation of the first three tests, the samples were collected at the emission stack. Immediately after completing each test, the samples were collected at the influent pipe to the blower. We had planned to collect all of the samples at the influent pipe to the blower; however, the samples were collected by using a gas sampling bulb with new tubing, and due to the high vacuum pressures, the sampling method could not overcome the applied vacuum while the blower was operating. Therefore, we collected the test initiation samples from the emission stack (under positive pressure after the blower). To allow for sample collection under ambient pressure during Pilot Test #4, the blower was temporarily shut off on December 29, 2011, and a sample was collected at the influent pipe instead of the stack. All of the extracted soil vapor samples were submitted to Friedman & Bruya, Inc. (F&B) in Seattle, Washington, for analysis of benzene, toluene, ethylbenzene, and total xylenes (BTEX) by EPA Method 8021B and GRO by Ecology Method NWTPH-Gx. The samples analytical results are described below and presented in Table 1. Copies of the laboratory reports are attached.

Pilot Test #1

Pilot Test #1 was conducted on December 12, 2011, and a vacuum pressure of approximately 97 inches of water column was initially applied to soil vapor extraction point SVE-1. Groundwater de-watering was not conducted during the test. The airflow rate was only 18 cubic feet per minute (cfm) and the PID readings decreased from 89.1 to 12.1 parts per million (ppm) in 70 minutes. The extracted soil vapor sample collected at system initiation (Test1-Sample1) contained a GRO concentration of 30 milligrams per cubic meter [mg/m^3; converted to 6.9 ppm by volume (ppm-v)]. To expose more of the SVE point screen during the test, the applied pressure was reduced to 60 inches of water column after the second hour of the test by opening a dilution valve on the influent pipe to the blower. After reducing the pressure, the airflow rate (prior to the dilution valve) decreased to approximately 14 to 16 cfm, and the first PID reading was only 7.1 ppm. The PID readings were measured at the emission stack, except for two occasions during the last 100 minutes of the test when we temporarily shut off the blower and measured the PID readings at the influent pipe to the blower (prior to the dilution valve). The PID readings at the influent pipe were 106.2 and 161.2 ppm; however, the

extracted soil vapor sample (Test1-Sample2) at the completion of the test (collected at the influent pipe) only contained a GRO concentration of 47 mg/m^3 (10.8 ppm-v).

After almost four hours of operation, the test was terminated. During the test, vacuum pressures were not measured at any of the monitoring wells or at soil vapor extraction point SVE-2.

Pilot Test #2

On December 13, 2011, the pilot test at SVE-1 was repeated; however, to assess the effects of de-watering the shallower saturated zone above the Unit B silty sand, a Grundfos Redi-Flo 2 submersible pump was installed in SVE-1. The extracted water was pumped into a 4,000-gallon tank for temporary storage, and a totalizing flow meter was used to monitor the groundwater pumping rate.

The initial groundwater pumping rate was approximately 2.5 gallons per minute (gpm); however, after removing the water from the well and associated gravel pack, the pumping rate decreased to approximately 0.13 to 0.19 gpm for the rest of the test. During the 9-hour-long test, a total of 77.1 gallons of groundwater were pumped. The groundwater drawdown in SVE-1 was approximately 8.80 feet, and by the end of the test, groundwater drawdowns of 1.62, 0.64, 0.50, and 0.67 feet were observed in SVE-2, MW-1, MW-4, and MW-5, respectively. SVE-2, MW-4, and MW-5, which are at least partially screened within the shallow saturated zone above Unit B, are located approximately 31 to 72 feet from SVE-1 (see Figure 4). MW-1 is screened within the deeper saturated zone above and within the Unit D silts, and it is located approximately 9 feet from SVE-1. Groundwater drawdown was not observed at wells MW-2 or MW-3. MW-2 and MW-3 are screened within the deeper saturated zone above and/or within Unit D, and are located approximately 63 and 150 feet, respectively, from SVE-1. The extensive radius of pumping influence after extracting only 77 gallons of water indicates that recharge to the shallow groundwater above Unit B, within the test area, was limited. The groundwater drawdown in MW-1 demonstrates the hydraulic continuity between the shallower saturated zone above Unit B and the deeper water table above Unit D.

During Pilot Test #2, a vacuum pressure of approximately 97 inches of water column was applied to SVE-1. The airflow rate was 16 to 18 cfm and the PID readings at the emission stack decreased from approximately 80 to 4 ppm during the test. The extracted soil vapor sample (Test2-Sample1) at system initiation (at the stack) did not contain detectable BTEX or GRO concentrations; however, the sample (Test2_Sample2) collected at system termination (at the influent pipe) contained a GRO concentration of 1,900 mg/m^3 (437 ppm-v).

During the test, vacuum pressures (0.30 to 1.0 inches of water column) were detected at SVE-2, but not in any of the monitoring wells. SVE-2 is located approximately 31 feet from

SVE-1 (see Figure 4). Vacuum pressures were consistently present at SVE-2 after conducting the test for approximately two hours.

After approximately five hours of the test, SLR collect a sample of the extracted groundwater for laboratory analysis. The sample was submitted to F&B for analysis of BTEX by EPA Method 8021B and GRO by Ecology Method NWTPH-Gx. The sample contained benzene and GRO concentrations of 430 and 23,000 µg/L, respectively. The water sample analytical results are presented in Table 2 and a copy of the laboratory report is attached.

Pilot Test #3

On December 14, 2011, an additional SVE pilot test with groundwater extraction was conducted at monitoring well MW-1, which is screened through the deeper water table above Unit D. This test was conducted to: 1) assess the potential effectiveness of combined SVE and groundwater extraction at removing gasoline from the capillary fringe of the deeper water table (above Unit D), and 2) further assess the hydraulic connection between the shallow saturated zone above Unit B and the deeper water table above Unit D. This test followed the same procedures as Pilot Test #2.

The initial groundwater pumping rate was approximately 2.5 gpm; however, after removing the water from the well and associated gravel pack, the pumping rate decreased to a rate that could not be measured by the flow meter. After approximately 7 hours, we moved the test to MW-2 to find out if the very low pumping rate at MW-1 was due to localized geologic conditions. At MW-2, the pumping rate quickly decreased from 2.5 to 0.5 gpm; however, after 10 minutes, we took the sample port off of the influent pipe to the blower and the open hole appeared to slightly increase the pumping rate. To assess the possible scenario that a vacuum lock had formed on MW-1 and was inhibiting groundwater flow into the well, we moved the test back to MW-1 and took the sample port off of the influent pipe. After removal of the sample port, the pumping rate did not increase over a period of approximately 20 minutes.

After the pumping rate did not increase at MW-1, we moved the test back to MW-2 to further assess the yields of the deeper saturated zone above Unit D. The pumping rate at MW-2 was approximately 0.2 gpm for a period of one hour. During the approximate 9-hour-long test at MW-1 and MW-2, a total of only 19.8 gallons of groundwater were recovered, and it appears that the yield of the deeper saturated zone above Unit D is up to 0.2 gpm. The lower pumping rate at MW-1 represents the geologic conditions near the well, and not a potential vacuum lock on the well during the test.

The groundwater drawdown in MW-1 was approximately 8.90 feet, and by the end of the test, groundwater drawdown was not observed in the SVE points or any of the other monitoring wells, except MW-2 due to the temporary pumping at that well. There was also no observed

drawdown in the SVE points or any of the other monitoring wells during the pumping at MW-2.

During Pilot Test #3, a vacuum pressure of approximately 95 to 97 inches of water column was applied to MW-1 or MW-2. The airflow rates were 16 to 18 cfm and the PID readings at the emission stack were consistently less than 3 ppm during the test. The extracted soil vapor sample (Test3_Sample1) at system initiation contained a GRO concentration of 85 mg/m^3 (19.6 ppm-v). During the test on MW-1 or MW-2, there were no detected vacuum pressures in any of the SVE points or the other monitoring wells.

Pilot Test #4

Based on a comparison of the results of Pilot Test #1 and Pilot Test #2, the de-watering of the shallow saturated zone above Unit B allowed access to more of the hydrocarbon-impacted soil and improved the radius of vacuum influence. To determine if a longer period of de-watering would further enhance the SVE operations, Pilot Test #4 was conducted over a two week period at SVE-1. To minimize the maintenance associated with the groundwater pumping, a bottom-inlet pneumatic pump (a QED AP2B AutoPump) replaced the Grundfos pump. In accordance with ORCAA requirements, SLR installed two, 55-gallon carbon-filled canisters in series to the effluent line from the blower to treat the extracted soil vapors.

Pilot Test #4 was conducted from December 22, 2011 through January 5, 2012, and the pump and blower operated continuously, except for the period from the afternoon of December 30th through the morning of January 3rd when the equipment was inadvertently shut off. During the approximate 10-day-long period of operation, a total of 2,511 gallons of shallow groundwater were pumped, and the average pumping rate was approximately 0.17 gpm. By the end of the test, the groundwater drawdowns in SVE-2, MW-4, and MW-5, which are at least partially screened within the shallow saturated zone above Unit B, were 2.03, 0.70, and 0.89 feet, respectively. The groundwater drawdown in MW-1, which is partially screened within the deeper saturated zone above Unit D, was 2.59 feet. Groundwater drawdown was not observed at deeper saturated zone wells MW-2 or MW-3. Except possibly at well MW-5, it is not known if the groundwater drawdowns in the monitoring points had stabilized by the end of the test.

During Pilot Test #4, a vacuum pressure of approximately 96 inches of water column was initially applied to SVE-1; however, the applied pressure decreased to 86 inches of water column by the end of the test. The airflow rate was initially 53 cfm and it increased during the test to 75 cfm. The decreased pressure and increased airflow rate demonstrate that de-watering of the shallow saturated zone improved the performance of the SVE system. The PID reading at the influent pipe to the blower was initially 922 ppm, and the readings steadily decreased to 250 ppm by the end of the test. However, the extracted soil vapor samples collected on

December 29th (TEST4-Sample1) and January 5th (Test4_Sample2) at the influent pipe contained lower GRO concentrations (6.9 and 41.4 ppm-v, respectively).

By the end of the test, vacuum pressures were detected at all of the monitoring points, except MW-3. The vacuum pressure at SVE-2 was 4.5 inches of water column and the vacuum pressures at MW-1, MW-2, MW-3, MW-4, and MW-5 ranged from 0.03 to 0.70 inches of water column.

On December 29, 2011, SLR pumped some of the water in the temporary storage tank through two, 55-gallon carbon-filled canisters in series for treatment, and collected a sample of the effluent from the second carbon canister. The sample was submitted to F&B for analysis of BTEX and GRO. The sample did not contain BTEX or GRO concentrations greater than the MRLs. After completing Pilot Test #4, OWSI personnel pumped the all of the water in the storage tank through the carbon-filled canisters for treatment. The treated water was pumped into a tanker truck and hauled to the OWSI wastewater treatment plant in Port Ludlow for disposal.

EVALUATION OF PILOT TEST DATA

The results of the pilot tests indicate the following:

- There is limited recharge to the shallow groundwater above Unit B beneath the east-central part of the property (the area of concern), and limited pumping can significantly reduce the shallow water levels
- The shallow groundwater above Unit B is hydraulically connected to the deeper water table above Unit D
- De-watering of the shallow groundwater zone above Unit B exposes more of the hydrocarbon-impacted soil to the applied vacuum, and extracts the groundwater that contains the greatest petroleum hydrocarbon concentrations at the property
- The radius of shallow groundwater pumping influence is greater than 70 feet
- Extracted soil vapor sample analytical results and corresponding PID readings from Pilot Tests #2 and #4 were inconsistent and may reflect difficulties collecting a representative sample during operation of the blower

In addition to the results listed above, two key metrics that were used to evaluate the potential effectiveness of SVE/de-watering are the effective radius of vacuum influence and the hydrocarbon mass recovery rates.

Effective Radius of Vacuum Influence

For SVE system design purposes, the effective radius of applied vacuum influence is the maximum distance from an extraction point where the airflow rate is sufficient to remove the volatile petroleum hydrocarbons from vadose zone soils within a reasonable time [Chevron Research and Technology Company (CRTC), 1991]. To determine this radius of vacuum influence, SLR normalized the final vacuum pressure readings from the monitoring points during Pilot Test #4 by dividing the measured pressures by the final applied pressure at SVE-1, and converting to percentage values. The normalized values and distances from SVE-1 were then plotted on semi-log graph paper, and a best fit line of the data was used to represent the spatially averaged radial distribution of vacuum induced by SVE-1. In accordance with CRTC (1991) protocols, we conservatively assumed that the radial distance that corresponds to 1% of the applied vacuum, as interpolated from the fitted vacuum distribution line, represents the effective radius of vacuum influence and the appropriate spacing of SVE points in a full-scale system. Based on the data from Pilot Test #4, the effective radius of vacuum influence at the site is estimated to be 46 feet. The effective radius of influence should increase with a longer operation period because more of the shallow saturated zone will be de-watered. A copy of the plot of the normalized vacuum data is attached.

Hydrocarbon Mass Recovery Rates

To calculate the total hydrocarbon mass removal rates during the extended pilot test, SLR used the airflow and soil vapor sample analytical data collected during Pilot Test #4, after one week of the test and at the termination of the test. The mass removal rates were calculated by using the following equation:

> Removal rate (lbs/day) = airflow rate (cfm) x GRO concentration (ppm-v) x molecular weight of GRO (g/mole) x 1.58^{-7} x 24 hours/day (USEPA, 1989)

On December 29, 2011 (7 days after test activation), the hydrocarbon mass removal rate was 0.14 pounds per day. On January 5, 2012 (2 days after reactivating the blower and pump), the hydrocarbon mass removal rate increased to 1.2 pounds per day. These mass recovery rates may be biased low because there were significant discrepancies between the PID readings (392 and 250 ppm-v) and the analyzed GRO concentrations in extracted soil vapor samples (6.9 and 41.4 ppm-v). As stated previously, the differences between the PID readings and the GRO concentrations may be due to difficulties collecting representative samples. When using the PID readings instead of the analyzed concentrations, the hydrocarbon mass removal rates on December 29th and January 5th were 8.05 and 7.27 pounds per day, respectively. The mass removal rate calculation sheet is attached. The

hydrocarbon mass removal rates were limited by the presence of the shallow groundwater, and the rate should increase with continued removal of the groundwater.

CONCLUSIONS

In December 2011 and January 2012, four SVE pilot tests were conducted at the OWSI facility. The purposes of the tests were to: 1) assess the potential effectiveness of SVE, with and without groundwater de-watering, at remediating the remaining volatile petroleum hydrocarbon-impacted soil, 2) determine if groundwater extraction can effectively de-water the shallower portion of the saturated zone (above the Unit B silty sand), expose the capillary fringe above the deeper water table (above the Unit D silts), and allow SVE to remove additional petroleum hydrocarbon vapors from the shallower saturated zone and the capillary fringe, and 3) obtain the information necessary for potential future design and implementation of an SVE system, with or without groundwater recovery/treatment.

