ENGINEERING DESIGN REPORT
SHALLOW AQUIFER CLEANUP ACTION

BSB PROPERTY
KENT, WASHINGTON

DECEMBER 15, 2011

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This Engineering Design Report has been prepared on behalf of B.S.B. Diversified Company, Inc., for the Washington State Department of Ecology by the following licensed professionals:

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TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

1.0 INTRODUCTION

PES Environmental, Inc. (PES), has prepared this engineering design report (EDR) for a cleanup action at the B.S.B. Diversified Company, Inc. (BSB), property located at 8202 South 200th Street, Kent, Washington (referred to as the Property; see Figure 1). This EDR has been prepared under Consent Decree No. 11-2-27288-5 (CD) between BSB and the State of Washington, Department of Ecology (Ecology) and is consistent with the requirements of the Model Toxics Control Act (MTCA), Chapter 173-340-400 of the Washington Administrative Code (WAC). The EDR describes a cleanup action being implemented for the shallow aquifer at the Property. Any cleanup actions required for the deep aquifer beneath the property will be covered through a future Ecology cleanup action plan (CAP).

1.1 Property Description

The Property is located in Township 22 North, Range 4 East, Section 1H at a latitude of 47 degrees 25’ 22” North and a longitude of 122 degrees 13’ 51” West. The 4.2-acre Property is currently a fenced, vacant lot that slopes gently to the north. The area surrounding the Property is topographically flat and is zoned “Limited Industrial.” The Property is bounded on the north by South 200th Street and the Hexcel Corporation (Hexcel) industrial facility. Commercial and industrial park properties are located to the west and south of the Property, and the Carr industrial facility is immediately to the east of the Property.

1.2 Historical Waste Treatment Operations

A variety of industrial and hazardous wastes that were generated on the metal finishing and electroplating plant located on the north side of South 200th Street (now part of the Hexcel Facility) were formerly treated and stored in a waste treatment area located on the Property (Figure 2). The waste treatment area was located in the northeast and southern portions of the Property, and a parking lot was located in the northwest portion of the parcel. Waste handling reportedly occurred on the Property between the mid 1950s, when electroplating operations were begun on the property north of South 200th Street, and 1985, when treatment, storage, and disposal activities ceased. The waste treatment operations included an equalizing lagoon, four aboveground treatment tanks, a sludge settling lagoon, sludge drying beds, a connection to the sanitary sewer for the disposal of treated water, and a drum storage area.

1.3 Previous Investigations

In the early 1980s, the United States Environmental Protection Agency (USEPA) initiated investigations at the Property. BSB conducted a series of investigations in subsequent years both on and off the Property. These investigations included drilling soil borings; installing monitoring wells and piezometers; collecting and analyzing soil-gas samples, sludge samples, soil samples, and groundwater samples; measuring groundwater levels; and conducting hydraulic conductivity tests. These investigations are summarized in a Final Focused Remedial Investigation Summary/Feasibility Study (FRI/FS) report (PES, 2008) and a Remedial Investigation Report Addendum (PES, 2011a).

1.4 Property Remediation

Soil and groundwater cleanup actions have been conducted at the Property as part of Resource Conservation and Recovery Act (RCRA) closure activities in the late 1980s and early 1990s. These cleanup actions have included:

- Removal and closure of solid and hazardous waste management units;
- Removal of contaminated solids from the former sludge settling lagoon and the former equalizing lagoon;
- Excavation of approximately 2,000 cubic yards of contaminated soil from the primary source area on the Property;
- Consolidation, stabilization, and isolation of dangerous waste solids in the former sludge drying beds;
- Capping of potentially impacted portions of the Property; and
- Installation and operation of a groundwater extraction and treatment corrective measures system (CMS).

Between August 1992 and August 2011, the CMS removed groundwater contaminated with halogenated VOCs (HVOCs) beneath the BSB and Hexcel properties. The CMS consisted of two recovery wells (HYR-1 and HYR-2) located on the Property and four recovery wells (CG-1 through CG-4) located on the Hexcel property. The system was separated by location of the recovery wells in April 2006, with BSB taking responsibility for HYR-1 and HYR-2, and Hexcel taking responsibility for CG-1 through CG-4. BSB's recovered groundwater was discharged to the King County sewer treatment system, with pretreatment by an air stripper required during the last year of operation.

As a result of these cleanup actions, conditions at the Property have stabilized, contaminated soil and waste has been treated and/or removed from the Property, over 10,000 pounds of HVOCs have been removed and treated by operation of the CMS, and the potential risks to human health and the environment have been reduced and controlled. The CMS was designed to control off-Property migration of HVOCs. Other potential Property exposures are also being controlled through a combination of engineering and institutional controls. However, residual HVOC concentrations in groundwater and potential dense nonaqueous phase liquid (DNAPL) may remain in the primary source area of the Property.

1.5 Project Purpose

The purpose of the project is to implement the cleanup action for the shallow aquifer at the Property that was selected in the CAP, which is provided as Exhibit A in the CD. The cleanup action consists of a soil-bentonite cutoff wall (SBCW) around, and a cap over, all of the Property and gradient control within the Property containment area using a zero valent iron (ZVI) reactor vault.

The purpose of the EDR is to provide the information used in the development and review of the construction plans and specifications, and to document the engineering concepts and design criteria used for design of the cleanup action, consistent with WAC 173340-400(4)(a). This EDR also appends previously submitted construction and design documents (the construction drawings, specifications, and construction quality assurance [CQA] plan in Appendix A), a health and safety plan (HASP, Appendix B), test data used in design (Appendix C), and geotechnical boring logs (Appendix D).

