CLEANUP ACTION PLAN

Fred Meyer Stores, Inc. - Port Orchard Site
1900 SE Sedgewick Road
Port Orchard, Washington
Ecology Site ID #96424236 (formerly J5E03)

Submitted to:

Washington Department of Ecology
Northwest Regional Office - Voluntary Cleanup Program
3190 160th Avenue SE
Bellevue, Washington 98008

Submitted by:

AMEC Earth & Environmental, Inc.
7376 SW Durham Road
Portland, Oregon 97224

9-61M-102820

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Mr. Russ Olsen, MPA
Voluntary Cleanup Program Unit Manager
State of Washington Department of Ecology, NW Regional Office
3190 160th Avenue SE
Bellevue, Washington 98008

Dear Mr. Olsen:

Re: Cleanup Action Plan
Fred Meyer Property
1900 SE Sedgewick Road, Port Orchard, Washington
Ecology Site ID #2555

On behalf of Fred Meyer Stores, Inc. (Fred Meyer), AMEC Earth & Environmental, Inc. (AMEC) has prepared this Cleanup Action Plan for the above-referenced property located in Port Orchard, Washington (Site). This report has been prepared to:

- Evaluate suitable cleanup action alternatives for treating residual petroleum-related contamination in subsurface soil and groundwater beneath the Site.
- Identify the most feasible cleanup action and present an approach for decreasing residual concentrations of petroleum-impacted soil and groundwater to below cleanup levels considered safe for unrestricted land use (i.e., Method A).

The following general recommendations are based upon AMEC's review of available historical soil and groundwater investigation datasets, evaluation of the current Site conditions, a conceptual site model (CSM) exposure pathway assessment, and screening of cleanup action alternatives:

- Continued operation of the AS/SVE system is recommended until concentrations of contaminants of potential concern (COPCs) remaining in soil and groundwater beneath the Site are reduced to levels less than the Model Toxics Control Act (MTCA) Method A cleanup standards.

Sincerely,

AMEC Earth & Environmental, Inc.

Heidi Rice, PE
Environmental Engineer

Kurt Harrington, PE, PMP
Project Manager

Attachments

c: Mr. Daniel Hermann, Fred Meyer Stores, Inc.

AMEC Earth & Environmental, Inc.
7376 SW Durham Road
Portland, Oregon
USA 97224
Tel +1 (503) 639-3400
Fax +1 (503) 620-7892

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1.0 INTRODUCTION

AMEC Earth & Environmental, Inc. (AMEC) has prepared this Cleanup Action Plan (CAP) behalf of Fred Meyer Stores, Inc. (Fred Meyer) for the Fred Meyer-Port Orchard fueling station located at the southeastern corner of the intersection of SE Sedgewick Road and Bethel Road SE in Port Orchard, Washington (Figure 1). A leak from an underground storage tank (UST) system at a former Texaco-branded service station which operated at the subject property until 1988 is allegedly responsible for petroleum hydrocarbon impacts to soil and groundwater at the subject property and adjacent parcels located to the southwest, and are collectively referred to as the Site. This document has been prepared in general accordance with Model Toxics Control Act (MTCA) Cleanup Regulations Chapter 173-340 of the Washington Administrative Codes (WAC), under the Voluntary Cleanup Program. This document is intended to fulfill Ecology’s request for a Feasibility Study (FS) deliverable dated February 26, 2010.

1.1 Purpose

The purpose of this CAP is to present the approach for the remediation of petroleum contaminated soil and groundwater. Remedial measures for the impacted media were evaluated for the most feasible remedy. Following a brief evaluation of suitable remedies, the recommended remedial action is described in detail. Work activities described in this CAP were designed to reduce human health and ecological risks associated with the petroleum contaminated soil and groundwater to within acceptable levels and allow for future uses of the Site without further environmental concerns.

1.2 Report Organization

This document presents a brief background of the Site, findings of the remedial investigation (RI), remedial alternatives considered, remedial action objectives (RAOs) and performance criteria, implementation of the selected alternative, and monitoring. Individual sections of the report are as follows:

- Section 1 - Introduction
- Section 2 - Summary of Site Conditions
- Section 3 - Cleanup Requirements
- Section 4 - Remedial Alternatives Considered
- Section 5 - Selected Site Cleanup Alternatives
- Section 6 - Cleanup Action Implementation and Performance Monitoring
- Section 7 - Implementation Schedule

2.0 SUMMARY OF SITE CONDITIONS

This section presents a summary of the Site conditions as described in the RI Report, (AMEC, 2009a).

2.1 Subject Property and Site Description

The Fred Meyer subject property is located at the southeast corner (Pad C-currently a Fred Meyer branded fuel station) of the intersection of Sedgewick Road S.E. and Bethel Road S.E. in Port Orchard, Washington (Figure 1). The Leaking Underground Storage Tank (LUST) file number assigned by the Washington Department of Ecology (Ecology) for the Site is #96424236.

For the purposes of this report, the subject property consists of an approximately 0.58-acre portion (designated “Pad C” by Fred Meyer) of a larger Fred Meyer Store. The subject property is bounded by the northwest entrance driveway to Fred Meyer Store to the south, the Bethel Road SE and SE Sedgewick Road right-of-ways (ROWs) to the west and north, respectively and by the Fred Meyer Store parking lot to the east (Figure 2). The subject property is located in the N.W. 1/4 of the N.W. 1/4 of Section 12, Township 23 North, Range 1 East, Willamette Meridian.

The subject property and full lateral extent of historical petroleum hydrocarbon impacts to soil and groundwater encountered at the property and adjacent parcels located to the southwest, and are collectively referred to as the Site. The Site is characterized by residential and commercial properties, open fields and wooded areas. A BP branded gasoline service station is located across SE Sedgewick Road to the north of the subject property and a Chevron branded service station is located to the northwest across the intersection of SE Sedgewick Road and Bethel Road SE.

2.2 Site Background

The Site has been under investigation and remediation for soil and groundwater contamination since June 1990, at which time Ecology detected elevated levels of gasoline constituents in domestic drinking water wells located downgradient of the subject property. The soil and groundwater contamination was attributed to a historic release from an underground storage tank (UST) system associated with a Texaco service station formerly located on the subject property. In August 1991, Ecology conducted a groundwater contamination assessment at the subject property and adjacent properties to the south. The assessment included the sampling of domestic drinking water wells in the Site and the installation of eight monitoring wells (MW-1D, MW-1S, MW-2D, MW-2S, MW-101, MW-102, MW-103, and MW-104) to collect soil and groundwater samples. Assessment results indicated benzene, toluene, ethylbenzene, and total xylenes (BTEX) and gasoline-range organics (GRO) in soil and groundwater at concentrations above MTCA Method A or B cleanup levels. Benzene and total xylenes were also detected at elevated concentrations in two nearby domestic drinking water wells. Ecology reported the presence of light non-aqueous phase liquid (LNAPL) in on-Site monitoring wells. The likely source of the groundwater contamination plume was identified as a historical release from a UST system associated with a Texaco branded service station formerly located on the subject property.

An on-Site remediation system installed by Ecology operated from July 1995 through April 1998 (Ecology, 1998). The remediation system consisted of a LNAPL recovery system, a soil vapor extraction (SVE) system, an air-sparging (AS) unit, an off-gas vapor treatment unit, and a mechanism to inject hydrogen peroxide into groundwater. Ecology reported its remediation system recovered a total of approximately 19 gallons of LNAPL and approximately 4,600 pounds of petroleum hydrocarbon vapors from the Site's subsurface between 1995 and 1998. All LNAPL reportedly had been removed prior to system(s) deactivation in April 1998. Ecology stated that the groundwater plume was restricted to the subject property in the vicinity of monitoring well MW-103 and that gasoline in groundwater at the domestic drinking water wells had decreased steadily since initiation of the remediation system.

GN Northern conducted a Phase I Environmental Site Assessment (ESA) of the subject and surrounding properties in October 1998. Based on its results, GN Northern conducted a limited Phase II ESA in January 1999, to assess the potential for subsurface contamination in the vicinity of suspected heating oil UST locations at the subject property. Phase II ESA results indicated that gasoline remained in soils and groundwater in the vicinity of the former Texaco service station at concentrations exceeding MTCA Method A or B cleanup standards. A soil and groundwater assessment was conducted southeast from the subject property, in the vicinity of the suspected heating oil UST locations, revealed evidence of minor soil or groundwater contamination, none of which appeared to extend on to the Site. At the request of Fred Meyer, AMEC conducted a subsurface assessment at the subject property in the vicinity of the former Texaco service station in June 1999, during the initial stages of the construction of a new Fred Meyer store. The assessment involved the completion of six direct-push soil borings (BH-20 through BH-25), six vapor test wells (VP-1 through VP-6), and four groundwater monitoring wells (MW-105 through MW-108). Following feasibility testing, AMEC designed and assisted in the installation of a new AS/SVE system, which was activated in March 2000 (AMEC, 2000a). During AMEC's initial Site visit in June 1999, approximately 1 liter of LNAPL as GRO was removed from monitoring well MW-103 by hand bailing. Measurable LNAPL was encountered in monitoring well MW-103 in August and November 1999, at thicknesses of 0.02 and

0.03 feet, respectively. An absorbent sock was installed in this well to remove remaining LNAPL.

From August 1999 through March 2000, three Ecology monitoring wells (MW-1-S, MW-1-D, and MW-104) were destroyed during construction activities on the subject property despite AMEC's attempts to protect and salvage the wells. In addition, AMEC decommissioned Ecology's remediation system in September 1999, and four Ecology AS wells (SP-1 through SP-4) in November 1999. From March through June 2001, three more monitoring wells (MW-106, MW-107, and MW-108) were destroyed during construction of the Fred Meyer retail fueling center and adjacent Bethel Road paving work. From June 2001 through September 2008, only monitoring wells MW-103 and MW-105 remained and were monitored as compliance points on a quarterly basis. In October 2008, four replacement groundwater monitoring wells (monitoring wells MW-108A, MW-109, MW-110, and MW-111) were installed to complete the Site's compliance monitoring point network (Figure 2).

The current *in-situ* AS/SVE remediation system at the subject property was installed from November 1, 1999 through January 26, 2000, and was activated on March 1, 2000. The system consists of 10 AS wells (AS-1 through AS-10), 5 new SVE wells (VES-1 through VES-5), and an aboveground compound. The in-place components of the system were installed throughout the area of expected soil and groundwater impact (the western portion of Pad C and the eastern edge of Bethel Road S.E.). Five of the AS wells and three of the SVE wells were installed vertically, with the remaining AS and SVE wells installed at an angle of approximately 45° from vertical (Figure 2). The aboveground compound controls and monitors all of the AS and SVE wells, the SVE air stream, and the SVE filter system. The SVE exhaust stream flows through a primary and secondary granular activated carbon (GAC) filter array prior to discharging into the atmosphere.

The near-surface soils in this vicinity generally consist of Vashon-age deposits. The hydrogeologic units typically consist of the shallow aquifer (Qvr), the Vashon till (Qvt) confining unit, and the Vashon aquifer (Qva). These units are commonly heterogeneous and locally discontinuous; Kahle (1998) provides the following descriptions and ranges of unit thickness typically found in areas of Kitsap County:

- Shallow aquifer (Qvr) – This discontinuous unconfined aquifer consists of sand, gravel, and silt and generally ranges from about 10 to 40 ft in thickness (with an average of 25 ft), where encountered. It is composed mostly of recessional outwash, but may include younger stream, beach, or landslide deposits.
- Vashon till confining unit (Qvt) – This low-permeability unit consists of compacted and poorly sorted silt, sand and gravel, although it may contain local water-bearing

lenses of sand and gravel. This unit generally ranges from about 10 to 100 ft in thickness, with an average encountered thickness of 45 ft.

- Vashon aquifer (Qva) – This aquifer consists of well-sorted sand or sand and gravel, with lenses of silt and clay. Most of the unit is unconfined; however, it is confined locally where it is fully saturated and overlain by till. The unit typically ranges from about 20 to 200 ft in thickness, with an average encountered thickness of about 100 ft. Most of the wells in the area tap this aquifer.

Shallow groundwater in the vicinity of the Site generally is encountered at depths of less than 30 feet below ground surface (bgs). Measurements conducted by AMEC at the Site from July 1999 through January 2010, indicate shallow groundwater fluctuates between 15 and 25 feet bgs. Groundwater flow at the Site is expected to be directed towards the southwest, towards an unnamed tributary of Blackjack Creek.

The hydraulic gradient observed between Site monitoring wells MW-109 and MW-111 is typically 0.10 vertical feet per lateral foot (ft/ft) based upon data collected in January 2010 (AMEC, 2010). The average hydraulic conductivity in the shallow fill varies between 0.04 and 100 ft/day (Thomas et. al. 1997).

2.3 Conceptual Site Model

The Conceptual Site Model (CSM) consists of potentially complete exposure routes for current receptors including the incidental ingestion of, dermal contact with, and/or inhalation of volatiles in affected soil or groundwater by construction/excavation workers identified as current or future potential receptors.

Soil

Cleanup Levels:

Groundwater at this Site has been impacted by the identified releases; therefore soil cleanup levels based on leaching (protection of groundwater) are appropriate. To establish soil concentrations protective of groundwater MTCA Method A cleanup levels were selected.

The Site does not meet the MTCA definition of an industrial property; therefore soil cleanup levels suitable for unrestricted land use will also need to be considered. For unrestricted land use, the soil cleanup level is based on the direct contact pathway and residential use. Again MTCA Method A levels were selected for this Site.

Points of Compliance:

The point of compliance based on the protection of groundwater is Site wide throughout the soil profile and may extend below the water table. For soil cleanup levels based on direct contact, the point of compliance is defined as throughout the Site from the ground surface to fifteen feet below the ground surface.

