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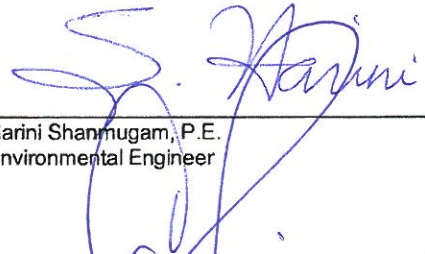
Remedial Action Plan

Former ARCO Facility No.5544

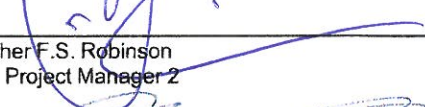
19918 68th Avenue South,
Kent, WA

July 5, 2012

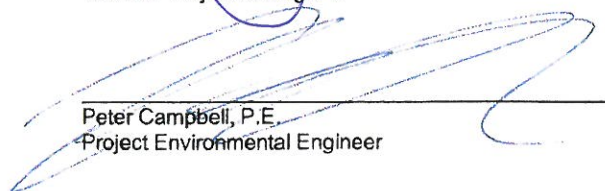




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Exp 2/14/2014

Remedial Action Plan

Former ARCO Facility No.5544
19918 68th Avenue South,
Kent, Washington

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1. Introduction

On behalf of BP West Coast Products, LLC (BP), ARCADIS U.S., Inc. (ARCADIS) has prepared this Remedial Action Plan (RAP) for Atlantic Richfield Company (ARCO) for the former ARCO Facility No. 5544 located at 19918 68th Avenue South in Kent, Washington (the site). A site location map is presented on **Figure 1**. A site aerial map is presented on **Figure 2**.

2. Objective

The objective of the RAP is to outline the actions that would allow for a No Further Action (NFA) designation for the site on behalf of BP. This RAP summarizes the Air Sparge /Soil Vapor extraction (AS/SVE) remedial strategy and proposed activities for system installation, system optimization, maintenance and performance monitoring.

3. Background

The site is currently an active Chevron retail gasoline station located on the east side of 68th Avenue (West Valley Highway) at the eastern terminus of South 199th Place, in Kent, Washington.

The surrounding area is primarily commercial with retail businesses located to the north and south of the site, Mill Creek to the east of the site, and 68th Avenue South to the west of the site. Site features include a station building with mini mart and Subway Sandwich shop, four fuel dispensers situated on four concrete dispenser islands, an oil/water separator, and a concrete swale and rock spill way in the southeast corner. The underground storage tanks (USTs) are located in a common tank basin along the southern property boundary. A drive-up espresso stand is located along the southern property line to the west of the UST complex. The topography of the site is generally flat. A site plan depicting current site features is presented on **Figure 3**.

4. Site Cleanup Levels

The Washington State Department of Ecology (DOE) mandates cleanup levels under Model Toxics Control Act (MTCA) Method A, Method B and Method C Cleanup Levels (CLs). The Method A CLs have been established for groundwater where drinking water is a beneficial use, soil for unrestricted land use and industrial properties. Residual and dissolved phase constituents of concern (COCs) detected at the site above MTCA Method A CLs are as follows:

- Gasoline Range Organics (GRO) (soil and groundwater)
- benzene (soil and groundwater)
- toluene (soil and groundwater)
- ethylbenzene (soil and groundwater)
- total xylenes (soil and groundwater)

Additional guidance used to compare residual and dissolved phase concentrations of COCs with clean up criteria is from the Washington State Department of Ecology Model Toxics Control Act Cleanup Regulation Method A Cleanup Levels (MTCA Chapter 173-340).

Groundwater		Soils	
Constituent	Clean-up Criteria (µg/L)¹	Constituent	Clean-up Criteria (mg/kg)¹
GRO	800 / 1,000 ²	GRO	30 / 100 ²
Benzene	5	Benzene	0.03
Toluene	1,000	Toluene	7
Ethylbenzene	700	Ethylbenzene	6
Total Xylenes	1,000	Total Xylenes	9
MTBE	20		

¹ Clean-up Criteria based on Washington State MTCA Method A Cleanup Levels for Soils and Groundwater (MTCA Cleanup Regulation 173-340).

² Method A Cleanup Levels for GRO are determined based on the presence of benzene.

µg/L = micrograms per liter.

mg/kg = milligrams per kilogram.

5. Site History

In March 2002, Delta Environmental Consultants, Inc. (Delta) collected soil samples from product line trenches during upgrade activities and advanced six soil borings to 19 feet below ground surface (bgs). The six soil borings were converted into monitoring wells (MW-1 through MW-6). A total of seven soil confirmation samples were collected from the dispenser island and product line trenches and twelve soil samples were collected during installation of monitoring wells MW-1 through MW-6. Analytical results of the dispenser and product line confirmation samples indicated concentrations of total petroleum hydrocarbons in the gasoline range organics (GRO) and benzene were detected above Method A CLs in five of the seven samples. Sample depths ranged

from 3.5 feet bgs to 4 feet bgs. Analytical results of soil samples collected during the installation of MW-1 through MW-6 indicated concentrations of GRO, benzene, toluene, ethylbenzene, and total xylenes (BTEX collectively) were detected above Method A CLs. Concentrations of constituents of concern (COCs) identified in soil sampled below the groundwater table are likely representative of dissolved concentrations within a saturated soil sample. Stockpiled soils (approximately 43.17 tons) were transported to TPS Technologies, Inc (TPS) in Tacoma, Washington for thermal treatment and recycling (Delta 2002).

In April 2003, Delta conducted a subsurface investigation at the site. The investigation included advancing six soil borings to a maximum depth of 23 feet bgs. Four borings were completed as groundwater monitoring wells MW-7 through MW-10. One boring was completed as an AS well (AS-1), and one boring was completed as a SVE well (SVE-1). Analytical results for soil samples collected during well installation indicated GRO and BTEX were not detected above laboratory reporting limits (RLs) in MW-7 through MW-10 and VE-1. Soil samples collected from AS-1 at 5 feet and 7 feet bgs indicated concentrations of GRO and BTEX above Method A CLs. A total of seven 55 gallon drums containing soil cuttings were transported to TPS for treatment and disposal (Delta 2003).

In April 2003, Delta conducted a pilot test to assess the effectiveness of a SVE and AS system as the appropriate remedial technology for impacted soil and groundwater at the site. Pilot test results indicated the use of an SVE/AS system would provide an effective means for remediation of impacted soil and groundwater at the site.

From September to December 2003, Delta contracted Cascade Drilling, Inc. (Cascade) and Custom Backhoe & Dumptruck Services, Inc. (Custom Backhoe) to perform the installation of an SVE/AS remediation system on-site. Delta oversaw the installation of six AS wells (AS-2 through AS-7) and five SVE wells (SVE-2 through SVE-6). The AS wells were installed to a depth of 23 feet bgs each and the SVE wells were installed to 10 feet bgs by Cascade. Custom Backhoe conducted the construction activities for the remediation system which included trenching, system piping, and remediation system equipment. During installation activities, Delta collected soil samples from the drill cuttings and trenching stockpiles for disposal purposes only. No samples were collected for delineation or site characterization purposes. Stockpile soil samples were analyzed for BTEX, GRO, and total Lead. A total of approximately 119 tons of stockpiled soil were transported by Custom Backhoe to TPS Lakewood disposal facility in Lakewood, Washington for disposal by thermal treatment and recycling.

The SVE/AS remediation system was installed in the third quarter of 2003 and operated intermittently until the end of 2005. The system operated for approximately 9,311 hours removing approximately 6,188 pounds of Volatile Petroleum Hydrocarbons (VPH).

Groundwater at the site has been monitored on a semi-annual or quarterly schedule since 2002. Current groundwater conditions at the site indicate concentrations of COCs from samples collected from MW-2 and MW-6 exceed Method A CLs.

ARCADIS advanced two hand augered soil borings in the vicinity of monitoring wells MW-2 and MW-6 to assess subsurface conditions in 2010. A total of four soil samples were submitted during this site assessment. Analytical reports indicate GRO, BTEX, and MTBE were not detected above the RLs. Concentrations of total lead reported above the RL were below the Method A CLs.

6. Regional and Site-Specific Settings

6.1 Regional Geology and Hydrogeology

The site is located in the Puget Lowland, bound by the North Cascade Mountains to the east, South Cascade Mountains to the south, Puget Sound and Olympic Mountains to the west. (Lasmanis 1991). The Puget Lowland is underlain by unconsolidated deposits originating from continental glacial drift from the Pleistocene age (WA DNR 2005). Such deposits are typically sand and gravel, which can be as much as 3,000 feet deep, and often form discontinuous lenses. The local topography slopes to the south and the approximate elevation of the site is 140 feet above mean sea level (msl).

Surficial geology is dominated by Pleistocene glacial alluvium with recent alluvium in river floodplains and mouths. Pleistocene sediments are typically well-compacted beds of very dense till interbedded with sands, silts and gravel with occasional lacustrine deposits. Beds of till are often several meters thick containing frequent discontinuous "lenses" of more permeable material. Perched groundwater frequently occurs in the lenses with larger aquifers occupying sandy strata over lying permeable till or silt deposits. Mill Creek is located 100 feet east of the site and is the nearest surface water body.

6.2 Site-Specific Semi-annual Gauging Data

Depth to groundwater measured in monitoring wells at the site have ranged from 5.56 to 14.30 feet below top of casing (btoc). Groundwater gauging data and select analytical results are summarized in **Table 1**. Depth to groundwater in the vicinity of the current dissolved phase plume (wells MW-2 and MW-6) ranges from 7.01 to 7.49 feet btoc based on groundwater monitoring data collected from first quarter 2012. During the most recent groundwater monitoring event in March 2012, depths to groundwater ranged from 5.58 feet bgs in well MW-1 to 7.56 feet bgs in well MW-5. Groundwater elevation and analytical results from first quarter 2012 groundwater monitoring event are presented on **Figure 4**.

7. Site Petroleum Hydrocarbon Impacts

7.1 Soil Impacts

A total of twenty three soil borings have been advanced at the site since the initial site investigation by Delta. The advanced soil borings included ten groundwater monitoring wells (MW-1 through MW-10), seven air sparge wells (AS-1 through AS-7) and six soil vapor extraction wells (SVE-1 through SVE-6). Boring logs for these wells are included in **Appendix A**. Additional soil sampling occurred during an ARCADIS site investigation in 2010 (HA-1 and HA-2).

COC impacts to soil were generally detected in the vicinity of the dispenser islands and product lines at approximately 3 to 10 feet bgs. Hydrocarbon related soil impacts were not observed in the vicinity of the UST basin. Historical soil analytical data is summarized in **Table 2** and presented on **Figure 5**. Historical soil sampling data indicates GRO and BTEX constituents were detected at concentrations exceeding MTCA Method A CLs in the following soil samples that remain in place:

Product Piping and Dispenser Island Soil Samples :

- Soil samples 5544-1/9-DIS 4-3.5 at 3.5 feet bgs and 5544-1/9-PL-2-4 at 4 feet bgs exceeded the Method A CL for GRO with concentrations of 162 and 59.3 mg/kg, respectively.
- Soil samples 5544-1/9-DIS-3-3.5 at 3.5 feet bgs, 5544-1/9-DIS-4-3.5 at 3.5 feet bgs, 5544-1/9-PL-1-3.5 at 3.5 feet bgs, 5544-1/9-PL-2-4 and 5544-1/9-PL-3-4 at 4

feet bgs exceeded the Method A CL for benzene with concentrations of 0.353 mg/kg, 1.89 mg/kg, 0.353 mg/kg, 1.65 mg/kg and 0.388 mg/kg, respectively.

- Soil samples 5544-1/9-DIS 4-3.5 at 3.5 feet bgs and 5544-1/9-PL-2-4 at 4 feet bgs exceeded the Method A CL for total xylenes with concentrations of 27.5 mg/kg and 10.5 mg/kg respectively.

Monitoring well and Air Sparge Well Installation Soil Samples:

- Soil samples MW-2 at 5 feet bgs and 10 feet bgs exceeded the Method A CL for GRO with concentrations of 508 mg/kg and 44.8 mg/kg respectively.
- Soil samples MW-5 at 10 feet bgs, MW-6 at 5 and 10 feet bgs exceeded the Method A CL for GRO with concentrations of 65.5 mg/kg, 16,000 mg/kg and 111 mg/kg respectively.
- Soil samples AS-1-5 at 5 feet bgs and AS-1-7 at 7 feet bgs exceeded the Method A CL for GRO with concentrations of 84.9 mg/kg and 3,290 mg/kg respectively.
- Soil samples MW-2 at 5 feet bgs and 10 feet bgs exceeded the Method A CL for benzene with concentrations of 2.93 and 10.8 mg/kg respectively.
- Soil samples MW-5 at 10 feet bgs, MW-6 at 5 and 10 feet bgs exceeded the Method A CL for benzene with concentrations of 0.358 mg/kg, 183 mg/kg and 13.9 mg/kg respectively.
- Soil samples AS-1-5 and AS-1-7 exceeded the Method A CL for benzene with concentrations of 0.449 mg/kg and 21.2 mg/kg respectively.
- Soil samples MW-2 at 5 feet bgs, MW-6 at 5 feet bgs, MW-6 at 10 feet bgs and AS-1-7 at 7 feet bgs exceeded the Method A CL for toluene with concentrations of 11 mg/kg, 1,500 mg/kg, 22.7 mg/kg and 291 mg/kg respectively.
- Soil samples MW-2 at 5 feet bgs, MW-6 at 5 feet bgs, and AS-1-7 at 7 feet bgs exceeded the Method A CL for ethylbenzene with concentrations of 14.8 mg/kg, 499 mg/kg, and 105 mg/kg, respectively.

- Soil samples MW-2 at 5 feet bgs, MW-5 at 10 feet bgs, MW-6 at 5 feet bgs, AS-1-5 at 5 feet bgs, and AS-1-7 at 7 feet bgs exceeded the Method A CLs for total xylenes with concentrations of 68.4 mg/kg, 13.2 mg/kg, 2,450 mg/kg, 11.8 mg/kg, and 533 mg/kg, respectively.

Cross-section figures with soil analytical data are presented on **Figures 9** through **11**.

7.2 Groundwater Impacts

A semiannual groundwater monitoring program was initiated at this site in 2002, and is currently ongoing. Historically, ten monitoring wells (MW-1 through MW-10) have been used to monitor groundwater at the site.

GRO and/or BTEX have been detected above Method A CLs in groundwater samples from wells MW-2, MW-4, MW-5, MW-6 and MW-10. The maximum concentration of GRO was 513,000 µg/L (MW-6) in the groundwater sample collected during the third quarter of 2004. The maximum concentration of benzene was 52,500 µg/L (MW-6) in the groundwater sample collected during the third quarter of 2004. The maximum concentration of MTBE was 6,840 µg/L (MW-6) in the groundwater sample collected during the first quarter of 2002. MTBE has not been detected at concentrations above MTCA Method A CLs in groundwater samples from any of the other wells at the site. Measurable Light non-aqueous phase liquid (LNAPL) has not been detected in any of the wells at the site.

Petroleum hydrocarbons in groundwater are primarily located in the vicinity of the dispenser islands. The most recent groundwater sampling event occurred in March 2012. At this time, the maximum GRO concentration was 46,000 µg/L detected in the sample from monitoring well MW-6, located south of the dispenser islands. The maximum benzene concentration was 304 µg/L from monitoring well MW-6. During the March 2012 groundwater monitoring event, the depth to groundwater was between 5.58 and 7.56 feet btoc. A groundwater elevation with analytical results summarizing the most recent groundwater monitoring event is presented on **Figure 4**. Isoconcentration contours for GRO and benzene are presented on **Figures 6 and 7**.

7.3 Historical Site Remediation

Product piping replacement activities were conducted in 2002. During product piping replacement activities, trenching occurred to approximately one foot bgs, and the total amount of soil excavated and disposed is not available (Delta 2002).

In April 2003, Delta conducted AS and SVE pilot tests at the site. SVE pilot testing consisted of extracting vapors for approximately 4 hours from extraction well VE-1 and monitoring induced vacuum on surrounding monitoring wells (MW-2, MW-5, MW-6, and MW-9). Mass removal rates were calculated using analytical vapor concentrations, measured flow rates, temperature and vacuum. A radius of influence (ROI) of 80 feet was calculated during the SVE pilot test on VE-1. The ROI was determined based on induced vacuum measured at observation monitoring wells. Vapor samples collected from the SVE blower effluent during the SVE test contained maximum GRO and benzene concentrations of 3,680 and 42.5 milligrams per cubic meter (mg/m^3) respectively. Vapor samples collected from the SVE blower effluent during AS/SVE test contained maximum GRO and benzene concentrations of 39,000 and 570 mg/m^3 .

An AS pilot test was performed on AS well AS-1; wells MW-1, MW-2, MW-3, MW-5, MW-6, and MW-10 were used as monitoring wells. Dissolved oxygen (DO) concentrations, Oxidation Reduction Potential (ORP) and water levels were monitored to determine the ROI. Based on Delta's pilot testing a 15 foot airsparge ROI is feasible

Based on the results of the AS and SVE pilot tests, Delta concluded that these technologies would be effective in reducing petroleum hydrocarbon concentrations in the soil and groundwater at the site (Delta 2003).

8. Evaluation of Remedial Alternatives

The following provides a feasibility discussion for potential remedial alternatives for the site. For the purpose of this RAP, three remedial alternatives were identified and evaluated for their effectiveness at remediating affected soil and groundwater:

- monitored natural attenuation (MNA)
- enhanced anaerobic bio-oxidation using electron acceptor solution injected / gravity feed into the dissolved phase petroleum hydrocarbon plume
- remediation using a new AS and SVE system to address identified soil and groundwater impacts in the vicinity of the dispenser island

8.1 Alternative 1 - MNA

This alternative does not involve the implementation of engineered remedial technologies to remove, treat or contain COCs at the site. Under this alternative,

natural attenuation processes will reduce chemical concentrations through time and routine (semi-annual) groundwater monitoring will be performed to document changes.

MNA has been defined as the reliance on natural attenuation processes (within the context of a carefully controlled and monitored site cleanup approach) to achieve site specific remediation objectives within a time frame that is reasonable compared to that offered by other, more active methods. The “natural attenuation processes” at work in such a remediation approach include a variety of physical, chemical or biological processes that, under favorable conditions, act to reduce the mass, toxicity, mobility, volume or concentration of COCs in soil and groundwater. These in-situ processes include dilution, sorption, biodegradation, volatilization and chemical-biological stabilization, transformation or destruction of COCs.

Natural attenuation processes are typically occurring at all sites, but to varying degrees of effectiveness, depending on the types and concentrations of contaminants present, and physical, chemical, and biological characteristics of the soil and groundwater. Natural attenuation processes may reduce the potential risk posed by site contamination in three ways:

1. The contaminant may be converted to less toxic form through destructive processes such as bioremediation or abiotic transformations.
2. Potential exposure levels may be reduced by lowering concentrations levels through physical processes or by dilution.
3. Contaminant mobility and bioavailability may be reduced by sorption to the soil or aquifer matrix.

Long term trends indicate that COC concentrations in samples collected from monitoring wells MW-2 and MW-6 fluctuate with groundwater elevation within the on-site plume. However, MNA is not the preferred remedial alternative at this site due to elevated COC concentrations and a prohibitive timeframe required to achieve dissolved concentrations below Method A CLs.

8.2 Alternative 2 – Enhanced Anaerobic Biodegradation

Organic carbon in the form of petroleum hydrocarbons can stimulate indigenous microorganisms to utilize naturally occurring electron acceptors in microbial respiration. As the indigenous ecology evolves, available electron acceptors are depleted in

general order of thermodynamic favorability: oxygen, nitrate, manganese, iron, sulfate, and eventually carbon dioxide under methanogenic conditions. The electron acceptors are reduced through electron transport as the petroleum hydrocarbons are oxidized to benign end products, including hydrogen, acetic acid, carbon dioxide, etc.

Typical petroleum release sites can generate strongly reducing environments dominated by sulfate-reduction and methanogenesis. If sulfate or other electron acceptors are present in sufficient quantity to meet the stoichiometric demand of the available petroleum impacts, petroleum constituents can be destroyed naturally. This remedial alternative involves adding sulfate as an electron acceptor in the form of Epsom salt (i.e., magnesium sulfate heptahydrate) to enhance ongoing petroleum hydrocarbon oxidation.

Enhanced anaerobic biooxidation was not selected as the preferred remedial method for this site as this remedial strategy focuses on petroleum hydrocarbons in soil and groundwater within the saturated and smear zone only. Soil sampling data indicate petroleum hydrocarbons remain in vadose zone soil as well. In addition the COC concentrations two to three orders of magnitude above CLs detected in soil and groundwater would require a large mass of electron acceptor solution and may not be cost-effective.