1.6 Report Organization

Section 1 – Introduction: Provides a description of the site, the purpose of the cleanup action, and the organization of the report.

Section 2 – Summary of Site Conditions: Describes the conditions at the Property.

Section 3 – Design Basis Review: Describes the cleanup action objectives and a description of the shallow aquifer cleanup action and the basis for the design of the final cleanup action.

Section 4 – SBCW Design: Describes the design of the SBCW, including the alignment, construction, and soil-bentonite mix design.

Section 5 –Design of Groundwater Treatment Components: Describes the design of the collection trench, reactor vault, treatment media in the reactor vault, and discharge pipe from the reactor vault to the sewer.

Section 6 – Final Cover Design: Describes the design of the final cover, including the cover limits, cover material, soil backfill, erosion control, and stormwater management.

Section 7 – Cleanup Action Implementation: Provides information on required permits and approvals, health and safety, construction quality assurance/quality control (QA/QC), O&M, and compliance monitoring.

Section 6 – Other Requirements: Provides a brief summary of other cleanup action requirements, including institutional controls, public participation plan, and financial assurance.

Section 7 – Reporting and Schedule: Provides a description of the reporting requirements and the schedule for implementing the cleanup action.

Section 8 – References: Lists the sources of information referenced in the document.

2.0 SUMMARY OF SITE CONDITIONS

2.1 Summary of Environmental Conditions

Following is a summary of the environmental conditions at the Property. For additional details, see the FRI/FS report (PES, 2008) and RI Report Addendum (PES, 2011a).

2.1.1 Hydrogeology

Figure 3 presents a sampling location map, and Figure 4 provides a typical cross section across the Property. Five hydrostratigraphic units (labeled by letter from shallowest to deepest) have been identified at the Property: two aquifers (referred to as Layers B and D) and three low-permeability zones (referred to as Layers A, C, and E/F). Layers A, C, E, and F are fine grained and exhibit low permeability. Layers B and D are composed of relatively high permeability sand.

Layer A. The uppermost portion of this unit is unsaturated or only seasonally saturated. The unit is laterally continuous and likely serves as a barrier to downward groundwater movement.

Layer B. The entire thickness of Layer B is saturated, and the Layer B sand forms the shallow aquifer at the Property. An intermediate silt largely divides Layer B into two subunits. For the purpose of assessing groundwater flow and the nature and extent of contamination, Layer B has historically been divided into two aquifer zones. The shallow aquifer zone is defined as the upper portion of Layer B, above the intermediate silt, and the intermediate aquifer zone is defined as the lower portion of Layer B, below the intermediate silt. Wells or piezometers at the Property monitor the shallow and/or intermediate aquifer zones.

Layer C. The silt of Layer C was encountered throughout the Property. This unit serves as an aquitard to vertical groundwater flow and a restriction to the vertical transport of contaminants at the Property. The top of the unit has been found from approximately 27 to 44 feet below ground surface (bgs), with thicknesses ranging from approximately 3.7 to 21 feet. No wells or piezometers at the Property are screened in Layer C.

Layer D. This unit forms the deeper aquifer at the Property and consists primarily of saturated fine to medium sand with interbeds of silty sand. Layer D contains occasional interbeds of sandy silt, silt, and organic soil and occasional accumulations of shell fragments and wood fragments. Property monitoring wells or piezometers monitor both the upper and lower portions of the deep aquifer.

Layer E/F. Layer E/F, the deepest unit encountered during on- or off-property investigations, consists of laminated to massive, gray, moderate to high plasticity silt and clay. The unit contains trace fine sand and fine to coarse gravel, with occasional scattered shell fragments and wood fragments. The upper few feet of the unit can also include interbedded silty sand. Similar to the Layer C silt, the silt and clay of transitional Layer E and Layer F serve as an aquitard to vertical groundwater flow and a restriction to the vertical transport of contaminants at the Property.

2.1.2 Groundwater Flow

Depth to groundwater at the Property has varied from approximately 2 to 12 feet below ground surface (bgs), and groundwater elevations at the Property have varied from approximately 17.5 to 25 feet (relative to the North American Vertical Datum of 1988 [NAVD 88]) in wells screened in Layers A and B, and from approximately 18 to 28 feet in wells screened in Layers D and E. In well clusters, the Layer D potentiometric heads were generally higher than the Layer B potentiometric heads. Downward vertical gradients across Layer C occurred periodically during winter and spring recharge. Groundwater elevations have varied up to approximately 6.5 feet seasonally in wells completed in Layers A and B and up to approximately 5 feet seasonally in wells completed in Layers D and E. Groundwater elevations were highest in winter to spring and lowest in the fall, lagging approximately 2 to 4 months behind precipitation.

Horizontal hydraulic conductivities determined from a short-term pumping test in HYR-1 ranged from 43 to 56 feet/day (1.51×10^{-2} to 1.96×10^{-2} centimeters per second [cm/sec]). No aquifer tests were conducted in Layer D at the Property, but one conducted in a deep well on the Hexcel property yielded horizontal hydraulic conductivity results of 57 to 85 feet/day (2×10^{-2} to 3×10^{-2} cm/sec). The vertical hydraulic conductivities of the Layer B intermediate silt samples were 6.9×10^{-7} and 3.5×10^{-6} cm/sec, respectively, and the vertical hydraulic conductivities of the Layer C silt samples were 1.1×10^{-7} to 5.1×10^{-6} cm/sec. The vertical hydraulic conductivity of a Layer F soil sample collected east of 84th Avenue South was 3.6×10^{-7} cm/sec, and the vertical hydraulic conductivity of a Layer F soil sample collected in the center of the BSB Property was 3.2×10^{-8} cm/sec.