Groundwater

Cleanup Levels:

The groundwater at the Site is classified as potable to protect drinking water beneficial uses. Method A cleanup levels for potable groundwater were selected for this Site. Note: Method A groundwater cleanup levels will be protective of any other exposure pathway.

Point of Compliance:

The standard point of compliance for groundwater is throughout the Site from the uppermost level of the saturated zone extending vertically to the lowest depth which could potentially be affected.

Additional consideration to off-Site receptors was evaluated in November 1999 when utility cutoff collars were installed downgradient of the subject property, as described in the Environmental Activities during Sewer Line Construction report (AGRA 1999). Stormwater is collected through catch basins and piped into the municipal storm sewer located beneath SE Sedgewick and Bethel Road. Stormwater drainage on the roadway and sidewalk portions of the subject property is conveyed through pipes and/or ditch before entering a storm detention pond located south of the Site.

No known areas of particular environmental value, such as wetlands or critical habitat, are present at the Site. The simplified terrestrial ecological evaluation concluded for the Site indicated that no adverse affects are realized to the off-Site habitat quality or other urban wildlife species.

A description of the CSM and receptors potentially affected by residual contamination is provided in the RI Report.

3.0 CLEANUP REQUIREMENTS

This section presents a summary of the Site conditions as described in the RI Report, (AMEC 2010). The MTCA cleanup regulations provide that a cleanup action must comply with cleanup levels for identified COPCs, points of compliance, and applicable or regulatory requirements, based on federal and state laws (WAC 173-340-710). Method A criteria was selected since the Site was subject to relatively routine cleanup actions based upon relatively few hazardous substances. The Site cleanup levels, points of compliance, and the applicable regulatory requirements for the selected cleanup remedy are briefly summarized in the following sections.

3.1 Human Health and Environmental Concerns

The COPCs at the Site may present a hazard to construction workers who may come into contact with the petroleum-impacted soil and/or groundwater during any deep earth-disturbing activity (i.e., greater than 15 feet bgs - this is not the highest designated use see comment above) or residential users of the groundwater supplied from the Site. Although there aren't any future development activities anticipated at the subject property, both of these activities could expose people to unsafe levels of the Site contaminants.

3.2 Indicator Hazardous Substances

Under MTCA, "indicator hazardous substances" means the subset of hazardous substances present at a Site for monitoring and analysis during any phase of remedial action for the purpose of characterizing the Site or establishing cleanup requirements for that Site. Ecology may eliminate consideration of those hazardous substances that contribute a small percentage of the overall threat to human health and the environment at a Site that is contaminated with a relatively large number of COPCs (WAC 173-340-703). The remaining COPCs can then serve as indicator hazardous substances for purposes of defining Site cleanup requirements.

GRO and related BTEX compounds are the primary COPCs at the Site. Low levels of DRO were detected in groundwater sampled from several borings, but these detections appear to be overlap of weathered GRO into the diesel range. The gasoline additives EDB, EDC, and MTBE were not detected in groundwater collected from the source area or at locations downgradient and cross gradient from the source area, however the laboratory detection limits were not sufficient to determine if EDB is present or not at the Site. EDB will have to be monitored during compliance monitoring to make a final determination. Naphthalene has not been detected in groundwater at concentrations exceeding the MTCA Method A cleanup level since 2002. In general, GRO and BTEX have been used as the indicator hazardous substances in subsurface soil and groundwater beneath the Site. Additional compliance monitoring may be required for DRO and other constituents, consistent with the monitoring requirements listed in DOE Table 830-1.

3.3 Cleanup Levels

Cleanup standards consist of 1) cleanup levels that are protective of human health and the environment; and 2) the point of compliance at which the cleanup levels must be met. To eliminate receptor exposure to COPCs during Site development activities and to protect the soil and groundwater, the cleanup levels under MTCA Method A for unrestricted use were selected for the Site COPCs.

The primary COPCs identified at the Site include GRO and BTEX. While these contaminants may not represent the total hazard from this Site, their treatment to MTCA Method A cleanup standards will include the removal of the other petroleum-related compounds. Historical and current chemical analytical test results for soil and groundwater are summarized in the RI Report (AMEC, 2010). Table 1 presents the list of COPCs and the associated MTCA Method A cleanup levels.

3.4 Points of Compliance

Under MTCA, the point of compliance is the point or location on a Site where the cleanup levels must be attained. In accordance with WAC 173-340-740(6)(d) and WAC 173-340-7490(4)(b), the standard point of compliance for the soil and groundwater cleanup levels shown in Table 1. As indicated above for soil, the point of compliance based on the protection of groundwater (leaching) is Site-wide throughout the soil profile and may extend below the water table. For soil cleanup levels based on direct contact (both human and ecologic species), the point of compliance is defined as throughout the Site from the ground surface to 15 feet below the ground surface. The most stringent level is used. In this case the Method A level would be throughout the soil profile.

For groundwater the standard point of compliance is throughout the Site from the uppermost level of the saturated zone extending vertically to the lowest depth which could potentially be affected. The extent of the groundwater plume has been reduced to an area limited to the northwest corner of the property where concentrations or GRO and BTEX in groundwater are generally less than MTCA Method A cleanup levels. The periodic detections of GRO and BTEX compounds (particularly benzene) at concentrations exceeding the MTCA Method A cleanup levels are attributed to fluctuations in the water table and subsequent remobilization of residual contamination trapped in soil at depths at or near the vadose zone/groundwater interface. Downgradient monitoring wells MW-108A and MW-111, located within the Bethel Road SE ROW, serve as off-property monitoring points.

3.5 Remedial Action Objectives

The overall remedial action objective (RAO) is to protect human health and the environment. RAOs form the basis for developing and evaluating remedial actions because the selected remedy must meet Site-specific RAOs.

The purpose of the following abbreviated FS portion of the CAP is to evaluate cleanup alternatives and technologies according to MTCA rules contained in WAC 173-340-360. Included in MTCA are minimum criteria for cleanup alternatives, preference for permanent cleanup alternative, and the process for making these decisions.

The RAOs consist of:

- Protect current and future residential exposure to soil contaminants.
- Protect current and future beneficial use of groundwater, by attaining groundwater cleanup levels.
- Attain cleanup levels and within a reasonable time frame.
- Continue to operate to implement the interim remedial action measure to meet the cleanup levels indicated or until interim remedial action measure (IRAM) is no longer effectively achieving progress towards cleanup and final selected remedial action is approved and implemented.
- Attain TPH cleanup levels in soil and groundwater at the Site.

The remedial objectives can be achieved by eliminating or mitigating exposure pathways to humans and by eliminating or reducing petroleum hydrocarbon concentrations in Site soil and groundwater.

3.6 Applicable Regulatory Requirements

In addition to the cleanup standards developed through the MTCA process, other regulatory requirements must be considered in the selection and implementation of the cleanup action. MTCA requires the cleanup standards to be “at least as stringent as all applicable state and federal laws” [WAC 173-340-700(6)(a)]. Besides establishing minimum requirements for cleanup standards, applicable federal, state, and local laws and ordinances may also impose certain technical and procedural requirements for performing cleanup actions. These requirements are described in WAC 173-340-710.

The following regulations apply to the soil and groundwater media at the Site, the health and safety of workers conducting cleanup actions at the Site, and the wastes generated by the cleanup action:

- The final disposition of the petroleum-impacted soil originating from the Site will be evaluated using Ecology's Guidance for Remediation of Petroleum Contaminated Soils under WAC 173-340 and -360 (1995).
- The Department of Labor has published final rules (29 CFR Part 1910.120, March 6, 1990) that amend the existing Occupational Safety and Health Administration (OSHA) standards for hazardous waste operations and emergency response. Within the State of Washington, these requirements are addressed in WAC 296-843, Hazardous Waste Operations. These regulations apply to the activities to be performed at this Site as remediation, or cleanup, under the Federal Resource Conservation and Recovery Act of 1976 and/or the MTCA. The protocols described in a health and safety plan are designed to ensure compliance with state and federal regulations governing worker safety on hazardous waste sites, and the protection monitoring requirements of the MTCA found at WAC Chapter 173-340-410.
- The Port Orchard Municipal Code Title 16, "Land Use Regulatory Code" is required for any development and building permitting at the Site.
- Water Quality - The federal Water Pollution Control Act (a.k.a., the Clean Water Act [CWA]) created programs for permitting wastewater discharges to surface water or to publicly owned treatment works (POTWs). Related Washington regulations are found in WAC 173-220. Discharge of wastewater, such as condensate from a SVE system, to a POTW is considered an off-Site activity. Remedial responses including discharges to a POTW must comply with National Pretreatment Program regulations as well as local POTW requirements. Recovered groundwater is not currently discharged to the local POTW, but it is considered later in this report as a potential remedial technology component of remedial action alternatives. Through the Underground Injection Control (UIC) program, Safe Drinking Water regulations also control the discharge of water, such as treatment solutions, into aquifers. Washington UIC regulations are found in WAC 173-218.
- Air Quality - Applicable for Site excavation work that could generate dust. Controls would need to be in place during construction (e.g., wetting or covering exposed soils and stockpiles), as necessary, to meet the substantive restrictions on off-Site transport of airborne particulates by the local agency. In addition, regardless of whether any VOCs are emitted during treatment, air quality must be considered in accordance with the 1990 Amendments to the Federal Clean Air Act 40 CFR part 70 and Washington Clean Air Act contained in WAC Chapter 173-401.
- General Environment - SEPA applies to cleanup actions that may affect the environment. MTCA cleanup actions are not exempt from SEPA procedures and Ecology is required to use a SEPA checklist to determine if a proposed cleanup

action will or will not have a significant adverse impact on the environment. If Ecology determines that there is no impact, Ecology issues a Determination of Nonsignificance (DNS) or a mitigated DNS with conditions.

- Monitoring Well Network - Ecology enforces rules for the construction, maintenance, and abandonment of monitoring and other types of wells in Washington (WAC 173-160), including injection wells.

4.0 REMEDIAL ALTERNATIVES CONSIDERED

This section summarizes the cleanup technologies and alternatives considered, and the basis for selection of the site-wide remedy. **For the purposes of evaluating the Site-wide remedial strategy, each of the technologies were considered individually, assuming full-scale implementation of the remedial alternative in year 1998; since that was the time period in which the original remediation system was destroyed and the magnitude and extent of impacted soil and groundwater defined.** It should be noted, however, that an IRAM system, consisting of an AS and SVE system has been operating periodically at the Site since year 2000. Figures 3 and 4 depict the extent of the groundwater and soil contamination during the time-frame that remedial action was implemented at the Site, as a basis for comparison between all remedial technologies.

Several remedial alternatives are possible for soil treatment and/or groundwater treatment at the Site. Specific technologies identified for impacted soil include the following:

- Intrinsic bioremediation (monitored natural attenuation);
- Low-permeability cap;
- Excavation and landfill disposal;
- Excavation and volatilization treatment;
- Excavation and biological treatment;
- Excavation and thermal treatment;
- Excavation and soil washing;
- Excavation and chemical treatment;
- In-situ soil vapor extraction (SVE);
- In-situ biological treatment;
- In-situ recirculating bioremediation wells;
- In-situ soil flushing;

- In-situ thermally enhanced sparging; and
- In-situ chemical treatment.

The technologies identified for initial screening evaluation for groundwater consisted of the following:

- Intrinsic bioremediation (monitored natural attenuation);
- Institutional controls and groundwater monitoring;
- Containment - vertical barriers;
- Groundwater recovery and treatment using horizontal well(s);
- Groundwater recovery and treatment using trench(es);
- Dual phase extraction;
- Biological treatment using ORC® to increase dissolved oxygen (DO);
- In-situ air sparging (AS);
- In-situ steam flushing;
- In-situ passive treatment - reactive walls; and
- In-situ chemical oxidation (ISCO) treatment.

Other secondary technologies and engineering controls, such as utility cut-off collars, were evaluated for the Site to specifically address secondary impacts related to soil and groundwater treatment. Several of the technologies identified for soil, groundwater, and specific engineering controls are not suitable to meet the Site-specific RAO's. Also, not enough Site characterization information was available to evaluate all of the above technologies. Therefore, these technologies were not included in the next steps required to identify a cleanup alternative for the Site. The following section describes site-specific data gaps and also describes additional details of technology retention.

4.1 Data Gaps

Data gaps exist which may be a limiting factor in evaluation of remedial technologies. The following are examples of data gaps specific to the Site:

- The contaminant release mechanism from the UST system is unknown (i.e., quantity, time, and duration).
- Density and mobility of free product that was known to be present at the Site in the 1990's.

- Soil parameters that would affect bioremediation or chemical injection, such as soil oxidant demand, presence of petroleum degrading colonies, and mineral content of soil.
- Aquifer parameters that would affect pumping or injection-related technologies, such as hydraulic conductivity.

Consideration of these data gaps were used in the selection and screening of the cleanup action alternatives presented herein. Subsequently, the removal of the contaminant source (i.e., former Texaco UST system and LNAPL) was considered paramount in restoring subsurface conditions to levels protective of human health and the environment. In addition, the frequency and duration of post-cleanup action monitored natural attenuation are based on experience and professional judgment. This effort attempted to strike a balance between reasonably conservative and optimistic assumptions.