Based on a comparison of the applied vacuum pressures, airflow rates, PID readings, and vacuum pressure readings (in the monitoring points) during Pilot Test #1 and Pilot Test #4, de-watering of the shallow saturated zone improves SVE performance at the site. The de-watering reduces resistance to subsurface airflow and exposes more of the hydrocarbon-impacted soil to the applied vacuum. Furthermore, the extracted water sample results, as well as previous shallow groundwater sampling results (SLR, 2011), show that de-watering removes the groundwater that contains the greatest petroleum hydrocarbon concentrations at the site. Based on the interpreted geology and hydrogeology of the facility, it appears that there is a relatively limited volume of water in the shallow saturated zone above Unit B. Based on the groundwater drawdown in each of the shallow groundwater monitoring points during a limited period of pumping, it appears that recharge to the shallow saturated zone is limited, and we believe that this zone can be effectively de-watered within the area of concern. Since the shallow groundwater above Unit B and the deeper water table above Unit D are hydraulically connected, the pumping operations would also lower the deeper water table, exposing the capillary fringe. By combining de-watering with SVE, the higher permeability hydrocarbon-impacted soil at the site should be exposed to an applied vacuum. Due to preferential airflow through the higher permeability soils, some of the hydrocarbons within finer-grained soils may not be accessible to the vacuum.

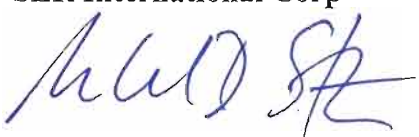
Based on the limited area of hydrocarbon-impacted soil [approximately 3,140 square feet; maximum length of approximately 65 feet and maximum width of approximately 58 feet (see Figure 3)] and an estimated effective radius of vacuum influence of at least 46 feet, SLR believes that SVE, combined with shallow groundwater de-watering, would be an effective method to remediate the remaining source of the hydrocarbon-impacted groundwater. The petroleum hydrocarbons in the coarser-grained (higher permeability) soils should be

effectively remediated and any remaining hydrocarbons in finer-grained (lower permeability) soils would leach to the groundwater at very low rates due to limited water movement through those soils. The risks associated with any remaining impacted soil would be low because the contamination would occur at depths below 10 feet bgs beneath the garage building and below 15 feet bgs outside of the building footprint.

SLR appreciates the opportunity to provide our services. If you have any questions, please call me at (425) 402-8800.

Sincerely,

SLR International Corp



Michael D. Staton, L.G.
Principal Geologist

Attachments: Limitations
References
Tables 1 and 2
Figures 1 through 5
Field Notes
Laboratory Reports
Plot of Normalized Vacuum Data
Hydrocarbon Mass Removal Calculations

cc: Diana Smeland, Port Ludlow Associates
Sue Schroader, Olympic Property Group
Joe Rehberger, Cascadia Law Group
Chip Goodhue, Aspect Consulting Group
Tom Kilbane, Short Cressman & Burgess

LIMITATIONS

The services described in this report were performed consistent with generally accepted professional consulting principles and practices. No other warranty, express or implied, is made. These services were performed consistent with our agreement with our client. This report is solely for the use and information of our client unless otherwise noted. Any reliance on this report by a third party is at such party's sole risk.

Opinions and recommendations contained in this report apply to conditions existing when services were performed and are intended only for the client, purposes, locations, time frames, and project parameters indicated. We are not responsible for the impacts of any changes in environmental standards, practices, or regulations subsequent to performance of services. We do not warrant the accuracy of information supplied by others, nor the use of segregated portions of this report.

REFERENCES

Applied Geotechnology, Inc. 1991. *Hydrocarbon Contamination Assessment and Underground Storage Tank Removal, Port Ludlow Water District, Port Ludlow, Washington*. March 4.

Chevron Research and Technology Company. 1991. *Chevron USA Inc. Marketing Department Vapor Extraction System Performance Study*. Environmental Group. Site Assessment and Remediation Unit. October 10.

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United States Environmental Protection Agency. 1989. *Estimating Air Emissions from Petroleum UST Cleanups*. Office of Underground Storage Tanks. June.

TABLES

Table 1
Extracted Soil Vapor Sample Analytical Results
Olympic Water and Sewer Property
Port Ludlow, Washington

Pilot Test Number/ Location	Sample Name	Sample Location	Sample Date	Active Test Duration Prior to Sample Collection (Hours)	Analytical Results (mg/m^3)				
					Benzene[a]	Toluene[a]	Ethylbenzene[a]	Total Xylenes[a]	Gasoline-Range Organics[b]
Test #1/SVE-1	Test1-Sample1	Stack	12/12/11	0.1	0.26	0.40	<0.1	<0.3	30
	Test1-Sample2	Influent to Blower[c]	12/12/11	3.7	0.35	0.88	0.30	0.68	47
Test #2/SVE-1	Test2-Sample1	Stack	12/13/11	0.1	<0.1	<0.1	<0.1	<0.3	<10
	Test2_Sample2	Influent to Blower[c]	12/13/11	8.3	14	32	5.0	10	1,900
Test #3/MW-1	Test3_Sample1	Stack	12/14/11	0.1	0.58	1.6	0.62	1.6	85
Test #4/SVE-1	TEST4-Sample1	Influent to Blower[c]	12/29/11	162.3	0.18	0.46	0.53	1.8	30
	Test4_Sample2	Influent to Blower[c]	01/05/12	45	2.5	5.1	1.6	4.6	180

Notes:

mg/m^3 = Milligrams per cubic meter.

[a] = Benzene, toluene, ethylbenzene, and total xylenes by EPA Method 8021B.

[b] = Gasoline-range organics by Ecology Method NWTPH-Gx.

[c] = The sample was collected after shutting off the blower.

Table 2
Extracted Water Sample Analytical Results
Olympic Water and Sewer Property
Port Ludlow, Washington

Sample Name	Sample Location	Sample Date	Analytical Results (µg/L)				
			Benzene[a]	Toluene[a]	Ethylbenzene[a]	Total Xylenes[a]	Gasoline-Range Organics[b]
Effluent_Pre-Carbon	Influent to Storage Tank	12/13/11	430	1,900	<20	2,000	23,000
System-Effluent_122911	Effluent from Second Carbon Canister	12/29/11	<1	<1	<1	<3	<100

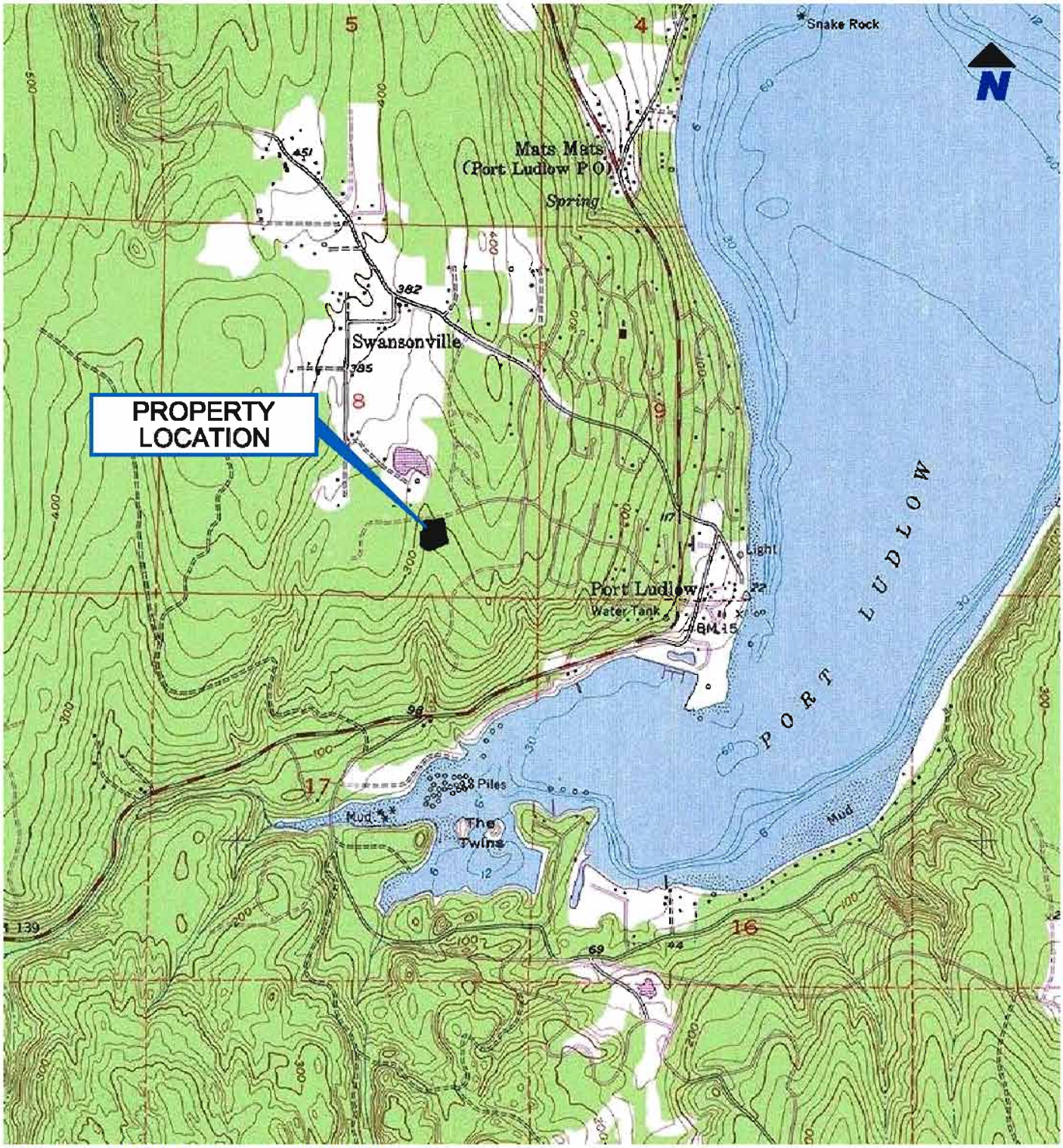
Notes:

µg/L = Micrograms per liter.

[a] = Benzene, toluene, ethylbenzene, and total xylenes by EPA Method 8021B.

[b] = Gasoline-range organics by Ecology Method NWTPH-Gx.

FIGURES



SOURCE: USGS 7.5 MINUTE QUADRANGLE PORT LUDLOW, WA 1991; CONTOUR INTERVAL, 20 FEET.

SCALE 1" = 2,000'
WHEN PLOTTED ON 8 1/2 x 11

0 1000 2000 4000

THIS DRAWING IS FOR CONCEPTUAL PURPOSES ONLY. ACTUAL LOCATIONS MAY VARY AND NOT ALL STRUCTURES ARE SHOWN.

SLR
22118 20th AVE SE
BLDG. G, SUITE 202
BOTHELL, WA 98021
T: 425-402-8800
F: 425-402-8488

OLYMPIC WATER & SEWER, INC. PROPERTY
781 WALKER WAY
PORT LUDLOW, WASHINGTON

Drawing
PROPERTY LOCATION MAP

Date JANUARY 23, 2012	Scale 1"=2000'	Fig. No. 1
File Name 03-01.DWG	Project No. 101.00433.00003	

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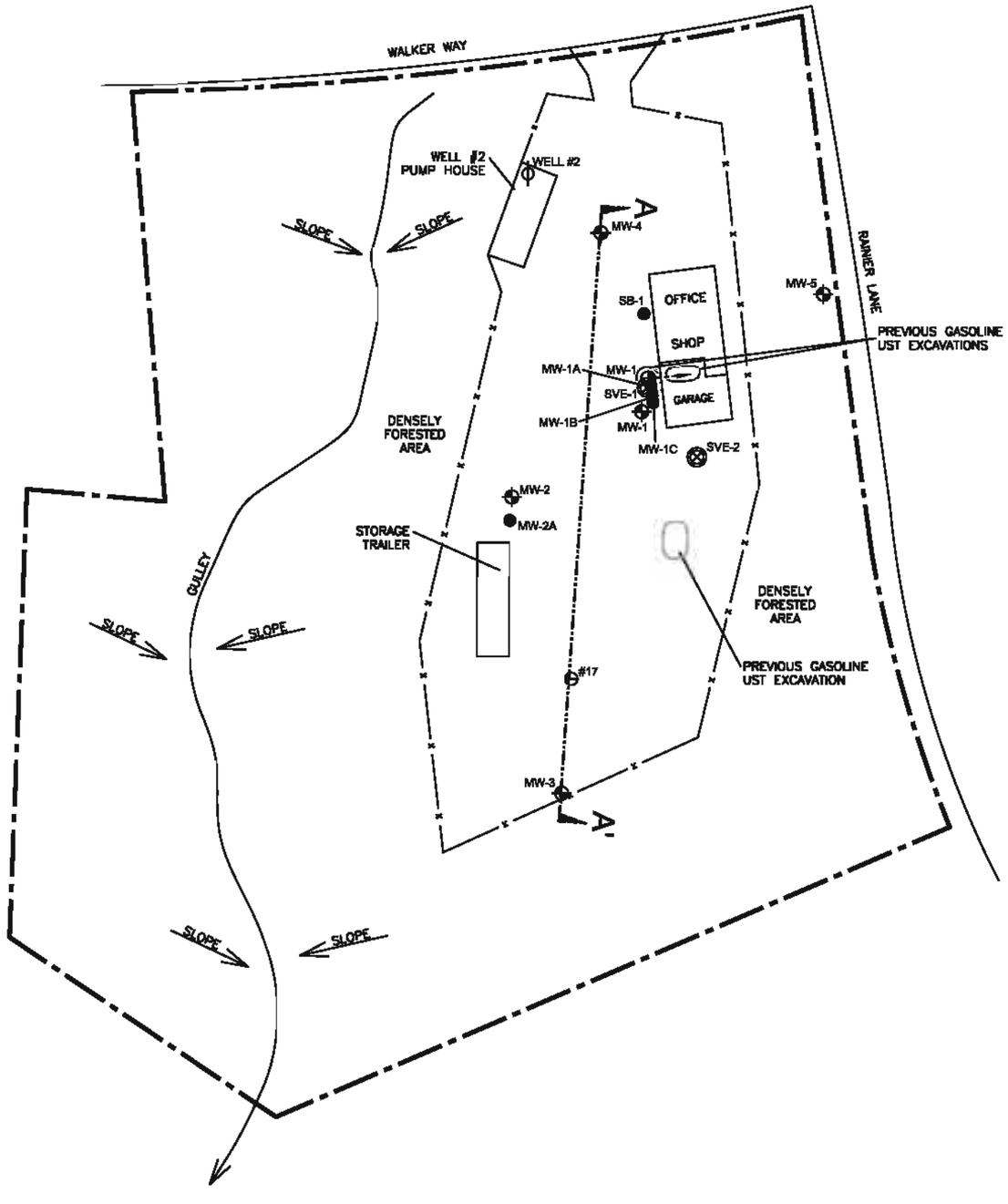

N

NOTES

LEGEND

- PROPERTY BOUNDARY
- SVE-1 — SOIL VAPOR EXTRACTION POINT LOCATION AND DESIGNATION
- MW-1 — GROUNDWATER MONITORING WELL LOCATION AND DESIGNATION
- MW-2A — APPROXIMATE SOIL BORING LOCATION AND DESIGNATION
- #17 — EXISTING CASING LOCATION AND DESIGNATION
- WELL #2 — EXISTING WATER SUPPLY WELL LOCATION AND DESIGNATION
- MW-1 — PREVIOUS ANGLE BORING LOCATION, DESIGNATION, AND DIRECTION FROM VERTICAL
- FENCE
- A — A' — LOCATION OF GEOLOGIC CROSS SECTION ON FIGURE 5

THIS DRAWING IS FOR CONCEPTUAL PURPOSES ONLY. ACTUAL LOCATIONS MAY VARY AND NOT ALL STRUCTURES ARE SHOWN.