8.3 Alternative 3 – Air Sparge and Soil Vapor Extraction

An AS/SVE system involves injecting air under pressure into the saturated zone to increase dissolved phase oxygen concentrations thus degrading dissolved-phase COC concentrations through aerobic degradation. Air sparging also increases volatilization of dissolved phase petroleum hydrocarbon impacts through phase transfer from dissolved phase to vapor phase. SVE removes residual LNAPL and sorbed-phase hydrocarbons from vadose zone soils, as well as, captures the vapor phase from sparging activities. Currently, AS/SVE piping exists in the area of petroleum hydrocarbons in groundwater above CLs. The AS/SVE equipment has been shutdown for several years. ARCADIS attempted restarting the existing catalytic oxidizer unit and SVE blower and identified that the systems were not operational. In order to implement AS/SVE at this site using the existing underground piping, a new skid mounted AS/SVE unit will be placed onsite. Components of this alternative include:

- Installing a new mobile AS/SVE treatment system at the site

- Expanding existing trenching and subsurface piping for additional AS wells that have been installed
- Conduct air monitoring activities to evaluate the reduction of total volatile organic compound (VOC) concentrations in the influent air to the treatment system
- Continued groundwater and air monitoring activities to evaluate the reduction of VOCs concentrations in soil and groundwater

AS/SVE is the preferred remedial alternative at this site. A pilot study and interim remedial action with AS/SVE has been performed at this site that shows AS/SVE can effectively be used for the removal of volatile petroleum hydrocarbons (see Section 7.3 for more detail on pilot study). System operational data indicates that initial mass removal rates were above 200 lbs of TPH per day. However, flow rates and mass removal rates quickly diminished. Near the end of system operation it appears that AS wells had significant fouling as pressure increases above 30 psi were applied with little to no increase in flow rates.

9. Remedial Design

9.1 Objectives

To address on-site GRO and BTEX impacts stemming from historical site activities, ARCADIS proposes to install new AS/SVE equipment at the existing equipment pad. Existing system piping and trenching will be expanded to connect newly installed AS wells AS -9, AS-9, AS-10 and AS-11. . The air sparge system will operate on AS wells AS-8, AS-9, AS-10 and AS-11. During system operation, vapor concentrations will be monitored from individual SVE wells, the pretreatment effluent stream, and the post-treatment effluent stack with a photoionization detector (PID) or Flame ionization detector (FID) on a monthly basis to determine mass removal in the vapor phase. Monitoring wells MW-2 and MW-6 will be monitored for decreasing groundwater concentration trends.

Based on current dissolved concentrations, it is estimated that active remediation will take place until dissolved phase concentrations are reduced to within one order of magnitude of Method A CLs or SVE mass removal has reached asymptotic rates. The system will be periodically evaluated to determine appropriate actions needed to reach

a “No Further Action” designation. When asymptotic mass removal rates are achieved and dissolved phase COCs show declining trends a rebound study will be performed to assess the long term effectiveness of the system and to determine if MNA would be a feasible approach to attain groundwater and soil compliance goals. To determine the effectiveness of sparging activities on dissolved phase groundwater concentrations, groundwater samples will be collected and analyzed one month after system shutdown. If significant rebound is observed in groundwater concentrations following system shutdown, the system will be restarted. If groundwater concentrations remain significantly above MTCA Method A CLs without indication of decreasing trends, an alternative remedial approach will be assessed.

9.2 Remedial Approach

ARCADIS will remediate petroleum hydrocarbon impacts on site through implementation of an AS/SVE system. Remediation equipment will be procured through a system vendor to meet ARCADIS design specifications.

New AS wells were installed in the impacted area based on previous site assessments. The results from a previous pilot study concluded that a 15 foot radius of influence (ROI) could be achieved by AS wells, and a ROI of 50 feet could be used for SVE wells (Delta 2003). These design criteria are within typical AS/SVE system design criteria as described in *The Air Sparging Design Paradigm* (Leeson & Johnson et. al, 2002) and Army Corps of Engineers Engineering Manual- EM1110-1-4001 (US Army Corps of Engineers, 2002). The proposed system layout is shown on **Figure 13**.

Four new AS wells (AS-8 to AS-11) were installed within the impacted area on 25 foot centers to ensure effective treatment of dissolved and sorbed phase impacts within the saturated zone. The AS system will increase dissolved oxygen in the groundwater and enhance biodegradation processes. The injected air also facilitates the phase transfer of petroleum related hydrocarbons from the dissolved and sorbed phases to the vapor phase for removal by the SVE system.

The AS system will be operated in conjunction with SVE system to facilitate the recovery of vapor phase hydrocarbons produced by sparging, The SVE system will also be used to remediate vadose zone soils. Previous soil site assessment work has shown vadose zone soil impacts within the dispenser island area. Based on this ROI, existing extraction wells SVE-3 through SVE-5 will provide adequate coverage to address potential vapor migration caused by air sparging and petroleum hydrocarbon impacted vadose zone soils.

The AS/SVE design is based on previous pilot test and system operational data. The design radius of influence will be verified during startup and testing procedures to ensure adequate vacuum influence and air flow is occurring over the treatment area. System optimization will depend on results from startup.

9.3 Well Design and Completion Details

Based on pilot study results, the effective AS well ROI is approximately 25 feet (Delta 2003). Considering well spacing and the targeted treatment area, four new AS wells were installed.

AS wells were installed between November 16 and November 17, 2011. Borehole clearance was performed with a vacuum truck and air knife. Borehole clearance was performed to a depth of 6.5 feet bgs at a diameter of 110 percent of auger width. AS wells were advanced using a 10-inch hollow-stem auger. Samples were screened with a photoionization detector (PID) and classified using the Unified Soil Classification System (USCS). The AS borings were advanced to depths varying between 18 and 23 feet bgs. AS wells AS-8 through AS-11 were 2-inch diameter schedule 80 polyvinyl chloride (PVC) installed to depths ranging between 18 and 23 feet bgs with 2 feet of 0.020" stainless steel screen at the bottom of the well. #2-12 silica sand was placed to a depth of 1-foot above the top of screen. A pelletized bentonite seal was placed above the sand and neat cement was placed above the pelletized bentonite seal to a depth just below the well box for temporary completion. Well completion details for the newly installed AS wells are included in **Appendix A**.

The newly installed AS wells were developed to remove fine particulate matter, clay, and silt from the well screen. Wells were developed through jetting techniques. Development through jetting introduces high velocity water into the well screen through a small diameter tube equipped with nozzles. Injected water is purged simultaneously, effectively keeping the in-well water level equal to the static water level. The well was initially gently surged to remove fines by moving the pump the length of the saturated screen. The submersible pump purged between 0.5 to 4 gallons per minute (gpm). Well development purge water was stored onsite and disposed of at an approved disposal facility. SVE wells will be used to recover soil vapor produced during sparging activities and to remove residual and vapor phase impacts in vadose zone soils.

Based on results of the 2003 pilot study the SVE ROI is 80 feet, so existing SVE wells SVE-3 through SVE-5 should provide adequate coverage (Delta 2003). Well integrity was verified by ARCADIS field personnel during a previous site visit. The design radius

of influence will be verified during startup and testing procedures to ensure adequate vacuum influence and air flow is occurring over the treatment area. Startup procedures are described in Section 12.2 *System Start-up and Optimization*.

9.4 System Components

The AS/SVE system will be installed in a skid mounted temporary portable building to enable use of this system at different sites throughout Washington. The system includes a regenerative blower, knockout tank, vacuum piping manifold, AS compressor blower, AS manifold, heat exchanger, ventilation fans, programmable logic control (PLC), pressure, temperature, vacuum and flow gauges and transmitters, and system heaters. The effluent vapor will initially be treated through an electric catalytic oxidizer mounted to the outside of the portable building. Based on effluent concentrations, the effluent treatment train may be switched to a tow inline granular activated carbon vessels

9.5 AS System

Based on design calculations attached in **Appendix B**, the AS compressor will have to be capable of producing air at 20 psig. Typical air flow rate to an AS well is 5 to 7 scfm. To improve air distribution and lower capital and operational costs, the AS system will operate in a pulsed mode. It is assumed that in pulse mode, a maximum of three wells will be sparging at the same time, therefore, the maximum blower capacity will be approximately 30 scfm. At this flow rate, the maximum piping pressure drop is calculated to be less than 1 psi. The compressor will initially be connected to four AS wells through a manifold consisting of individual well monitoring gauges and valves. Manifold gauges and valves include a rotameter, solenoid valve, gate valve, and pressure indicator. Immediately following the compressor, air will flow through a heat exchanger with condensate drain to reduce the air stream temperature and vapor content. The AS compressor will have an internal pressure relief switch to prevent high internal pressure buildup which may cause blower and piping damage. The compressor air inlet is composed of a filter to pull ambient air in from the exterior of the system compound. High pressure and temperature switches will be interlocked with the main PLC to automatically shut down the system if conditions become abnormal. Solenoid valves and a system timer will allow for pulsed sparging of three to four wells at a time. The pulsing schedule will be determined during the initial system optimization.

9.6 Soil Vapor Extraction System

The SVE blower will be selected to accommodate a wide range of applications and flow rates using a variable speed drive. Based on previous SVE operation, the SVE wells will be operated at a flow of 30 to 40 SCFM. The blower will initially be connected to three SVE wells through a manifold consisting of individual well monitoring gauges and valves. Based on this extraction flow rate and an estimated maximum piping pressure drop of 1 psi, the vacuum blower will need a capacity of approximately 150 scfm. Manifold gauges and valves include a differential pressure gauge, gate valve, and vacuum indicator. Prior to the blower, piping will run through a condensate knock out drum. The blower will be equipped with a vacuum relief valve to prevent high vacuum in the system which may cause blower and piping damage. The blower air inlet bleed valve is composed of a filter and silencer to pull ambient air in from the exterior of the system and adjust vacuum. High vacuum and temperature switches are interlocked with the main PLC to automatically shut down the system if conditions become abnormal.

9.7 Remedial Compound

The remedial enclosure is composed of an equipment room housing the AS compressor and manifold, as well as SVE system components. The control panel will be mounted on the building exterior and contain a wireless cellular modem, a programmable logic control (PLC) with user interface, heater, ventilation fan, and the main system breakers and switches. Additional health and safety equipment, including an emergency eyewash station, first aid kit, and fire extinguisher, will be installed in the equipment room.

9.8 Air Sparge Conveyance Piping

Existing AS piping will be expanded and used to connect the newly installed AS wells. Stub ups were left in place during the initial system installation for ease of system expansion. Trenching will lead from the stub ups located at the south east and south west corners of the dispenser islands. New AS piping will be connected to the stub outs and connect newly installed sparge wells AS-8 and AS-10. Conveyance piping leading to AS-9 and AS-11 will tie in to existing AS lines at the well box of AS-4 and AS-5. The AS conveyance piping will be 1-inch diameter acrylonitrile-butadiene-styrene (ABS) piping or chlorinated PVC (CPVC) to allow for the increased pressures required during sparging. The existing AS conveyance piping will be connected to the AS

manifold via union fittings and lead through the sidewall of the system building. All above ground piping will be steel or pressure rated rubber hose.

9.9 Soil Vapor Extraction Conveyance Piping

Existing SVE conveyance piping will be connected to the new skid mounted system through the system building. The existing manifold will be removed and new fittings will be placed on the conveyance piping in order to connect to the new internal manifold.

10. Site Construction Activities

10.1 Site Preparation

The construction perimeter will be fenced off in sections with secure temporary fencing during trenching and system installation activities. A traffic control plan will be established with agreement by the business and property owners in order to reduce impacts to service station operations. A pre-construction meeting was scheduled prior to drilling, and a second pre-construction meeting will be scheduled prior to trenching involving an ARCADIS representative and contractor representatives. An additional private utility locate prior to trenching activities will be scheduled to locate utility markings.

10.2 System Removal

The existing remediation equipment will be removed from the site and salvageable parts will be re-used or recycled. Piping will be cut just above grade and re-fitted to connect to the new system. The new skid mounted system will be placed on the existing pad and fencing will remain in place.

10.3 Utility Clearance

A public utility clearance will be conducted prior to construction activities. A private utility locating service will also be scheduled for site clearance using ground penetrating radar (GPR) and magnetic locating equipment to identify utilities not included under the public locate. Representatives from the general contractor will be present to ensure that equipment maneuverability and site access is adequate around the placement of trenching.

10.4 Trenching

Trenching will be completed by an ARCADIS-approved subcontractor. Trenching will be excavated to a minimum of 18-inches. Two inches of self compacting sand bedding material will be placed in the trench prior to conveyance piping. An additional 2 inches of bedding material will be placed over and surrounding the piping. Geotextile fabric will be placed above the sand bedding to ensure separation from controlled density fill (CDF). CDF and locating tape will be placed within the upper 1-foot of trench.

Trenching will be finished to match existing grade. Where trenching is installed through asphalt or concrete, the surface will initially be saw-cut. Upon completion, trenching through asphalt will be sealed and concrete will be matched to the existing surface.

Proposed trenching locations are shown on **Figure 13**.

10.5 Soil Disposal

Excavated soil will be screened in accordance with Guidance for Site Checks and Site Assessments for Underground Storage Tanks from the DOE (DOE 2003). Excavated soil will be screened using a photoionization detector (PID); screened soil showing a response above background PID levels will be segregated into bermed containment areas. Segregated soils will be sampled based on above mentioned DOE guidance document (DOE 2003). Soil samples will be submitted to Pace Analytical Laboratories (Pace) for the following analyses:

- GRO by NWTPH-Gx
- DRO by NWTPH-Dx
- BTEX by EPA 8021B
- Total Lead by EPA 6010B

Pending sampling results, waste soil will be loaded onto haul trucks for transport to the appropriate disposal facility. Remaining soil will be excavated and stored on-site and used as trenching backfill. Soil stockpiles will be covered with plastic sheeting at the end of each day.

10.6 System Delivery and Install

10.6.2 System Install

The system will be delivered to Seattle with internal components connected and tested. The system will be placed by the general contractor on-site under the direction of ARCADIS personnel.

Electrical permits will be obtained by the electrical contractor, and connections will be tested prior to utility company and city inspection. Final electrical system inspection, including voltage loading from ground to phase and between phases, will be performed in the presence of ARCADIS personnel and relevant subcontractors.

10.7 Site Surveying and As-Built Report

An ARCADIS – approved licensed surveyor will survey existing site features including building corners, monitoring well top-of-casing , new AS wells relative to NAD83 horizontal datum. The surveyors will measure well top-of-casing elevations relative to NAVD88 vertical datum to the nearest 0.01 feet. The NAVD88 datum is the standard vertical geoid used by the North American Geological Survey. For reporting purposes, the NAVD88 referenced datum will be considered mean sea level. An as-built report with drawings, soil boring data, soil disposal data, and final trenching and well locations will be submitted to Ecology following completion of system installation.

11. System Monitoring

11.1 Baseline Monitoring

Prior to system startup, groundwater will be sampled to obtain baseline conditions in site wells. Groundwater samples will be collected using dedicated, disposable Teflon® bailers. Water levels will be gauged and three casing volumes of groundwater will be purged from each well. Biogeochemical parameters will be collected with a downhole multi-meter and include DO, ORP, conductivity, pH, and temperature.

Groundwater samples will also be submitted to Pace for the following COC chemical analyses:

- GRO by NWTPH-Gx

- BTEX by EPA Method 8021B
- MTBE by EPA Method 8260B

11.2 System Start-up and Optimization

During initial start-up activities, design criteria will be tested to ensure adequate AS and SVE radius of influence are met. Initial testing will involve system operation in an unloaded condition with bleed valves open. Pressure, temperature, flow and effluent vapor concentration readings will be recorded as baseline conditions.

11.3 SVE Optimization

The SVE system will be optimized so that field operating conditions meet design criteria. The AS system will remain off and all SVE wells will be closed. Vacuum gauges will be placed on the well heads of MW-2, MW-5 and MW-6. The main manifold bleed valve and flow control valve for well SVE-3, SVE-4 and SVE-5 will be fully opened. System flow and vacuum data will then be recorded from the manifold. Additional vacuum readings will be taken from the vacuum gauges placed on MW-2, MW-5 and MW-6. The vacuum gauges will read a minimum of 0-30 inches of water. The variable speed throttle will initially be set at the midpoint. The bleed valve will be throttled closed until a total system vacuum reaches a maximum set point (e.g. 40 inches of water). Vacuum readings on the monitoring well gauges, as well as total flow readings will be recorded every five minutes for 30 minutes. Results will be plotted logarithmically to verify the induced vacuum radius of influence. Additional bleed valve throttling will occur and measurements will be taken until adequate ROI and flow rate are met.

11.4 Air Sparge Mounding Test

To determine optimal pulsed operation timing, monitoring wells will be monitored for DO and groundwater mounding effects during initial startup of each AS well. A downhole DO meter and a water level transducer will be installed in adjacent monitoring wells during the operation of each AS well. Pressure and flow will be adjusted using bleed valves and the variable frequency drive on the compressor to obtain adequate radius of influence. DO and mounding effects will be plotted vs. time to determine peak DO concentrations and groundwater elevation influence.

11.5 Compliance Well Monitoring

COC analysis will occur on select monitoring wells (MW-2, MW-5 and MW-6) following system startup on a quarterly basis thereafter. Semiannual groundwater sampling will continue as scheduled.

Monitoring wells MW-2, MW-5 and MW-6 will be monitored for observable signs of sparging (i.e., bubbling) and a measureable increase in DO during the first two weeks of operation and annually thereafter.

System parameters will be collected daily during the first week of operation, weekly for the first month of operation and monthly thereafter. System readings will include manifold pressure, individual well pressure, individual well flow, overall system flow, and pre- and post-heat exchanger temperature and pressure readings. PID measurements will be taken from the SVE system effluent stack on a monthly basis. Influent air filters will be inspected and cleaned or replaced monthly. Compressor oil level will be checked monthly and changed if necessary. Compressor oil will be changed as specified under the manufacturer's preventive maintenance recommendations. Additional system maintenance procedures will include recordable hours of operation on each sparge well, as well as system-wide operation, and adjustments to sparge pressure, vacuum pressure and flow rates.

11.6 Shutdown Criteria

The AS/SVE system is expected to operate for one year. Periodic shutdown of both the AS and SVE components will be performed to evaluate concentration rebound in groundwater and soil vapor. A rebound test will be recommended after mass removal has reached asymptotic rates and dissolved phase groundwater concentrations are within an order of magnitude of CLs and indicate overall decreasing trends. During rebound testing, the system will remain shut down for approximately one month, and compliance wells will be sampled for GRO and BTEX. The system will be restarted and allowed to run approximately 24-hours. Vapor samples will be collected and submitted for COC analysis. The system will again be shutdown pending analytical data. If dissolved concentrations rebound above the pre-rebound test groundwater data for GRO and BTEX the AS system shall be restarted. If SVE vapor analytical samples show significant rebound the SVE will operate until asymptotic mass removal rates are again observed. If continued system operation is required, subsequent rebound evaluation should be conducted following the initial rebound test. If rebounded concentrations are not lower than those detected during the previous rebound

evaluation, the AS system may no longer be effective and additional site remediation strategies should be considered. If system shutdown criteria are met, equipment will remain near the location and available for hookup for one year after shutdown to evaluate rebound prior to decommissioning.

11.7 Post -Remediation Success Criteria

After system shutdown, groundwater will be monitored quarterly to determine if stable and decreasing dissolved-phase plume concentrations are present and support a move to an MNA strategy or potentially a "No Further Action" designation.

12. Schedule

Following RAP submittal, ARCADIS will perform system trenching and system delivery is expected during the second quarter of 2012. As-built drawings along with system installation and optimization details will be submitted following completion of system installation and start up.

13. References

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United States Army Corps of Engineers 2002. Engineering and Design - Soil Vapor Extraction and Bioventing. EM 1110-1-4001. June 2002.



Remedial Action Plan

Former ARCO Facility No.5544

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Washington State Department of Ecology, April 2003, Guidance for Site Checks and Site Assessments for Underground Storage Tanks.

Washington State Department of Natural Resources. 2005. Geologic Map of Washington State.