4.2 Identification and Development of Cleanup Alternatives

Cleanup technologies identified to address the site-specific RAO identified above are presented in Table 2. Each of the technologies identified in Table 2 were qualitatively assessed for effectiveness, implementability, and reasonableness of cost to identify which of the technologies to retain for further analysis. These preliminary screening factors are described in Appendix A. Based on specific advantages, the following technologies were retained:

General Response Actions

- No Action
- Activity Restrictions
- Utility Cut-off collars

Petroleum Free Product

- Product Skimming
- Excavation

Petroleum Impacted Soil

- Excavation
- Soil Vapor Extraction (SVE)

Petroleum Contaminated Groundwater

- Groundwater Extraction with Ex-Situ Treatment (GWE)
- Air Sparging (AS) with SVE
- Monitored Natural Attenuation (MNA)
- Oxidant Injection with Iron Activated Sodium Persulfate

The retained technologies were assembled into three separate cleanup action alternatives (Alternative No. 2 through No. 4) that include combinations of the retained technologies. Alternative No. 1 (No Action) was included for purposes of comparison and does not constitute a cleanup action to unrestricted MTCA Method A cleanup levels. Cleanup action alternatives were identified by arranging the retained components into sequential treatment approaches designed to achieve cleanup standards. In general, the order of selected alternatives ranks from least likely to meet the site-specific RAO within a reasonable time frame (i.e., Alternative No. 1 - No Action) to most likely and permanent action (i.e., Alternative No. 4 - Physical Destruction of Groundwater COPCs and Removal of All Accessible Petroleum-Impacted Soil). Table 3 provides descriptions of the cleanup action alternatives, and provides additional information regarding design assumptions, additional unknowns that may affect the design assumptions, and advantages and disadvantages associated with each alternative. In accordance with WAC 173-340-350(8)(b)(ii)(A) the cleanup action selection process (i.e., feasibility study) includes at least one permanent cleanup action alternative to serve as a baseline against which other alternatives are evaluated for the purposes of determining whether the cleanup action selected is permanent to the maximum extent practicable. Alternative No. 4 was identified as the “Most Practicable Permanent Cleanup Action”.

An unknown associated with each cleanup action alternative is the relative success, duration, and frequency of compliance monitoring, if applicable, following implementation of these baseline cleanup action components. During compliance monitoring, additional reductions of COPC concentrations may occur through natural processes such as biodegradation, diffusion, dispersion, hydrolysis, and sorption. Natural attenuation can be an effective long-term method for mitigating risks. Typical goals for MNA are demonstrated decreases in contaminant mass, toxicity, mobility, volume, or concentrations. Progress toward natural attenuation is typically demonstrated through long-term groundwater quality monitoring. Although a formal MNA monitoring program has not been included as a component to many of the alternatives evaluated, natural attenuation may be occurring throughout the period of compliance monitoring indicated for several of the remedial alternatives. The actual occurrence of natural attenuation required at the Site will have an impact on the costs.

Costs were developed for the Site, based on the design assumptions listed in Table 3. A summary of the cost breakdown for each of the remedial alternatives is presented in Appendix B. The net present value of future costs associated with the various treatment system operation/maintenance and MNA durations was calculated assuming an interest rate of 2% after inflation.

4.2.1 Alternative 1 - No Action (Hypothetical)

Alternative 1 consists of no action. The assumptions for Alternative one include installation of institutional controls to restrict current/future groundwater use and excavation activities in the Site, as well as to decommission the existing monitoring well network at the Site (Figure 2).

4.2.2 Alternative 2 - SVE and GWE (Hypothetical)

An SVE system would be installed that includes the installation of up to six, 10-foot deep vertical SVE wells throughout the impacted vadose zone area (Figure 4). Two skimmer pumps would be installed at the Site for free product recovery. The SVE system design is based on air flow rates of approximately 60 cubic feet per minute (cfm) at an applied vacuum pressure of 40 inches of water. For groundwater treatment the alternative considers the installation of four 4-inch diameter GWE wells along the downgradient perimeter of the groundwater plume producing a total maximum extracted flow rate of 16 gallons per minute (gpm). Conveyance piping would be trenched up to 300 feet (in total length) to route the lines to a common treatment compound. Extracted soil vapor and groundwater would be treated through adsorption using GAC vessels (i.e., four-1,000-pound adsorbers for recovered liquids and two 1,000-pound GAC adsorbers for recovered vapors). The treated groundwater would be discharged to the municipal storm system under an approved NPDES discharge permit.

Alternative 2 assumes that GWE would be performed for a 10-year period with quarterly groundwater quality monitoring, followed by another 10 years of semiannual groundwater quality monitoring before groundwater cleanup levels are achieved. Compliance monitoring would be conducted at the Site for an additional 2 years at 6 wells to verify cleanup levels were achieved at the Site and one round of soil confirmation sampling, followed by system decommissioning.

4.2.3 Alternative 3 - AS/SVE (Implemented)

One components of Alternative 3 is the same as Alternative 2, the installation of two skimmer pumps for free product removal. In addition, bentonite utility cut-off walls would be installed at up to four locations adjacent to the subject property to reduce the potential for constituent migration within shallow perched groundwater along the existing utility corridors. The petroleum impacted soil and groundwater would be treated through the installation and operation of an AS and SVE. The AS and SVE system includes installation of up to 17, 25-foot deep AS wells and six 10-foot deep vertical SVE wells throughout the impacted soil (Figure 4) and groundwater (Figure 3) areas. The system would be capable of an injection flow rate of approximately 5 cfm per AS well at up to 10 pounds per square inch of pressure. The SVE system design is based on air flow rates of approximately 60 cfm at an applied vacuum pressure of 40 in. (water). Conveyance piping would be trenched up to 300 feet (in total length) to route the lines to a common treatment compound. SVE vapors would be treated through GAC vessels for the duration of the system operation, anticipated to be up to 10 years to meet the treatment requirements, with two additional years of compliance monitoring. One round of soil confirmation sampling would be performed, followed by system decommissioning.

4.2.4 Alternative 4 - Excavation of Hot Spot Soils and ISCO of Impacted Groundwater (Hypothetical)

One component of Alternative 4 is the same as Alternative 3; the implementation of bentonite utility cut-off walls at up to four locations adjacent to the subject property to reduce the potential for constituent migration within shallow perched groundwater along the existing utility corridors during remedy implementation. Soil with elevated levels of petroleum hydrocarbons near the former Texaco UST system would be addressed through excavation and off-site disposal. The petroleum-impacted groundwater area shown in Figure 3 would be treated via the direct injection of a strong chemical oxidant through an injection network of up to 24 locations on 16-foot centers to depths ranging from 20 to 25 feet bgs.

Oxidant injection assumes roughly 23,000 pounds of iron activated sodium persulfate during two primary rounds and one polish injection event through permanent wells. Monitoring events would be performed at the Site after 30 and 45 days following the two primary events and after 45 and 60 days following the polish round. Following excavation and treatment, groundwater would be monitored at the Site for two years quarterly. Alternative 4 is based on the assumption that the monitoring well network would be decommissioned after two years of compliance monitoring and a final round of soil confirmation sampling.

4.3 Detailed Evaluation of Cleanup Action Alternatives

This section presents a detailed analysis of selected remedial action alternatives for the Site. Each potential remedial action alternative is evaluated according to the requirements of using permanent solutions to the maximum extent practicable (WAC 173-340-360(5)), providing for a reasonable restoration time frame (WAC 173-340-360(6)), and considering public concerns raised during public comment on the cleanup action plan (WAC 173-340-360 (10) through (13)).

4.3.1 Evaluation Criteria

The evaluation criteria consist of MTCA threshold requirements listed in WAC 173-340(2)(a) and (b)), as well as several criteria for disproportionate cost analysis, described in the following sections.

Threshold Requirements

MTCA cleanup alternatives must meet four minimum requirements. A cleanup action must:

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

All of the soil and groundwater alternatives evaluated in this report have been developed to meet these four minimum requirements.

Other MTCA Requirements

After meeting the minimum requirements, MTCA requires that a cleanup action alternative meet three other requirements:

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

MTCA requires permanent cleanup actions to the maximum extent practicable. To determine if a cleanup action uses permanent solutions to the maximum extent practicable alternatives are evaluated using a “disproportionate cost analysis” as specified in WAC 173-340-360(3)(e).

MTCA Disproportionate Cost Analysis

The evaluation of the alternatives was based on MTCA's disproportionate cost analysis (DCA) that identifies which of the alternatives meeting MTCA threshold requirements is permanent to the maximum extent practicable. This analysis compares the relative benefits and costs of cleanup alternatives in selecting the alternative whose incremental cost is not disproportionate to the incremental benefits.

The seven criteria used in the DCA, as specified in WAC 173-340-360(2) and (3), are:

- Protectiveness
- Permanence
- Cost
- Long-term effectiveness
- Short-term risk management
- Implementability
- Consideration of public concerns

Costs are disproportionate to benefits if the incremental costs of a more-permanent alternative is greater than the incremental degree of benefits achieved by that alternative over that of lower cost alternatives (WAC 173-340(3)(e)(i)).

Protectiveness. An alternative's ability to achieve protectiveness is a key factor. Overall protectiveness includes the degree of overall risk reduction, the time required to reduce risk and attain cleanup levels, and the improved overall quality of the environment at a Site.

Permanence. The long-term success of an alternative can be measured by the degree to which an alternative permanently reduces the toxicity, mobility, or volume of hazardous substances, including the originally contaminated material and post-treatment residual materials.

Cost. Cost considerations include design, construction, and installation costs; the net present value (NPV) of long-term costs; and agency oversight costs. Long-term costs include operation and maintenance, monitoring, equipment replacement, and maintaining institutional controls.

Long-term Effectiveness. An alternative's long term effectiveness is based on the reliability of treatment technologies to meet and maintain cleanup levels, and if using engineering or institutional controls, on their reliability to manage residual risks. Long term reliability is also influenced by uncertainties associated with potential long term risk management.

Short-term Risk Management. Short-term risk evaluates the risk posed by the cleanup action during its implementation (including construction and operation), based on potential impacts to the community, workers, and the environment, and the effectiveness and reliability of protective or mitigation measures.

Implementability. An alternative's implementability is evaluated on the basis of whether it is easy or difficult to implement depending on practical, technical, or legal difficulties that may be associated with construction and implementation, including scheduling delays. Implementability also depends upon the ability to measure the remedy's effectiveness and its consistency with MTCA and other regulatory requirements.

Consideration of Public Concerns. Potential public concerns, whether from individuals, community groups, local governments, tribes, and federal and state agencies, about a proposed cleanup alternative are addressed by means of MTCA's public involvement process during Ecology's remedy selection process.

5.0 SELECTED SITE CLEANUP ACTION

Alternative 3 was selected for the Site cleanup action and includes the following components:

- Installation of skimmer pumps for free product removal;
- Installation of bentonite utility cut-off walls;
- Installation and operation of an AS and SVE system;
- Compliance and confirmation sampling and monitoring; and
- System decommissioning.

5.1 Rational for Selection

Table 4 summarizes the results of the final screening process. Each alternative has been assigned a numerical score relative to the balancing factors. The results of this numerical scoring process and qualitative evaluation indicate that Alternative No. 3 (AS/SVE) is the most protective, permanent, and effective cleanup action for meeting the site-specific RAO (i.e., meet soil and groundwater MTCA Method A cleanup levels) within a reasonable timeframe.

6.0 CLEANUP ACTION IMPLEMENTATION AND PERFORMANCE MONITORING

The following interim remedial action measures have been implemented at the Site to date to achieve cleanup:

- Implementation of Selected Cleanup Action; and
- Compliance monitoring.

The components are described in the following sections.

6.1 Implementation of the Selected Cleanup Action

Several components of the selected cleanup action have been implemented successfully at the Site to achieve Site-wide cleanup. The AS/SVE system and Utility protection activities were implemented as Interim Remedial Action Measures.

Interim Remedial Action Measures

The current *in-situ* AS/SVE remediation system at the subject property was installed from November 1, 1999 through January 26, 2000, and was activated on March 1, 2000. The system consists of 10 AS wells (AS-1 through AS-10), 5 new SVE wells (VES-1 through VES-5), and an aboveground compound. The in-place components of the system were installed throughout the area of expected soil and groundwater impact (the western portion of Pad C and the eastern edge of Bethel Road S.E.). Five of the AS wells and three of the SVE wells were installed vertically, with the remaining AS and SVE wells installed at an angle of approximately 45° from vertical (Figure 2). The aboveground compound controls and monitors all of the AS and SVE wells, the SVE air stream, and the SVE filter system. The SVE exhaust stream flows through a primary and secondary granular activated carbon (GAC) filter array prior to discharging into the atmosphere.

Beginning in August 2002, the AS component of the groundwater treatment system became inoperative as a result of damages incurred during construction of the Fred Meyer branded fuel station. The SVE system was operated at a limited capacity during this period. In June 2006, the SVE system became completely inoperative following further damage to its aboveground components.

An assessment of the combined AS/SVE system was conducted during a Site visit during June 2008. Following evaluation of the new Site assessment activities, two new SVE blowers, a condensate trap, and two rebuilt AS compressor heads were installed, and the dual AS/SVE systems were reactivated in February 2009. Shortly following system startup, AMEC measured and/or recorded vacuum pressure, air velocity and vapor level (using a PID) in each SVE conveyance line, as well as flow rate in each AS conveyance line.

The restoration of the groundwater monitoring well network and AS/SVE remediation system involved a series of four sequential phases of work completed by AMEC from August 2008 through February 2009. The first task or phase of work was conducted in August 2008 and employed direct-push drilling technology to obtain information regarding residual petroleum hydrocarbon impacts to soil and groundwater remaining from the former Texaco UST system. A second phase of work was conducted in October 2008 and included the installation of four replacement groundwater monitoring wells. A third phase of work included the collection of groundwater quality data from the new monitoring well network (a total of six wells) in January 2009. The previously collected subsurface soil data and groundwater quality data were then used to guide decisions regarding which components of the AS/SVE remediation system to repair and reactivate. Lastly, a fourth phase of work was conducted in February 2009 and included replacement of the AS equipment (compressors, pressure tank, and condensate trap) and reactivation of the dual treatment system and two new SVE blowers (Gast SVE blowers (Model R7100A-3).