SCALE: 1" = 50'
WHEN PLOTTED AT 11" x 17" PAGE SIZE
0 50 100 150'

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Drawing
INVESTIGATION LOCATIONS

Date	Scale	Fig. No.
JANUARY 23, 2012	AS SHOWN	2
File Name 03-02	Project No. 101.00433.00003	

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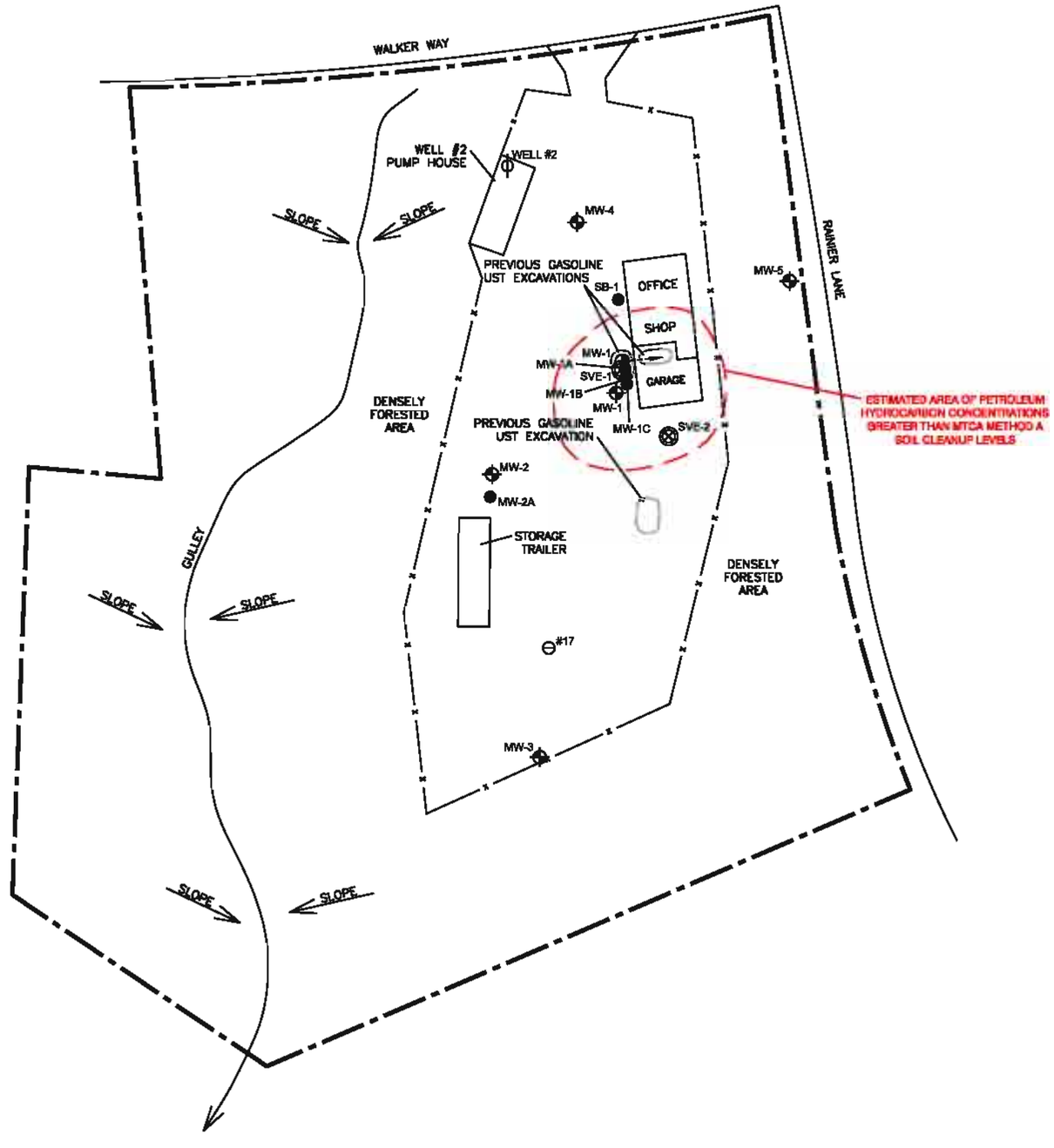

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SCALE: 1" = 50'
WHEN PLOTTED AT 11" x 17" PAGE SIZE
0 50 100 150'

N

NOTES

LEGEND

- PROPERTY BOUNDARY
- SVE-1 — SOIL VAPOR EXTRACTION POINT LOCATION AND DESIGNATION
- MW-1 — GROUNDWATER MONITORING WELL LOCATION AND DESIGNATION
- MW-2A — APPROXIMATE SOIL BORING LOCATION AND DESIGNATION
- #17 — EXISTING CASING LOCATION AND DESIGNATION
- WELL #2 — EXISTING WATER SUPPLY WELL LOCATION AND DESIGNATION
- MW-1 — PREVIOUS ANGLE BORING LOCATION, DESIGNATION, AND DIRECTION FROM VERTICAL
- FENCE

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PORT LUDLOW, WASHINGTON

Drawing: ESTIMATED AREA OF PETROLEUM HYDROCARBON-IMPACTED SOIL

Date: JANUARY 23, 2012	Scale: AS SHOWN	Fig. No. 3
File Name: 03-03	Project No.: 101.00433.00003	

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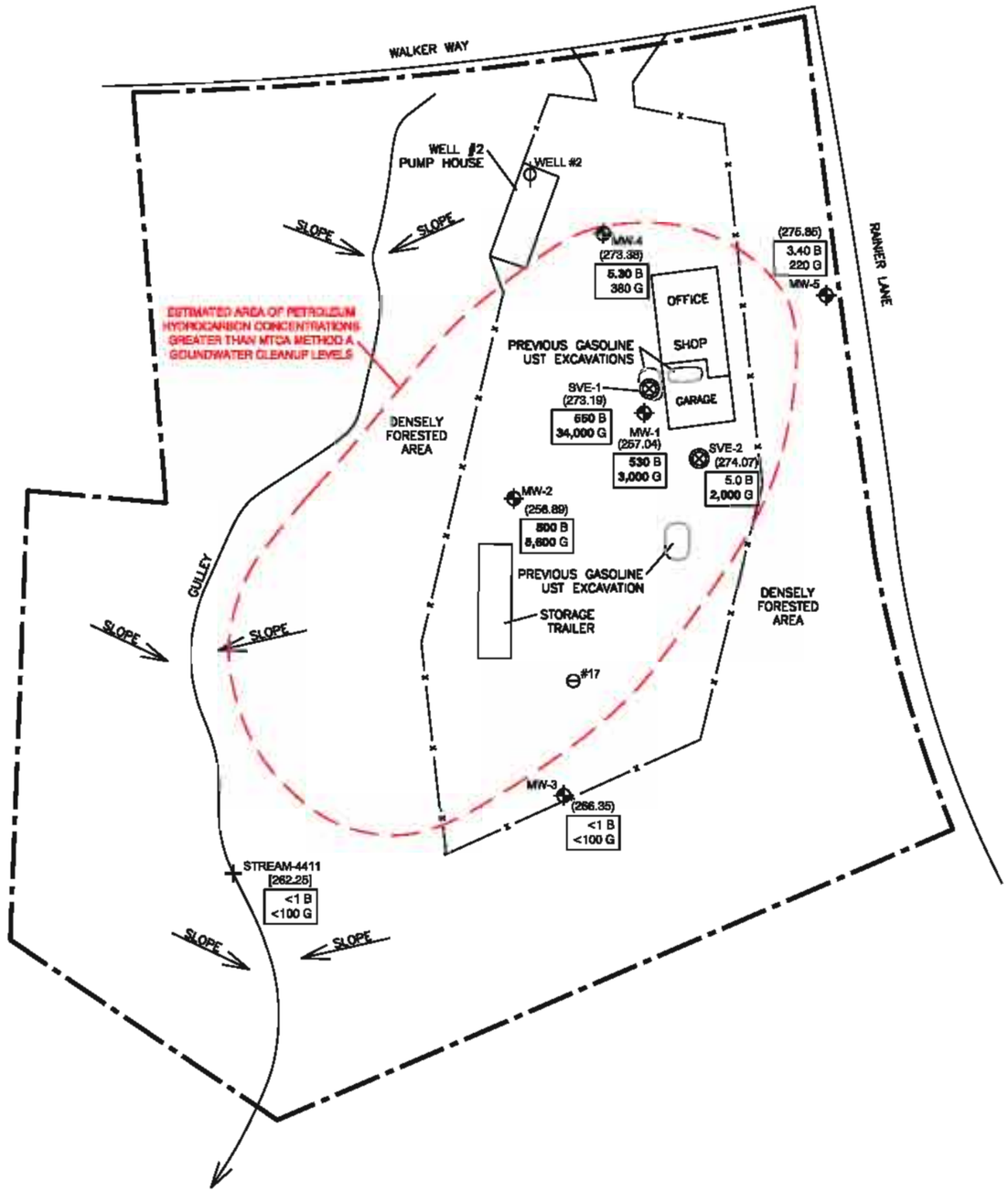

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SCALE: 1" = 50'
WHEN PLOTTED AT 11" x 17" PAGE SIZE
0 50 100 150'

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NOTES

LEGEND

- PROPERTY BOUNDARY
- MW-1 — GROUNDWATER MONITORING WELL LOCATION AND DESIGNATION
- STREAM-4411 — APPROXIMATE STREAM SAMPLE LOCATION AND DESIGNATION
- SVE-1 — SOIL VAPOR EXTRACTION POINT LOCATION AND DESIGNATION
- #17 — EXISTING CASING LOCATION AND DESIGNATION
- WELL #2 — EXISTING WATER SUPPLY WELL LOCATION AND DESIGNATION
- FENCE
- (273.19) — SHALLOW GROUNDWATER ELEVATION (IN FEET ABOVE NAVD 88 DATUM) ON APRIL 8, 2011
- [262.25] — APPROXIMATE SURFACE WATER ELEVATION (IN FEET ABOVE NAVD 88 DATUM) ON APRIL 4, 2011
- 5.30 B / 380 G — B=BENZENE CONCENTRATION IN APRIL 2011 GROUNDWATER SAMPLE (IN µg/L); G=GRO CONCENTRATION IN APRIL 2011 GROUNDWATER SAMPLE (IN µg/L)

NOTE: CONCENTRATIONS IN BOLD EXCEED THE MTCA METHOD A GROUNDWATER CLEANUP LEVELS.

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PORT LUDLOW, WASHINGTON

Drawing: ESTIMATED AREA OF GASOLINE-IMPACTED SHALLOW GROUNDWATER

Date	JANUARY 23, 2012	Scale	AS SHOWN	Fig. No.	4
File Name	03-04.DWG	Project No.	101.00433.00003		

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NORTH
A

SOUTH
A'

MW-4

SVE-1
(PROJECTED 20 FEET)

MW-1
(PROJECTED 19 FEET)

MW-2
(PROJECTED 26 FEET)

MW-3

OFFICE/GARAGE BUILDING
(PROJECTED 30 FEET)

ELEVATION (FEET)

300
295
290
285
280
275
270
265
260
255
250
245
240
235
230

UNIT A
UNIT B
UNIT C
UNIT D
UNIT E

[<0.02]
[<0.03]
[0.49*]
[<0.03]
[0.21**]
[<0.03]
[<0.03]
[0.21**]
[<0.03]
[0.036**]

LEGEND

MW-4 — EXPLORATION LOCATION AND DESIGNATION

SCREEN LOCATION

INFERRED GROUNDWATER TABLE SURFACE PRIOR TO PILOT TEST ON DECEMBER 12, 2011

[0.21] — BENZENE CONCENTRATIONS IN SOIL SAMPLE (IN MG/KG)

INFERRED CONTACT: LITHOLOGIC UNIT

INFERRED CONTACT: INTERBED WITHIN UNIT

GRAVEL WITH COBBLES (GP)

SAND, GRAVELLY SAND, AND SAND AND GRAVEL (SP), INCLUDES SILT SAND (SM) AND SILT (ML) INTERBEDS

SILTY SAND (SM)

SILT, CLAYEY SILT, SANDY SILT, AND GRAVELLY SILT (ML), INCLUDES SAND AND GRAVEL (SP) INTERBEDS

NOTES

1) CROSS SECTION LOCATION IS SHOWN ON FIGURE 2.
2.) ELEVATIONS ARE RELATIVE TO NAVD 88 DATUM.
3.) CONCENTRATIONS IN BOLD EXCEED THE MTCA METHOD A SOIL CLEANUP LEVEL.
4.) *= SAMPLE COLLECTED FROM ADJACENT BORING MW-1B.
5.) **=THE BENZENE CONCENTRATIONS IN THE SATURATED SOIL SAMPLE LIKELY REFLECT BENZENE DISSOLVED IN THE PORE WATER, RATHER THAN ADSORBED TO THE SOIL.
6.) WELL#17 IS NOT INCLUDED DUE TO DATA LIMITATIONS.