ARCADIS

Tables

**Table 1
Groundwater Gauging Data and Select Analytical Results
WA-05544**

19860 68th Ave So, Kent, WA 98032

All analytical results are presented in micrograms per liter (µg/L)

Well	Date	Notes	TOC	DTW	NAPL	GWE	GRO	DRO	HO	Benzene	Toluene	Ethylbenzene	Total Xylenes	MTBE	EDB	EDC	Total Lead	Dissolved Lead
Model Toxics Control Act (MTCA) Method A Cleanup Levels (CULs) in µg/L							800/1,000	500	500	5	1,000	700	1,000	20	0.01	5	15	--
MW-1	3/12/2002	(P)	196.78	7.45	0.0	189.33	<50.0	--	--	<0.500	<0.500	<0.500	<1.00	<1.00	--	--	19.1	<1.00
MW-1	8/30/2002	(P)	196.78	10.10	0.0	186.68	<50.0	--	--	<0.500	<0.500	<0.500	<1.00	<2.00	<0.01	<1.00	44.2	<1.00
MW-1	3/24/2003	(P)	196.78	6.75	0.0	190.03	<50.0	--	--	<0.500	<0.500	<0.500	<1.00	<1.00	--	--	2.3	<1.00
MW-1	4/22/2003	(NS)	196.78	8.62	0.0	188.16	--	--	--	--	--	--	--	--	--	--	--	--
MW-1	6/30/2003	(P)	196.78	9.57	0.0	187.21	<50.0	--	--	<0.500	<0.500	<0.500	<1.00	<1.00	--	--	<1.00	<1.00
MW-1	9/15/2003	(P)	196.78	10.27	0.0	186.51	<50.0	--	--	<0.500	<0.500	<0.500	<1.00	<1.00	--	--	<1.00	<1.00
MW-1	12/30/2003	(P)	196.78	8.75	0.0	188.03	<50.0	--	--	<0.500	<0.500	<0.500	<1.00	<1.00	--	--	<1.00	<1.00
MW-1	7/13/2004	(NS)	196.78	9.85	0.0	186.93	--	--	--	--	--	--	--	--	--	--	--	--
MW-1	11/1/2004	(NP)	196.78	9.60	0.0	187.18	<80.0	--	--	<0.200	<0.500	<0.500	<1.00	<2.00	--	--	<1.00	--
MW-1	3/3/2005	(NP)	196.78	9.11	0.0	187.67	<80.0	--	--	<0.200	<0.500	<0.500	<1.00	<2.00	--	--	<1.00	--
MW-1	6/12/2005	(NP)	196.78	8.88	0.0	187.90	<80.0	--	--	<0.200	<0.500	<0.500	<1.00	<2.00	--	--	<1.00	--
MW-1	8/28/2005	(NS)	196.78	10.13	0.0	186.65	--	--	--	--	--	--	--	--	--	--	--	--
MW-1	11/17/2005	(NS)	196.78	8.88	0.0	187.90	--	--	--	--	--	--	--	--	--	--	--	--
MW-1	3/5/2006	(NS)	196.78	8.49	0.0	188.29	--	--	--	--	--	--	--	--	--	--	--	--
MW-1	10/24/2006	(NS)	196.78	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MW-1	3/22/2007	(NS)	196.78	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MW-1	5/30/2007	(NS)	196.78	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MW-1	9/4/2007	(NS)	196.78	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MW-1	11/13/2007	(NS)	196.78	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MW-1	3/12/2008	(NP)	196.78	8.90	0.0	187.88	<50.0	--	--	<0.500	<0.500	<0.500	<3.00	<1.00	--	--	--	--
MW-1	6/9/2008	(NP)	196.78	8.74	0.0	188.04	<50.0	--	--	<0.500	<0.500	<0.500	<3.00	<1.00	--	--	--	--
MW-1	8/6/2008	(NS)	196.78	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MW-1	10/8/2008	(NS)	196.78	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MW-1	1/15/2009	(NP)	196.78	6.64	0.0	190.14	<50.0	--	--	<0.500	<0.500	<0.500	<3.00	<1.00	--	--	--	--
MW-1	4/2/2009	(NP)	196.78	7.89	0.0	188.89	<50.0	--	--	<0.500	<0.500	<0.500	<1.00	<1.00	--	--	<1.00	<1.00
MW-1	10/14/2009	(NS)	196.78	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MW-1	3/22/2010	(NP)	26.12	7.70	--	18.42	<50	--	--	<1.0	<1.0	<1.0	<3	<1.0	--	--	--	--
MW-1	6/22/2010	(NP)	26.12	7.14	--	18.98	--	--	--	--	--	--	--	--	--	--	--	--
MW-1	3/10/2011	(NP)	26.12	5.82	0.0	20.30	<50.0	--	--	<1.0	<1.0	<1.0	<3.0	<1.0	--	--	<20.0	<10.0
MW-1	9/19/2011	(NP)	26.12	8.73	0.0	17.39	<50.0	--	--	<1.0	<1.0	<1.0	<3.0	<1.0	--	--	<10.0	<10.0
MW-1	3/16/2012	(NP)	26.12	5.58	0.0	20.54	<50.0	--	--	<1.0	<1.0	<1.0	<3.0	<1.0	--	--	<10.0	<10.0
MW-2	3/12/2002	(P)	198.02	8.60	0.0	189.42	201,000	--	--	40,800	39,700	4,240	19,900	2,250	--	--	50.4	<1.00
MW-2	8/30/2002	(P)	198.02	11.04	0.0	186.98	74,000	--	--	24,300	4,590	2,270	7,530	2,620	<0.01	<100	121	<1.00
MW-2	3/24/2003	(P)	198.02	8.45	0.0	189.57	47,900	--	--	12,800	2,550	1,680	4,870	1,950	--	--	13.9	<1.00
MW-2	4/22/2003	(NS)	198.02	9.31	0.0	188.71	--	--	--	--	--	--	--	--	--	--	--	--
MW-2	6/30/2003	(P)	198.02	10.43	0.0	187.59	51,000	--	--	12,100	2,500	2,290	5,720	2,370	--	--	52.9	9.95

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WA-05544

19860 68th Ave So, Kent, WA 98032

All analytical results are presented in micrograms per liter (µg/L)

Well	Date	Notes	TOC	DTW	NAPL	GWE	GRO	DRO	HO	Benzene	Toluene	Ethylbenzene	Total Xylenes	MTBE	EDB	EDC	Total Lead	Dissolved Lead
Model Toxics Control Act (MTCA) Method A Cleanup Levels (CULs) in µg/L							800/1,000	500	500	5	1,000	700	1,000	20	0.01	5	15	--
MW-2	9/15/2003	(P)	198.02	11.33	0.0	186.69	33,600	--	--	6,000	1,390	1,840	4,320	1,590	--	--	14.7	<1.00
MW-2	12/30/2003	(P)	198.02	9.36	0.0	188.66	74,000	--	--	10,100	12,800	1,980	8,510	1,070	--	--	8.74	<1.00
MW-2	7/13/2004	(NP)	198.02	10.71	0.0	187.31	68,200	--	--	12,700	3,890	1,710	6,860	1,630	--	--	<1.00	<1.00
MW-2	11/1/2004	(NP)	198.02	9.11	0.0	188.91	<80.0	--	--	25.5	<1.00	<1.00	<2.00	355	--	--	<1.00	--
MW-2	3/3/2005	(NP)	198.02	12.20	0.0	185.82	<80.0	--	--	<0.400	<1.00	<1.00	<2.00	229	--	--	1.82	--
MW-2	6/12/2005	(NP)	198.02	10.00	0.0	188.02	4,020	--	--	616	33	523	490	117	--	--	<1.00	--
MW-2	8/28/2005	(NP)	198.02	11.14	0.0	186.88	5,400	--	--	1,500	3.57	66.6	63.9	229	--	--	<1.00	--
MW-2	11/17/2005	(NP)	198.02	10.25	0.0	187.77	<50.0	--	--	0.72	<0.500	<0.500	<1.00	106	--	--	<1.00	--
MW-2	3/5/2006	(NP)	198.02	9.05	0.0	188.97	69.2	--	--	3.14	<0.500	1.59	2.98	46.5	--	--	<1.00	--
MW-2	10/24/2006	(P)	198.02	11.08	0.0	186.94	733	--	--	84.3	1.18	66.1	10.6	358	--	--	--	--
MW-2	3/22/2007	(P)	198.02	8.43	0.0	189.59	51,900	--	--	2,380	4,810	3,350	13,700	<100	--	--	--	--
MW-2	5/30/2007	(P)	198.02	9.97	0.0	188.05	51,900	--	--	1,650	3,390	2,360	7,650	119	--	--	--	--
MW-2	9/4/2007	(P)	198.02	10.22	0.0	187.80	81,900	--	--	1,480	221	3,120	24,100	131	--	--	--	--
MW-2	11/13/2007	(P)	198.02	10.32	0.0	187.70	21,200	--	--	426	89.9	594	1,760	65.5	--	--	--	--
MW-2	3/12/2008	(NP)	198.02	9.15	0.0	188.87	91,100	--	--	304	2,240	3,750	16,700	6.41	--	--	--	--
MW-2	6/9/2008	(NP)	198.02	6.65	0.0	191.37	22,100	--	--	11.7	963	632	3,360	<1.00	--	--	--	--
MW-2	8/6/2008	(NP)	198.02	10.60	0.0	187.42	61,200	--	--	268	1,510	3,400	16,500	1.48	--	--	--	--
MW-2	10/8/2008	(NP)	198.02	10.41	0.0	187.61	52,300	--	--	127	172	2,120	10,600	<1.00	--	--	--	--
MW-2	1/15/2009	(NP)	198.02	8.00	0.0	190.02	34,700	--	--	361	308	1,540	5,100	21.8	--	--	--	--
MW-2	4/2/2009	(NP)	198.02	8.89	0.0	189.13	81,600	--	--	90.3	1,120	3,590	18,700	<10	--	--	<1.00	<1.00
MW-2	10/14/2009	(NP)	198.02	9.86	0.0	188.16	45,000	--	--	98	38	2,300	8,000	<1.00	--	--	<2.00	--
MW-2	3/22/2010	(NP)	27.32	8.66	--	18.66	84,000	--	--	43	490	3,400	15,000	<1.0	--	--	--	--
MW-2	6/22/2010	(NP, H)	27.32	8.16	--	19.16	--	--	--	--	--	--	--	--	--	--	--	--
MW-2	3/10/2011	(NP)	27.32	7.19	0.0	20.13	47,800	--	--	19.9	548	2,380	9,250	<1.0	--	--	<10.0	<10.0
MW-2	9/19/2011	(NP)	27.32	10.45	0.0	16.87	37,000	--	--	66.0	10.9	2,210	2,410	<1.0	--	--	<10.0	<10.0
MW-2	3/16/2012	(NP)	27.32	7.19	0.0	20.13	30,800	--	--	32.5	17.5	1,960	3,050	<1.0	--	--	<10.0	<10.0
MW-3	3/12/2002	(P)	197.49	7.90	0.0	189.59	<50.0	--	--	<0.500	<0.500	<0.500	<1.00	<1.00	--	--	55.7	<1.00
MW-3	8/30/2002	(P)	197.49	10.50	0.0	186.99	<50.0	--	--	<0.500	<0.500	<0.500	<1.00	<2.00	<0.01	<1.00	63.8	<1.00
MW-3	3/24/2003	(P)	197.49	7.60	0.0	189.89	<50.0	--	--	<0.500	<0.500	<0.500	<1.00	<1.00	--	--	1.8	<1.00
MW-3	4/22/2003	(NS)	197.49	8.60	0.0	188.89	--	--	--	--	--	--	--	--	--	--	--	--
MW-3	6/30/2003	(P)	197.49	9.45	0.0	188.04	<50.0	--	--	<0.500	<0.500	<0.500	<1.00	<1.00	--	--	13.4	3.63
MW-3	9/15/2003	(P)	197.49	10.67	0.0	186.82	<50.0	--	--	<0.500	<0.500	<0.500	<1.00	<1.00	--	--	14	<1.00
MW-3	12/30/2003	(P)	197.49	8.65	0.0	188.84	<50.0	--	--	<0.500	<0.500	<0.500	<1.00	<1.00	--	--	2.17	<1.00
MW-3	7/13/2004	(NS)	197.49	10.27	0.0	187.22	--	--	--	--	--	--	--	--	--	--	--	--
MW-3	11/1/2004	(NP)	197.49	9.50	0.0	187.99	<80.0	--	--	<0.200	<0.500	<0.500	<1.00	<2.00	--	--	<1.00	--
MW-3	3/3/2005	(NP)	197.49	8.42	0.0	189.07	<80.0	--	--	<0.200	<0.500	<0.500	<1.00	<2.00	--	--	<1	--
MW-3	6/12/2005	(NP)	197.49	9.32	0.0	188.17	<80.0	--	--	<0.200	<0.500	<0.500	<1.00	<2.00	--	--	<1.00	--

Table 1
Groundwater Gauging Data and Select Analytical Results
WA-05544

19860 68th Ave So, Kent, WA 98032

All analytical results are presented in micrograms per liter (µg/L)

Well	Date	Notes	TOC	DTW	NAPL	GWE	GRO	DRO	HO	Benzene	Toluene	Ethylbenzene	Total Xylenes	MTBE	EDB	EDC	Total Lead	Dissolved Lead
Model Toxics Control Act (MTCA) Method A Cleanup Levels (CULs) in µg/L							800/1,000	500	500	5	1,000	700	1,000	20	0.01	5	15	--
MW-3	8/28/2005	(NS)	197.49	10.64	0.0	186.85	--	--	--	--	--	--	--	--	--	--	--	--
MW-3	11/17/2005	(NS)	197.49	9.15	0.0	188.34	--	--	--	--	--	--	--	--	--	--	--	--
MW-3	3/5/2006	(NS)	197.49	8.28	0.0	189.21	--	--	--	--	--	--	--	--	--	--	--	--
MW-3	10/24/2006	(NS)	197.49	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MW-3	3/22/2007	(NS)	197.49	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MW-3	5/30/2007	(NS)	197.49	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MW-3	9/4/2007	(NS)	197.49	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MW-3	11/13/2007	(NS)	197.49	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MW-3	3/12/2008	(NP)	197.49	8.85	0.0	188.64	<50.0	--	--	<0.500	<0.500	<0.500	<3.00	<1.00	--	--	--	--
MW-3	6/9/2008	(NP)	197.49	7.56	0.0	189.93	<50.0	--	--	<0.500	<0.500	<0.500	<3.00	<1.00	--	--	--	--
MW-3	8/6/2008	(NP)	197.49	10.07	0.0	187.42	<50.0	--	--	<0.500	<0.500	<0.500	<3.00	<1.00	--	--	--	--
MW-3	10/8/2008	(NP)	197.49	9.62	0.0	187.87	<50.0	--	--	<0.500	<0.500	<0.500	<3.00	<1.00	--	--	--	--
MW-3	1/15/2009	(NP)	197.49	7.15	0.0	190.34	<50.0	--	--	<0.500	<0.500	<0.500	<3.00	<1.00	--	--	--	--
MW-3	4/2/2009	(NP)	197.49	8.05	0.0	189.44	<50.0	--	--	<0.500	<0.500	<0.500	<1.00	<1.00	--	--	<1.00	<1.00
MW-3	10/14/2009	(NS)	197.49	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MW-3	3/22/2010	(NP)	26.83	7.89	--	18.94	<50	--	--	<1.0	<1.0	<1.0	<3	<1.0	--	--	--	--
MW-3	3/22/2010	(Dup)(NP)	26.83	7.89	--	18.94	<50	--	--	<1.0	<1.0	<1.0	<3	<1.0	--	--	--	--
MW-3	6/22/2010	(NP)	26.83	7.44	--	19.39	--	--	--	--	--	--	--	--	--	--	--	--
MW-3	3/10/2011	(NP)	26.83	7.54	0.0	19.29	<50.0	--	--	<1.0	<1.0	<1.0	<3.0	<1.0	--	--	<10.0	<10.0
MW-3	9/19/2011	(NP)	26.83	9.41	0.0	17.42	<50.0	--	--	<1.0	<1.0	<1.0	<3.0	<1.0	--	--	<10.0	<10.0
MW-3	3/16/2012	(NP)	26.83	6.30	0.0	20.53	<50.0	--	--	<1.0	<1.0	<1.0	<3.0	<1.0	--	--	<10.0	<10.0
MW-4	3/12/2002	(P)	197.68	7.38	0.0	190.30	<50.0	--	--	<0.500	<0.500	<0.500	<1.00	<1.00	--	--	23.2	<1.00
MW-4	8/30/2002	(P)	197.68	10.97	0.0	186.71	1,400	--	--	48	1.05	0.743	124	9.57	<0.01	<1.00	61	<1.00
MW-4	3/24/2003	(P)	197.68	8.65	0.0	189.03	<50.0	--	--	<0.500	<0.500	<0.500	<1.00	<1.00	--	--	5.53	<1.00
MW-4	4/22/2003	(NS)	197.68	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MW-4	6/30/2003	(P)	197.68	10.61	0.0	187.07	903	--	--	28.9	<0.500	<0.500	16.7	<5.00	--	--	9.17	4.56
MW-4	9/15/2003	(P)	197.68	11.16	0.0	186.52	848	--	--	20.5	<0.500	<0.500	3.73	<1.00	--	--	5.15	<1.00
MW-4	12/30/2003	(P)	197.68	9.61	0.0	188.07	144	--	--	1	<0.500	<0.500	2.4	<1.00	--	--	15.1	<1.00
MW-4	7/13/2004	(NS)	197.68	9.98	0.0	187.70	--	--	--	--	--	--	--	--	--	--	--	--
MW-4	11/1/2004	(P)	197.68	10.60	0.0	187.08	<80.0	--	--	<0.200	<0.500	<0.500	<1.00	<2.00	--	--	2.3	--
MW-4	3/3/2005	(NS)	197.68	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MW-4	6/12/2005	(NP)	197.68	9.78	0.0	187.90	<80.0	--	--	<0.200	<0.500	<0.500	<1.00	<2.00	--	--	<1.00	--
MW-4	8/28/2005	(NS)	197.68	11.00	0.0	186.68	--	--	--	--	--	--	--	--	--	--	--	--
MW-4	11/17/2005	(NP)	197.68	9.81	0.0	187.87	<50.0	--	--	<0.500	<0.500	<0.500	<1.00	<1.00	--	--	<1.00	--
MW-4	3/5/2006	(NS)	197.68	9.31	0.0	188.37	--	--	--	--	--	--	--	--	--	--	--	--
MW-4	10/24/2006	(NS)	197.68	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MW-4	3/22/2007	(NS)	197.68	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

**Table 1
Groundwater Gauging Data and Select Analytical Results
WA-05544**

19860 68th Ave So, Kent, WA 98032

All analytical results are presented in micrograms per liter (µg/L)

Well	Date	Notes	TOC	DTW	NAPL	GWE	GRO	DRO	HO	Benzene	Toluene	Ethylbenzene	Total Xylenes	MTBE	EDB	EDC	Total Lead	Dissolved Lead
Model Toxics Control Act (MTCA) Method A Cleanup Levels (CULs) in µg/L							800/1,000	500	500	5	1,000	700	1,000	20	0.01	5	15	--
MW-4	5/30/2007	(NS)	197.68	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MW-4	9/4/2007	(NS)	197.68	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MW-4	11/13/2007	(NS)	197.68	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MW-4	3/13/2008	(NP)	197.68	9.72	0.0	187.96	<50.0	--	--	<0.500	<0.500	<0.500	<3.00	<1.00	--	--	--	--
MW-4	6/9/2008	(NP)	197.68	9.55	0.0	188.13	<50.0	--	--	<0.500	<0.500	<0.500	<3.00	<1.00	--	--	--	--
MW-4	8/6/2008	(NS)	197.68	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MW-4	10/8/2008	(NP)	197.68	10.31	0.0	187.37	<50.0	--	--	<0.500	<0.500	<0.500	<3.00	<1.00	--	--	--	--
MW-4	1/15/2009	(NP)	197.68	8.13	0.0	189.55	<50.0	--	--	<0.500	<0.500	<0.500	<3.00	<1.00	--	--	--	--
MW-4	4/2/2009	(NP)	197.68	8.13	0.0	189.55	<50.0	--	--	<0.500	<0.500	<0.500	<1.00	<1.00	--	--	<1.00	<1.00
MW-4	10/14/2009	(NS)	197.68	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MW-4	3/22/2010	(NP)	27.01	8.72	--	18.29	<50	--	--	<1.0	<1.0	<1.0	<3	<1.0	--	--	--	--
MW-4	6/22/2010	(NP, H)	27.01	8.14	--	18.87	--	--	--	--	--	--	--	--	--	--	--	--
MW-4	3/10/2011	(NP)	27.01	6.73	0.0	20.28	<50.0	--	--	<1.0	<1.0	<1.0	<3.0	<1.0	--	--	<10.0	<10.0
MW-4	9/19/2011	(NP)	27.01	9.71	0.0	17.30	<50.0	--	--	<1.0	<1.0	<1.0	<3.0	<1.0	--	--	<10.0	<10.0
MW-4	3/16/2012	(NP)	27.01	6.70	0.0	20.31	<50.0	--	--	<1.0	<1.0	<1.0	<3.0	<1.0	--	--	<10.0	<10.0
MW-5	3/12/2002	(P)	198.21	8.82	0.0	189.39	52,100	--	--	7,210	3,770	2,670	9,070	233	--	--	124	<1.00
MW-5	8/30/2002	(P)	198.21	11.20	0.0	187.01	55,200	--	--	15,400	2,200	1,590	7,160	478	<0.01	<100	144	<1.00
MW-5	3/24/2003	(P)	198.21	8.70	0.0	189.51	48,400	--	--	19,900	282	331	1,230	1,540	--	--	14.2	<1.00
MW-5	4/22/2003	(NS)	198.21	9.52	0.0	188.69	--	--	--	--	--	--	--	--	--	--	--	--
MW-5	6/30/2003	(P)	198.21	10.87	0.0	187.34	62,900	--	--	17,900	1,500	1,110	4,070	571	--	--	63.9	8.35
MW-5	9/15/2003	(P)	198.21	11.60	0.0	186.61	61,600	--	--	19,300	554	1,250	4,640	520	--	--	9.75	<1.00
MW-5	12/30/2003	(P)	198.21	9.70	0.0	188.51	52,600	--	--	12,500	1,630	1,910	7,180	307	--	--	9.85	<1.00
MW-5	7/13/2004	(P)	198.21	10.83	0.0	187.38	41,800	--	--	6,090	3,230	2,680	10,500	<100	--	--	2.82	<1.00
MW-5	11/1/2004	(NP)	198.21	8.39	0.0	189.82	6,090	--	--	3,630	<10.0	26	139	925	--	--	<1.00	--
MW-5	3/3/2005	(NP)	198.21	10.83	0.0	187.38	<80.0	--	--	1.8	<2.50	<2.50	<5.00	835	--	--	<1	--
MW-5	6/12/2005	(NP)	198.21	10.30	0.0	187.91	1,110	--	--	129	0.82	33.1	289	196	--	--	<1.00	--
MW-5	8/28/2005	(NP)	198.21	11.30	0.0	186.91	1,330	--	--	116	<0.500	112	53.5	148	--	--	<1.00	--
MW-5	11/17/2005	(NP)	198.21	10.03	0.0	188.18	<50.0	--	--	1.21	<2.50	<2.50	<5.00	161	--	--	4.63	--
MW-5	3/5/2006	(NP)	198.21	9.23	0.0	188.98	143	--	--	8.54	<0.500	11.4	2.66	115	--	--	<1.00	--
MW-5	10/24/2006	(P)	198.21	14.30	0.0	183.91	104	--	--	1.43	<0.500	<0.500	<3.00	91.8	--	--	--	--
MW-5	3/22/2007	(P)	198.21	8.76	0.0	189.45	<50.0	--	--	3.25	<0.500	<0.500	<3.00	79	--	--	--	--
MW-5	5/30/2007	(P)	198.21	10.19	0.0	188.02	3,080	--	--	2,220	6.83	1,210	969	57.6	--	--	--	--
MW-5	9/4/2007	(P)	198.21	10.46	0.0	187.75	1,180	--	--	255	<0.500	8.34	4.99	16	--	--	--	--
MW-5	11/13/2007	(P)	198.21	10.73	0.0	187.48	225	--	--	9.92	<0.500	<0.500	<3.00	17.4	--	--	--	--
MW-5	3/12/2008	(NP)	198.21	9.37	0.0	188.84	511	--	--	45.4	0.5	4.54	34	<1.00	--	--	--	--
MW-5	6/9/2008	(NP)	198.21	8.27	0.0	189.94	243	--	--	4.18	17.9	3.09	66.7	<1.00	--	--	--	--
MW-5	8/6/2008	(NP)	198.21	10.74	0.0	187.47	<50.0	--	--	<0.500	<0.500	<0.500	<3.00	<1.00	--	--	--	--