Figures 5 and 6 present groundwater contour maps in the shallow and intermediate aquifer zones, respectively, on March 4, 2011. These contour maps, which include off-Property wells and piezometers to provide areal context, were generated using data collected when the groundwater extraction wells were operating. Groundwater flow in the shallow and intermediate aquifer zones is generally toward the northeast, with the contours showing groundwater capture by the extraction wells. A north-northeast to northeast flow direction was indicated as well by historical data collected before the groundwater extraction system was installed, with seasonal variations within a 20- to 30-degree range. Though not shown, groundwater flow in the deep aquifer zone is also generally toward the northeast, but because of intervening Layer C, there is no discernible effect from the intermediate zone extraction wells. Groundwater recharge likely occurs by precipitation and surface water (drainage ditches) infiltration in significant unpaved areas to the southwest of the Property. Groundwater discharge likely occurs to the 196th East Valley Highway Drainage Ditch, the closest reach of which is located about 2,000 feet northeast of the Property.

Using average horizontal hydraulic gradients, a typical effective porosity, and a range in horizontal hydraulic conductivities, the horizontal groundwater flow rate (average linear velocity) in the shallow, intermediate, and deep aquifer zones varied from 135 to 175, 115 to150, and 110 to 165 feet per year, respectively. Based on mean upward gradients, a conservative effective porosity, and a range in vertical hydraulic conductivities, the estimated upward groundwater flow rate across Layer C beneath the Property was 0.4 to 12 feet per 100 years.

2.1.3 Nature and Distribution of Contamination

The CAP provides a summary of the nature and distribution of contamination at the Property, and a detailed presentation of contamination at the Property is presented in the FRI/FS report (PES, 2008) and the RI report addendum (PES, 2011a). Since the shallow cleanup action primarily provides containment for groundwater at the Property, a brief summary of the nature and distribution of contamination in the shallow aquifer within the boundaries of the Property and immediately north of the Property (between the Property and South 200th Street) follows. Off-Property results are discussed when necessary to provide clarity to the results from investigations conducted at the Property. No polychlorinated biphenyls (PCBs) or pesticides were detected in the groundwater samples analyzed, and only two semivolatile organic compounds (SVOCs) were detected at low concentrations in the analyzed groundwater samples.

Metals. In general, metals were either infrequently detected or detected at low concentrations in groundwater from Property wells. The results were low enough that only arsenic was considered in the development of IHSs. Dissolved arsenic was detected in groundwater samples from shallow and intermediate wells, often at similar concentrations to upgradient wells. Detections ranged from the method reporting limit (MRL) of 5 µg/L to 37 µg/L.

HVOCs in Direct-Push Borings. Fifteen HVOCs were detected in groundwater samples collected from the direct-push borings drilled at the Property (sampled in the shallow and intermediate aquifer zones) in 1999 and 2000. The constituents with the highest detections were trichloroethene (TCE), cis-1,2-dichloroethene (cDCE), and vinyl chloride (VC); the detected concentrations were similar to those in monitoring well samples. The highest concentrations of HVOCs were in borings located near and downgradient of the former drum storage area, two borings at the north end of the former southeastern drying bed, and four borings located near the western (upgradient) boundary of the Property.

HVOCs in Monitoring Wells. Since sampling of the wells began in the mid-1980s, 14 HVOCs have been detected routinely during at least part of the sampling history. TCE, cDCE, and VC were detected at the highest concentrations and were the most frequently detected compounds. The highest concentrations of these HVOCs (low mg/L) have been detected in HYCP-3i, located in the former drum storage area.

HVOC Time Trends. TCE, cDCE, and VC concentrations have varied in each well over time, with much of the shorter-term variation likely due to seasonal changes. HVOC concentrations in Layer B (shallow and intermediate aquifer zone) monitoring wells have decreased significantly since activation of the groundwater recovery system in August 1992. HVOC concentrations in wells located near the former drum storage area (HYCP-3s, HYCP-3i, and HYCP-4) have fluctuated the most with less significant longer-term HVOC concentration declines than those apparent in Layer B monitoring wells installed further from the former drum storage area (HYCP-1i, HYCP-2, HYCP-5, HYCP-6, HYO-2, and Ls).

Spatial Distribution of HVOCs. HVOC concentrations were typically higher in the groundwater samples collected from the upper portion of Layer B (i.e., above the intermediate silt layer) compared to groundwater samples collected from the lower portion of Layer B. The intermediate silt layer appears to have been effective in mitigating HVOC migration into the lower portion of Layer B. At four locations (GP-1, GP-13, GP-14, and the HYCP-3 groundwater monitoring well pair), however, groundwater HVOC concentrations were higher in the lower portion of Layer B.

Figures 7, 8, and 9 present 2010 horizontal distributions of TCE, cDCE, and VC, respectively, beneath the Property. Groundwater impacted with HVOCs at the Property originates primarily near the former drum storage area and adjacent ditch. Although groundwater analytical results from some borings (e.g., SP-18, SP-21, and SP-30) installed upgradient of the former drum storage area and downgradient of the former sludge drying beds indicated elevated levels of cDCE, minimal levels of TCE were detected. Because much higher levels of TCE and cDCE have been detected within and near the former drum storage area (e.g., HYCP-3i, SP-12b) than have been detected at the downgradient edge of the former sludge lagoons (SP-19, SP-20, and SP-22), the investigation results indicate that the predominant source at the Property is located in the former drum storage area, not in the former sludge drying beds.