0 20 40 60'
HORIZONTAL SCALE (FEET)

0 10 20 30'
VERTICAL SCALE (FEET)

SLR

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Drawing
HYDROGEOLOGIC CONDITIONS IN DECEMBER 2011

Date MAY 17, 2011	Scale AS SHOWN	Fig. No. 5
File Name 07-05.DWG	Project No. 101.00433.00003	

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FIELD NOTES

Soil Vapor Extraction Pilot Test - Olympic Water and Sewer, Inc. Facility, 781 Walker Way, Port Ludlow, WA

SLR International Corp
22118 20th Ave. SE, G-202
Bothell, WA 98021

Date: 12/12/11
Start Time: 1150
End Time: 1530

Weather: Clear, sunny, ~40°

Field Staff: CAL

SVE Point: SVE-1 | Dewatering?: Yes/(No)

SVE Equipment: Rotron EN593MSL regen. blower
Cyclonic moisture knockout tank
3" Rubber flexible extraction hose

Dewatering Equipment: None.

Air Samples		Water Samples	
Name	Time	Name	Time
SVE-1 TEST 1 SAMPLE 1[a]	1200	N/A	N/A
TEST 1 SAMPLE 2[b]	1530		

Time (24-hr)	Applied Vacuum (in. Hg)	Air Flow Rate (fpm)	Water Flow Rate (gpm)	PID Reading (ppm)	Water Levels (ft. BTOC)							Vacuum Measurements (in. H_2O)						
					SVE-1	SVE-2	MW-1	MW-2	MW-3	MW-4	MW-5	SVE-1	SVE-2	MW-1	MW-2	MW-3	MW-4	MW-5
1140	SYSTEM TURNED OFF →				26.51 (21.72 @ 12/12/11)	25.82	40.09	40.69	29.33	27.52	29.26	SYSTEM TURNED OFF →						
1150	96.5	876	N/A	89.9[a]	~~21.72~~	26.19	40.09	40.69	29.33	27.52	29.26	96.5	0.00	0.00	0.00	0.00	0.00	0.00
1250	97.0	799	N/A	12.1[a]	20.53	26.08	40.11	40.14	29.25	27.55	29.22	97.0	0.00	0.00	0.00	0.00	0.00	0.00
1350	60.0	679	N/A	7.1[a]	~~20.48~~	25.88	40.14	40.07	29.26	27.54	29.09	60.0	0.00	0.00	0.00	0.00	0.00	0.00
1450	60.0	705	N/A	106.2[b]	21.28	25.68	40.13	39.99	29.22	27.50	29.02	60.0	0.00	0.00	0.00	0.00	0.00	0.00
1530	60.0	746	N/A	161.2[b]	21.65	25.59	40.18	39.98	29.21	27.52	29.00	SYSTEM TURNED OFF						

Notes:
Diluted vacuum to 60" H_2O @ 1345

a) Soil vapor samples and PID readings collected at system exhaust stack.
b) Soil vapor samples and PID readings collected at manifold after turning SVE blower off.

Soil Vapor Extraction Pilot Test - Olympic Water and Sewer, Inc. Facility, 781 Walker Way, Port Ludlow, WA

SLR International Corp
22118 20th Ave. SE, G-202
Bothell, WA 98021

Date: 12/13/11
Start Time: 1020
End Time: 1830

Weather: Overcast ~43°F, dry

Field Staff: Chris Lee

SVE Point: SVE-1 | Dewatering?: (Yes)/No

SVE Equipment: Rotron EN523MSL regen. blower
Cyclonic moisture knockout tank (55-gal)
2" flexible rubber extraction hose.

Dewatering Equipment: Grundfos RediFlo 2 w/
Baldor VFD
Master Meter BL05 Totalizer

Air Samples	
Name	Time
TEST2 – SAMPLE 1 [a]	1020
TEST2 – SAMPLE 2 [b]	1830

Water Samples	
Name	Time
EFFLUENT – PRE-CARBON	1430

Time (24-hr)	Applied Vacuum (in. Hg)	Air Flow Rate (fpm)	Water Flow Rate (gpm)	PID Reading (ppm)	Water Levels (ft. BTOC) SVE-1	SVE-2	MW-1	MW-2	MW-3	MW-4	MW-5	Vacuum Measurements (in. H_2O) SVE-1	SVE-2	MW-1	MW-2	MW-3	MW-4	MW-5
0930	0.00	N/A	0.00	N/A	28.00	NM	→					SYSTEM TURNED OFF	→					
0940	0.00	N/A	2.50	N/A	35.20	26.38	39.94	39.78	29.12	27.35	28.98	SYSTEM TURNED OFF	→					
0945	97.0	773	0.00	78.9 [a]	35.20	26.38	39.94	39.78	29.12	27.35	28.98	97.0	0.00	0.00	0.00	0.00	0.00	0.00
1005	STOPPED TEST FOR REPAIRS				→							→						
1020	97.0	829	0.04 [c]	79.8 [a]	37.15	26.38	39.94	39.78	29.12	27.35	28.98	97.0	0.30	0.00	0.00	0.00	0.00	0.00
1050	97.0	801	0.33	4.0 [a]	33.56	NM	→					→						
1120	97.0	814	0.19	3.4 [a]	35.07	27.13	40.18	39.79	29.10	27.50	29.25	97.0	0.00	0.00	0.00	0.00	0.00	0.00
1150	97.0	821	0.19	29.1 [a]	35.18	26.71	40.31	39.77	29.09	27.52	29.28	97.0	1.00	0.00	0.00	0.00	0.00	0.00
1330	97.0	796	0.19	4.4 [a]	35.20	26.89	40.36	39.77	29.08	27.54	29.14	97.0	0.90	0.00	0.00	0.00	0.00	0.00
1400	97.0	771	0.13	6.4 [a]	35.20	27.25	40.34	NM	→			97.0	0.95	0.00	0.00	0.00	0.00	0.00
1430	97.0	764	0.13	9.0 [a]	35.20	27.31	40.37	39.78	29.08	27.59	29.23	97.0	0.50	0.00	0.00	0.00	0.00	0.00
1500	97.0	801	0.13	11.6 [a]	35.20	27.40	40.38	NM	→			97.0	0.70	0.00	0.00	0.00	0.00	0.00
1530	97.0	777	0.13	8.7 [a]	35.20	27.58	40.38	39.79	29.07	27.63	29.44	97.0	0.60	0.00	0.00	0.00	0.00	0.00
1600	97.0	765	0.13	8.7 [a]	35.20	27.64	40.47	39.79	29.16	27.72	29.51	97.0	0.50	0.00	0.00	0.00	0.00	0.00
1630	97.0	761	0.13	8.4 [a]	35.20	27.85	40.51	39.79	29.19	27.80	29.58	97.0	0.30	0.00	0.00	0.00	0.00	0.00
1700	97.0	777	0.13	8.4 [a]	35.20	27.91	40.53	39.79	29.24	27.85	29.61	97.0	0.40	0.10	0.00	0.00	0.00	0.00
1730	97.0	764	0.13	3.9 [a]	35.20	27.94	40.55	39.79	29.28	27.85	29.61	97.0	0.30	0.10	0.00	0.00	0.00	0.00
1800	97.0	771	0.15	4.0 [a]	35.20	27.97	40.56	39.79	29.21	27.85	29.63	97.0	0.50	0.10	0.00	0.00	0.00	0.00
1830	97.0	768	0.15	4.1 [a]	35.20	28.00	40.58	39.79	29.09	27.85	29.65	97.0	0.50	0.10	0.00	0.00	0.00	0.00

Notes: Totalizer reading @ beginning of test: 22.5 gallons; @ end: 96.6 gallons
Turned Grundfos pump on @ 0930 Top of pump @ 35.22'

PID Reading in well @ time of collection of Test2_Sample 2 was 598.6ppm.

1220 - 1330 Pump stopped pumping, water was drawn back into SVE-1 by vacuum. PID jumped to 850 ppm. Removed, cleaned, & reinstalled pump.

1540 OWSI staff turned off power to dewatering pump accidentally. Vacuum sucked water back into SVE-1 from hose. Turned vacuum off, restarted pump. Restarted vacuum, PID concentration jumped to 886 ppm & dropped back down to 37.7 ppm after 5 mins.

a) Soil vapor samples and PID readings collected at system exhaust stack.
b) Soil vapor samples and PID readings collected at manifold after turning SVE blower off.

Soil Vapor Extraction Pilot Test - Olympic Water and Sewer, Inc. Facility, 781 Walker Way, Port Ludlow, WA

SLR International Corp 22118 20th Ave. SE, G-202 Bothell, WA 98021	Date: 12/14/11 Start Time: 1050 End Time: 1550	Weather: Overcast, dry, ~40°F	Field Staff: Chris Lee	SVE Point: MW-1	Dewatering?: (Yes)/No

SVE Equipment: Rotron EN503MSL regenerative blower
Cyclone moisture knockout tank (55gal)
2" flexible rubber extraction hose

Dewatering Equipment: Grundfos Redi-Flo 2 w/ Baldor VFD
Master Meter BL05 totalizing water meter

Air Samples		Water Samples	
Name	Time	Name	Time
TEST 3 - SAMPLE 1	1050		

Time (24-hr)	Applied Vacuum (in. H_2O)	Air Flow Rate (fpm)	Water Flow Rate (gpm)	PID Reading (ppm)	Water Levels (ft. BTOC)							Vacuum Measurements (in. H_2O)						
					SVE-1	SVE-2	MW-1	MW-2	MW-3	MW-4	MW-5	SVE-1	SVE-2	MW-1	MW-2	MW-3	MW-4	MW-5
1040	0.00	0.00	2.5	0.00	26.50	25.84	39.98	39.96	29.18	27.54	29.05	SYSTEM TURNED OFF →						
1050	97.0	804	0.00	1.6	26.50	25.84	48.98	39.96	29.18	27.54	29.05	0.00	0.00	97.0	0.00	0.00	0.00	0.00
1100	97.0	820	0.00	1.9	26.49	25.80	48.87	39.96	29.18	27.52	29.05	0.00	0.00	97.0	0.00	0.00	0.00	0.00
1150	96.0	810	0.00	1.8	26.45	25.78	48.90	39.95	29.18	27.51	29.03	0.00	0.00	96.0	0.00	0.00	0.00	0.00
1200	97.0	808	0.00	1.5	26.42	25.78	48.84	39.92	29.19	27.49	29.00	0.00	0.00	97.0	0.00	0.00	0.00	0.00
1250	97.0	792	0.00	1.4	26.40	25.78	48.87	39.92	29.18	27.49	29.00	0.00	0.00	97.0	0.00	0.00	0.00	0.00
1300	97.0	795	0.00	1.2	26.39	25.76	48.87	39.92	29.18	27.48	29.00	0.00	0.00	97.0	0.00	0.00	0.00	0.00
1350	97.0	791	0.00	1.5	26.37	25.75	48.87	39.91	29.18	27.49	28.98	0.00	0.00	97.0	0.00	0.00	0.00	0.00
1420	97.0	809	0.00	1.6	26.37	25.72	48.88	39.90	29.18	27.47	28.98	0.00	0.00	97.0	0.00	0.00	0.00	0.00
1450	97.0	788	0.00	1.9	26.35	25.71	48.90	39.88	29.17	27.46	28.97	0.00	0.00	98.0	0.00	0.00	0.00	0.00
1520	97.0	790	0.00	2.1	26.34	25.69	48.88	39.88	29.16	27.47	28.97	0.00	0.00	98.0	0.00	0.00	0.00	0.00
1550	97.0	769	0.00	2.0	26.34	25.68	48.86	39.88	29.16	27.47	28.97	0.00	0.00	98.0	0.00	0.00	0.00	0.00
TURNED SYSTEM OFF & MOVED TO MW-2					—													
1620	95.0	784	0.00	1.8	26.33	25.69	48.80	47.30	29.06	27.43	28.97	0.00	0.00	95.0	0.00	0.00	0.00	0.00
TURNED SYSTEM OFF & MOVED BACK TO MW-2 →																		

Notes: Totalizer reading @ beginning of test: 96.6 gallons
Top of pump @ 48.98'

1430 Pump completely dewatered well, was overcome by vacuum. Vacuum pulled all water in pump tube back into MW-1. PID reading jumped to 900+ ppm. Stopped vacuum, measured draw at 47.35'. Restarted pump, measured increased flow rate of 0.5 gpm. Restarted vacuum, flow stopped.

Soil vapor samples and PID readings were all collected at system exhaust stack.

Soil Vapor Extraction Pilot Test - Olympic Water and Sewer, Inc. Facility, 781 Walker Way, Port Ludlow, WA

SLR International Corp
22118 20th Ave. SE, G-202
Bothell, WA 98021

Date: 12/14/11
Start Time: 1600
End Time: 1740

Weather: Overcast, dry, ~ 40°F

Field Staff: Chris Lee

SVE Point: MW-2 | Dewatering?: (Yes)/No

SVE Equipment: Rotron EN523MSL regen. blower
Cyclonic moisture knockout tank
2" rubber flexible extraction hose

Dewatering Equipment: Grundfos Redi-Flo 2 submersible pump w/ Baldor VFD control
Master Meter BL05 totalizing water meter

Air Samples	
Name	Time

Water Samples	
Name	Time

Time (24-hr)	Applied Vacuum (in. ~~Hg~~ H2O)	Air Flow Rate (fpm)	Water Flow Rate (gpm)	PID Reading (ppm)	Water Levels (ft. BTOC)							Vacuum Measurements (in. H_2O)						
					SVE-1	SVE-2	MW-1	MW-2	MW-3	MW-4	MW-5	SVE-1	SVE-2	MW-1	MW-2	MW-3	MW-4	MW-5
1600	0.00	0.00	2.5	1.8	26.33	25.76	47.07	39.33	29.16	27.47	28.97	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1610	97.0	797	0.5	1.6	26.33	25.75	47.00	49.13	29.16	27.43	28.97	0.00	0.00	0.00	97.0	0.00	0.00	0.00
TURNED SYSTEM OFF & MOVED TO MW-2																		
1640	95.0	761	0.2	1.7	26.33	25.72	46.70	49.13	29.13	27.42	28.97	0.00	0.00	0.00	95.0	0.00	0.00	0.00
1710	95.0	754	0.2	1.5	26.33	25.69	46.03	49.13	29.09	27.40	28.97	0.00	0.00	0.00	95.0	0.00	0.00	0.00
1740	95.0	780	0.2	1.7	26.33	25.68	46.00	49.13	29.07	27.40	28.97	0.00	0.00	0.00	95.0	0.00	0.00	0.00
→ Operated system @ MW-2 w/ sample port plug removed to alleviate vacuum lock.																		

Notes: Totalizer reading @ beginning of test: 97.2 gallons.
Totalizer reading @ end of test: 120.2 gallons

1740: Pump developed ground fault & stopped pumping. PID shot up to 900+ ppm as water was drawn back into MW-2 by vacuum.

Soil vapor samples and PID readings were all collected at system exhaust stack.