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WA-05544**

19860 68th Ave So, Kent, WA 98032

All analytical results are presented in micrograms per liter (µg/L)

Well	Date	Notes	TOC	DTW	NAPL	GWE	GRO	DRO	HO	Benzene	Toluene	Ethylbenzene	Total Xylenes	MTBE	EDB	EDC	Total Lead	Dissolved Lead
Model Toxics Control Act (MTCA) Method A Cleanup Levels (CULs) in µg/L							800/1,000	500	500	5	1,000	700	1,000	20	0.01	5	15	--
MW-5	10/8/2008	(NP)	198.21	10.80	0.0	187.41	<50.0	--	--	<0.500	<0.500	<0.500	<3.00	<1.00	--	--	--	--
MW-5	1/15/2009	(NP)	198.21	8.29	0.0	189.92	<50.0	--	--	<0.500	<0.500	<0.500	<3.00	93.9	--	--	--	--
MW-5	4/2/2009	(NP)	198.21	9.30	0.0	188.91	<50.0	--	--	<0.500	<0.500	<0.500	<1.00	1.39	--	--	<1.00	<1.00
MW-5	10/14/2009	(NP)	198.21	10.30	0.0	187.91	<50.0	--	--	<1.00	<1.00	<1.00	<2.00	<1.00	--	--	<2.00	--
MW-5	3/22/2010	(NP)	27.53	8.93	--	18.60	64	--	--	<1.0	<1.0	<1.0	<3	<1.0	--	--	--	--
MW-5	6/22/2010	(NP, H)	27.53	8.61	--	18.92	--	--	--	--	--	--	--	--	--	--	--	--
MW-5	3/10/2011	(NP)	27.53	7.60	0.0	19.93	<50.0	--	--	<1.0	<1.0	<1.0	<3.0	1.1	--	--	<10.0	<10.0
MW-5	9/19/2011	(NP)	27.53	10.17	0.0	17.36	830	--	--	<1.0	<1.0	3.6	16.6	<1.0	--	--	<10.0	<10.0
MW-5	3/16/2012	(NP)	27.53	7.56	0.0	19.97	167	--	--	<1.0	<1.0	<1.0	<3.0	2.9	--	--	<10.0	<10.0
MW-6	3/12/2002	(P)	198.24	8.90	0.0	189.34	187,000	--	--	49,800	27,600	2,650	12,300	6,840	--	--	176	<1.00
MW-6	8/30/2002	(P)	198.24	11.11	--	187.13	105,000	--	--	36,900	6,910	1,410	6,770	1,230	<0.01	<200	157	<1.00
MW-6	3/24/2003	(P)	198.24	8.60	0.0	189.64	101,000	--	--	26,800	7,090	1,690	7,780	2,480	--	--	19.7	<1.00
MW-6	4/22/2003	(NS)	198.24	9.33	0.0	188.91	--	--	--	--	--	--	--	--	--	--	--	--
MW-6	6/30/2003	(P)	198.24	10.35	0.0	187.89	61,700	--	--	18,700	4,610	990	4,030	860	--	--	46.7	2.27
MW-6	9/15/2003	(P)	198.24	11.50	0.0	186.74	109,000	--	--	29,000	8,690	1,720	7,310	1,390	--	--	12.6	<1.00
MW-6	12/30/2003	(P)	198.24	9.60	0.20	188.80	333,000	--	--	45,200	64,400	6,030	31,300	1,960	--	--	1.85	<1.00
MW-6	7/13/2004	(NP)	198.24	10.27	0.08	188.03	513,000	--	--	52,500	98,600	8,300	43,600	3,620	--	--	<1.00	<1.00
MW-6	11/1/2004	(NP)	198.24	10.32	0.0	187.92	123	--	--	29.6	10.4	<5.00	16.5	947	--	--	<1.00	--
MW-6	3/3/2005	(NP)	198.24	13.23	0.0	185.01	<80.0	--	--	<0.400	<1.00	<1.00	<2.00	227	--	--	<1	--
MW-6	6/12/2005	(NP)	198.24	10.17	0.0	188.07	7,780	--	--	431	919	978	4,170	349	--	--	<1.00	--
MW-6	8/28/2005	(NP)	198.24	11.26	0.0	186.98	10,400	--	--	760	207	385	1,660	579	--	--	<1.00	--
MW-6	11/17/2005	(NP)	198.24	10.93	0.0	187.31	<50.0	--	--	0.6	<0.500	<0.500	<1.00	139	--	--	<1.00	--
MW-6	3/5/2006	(NP)	198.24	9.22	0.0	189.02	304	--	--	<0.500	8.16	2.94	54.5	107	--	--	<1.00	--
MW-6	10/24/2006	(P)	198.24	11.21	0.0	187.03	11,800	--	--	570	14.2	608	1,730	1,020	--	--	--	--
MW-6	3/22/2007	(P)	198.24	8.55	0.0	189.69	41,500	--	--	1,100	2,380	2,400	16,300	961	--	--	--	--
MW-6	5/30/2007	(P)	198.24	9.90	0.0	188.34	62,700	--	--	1,260	921	1,990	15,100	307	--	--	--	--
MW-6	9/4/2007	(P)	198.24	10.41	0.0	187.83	91,800	--	--	1,350	2,500	3,480	14,900	<100	--	--	--	--
MW-6	11/13/2007	(P)	198.24	10.54	0.0	187.70	5,380	--	--	196	<0.500	366	76.8	1,300	--	--	--	--
MW-6	3/12/2008	(NP)	198.24	9.45	0.0	188.79	85,300	--	--	1,030	2,270	2,470	17,100	555	--	--	--	--
MW-6	6/9/2008	(NP)	198.24	7.99	0.0	190.25	139,000	--	--	238	--	1,580	164	<1.00	--	--	--	--
MW-6	8/6/2008	(NP)	198.24	10.56	0.0	187.68	69,700	--	--	678	34	2,350	18,900	22.9	--	--	--	--
MW-6	10/8/2008	(NP)	198.24	10.58	0.0	187.66	68,900	--	--	470	24.7	1,130	12,500	95	--	--	--	--
MW-6	1/15/2009	(NP)	198.24	8.21	0.0	190.03	22,500	--	--	182	10.7	746	2,550	687	--	--	--	--
MW-6	4/2/2009	(NP)	198.24	9.08	0.0	189.16	80,100	--	--	415	164	2,240	18,100	57.6	--	--	<1.00	<1.00
MW-6	10/14/2009	(NP)	198.24	9.25	0.0	188.99	71,000	--	--	580	15	3,300	22,000	41	--	--	<2.00	--
MW-6	3/22/2010	(NP)	27.50	8.77	--	18.73	100,000	--	--	480	390	2,500	19,400	6.2	--	--	--	--
MW-6	6/22/2010	(NP, H)	27.50	8.39	--	19.11	--	--	--	--	--	--	--	--	--	--	--	--

Table 1
Groundwater Gauging Data and Select Analytical Results
WA-05544

19860 68th Ave So, Kent, WA 98032

All analytical results are presented in micrograms per liter (µg/L)

Well	Date	Notes	TOC	DTW	NAPL	GWE	GRO	DRO	HO	Benzene	Toluene	Ethylbenzene	Total Xylenes	MTBE	EDB	EDC	Total Lead	Dissolved Lead
Model Toxics Control Act (MTCA) Method A Cleanup Levels (CULs) in µg/L							800/1,000	500	500	5	1,000	700	1,000	20	0.01	5	15	--
MW-6	3/10/2011	(NP)	27.50	7.51	0.0	19.99	103,000	--	--	314	189	1,150	23,400	<1.0	--	--	<10.0	<10.0
MW-6	9/19/2011	(NP)	27.50	10.47	0.0	17.03	67,900	--	--	300	45.4	1,800	8,320	10.4	--	--	<10.0	<10.0
MW-6	3/16/2012	(NP)	27.50	7.49	0.0	20.01	46,000	--	--	304	19.8	1,640	4,990	10.1	--	--	<10.0	<10.0
MW-7	4/22/2003	(P)	197.32	9.24	0.0	188.08	<50.0	--	--	<0.500	<0.500	<0.500	<1.00	<1.00	--	--	15.8	--
MW-7	6/30/2003	(P)	197.32	10.33	0.0	186.99	<50.0	--	--	<0.500	<0.500	<0.500	<1.00	<1.00	--	--	25	7.06
MW-7	9/15/2003	(P)	197.32	10.82	0.0	186.50	<50.0	--	--	<0.500	<0.500	<0.500	<1.00	<1.00	--	--	14.4	<1.00
MW-7	12/30/2003	(P)	197.32	9.31	0.0	188.01	<50.0	--	--	<0.500	<0.500	<0.500	<1.00	<1.00	--	--	1.35	<1.00
MW-7	7/13/2004	(NS)	197.32	10.38	0.0	186.94	--	--	--	--	--	--	--	--	--	--	--	--
MW-7	11/1/2004	(NP)	197.32	10.20	0.0	187.12	<80.0	--	--	<0.200	<0.500	<0.500	<1.00	<2.00	--	--	<1.00	--
MW-7	3/3/2005	(NP)	197.32	9.80	0.0	187.52	<80.0	--	--	<0.200	<0.500	<0.500	<1.00	<2.00	--	--	<1	--
MW-7	6/12/2005	(NP)	197.32	9.49	0.0	187.83	<80.0	--	--	<0.200	<0.500	<0.500	<1.00	<2.00	--	--	1.38	--
MW-7	8/28/2005	(NS)	197.32	10.63	0.0	186.69	--	--	--	--	--	--	--	--	--	--	--	--
MW-7	11/17/2005	(NS)	197.32	9.54	0.0	187.78	--	--	--	--	--	--	--	--	--	--	--	--
MW-7	3/5/2006	(NS)	197.32	8.96	0.0	188.36	--	--	--	--	--	--	--	--	--	--	--	--
MW-7	10/24/2006	(NS)	197.32	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MW-7	3/22/2007	(NS)	197.32	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MW-7	5/30/2007	(NS)	197.32	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MW-7	9/4/2007	(NS)	197.32	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MW-7	11/13/2007	(NS)	197.32	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MW-7	3/12/2008	(NP)	197.32	9.42	0.0	187.90	<50.0	--	--	<0.500	<0.500	<0.500	<3.00	<1.00	--	--	--	--
MW-7	6/9/2008	(NP)	197.32	9.29	0.0	188.03	<50.0	--	--	<0.500	3.18	1.67	32.5	<1.00	--	--	--	--
MW-7	8/6/2008	(NS)	197.32	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MW-7	10/8/2008	(NS)	197.32	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MW-7	1/15/2009	(NP)	197.32	7.65	0.0	189.67	<50.0	--	--	<0.500	<0.500	<0.500	<3.00	<1.00	--	--	--	--
MW-7	4/2/2009	(NP)	197.32	8.52	0.0	188.80	<50.0	--	--	<0.500	<0.500	<0.500	<1.00	<1.00	--	--	<1.00	<1.00
MW-7	10/14/2009	(NS)	197.32	8.97	0.0	188.35	--	--	--	--	--	--	--	--	--	--	--	--
MW-7	3/22/2010	(NP)	26.64	8.39	--	18.25	<50	--	--	<1.0	<1.0	<1.0	<3	<1.0	--	--	--	--
MW-7	6/22/2010	(NP, H)	26.64	7.82	--	18.82	--	--	--	--	--	--	--	--	--	--	--	--
MW-7	3/10/2011	(NP)	26.64	6.27	0.0	20.37	<50.0	--	--	<1.0	<1.0	<1.0	<3.0	<1.0	--	--	<10.0	<10.0
MW-7	9/19/2011	(NP)	26.64	9.38	0.0	17.26	<50.0	--	--	<1.0	<1.0	<1.0	<3.0	<1.0	--	--	<10.0	<10.0
MW-7	3/16/2012	(NP)	26.64	6.31	0.0	20.33	<50.0	--	--	<1.0	<1.0	<1.0	<3.0	<1.0	--	--	<10.0	<10.0
MW-8	4/22/2003	(P)	196.68	8.45	0.0	188.23	<50.0	--	--	<0.500	<0.500	<0.500	<1.00	<1.00	--	--	14.7	--
MW-8	6/30/2003	(P)	196.68	9.61	0.0	187.07	<50.0	--	--	<0.500	<0.500	<0.500	<1.00	<1.00	--	--	12.8	4.24
MW-8	9/15/2003	(P)	196.68	10.20	0.0	186.48	<50.0	--	--	<0.500	<0.500	<0.500	<1.00	<1.00	--	--	16.9	<1.00
MW-8	12/30/2003	(P)	196.68	8.60	0.0	188.08	<50.0	--	--	<0.500	<0.500	<0.500	<1.00	<1.00	--	--	1.53	<1.00
MW-8	7/13/2004	(NS)	196.68	9.56	0.0	187.12	--	--	--	--	--	--	--	--	--	--	--	--
MW-8	11/1/2004	(NP)	196.68	9.45	0.0	187.23	<80.0	--	--	<0.200	<0.500	<0.500	<1.00	<2.00	--	--	<1.00	--

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Groundwater Gauging Data and Select Analytical Results
WA-05544**

19860 68th Ave So, Kent, WA 98032

All analytical results are presented in micrograms per liter (µg/L)

Well	Date	Notes	TOC	DTW	NAPL	GWE	GRO	DRO	HO	Benzene	Toluene	Ethylbenzene	Total Xylenes	MTBE	EDB	EDC	Total Lead	Dissolved Lead
Model Toxics Control Act (MTCA) Method A Cleanup Levels (CULs) in µg/L							800/1,000	500	500	5	1,000	700	1,000	20	0.01	5	15	--
MW-8	3/3/2005	(NP)	196.68	8.94	0.0	187.74	<80.0	--	--	<0.200	<0.500	<0.500	<1.00	<2.00	--	--	<1	--
MW-8	6/12/2005	(NP)	196.68	8.81	0.0	187.87	<80.0	--	--	<0.200	<0.500	<0.500	<1.00	<2.00	--	--	<1.00	--
MW-8	8/28/2005	(NS)	196.68	9.97	0.0	186.71	--	--	--	--	--	--	--	--	--	--	--	--
MW-8	11/17/2005	(NS)	196.68	8.85	0.0	187.83	--	--	--	--	--	--	--	--	--	--	--	--
MW-8	3/5/2006	(NS)	196.68	8.16	0.0	188.52	--	--	--	--	--	--	--	--	--	--	--	--
MW-8	10/24/2006	(NS)	196.68	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MW-8	3/22/2007	(NS)	196.68	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MW-8	5/30/2007	(NS)	196.68	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MW-8	9/4/2007	(NS)	196.68	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MW-8	11/13/2007	(NS)	196.68	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MW-8	3/12/2008	(NP)	196.68	8.68	0.0	188.00	<50.0	--	--	<0.500	<0.500	<0.500	<3.00	<1.00	--	--	--	--
MW-8	6/9/2008	(NP)	196.68	8.51	0.0	188.17	<50.0	--	--	<0.500	<0.500	<0.500	<3.00	<1.00	--	--	--	--
MW-8	8/6/2008	(NS)	196.68	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MW-8	10/8/2008	(NS)	196.68	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MW-8	1/15/2009	(NP)	196.68	7.13	0.0	189.55	<50.0	--	--	<0.500	<0.500	<0.500	<3.00	<1.00	--	--	--	--
MW-8	4/2/2009	(NP)	196.68	7.80	0.0	188.88	<50.0	--	--	<0.500	<0.500	<0.500	<1.00	<1.00	--	--	<1.00	<1.00
MW-8	10/14/2009	(NS)	196.68	8.45	0.0	188.23	--	--	--	--	--	--	--	--	--	--	--	--
MW-8	3/22/2010	(NP)	26.00	7.59	--	18.41	<50	--	--	<1.0	<1.0	<1.0	<3	<1.0	--	--	--	--
MW-8	6/22/2010	(NP, H)	26.00	7.23	--	18.77	--	--	--	--	--	--	--	--	--	--	--	--
MW-8	3/10/2011	(NP)	26.00	5.56	0.0	20.44	<50.0	--	--	<1.0	<1.0	<1.0	<3.0	<1.0	--	--	<10.0	<10.0
MW-8	9/19/2011	(NP)	26.00	8.76	0.0	17.24	<50.0	--	--	<1.0	<1.0	<1.0	<3.0	<1.0	--	--	<10.0	<10.0
MW-8	3/16/2012	(NP)	26.00	5.68	0.0	20.32	<50.0	--	--	<1.0	<1.0	<1.0	<3.0	<1.0	--	--	<10.0	<10.0
MW-9	4/22/2003	(P)	197.42	8.77	0.0	188.65	<50.0	--	--	<0.500	<0.500	<0.500	<1.00	<1.00	--	--	17.2	--
MW-9	6/30/2003	(P)	197.42	10.25	0.0	187.17	<50.0	--	--	<0.500	<0.500	<0.500	<1.00	<1.00	--	--	47.3	4.67
MW-9	9/15/2003	(P)	197.42	10.83	0.0	186.59	<50.0	--	--	<0.500	<0.500	<0.500	<1.00	<1.00	--	--	12.9	<1.00
MW-9	12/30/2003	(P)	197.42	8.99	0.0	188.43	<50.0	--	--	<0.500	<0.500	<0.500	<1.00	<1.00	--	--	17.9	<1.00
MW-9	7/13/2004	(NS)	197.42	10.08	0.0	187.34	--	--	--	--	--	--	--	--	--	--	--	--
MW-9	11/1/2004	(NP)	197.42	9.75	0.0	187.67	<80.0	--	--	<0.200	<0.500	<0.500	<1.00	<2.00	--	--	1.79	--
MW-9	3/3/2005	(NP)	197.42	8.98	0.0	188.44	<80.0	--	--	<0.200	<0.500	<0.500	<1.00	<2.00	--	--	<1	--
MW-9	6/12/2005	(NP)	197.42	9.49	0.0	187.93	<80.0	--	--	<0.200	<0.500	<0.500	<1.00	<2.00	--	--	<1.00	--
MW-9	8/28/2005	(NS)	197.42	10.59	0.0	186.83	--	--	--	--	--	--	--	--	--	--	--	--
MW-9	11/17/2005	(NS)	197.42	9.52	0.0	187.90	--	--	--	--	--	--	--	--	--	--	--	--
MW-9	3/5/2006	(NS)	197.42	8.55	0.0	188.87	--	--	--	--	--	--	--	--	--	--	--	--
MW-9	10/24/2006	(NS)	197.42	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MW-9	3/22/2007	(NS)	197.42	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MW-9	5/30/2007	(NS)	197.42	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MW-9	9/4/2007	(NS)	197.42	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

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Groundwater Gauging Data and Select Analytical Results
WA-05544**

19860 68th Ave So, Kent, WA 98032

All analytical results are presented in micrograms per liter (µg/L)