6.2 Compliance Monitoring

There are three types of compliance monitoring identified for interim or remedial cleanup actions performed under MTCA (WAC 173-340-410): Protection, Performance, and Compliance Monitoring.

The definition of each is presented below (WAC 173-340-410 [1]):

- Protection Monitoring -To confirm that human health and the environment are adequately protected during construction and the operation and maintenance period of an interim action or cleanup action as described in the safety and health plan.
- Performance Monitoring - To confirm that the cleanup action has attained cleanup standards and other performance standards such as construction quality control measurements or monitoring necessary to demonstrate compliance with a permit or, where a permit exemption applies, the substantive requirements of other laws.
- Confirmation Monitoring - To confirm the long-term effectiveness of the cleanup action once cleanup standards and other performance standards have been attained.

This cleanup action involves all three monitoring types. Each type is discussed here.

6.2.1 Protection Monitoring (Completed)

A site-specific health and safety plan (HASP) was been prepared for the Site work conducted under the interim cleanup action implemented at the Site that met the minimum requirements for such a plan identified in federal (Title 29 CFR, Parts 1910.120, and 1926) and state regulations (WAC Title 296).

Protection monitoring completed at the Site included personal and perimeter air sampling for VOCs during performance of routine system operation and maintenance. The frequency of sampling and period of monitoring for personal air sampling was established in the HASP.

6.2.2 Performance Monitoring (Ongoing)

The objectives for performance monitoring are to demonstrate compliance with the MTCA cleanup regulations and to document the Site conditions upon completion of the cleanup action. To demonstrate such compliance, the confirmation performance monitoring activities for soil and groundwater have been conducted to confirm that cleanup levels have been achieved. AMEC continues to complete quarterly groundwater quality monitoring in the Site's six compliance monitoring wells, as well as quarterly operations and maintenance monitoring of the AS/SVE systems. Groundwater compliance monitoring locations were described in the Restoration of Groundwater Monitoring Well Network and Remediation System, and Fourth Quarterly 2008 Monitoring Results Report (AMEC, 2009a).

Soil

During October 2008, the findings of the direct-push assessment were used to select appropriate locations for installing new groundwater monitoring wells MW-108A, MW-109, MW-110 and MW-111 to replace previously existing wells (MW-104, MW-106, MW-107 and MW-108) that were inadvertently damaged during 1999 and 2000 property redevelopment activities. Four soil samples collected from the newly installed monitoring well borings were analyzed for petroleum hydrocarbon identification by NWTPH-HCID, with follow-up analysis for GRO and BTEX compounds on the soil sample collected from boring MW-110 at a depth of 20 to 25 feet bgs. GRO were detected in one on-Site soil sample located near the vadose zone/water interface (smear zone) at a concentration (300 mg/kg) exceeding the MTCA Method A Cleanup Level for GRO in soil in monitoring well MW-110 boring completed near the former Texaco UST system (i.e., source area). Benzene was not detected at a concentration exceeding the method reporting limit in this source area boring indicating that the AS/SVE has been effective in removing most of the volatile contaminant fraction. Toluene (0.85 mg/kg), ethylbenzene (2.0 mg/kg) and total xylenes (5.3 mg/kg) were detected at concentrations less than the respective MTCA Method A cleanup levels in the MW-110 soil sample. Direct-push borings B-11, B-12, and B-14 were conducted within the central portion of the groundwater plume to evaluate groundwater conditions in the source area. Field screening evidence of minor petroleum impacted soil was observed in borings B-12 and B-14 between depths of 18 and 22 feet bgs (smear zone).

Groundwater

Groundwater performance monitoring has been conducted quarterly at the Site monitoring wells since year 2000. Currently, six compliance monitoring wells are sampled for COPCs on a quarterly basis. In general, the groundwater samples were analyzed for the presence of GRO and VOCs, including BTEX compounds, EDC, EDB, MTBE and naphthalene.

The extent of the groundwater plume has been reduced to an area limited to the northwest corner of the Site and bounded by monitoring well MW-110 and boring B-14 to the northwest, monitoring well MW-109 and boring B-12 to the east, and monitoring well MW-103 to the south (Figure 3). Recent groundwater monitoring results suggest the residual concentrations of GRO and BTEX compounds within the plume are generally less than MTCA Method A cleanup levels. However; concentrations of GRO and BTEX compounds in excess of the MTCA Method A cleanup levels may be present in localized areas within the remaining plume and periodically detected as evidenced by the recent detections of GRO at a concentration of 1,320 µg/L in monitoring well MW-103 (January 2010) or benzene at a concentration of 27.4 µg/L in monitoring well MW-109 (June 2009). The periodic detections of GRO and benzene at concentrations exceeding the MTCA Method A cleanup levels may be attributed to fluctuations in the water table and the resulting remobilization of residual contamination trapped in soil within the smear zone. This response to groundwater changes indicates that soil contamination still exceeds the appropriate cleanup levels. In addition groundwater is also considered contaminated and not meeting cleanup levels. GRO and BTEX concentrations detected in groundwater sampled from monitoring wells MW-103, MW-109 and MW-110, which are located near the former source area, have generally decreased since reactivation of the AS/SVE in February 2009. GRO and VOCs have generally not been detected during recent groundwater monitoring events in monitoring wells located outside and downgradient of the source area (i.e., MW-105, MW-108A, and MW-111).

Neither measurable LNAPL nor a petroleum-related sheen has been detected in the Site's compliance monitoring wells (MW-103, MW-105, MW-108A, MW-109, MW-110, and MW-111) during recent monitoring events.

Subsurface Remediation Systems

The subsurface remediation systems will be monitored routinely for performance to demonstrate that mass removal is occurring at the Site and cleanup objectives are being achieved through mass removal. Additional performance monitoring will be conducted to provide evidence supporting the effectiveness of treating the subsurface via the AS/SVE system.

Continued operation of the AS/SVE system is expected to further reduce the residual concentrations of GRO and benzene present in source area groundwater over time. Based on PID measurements and air flow readings in the SVE exhaust stack, the vapor extraction system is currently removing less than 0.1 pounds per day of VOCs from the Site vadose zone. It appears that the SVE system has removed over 1,000 pounds of the more mobile fraction petroleum contamination since startup in 2000. The remaining contamination is less volatile and more strongly adsorbed to semi-saturated soil located from 18 to 22 feet below ground surface. Therefore, biodegradation has become the dominant factor in treating residual contamination in the smear zone. Dissolved oxygen (DO) levels in groundwater have increased from less than 1 mg/L to approximately 6-8 mg/L in most of the Site's monitoring wells since reactivation of the AS system in February 2009. Increased DO levels in groundwater are expected to increase the rate of biodegradation of residual petroleum contamination beneath the Site.

The AS/SVE system will continue to operate on an intermittent or continuous basis until four consecutive quarters of GRO and BTEX concentrations within MTCA Method A cleanup standards are achieved in all Site monitoring wells (including source area wells MW-103, MW-109 and MW-110). At this time, AMEC does not anticipate having to add additional AS/SVE wells within the source area to reach this compliance goal by approximately 2012. However, the results of continued quarterly groundwater monitoring (i.e., GRO, BTEX and anions/cations) will ultimately dictate whether additional *in-situ* treatment wells and/or approaches are required to achieve MTCA Method cleanup standards in source area soil and groundwater within a reasonable timeframe.

6.2.3 Confirmation (Post-Remediation) Monitoring (Pending)

Post-remediation confirmation monitoring is anticipated for the Site groundwater following deactivation of the AS/SVE system to assess potential rebound. As mentioned above, AMEC anticipates initiating confirmation monitoring in 2012. It is estimated that quarterly confirmation groundwater monitoring will be conducted in the Site's six monitoring wells for GRO and BTEX for a period of two years following deactivation of the AS/SVE system. Site cleanup will be deemed complete when GRO and BTEX concentrations in groundwater samples obtained from the Site's six compliance wells are all below MTCA Method A standards for a minimum of four consecutive quarters. It is assumed that once concentrations of GRO and BTEX in groundwater from all Site monitoring wells remain below MTCA Method A cleanup standards that impacted source area soil (i.e., MW-103, MW-109 and MW-110) located within the smear zone will too have been remediated to MTCA Method A cleanup standards.

One round of soil confirmation sampling will be completed at the Site after groundwater has been shown to meet the Cleanup Levels for the Site. The final confirmation sampling will be completed in accordance with an Ecology-approved Work Plan.

7.0 IMPLEMENTATION SCHEDULE

On-going operation of the AS and SVE systems will be conducted and quarterly groundwater monitoring will be conducted until COC levels are brought to levels within MTCA level A cleanup levels.

The quarterly reports will describe the results of the remedial activities conducted on-Site to allow Ecology to evaluate whether the cleanup action meets the substantive requirements set forth in WAC Chapter 173-340.

The cleanup action described in this CAP will be completed within a reasonable time. The anticipated date of the next quarterly report submittal (1Q10) is May 2010 for submittal to Ecology for review.

If you have any questions or comments regarding this report, please contact the undersigned at (503) 639-3400.

AMEC Earth & Environmental, Inc.

Heidi Rice, PE	Kurt Harrington, PE, PMP
Environmental Engineer	Project Manager

HR/KH/lm

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LIMITATIONS

This report was prepared exclusively for Fred Meyer Stores, Inc. (Fred Meyer) by AMEC Earth & Environmental, Inc.(AMEC) The quality of information, conclusions, and recommendations contained herein is consistent with the level of effort involved in AMEC services and based on 1) information available at the time of preparation; 2) data supplied by outside sources; and 3) the assumptions, conditions and qualifications set forth in this report. This report is intended to be used by Fred Meyer for the Port Orchard Site only, subject to the terms and conditions of its contract with AMEC. Any other use of, or reliance on, this report by any third party is at that party's sole risk. The analyses and recommendations contained in this report are based on data obtained from others, as well as subsurface exploration. The methods used indicate subsurface conditions only at the specific locations where samples were obtained, only at the time they were obtained, and only to the depths penetrated. Samples cannot be relied on to accurately reflect the strata variations that usually exist between sampling locations.

TABLES

TABLE 1
Cleanup Levels
Fred Meyer Stores -Port Orchard Site
Ecology Site ID #96424236

Contaminants of Potential Concern (COPC) List			**MTCA Method A Table 720-1 (µg/L)**	**MTCA Method A Table 740-1 (mg/kg)**
Medium	CAS No.		Groundwater	Soil
Total Petroleum Hydrocarbon (TPH)				
Diesel Range Hydrocarbons	68334-30-5	--	500	2,000
Gasoline Range Hydrocarbons, with Benzene present	86290-81-5	--	800	30
Gasoline Range Hydrocarbons, without Benzene present	86290-81-5	--	1,000	100
Heavy Oils	8008-20-6	--	500	2,000
Select Volatile Organic Compounds (VOCs)				
Benzene	71-43-2	c	5	0.03
Ethylbenzene	100-41-4	c	700	6
Toluene	108-88-3	nc	1,000	7
Total Xylenes	1330-20-7	nc	1,000	9

Notes:
c = carcinogen
nc = noncarcinogen
µg/L = micrograms per Liter
mg/kg = milligrams per kilogram

TABLE 2
Qualitative Evaluation of Remedial Technologies
Fred Meyer Stores - Port Orchard Site
Ecology Site ID #96424236

General Response Action	Remedial Technology	Effectiveness	Implementability	Reasonableness of Cost	Retained?	Reason for Retaining or Eliminating
No Action	None	Low	High	High	Yes	Does not meet remedial action objectives, but will be used as a baseline to compare other alternatives.
Institutional Controls	Activity Restrictions	Medium	High	High	Yes	No long-term reduction of contaminant concentrations. To be used in conjunction with cleanup actions to break potentially complete exposure pathways (e.g., direct contact by trench worker and groundwater ingestion at water wells) if not cleaning up to MTCA A.
Engineering Controls	Utility Cut-Off Collars	High	High	High	Yes	Removes constituent migration off-site along utility corridors. Not currently applicable, however was implemented at the Site related to impacts discovered downgradient of the Site. May be combined with additional alternatives to remove the potential exposure pathway related to future off-site migration.
Petroleum Free Product						
Ex-situ Treatment Technologies						
Removal	Product Skimming	High	High	High	Yes	Effectively removes small volumes of free product from the subsurface immediately surrounding a well. Above-grade product containment and waste disposal required, causing additional handling requirements. Alternative retained because it was previously implemented at the Site to remove free product and may be combined with alternatives for evaluation considering the infrastructure that was present at the Site.
	Excavation	High	Medium	Medium	Yes	Significant reduction of free product mass in soil can be removed through excavation. Intrusive activities are disruptive to existing commercial business. Should be implemented in conjunction with groundwater remedy to avoid recontamination of the imported backfill.
	Dual Phase Extraction with Ex-Situ Treatment	High	Medium	Low	No	Can be effective in removing free product from subsurface (particularly fine-grained material), depending on the product density and mobility. Dual phase extraction may also influence groundwater impacts, groundwater gradient and flow direction, and provide hydraulic control against downgradient migration. However, there is insufficient contaminant mass (i.e., no free product remaining) to warrant to the cost to implement this technology.
In-situ Treatment Technologies						
Physical	Thermal Treatment (electrical resistive heating)	Medium	Low	Low	No	There is insufficient contaminant mass remaining to justify implementing this technology.
Petroleum Impacted Soil						
Ex-situ Treatment Technologies						
Removal	Excavation	High	Medium	Medium	Yes	Significant reduction of contaminant mass in source areas. Intrusive activities are disruptive to existing commercial business. Residual contaminant mass is located at depths between 18 and 22 feet bgs and would require shoring along adjacent ROWs. The PCS will be moved from the Site to another location where potential receptors may be present. Must be implemented in conjunction with groundwater remedy to avoid recontamination of imported backfill.
Biological	Landfarming	Low	High	High	No	Excavation and placement of contaminated soil in an area of controlled site conditions. A large space is required for an extended period of time for aerobic reduction of site contaminants. This cleanup action is not protective of human health and the environment.
In-situ Treatment Technologies						
Physical	Soil Vapor Extraction	Medium	Low	Low	Yes	Proven to be effective at reducing contaminant concentrations in vadose zone, but its effectiveness is reduced in lower permeability soils. Pilot-scale testing is required to determine actual area of influence. Promotes enhanced biodegradation to speed up remedy.
	Low Temperature Thermal Desorption	Medium	Low	Low	No	Cost prohibitive.
Biological	Bioventing	Low	High	High	No	Relatively long periods of time are required for aerobic reduction of site contaminants. This cleanup action is not protective of human health and the environment in the interim. This cleanup action has not been incorporated with the various remedial alternatives because of the time frame required.