Another source of comparatively low-level HVOCs in groundwater beneath the Property appears to be from an off-site location to the southwest of the Property. Monitoring wells HY-1s and HY-1i, located cross-gradient of the former drum storage area, have had consistent detections of HVOCs since installation with significant increases in HVOC concentrations after activation of the groundwater recovery system. Groundwater samples collected from direct-push borings SP-15, SP-16, SP-17, SP-18, SP-19, and SP-21, located upgradient or cross-gradient of the former drum storage area, also contained elevated concentrations of cDCE or VC.

The HVOC plume extends from the former drum storage area to the northeast, in the direction of local groundwater flow. Groundwater recovery at HYR-1 and HYR-2 has resulted over time in a smaller HVOC plume footprint with considerably lower HVOC concentrations in the plume at the Property.

DNAPL. Direct-push drilling, continuous coring, visual examination of soil samples, PID screening of soil cores, and laboratory HVOC analysis of soil and groundwater samples were used at the Property to try to identify the presence of DNAPL. DNAPL was not observed during drilling at the Property, but the highest soil laboratory HVOC results indicate the potential presence of DNAPL. Similarly, DNAPL has not been observed in any monitoring well at the Property; however, two lines of indirect evidence indicate that DNAPL is likely present in or near the former drum storage area:

- **Groundwater HVOC concentrations.** A common indicator for the potential presence of DNAPL upgradient of the area monitored is HVOC concentrations greater than 1 percent of the water solubility of the DNAPL component of interest. TCE concentrations in HYCP-3i are frequently above 1 percent of 1,100 mg/L, the solubility limit of TCE in water; and

- **Persistence of contamination.** Contamination persistent at a location may be indicative of DNAPL upgradient of the location. TCE concentrations in recovery well HYR-1 have been very slowly declining for the last 15 years, indicating the likelihood of an upgradient DNAPL source.

3.0 DESIGN BASIS REVIEW

3.1 Cleanup Action Objectives

The Cleanup Action Objectives (CAOs) are based on an evaluation of the data collected during previous investigations and on the established cleanup levels. The focus of the CAOs is protection of human health. Since the Property qualifies for an exclusion from a terrestrial ecological evaluation in accordance with the requirements of WAC 173-340-7491(c), no terrestrial ecological-based CAOs were developed. Since there are no promulgated surface water standards for the indicator hazardous substances (IHSs) at the Property, the human health standards are assumed to be protective and there are no aquatic ecological-based CAOs. Following are the human health-based CAOs identified in the CAP.

3.1.1 Soil Cleanup Action Objectives

The CAOs for soil at the Property is as follows:

- Control incidental ingestion of and dermal contact with soil, and inhalation of particulates and vapors from soil, by future subsurface construction workers on the Property; and
- Contain groundwater that may be impacted by soil containing contaminants of concern

3.1.2 Groundwater Cleanup Action Objectives

The CAOs for groundwater at the Property are as follows:

- Control ingestion of groundwater containing IHSs at concentrations exceeding the applicable cleanup levels;
- Control migration of groundwater containing IHSs at concentrations exceeding the applicable cleanup levels from the Property to surface water; and
- Control inhalation of VOC-containing vapors from groundwater by subsurface construction workers on the Property.

3.2 Description of the Cleanup Action and Design Basis

The shallow aquifer cleanup action consists of installation of (1) a SBCW keyed into the Layer C silt aquitard to contain shallow aquifer HVOCs within the Property, (2) a reactor vault that will treat groundwater discharged from the containment area to provide gradient control, and (3) an asphalt cap over the Property to reduce infiltration into the shallow aquifer. Figure 10 provides a conceptual layout of the SBCW alignment, capped area, and location of the reactor vault system.

The SBCW will generally follow the perimeter of the Property, and the reactor vault will be located within the northeast (i.e., downgradient) corner of the contained area. The SBCW will divert upgradient groundwater around the Property and the ZVI in the reactor vault will destroy contaminants in the groundwater that is discharged from the containment cell. The cap will minimize surface water infiltration. Since the shallow aquifer beneath the Property will be fully contained, flow through both the contaminated area and the need to discharge groundwater through the reactor vault is nearly eliminated except for small amounts of water that may infiltrate the cutoff wall and cap, and for flow induced by seasonal changes in water levels in the surrounding aquifer. The construction drawings, specifications, and CQA manual for the cleanup action are included in Appendix A.

3.2.1 Soil-Bentonite Cutoff Wall

The SBCW is approximately 27 inches thick, 1,580 feet long, and extends to an average depth of approximately 40 feet bgs (average depth to key into Layer C). The SBCW will be constructed from site soils from the SBCW alignment and bentonite mixed in-situ to provide a target maximum hydraulic conductivity of 1×10^{-7} cm/sec.

3.2.2 Reactor Vault System

The reactor vault system will consist of the following major components:

- A high permeability groundwater collection zone surrounding the reactor vault;
- A concrete reactor vault, which will consist of a series of six chambers connected in series that will contain the required amount of ZVI to provide the required contact time at the maximum anticipated flow rate through the vault. The first (inlet) chamber will be the only connection between the reactor vault and the surrounding groundwater collection zone; and
- A collection sump and pump and automated control system in the sixth and final chamber to provide discharge of treated water from the reactor vault to an existing on-site side sewer connection.

The amount of ZVI required to effectively treat groundwater flowing through the vault is based primarily on: (1) the reaction kinetics of the ZVI with contaminants in Property groundwater, (2) the maximum flow rate of groundwater to be discharged from the containment area (i.e., system hydraulics), and (3) the parameter concentration limits applicable to the discharge of treated groundwater to the sanitary sewer. Based on an evaluation of these factors, enough ZVI will be added to provide the required contact time and treatment prior to discharge to the sanitary sewer. Discharged water will be treated to meet the applicable King County Industrial Waste (KCIW) screening levels.