Well	Date	Notes	TOC	DTW	NAPL	GWE	GRO	DRO	HO	Benzene	Toluene	Ethylbenzene	Total Xylenes	MTBE	EDB	EDC	Total Lead	Dissolved Lead
Model Toxics Control Act (MTCA) Method A Cleanup Levels (CULs) in µg/L							800/1,000	500	500	5	1,000	700	1,000	20	0.01	5	15	--
MW-9	11/13/2007	(NS)	197.42	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MW-9	3/12/2008	(NP)	197.42	9.20	0.0	188.22	<50.0	--	--	<0.500	<0.500	<0.500	<3.00	<1.00	--	--	--	--
MW-9	6/9/2008	(NP)	197.42	8.91	0.0	188.51	<50.0	--	--	<0.500	<0.500	<0.500	<3.00	<1.00	--	--	--	--
MW-9	8/6/2008	(NP)	197.42	10.18	0.0	187.24	<50.0	--	--	<0.500	<0.500	<0.500	<3.00	<1.00	--	--	--	--
MW-9	10/8/2008	(NP)	197.42	10.10	0.0	187.32	<50.0	--	--	<0.500	<0.500	<0.500	<3.00	<1.00	--	--	--	--
MW-9	1/15/2009	(NP)	197.42	7.61	0.0	189.81	<50.0	--	--	<0.500	<0.500	<0.500	<3.00	<1.00	--	--	--	--
MW-9	4/2/2009	(NP)	197.42	8.50	0.0	188.92	<50.0	--	--	<0.500	<0.500	<0.500	<1.00	<1.00	--	--	1.32	<1.00
MW-9	10/14/2009	(NS)	197.42	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MW-9	3/22/2010	(NP)	26.76	8.41	--	18.35	<50	--	--	<1.0	<1.0	<1.0	<3	<1.0	--	--	--	--
MW-9	6/22/2010	(NP, H)	26.76	7.88	--	18.88	--	--	--	--	--	--	--	--	--	--	--	--
MW-9	3/10/2011	(NP)	26.76	6.57	0.0	20.19	<50.0	--	--	<1.0	<1.0	<1.0	<3.0	<1.0	--	--	<10.0	<10.0
MW-9	9/19/2011	(NP)	26.76	9.62	0.0	17.14	<50.0	--	--	<1.0	<1.0	<1.0	<3.0	<1.0	--	--	<10.0	<10.0
MW-9	3/16/2012	(NP)	26.76	6.59	0.0	20.17	<50.0	--	--	<1.0	<1.0	<1.0	<3.0	<1.0	--	--	<10.0	<10.0
MW-10	4/22/2003	(P)	197.70	8.59	0.0	189.11	278	--	--	30.9	<0.500	<0.500	28.5	<2.00	--	--	5.92	--
MW-10	6/30/2003	(P)	197.70	10.48	0.0	187.22	195	--	--	38	<0.500	0.535	5.73	<5.00	--	--	19.8	11.7
MW-10	9/15/2003	(P)	197.70	10.93	0.0	186.77	154	--	--	42	0.5	<0.500	4.18	<1.00	--	--	7.69	<1.00
MW-10	12/30/2003	(P)	197.70	8.81	0.0	188.89	312	--	--	39.3	<0.500	<0.500	24.6	<1.00	--	--	8.78	<1.00
MW-10	7/13/2004	(NS)	197.70	10.35	0.0	187.35	--	--	--	--	--	--	--	--	--	--	--	--
MW-10	11/1/2004	(NP)	197.70	8.55	0.0	189.15	<80.0	--	--	<0.200	<0.500	<0.500	<1.00	<2.00	--	--	<1.00	--
MW-10	3/3/2005	(NP)	197.70	9.40	0.0	188.30	<80.0	--	--	<0.200	<0.500	<0.500	<1.00	<2.00	--	--	<1	--
MW-10	6/12/2005	(NP)	197.70	9.59	0.0	188.11	<80.0	--	--	<0.200	<0.500	<0.500	<1.00	<2.00	--	--	<1.00	--
MW-10	8/28/2005	(NS)	197.70	10.75	0.0	186.95	--	--	--	--	--	--	--	--	--	--	--	--
MW-10	11/17/2005	(NP)	197.70	9.79	0.0	187.91	<50.0	--	--	<0.500	<0.500	<0.500	<1.00	<1.00	--	--	<1.00	--
MW-10	3/5/2006	(NS)	197.70	8.40	0.0	189.30	--	--	--	--	--	--	--	--	--	--	--	--
MW-10	10/24/2006	(NS)	197.70	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MW-10	3/22/2007	(NS)	197.70	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MW-10	5/30/2007	(NS)	197.70	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MW-10	9/4/2007	(NS)	197.70	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MW-10	11/13/2007	(NS)	197.70	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MW-10	3/12/2008	(NP)	197.70	9.11	0.0	188.59	<50.0	--	--	<0.500	<0.500	<0.500	<3.00	<1.00	--	--	--	--
MW-10	6/9/2008	(NP)	197.70	8.55	0.0	189.15	<50.0	--	--	<0.500	<0.500	<0.500	<3.00	<1.00	--	--	--	--
MW-10	8/6/2008	(NS)	197.70	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MW-10	10/8/2008	(NS)	197.70	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MW-10	1/15/2009	(NP)	197.70	7.66	0.0	190.04	<50.0	--	--	<0.500	<0.500	<0.500	<3.00	<1.00	--	--	--	--
MW-10	4/2/2009	(NP)	197.70	8.55	0.0	189.15	<50.0	--	--	<0.500	<0.500	<0.500	<1.00	<1.00	--	--	<1.00	<1.00
MW-10	10/14/2009	(NS)	197.70	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MW-10	3/22/2010	(NP)	27.01	8.18	--	18.83	<50	--	--	<1.0	<1.0	<1.0	<3	<1.0	--	--	--	--

Table 1
Groundwater Gauging Data and Select Analytical Results
WA-05544

19860 68th Ave So, Kent, WA 98032

All analytical results are presented in micrograms per liter (µg/L)

Well	Date	Notes	TOC	DTW	NAPL	GWE	GRO	DRO	HO	Benzene	Toluene	Ethylbenzene	Total Xylenes	MTBE	EDB	EDC	Total Lead	Dissolved Lead
Model Toxics Control Act (MTCA) Method A Cleanup Levels (CULs) in µg/L							800/1,000	500	500	5	1,000	700	1,000	20	0.01	5	15	--
MW-10	6/22/2010	(NP, H)	27.01	7.98	--	19.03	--	--	--	--	--	--	--	--	--	--	--	--
MW-10	3/10/2011	(NP)	27.01	7.11	0.0	19.90	<50.0	--	--	<1.0	<1.0	<1.0	<3.0	<1.0	--	--	<10.0	<10.0
MW-10	9/19/2011	(NP)	27.01	9.80	0.0	17.21	<50.0	--	--	<1.0	<1.0	<1.0	<3.0	<1.0	--	--	<10.0	<10.0
MW-10	3/16/2012	(NP)	27.01	7.01	0.0	20.00	<50.0	--	--	<1.0	<1.0	<1.0	<3.0	<1.0	--	--	<10.0	<10.0

msl = Mean sea level

TOC = Top of casing

GWE = Groundwater elevation above msl

DTW = Depth to water below TOC

All analytical results are in micrograms per liter (µg/L)

TOC/DTW/LNAPL/GWE measurements are in feet (ft)

ND = Not detected at or above the laboratory reporting limit

-- = Not analyzed/not applicable

NE = Top of casing not established

DUP = Duplicate sample

NS = Not Sampled

NAPL = Non-Aqueous Phase Liquid Thickness

GRO = Total Petroleum Hydrocarbons - Gasoline Range Organics

DRO = Total Petroleum Hydrocarbons - Diesel Range Organics

HO = Total Petroleum Hydrocarbons- Heavy Oil Range Organics

EDB = Ethylene Dibromide

EDC = 1,2-Dichloroethane

MTBE = Methyl Tertiary Butyl Ether

BTEX = Benzene, Toluene, Ethylbenzene and Total Xylenes

P = Purge sampling

LFP = Low flow purge sampling

NP = No purge sampling

GRO, DRO, HO methods by Ecology NW Methods; BTEX, MTBE and EDB by 8260B, lead by EPA 6000/7000 Series, EDC by EPA 8011

Historic analysis by former consultant of BTEX, MTBE and EDB by EPA 8021B and confirmed with EPA 8260B if necessary

Groundwater Elevation - If NAPL is present, the elevation is corrected according to the following formula, (TOC elevation - depth to water) + (0.8 X NAPL Thickness)

800/1,000 = GRO MTCA cleanup levels with benzene present (800) and without (1,000)

Data collected prior to 2010 have been provided by previous consultants and are included as historical reference only

Site resurveyed in 2010. TOC elevation in reference to vertical datum N.A.V.D. 88 and horizontal datum NAD 83/98

H = Sample was prepped or analyzed beyond the specified holding time

Y = The chromatographic response resembles a typical fuel pattern

BOLD constituent detected above MTCA Cleanup Levels

TABLE 2
Historical Soil Analytical Data

ARCO Facility No. 5544
19918 68th Ave S.
Kent, WA 98032

Sample ID	Date Collected	Sample Depth (feet)	GRO mg/kg	BTEX				MTBE mg/kg	Total Lead mg/kg
				B mg/kg	T mg/kg	E mg/kg	X mg/kg		
MTCA Method A Cleanup Levels			30	0.03	7	6	9	0.1	250
5544-1/9-DIS-1-4	1/9/2002	4	<5.00	<0.0300	<0.0500	<0.0500	<0.100	<0.100	2.98
5544-1/9-DIS-2-4	1/9/2002	4	19.7	<0.0300	0.0515	<0.0500	0.198	<0.100	18.7
5544-1/9-DIS-3-3.5	1/9/2002	3.5	20.4	0.353	0.0862	0.656	1.25	<0.100	25.9
5544-1/9-DIS-4-3.5	1/9/2002	3.5	162	1.89	4.06	3.7	27.5	<1.00	33.7
5544-1/9-PL-1-3.5	1/9/2002	3.5	6.35	0.353	0.0523	0.297	1.03	<0.100	10.3
5544-1/9-PL-2-4	1/9/2002	4	59.3	1.65	2.23	2.31	10.5	<0.200	7.85
5544-1/9-PL-3-4	1/9/2002	4	7.52	0.388	<0.0500	0.346	1.35	<0.100	6.43
5544-1/9-STK-1 ¹	1/9/2002	NA	<5.00	<0.0300	<0.0500	<0.0500	<0.100	<0.100	3.2
5544-1/9-STK-2 ¹	1/9/2002	NA	<5.00	<0.0300	<0.0500	<0.0500	<0.100	<0.100	4.48
5544-1/9-STK-3 ¹	1/9/2002	NA	8.69	0.0696	<0.0500	0.188	1.14	<0.100	5.51
MW-1	2/12/2002	5	<5.00	<0.0300	<0.0500	<0.0500	<0.100	<0.100	1.69
MW-1	2/12/2002	10	<5.00	<0.0300	<0.0500	<0.0500	<0.100	<0.100	4.92
MW-2	2/12/2002	5	508	2.93	11	14.8	68.4	<1.00	3.07
MW-2	2/12/2002	10	44.8	10.8	0.23	3.89	6.91	<1.00	5.33
MW-3	2/12/2002	5	<5.00	<0.0300	<0.0500	<0.0500	<0.100	<0.100	1.69
MW-3	2/12/2002	10	<5.00	<0.0300	<0.0500	<0.0500	<0.100	<0.100	1.91
MW-4	2/12/2002	5	<5.00	<0.0300	<0.0500	<0.0500	<0.100	<0.100	1.45
MW-4	2/12/2002	10	<5.00	<0.0300	<0.0500	<0.0500	<0.100	<0.100	4.31
MW-5	2/12/2002	5	5.45	0.0388	<0.0500	0.125	0.659	<0.100	4.3
MW-5	2/12/2002	10	65.5	0.358	3.01	3.52	13.2	<0.200	4.09
MW-6	2/13/2002	5	16,000	183	1,500	499	2,450	<1.00	2.39
MW-6	2/13/2002	10	111	13.9	22.7	2.73	14.4	<1.00	3.03
MW-7-7	4/7/2003	7	<5.00	<0.0300	<0.0500	<0.0500	<0.100	<0.100	1.34
MW-8-7	4/7/2003	7	<5.00	<0.0300	<0.0500	<0.0500	<0.100	<0.100	6.31
MW-9-7	4/7/2003	7	<5.00	<0.0300	<0.0500	<0.0500	<0.100	<0.100	3.05
MW-10-5	4/8/2003	5	<5.00	<0.0300	<0.0500	<0.0500	<0.100	<0.100	13.1
MW-10-7	4/8/2003	7	<5.00	<0.0300	<0.0500	<0.0500	<0.100	<0.100	3.79
AS-1-5	4/8/2003	5	84.9	0.449	2.78	1.89	11.8	<1.00	4.90
AS-1-7	4/8/2003	7	3,290	21.2	291	105	533	<1.00	1.73
SVE-1-7	4/7/2003	7	<5.00	<0.0300	<0.0500	<0.0500	<0.100	<0.100	1.99
AUS-HB-1 (3.5')	7/20/2010	3.5	<4.8	<0.019	<0.048	<0.048	<0.048	<0.048	11
AUS-HB-1 (5')	7/20/2010	5	<6.3	<0.025	<0.063	<0.063	<0.063	<0.063	3.4
AUS-HB-2 (3.5-4')	7/20/2010	3.5-4	<5.1	<0.020	<0.051	<0.051	<0.051	<0.051	3.3
AUS-HB-2 (5')	7/20/2010	5	<5.6	<0.023	<0.056	<0.056	<0.056	<0.056	4.5

Notes:

mg/kg = milligrams per kilograms.

BTEX = benzene, toluene, ethylbenzene, and total xylenes.

MTBE = methyl tertiary butyl ether.

GRO = gasoline range organics

MTCA Model Toxics Control Act

< = not detected above laboratory reporting limits

NA = not applicable

¹ STK-1 through 3 represents stocked piled soil that has been removed from the site.

GRO analyzed by method NWTPH-Gx

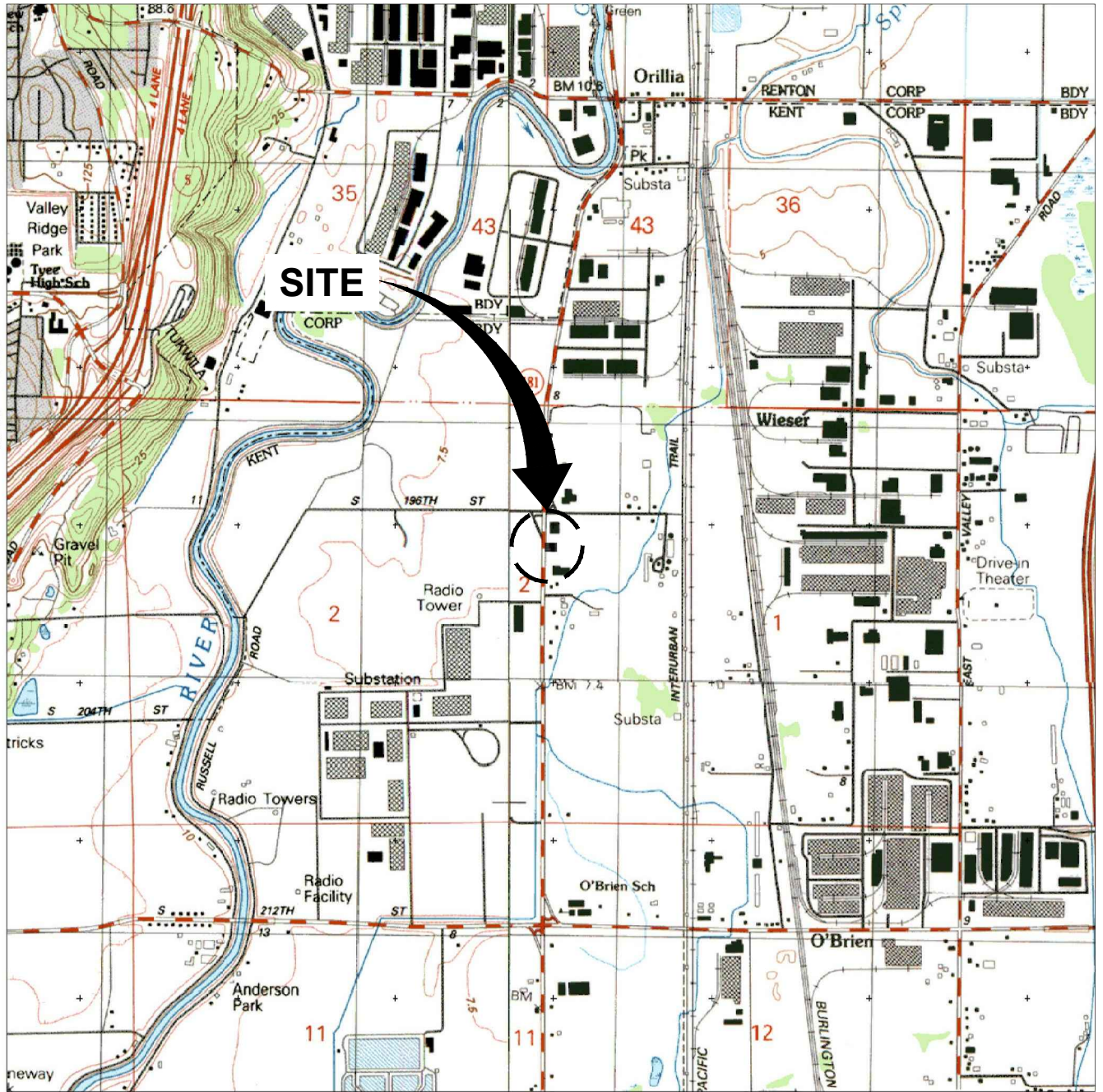
BTEX, MTBE analyzed by Method 8260B

Total Lead analyzed by Method 6020

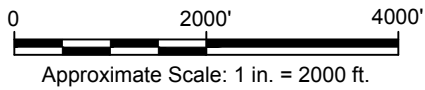
ARCADIS

Figures

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REFERENCE: BASE MAP USGS 7.5. MIN. TOPO. QUAD., BURIEN & RENTON, WA., PHOTOREVISED 1983.