TABLE 2
Qualitative Evaluation of Remedial Technologies
Fred Meyer Stores - Port Orchard Site
Ecology Site ID #96424236

General Response Action	Remedial Technology	Effectiveness	Implementability	Reasonableness of Cost	Retained?	Reason for Retaining or Eliminating
Petroleum Contaminated Groundwater						
Ex-situ Treatment Technologies						
Removal	Groundwater Extraction and Ex-Situ Treatment	High	Medium	Medium	Yes	Significant reduction of contaminant mass in groundwater. Extraction may influence groundwater gradient and flow direction, and provide hydraulic control against the downgradient movement of the contaminant plume. Lowers the water table and may promote natural degradation. Secondary treatment requirements required, with possibilities including air-stripping, granular activated carbon, or discharge to local publicly owned treatment works.
	Dual Phase Extraction with Ex-Situ Treatment	High	Medium	Low	No	Significant reduction of contaminant mass in groundwater and vadose zone. Effectively removes free product from subsurface. Dual phase extraction may influence groundwater gradient and flow direction, and provide hydraulic control against the downgradient mobilization of constituents. There is insufficient contaminant mass remaining to justify the cost to implement this technology.
In-situ Treatment Technologies						
Physical	Air Sparging	Low	Medium	Medium	Yes	Proven to be effective at reducing contaminant concentrations in groundwater, but its effectiveness is reduced in lower permeability soils. Typically is used in conjunction with SVE. Pilot-scale testing is required to determine actual area of influence.
	Soil Vapor Extraction	Low	Medium	Medium	Yes	Proven to be effective at reducing contaminant concentrations in groundwater and vadose zone, but its effectiveness may be reduced in lower permeability soils. Typically is used in conjunction with AS. Pilot-scale testing is required to determine actual area of influence.
	Thermal Treatment (electrical resistive heating)	Medium	Low	Low	No	Cost prohibitive.
Biological	Monitored Natural Attenuation	Low	High	High	Yes	Additional testing is required to determine if subsurface conditions are optimal for aerobic degradation. Relatively long periods of time are required for reduction of site contaminants. This cleanup action must be combined with additional alternatives (e.g., Air Sparging).
	Enhanced Bioremediation	Low	Medium	Low	No	The delivery and effective distribution of electron acceptors (typically oxygen), nutrients, or microbes that are acclimated to the contaminated groundwater is reduced by non-homogeneous soils and low groundwater gradient. Insufficient data to accurately cost this technology, nor is there sufficient contaminant mass to justify its implementation.
Chemical	Oxidant Injection (iron activated sodium persulfate)	Medium	Medium	Low	Yes	Contaminants are treated rather than transferred to a vapor phase. The delivery and effective distribution of oxidant and catalysts are reduced in lowered permeability silt lenses present in the soil at site. High natural organic content of soil may limit the effectiveness of this technology. Insufficient data to accurately cost this technology, nor is there sufficient contaminant mass to justify its implementation.

TABLE 3
Remedial Alternative Descriptions
Fred Meyer Stores - Port Orchard Site
Ecology Site ID #96424236

Alternative Description	Design Assumptions	Unknowns	Preliminary Screening of Remedial Alternatives (Comments)	
			Advantages	Disadvantages
Alternative 1 No Action	Implement institutional controls to restrict current/future groundwater use and excavation activities in the vicinity of the site, and decommission the wells at the Site.	Future distribution of contaminants in soil and groundwater. Risks posed by residual contamination (e.g., vapor intrusion of underground and aboveground facilities, future contact by earthworkers, and migration to potable aquifers). Site conditions (e.g., soil permeability, redox conditions, degree of heterogeneity, preferential pathways) affecting contaminant mobility, plume expansion, and rate of natural attenuation. Potential for third party liability. Cleanup levels and regulatory enforcement action(s).	Lowest cost.	Does not meet the minimum requirements of Washington Administrative Code (WAC) 173-340-360 "Selection of Cleanup Actions." Does not meet remedial action objectives (RAOs) or provide any additional reduction of existing risks at the Site within a reasonable timeframe. Groundwater constituents may migrate off-site or into water-bearing zones with a higher beneficial use. Liable for risks and management costs associated with petroleum-impacted soil and groundwater. Subject to Washington Department of Ecology (WDOE) enforcement actions and third party claims.
Alternative 2 (1) Skimmer for Free Product Removal; (2) SVE for Vadose Zone for 10 Years; (3) Groundwater Extraction with Ex-Situ Treatment through Granular Activated Carbon for 20 years; and (4) Groundwater monitoring for system performance period and compliance monitoring for an additional 2 Years.	Preclude the use of groundwater on site for drinking water until cleanup action is complete. Includes short-term product skimming similar to what was implemented in 1998. Includes the installation of up to six 10-foot deep vertical soil vapor extraction (SVE) wells throughout a 3,600-ft^2 area of impacted vadose zone. Assumed SVE air flow rates of approximately 60 cfm while applying vacuum pressures between 40 (in. water). Installation of four 4-inch diameter groundwater extraction (GWE) wells along perimeter of groundwater plume. Assumes that a total maximum GWE flow rate of 16 gpm. Includes excavating a GWE/SVE conveyance piping trench line up to 300' (in total length) X 2' (wide) X 12' (deep) routing pipe to a common treatment compound. Replace unimpacted cuttings as backfill within GWE/SVE trench and top with 2-inch minus drain rock. Treat extracted groundwater with four 1,000-pound granular activated carbon (GAC) adsorbers and treat extracted SVE vapors with two 1,000-pound GAC vessels. Discharge treated groundwater to City storm sewer under NPDES permit. Assumes 10 years of SVE O&M and GWE system O&M, with quarterly ground water monitoring (GWM), followed by 10 years of GWE O&M only and semiannual GWM and 2 additional years of GWM at 5 wells. Includes system decomm	Heterogeneity of the subsurface environment and its impact on the distribution of air and groundwater flow control. Ability to depress the water table and influence groundwater flow direction in the surrounding formation at 16 gpm or less. Degree of treatment system operations and maintenance (O&M) and duration. Effective radius of influence of SVE outside each well. Frequency and duration of MNA monitoring. Permitting and treatment requirements for GWE/SVE discharges. Effectiveness on weathered petroleum compounds site conditions effecting contaminant persistence/mobility. Frequency and duration of actual GWM.	With hydraulic control in place, don't need to restrict water use on downgradient and off-site properties. Large reduction of contaminant mass in soil and groundwater. Can be a cost-effective groundwater treatment alternative provided residual contamination in soil and groundwater is amenable to natural attenuation/biodegradation.	Unlikely that GWE can depress the water table sufficiently to make contaminant mass in the smear zone amenable to SVE treatment. Long-term hydraulic control may be required to meet RAOs. Biofouling or mineral precipitation in extraction wells or treatment processes can reduce overall GWE performance and increase O&M costs. Long-term GWE O&M is costly.
Alternative 3 (1) Utility cutoff collar; (2) Skimmer for Free Product Removal; (3) AS/SVE System for Vadose Zone and Groundwater for 12 years; and (4) Compliance Monitoring during system operation and an additional 2 Years.	Item (2) is the same as Alternative 2. Install bentonite cutoff wall, 5-feet wide by 5-feet deep at up to four locations adjacent to the site to reduce constituent migration within the shallow perched groundwater movement along the existing utility corridors. Install a skimmer at one well location, MW-103 to remove residual free product. Install an air sparge (AS) and SVE system to address groundwater and vadose zone contaminants. Includes the installation of up to seventeen 25-foot deep AS wells throughout a 4,800 ft^2 area of groundwater impact and six 10-foot deep vertical SVE wells throughout a 3,600-ft^2 area of impacted vadose zone. Assumed air injection flow rates of approximately 5 cfm per AS well and up to 10 psi. Assumed SVE air flow rates of approximately 60 cfm while applying vacuum pressures between 40 (in. water). Includes excavation of 300' (linear feet) X 2' (wide) X 12' (deep) of AS/SVE trenching to a common treatment compound. Treat extracted SVE vapors with two 1,000-pound GAC adsorbers. Assumes 10 years of system O&M (bi-weekly visits). Assumes 12 years of quarterly GWM at 6 wells. Includes system decommissi	Heterogeneity of the subsurface environment and its impact on the distribution of air and groundwater flow control. A Degree of treatment system operations and maintenance (O&M) and duration. Effective radius of influence of AS/SVE outside wells. Effectiveness on weathered petroleum compounds site conditions effecting contaminant persistence/mobility. Occurance of natural attentuation at the Site.	AS/SVE have been proven effective at reducing most gasoline-related COPCs in soil and groundwater. SVE promotes volatilization of contaminants in the vadose, capillary fringe and dissolved in pore water, as well as stimulates biodegradation. Also, SVE reduces the potential for petroleum vapors to migrate into buildings or dissolve in groundwater. AS promotes biodegradation in saturated and unsaturated soils by increasing subsurface oxygen concentrations. Relatively low capital costs compared with other remediation technologies. AS/SVE operation causes minimal disturbance to site operations.	AS/SVE effectiveness is reduced in tight, low permeability soil outside the backfilled areas. AS can cause groundwater mounding and thereby laterally spread contaminants in groundwater.
Alternative 4 (1) Utility cutoff collar; (2) Soil excavation and disposal of source area PCS; (3) Two rounds of Chemical Oxidant Injection for Groundwater ; (4) Complaince monitoring during remedy implementation and an additional 2 Years.	Item (2) is the same as Alternative 3. Includes the excavation and off-site disposal of 3,500 cubic yards of PCS. Includes the direct injection of a strong chemical oxidant at 24 locations on 16-foot centers to depths ranging between 20 and 25 feet bgs within an approximately 4,800-ft^2 area of remaining impacted soil and groundwater. Oxidant injection of iron activated sodium persulfate during two primary rounds and one polish injection event through permanent wells. Monitoring events performed after 30 and 45 days following the two primary events. Monitoring events performed after 45 and 60 days following the polish round. Followed by two years of quarterly groundwater quality monitoring. Assumes a natural hydraulic gradient of 0.1 feet per foot and roughly 23,000 pounds of oxidant and 900 pounds of iron activator injected per injection round. Decommission system after NFA.	Duration of PCS removal and loss fueling station revenue compensation requirements. Final total volume of excavated soil and density (i.e., actual soil weight affecting disposal costs). Excavation wall stability and degree of temporary bracing or tied-back shoring required to limit settlement and damage to surrounding structures (i.e., building, roadways and/or subsurface utilities). Dewatering requirements. Type of excavation equipment required. Permitting requirements associated with utility reroute and PCS removal/backfilling/site restoration. Ability to discharge treated water removed during excavation. Ability to delivery the chemical oxidant in tight, low-permeability soil and low groundwater gradient. Heterogeneity of the subsurface environment. Effectiveness of oxidant for some COPCs under site conditions (e.g., pH, oxidation reduction potential, presence of competing naturally occurring organics). Number of injections required to reduce COPCs to treatment standards. Permitting requirements for oxidation injections. Total treatment time to reach cleanup goals and occurance of natural attenuation.	Excavation allows for rapid removal of PCS. Groundwater removed during excavation dewatering contributes to mass reduction. In general, oxidant injection is easy to implement with minimal disturbance to site operations. Provides a large COP mass reduction in material not amenable to bioremediation. Contaminants are treated rather than transferred to a vapor phase. Reduces risk of vapor intrusion and future groundwater consumption pathway. Shorter remedy period, if effective.	High cost related to PCS removal and disposal of PCS and dewatered liquids. Temporary closure of fueling operations. Need to re-route utilities. Deep excavation will require geotech study, shoring, permitting and monitoring. Injecting catalyst compounds (e.g., peroxide) under the required high pressures using direct-push drilling methods can be difficult. High material cost associated with chemical oxidant. Multiple injections and large amount of oxidant may be necessary to reduce COCs to treatment standards. May be low contact between oxidant and contaminant in heterogeneous conditions or in areas with low permeability. High natural organic content of soil may limit effectiveness. Special precautions may be needed to protect worker health and safety during injections. Oxidation reactions may form toxic by-products in the groundwater or in off-gases.