Soil Vapor Extraction Pilot Test - Olympic Water and Sewer, Inc. Facility, 781 Walker Way, Port Ludlow, WA

SLR International Corp 22118 20th Ave. SE, G-202 Bothell, WA 98021	Date: 12/22/11 Start Time: 1345 End Time: 1450	Weather: Overcast, ~45°f, dry	Field Staff: Chris Lee	SVE Point: SVE-1 Dewatering?: (Yes)/No SVE Equipment: Rotron EN523MSL regen. blower w/ cyclonic moisture knockout tank 2" rubber flexible extraction hose

Air Samples: Name	Air Samples: Time	Water Samples: Name	Water Samples: Time	
				Totalizer Reading At Start: 120.5 At End: 134.5
				Dewatering Equipment: QED AP4 recirculation pump BL05 water meter

Time (24-hr)	Applied Vacuum (in. Hg) [H_2O]	Air Flow Rate (fpm)	Water Flow Rate (gpm)	PID Reading[a] (ppm)	Water Levels (ft. BTOC) SVE-1	SVE-2	MW-1	MW-2	MW-3	MW-4	MW-5	Vacuum Measurements (in. H_2O) SVE-1	SVE-2	MW-1	MW-2	MW-3	MW-4	MW-5
1330	0.0	0.0	1.5	0.0	NM	26.13	39.98	40.25	29.11	27.44	29.22	0.00	0.0	0.0	0.0	0.0	0.0	0.0
1350	80.0	2,433	0.15	921.9	NM	26.13	39.98	40.25	29.11	27.44	29.22	80.0	0.0	0.0	0.0	0.0	0.0	0.0
1410	96.0	2,475	0.15	4537	NM	26.13	39.98	40.25	29.11	27.44	29.23	96.0	0.0	0.0	0.0	0.0	0.0	0.0
1430	96.0	2,468	0.15	2965	NM	26.55	40.03	40.20	29.08	27.45	29.23	96.0	0.0	0.0	0.0	0.0	0.0	0.0

Notes: Totalizer reading before starting pump: 117.0
Totalizer reading after starting pump but before starting blower, after pump completely dewatered well: 120.5
Totalizer reading at time left site: 134.5

1300 Bailed sediment from SVE-1 prior to inserting pump.
1330 Started pump & allowed to run until frequency of pumping cycles ceased - 1350. Then started blower

Top of pump is 38" above bottom of well.

a) PID readings were all collected at manifold after turning SVE blower off
b) PID readings at exhaust stack (after carbon treatment) were consistently 0.0 ppm.

Soil Vapor Extraction Pilot Test - Olympic Water and Sewer, Inc. Facility, 781 Walker Way, Port Ludlow, WA Page 1 of 1

SLR International Corp 22118 20th Ave. SE, G-202 Bothell, WA 98021	Date: 12/29/11 Start Time: 0930 End Time: 1200	Weather: Overcast, ~42°	Field Staff: Chris Lee	SVE Point: SVE-1 SVE Equipment: Rotron EN573MSL regenerative blower w/ cyclone moisture knockout tank 2" rubber flexible extraction hose Totalizer Reading At Start: 1,773 At End: 1,798 Dewatering Equipment: QED AP2 remediation pump BL05 water meter

Dewatering?: (Yes) No

Air Samples		Water Samples	
Name	Time	Name	Time
TEST 4 - SAMPLE 1 a	1000	SYSTEM EFFLUENT - 122911	1030

Time (24-hr)	Applied Vacuum (in. Hg)	Air Flow Rate (fpm)	Water Flow Rate (gpm)	PID Reading[a] (ppm)	Water Levels (ft. BTOC)							Vacuum Measurements (in. H_2O)						
					SVE-1	SVE-2	MW-1	MW-2	MW-3	MW-4	MW-5	SVE-1	SVE-2	MW-1	MW-2	MW-3	MW-4	MW-5
0950	90.0	2,419	0.24	392.2	NM	27.61	42.33	39.86	39.00	38.03	~~27.61~~ 31.23	90.0	1.0	0.0	0.0	0.0	0.0	0.0

Notes:

Flow Test: 1791.7 1796.5 20 mins 0.24gpm

1000 Turned off system to measure PID reading & collect air sample from well.
Used camlock fittings to connect hoses & collect water sample after allowing water to gravity flow through carbon canisters (2).

1045 Water sample was difficult to collect - bubbles were difficult to eliminate from VOAs.

1045 Restarted system.

a) Extracted soil vapor samples and PID readings were all collected at manifold after turning SVE blower off.
b) PID readings at exhaust stack (after carbon treatment) were consistently 0.0 ppm.

Soil Vapor Extraction Pilot Test - Olympic Water and Sewer, Inc. Facility, 781 Walker Way, Port Ludlow, WA Page 1 of 1

SLR International Corp
22118 20th Ave. SE, G-202
Bothell, WA 98021

Date: 11/5/12
Start Time: 0715
End Time: 1220 1130

Weather: ~40°F Dry, overcast

Field Staff: Chris Lee

SVE Point: SVE-1 Dewatering?: (Yes)/No

SVE Equipment: Rotron EN523MSL regen. blower w/ cyclonic 55-gal moisture knockout tank 2" rubber flexible extraction hose

Totalizer Reading At Start: 2,608 At End: 2,631

Dewatering Equipment: QED 4PH pneumatic remediation pump 402 BL05 3/5" water meter

Air Samples		Water Samples	
Name	Time	Name	Time
TEST 4 SAMPLE 2"	0900		

Time (24-hr)	Applied Vacuum (in. H_2O)	Air Flow Rate (fpm)	Water Flow Rate (gpm)	PID Reading @ (ppm)	Water Levels (ft. BTOC)							Vacuum Measurements (in. H_2O)						
					SVE-1	SVE-2	MW-1	MW-2	MW-3	MW-4	MW-5	SVE-1	SVE-2	MW-1	MW-2	MW-3	MW-4	MW-5
0725	86.0	3,450	0.25	249.9	NM	25.16	42.57	40.15	29.09	28.14	30.11	86.0	4.5	0.50	0.30	0.00	0.70	0.03

Notes: Flow Test: 2,608.5g – 2,611.0g over 10 mins = 0.25 gpm

PID reading @ stack : 0.0ppm

0910 Begin disassembly of system.

0930 OWSI begins pumping water through carbon using vacuum truck.

a) Extracted soil vapor samples and PID readings were all collected at manifold after turning SVE blower off.

b) PID readings at exhaust stack (after carbon treatment) were consistently 0.0 ppm

LABORATORY REPORTS

FRIEDMAN & BRUYA, INC.

ENVIRONMENTAL CHEMISTS

James E. Bruya, Ph.D.
Yelena Aravkina, M.S.
Bradley T. Benson, B.S.
Kurt Johnson, B.S.

3012 16th Avenue West
Seattle, WA 98119-2029
TEL: (206) 285-8282
e-mail: fbi@isomedia.com

December 20, 2011

Mike Staton, Project Manager
SLR International Corp.
22118 20th Ave. SE., G-202
Bothell, WA 98021

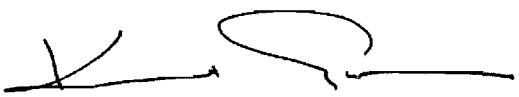
Dear Mr. Staton:

Included are the results from the testing of material submitted on December 13, 2011 from the Olympic Water & Sewer, Inc, 101.00433.00003, F&BI 112183 project. There are 4 pages included in this report. Any samples that may remain are currently scheduled for disposal in 30 days. If you would like us to return your samples or arrange for long term storage at our offices, please contact us as soon as possible.

We appreciate this opportunity to be of service to you and hope you will call if you should have any questions.

Sincerely,

FRIEDMAN & BRUYA, INC.



Kurt Johnson
Chemist

Enclosures
mcp/KJ
SLR1220R.DOC

CASE NARRATIVE

This case narrative encompasses samples received on December 13, 2011 by Friedman & Bruya, Inc. from the SLR International Corp. Olympic Water & Sewer, Inc, 101.00433.00003 project. Samples were logged in under the laboratory ID's listed below.

Laboratory ID	SLR International Corp.
112183 -01	Test1-Sample1
112183 -02	Test1-Sample2
112183 -03	Test2-Sample1

All quality control requirements were acceptable.

Date of Report: 12/20/11
Date Received: 12/13/11
Project: Olympic Water & Sewer, Inc, 101.00433.00003, F&BI 112183
Date Extracted: 12/14/11
Date Analyzed: 12/14/11

RESULTS FROM THE ANALYSIS OF VAPOR SAMPLES FOR BENZENE, TOLUENE, ETHYLBENZENE, XYLENES AND TPH AS GASOLINE USING MODIFIED EPA METHOD 8021B AND NWTPH-Gx

Results Reported as mg/m^3

Sample ID Laboratory ID	Benzene	Toluene	Ethyl Benzene	Total Xylenes	Gasoline Range	Surrogate (% Recovery) (Limit 50-150)
Test1-Sample1 112183-01	0.26	0.40	<0.1	<0.3	30	97
Test1-Sample2 112183-02	0.35	0.88	0.30	0.68	47	93
Test2-Sample1 112183-03	<0.1	<0.1	<0.1	<0.3	<10	98
Method Blank 01-2210 MB	<0.1	<0.1	<0.1	<0.3	<10	96

Date of Report: 12/20/11
Date Received: 12/13/11
Project: Olympic Water & Sewer, Inc, 101.00433.00003, F&BI 112183

QUALITY ASSURANCE RESULTS FOR THE ANALYSIS OF VAPOR SAMPLES FOR BENZENE, TOLUENE, ETHYLBENZENE, XYLENES, AND TPH AS GASOLINE USING MODIFIED EPA METHOD 8021B AND NWTPH-Gx

Laboratory Code: 112183-03 (Duplicate)

Analyte	Reporting Units	Sample Result	Duplicate Result	Relative Percent Difference (Limit 20)
Benzene	mg/m^3	<0.1	<0.1	nm
Toluene	mg/m^3	<0.1	<0.1	nm
Ethylbenzene	mg/m^3	<0.1	<0.1	nm
Xylenes	mg/m^3	<0.3	<0.3	nm
Gasoline	mg/m^3	<10	<10	nm

Laboratory Code: Laboratory Control Sample

Analyte	Reporting Units	Spike Level	Percent Recovery LCS	Acceptance Criteria
Benzene	mg/m^3	5.0	89	70-130
Toluene	mg/m^3	5.0	93	70-130
Ethylbenzene	mg/m^3	5.0	91	70-130
Xylenes	mg/m^3	15	90	70-130
Gasoline	mg/m^3	100	124	70-130

Data Qualifiers & Definitions

a - The analyte was detected at a level less than five times the reporting limit. The RPD results may not provide reliable information on the variability of the analysis.

A1 – More than one compound of similar molecule structure was identified with equal probability.

b - The analyte was spiked at a level that was less than five times that present in the sample. Matrix spike recoveries may not be meaningful.

ca - The calibration results for this range fell outside of acceptance criteria. The value reported is an estimate.

c - The presence of the analyte indicated may be due to carryover from previous sample injections.

d - The sample was diluted. Detection limits may be raised due to dilution.

ds - The sample was diluted. Detection limits are raised due to dilution and surrogate recoveries may not be meaningful.

dv - Insufficient sample was available to achieve normal reporting limits and limits are raised accordingly.

fb - Analyte present in the blank and the sample.

fc – The compound is a common laboratory and field contaminant.

hr - The sample and duplicate were reextracted and reanalyzed. RPD results were still outside of control limits. The variability is attributed to sample inhomogeneity.

ht - Analysis performed outside the method or client-specified holding time requirement.

ip - Recovery fell outside of normal control limits. Compounds in the sample matrix interfered with the quantitation of the analyte.

j – The result is below normal reporting limits. The value reported is an estimate.

J - The internal standard associated with the analyte is out of control limits. The reported concentration is an estimate.

jl - The analyte result in the laboratory control sample is out of control limits. The reported concentration should be considered an estimate.

jr - The rpd result in laboratory control sample associated with the analyte is out of control limits. The reported concentration should be considered an estimate.

js - The surrogate associated with the analyte is out of control limits. The reported concentration should be considered an estimate.

lc - The presence of the compound indicated is likely due to laboratory contamination.

L - The reported concentration was generated from a library search.

nm - The analyte was not detected in one or more of the duplicate analyses. Therefore, calculation of the RPD is not applicable.

pc – The sample was received in a container not approved by the method. The value reported should be considered an estimate.

pr – The sample was received with incorrect preservation. The value reported should be considered an estimate.

ve - Estimated concentration calculated for an analyte response above the valid instrument calibration range. A dilution is required to obtain an accurate quantification of the analyte.

vo - The value reported fell outside the control limits established for this analyte.

x - The sample chromatographic pattern does not resemble the fuel standard used for quantitation.

112183

SAMPLE CHAIN OF CUSTODY ME 12-13-11

Send Report To MIKE STATON

Company SLR INTERNATIONAL CORP

Address 22118 20TH AVE SE, G-202

City, State, ZIP BOTHELL, WA 98021

Phone # (425) 402-8800 Fax # (425) 402-8485

SAMPLERS *(signature)*

PROJECT NAME/NO.: Olympic Water & Sewer, Inc. 101-00433.00003

PO#: 101-00433.00003

REMARKS 78-hour hold time

TURNAROUND TIME
- [x] Standard (2 Weeks)
- [ ] RUSH
- Rush charges authorized by

SAMPLE DISPOSAL
- [x] Dispose after 30 days
- [ ] Return samples
- [ ] Will call with instructions

Sample ID	Lab ID	Date Sampled	Time Sampled	Sample Type	# of containers	ANALYSES REQUESTED: TPH-Diesel	TPH-Gasoline	BTEX by 8021B	VOCs by8260	SVOCs by 8270	HFS	TPH as gasoline by 8015M						Notes
TEST 1_SAMPLE 1	01	12/12/11	1200	AIR	1			X				X						
TEST 1_SAMPLE 2	02	↓	1530	↓	↓			↓				↓						
TEST 2_SAMPLE 1	03	12/13/11	1020	↓	↓			↓				↓						

SIGNATURE	PRINT NAME	COMPANY	DATE	TIME
Relinquished by:	CHRIS LEE	SLR	12/13/11	1308
Received by:	ERIC YOUNG	F+B	12/13/11	1308
Relinquished by:				
Received by:		Samples received at 16 °C		

Friedman & Bruya, Inc.
3012 16th Avenue West
Seattle, WA 98119-2029
Ph. (206) 285-8282
Fax (206) 283-5044

FRIEDMAN & BRUYA, INC.

ENVIRONMENTAL CHEMISTS

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Kurt Johnson, B.S.

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Seattle, WA 98119-2029
TEL: (206) 285-8282
e-mail: fbi@isomedia.com

December 20, 2011

Mike Staton, Project Manager
SLR International Corp.
22118 20th Ave. SE., G-202
Bothell, WA 98021

Dear Mr. Staton:

Included are the results from the testing of material submitted on December 15, 2011 from the Olympic Water & Sewer, Inc, PO 101.00433.00003, F&BI 112222 project. There are 4 pages included in this report. Any samples that may remain are currently scheduled for disposal in 30 days. If you would like us to return your samples or arrange for long term storage at our offices, please contact us as soon as possible.