BP WEST COAST PRODUCTS, LLC.
 FORMER ARCO FACILITY No. 5544
 19918 68TH AVENUE SOUTH, KENT, WASHINGTON
REMEDIAL ACTION PLAN

SITE LOCATION MAP

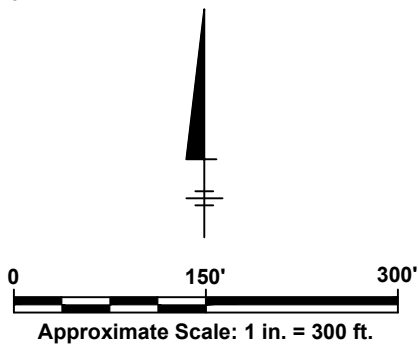


FIGURE
1

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GENERAL NOTES:
AERIAL PHOTOGRAPH
DATED 6/13/02



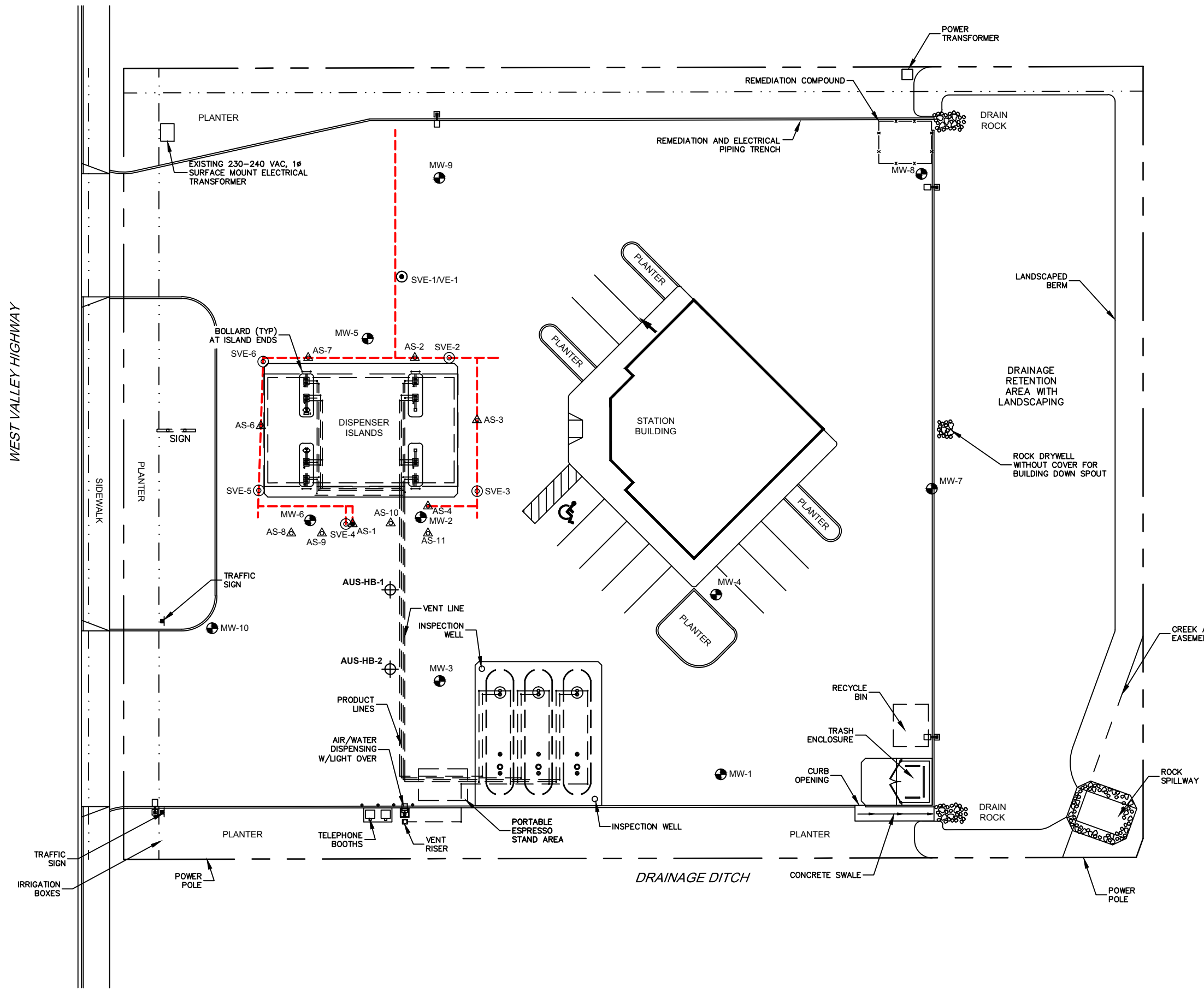
BP WEST COAST PRODUCTS, LLC.
FORMER ARCO FACILITY No. 5544
19918 68TH AVENUE SOUTH, KENT, WASHINGTON
REMEDIAL ACTION PLAN

SITE AERIAL MAP

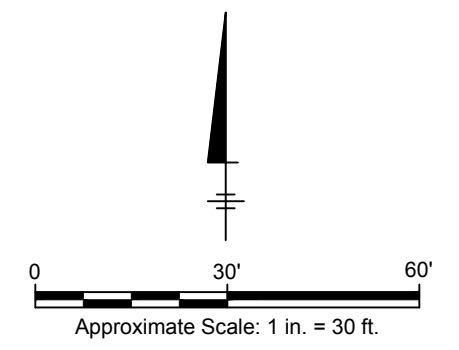


FIGURE
2

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- LEGEND:
- MW-1 ● MONITORING WELL LOCATION
 - SVE-1 ⊙ VAPOR EXTRACTION WELL LOCATION
 - AS-1 ▲ AIR SPARGE WELL LOCATION
 - AUS-HB-1 ⊕ HAND AUGERED SOIL BORING LOCATION
 - REMEDIATION AND ELECTRICAL PIPING TRENCH



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19918 68TH AVENUE SOUTH, KENT, WASHINGTON

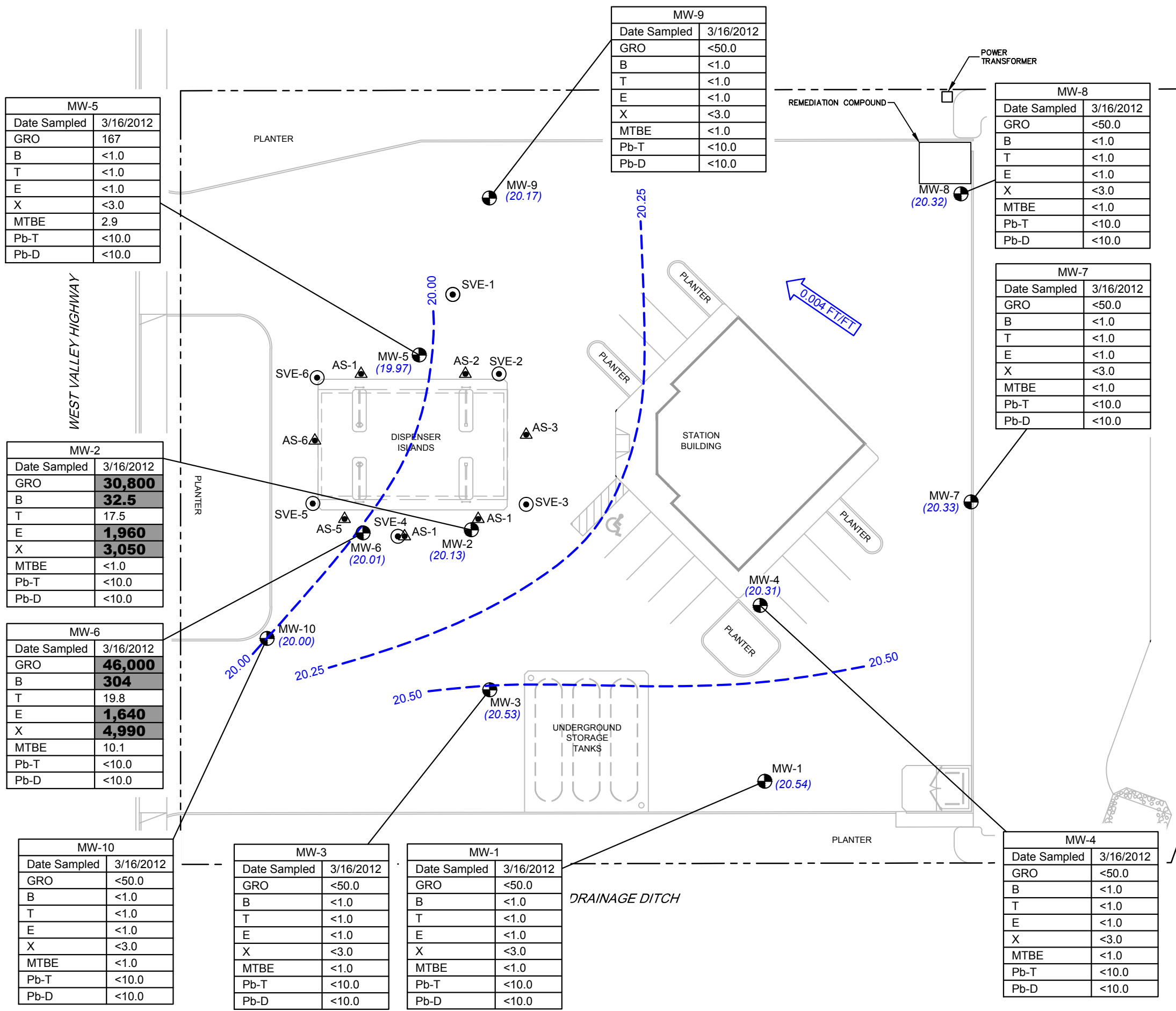
REMEDIATION ACTION PLAN

SITE PLAN

ARCADIS

FIGURE 3

CITY:\Read\ DIV\GROUP\Read\ DB\Read\ LD\Opt\ PIC\Opt\ PM\Read\ TM\Opt\ LVR\Opt\ION\OFF=REF*
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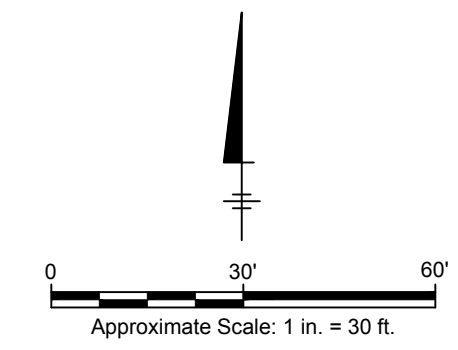


LEGEND:

- PROPERTY BOUNDARY
- MW-1 ● MONITORING WELL LOCATION
- VE-1 ○ VAPOR EXTRACTION WELL LOCATION
- AS-1 ▲ AIR SPARGE WELL LOCATION
- (20.33) GROUNDWATER ELEVATION (FEET ABOVE MEAN SEA LEVEL)
- < LESS THAN LABORATORY DETECTION LIMITS
- GROUNDWATER CONTOUR, DASHED WHERE INFERRED (FEET ABOVE MEAN SEA LEVEL)
- ← 0.004 FT/FT GROUNDWATER FLOW DIRECTION AND HYDRAULIC GRADIENT - FOOT PER FOOT

Sample ID	
Date	Date Collected
GRO	Total Petroleum Hydrocarbons in the Gasoline Range Organics
B	Benzene
T	Toluene
E	Ethylbenzene
X	Total Xylenes
MTBE	Methyl Tertiary Butyl Ether
Pb-D	Dissolved Lead
Pb-T	Total Lead

NOTES:
 ALL CONCENTRATIONS ARE MEASURED IN MICROGRAMS PER LITER (µg/L)
BOLD = ANALYTE DETECTED ABOVE MODEL TOXICS CONTROL ACT (MTCA) METHOD A CLEANUP LEVELS



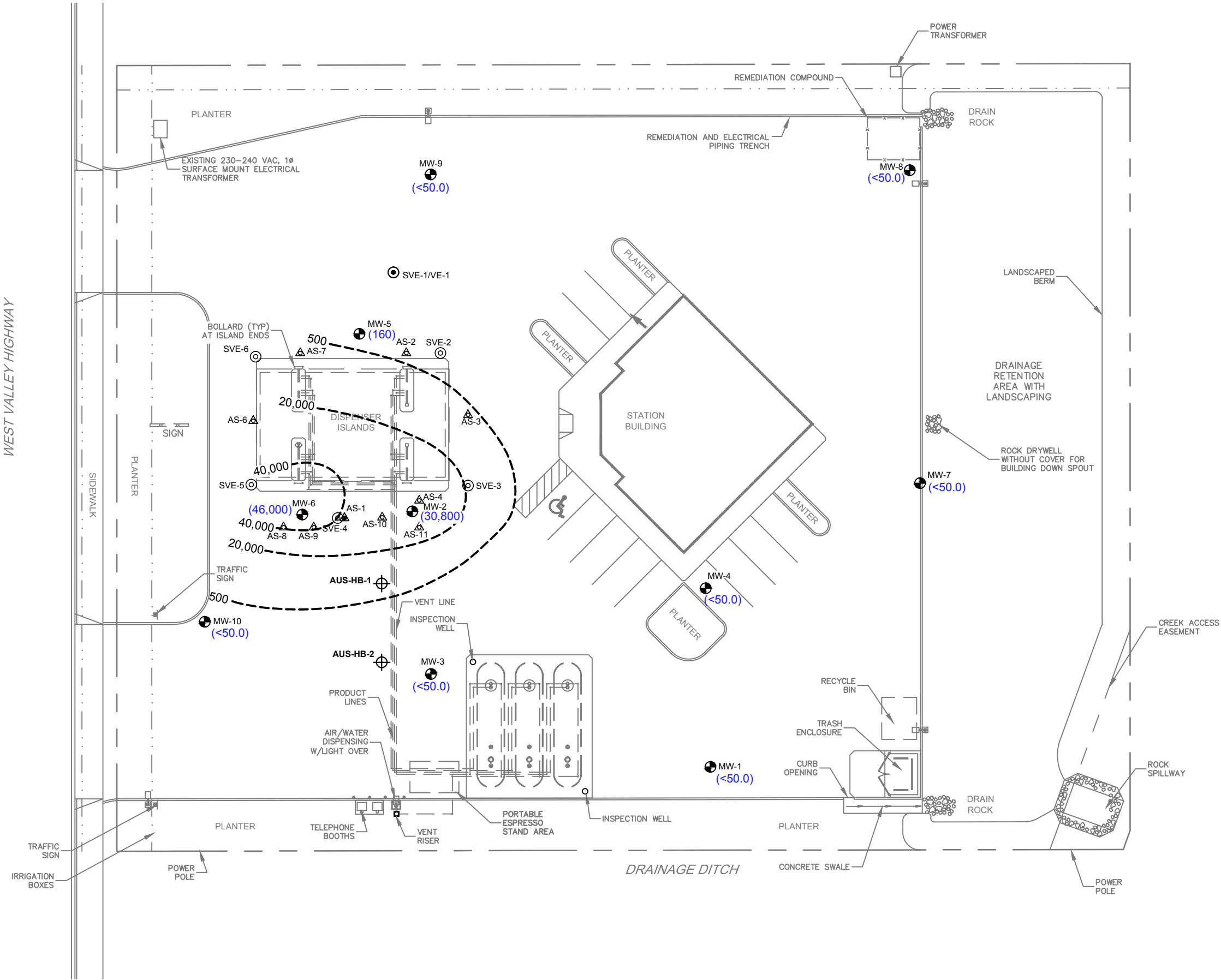
FORMER ARCO FACILITY No. 5544
 19918 68TH AVENUE SOUTH, KENT, WASHINGTON
REMEDIAL ACTION PLAN

GROUNDWATER ELEVATION CONTOURS WITH ANALYTICAL RESULTS
 MARCH 16, 2012

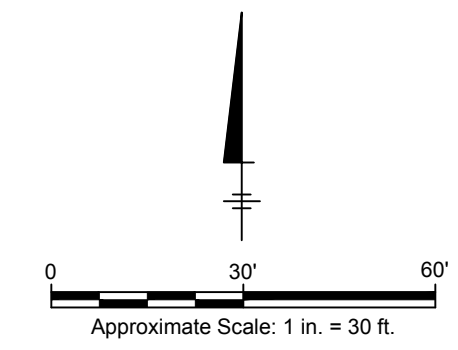


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WEST VALLEY HIGHWAY



- LEGEND:
- MW-1 ● MONITORING WELL LOCATION
 - VE-1 ⊙ VAPOR EXTRACTION WELL LOCATION
 - AS-1 ▲ AIR SPARGE WELL LOCATION
 - AUS-HB-1 ⊕ HAND AUGERED SOIL BORING LOCATION
 - 40,000 - - - INTERPOLATED GASOLINE RANGE ORGANICS CONTOUR LINE (µg/L)
 - <50.0 NOT DETECTED AT OR ABOVE THE LABORATORY REPORTING LIMIT
 - 46,000 GRO CONCENTRATION IN µg/L
 - µg/L MICROGRAMS PER LITER



BP WEST COAST PRODUCTS, LLC.
 FORMER ARCO FACILITY No. 5544
 19918 68TH AVENUE SOUTH, KENT, WASHINGTON
REMEDIAL ACTION PLAN

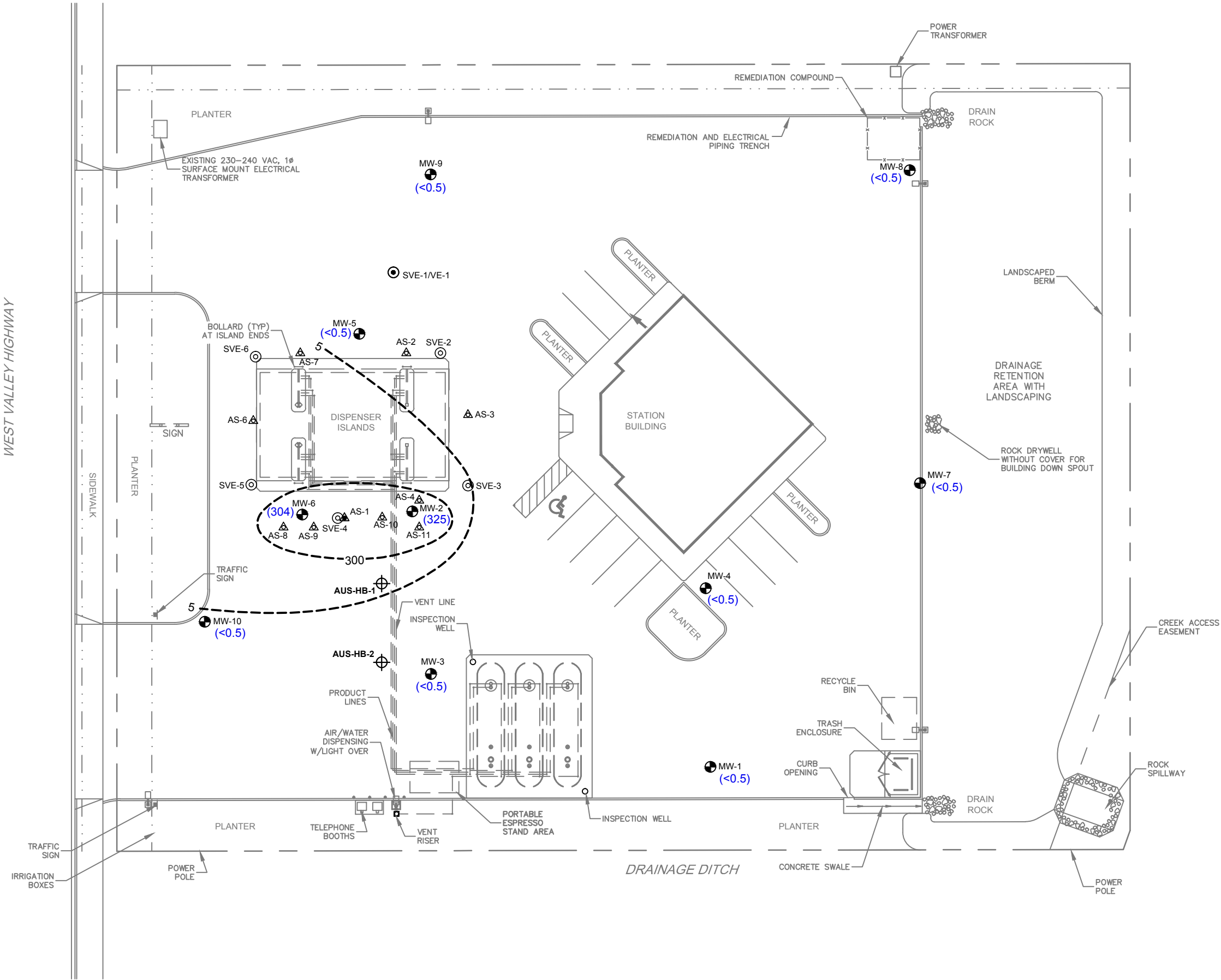
GRO ISOCONCENTRATION MAP
 MARCH 16, 2012

ARCADIS

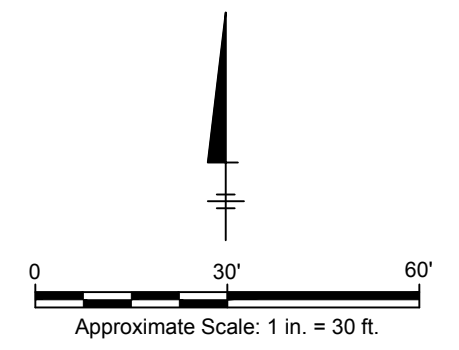
FIGURE
6

CITY:(Read) DIV:(GROUP:(Read) DB:(Read) LD:(Opt) PIC:(Opt) PM:(Read) TM:(Opt) Lyr:(Option):OFF=REF*
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WEST VALLEY HIGHWAY



- LEGEND:
- MW-1 ● MONITORING WELL LOCATION
 - VE-1 ○ VAPOR EXTRACTION WELL LOCATION
 - AS-1 ▲ AIR SPARGE WELL LOCATION
 - AUS-HB-1 ⊕ HAND AUGERED SOIL BORING LOCATION
 - 50 - - - INTERPOLATED BENZENE CONTOUR LINE (μg/L)
 - (<0.5) NOT DETECTED AT OR ABOVE THE LABORATORY REPORTING LIMIT
 - (304) BENZENE CONCENTRATION IN μg/L
 - μg/L MICROGRAMS PER LITER