3.2.3 Cap

After the SBCW and reactor vault have been constructed, the portions of the existing asphalt cap that are damaged during the construction of the cutoff wall will be repaired or replaced such that the final cover system will represent a continuous cover system over the whole Property. Imported fill will be used, if necessary, to create adequate surface grades for the new asphalt cover to promote runoff of precipitation. Runoff from the capped areas will be directed, as at present, to the existing stormwater control features on the north side of the property, which ultimately flow to the storm sewer system along South 200th Street.

3.2.4 Operation

Groundwater will be discharged from the vault when needed to maintain a predominantly inward gradient across the SBCW. Monthly measurements in piezometers inside and outside the northeast corner of the SBCW will monitor the gradient where the potentiometric surface is at its lowest level outside the wall, indicating the appropriate timing for discharge.

Water samples will be collected from the treatment system for compliance with the KCIW discharge authorization and to confirm that the required treatment objectives are being achieved. Discharge monitoring samples will be collected from the treatment system discharge pipe at the frequency specified in the discharge authorization; the samples will be analyzed for the parameters required by the authorization. Initial system performance and compliance monitoring will be performed as described in the Startup Plan (PES, 2011b). Long-term monitoring and O&M will be performed as described in Section 7.5.

4.0 SOIL-BENTONITE CUTOFF WALL DESIGN

The cleanup action includes the construction of a SBCW around the Property as described in Section 3.2. The objectives of the SBCW component of the remediation program are:

1. To minimize the flow of shallow aquifer groundwater, and potentially off-site contaminants, into the Property area from hydraulically upgradient areas (the south and west sides); and
2. To contain the on-site sources of contamination in the shallow aquifer when supplemented by gradient control.

The following SBCW design considerations were considered and are discussed below:

- Construction method;
- SBCW depth and subsurface conditions;
- Mix design;
- Structural integrity;
- Verticality; and
- Alignment relative to property boundary and areas of former RCRA closure activities.

4.1 Construction Method

Construction of a traditional soil-bentonite slurry wall involves excavating a trench with a backhoe, temporarily filling the trench with bentonite slurry to maintain the stability of the trench, then permanently backfilling the slurry-filled trench with a soil-bentonite mixture that is typically mixed on the ground adjacent to the trench.

From the early planning stages of this project, it has been proposed that the SBCW be constructed by DeWind One-Pass Trenching Inc. (DeWind), a construction company based in Holland, Michigan that specializes in the installation of SBCWs, using a proprietary One-Pass Trencher (OPT). The OPT is a track-mounted vehicle equipped with a cutting boom that resembles a large chain saw.

The OPT differs from the traditional approach in that the soil and bentonite (and water if necessary) are mixed in situ without the need to excavate the soil and support an open trench, or manage and mix potentially contaminated soils on the ground adjacent to the alignment. This continuous and simultaneous trenching and mixing process reduces the potential for irregularities or discontinuities in the SBCW, and results in a thoroughly mixed homogeneous soil-bentonite material. In addition, and of benefit at this Property, the OPT can construct a cutoff wall with tighter turns than are possible with a backhoe.

The following general construction procedures are anticipated:

- Decommission all obstructive site features from the alignment;

- Excavate an approximately 16-foot wide, 2- to 3-foot deep, working trench along the SBCW alignment. In order to reduce damage to the existing asphalt in the southern portion of the Property, the asphalt will be saw-cut along both the inside and outside edges of the working trench alignment, before the working trench is excavated. The working trench will provide the operating area for the OPT and will contain excess soil and soil-bentonite material generated during the subsequent SBCW construction activities;
- As noted in Section 4.6 below, a pilot test trench and pilot test pits or potholes will be excavated along the portion of the SBCW alignment that is adjacent to the former sludge drying beds, to explore for residual sludge materials;
- Establish the necessary SBCW construction support equipment;
- The OPT will be moved into the working trench and construction of the SBCW will be started by rotating the cutting boom through the subsurface soils into a vertical position. The boom will be capable of reaching the design depth of the wall and constructing a cutoff wall at least 2 feet wide;
- Thereafter, construction of the wall will proceed with the cutting boom in the vertical position serving to both cut the soils to the required depth (see Section 4.2, below) and mix the subsurface soils with bentonite powder, which is introduced into the SBCW trench below the surface through a tube attached to the OPT's cutting boom;
- Several pipe crossings will be built into the SBCW to allow utilities to be introduced into the Property in the future without requiring modifications to the SBCW. The crossings will be constructed using N-12 corrugated polyethylene pipe. The corrugations will ensure that hydraulic pathways are not created through the SBCW;
- After the SBCW has been constructed, excess soil-bentonite mixture will be mixed with cement and stabilized within the working trench; and
- All equipment involved in the construction that has potentially contacted contaminated material will be decontaminated before leaving the Property.