Notes

UST	Underground Storage Tank
MNA	Monitored Natural Attenuation
PCS	Petroleum Contaminated Soil (TPH > MTCA Method A)
cfm	cubic feet per minute
gpm	gallons per minute
bgs	below ground surface
COCs	Contaminants of Concern
RAO	Remedial Action Objectives (MTCA Method A Standards)
NFA	No Further Action Determination from WDOE
' and "	denotes feet and inches, respectively
SVE	Soil Vapor Extraction
AS	Air Sparging
GWE	Groundwater Extraction
GWM	Groundwater Monitoring

General Assumptions

Site groundwater flow is generally to the south.
Treatment standards for the site are protective of MTCA Method A Cleanup Levels.
Worker health and safety will be monitored, and a health and safety plan will be adopted for the site and communicated to site construction workers during construction.
Constituents of concern potentially include BTEX and TPH-Gx in soil, and CPAHs, BTEX, Lead, TPH-Dx and TPH-Gx in groundwater.
The final remedial approach will require the approval or oversight of the Washington Department of Ecology.
No costs included for potential third party liability or natural resource damages.
Utility locations estimated, based on As-Built Plan provided by the Battle Ground Community Development Department.
Cost estimates based on time and materials cost using AMEC current rates and markups.
Cost of due diligence, additional investigations, or remedy, required on the adjacent off-site property have not been included.
Limited debris or obstacles within targeted treatment areas and no overhead obstacles.
Dense non-aqueous phase liquid (DNAPL) or light non-aqueous phase liquid (LNAPL) is not present at the Site, and special precautions for DNAPL and LNAPL containment are not necessary.
No additional contaminant sources will be encountered during the implementation of remedial action at the Site.
Soil disposal is permitted at Subtitle D landfill, as non-hazardous waste.
No ecological receptors will be exposed to COCs above applicable screening levels.

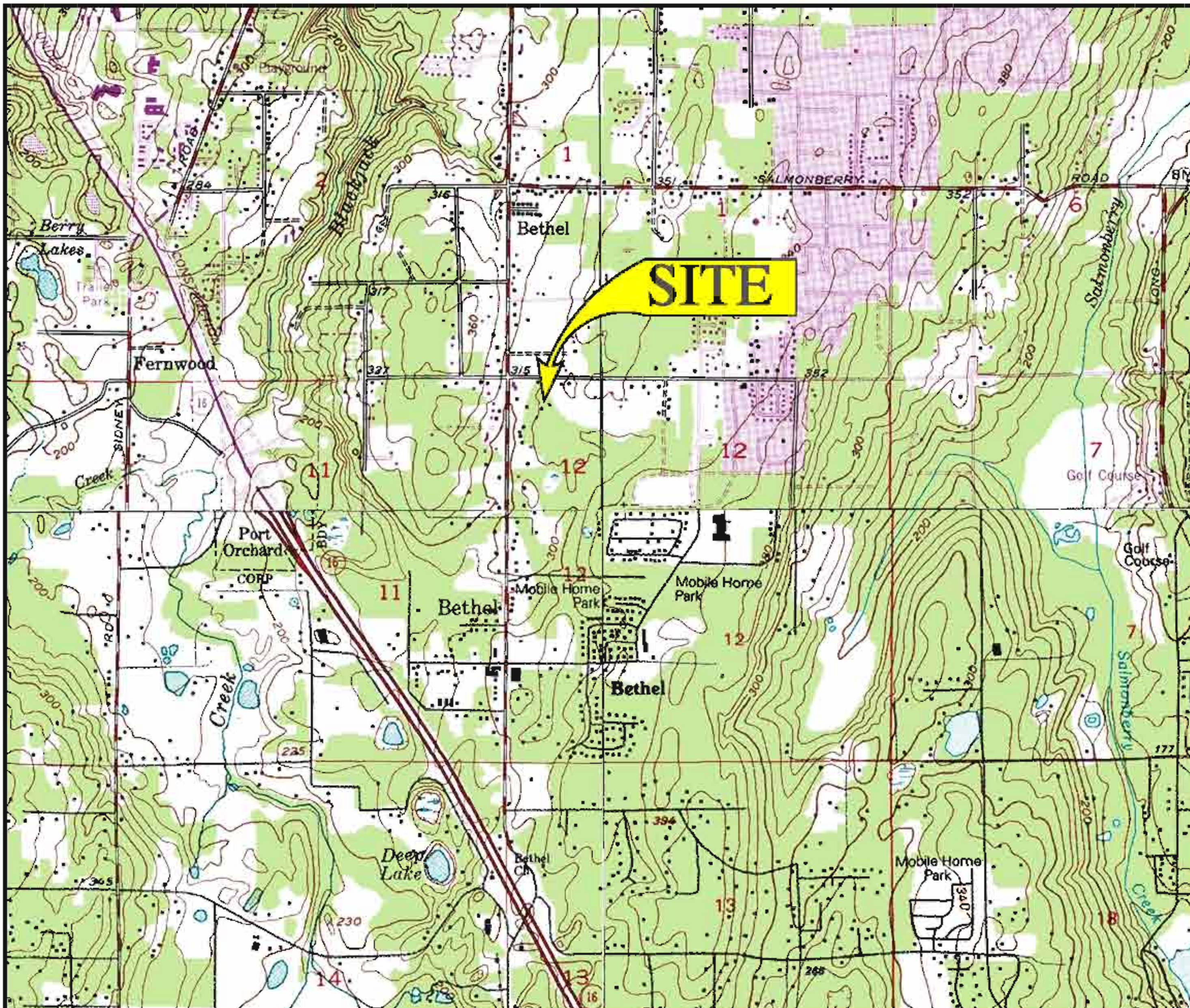
TABLE 4
Remedial Alternative Final Screen
Fred Meyer Stores - Port Orchard Site
Ecology Site ID #96424236

Evaluation Criteria	Alternative 1 No Action		Alternative 2 (1) Skimmer for Free Product Removal; (2) SVE for Vadose Zone for 10 Years; (3) Groundwater Extraction with Ex-Situ Treatment through Granular Activated Carbon for 20 years; and (4) Groundwater monitoring for system performance period and compliance monitoring for an additional 2 Years.		Alternative 3 (1) Utility cutoff collar; (2) Skimmer for Free Product Removal; (3) AS/SVE System for Vadose Zone and Groundwater for 12 years; and (4) Compliance Monitoring during system operation and an additional 2 Years.		Alternative 4 (1) Utility cutoff collar; (2) Soil excavation and disposal of source area PCS; (3) Two rounds of Chemical Oxidant Injection for Groundwater ; (4) Complaince monitoring during remedy implementation and an additional 2 Years.	
Protectiveness **5 = high protectiveness**	**1**	**No reduction of risks or improvement of overall environmental quality**	**2**	**Low/Medium**	**3**	**Medium**	**4**	**Medium/High**
Permanence **5 = high permanence**	**1**	**No permanent reduction of contaminant toxicity or mobility**	**4**	**Medium/High**	**4**	**Medium/High**	**5**	**High**
Reduction of Toxicity		None		Medium. Source removal and moderate reduction in contaminant mass.		Medium. Proven source removal and moderate reduction in contaminant mass.		High. Proven source removal and moderate potential to reduce accessible contaminant mass.
Reduction of Mobility		None		High. Should influence groundwater flow and reduce contaminant mobility near GWE and SVE will induce a vacuum for vapors within the vadose zone.		Medium/High. Should influence vadose zone vapors. Added treatment within contaminant plume further reduces contaminant mobility.		Medium/High. Should influence groundwater through treatment, though may cause mobility during implementation. Added treatment within contaminant plume further reduces contaminant mobility.
Effectiveness Over The Long Term **5 = high effectiveness**	**1**	**Low**	**2**	**Low/Medium**	**3**	**Medium**	**4**	**Medium/High**
Nature, Degree, and Certainties or Uncertainties of Alternative to be Successful		No source removal or reduction in contaminant volume or mobility.		Permitting requirements, persistence/mobility of residual contamination, risks/liability posed by residual contaminants, monitoring requirements, treatment time and landfill reliability.		Permitting requirements, radius of influence, persistence/mobility of residual contamination, risks/liability posed by residual contaminants, system O&M and GWM monitoring requirements, treatment time.		Permitting requirements, radius of influence, persistence/mobility of residual contamination, risks/liability posed by residual contaminants, and landfill reliability.
Reliability		None		Medium. Provided GWE influences contaminant mobility and residual contamination in tight soils are amenable to enhanced biodegradation.		Medium. Provided residual contamination is amenable to natural attenuation/biodegradation.		Medium. Provided residual contamination is amenable to natural attenuation/biodegradation.
Magnitude of Residual Risk		Potential direct and indirect exposure to COCs in soil and groundwater at concentrations posing an unacceptable risk to human health and the environment.		Potential direct and indirect exposure to residual COPCs in soil and groundwater at concentrations posing an unacceptable risk to human health and the environment.		Potential direct and indirect exposure to residual COCs in soil and groundwater at concentrations posing an unacceptable risk to human health and the environment.		Potential direct and indirect exposure to residual COCs in soil and groundwater at concentrations posing an unacceptable risk to human health and the environment. Additional Exposure to Chemicals during injection may increase risks.
Effectiveness of Controls Required to Manage Treatment Residues		None		Low/Medium. Reliance on institutional controls.		Medium/High. Further reduction of contaminant mass reduces dependence on institutional controls.		Medium/High. Further reduction of contaminant mass reduces dependence on institutional controls.
Time to Achieve RAOs		Greater Than 30 Years		22 Years		14 Years		2 Years
Management of Short-Term Risks **5 = low implementation risks**	**1**	**Low**	**3**	**Medium**	**5**	**High**	**2**	**low**
Implementation Risks		High risk and liability associated with No Action.		Potential damage to surrounding structures, public and construction worker safety, drilling and trenching within ROWs, risks posed by residual contaminants during MNA.		Potential damage to surrounding structures, public and construction worker safety, drilling in ROWs, fugitive vapors from AS, risks posed by residual contaminants during MNA.		Medium/Low. Potential damage to surrounding structures, public and construction worker safety, health hazard from oxidant, and risks posed by residual contaminants during MNA.
Effectiveness of Risk Mitigation Measures		None		Medium. Traffic control, health & safety program, institutional controls.		Medium/Low. Traffic control, health & safety program, SVE in combination with AS, and institutional controls.		Medium/Low. Shoring, health & safety program, and institutional controls.
Implementability **5 = high implementability**	**5**	**High**	**4**	**Medium/High**	**4**	**High**	**2**	**Medium/Low**
Difficulties and Unknowns Associated with Implementation		Does not constitute a cleanup action.		Actual permitting, SVE/GWE radius of influence, O&M duration and requirements, and treatment duration.		Actual permitting, AS/SVE radius of influence, O&M duration and requirements, and treatment timeframe.		Actual permitting, shoring, excavation, disposal, and long-term treatment O&M and GWM requirements. AS/SVE radius of influence is limited in fine-grained soils.
Ability to Monitor Effectiveness of Remedy		Does not constitute a cleanup action.		High		High		Medium/Low
Consistency with State, Federal, and Local Requirements		None		Medium		Medium/High		Medium
Involvement of Other Agencies or Governmental Bodies		Low		Medium		Medium		Medium/High
Availability of Equipment, Specialists, and Services		Does not constitute a cleanup action.		High		High		Medium/High
Consideration of Public Concerns **5 = high degree of consideration**	**1**	**Low**	**2**	**Low/Medium**	**3**	**Medium**	**4**	**Medium/High**
Acceptance by WDOE **5 = high likelihood of State acceptance**	**1**	**Low**	**2**	**Low/Medium**	**3**	**Medium**	**4**	**Medium/High**
Treatment Preference for High Levels of Mobile Contaminants		None		Medium. Capture vapor and dissolved phase petroleum hydrocarbons within SVE/GWE radius of influence.		Medium. Reduce vapor and dissolved phase contaminant mass. Practical attempt to influence contaminant mobility.		Medium/High. Source removal and large reduction in contaminant mass. Practical attempt to treat plume and influence contaminant mobility.
Minimize Long-Term Management		None		Low/Medium. May not meet RAOs within a reasonable time line.		Medium. Low to moderate potential to RAOs within a reasonable time line.		Medium/High. Moderate potential to RAOs within a reasonable time line. Long-term liability at landfill.
Minimize Risk		None		Low/Medium. Residual contaminant concentrations will likely remain in saturated fine-grained soils above MTCA Method A Standards for long time.		Medium. Submerged residual contaminant mass may remain above MTCA Method A Standards for some time. AS should increase MNA rate.		High. Lowering of contaminant concentrations in groundwater reduces threats to downgradient human receptors.
Reasonableness of Cost **5=low cost**	**5**	**Low Cost**	**3**	**High**	**4**	**Medium**	**2**	**Low**
Estimate of Cost Net Present Value		**$29,400**		**$1,703,343**		**$959,900**		**$2,189,509**
Uncertainty of Costs		Low		Cost to obtain necessary permits, material/equipment costs, groundwater pumping rate, O&M duration and cost, time for MNA, and GWM frequency/duration.		Material/equipment costs, time for treatment/MNA, treatment system effectiveness, sparge area of influence and O&M requirements,		Cost to obtain permits, volume and disposal of excavated material, material/equipment costs, shoring/dewatering requirements, time for treatment/MNA, oxidant treatment effectiveness and quantity required.
Total Score	***16***	**Alternative 1**	***22***	**Alternative 2**	***29***	**Alternative 3**	***27***	**Alternative 4**

Notes:
GWE = Groundwater Extraction
UST = Underground Storage Tank
PCS = Petroleum Contaminated Soil
MNA = Monitored Natural Attenuation
O&M = Operations and Maintenance
SVE = Soil Vapor Extraction
AS = Air Sparging
COCs = Contaminants of Concern

Example of Criteria Scoring and Relationship Between Numbers and Text: 1 = low, 2 = low/medium, 3 = medium, 4 = medium/high, 5 = high.

FIGURES



Heavy-duty	
Medium-duty	
Light-duty	
Unimproved dirt	
U.S. Route	State Route
Interstate Route	

BREMERTON WEST, WASH.
47122-E6-TF-024
1953
PHOTOREVISED 1981
DMA 1479 II SERIES V891

BREMERTON EAST, WASH.
N4730-W12230/7.5
1953
PHOTOREVISED 1981
DMA 1479 II SERIES V891

BURLEY, WASH.
47122-D6-TF-024
1953
PHOTOREVISED 1994
DMA 1478 II NW-SERIES V891

OLALLA, WASH.
47122-D5-TF-024
1953
PHOTOREVISED 1981
DMA 1478 I NE SERIES V891

WASHINGTON
QUADRANGLE LOCATION

1 1/2 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

SOURCE: USGS QUAD SHEET: BREMERTON WEST, BREMERTON EAST, BURLEY AND OLALLA, WASH.