We appreciate this opportunity to be of service to you and hope you will call if you should have any questions.

Sincerely,

FRIEDMAN & BRUYA, INC.

Kurt Johnson
Chemist

Enclosures
SLR1220R.DOC

CASE NARRATIVE

This case narrative encompasses samples received on December 15, 2011 by Friedman & Bruya, Inc. from the SLR International Corp. Olympic Water & Sewer, Inc, PO 101.00433.00003 project. Samples were logged in under the laboratory ID's listed below.

Laboratory ID	SLR International Corp.
112222 -01	Test2_Sample2
112222 -02	Test3_Sample1

All quality control requirements were acceptable.

Date of Report: 12/20/11
Date Received: 12/15/11
Project: Olympic Water & Sewer, Inc, PO 101.00433.00003, F&BI 112222
Date Extracted: 12/16/11
Date Analyzed: 12/16/11

RESULTS FROM THE ANALYSIS OF VAPOR SAMPLES FOR BENZENE, TOLUENE, ETHYLBENZENE, XYLENES AND TPH AS GASOLINE USING MODIFIED EPA METHOD 8021B AND NWTPH-Gx

Results Reported as mg/m^3

Sample ID Laboratory ID	Benzene	Toluene	Ethyl Benzene	Total Xylenes	Gasoline Range	Surrogate (% Recovery) (Limit 50-150)
Test2_Sample2 112222-01 1/5	14	32	5.0	10	1,900	96
Test3_Sample1 112222-02	0.58	1.6	0.62	1.6	85	95
Method Blank 01-2227 MB	<0.1	<0.1	<0.1	<0.3	<10	94

Date of Report: 12/20/11
Date Received: 12/15/11
Project: Olympic Water & Sewer, Inc, PO 101.00433.00003, F&BI 112222

QUALITY ASSURANCE RESULTS FOR THE ANALYSIS OF VAPOR SAMPLES FOR BENZENE, TOLUENE, ETHYLBENZENE, XYLENES, AND TPH AS GASOLINE USING MODIFIED EPA METHOD 8021B AND NWTPH-Gx

Laboratory Code: 112230-01 (Duplicate)

Analyte	Reporting Units	Sample Result	Duplicate Result	Relative Percent Difference (Limit 20)
Benzene	mg/m³	<0.1	<0.1	nm
Toluene	mg/m³	<0.1	<0.1	nm
Ethylbenzene	mg/m³	<0.1	<0.1	nm
Xylenes	mg/m³	<0.3	<0.3	nm
Gasoline	mg/m³	<10	<10	nm

Laboratory Code: Laboratory Control Sample

Analyte	Reporting Units	Spike Level	Percent Recovery LCS	Acceptance Criteria
Benzene	mg/m³	5.0	87	70-130
Toluene	mg/m³	5.0	91	70-130
Ethylbenzene	mg/m³	5.0	92	70-130
Xylenes	mg/m³	15	91	70-130
Gasoline	mg/m³	100	124	70-130

Data Qualifiers & Definitions

a - The analyte was detected at a level less than five times the reporting limit. The RPD results may not provide reliable information on the variability of the analysis.

A1 – More than one compound of similar molecule structure was identified with equal probability.

b - The analyte was spiked at a level that was less than five times that present in the sample. Matrix spike recoveries may not be meaningful.

ca - The calibration results for this range fell outside of acceptance criteria. The value reported is an estimate.

c - The presence of the analyte indicated may be due to carryover from previous sample injections.

d - The sample was diluted. Detection limits may be raised due to dilution.

ds - The sample was diluted. Detection limits are raised due to dilution and surrogate recoveries may not be meaningful.

dv - Insufficient sample was available to achieve normal reporting limits and limits are raised accordingly.

fb - Analyte present in the blank and the sample.

fc – The compound is a common laboratory and field contaminant.

hr - The sample and duplicate were reextracted and reanalyzed. RPD results were still outside of control limits. The variability is attributed to sample inhomogeneity.

ht - Analysis performed outside the method or client-specified holding time requirement.

ip - Recovery fell outside of normal control limits. Compounds in the sample matrix interfered with the quantitation of the analyte.

j – The result is below normal reporting limits. The value reported is an estimate.

J - The internal standard associated with the analyte is out of control limits. The reported concentration is an estimate.

jl - The analyte result in the laboratory control sample is out of control limits. The reported concentration should be considered an estimate.

jr - The rpd result in laboratory control sample associated with the analyte is out of control limits. The reported concentration should be considered an estimate.

js - The surrogate associated with the analyte is out of control limits. The reported concentration should be considered an estimate.

lc - The presence of the compound indicated is likely due to laboratory contamination.

L - The reported concentration was generated from a library search.

nm - The analyte was not detected in one or more of the duplicate analyses. Therefore, calculation of the RPD is not applicable.

pc – The sample was received in a container not approved by the method. The value reported should be considered an estimate.

pr – The sample was received with incorrect preservation. The value reported should be considered an estimate.

ve - Estimated concentration calculated for an analyte response above the valid instrument calibration range. A dilution is required to obtain an accurate quantification of the analyte.

vo - The value reported fell outside the control limits established for this analyte.

x - The sample chromatographic pattern does not resemble the fuel standard used for quantitation.

112222

SAMPLE CHAIN OF CUSTODY

KJ ME 12/15/11

Page # 1 of 1

Send Report To MIKE STATON

Company SLR INTERNATIONAL CORP

Address 22118 20TH AVE SE, G-202

City, State, ZIP BOTHELL, WA 98021

Phone #(425) 402-8800 Fax #(425) 402-8488

SAMPLERS (signature)

PROJECT NAME/NO. Olympic Water & Sewer, Inc 101.00433.00003

PO# 101.00433.00003

REMARKS 78-hour hold time.

TURNAROUND TIME
- [x] Standard (2 Weeks)
- [ ] RUSH
Rush charges authorized by

SAMPLE DISPOSAL
- [x] Dispose after 30 days
- [ ] Return samples
- [ ] Will call with instructions

Sample ID	Lab ID	Date Sampled	Time Sampled	Sample Type	# of containers	TPH-Diesel	TPH-Gasoline	BTEX by 8021B	VOCs by8260	SVOCs by 8270	HFS	TPH as gasoline by 8015M						Notes
TEST2_SAMPLE2	01	12/13/11	1830	AIR	1			X				X						
TEST3_SAMPLE1	02	12/14/11	1050	↓	↓			↓				↓						
												Samples received at						16 °C

SIGNATURE	PRINT NAME	COMPANY	DATE	TIME
Relinquished by:	CHRIS LEE	SLR	12/15/11	11:49
Received by:	JAMES E. KOCHER	CHAMPION	12/15/11	11:50
Relinquished by:				
Received by:	Nhan Phan	FEBI	12/15/11	1:10

Friedman & Bruya, Inc.
3012 16th Avenue West
Seattle, WA 98119-2029
Ph. (206) 285-8282
Fax (206) 283-5044

FRIEDMAN & BRUYA, INC.

ENVIRONMENTAL CHEMISTS

James E. Bruya, Ph.D.
Yelena Aravkina, M.S.
Bradley T. Benson, B.S.
Kurt Johnson, B.S.

3012 16th Avenue West
Seattle, WA 98119-2029
TEL: (206) 285-8282
e-mail: fbi@isomedia.com

January 6, 2012

Mike Staton, Project Manager
SLR International Corp.
22118 20th Ave. SE., G-202
Bothell, WA 98021

Dear Mr. Staton:

Included are the results from the testing of material submitted on December 30, 2011 from the Olympic Water & Sewer, Inc. 101.00433.00003, F&BI 112402 project. There are 4 pages included in this report. Any samples that may remain are currently scheduled for disposal in 30 days. If you would like us to return your samples or arrange for long term storage at our offices, please contact us as soon as possible.

We appreciate this opportunity to be of service to you and hope you will call if you should have any questions.

Sincerely,

FRIEDMAN & BRUYA, INC.

Kurt Johnson
Chemist

Enclosures
SLR0106R.DOC

CASE NARRATIVE

This case narrative encompasses samples received on December 30, 2011 by Friedman & Bruya, Inc. from the SLR International Corp. Olympic Water & Sewer, Inc. 101.00433.00003, F&BI 112402 project. Samples were logged in under the laboratory ID's listed below.

Laboratory ID	SLR International Corp.
112402-01	TEST4-Sample1

Please note that the relative percent difference (RPD) of the analysis of ethylbenzene and the xylenes in the laboratory control sample and laboratory control duplicate fell outside of the established control limits. The results have been flagged accordingly.

All other quality control requirements were acceptable.

Date of Report: 01/06/12
Date Received: 12/30/11
Project: Olympic Water & Sewer, Inc. 101.00433.00003, F&BI 112402
Date Extracted: 12/30/11
Date Analyzed: 12/30/11

RESULTS FROM THE ANALYSIS OF VAPOR SAMPLES FOR BENZENE, TOLUENE, ETHYLBENZENE, XYLENES AND TPH AS GASOLINE USING MODIFIED EPA METHOD 8021B AND NWTPH-Gx

Results Reported as mg/m^3

Sample ID Laboratory ID	Benzene	Toluene	Ethyl Benzene	Total Xylenes	Gasoline Range	Surrogate (% Recovery) (Limit 50-150)
TEST4-Sample1 112402-01	0.18	0.46	0.53	1.8	30	83
Method Blank 01-2313 MB	<0.1	<0.1	<0.1	<0.3	<10	90

Date of Report: 01/06/12
Date Received: 12/30/11
Project: Olympic Water & Sewer, Inc. 101.00433.00003, F&BI 112402

QUALITY ASSURANCE RESULTS FOR THE ANALYSIS OF VAPOR SAMPLES FOR BENZENE, TOLUENE, ETHYLBENZENE, XYLENES, AND TPH AS GASOLINE USING MODIFIED EPA METHOD 8021B AND NWTPH-Gx

Laboratory Code: 112402-01 (Duplicate)

Analyte	Reporting Units	Sample Result	Duplicate Result	Relative Percent Difference (Limit 20)
Benzene	mg/m^3	0.18 a	0.34 a	60 a
Toluene	mg/m^3	0.46 a	0.83	57 a
Ethylbenzene	mg/m^3	0.53	0.97	58 vo
Xylenes	mg/m^3	1.8	3.2	57 vo
Gasoline	mg/m^3	30 a	64	72 a

Laboratory Code: Laboratory Control Sample

Analyte	Reporting Units	Spike Level	Percent Recovery LCS	Acceptance Criteria
Benzene	mg/m^3	5.0	80	70-130
Toluene	mg/m^3	5.0	80	70-130
Ethylbenzene	mg/m^3	5.0	85	70-130
Xylenes	mg/m^3	15	81	70-130
Gasoline	mg/m^3	100	116	70-130

Data Qualifiers & Definitions

a - The analyte was detected at a level less than five times the reporting limit. The RPD results may not provide reliable information on the variability of the analysis.

A1 – More than one compound of similar molecule structure was identified with equal probability.

b - The analyte was spiked at a level that was less than five times that present in the sample. Matrix spike recoveries may not be meaningful.

ca - The calibration results for this range fell outside of acceptance criteria. The value reported is an estimate.

c - The presence of the analyte indicated may be due to carryover from previous sample injections.

d - The sample was diluted. Detection limits may be raised due to dilution.

ds - The sample was diluted. Detection limits are raised due to dilution and surrogate recoveries may not be meaningful.

dv - Insufficient sample was available to achieve normal reporting limits and limits are raised accordingly.

fb - Analyte present in the blank and the sample.

fc – The compound is a common laboratory and field contaminant.

hr - The sample and duplicate were reextracted and reanalyzed. RPD results were still outside of control limits. The variability is attributed to sample inhomogeneity.

ht - Analysis performed outside the method or client-specified holding time requirement.

ip - Recovery fell outside of normal control limits. Compounds in the sample matrix interfered with the quantitation of the analyte.

j – The result is below normal reporting limits. The value reported is an estimate.

J - The internal standard associated with the analyte is out of control limits. The reported concentration is an estimate.

jl - The analyte result in the laboratory control sample is out of control limits. The reported concentration should be considered an estimate.

jr - The rpd result in laboratory control sample associated with the analyte is out of control limits. The reported concentration should be considered an estimate.

js - The surrogate associated with the analyte is out of control limits. The reported concentration should be considered an estimate.

lc - The presence of the compound indicated is likely due to laboratory contamination.

L - The reported concentration was generated from a library search.

nm - The analyte was not detected in one or more of the duplicate analyses. Therefore, calculation of the RPD is not applicable.

pc – The sample was received in a container not approved by the method. The value reported should be considered an estimate.

pr – The sample was received with incorrect preservation. The value reported should be considered an estimate.

ve - Estimated concentration calculated for an analyte response above the valid instrument calibration range. A dilution is required to obtain an accurate quantification of the analyte.

vo - The value reported fell outside the control limits established for this analyte.

x - The sample chromatographic pattern does not resemble the fuel standard used for quantitation.

112402

SAMPLE CHAIN OF CUSTODY

KJ 12/30/11

Page # 1 of 1

Send Report To MIKE STATON

Company SLR INTERNATIONAL CORP

Address 22118 20TH AVE SE, G-202

City, State, ZIP BOTHELL, WA 98021

Phone # (425)402-8800 Fax # (425)402-8488

SAMPLERS *(signature)*

PROJECT NAME/NO.	PO#
OLYMPIC WATER & SEWER, INC 101.00433.00003	101.00433.00003

REMARKS

TURNAROUND TIME
- [x] Standard (2 Weeks)
- [ ] RUSH
- Rush charges authorized by

SAMPLE DISPOSAL
- [x] Dispose after 30 days
- [ ] Return samples
- [ ] Will call with instructions

Sample ID	Lab ID	Date Sampled	Time Sampled	Sample Type	# of containers	TPH-Diesel	TPH-Gasoline	BTEX by 8021B	VOCs by8260	SVOCs by 8270	HFS	TPH as gasoline by 8015M						Notes
TEST 4 - SAMPLE 1	01	12/29/11	1000	AIR	1			X				X						
																		Samples received at 16 °C

SIGNATURE	PRINT NAME	COMPANY	DATE	TIME
Relinquished by:	CHRIS LEE	SLR	12/30/11	0850
Received by:	Nhan Pham	FEBI	12/30/11	0850
Relinquished by:				
Received by:				

Friedman & Bruya, Inc.
3012 16th Avenue West
Seattle, WA 98119-2029
Ph. (206) 285-8282
Fax (206) 283-5044

FRIEDMAN & BRUYA, INC.