4.2 SBCW Depth and Subsurface Conditions

The subsurface conditions at the Property have been explored by a significant number of borings since the 1980s as summarized in Section 2.0. The concept for the SBCW was based, in part, on the identified presence of the stratum of low-permeability silt (Layer C) below the contaminated Layer B (shallow aquifer), with measured vertical hydraulic conductivities of 1.3 to 2.6 x 10^{-7} cm/sec. Furthermore, as noted in the PES (2006):

> "*...monthly data of water level elevations for multiple years (Appendix C of draft RI/FFS) indicates that the vertical hydraulic gradient across Layer C is predominantly upward from Layer D to Layer B. Although occasional reversals of the gradient occur, these are of limited extent and of short duration... Moreover, transient modeling of the slurry wall/reactor vessel alternative (Appendix H of draft RI/FFS) demonstrates that the remedy is likely to enhance this natural hydraulic control on vertical contaminant migration...*"

In January 2008, a series of Geoprobe borings were advanced along the proposed SBCW alignment to:

- Obtain additional subsurface data, principally to confirm the elevation of the top of Layer C; and
- Obtain composite soil samples, from throughout the majority of the subsurface profile, at four discrete locations along the proposed SBCW alignment (SP-103, SP-109, SP-121, and SP-127, one on each side of the Property). The locations were selected, based on prior subsurface information, to be ones where the soil profile in general was interpreted to have a higher ratio of sand to silt. The soil samples were used to perform laboratory mix design analyses, and since relatively coarse materials were used, the resulting mix design was intended to be conservative for the SBCW as a whole. This mix design testing is discussed in Section 4.3 below).

The top of Layer C is typically present at an elevation of 0 to 12 feet below NAVD 88 (equivalent to depths ranging from approximately 27 to 44 feet bgs). The SBCW has been designed to penetrate past the top of Layer C, and key into Layer C, a minimum of 3 feet, representing a penetration of at least 1.5 times the proposed nominal 2-foot width of the SBCW. In order to accommodate transitions in the stratigraphy of Layer C, and to reduce the variability of the elevation of the bottom of the SBCW, the proposed penetration of the bottom of the wall below the top of Layer C, ranges from the 3-foot minimum depth to about 10 feet. The interpreted subsurface information and the design profile of the SBCW are shown on Drawings 6 to 9 of the Phase II Construction Drawings.

From a construction standpoint, it should be straightforward to key the SBCW into Layer C, since Layer C (like Layers A and B above) is not cemented, does not contain boulders or other oversized material and is easily excavated.

4.3 SBCW Mix Design

To produce a low-permeability durable SBCW, the soil-bentonite mix must contain an adequate concentration of fines (silt/clay), a minimal amount of large diameter particles, and suitable concentrations of bentonite and water. The bentonite contributes to the low permeability of the mix and with the water creates a material similar to a high slump concrete that flows and backfills the entire profile of the excavated trench.

The goal is to design a backfill material based on using on-site soils from the alignment of the wall. This was considered desirable to reduce the quantity of material that otherwise would need to be hauled to and from the Property.

As noted in Section 4.1, soil samples were obtained throughout the majority of the proposed subsurface profile at four boring locations (SP-103, SP-109, SP-121, and SP-127, i.e. one on each side of the Property) that were judged to be the most conservative from a mix design perspective based on stratigraphic and grain size observations (i.e. the most coarse grained locations, representing a relative lack of fines). These samples were sent to Northwest Testing, Inc. (NTI), in Wilsonville, Oregon, for grain size (ASTM C117/C136) and Atterberg limits

(ASTM D4318) testing. The test data is presented in Appendix C. The following information was obtained from this testing:

- The samples from SP-103, SP-121, and SP-127 were non plastic;
- The sample from SP-121 contained the least amount of material finer than the #200 sieve (23.1 percent by weight); and
- The sample from SP-103 had the greatest amount of coarse grained material (8 percent by weight) between the ¾ and 1-inch sieve sizes.

Based on the above, the samples from SP-103 and SP-121 were selected for soil-bentonite mix evaluation as the samples from the entire SBCW alignment representative of the most challenging material (non-plastic, lack of fines, and highest coarse grained percentage) from a mix-design perspective. These samples were sent to Vector Engineering, Inc. (Vector) in Grass Valley, California for the mix-design testing. In addition, a sample of bentonite (Federal Jel 90, a premium-grade Wyoming bentonite product that meets the American Petroleum Institute [API] 13-A specification for drilling-fluid materials) was sent to Vector for the testing.

Vector performed independent grain size evaluations (ASTM D-1140 and C-117) of the two composite samples and prepared three mix-designs on both soil samples, using bentonite concentrations of 3, 5 and 7 percent, by dry weight). Hydraulic conductivity tests (ASTM D-5084, Method C) were performed on remolded specimens from each of the six soil-bentonite test samples. The hydraulic conductivity testing was performed using site groundwater samples as the permeant to determine whether any significant change in conductivity occurred during the tests, which were continued for between 76 hours (SP-103 at 7 percent bentonite) to 126.4 hours (SP-121 at 3 percent bentonite). No significant changes in hydraulic conductivity occurred during any of the tests.

The test data is presented in Appendix C and the hydraulic conductivity results are summarized in the following table:

SUMMARY OF SOIL-BENTONITE MIX DESIGN
HYDRAULIC CONDUCTIVITY TESTING

SAMPLE REFERENCE	BENTONITE CONTENT (% DRY UNIT WT)	HYDRAULIC CONDUCTIVITY AT END OF TEST (CM/SEC)
SP-103	3	8.6 E-8
SP-103	5	3.4 E-8
SP-103	7	2.7 E-8
SP-121	3	1.7 E-7
SP-121	5	5.4 E-8
SP-121	7	3.1 E-8

The data show:

- For both samples SP-103 and SP-121 increasing bentonite contents resulted in decreasing hydraulic conductivities;
- At a bentonite content of 3 percent, sample SP-121 exhibited a hydraulic conductivity greater than 1 x 10^{-7} cm/sec, the maximum target value for the SBCW, and sample SP-103 just met the required criterion;
- Bentonite contents of 5 percent, or greater, achieved hydraulic conductivities of 1 x 10^{-7} cm/sec or less for both samples; and
- A bentonite content of 6 percent, or higher, would achieve hydraulic conductivities of 5 x 10^{-8} cm/sec or less for both samples.