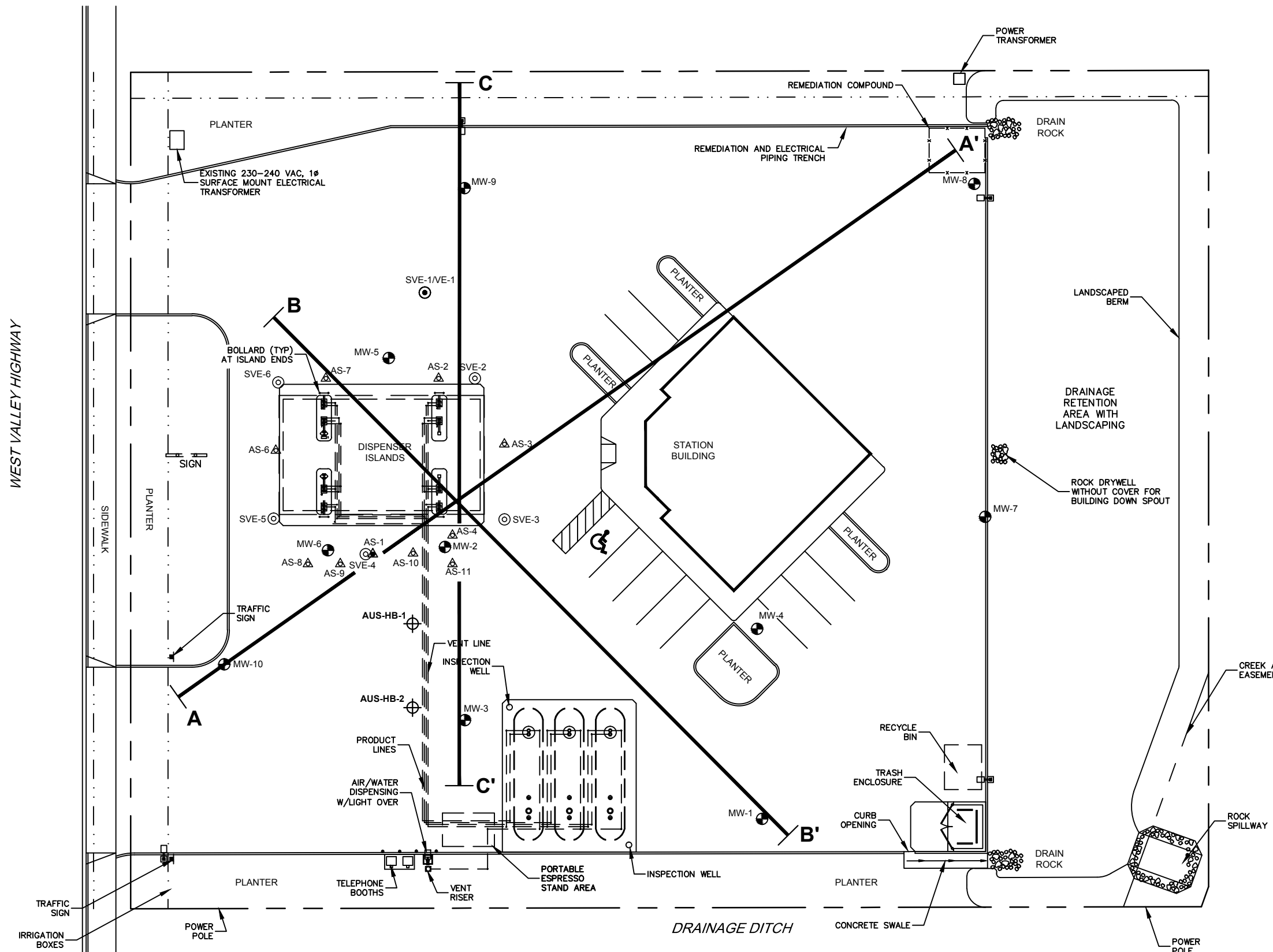
BP WEST COAST PRODUCTS, LLC.
 FORMER ARCO FACILITY No. 5544
 19918 68TH AVENUE SOUTH, KENT, WASHINGTON
REMEDIAL ACTION PLAN

BENZENE ISOCONCENTRATION MAP
 MARCH 16, 2012

ARCADIS

FIGURE
7

CITY: (Read) DIV: (Group) (Read) DB: (Read) LD: (Opt) PIC: (Opt) PM: (Read) TM: (Opt) LYN: (Option) OFF: (Ref)
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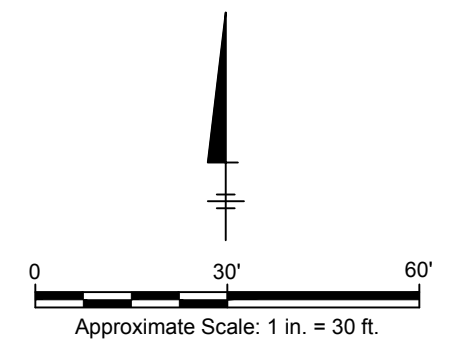


LEGEND:

- MW-1 MONITORING WELL LOCATION
- SVE-1 VAPOR EXTRACTION WELL LOCATION
- AS-1 AIR SPARGE WELL LOCATION
- AUS-HB-1 HAND AUGERED SOIL BORING LOCATION

CROSS SECTION LOCATION

A A'



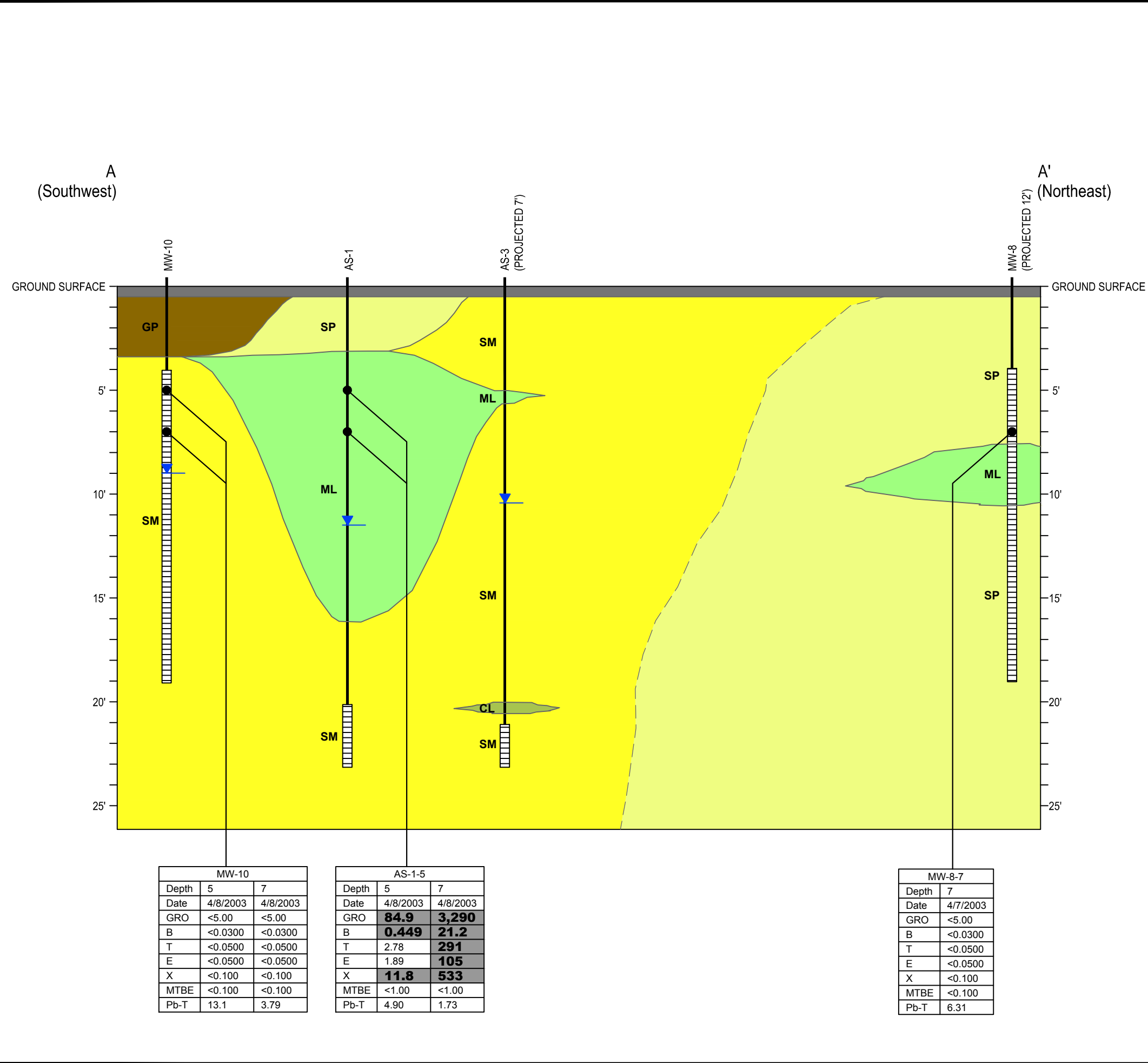
BP WEST COAST PRODUCTS, LLC.
 FORMER ARCO FACILITY No. 5544
 19918 68TH AVENUE SOUTH, KENT, WASHINGTON
REMEDIAL ACTION PLAN

CROSS SECTION LOCATION MAP

ARCADIS

FIGURE 8

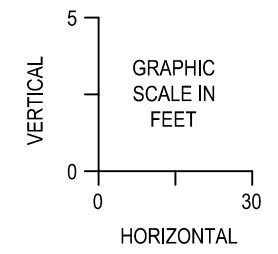
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LEGEND:

- GP** POORLY GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES.
- SP** POORLY GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES.
- SM** SILTY SANDS, SANDY SILT MIXTURES.
- ML** INORGANIC SILTS, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY.
- CL** CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS.
- ASPHALT**
- <** NOT DETECTED AT OR ABOVE THE LABORATORY LIMIT
- BOLD** REPRESENTS ANALYTES DETECTED ABOVE MTCA METHOD A CLEANUP LEVELS
- MW-10** MONITORING WELL IDENTIFICATION
- SOIL SAMPLE LOCATION
- SCREENED INTERVAL
- DEPTH TO WATER (FT BGS) on 3/16/2012
- GEOLOGIC CONTACT (DASHED WHERE INFERRED)

Sample Location	
Depth	Sample Depth
Date	Date Collected
GRO	Total Petroleum Hydrocarbons in the Gasoline Range Organics
B	Benzene
T	Toluene
E	Ethylbenzene
X	Total Xylenes
MTBE	Methyl Tertiary Butyl Ether
Pb-T	Total Lead



MW-10		
Depth	5	7
Date	4/8/2003	4/8/2003
GRO	<5.00	<5.00
B	<0.0300	<0.0300
T	<0.0500	<0.0500
E	<0.0500	<0.0500
X	<0.100	<0.100
MTBE	<0.100	<0.100
Pb-T	13.1	3.79

AS-1-5		
Depth	5	7
Date	4/8/2003	4/8/2003
GRO	84.9	3,290
B	0.449	21.2
T	2.78	291
E	1.89	105
X	11.8	533
MTBE	<1.00	<1.00
Pb-T	4.90	1.73

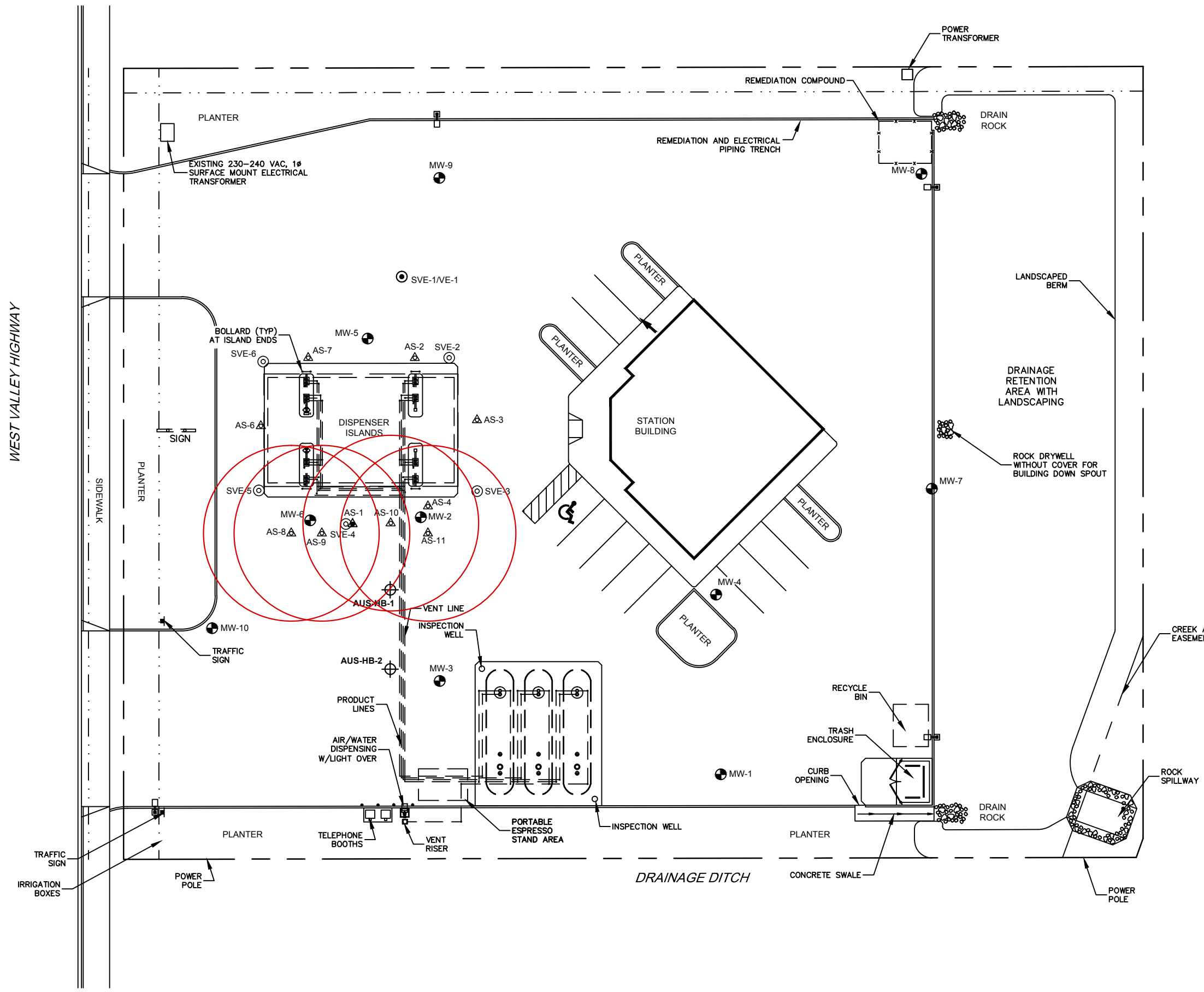
MW-8-7	
Depth	7
Date	4/7/2003
GRO	<5.00
B	<0.0300
T	<0.0500
E	<0.0500
X	<0.100
MTBE	<0.100
Pb-T	6.31

BP WEST COAST PRODUCTS, LLC.
 FORMER ARCO FACILITY No. 5544
 19918 68TH AVENUE SOUTH, KENT, WASHINGTON
REMEDIAL ACTION PLAN

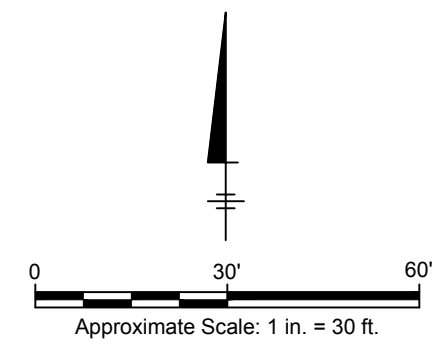
GEOLOGIC CROSS SECTION A-A'

FIGURE
9

CITY:\Read\DIV\GROUP\Read\DE\Read\LD\Opt\PIC\Opt\PM\Read\TYM\Opt\LYR\Opt\ION\OFF=REF*
 G:\ENV\CAD\Emeryville\ACT\GF09BPNAWA39\B12.dwg LAYOUT: 12. SAVED: 4/20/2012 2:24 PM ACADVER: 18.1S (LMS TECH) PAGES: 18. PLOTSETUP: ... PLOTSTYLETABLE: ARCADIS.CTB PLOTTED: 5/4/2012 12:49 PM BY: REYES, ALEC



- LEGEND:**
- MW-1 ● MONITORING WELL LOCATION
 - SVE-1 ⊙ VAPOR EXTRACTION WELL LOCATION
 - AS-1 ▲ AIR SPARGE WELL LOCATION
 - AUS-HB-1 ⊕ HAND AUGERED SOIL BORING LOCATION
 - RADIUS OF INFLUENCE



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 FORMER ARCO FACILITY No. 5544
 19918 68TH AVENUE SOUTH, KENT, WASHINGTON
REMEDIATION ACTION PLAN

AS/SVE TREATMENT SYSTEM SITE PLAN

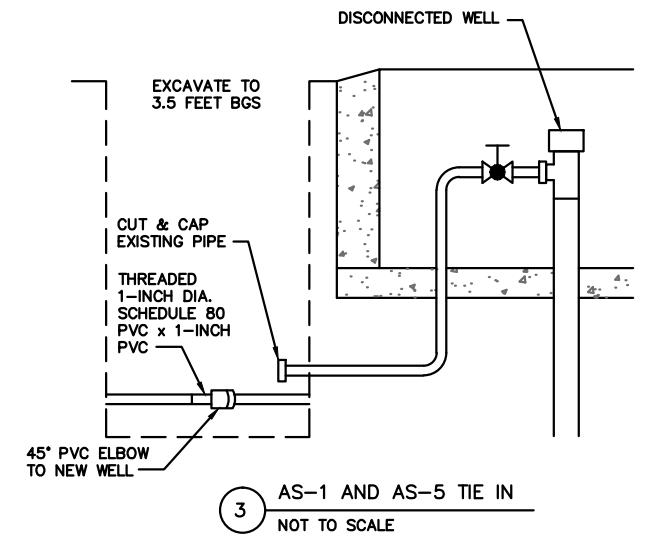
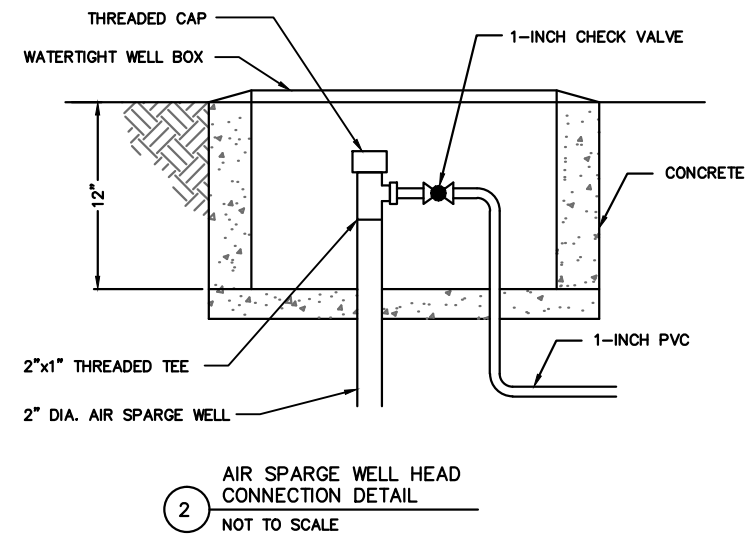
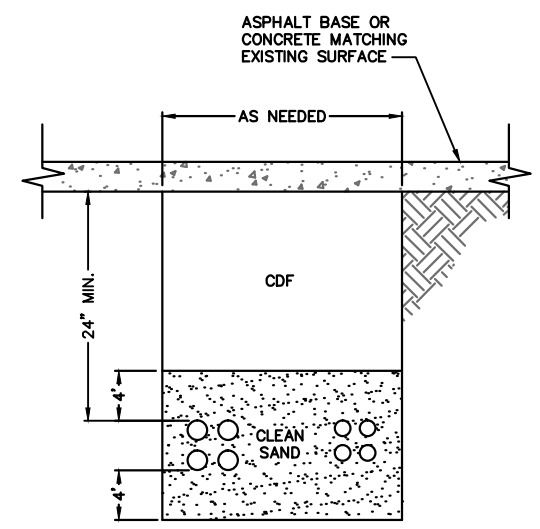
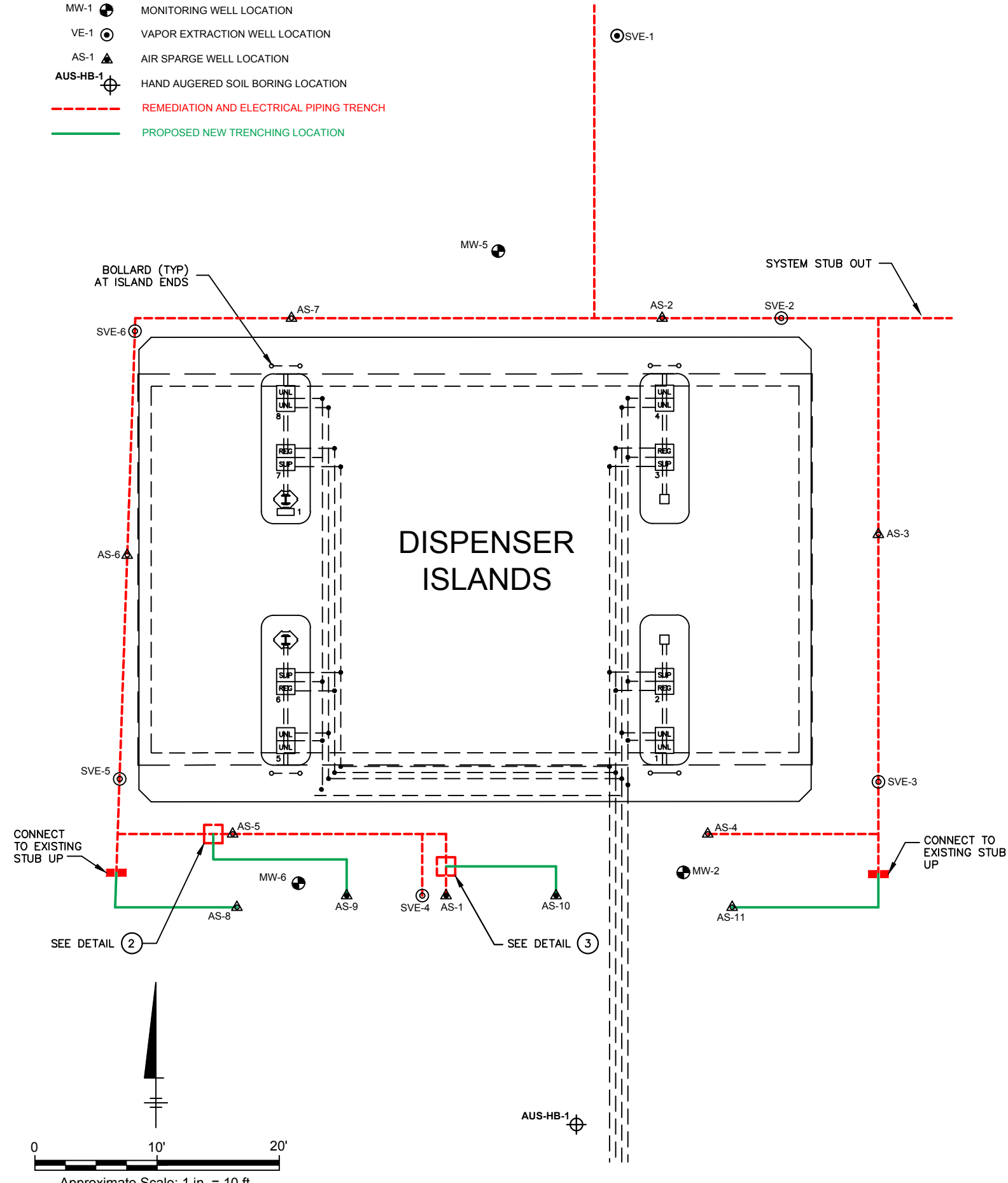
ARCADIS