ENVIRONMENTAL CHEMISTS

James E. Bruya, Ph.D.
Yelena Aravkina, M.S.
Bradley T. Benson, B.S.
Kurt Johnson, B.S.

3012 16th Avenue West
Seattle, WA 98119-2029
TEL: (206) 285-8282
e-mail: fbi@isomedia.com

January 10, 2012

Mike Staton, Project Manager
SLR International Corp.
22118 20th Ave. SE., G-202
Bothell, WA 98021

Dear Mr. Staton:

Included are the results from the testing of material submitted on January 6, 2012 from the Olympic Water & Sewer 101.00433.00003, F&BI 201053 project. There are 4 pages included in this report. Any samples that may remain are currently scheduled for disposal in 30 days. If you would like us to return your samples or arrange for long term storage at our offices, please contact us as soon as possible.

We appreciate this opportunity to be of service to you and hope you will call if you should have any questions.

Sincerely,

FRIEDMAN & BRUYA, INC.

Kurt Johnson
Chemist

Enclosures
mcp/KJ
SLR0110R.DOC

CASE NARRATIVE

This case narrative encompasses samples received on January 6, 2012 by Friedman & Bruya, Inc. from the SLR International Corp. Olympic Water & Sewer 101.00433.00003, F&BI 201053 project. Samples were logged in under the laboratory ID's listed below.

Laboratory ID	SLR International Corp.
201053-01	Test 4_Sample 2

All quality control requirements were acceptable.

Date of Report: 01/10/12
Date Received: 01/06/12
Project: Olympic Water & Sewer 101.00433.00003, F&BI 201053
Date Extracted: 01/06/12
Date Analyzed: 01/06/12

RESULTS FROM THE ANALYSIS OF VAPOR SAMPLES FOR BENZENE, TOLUENE, ETHYLBENZENE, XYLENES AND TPH AS GASOLINE USING MODIFIED EPA METHOD 8021B AND NWTPH-Gx

Results Reported as mg/m^3

Sample ID Laboratory ID	Benzene	Toluene	Ethyl Benzene	Total Xylenes	Gasoline Range	Surrogate (% Recovery) (Limit 50-150)
Test 4_Sample 2 201053-01	2.5	5.1	1.6	4.6	180	87
Method Blank 02-0038 MB	<0.1	<0.1	<0.1	<0.3	<10	88

Date of Report: 01/10/12
Date Received: 01/06/12
Project: Olympic Water & Sewer 101.00433.00003, F&BI 201053

QUALITY ASSURANCE RESULTS FOR THE ANALYSIS OF VAPOR SAMPLES FOR BENZENE, TOLUENE, ETHYLBENZENE, XYLENES, AND TPH AS GASOLINE USING MODIFIED EPA METHOD 8021B AND NWTPH-Gx

Laboratory Code: 201013-02 (Duplicate)

Analyte	Reporting Units	Sample Result	Duplicate Result	Relative Percent Difference (Limit 20)
Benzene	mg/m³	<0.1	<0.1	nm
Toluene	mg/m³	<0.1	<0.1	nm
Ethylbenzene	mg/m³	<0.1	<0.1	nm
Xylenes	mg/m³	<0.3	<0.3	nm
Gasoline	mg/m³	<10	<10	nm

Laboratory Code: Laboratory Control Sample

Analyte	Reporting Units	Spike Level	Percent Recovery LCS	Acceptance Criteria
Benzene	mg/m³	5.0	95	70-130
Toluene	mg/m³	5.0	96	70-130
Ethylbenzene	mg/m³	5.0	98	70-130
Xylenes	mg/m³	15	97	70-130
Gasoline	mg/m³	100	123	70-130

Data Qualifiers & Definitions

a - The analyte was detected at a level less than five times the reporting limit. The RPD results may not provide reliable information on the variability of the analysis.

A1 – More than one compound of similar molecule structure was identified with equal probability.

b - The analyte was spiked at a level that was less than five times that present in the sample. Matrix spike recoveries may not be meaningful.

ca - The calibration results for this range fell outside of acceptance criteria. The value reported is an estimate.

c - The presence of the analyte indicated may be due to carryover from previous sample injections.

d - The sample was diluted. Detection limits may be raised due to dilution.

ds - The sample was diluted. Detection limits are raised due to dilution and surrogate recoveries may not be meaningful.

dv - Insufficient sample was available to achieve normal reporting limits and limits are raised accordingly.

fb - Analyte present in the blank and the sample.

fc – The compound is a common laboratory and field contaminant.

hr - The sample and duplicate were reextracted and reanalyzed. RPD results were still outside of control limits. The variability is attributed to sample inhomogeneity.

ht - Analysis performed outside the method or client-specified holding time requirement.

ip - Recovery fell outside of normal control limits. Compounds in the sample matrix interfered with the quantitation of the analyte.

j – The result is below normal reporting limits. The value reported is an estimate.

J - The internal standard associated with the analyte is out of control limits. The reported concentration is an estimate.

jl - The analyte result in the laboratory control sample is out of control limits. The reported concentration should be considered an estimate.

jr - The rpd result in laboratory control sample associated with the analyte is out of control limits. The reported concentration should be considered an estimate.

js - The surrogate associated with the analyte is out of control limits. The reported concentration should be considered an estimate.

lc - The presence of the compound indicated is likely due to laboratory contamination.

L - The reported concentration was generated from a library search.

nm - The analyte was not detected in one or more of the duplicate analyses. Therefore, calculation of the RPD is not applicable.

pc – The sample was received in a container not approved by the method. The value reported should be considered an estimate.

pr – The sample was received with incorrect preservation. The value reported should be considered an estimate.

ve - Estimated concentration calculated for an analyte response above the valid instrument calibration range. A dilution is required to obtain an accurate quantification of the analyte.

vo - The value reported fell outside the control limits established for this analyte.

x - The sample chromatographic pattern does not resemble the fuel standard used for quantitation.

201053

SAMPLE CHAIN OF CUSTODY

TAT FJ 01/06/2012

Page # 1 of 6

Send Report To: MIKE STATON
Company: SLR INTERNATIONAL CORP
Address: 22118 20TH AVE SE, G-202
City, State, ZIP: BOTHELL, WA 98021
Phone # (425) 402-8800 Fax # (425) 402-8488

SAMPLERS (signature):

PROJECT NAME/NO.: Olympic Water & Sewer, Inc 101.00433.00003

PO#: 101.00433.00003

REMARKS:

TURNAROUND TIME
- [x] Standard (2 Weeks)
- [ ] RUSH
Rush charges authorized by:

SAMPLE DISPOSAL
- [x] Dispose after 30 days
- [ ] Return samples
- [ ] Will call with instructions

Sample ID	Lab ID	Date Sampled	Time Sampled	Sample Type	# of containers	TPH-Diesel	TPH-Gasoline	BTEX by 8021B	VOCs by8260	SVOCs by 8270	HFS	TPH as gasoline by NWTPH					Notes
TEST 4 - SAMPLE 2	01	1/5/12	0900	AIR	2			X				X					

ANALYSES REQUESTED

SIGNATURE	PRINT NAME	COMPANY	DATE	TIME
Relinquished by:	CHRIS LEE	SLR	1/6/12	1113
Received by: Bernadette Fa	Bernadette	Postal Exp	1-6-12	1113
Relinquished by:		Samples received at 16 °C		
Received by:				

Friedman & Bruya, Inc.
3012 16th Avenue West
Seattle, WA 98119-2029
Ph. (206) 285-8282
Fax (206) 283-5044

FRIEDMAN & BRUYA, INC.

ENVIRONMENTAL CHEMISTS

James E. Bruya, Ph.D.
Yelena Aravkina, M.S.
Bradley T. Benson, B.S.
Kurt Johnson, B.S.

3012 16th Avenue West
Seattle, WA 98119-2029
TEL: (206) 285-8282
e-mail: fbi@isomedia.com

January 3, 2012

Mike Staton, Project Manager
SLR International Corp.
22118 20th Ave. SE., G-202
Bothell, WA 98021

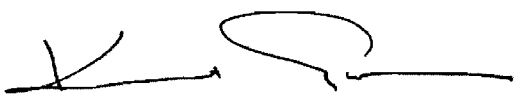
Dear Mr. Staton:

Included are the amended results from the testing of material submitted on December 15, 2011 from the Olympic Water & Sewer, Inc, PO 101.00433.00003, F&BI 112223 project. As requested, the results from the analysis of the sample Effluent_Pre-Carbon for benzene, toluene, ethylbenzene, and the xylenes (BTEX) have been reported.

We appreciate this opportunity to be of service to you and hope you will call if you should have any questions.

Sincerely,

FRIEDMAN & BRUYA, INC.



Kurt Johnson
Chemist

Enclosures
mcp/KJ
SLR1220R.DOC

FRIEDMAN & BRUYA, INC.

ENVIRONMENTAL CHEMISTS

James E. Bruya, Ph.D.
Yelena Aravkina, M.S.
Bradley T. Benson, B.S.
Kurt Johnson, B.S.

3012 16th Avenue West
Seattle, WA 98119-2029
TEL: (206) 285-8282
e-mail: fbi@isomedia.com

December 20, 2011

Mike Staton, Project Manager
SLR International Corp.
22118 20th Ave. SE., G-202
Bothell, WA 98021

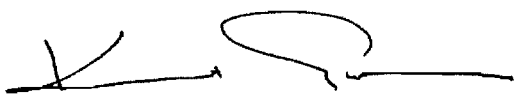
Dear Mr. Staton:

Included are the results from the testing of material submitted on December 15, 2011 from the Olympic Water & Sewer, Inc, PO 101.00433.00003, F&BI 112223 project. There are 4 pages included in this report. Any samples that may remain are currently scheduled for disposal in 30 days. If you would like us to return your samples or arrange for long term storage at our offices, please contact us as soon as possible.

We appreciate this opportunity to be of service to you and hope you will call if you should have any questions.

Sincerely,

FRIEDMAN & BRUYA, INC.



Kurt Johnson
Chemist

Enclosures
mcp/KJ
SLR1220R.DOC

CASE NARRATIVE

This case narrative encompasses samples received on December 15, 2011 by Friedman & Bruya, Inc. from the SLR International Corp. Olympic Water & Sewer, Inc, PO 101.00433.00003 project. Samples were logged in under the laboratory ID's listed below.

Laboratory ID	SLR International Corp.
112223 -01	Effluent_Pre-Carbon

All quality control requirements were acceptable.

Date of Report: 12/20/11
Date Received: 12/15/11
Project: Olympic Water & Sewer, Inc, PO 101.00433.00003, F&BI 112223
Date Extracted: 12/16/11
Date Analyzed: 12/16/11

RESULTS FROM THE ANALYSIS OF WATER SAMPLES FOR BENZENE, TOLUENE, ETHYLBENZENE, XYLENES AND TPH AS GASOLINE USING EPA METHOD 8021B AND NWTPH-Gx

Results Reported as ug/L (ppb)

Sample ID Laboratory ID	Benzene	Toluene	Ethyl Benzene	Total Xylenes	Gasoline Range	Surrogate (% Recovery) (Limit 52-124)
Effluent_Pre-Carbon 112223-01 1/20	430	1,900	<20	2,000	23,000	101
Method Blank 01-2224 MB	<1	<1	<1	<3	<100	94

Date of Report: 12/20/11
Date Received: 12/15/11
Project: Olympic Water & Sewer, Inc, PO 101.00433.00003, F&BI 112223

QUALITY ASSURANCE RESULTS FOR THE ANALYSIS OF WATER SAMPLES FOR BENZENE, TOLUENE, ETHYLBENZENE, XYLENES, AND TPH AS GASOLINE USING EPA METHOD 8021B AND NWTPH-Gx

Laboratory Code: 112205-01 (Duplicate)

Analyte	Reporting Units	Sample Result	Duplicate Result	Relative Percent Difference (Limit 20)
Benzene	ug/L (ppb)	<1	<1	nm
Toluene	ug/L (ppb)	<1	<1	nm
Ethylbenzene	ug/L (ppb)	<1	<1	nm
Xylenes	ug/L (ppb)	<3	<3	nm
Gasoline	ug/L (ppb)	<100	<100	nm

Laboratory Code: Laboratory Control Sample

Analyte	Reporting Units	Spike Level	Percent Recovery LCS	Acceptance Criteria
Benzene	ug/L (ppb)	50	88	72-119
Toluene	ug/L (ppb)	50	89	71-113
Ethylbenzene	ug/L (ppb)	50	89	72-114
Xylenes	ug/L (ppb)	150	84	72-113
Gasoline	ug/L (ppb)	1,000	99	70-119

Data Qualifiers & Definitions

a - The analyte was detected at a level less than five times the reporting limit. The RPD results may not provide reliable information on the variability of the analysis.

A1 – More than one compound of similar molecule structure was identified with equal probability.

b - The analyte was spiked at a level that was less than five times that present in the sample. Matrix spike recoveries may not be meaningful.

ca - The calibration results for this range fell outside of acceptance criteria. The value reported is an estimate.

c - The presence of the analyte indicated may be due to carryover from previous sample injections.

d - The sample was diluted. Detection limits may be raised due to dilution.

ds - The sample was diluted. Detection limits are raised due to dilution and surrogate recoveries may not be meaningful.

dv - Insufficient sample was available to achieve normal reporting limits and limits are raised accordingly.

fb - Analyte present in the blank and the sample.

fc – The compound is a common laboratory and field contaminant.

hr - The sample and duplicate were reextracted and reanalyzed. RPD results were still outside of control limits. The variability is attributed to sample inhomogeneity.

ht - Analysis performed outside the method or client-specified holding time requirement.

ip - Recovery fell outside of normal control limits. Compounds in the sample matrix interfered with the quantitation of the analyte.

j – The result is below normal reporting limits. The value reported is an estimate.

J - The internal standard associated with the analyte is out of control limits. The reported concentration is an estimate.

jl - The analyte result in the laboratory control sample is out of control limits. The reported concentration should be considered an estimate.

jr - The rpd result in laboratory control sample associated with the analyte is out of control limits. The reported concentration should be considered an estimate.

js - The surrogate associated with the analyte is out of control limits. The reported concentration should be considered an estimate.

lc - The presence of the compound indicated is likely due to laboratory contamination.

L - The reported concentration was generated from a library search.

nm - The analyte was not detected in one or more of the duplicate analyses. Therefore, calculation of the RPD is not applicable.

pc – The sample was received in a container not approved by the method. The value reported should be considered an estimate.

pr – The sample was received with incorrect preservation. The value reported should be considered an estimate.

ve - Estimated concentration calculated for an analyte response above the valid instrument calibration range. A dilution is required to obtain an accurate quantification of the analyte.

vo - The value reported fell outside the control limits established for this analyte.

x - The sample chromatographic pattern does not resemble the fuel standard used for quantitation.