Because mixing and placing operations in the field are less controlled than in the laboratory, the US Army Corps of Engineers (USCOE, 1996) recommends achieving a laboratory permeability of 5 x 10^{-8} cm/sec or less for an in place permeability of 1 x 10^{-7} cm/sec. Therefore, based on the test results and USCOE guidelines, a minimum bentonite content of 6 percent, by weight, is recommended.

The overall results of the testing program were also compared to data provided by USCOE (1996), which states that "soils with an appreciable amount of fines (preferably plastic) are necessary…", and provides the typical gradation criteria contained in the table below, for backfill soils to achieve a low permeability of 1 x 10^{-7} cm/sec or less:

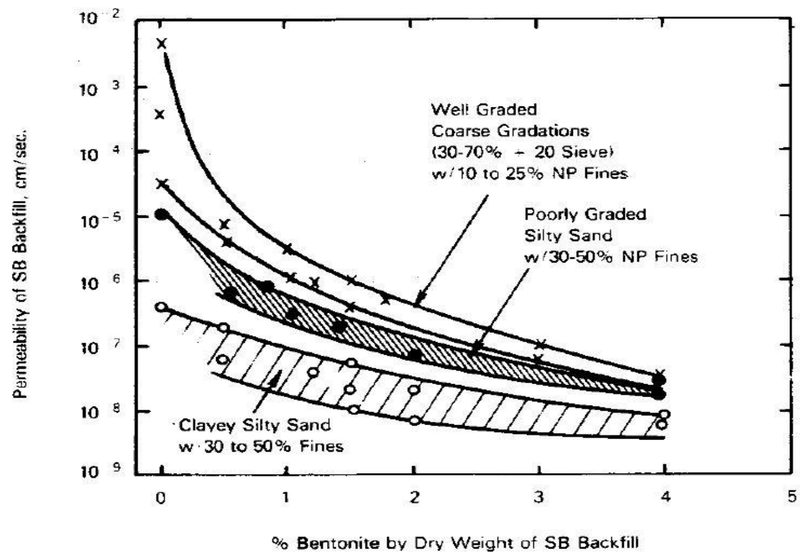
USCOE (1996) GRADATION CRITERIA

SCREEN SIZE OR NUMBER (U.S. STANDARD)	PERCENT PASSING BY DRY WEIGHT
3 inch	100
No. 4	40 – 80
No. 40	25 - 60
No. 200	20 - 40

As shown in the NGI and Vector laboratory gradation data, compared to the USCOE criteria the site soils are generally on the fine side relative to percents passing the No. 4 (88 to 90 percent) and No. 40 (61 to 72 percent) screen sizes, and meet the recommendations for the 3-inch (100 percent) and No. 200 (23 to 32 percent) screen sizes. Overall, the comparison between the site soils and the USCOE data, indicate that the soils (as confirmed by laboratory testing) should be able to be mixed with sodium bentonite to attain an in situ permeability of 1 x 10^{-7} cm/sec or less. However, the fact that the fines are generally non-plastic to low plasticity, rather than plastic means that a greater percentage of bentonite will be required to achieve the desired permeability than would be the case if the fines were plastic.

The laboratory data was also compared to the data presented by D'Appolonia (1980) shown in the figure below. This chart indicates that for the non-plastic site soils at least 4 percent bentonite would be expected to be required to achieve a soil-bentonite permeability of about 1×10^{-7} cm/sec.

Relationship Between Permeability and Quantity of Bentonite Added to SB Backfill



Source: D'Appolonia, 1980

Overall the laboratory tests appear consistent with published empirical data, and provide confidence that a SBCW can be constructed using on-site soils to meet the desired hydraulic conductivity criteria.

As noted above, groundwater from the Property, not laboratory tap water, was used as the permeant in all the testing, to check for deleterious effects of the ground water constituents on the soil-bentonite mixes. The laboratory testing did not indicate any problematic issues with the site water. However, given the noted presence of shell fragments in some of the subsurface soil samples, and since there is a possibility, at certain concentrations, for calcium in groundwater to adversely affect the permeability of sodium bentonite by exchanging calcium ions for sodium ions in the molecular structure (this exchange reduces the swell properties, and hence the low permeability properties, of sodium bentonite), Vista performed a literature review to complement the test results.

The reported concentrations of dissolved calcium in the groundwater samples from the Property were compared to the information found in the literature search. The results from permeability tests performed on sodium bentonite geosynthetic clay liners (GCLs) with weak divalent solutions were investigated by Jo et al. (2005). Jo reported that a divalent solution of calcium chloride (CaCl2) at a concentration of 20 milliMole (mM) (approximately 848 mg/L) resulted in an increase in the hydraulic conductivity of the GCL from approximately 2.0×10^{-9} cm/s to approximately 3.0×10^{-8} cm/s, at which point the salt concentrations of in the influent and effluent were the same, indicating chemical equilibrium with the sodium bentonite.

Calcium concentrations in groundwater at the Property have ranged from 15.8 to 54.8 mg/L (PES, 2005). The highest site concentration is over 15 times less than the concentration of the weak divalent solution investigated by Jo. Therefore, at the calcium concentrations found on site, the effects of the cation exchange on the permeability of the SBCW, as indicated from the laboratory testing, are expected to be negligible.

The gradations of composite soil samples obtained from the four locations along the SBCW alignment are presented in Appendix C. Although, the hydraulic conductivities of these samples were not determined prior to mixing with bentonite, the approximate hydraulic conductivities of the composite samples were estimated using the following relationship proposed by Hazen (1892):

$k = C_H(D_{10})^2$;

Where:

k = hydraulic conductivity (cm/sec);
C_H = Hazen empirical constant, equal approximately to 100; and
D_{10} =diameter (cm) at which 10 percent of the grain size is finer.