AMEC Earth & Environmental
7376 S.W. Durham Road
Portland OR. U.S.A. 97224

amec

CLIENT
FRED MEYER STORES, INC.

PROJECT: PORT ORCHARD	DWN BY: LR	DATUM: NAD27	DATE: APRIL 2010
TITLE: SITE LOCATION MAP	CHK'D BY: DMF	REV. NO.: X	PROJECT NO: 9-61M-10282-0
	PROJECTION: UTM ZONE 10N	SCALE: 1:24,000	FIGURE No. FIGURE 1

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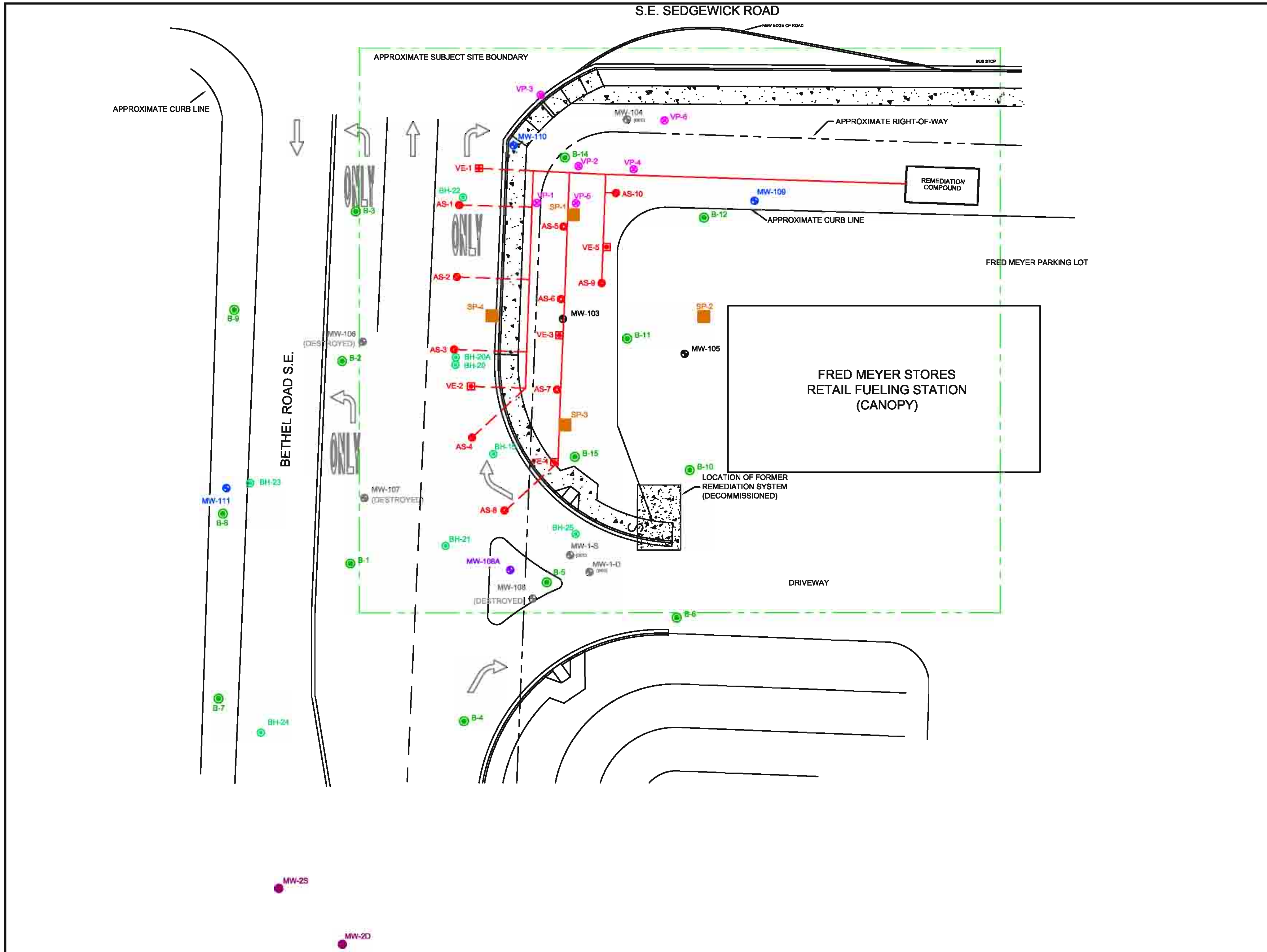
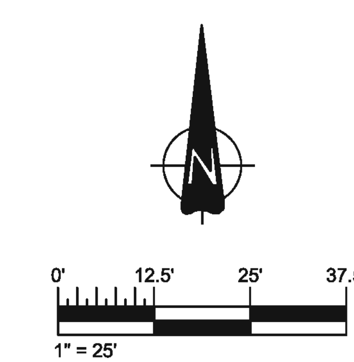


LEGEND

- AS-10 — AIR SPARGING WELL NUMBER AND APPROXIMATE LOCATION
- VE-5 — VAPOR EXTRACTION WELL NUMBER AND APPROXIMATE LOCATION
- MW-103 — 4" PVC MONITORING WELL NUMBER AND LOCATION. MW-103 AND MW-104 BY ECOLOGY, 1991, ALL OTHERS BY AGRA, NOVEMBER, 1999. MW-104, MW-1-S AND MW-1-D DESTROYED IN 1999/200. MW-106, MW-107, AND MW-108 DESTROYED IN 2001.
- MW-110 — MONITORING WELL INSTALLED 2008
- MW-108A — REPLACEMENT MONITORING WELL
- (DEC) — WELL DECOMMISSIONED
- B-12 — AUGUST 2008 GEOPROBE BORING
- BH-20 — STRATO PROBE BORING NUMBER AND LOCATION OF TEMPORARY 3/4" VAPOR TEST WELL VP BORINGS BY AGRA JULY 28, 1999 (APPROXIMATE LOCATION)
- VP-5 — STRATO PROBE BORING NUMBER AND LOCATION. BH-15 IS BY GN NORTHERN ON JANUARY 22, 1999. ALL OTHER BORINGS BY AGRA ON JULY 27, 28 AND 29, 1999. (APPROXIMATE LOCATION)
- SP-2 — SPARGING WELL, 1995 (APPROXIMATE LOCATION)
- MW-2D — MONITORING WELL, 1991 (APPROXIMATE LOCATION)
- REMEDIATION SYSTEM TRENCH
- ANGLED WELL LOCATION
- APPROXIMATE SITE BOUNDARY



SOURCE: AHBL CIVIL AND STRUCTURAL ENGINEERS, FILE NAME: 98169-B.dwg.
HISTORIC WELL LOCATIONS ARE APPROXIMATE AND ARE FOR ILLUSTRATIVE PURPOSES ONLY.

CLIENT: FRED MEYER STORES, INC.	DWN BY: DD/LR	PROJECT: PORT ORCHARD	DATE: APRIL 2010
	CHK'D BY: DS/DMF		PROJECT NO: 9-61M-10282-0
AMEC Earth & Environmental, 7376 S.W. Durham Road, Portland, OR. U.S.A. 97224	DATUM: -	TITLE: SITE PLAN AND SITE FEATURES	REV. NO.: -
	PROJECTION: -		FIGURE No. FIGURE 2
	SCALE: 1"=25'		

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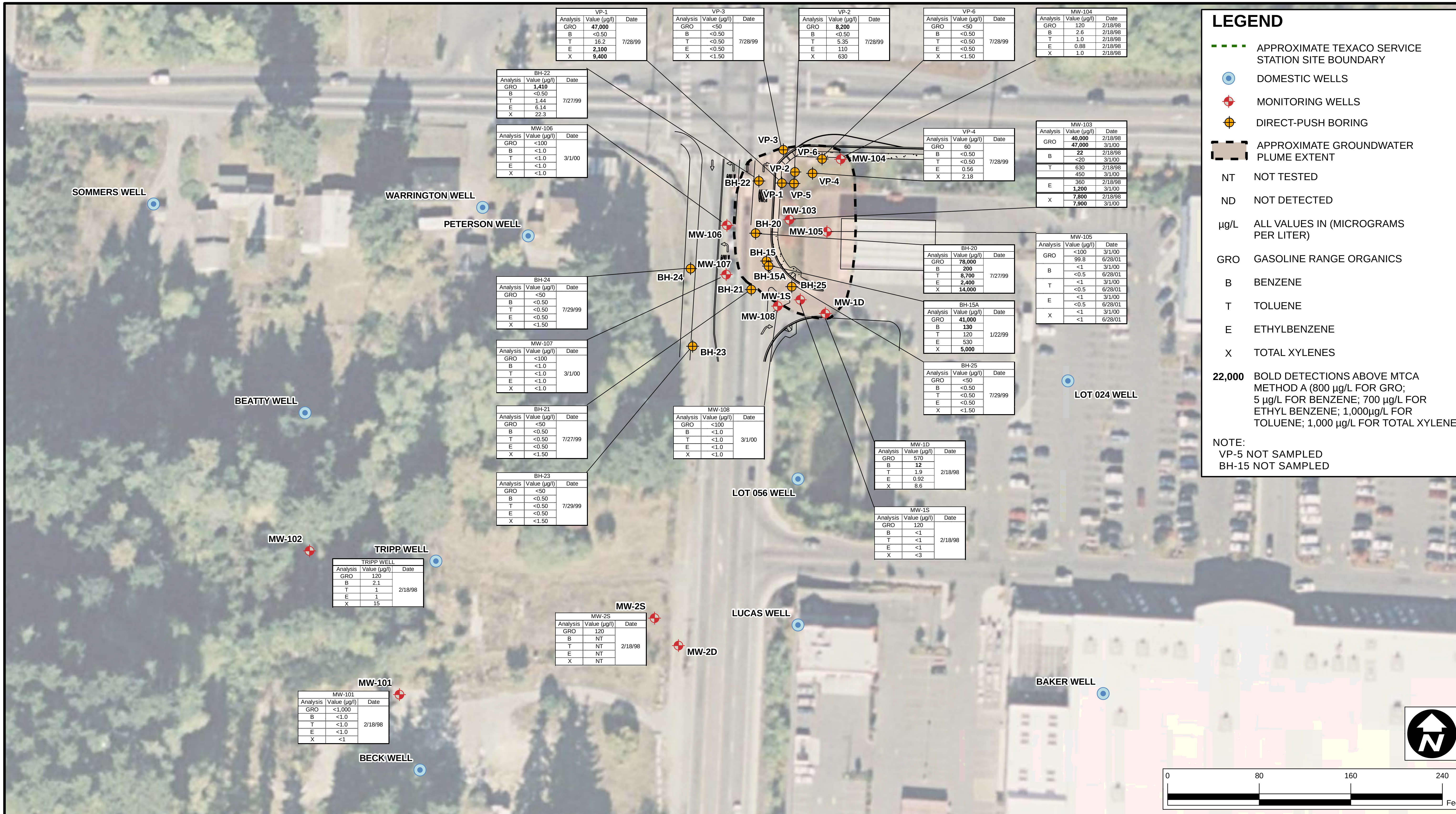


VP-1		
Analysis	Value (µg/l)	Date
GRO	**47,000**	7/28/99
B	<0.50	
T	16.2	
E	**2,100**	
X	**9,400**	

VP-3		
Analysis	Value (µg/l)	Date
GRO	<50	7/28/99
B	<0.50	
T	<0.50	
E	<0.50	
X	<1.50	

VP-2		
Analysis	Value (µg/l)	Date
GRO	**8,200**	7/28/99
B	<0.50	
T	5.35	
E	110	
X	630	

VP-6		
Analysis	Value (µg/l)	Date
GRO	<50	7/28/99
B	<0.50	
T	<0.50	
E	<0.50	
X	<1.50	

MW-104		
Analysis	Value (µg/l)	Date
GRO	120	2/18/98
B	2.6	2/18/98
T	1.0	2/18/98
E	0.88	2/18/98
X	1.0	2/18/98

BH-22		
Analysis	Value (µg/l)	Date
GRO	**1,410**	7/27/99
B	<0.50	
T	1.44	
E	6.14	
X	22.3	

MW-106		
Analysis	Value (µg/l)	Date
GRO	<100	3/1/00
B	<1.0	
T	<1.0	
E	<1.0	
X	<1.0	

VP-4		
Analysis	Value (µg/l)	Date
GRO	60	7/28/99
B	<0.50	
T	<0.50	
E	0.56	
X	2.18	

MW-103		
Analysis	Value (µg/l)	Date
GRO	**40,000**	2/18/98
	47,000	3/1/00
B	**22**	2/18/98
	<20	3/1/00
T	630	2/18/98
	450	3/1/00
E	360	2/18/98
	1,200	3/1/00
X	**7,800**	2/18/98
	7,900	3/1/00

MW-105		
Analysis	Value (µg/l)	Date
GRO	<100	3/1/00
	99.8	6/28/01
B	<1	3/1/00
	<0.5	6/28/01
T	<1	3/1/00
	<0.5	6/28/01
E	<1	3/1/00
	<0.5	6/28/01
X	<1	3/1/00
	<1	6/28/01

BH-20		
Analysis	Value (µg/l)	Date
GRO	**78,000**	7/27/99
B	**200**	
T	**8,700**	
E	**2,400**	
X	**14,000**	

BH-15A		
Analysis	Value (µg/l)	Date
GRO	**41,000**	1/22/99
B	**130**	
T	120	
E	530	
X	**5,000**	

BH-24		
Analysis	Value (µg/l)	Date
GRO	<50	7/29/99
B	<0.50	
T	<0.50	
E	<0.50	
X	<1.50	

MW-107		
Analysis	Value (µg/l)	Date
GRO	<100	3/1/00
B	<1.0	
T	<1.0	
E	<1.0	
X	<1.0	

BH-25		
Analysis	Value (µg/l)	Date
GRO	<50	7/29/99
B	<0.50	
T	<0.50	
E	<0.50	
X	<1.50	

BH-21		
Analysis	Value (µg/l)	Date
GRO	<50	7/27/99
B	<0.50	
T	<0.50	
E	<0.50	
X	<1.50	

MW-108		
Analysis	Value (µg/l)	Date
GRO	<100	3/1/00
B	<1.0	
T	<1.0	
E	<1.0	
X	<1.0	

MW-1D		
Analysis	Value (µg/l)	Date
GRO	570	2/18/98
B	**12**	
T	1.9	
E	0.92	
X	8.6	

BH-23		
Analysis	Value (µg/l)	Date
GRO	<50	7/29/99
B	<0.50	
T	<0.50	
E	<0.50	
X	<1.50	

MW-1S		
Analysis	Value (µg/l)	Date
GRO	120	2/18/98
B	<1	
T	<1	
E	<1	
X	<3	

TRIPP WELL		
Analysis	Value (µg/l)	Date
GRO	120	2/18/98
B	2.1	
T	1	
E	1	
X	15	

MW-2S		
Analysis	Value (µg/l)	Date
GRO	120	2/18/98
B	NT	
T	NT	
E	NT	
X	NT	

MW-101		
Analysis	Value (µg/l)	Date
GRO	<1,000	2/18/98
B	<1.0	
T	<1.0	
E	<1.0	
X	<1	

CLIENT LOGO

CLIENT: FRED MEYER STORES, INC.