112223

SAMPLE CHAIN OF CUSTODY KJ 12/15/11

V1

Page # 1 of 1

Send Report To MIKE STATON
Company SLR INTERNATIONAL CORP
Address 22118 20TH AVE SE, G-200
City, State, ZIP BOTHELL, WA 98021
Phone # (425) 402-8800 Fax # (425) 402-8488

SAMPLERS (signature)

PROJECT NAME/NO.: OLYMPIC WATER & SEWER, INC 101.00433.00003
PO#: 101.00433.00003

REMARKS

TURNAROUND TIME
☒ Standard (2 Weeks)
☐ RUSH
Rush charges authorized by

SAMPLE DISPOSAL
☒ Dispose after 30 days
☐ Return samples
☐ Will call with instructions

Sample ID	Lab ID	Date Sampled	Time Sampled	Sample Type	# of containers	TPH-Diesel	TPH-Gasoline	BTEX by 8021B	VOCs by8260	SVOCs by 8270	HFS	BTEX by 8260B						Notes
EFFLUENT - PRE CARBON	01 A-D	12/13/11	1430	WATER	4		X	✓										V=added per KJ 12/20/11
												Samples received at						2 °C

Friedman & Bruya, Inc.
3012 16th Avenue West
Seattle, WA 98119-2029
Ph. (206) 285-8282
Fax (206) 283-5044

FORMS\COC\COC.DOC

SIGNATURE	PRINT NAME	COMPANY	DATE	TIME
Relinquished by:	CHRIS LEE	SLR	12/15/11	11:49
Received by:	JAMES E. ROCHER	CHAMPION	12/15/11	11:50
Relinquished by:				
Received by:	Nhan Phan	FEBI	12/15/11	1:10

FRIEDMAN & BRUYA, INC.

ENVIRONMENTAL CHEMISTS

James E. Bruya, Ph.D.
Yelena Aravkina, M.S.
Bradley T. Benson, B.S.
Kurt Johnson, B.S.

3012 16th Avenue West
Seattle, WA 98119-2029
TEL: (206) 285-8282
e-mail: fbi@isomedia.com

January 6, 2012

Mike Staton, Project Manager
SLR International Corp.
22118 20th Ave. SE., G-202
Bothell, WA 98021

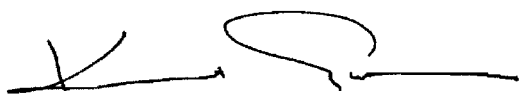
Dear Mr. Staton:

Included are the results from the testing of material submitted on December 30, 2011 from the Olympic Water & Sewer, Inc. 101.00433.00003, F&BI 112401 project. There are 4 pages included in this report. Any samples that may remain are currently scheduled for disposal in 30 days. If you would like us to return your samples or arrange for long term storage at our offices, please contact us as soon as possible.

We appreciate this opportunity to be of service to you and hope you will call if you should have any questions.

Sincerely,

FRIEDMAN & BRUYA, INC.



Kurt Johnson
Chemist

Enclosures
mcp/KJ
SLR0106R.DOC

CASE NARRATIVE

This case narrative encompasses samples received on December 30, 2011 by Friedman & Bruya, Inc. from the SLR International Corp. Olympic Water & Sewer, Inc. 101.00433.00003, F&BI 112401 project. Samples were logged in under the laboratory ID's listed below.

Laboratory ID	SLR International Corp.
112401-01	System-Effluent-122911

All quality control requirements were acceptable.

Date of Report: 01/06/12
Date Received: 12/30/11
Project: Olympic Water & Sewer, Inc. 101.00433.00003, F&BI 112401
Date Extracted: 01/03/12
Date Analyzed: 01/03/12

RESULTS FROM THE ANALYSIS OF WATER SAMPLES FOR BENZENE, TOLUENE, ETHYLBENZENE, XYLENES AND TPH AS GASOLINE USING EPA METHOD 8021B AND NWTPH-Gx

Results Reported as ug/L (ppb)

Sample ID Laboratory ID	Benzene	Toluene	Ethyl Benzene	Total Xylenes	Gasoline Range	Surrogate (% Recovery) (Limit 52-124)
System-Effluent-122911 112401-01	<1	<1	<1	<3	<100	89
Method Blank 02-0013 MB	<1	<1	<1	<3	<100	93

Date of Report: 01/06/12
Date Received: 12/30/11
Project: Olympic Water & Sewer, Inc. 101.00433.00003, F&BI 112401

QUALITY ASSURANCE RESULTS FOR THE ANALYSIS OF WATER SAMPLES FOR BENZENE, TOLUENE, ETHYLBENZENE, XYLENES, AND TPH AS GASOLINE USING EPA METHOD 8021B AND NWTPH-Gx

Laboratory Code: 112337-01 (Duplicate)

Analyte	Reporting Units	Sample Result	Duplicate Result	Relative Percent Difference (Limit 20)
Benzene	ug/L (ppb)	<1	<1	nm
Toluene	ug/L (ppb)	<1	<1	nm
Ethylbenzene	ug/L (ppb)	<1	<1	nm
Xylenes	ug/L (ppb)	<3	<3	nm
Gasoline	ug/L (ppb)	<100	<100	nm

Laboratory Code: Laboratory Control Sample

Analyte	Reporting Units	Spike Level	Percent Recovery LCS	Acceptance Criteria
Benzene	ug/L (ppb)	50	94	65-118
Toluene	ug/L (ppb)	50	95	72-122
Ethylbenzene	ug/L (ppb)	50	100	73-126
Xylenes	ug/L (ppb)	150	93	74-118
Gasoline	ug/L (ppb)	1,000	99	69-134

Data Qualifiers & Definitions

a - The analyte was detected at a level less than five times the reporting limit. The RPD results may not provide reliable information on the variability of the analysis.

A1 – More than one compound of similar molecule structure was identified with equal probability.

b - The analyte was spiked at a level that was less than five times that present in the sample. Matrix spike recoveries may not be meaningful.

ca - The calibration results for this range fell outside of acceptance criteria. The value reported is an estimate.

c - The presence of the analyte indicated may be due to carryover from previous sample injections.

d - The sample was diluted. Detection limits may be raised due to dilution.

ds - The sample was diluted. Detection limits are raised due to dilution and surrogate recoveries may not be meaningful.

dv - Insufficient sample was available to achieve normal reporting limits and limits are raised accordingly.

fb - Analyte present in the blank and the sample.

fc – The compound is a common laboratory and field contaminant.

hr - The sample and duplicate were reextracted and reanalyzed. RPD results were still outside of control limits. The variability is attributed to sample inhomogeneity.

ht - Analysis performed outside the method or client-specified holding time requirement.

ip - Recovery fell outside of normal control limits. Compounds in the sample matrix interfered with the quantitation of the analyte.

j – The result is below normal reporting limits. The value reported is an estimate.

J - The internal standard associated with the analyte is out of control limits. The reported concentration is an estimate.

jl - The analyte result in the laboratory control sample is out of control limits. The reported concentration should be considered an estimate.

jr - The rpd result in laboratory control sample associated with the analyte is out of control limits. The reported concentration should be considered an estimate.

js - The surrogate associated with the analyte is out of control limits. The reported concentration should be considered an estimate.

lc - The presence of the compound indicated is likely due to laboratory contamination.

L - The reported concentration was generated from a library search.

nm - The analyte was not detected in one or more of the duplicate analyses. Therefore, calculation of the RPD is not applicable.

pc – The sample was received in a container not approved by the method. The value reported should be considered an estimate.

pr – The sample was received with incorrect preservation. The value reported should be considered an estimate.

ve - Estimated concentration calculated for an analyte response above the valid instrument calibration range. A dilution is required to obtain an accurate quantification of the analyte.

vo - The value reported fell outside the control limits established for this analyte.

x - The sample chromatographic pattern does not resemble the fuel standard used for quantitation.

112401

SAMPLE CHAIN OF CUSTODY

KJ 12/30/11 C (VI

Page # _____ of _____

Send Report To Mike Staton

Company SLR International Corp

Address 22118 20th Ave SE, G-202

City, State, ZIP Bothell, WA 98021

Phone # (425)402-8800 Fax # (425)402-8488

SAMPLERS (signature)

PROJECT NAME/NO.: Olympic Water & Sewer, Inc 101.00433.00003

PO#: 101-00433.00003

REMARKS: Need results by Tuesday, January 2

TURNAROUND TIME
- ☐ Standard (2 Weeks)
- ☒ RUSH by Tuesday, Jan 2
- Rush charges authorized by CAL

SAMPLE DISPOSAL
- ☒ Dispose after 30 days
- ☐ Return samples
- ☐ Will call with instructions

Sample ID	Lab ID	Date Sampled	Time Sampled	Sample Type	# of containers	TPH-Diesel	TPH-Gasoline	BTEX by 8021B	VOCs by8260	SVOCs by 8270	HFS	BTEX by 8021	per KJ 1/5/12					Notes
System_Effluent-122911	01 A-9	12/29/11	1030	Water	3		X					X						
													Samples received at					5 °C

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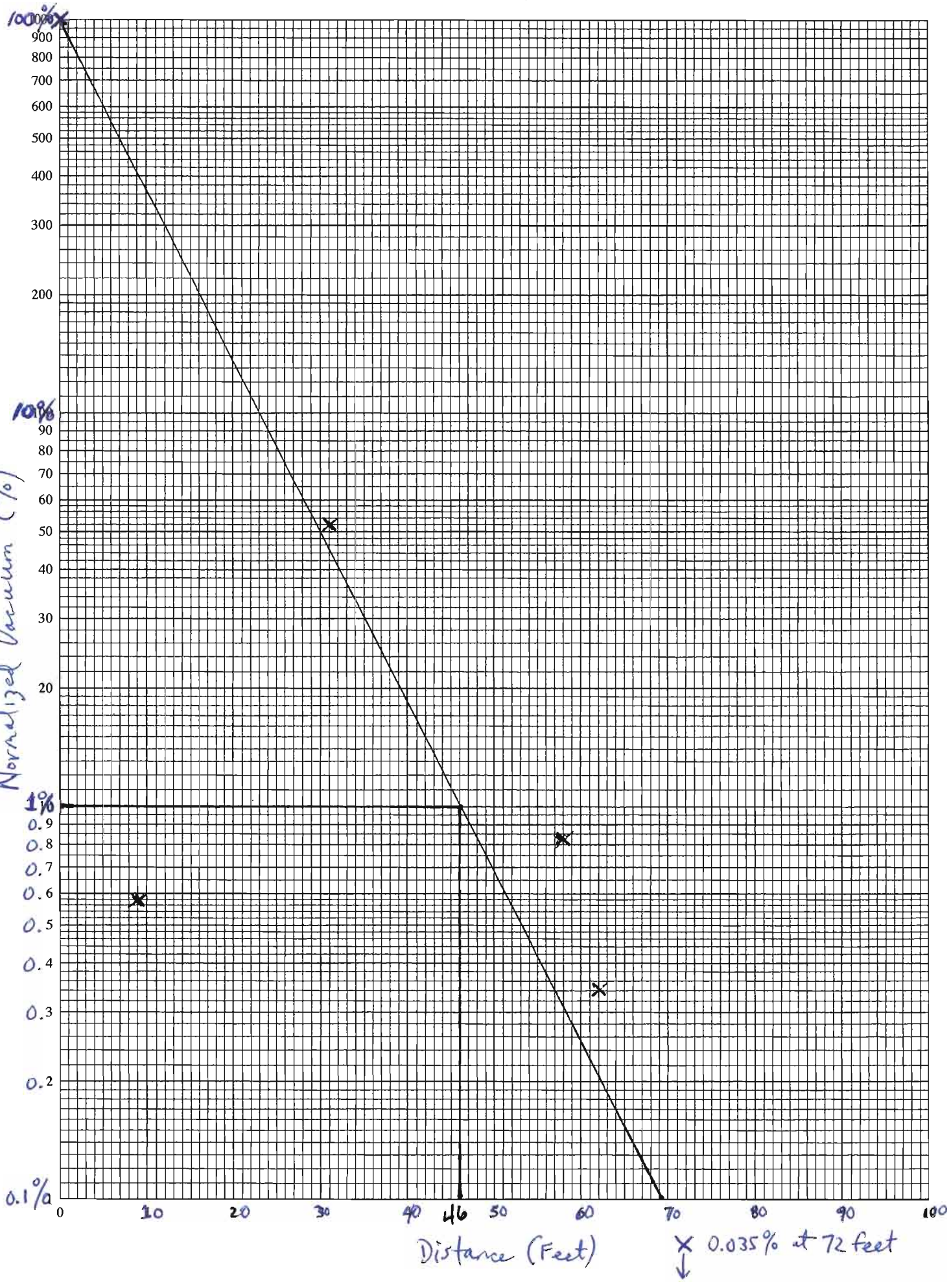
Seattle, WA 98119-2029
Ph. (206) 285-8282
Fax (206) 283-5044

SIGNATURE	PRINT NAME	COMPANY	DATE	TIME
Relinquished by:	Chris Lee	SLR	12/30/11	0850
Received by:	Nhan Phan	FEBI	12/30/11	0850
Relinquished by:				
Received by:				

PLOT OF NORMALIZED VACUUM DATA

NORMALIZED VACUUM PLOT
PILOT TEST #4



HYDROCARBON MASS REMOVAL CALCULATIONS

SLR

SUBJECT: Hydrocarbon Mass Removal Rates - Pilot Test #4

Job No: 101.00433.00003 | Made by M. Staton | Date 1/18/2012

Ref: | Checked C. Lee | Sheet 1 of 1

Reviewed

Hydrocarbon mass removal rate (lbs/day) = airflow rate (cfm) x gasoline concentration (ppm-v) x molecular weight (grams/mole) x 1.58×10^{-7} x 24 hours/day (USEPA, 1989)

The molecular weight of gasoline is 102.2 g/mole

1) Based on GRO concentration in sample collected on 12/29/2011,

Hydrocarbon mass removal rate = 53 cfm x 6.9 ppm-v x 102.2 g/mole x 1.58×10^{-7} x 24 hrs/day = **0.14 lbs/day**

2) Based on PID reading on 12/29/2011,

Hydrocarbon mass removal rate = 53 cfm x 392 ppm-v x 102.2 g/mole x 1.58×10^{-7} x 24 hrs/day = **8.05 lbs/day**

3) Based on GRO concentration in sample collected on 1/5/2012,

Hydrocarbon mass removal rate = 75 cfm x 41.4 ppm-v x 102.2 g/mole x 1.58×10^{-7} x 24 hrs/day = **1.20 lbs/day**

4) Based on PID reading on 1/5/2012,

Hydrocarbon mass removal rate = 75 cfm x 250 ppm-v x 102.2 g/mole x 1.58×10^{-7} x 24 hrs/day = **7.27 lbs/day**


Aspect
CONSULTING