FIGURE 12

CITY: (Read) DIV: (Group) (Read) DB: (Read) LD: (Opt) PIC: (Opt) PM: (Read) TM: (Opt) LVR: (Option) OFF: (Ref) ACADVER: 18.1S (LMS TECH) PAGES: 13 LAYOUT: 13 SAVED: 4/20/2012 2:19 PM PLOT: 5/4/2012 12:51 PM BY: REYES, ALEC

LEGEND:

- MW-1 MONITORING WELL LOCATION
- VE-1 VAPOR EXTRACTION WELL LOCATION
- AS-1 AIR SPARGE WELL LOCATION
- AUS-HB-1 HAND AUGERED SOIL BORING LOCATION
- REMEDIATION AND ELECTRICAL PIPING TRENCH
- PROPOSED NEW TRENCHING LOCATION



BP WEST COAST PRODUCTS, LLC.
 FORMER ARCO FACILITY No. 5544
 19860 68TH AVENUE SOUTH, KENT, WASHINGTON
REMEDIATION ACTION PLAN

**EXPANSION LAYOUT AND
 CONSTRUCTION DETAILS**

FIGURE
13




Appendix A

Boring Logs

Date Start/Finish: 11/16/2011 to 11/17/2011 Drilling Company: Cascade Drilling LP. Driller's Name: Drilling Method: Hollow Stem Auger Auger Size: 8 inch OD Rig Type: CME - 75 Sampling Method: 1.5 ft. by 2 inch Split Spoon	Northing: NM Easting: NM Casing Elevation: NM Borehole Depth: 21 ft bgs Surface Elevation: NM Descriptions By: Eric Epple	Well/Boring ID: AS-8 Client: BP West Coast Products, LLC. Location: WA-5544 19918 68th Avenue South Kent, Washington
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DEPTH	ELEVATION	Sample Run Number	Sample/Int/Type	Recovery (feet)	Blow Counts	N-Value	PID Headspace (ppm)	Analytical Sample	USCS Code	Geologic Column	Stratigraphic Description	Well/Boring Construction
0	0										Asphalt and Aggregate	Concrete 2" Well Cap Sand Backfill
		AK	3-3.5	NA	AK	1.9			CL		Silty Sandy CLAY with some Gravel, low plasticity, stiff, moist.	
-5	-5	AK	5-5.5	NA	AK	12.4			CL		Silty Sandy CLAY with some Gravel, low plasticity, stiff, moist.	Neat Cement
		AK	7-7.5	NA	AK	1147			ML		Sandy SILT, stiff, no plasticity, slight odor, moist.	
-10	-10	1	10-11.5	1.5	2 1 1	3	1770		ML		Clayey SILT, medium stiff, low plasticity, grey, moist.	2" Schedule 80 PVC Riser Hydrated Bentonite Chips

 <i>Infrastructure · Water · Environment · Buildings</i>	Remarks: AK = Air Knife bgs = below ground surface ft. = feet NM = Not Measured OD = Outer Diameter PVC = Polyvinyl Chloride
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Date Start/Finish: 11/16/2011 to 11/17/2011 Drilling Company: Cascade Drilling LP. Driller's Name: Drilling Method: Hollow Stem Auger Auger Size: 8 inch OD Rig Type: CME - 75 Sampling Method: 1.5 ft. by 2 inch Split Spoon	Northing: NM Easting: NM Casing Elevation: NM Borehole Depth: 21 ft bgs Surface Elevation: NM Descriptions By: Eric Epple	Well/Boring ID: AS-8 Client: BP West Coast Products, LLC. Location: WA-5544 19918 68th Avenue South Kent, Washington
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DEPTH	ELEVATION	Sample Run Number	Sample/Int/Type	Recovery (feet)	Blow Counts	N-Value	PID Headspace (ppm)	Analytical Sample	USCS Code	Geologic Column	Stratigraphic Description	Well/Boring Construction
-15	-15	2	15-16.5	1.5	5 7 8	15	20.0		SM		Silty SAND, fine to medium grain, poorly graded, sub-angular, greyish brown, moist to wet.	
		3	18-19.5	1.5	1 3 4	7	3.0		CL		CLAY, medium to high plasticity, stiff to soft, grey, moist.	
-20	-20	4	19.5-21.0	1.5	2 5 7	12	3.4		SP		SAND, medium grading, very loose, fine to medium grain, black, wet.	

	Remarks: AK = Air Knife bgs = below ground surface ft. = feet NM = Not Measured OD = Outer Diameter PVC = Polyvinyl Chloride
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Date Start/Finish: 11/16/2011 Drilling Company: Cascade Drilling LP. Driller's Name: Drilling Method: Hollow Stem Auger Auger Size: 8 inch OD Rig Type: CME - 75 Sampling Method: 1.5 ft. by 2 inch Split Spoon	Northing: NM Easting: NM Casing Elevation: NM Borehole Depth: 21 ft bgs Surface Elevation: NM Descriptions By: Eric Epple	Well/Boring ID: AS-9 Client: BP West Coast Products, LLC. Location: WA-5544 19918 68th Avenue South Kent, Washington
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DEPTH	ELEVATION	Sample Run Number	Sample/Int/Type	Recovery (feet)	Blow Counts	N-Value	PID Headspace (ppm)	Analytical Sample	USCS Code	Geologic Column	Stratigraphic Description	Well/Boring Construction
0	0										Asphalt and Aggregate	Concrete 2" Well Cap Sand Backfill
		AK	3-3.5	NA	AK		61.0		CL		Silty Sandy CLAY with trace Gravel, low to medium plasticity, moist.	
-5	-5	AK	5-5.5	NA	AK		73.9		CL		Silty Sandy CLAY with trace Gravel, low to medium plasticity, moist.	Neat Cement
		AK	7-7.5	NA	AK		1547		SM		Silty Sand with trace fine to coarse Gravel, loose, fine grain, poorly graded, dark grey, moist to damp.	
-10	-10	1	10-11.5	1.5	1 2 1	3	394		ML		SILT, stiff, no plasticity, grey, moist.	2" Schedule 80 PVC Riser
									ML		Clayey SILT, low plasticity, soft, moist to wet.	Hydrated Bentonite Chips

 <i>Infrastructure · Water · Environment · Buildings</i>	Remarks: AK = Air Knife bgs = below ground surface ft. = feet NM = Not Measured OD = Outer Diameter PVC = Polyvinyl Chloride
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Date Start/Finish: 11/16/2011 Drilling Company: Cascade Drilling LP. Driller's Name: Drilling Method: Hollow Stem Auger Auger Size: 8 inch OD Rig Type: CME - 75 Sampling Method: 1.5 ft. by 2 inch Split Spoon	Northing: NM Easting: NM Casing Elevation: NM Borehole Depth: 21 ft bgs Surface Elevation: NM Descriptions By: Eric Epple	Well/Boring ID: AS-9 Client: BP West Coast Products, LLC. Location: WA-5544 19918 68th Avenue South Kent, Washington
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DEPTH	ELEVATION	Sample Run Number	Sample/Int/Type	Recovery (feet)	Blow Counts	N-Value	PID Headspace (ppm)	Analytical Sample	USCS Code	Geologic Column	Stratigraphic Description	Well/Boring Construction
-15	-15	2	15-16.5	1.5	2 3 7	10	8.0		SM		SILT with some fine SAND, no plasticity, stiff, wet.	
		3	18-19.5	1.5	5 5 3	8	40.7		SM		SAND with trace Silt, loose, fine grain, poorly graded, brown, wet.	
-20	-20	4	19.5-21.0	1.5	2 5 7	12	28.2		SM			
									CL		CLAY, medium to high plasticity, stiff, dark grey, moist to wet.	
									SM		Sandy SILT, no plasticity, stiff, wet.	

 <i>Infrastructure · Water · Environment · Buildings</i>	Remarks: AK = Air Knife bgs = below ground surface ft. = feet NM = Not Measured OD = Outer Diameter PVC = Polyvinyl Chloride
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Date Start/Finish: 11/16/2011 Drilling Company: Cascade Drilling LP. Driller's Name: Drilling Method: Hollow Stem Auger Auger Size: 8 inch OD Rig Type: CME - 75 Sampling Method: 1.5 ft. by 2 inch Split Spoon	Northing: NM Easting: NM Casing Elevation: NM Borehole Depth: 22.5 ft bgs Surface Elevation: NM Descriptions By: Eric Epple	Well/Boring ID: AS-10 Client: BP West Coast Products, LLC. Location: WA-5544 19918 68th Avenue South Kent, Washington
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DEPTH	ELEVATION	Sample Run Number	Sample/Int/Type	Recovery (feet)	Blow Counts	N-Value	PID Headspace (ppm)	Analytical Sample	USCS Code	Geologic Column	Stratigraphic Description	Well/Boring Construction
0	0										Asphalt and Aggregate	Concrete 2" Well Cap Sand Backfill
		AK	3-3.5	NA	AK	5.9			SM	SM	Sandy SILT with little Gravel (fine pebbles to medium cobbles), soft to stiff, no plasticity, grey, moist.	
-5	-5	AK	5-5.5	NA	AK	16.4			SM	SM	Sandy SILT with some Clay and little Gravel (fine pebbles to medium cobbles), soft to stiff, no plasticity, grey, moist.	Neat Cement
		AK	7-7.5	NA	AK	1116			SM	SM	Sandy SILT with some Clay and little Gravel (fine pebbles to medium cobbles), soft to stiff, no plasticity, grey, moist.	
-10	-10	1	10-11.5	1.5	2 1 1	2	315		ML	ML	SILT with trace Clay and fine Sand, no plasticity, very soft, grey, wet.	2" Schedule 80 PVC Riser Hydrated Bentonite Chips

 <i>Infrastructure · Water · Environment · Buildings</i>	Remarks: AK = Air Knife bgs = below ground surface ft. = feet NM = Not Measured OD = Outer Diameter PVC = Polyvinyl Chloride
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Date Start/Finish: 11/16/2011 Drilling Company: Cascade Drilling LP. Driller's Name: Drilling Method: Hollow Stem Auger Auger Size: 8 inch OD Rig Type: CME - 75 Sampling Method: 1.5 ft. by 2 inch Split Spoon	Northing: NM Easting: NM Casing Elevation: NM Borehole Depth: 22.5 ft bgs Surface Elevation: NM Descriptions By: Eric Epple	Well/Boring ID: AS-10 Client: BP West Coast Products, LLC. Location: WA-5544 19918 68th Avenue South Kent, Washington
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DEPTH	ELEVATION	Sample Run Number	Sample/Int/Type	Recovery (feet)	Blow Counts	N-Value	PID Headspace (ppm)	Analytical Sample	USCS Code	Geologic Column	Stratigraphic Description	Well/Boring Construction
15	-15	2	15-16.5	1.5	6 7 8	15	199		SM		Sandy SILT with some Clay, no plasticity, very soft, grey, wet.	
									SP		SAND, loose, fine to medium grain, medium grading, wet.	
		3	18-19.5	1.5	4 1 2	3	12.3		SM		Silty SAND, loose, fine grain, well graded, grey, wet.	
		4	19.5-21.0	1.5	2 2 3	5	1.9		CL		CLAY with trace Silt, medium to high plasticity, stiff, brown, moist.	
20	-20	5	21-22.5	1.5	2 3 3	6	1.7		SM		Silty SAND, dense, fine grain, dark grey, wet.	

 <i>Infrastructure · Water · Environment · Buildings</i>	Remarks: AK = Air Knife bgs = below ground surface ft. = feet NM = Not Measured OD = Outer Diameter PVC = Polyvinyl Chloride
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Date Start/Finish: 11/16/2011 Drilling Company: Cascade Drilling LP. Driller's Name: Drilling Method: Hollow Stem Auger Auger Size: 8 inch OD Rig Type: CME - 75 Sampling Method: 1.5 ft. by 2 inch Split Spoon	Northing: NM Easting: NM Casing Elevation: NM Borehole Depth: 24.5 ft bgs Surface Elevation: NM Descriptions By: Eric Epple	Well/Boring ID: AS-11 Client: BP West Coast Products, LLC. Location: WA-5544 19918 68th Avenue South Kent, Washington
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DEPTH	ELEVATION	Sample Run Number	Sample/Int/Type	Recovery (feet)	Blow Counts	N-Value	PID Headspace (ppm)	Analytical Sample	USCS Code	Geologic Column	Stratigraphic Description	Well/Boring Construction
0	0										Asphalt and Aggregate	
											Gravelly Silty SAND, dense, fine to coarse grain, well graded, brown, moist.	Concrete 2" Well Cap Sand Backfill
		AK 3- 3.5	NA	AK		0.1			CL		Sandy Gravelly CLAY with little Silt, stiff, low to medium plasticity, dark brown, damp.	
-5	-5	AK 5- 5.5	NA	AK		0.5			CL		Silty CLAY with little Gravel and Sand, stiff, medium to high plasticity, brown, damp.	Neat Cement
		AK 7- 7.5	NA	AK		0.0			CL		Silty CLAY with little Gravel and Sand, stiff, medium to high plasticity, brown, damp.	
-10	-10	1 10- 11.5	1.5	3 1 1	2	0.9			ML		SILT with trace Sand and Clay, very soft to soft, dark grey, moist to wet.	2" Schedule 80 PVC Riser Hydrated Bentonite Chips

 <i>Infrastructure · Water · Environment · Buildings</i>	Remarks: AK = Air Knife bgs = below ground surface ft. = feet NM = Not Measured OD = Outer Diameter PVC = Polyvinyl Chloride
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Date Start/Finish: 11/16/2011 Drilling Company: Cascade Drilling LP. Driller's Name: Drilling Method: Hollow Stem Auger Auger Size: 8 inch OD Rig Type: CME - 75 Sampling Method: 1.5 ft. by 2 inch Split Spoon	Northing: NM Easting: NM Casing Elevation: NM Borehole Depth: 24.5 ft bgs Surface Elevation: NM Descriptions By: Eric Epple	Well/Boring ID: AS-11 Client: BP West Coast Products, LLC. Location: WA-5544 19918 68th Avenue South Kent, Washington
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DEPTH	ELEVATION	Sample Run Number	Sample/Int/Type	Recovery (feet)	Blow Counts	N-Value	PID Headspace (ppm)	Analytical Sample	USCS Code	Geologic Column	Stratigraphic Description	Well/Boring Construction
-15	-15	2	15-16.5	1.5	5 7 10	17	0.9		ML		SILT with trace Sand and Clay, very soft to soft, dark grey, moist to wet.	<p>Hydrated Bentonite Chips</p> <p>2" Schedule 80 PVC Riser</p> <p>#2/12 Sand</p> <p>2" Stainless Steel 0.020" Slotted Screen</p> <p>Backfill</p>
									SM		Silty SAND, loose, fine to medium grain, medium grading, brown, wet.	
-20	-20	3	20-21.5	1.5	1 3 3	6	0.0		CL		CLAY, very high plasticity, moist.	
		4	21.5-23	1.5	3 7 7	14	0.2		SM		Silty SAND, loose, fine grain, poorly graded, dark grey, wet.	
		5	23-24.5	1.5	3 2 3	5	0.3					

<p>ARCADIS Infrastructure · Water · Environment · Buildings</p>	Remarks: AK = Air Knife bgs = below ground surface ft. = feet NM = Not Measured OD = Outer Diameter PVC = Polyvinyl Chloride
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Appendix B

Design Calculations

**Remediation Design Calculations
For Soil Vapor Extraction and Air Sparge System**

Prepared for:

Remedial Action Plan
Former BP Station No. 5544
19918 68th Avenue South
Kent, Washington

Prepared by:

ARCADIS
2300 Eastlake Avenue East, Suite 100
Seattle, Washington

April 20, 2012

AIR SPARGE (AS)

Minimum Injection Pressure

(Air Sparging Design Paradigm)

Minimum Injection Pressure = (0.43) * (hydrostatic head) + [air entry pressure for the well annulus packing material + air entry pressure for the formation (sand and gravel - assume 0.2 psig per *Air Sparging Design Paradigm*)]

Low groundwater

$$\text{Minimum Injection Pressure} = (0.43) * (21 \text{ feet} - 14.30 \text{ feet}) + (0.2 \text{ psi}) = \boxed{3.08 \text{ psi}}$$

High groundwater

$$\text{Maximum Injection Pressure} = (0.43) * (21 \text{ feet} - 5.56 \text{ feet}) + (0.3 \text{ psi}) = \boxed{6.84 \text{ psi}}$$

Maximum Injection Pressure

(US Army Corps of Engineers *In-Situ Air Sparging*)

$$\text{Pressure}_{\text{soil column}} = (\text{depth}_{\text{top well screen}}) * (G_s) * (1-n) * (\rho_{\text{H}_2\text{O}})$$

$$\text{Pressure}_{\text{H}_2\text{O column}} = (\text{depth}_{\text{top well screen}} - \text{DTW}) * (n) * (\rho_{\text{H}_2\text{O}})$$

G_s = Specific gravity of soil = 2.7 * (specific gravity of water @ 20 degrees Celsius)
 n = Porosity = 30 % = 0.30 (silty sand)
 $\text{depth}_{\text{top well screen}} = 21 \text{ ft}$
 $\rho_{\text{H}_2\text{O}}$ = density of water
DTW = Depth to water table = 5.56 ft

$$P_{\text{soil column}} = (21 \text{ ft}) * (2.7) * (1 - 0.30) * (62.4 \frac{\text{lb}_m}{\text{ft}^3}) = 2476.6 \frac{\text{lb}_m}{\text{ft}^2} = 17.08 \text{ psi}$$

$$P_{\text{H}_2\text{O column}} = (21 \text{ ft} - 5.56) * (0.30) * (62.4 \frac{\text{lb}_m}{\text{ft}^3}) = 289.03 \frac{\text{lb}_m}{\text{ft}^2} = 2 \text{ psi}$$

$$\text{Total Overburden Pressure} = P_{\text{soil column}} + P_{\text{H}_2\text{O column}} = 17.08 \text{ psi} + 2 \text{ psi} = 19.08 \text{ psi}$$

Air Sparge design paradigm suggests a range of: $P_{\text{Injection}} = 0.6 * (\text{Total Overburden Pressure})$ to $P_{\text{Injection}} = 0.8 * (\text{Total Overburden Pressure})$

$$P_{\text{Injection}} = 0.6 * (\text{Total Overburden Pressure}) = 0.6 * (19.08 \text{ psi}) = \boxed{11.45 \text{ psi}}$$

$$P_{\text{Injection}} = 0.8 * (\text{Total Overburden Pressure}) = 0.8 * (19.08 \text{ psi}) = \boxed{15.26 \text{ psi}}$$

Air Flow

There are 4 proposed AS wells. The AS wells will be divided up into 2 zones with 2 wells each. Therefore, the total required flow = 2 * (15 scfm) = 30 scfm.

The AS compressor must be capable of producing 30 scfm at a pressure between approximately 3 to 15 psi at the well head, and designed for three phase electrical

service. Air flow will be 15 scfm at each well, with a maximum injection pressure of 15 psi.

Frictional Pressure Loss

Based on a maximum flow rate of 30 scfm and a pipe diameter of 1 inches, the pressure loss due to friction is anticipated to be 0.038 inches H₂O (0.0014 psi) per foot of pipe. An extra 5 feet of pipe length per 90 degree elbow was also figured into the pressure loss calculation. An estimated 254 feet of maximum pipe run per zone and 11 elbows results in a maximum pressure loss of 11.7 in H₂O. This converts to 0.43 psi.

The friction loss was estimated based on Figure 5-15 in US Army Corps of Engineers Manual EM 1110-1-4001, Engineering and Design - Soil Vapor Extraction and Bioventing (2002).