AMEC Earth & Environmental
7376 SW Durham Road
Portland, OR, U.S.A. 97224

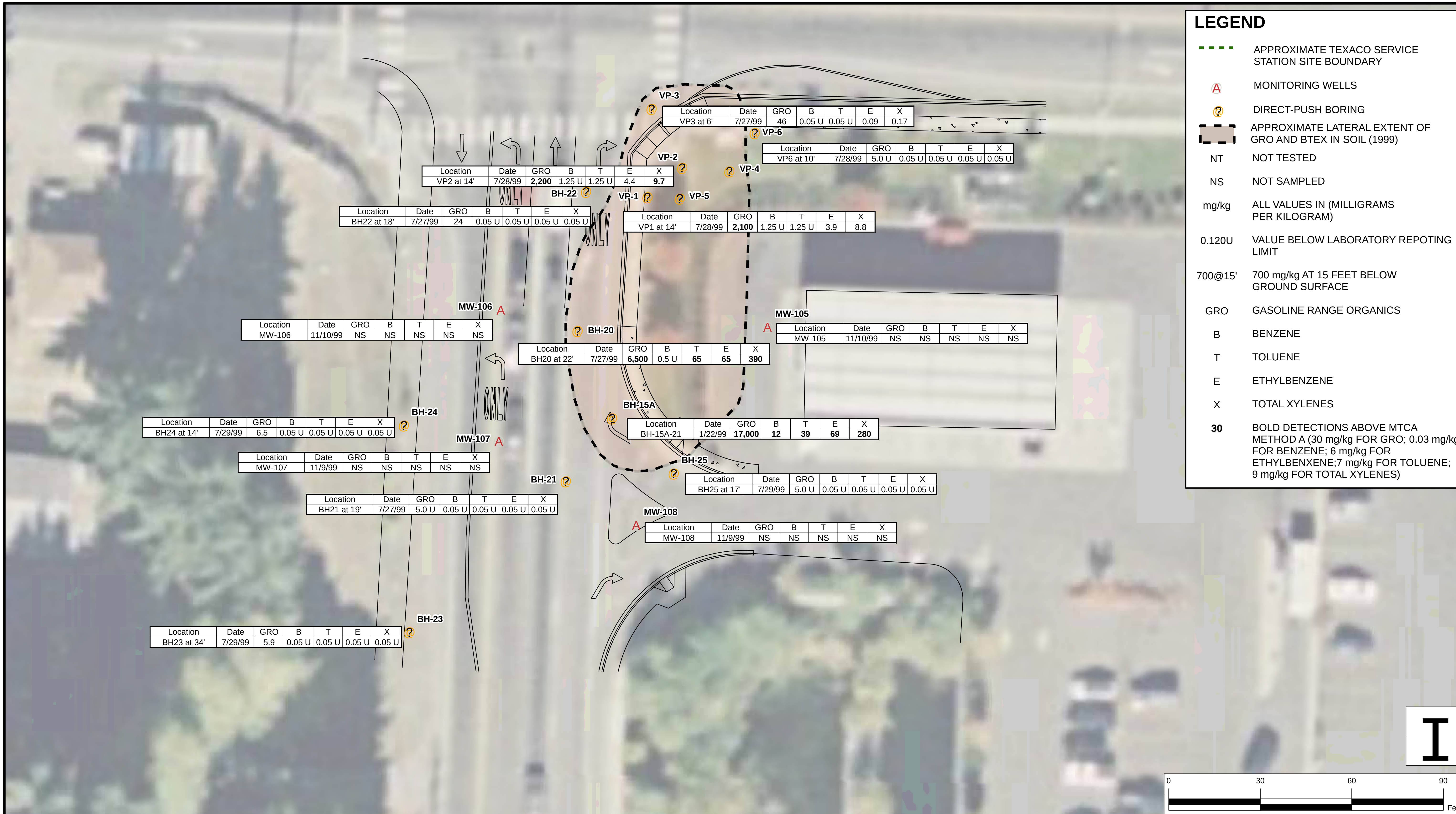
DWN BY: PM
CHK'D BY: AC/BC
DATUM: NAD83
PROJECTION: WA SP N. Ft.
SCALE: 1 inch = 80 feet

PROJECT: PORT ORCHARD

TITLE: APPROXIMATE GROUNDWATER PLUME EXTENT 1998 - 2001 (GRO AND BTEX) SELECT VALUES

DATE: APRIL 2010
PROJECT NO.: 9-61M-10282-0
REV. NO.: 1
FIGURE NO.: FIGURE 3

K:\10000\10200\10282\CAP\DWGs\Fig 3 - Approx GW Plume GRO and BTEX 1998-2001.mxd



Location	Date	GRO	B	T	E	X
VP3 at 6'	7/27/99	46	0.05 U	0.05 U	0.09	0.17
VP6 at 10'	7/28/99	5.0 U	0.05 U	0.05 U	0.05 U	0.05 U
VP2 at 14'	7/28/99	**2,200**	1.25 U	1.25 U	4.4	**9.7**
BH22 at 18'	7/27/99	24	0.05 U	0.05 U	0.05 U	0.05 U
VP1 at 14'	7/28/99	**2,100**	1.25 U	1.25 U	3.9	8.8
MW-106	11/10/99	NS	NS	NS	NS	NS
MW-105	11/10/99	NS	NS	NS	NS	NS
BH20 at 22'	7/27/99	**6,500**	0.5 U	**65**	**65**	**390**
BH24 at 14'	7/29/99	6.5	0.05 U	0.05 U	0.05 U	0.05 U
BH-15A-21	1/22/99	**17,000**	**12**	**39**	**69**	**280**
MW-107	11/9/99	NS	NS	NS	NS	NS
BH25 at 17'	7/29/99	5.0 U	0.05 U	0.05 U	0.05 U	0.05 U
BH21 at 19'	7/27/99	5.0 U	0.05 U	0.05 U	0.05 U	0.05 U
MW-108	11/9/99	NS	NS	NS	NS	NS
BH23 at 34'	7/29/99	5.9	0.05 U	0.05 U	0.05 U	0.05 U

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DWN BY: PM
CHK'D BY: AC/BC
DATUM: NAD83
PROJECTION: WA SP N. Ft.
SCALE: 1 inch = 30 feet

PROJECT: PORT ORCHARD

TITLE: GRO AND BTEX CONCENTRATIONS IN SOIL 1999

DATE: APRIL 2010
PROJECT NO.: 9-61M-10282-0
REV. NO.: 1
FIGURE NO.: FIGURE 4

K:\10000\10200\10282\CAP\DWGs\Fig 4 - Approx Soil Plume GRO and BTEX 1999.mxd

APPENDIX A

Definitions of Evaluation Criteria

APPENDIX A

WAC 173-340-360 Selection of Cleanup Actions
Definitions of Evaluation Criteria

The following criteria shall be used to evaluate and compare each cleanup action alternative when conducting a disproportionate cost analysis to determine whether a cleanup action is permanent to the maximum extent practicable.

Protectiveness

The ability of each cleanup action alternative to provide overall protectiveness of human health and the environment is a key factor in the screening and selection process. Overall protectiveness includes the degree of overall risk reduction, time required to reduce risk and attain cleanup standards, mitigation of on-site and off-site risks associated with implementation of the cleanup action alternative, and improvement of the overall environmental quality.

Permanence

The degree to which the cleanup action alternative permanently reduces the toxicity, mobility, or volume of hazardous substances provides a measure of long-term success. When evaluating cleanup action technologies in regards to permanence, the ability of the alternative to destroy hazardous substances, and to reduce and eliminate hazardous substances releases and sources are considered in the selection and screening process. The selection process also considers whether the treatment process is reversible or irreversible, and the characteristics and quantity of residuals generated during treatment.

Cost

Consideration of cost during screening of the cleanup action technologies includes construction and installation costs, the net present value of long-term costs, and recoverable costs for agency oversight. Long-term costs include operation and maintenance costs, monitoring costs, equipment replacement costs, and the cost of maintaining institutional controls. Costs associated with the construction and operations of the cleanup action alternative include pretreatment, analytical, labor, and waste management costs. Design life of the alternative and replacement and repair cycles for major components are also considered when estimating alternative costs.

Long-Term Effectiveness

In general, long-term effectiveness provides a measure of certainty in regard to the cleanup action alternative’s ability to successfully achieve the established cleanup levels. Assessment of long-term effectiveness includes consideration of the alternative’s reliability during the period of time during which hazardous substances are expected to remain on site at concentrations that exceed the cleanup levels, and of the effectiveness of controls required to manage treatment residuals or remaining hazardous substances. When evaluating technologies that include engineering and institutional controls, the evaluation of long-term effectiveness focuses on the control’s continued ability to prevent exposure to contaminated media. Technologies that completely and permanently destroy the hazardous substances would have the highest level of long-term effectiveness since it would be impossible for a successfully implemented remedy to fail.

Management of Short-Term Risks

This evaluation criterion addresses risks to human health and the environment associated with construction and implementation of the alternative, and the effectiveness of measures used to manage such risks. Consideration of the management of short-term risks is a qualitative assessment.

Technical and Administrative Implementability

The assessment of implementability is intended to determine whether, or with how much difficulty, the cleanup action alternative can be effectively implemented. Implementability includes considerations such as technical feasibility, availability of off-site facilities, services, and materials, administrative and regulatory requirements, implementation scheduling, alternative size and complexity, monitoring requirements, access for construction, and integration with existing facility operations.

Consideration of Public Concerns

Community concerns regarding the cleanup action alternative should be considered and addressed by the alternative during construction and implementation. Community members may include individuals, community groups, local government, tribes, and federal and state agencies.

APPENDIX B

Table B-1 - Remedial Alternative Cost Summary

APPENDIX B
TABLE B-1
Remedial Alternative Cost Summary
Fred Meyer - Port Orchard

Alternative Description	Design and Installation Cost ($)	Total Quarterly GWM and O&M ($)	Quarterly GWM and O&M Years Incurred	Total Semi-Annual GWM and O&M ($)	Semi-Annual GWM and O&M Years Incurred	Total Estimated System O&M and GWM Costs ($)	NPV of System O&M and GWM ($)	Final Soil Confirmation Sampling and Well Decommissioning Costs ($)	Project Year Incurred	NPV of Soil sampling and Well Decommissioning ($)	Total Estimated Costs ($)
Alternative 1 No Action	$0	$0	NA	$0	NA	$0	None	$30,552	2	$29,400	$29,400
Alternative 2 (1) Skimmer for Free Product Removal; (2) SVE for Vadose Zone for 10 Years; (3) Groundwater Extraction with Ex-Situ Treatment through Granular Activated Carbon for 20 years; and (4) Groundwater monitoring for compliance monitoring for system performance period and an additional 2 Years.	$409,320	$776,947	10	$491,576	12	$1,268,522	$794,900	$40,195	23	$25,500	$1,703,343
Alternative 3 (1) Utility cutoff collar; (2) Skimmer for Free Product Removal; (3) AS/SVE System for Vadose Zone and Groundwater for 10 years; and (4) Compliance Monitoring during system operation and an additional 2 Years.	$351,642	$564,958	14	$0	NA	$564,958	$331,200	$58,227	15	$43,300	$959,900
Alternative 4 (1) Utility cutoff collar; (2) Soil excavation and disposal for free product removal and vadose zone; (3) Two rounds of Chemical Oxidant Injection for Groundwater ; (4)Compliance Monitoring during remedy implementation and an additional 2 Years.	$1,973,192	$72,859	2	$0	NA	$145,717	$42,800	$77,859	5	$70,600	$2,189,509

Notes:

The estimated costs are order of magnitude cost estimates, based on estimated quantities and screening criteria stated in Table 2. Additional specific costs that have not been included in these estimates include public relations, legal fees, taxes, additional site characterization activities, excavation sidewall shoring, UST permitting and compliance monitoring, disposal of wastes other than non-hazardous designated wastes, and regulatory oversight. Net Present Value (NPV) assumes an interest rate of 2% after inflation.

[a]Well decommissioning cost included in design and installation cost.