Based on a D_{10} of about 0.003 cm, as determined in the laboratory (based on approximately 25 percent of the sample being finer than the #200 sieve [0.074 mm]), the hydraulic conductivity of the composite soil samples is estimated to be approximately 9×10^{-4} cm/sec. Therefore, constructing a SBCW with a target hydraulic permeability of 1×10^{-7} cm/sec or less will result in an overall reduction in the rate of rate of migration of about four orders of magnitude (change from about 10^{-3} to 10^{-7} cm/sec). Since the estimated hydraulic conductivity of the soils is based on a composite sample, the relative effect on the most permeable soils would be even greater.

4.4 Structural Integrity

The strength of SBCWs is not a primary concern when designing pollution migration cut-off walls, since load carrying capacity is not usually an issue. In this case no excessive vertical loads are expected on the wall; therefore soil-bentonite is considered an appropriate material for this application.

Under typical conditions SBCWs are constructed with a minimum width of 2 feet to provide an adequate containment barrier. The thickness is determined primarily by head differential across the barrier and concern for hydrofracture. However, a width of 2 feet is regarded as a minimum nominal width under most circumstances and SBCW equipment is usually configured to construct walls with widths of 2 foot or greater.

Case (1982) recommends that a SBCW should have a width of 0.5 to 0.75 feet per 10 feet of hydrostatic head on the wall. On this basis the proposed wall would be rated for approximately 40 to 27 feet of hydrostatic head.

As presented in Section 2.1.2, groundwater elevations vary up to approximately 6.5 feet seasonally in wells completed in Layers A and B and up to approximately 5 feet seasonally in wells completed in Layers D and E. These variations are substantially less than the maximum referenced recommended guideline value. Therefore, the proposed SBCW will have adequate structural integrity.

4.5 Verticality

USEPA (1998) recognizes that the verticality of a cutoff-wall is particularly important when the design and construction methods involve joints, such as those between slurry wall panels, but is less critical for continuous excavation of the trench if the construction procedure provides for a positive method to control the continuity of the trench between adjacent excavated sections. The proposed DeWind OPT ensures continuous construction; therefore, the verticality of the proposed SBCW is not a concern.

4.6 SBCW Alignment

4.6.1 Alignment Relative to Property Boundary

The alignment of the SBCW has been kept as close to the Property boundary as practicable, within limitations provided by the construction equipment and site features. In this regard, the following were considered:

- A minimum radius of approximately 30 feet; and
- A minimum distance of 12 feet from the property line to allow for the width of the OPT, the working trench and construction of the final cover; however, where the topography at the edge of the Property is relatively steep (e.g. the south-east corner) the 12-foot distance was taken from the top of the slope, rather than the property line to enable the working trench to be constructed without day-lighting through the edge of the existing asphalt cover.

4.6.2 Alignment Relative to Areas of Former RCRA Closure Activities

Several RCRA closure activities have been performed at the Property (PES, 2005), including: (i) equalizing lagoon and sludge settling lagoon, (ii) sludge drying bed, and (iii) drum storage area. Each of these closure areas are considered relative to the alignment of the SBCW. Information about these is presented below.

Equalizing Lagoon and Sludge Settling Lagoon. The former equalizing lagoon and sludge settling lagoon were located in the northeastern portion of the Property (Figure 2). These were closed between September and December 1987, consistent with an EPA-approved closure plan. The closure involved excavating sludge materials, over-excavating at least 12 inches of underlying native soil, backfilling with clean, granular soil, and constructing an asphalt cover system over each area. Some areas of the settling basin were stabilized with geotextile before backfilling. The proposed slurry wall alignment will likely cross the portions of the former equalizing lagoon but should generally pass south of the former settling lagoon.

Sludge Drying Beds. Sludge drying beds were located in the southwest and southeast portions of the property. The beds in the southwest portion of the Property were closed between July and October 1988 consistent with and EPA-approved closure plan. The closure included excavating the sludge and 6 inches of underlying native soil (including the entire berms between the former sludge drying beds), lining the base of the excavations with woven geotextile and an overlying impermeable liner, placing mixed stabilized sludge and soil in the center of the excavation, filling the perimeter of the excavation with clean, granular soil, and constructing a cover system over the area. The cover system includes, from bottom to top, two geotextiles, a PVC liner, granular backfill, crushed rock base layer, and asphalt pavement. The beds in the southeast portion of the property were filled with clean soil and capped in 1988 at the same time as the southwest beds (PES, 2005). These closures resulted in the construction of a RCRA cap over the approximately, southern half of the Property as shown on the drawings.

The precise limits of the sludge drying bed closure areas relative to the proposed SBCW (and associated working trench) alignment are unknown. Therefore, it is possible that residual sludge or remedial materials may be encountered along the SBCW alignment. For this reason, it is proposed to incorporate exploratory activities along approximately the southern half of the SBCW alignment between Station 12+25 and Station 3+70 to explore for stabilized and unstabilized sludge and PVC cap.

The subsurface exploration will consist of a continuous trench, approximately 6 feet deep, between Stations 12+25 and 1+75, and potholes, approximately 6 feet deep, at 50-foot intervals between Stations 1+75 and 3+70, as indicated on Drawing 5 of the Phase I plans. If sludge or closure materials are encountered remedial measures may be proposed, depending on the nature of materials encountered. Remedial measures could include excavating/removing sludge, backfilling with clean soil, repairing cover materials, and making minor adjustments to the alignment of the SBCW.

5.0 DESIGN OF GROUNDWATER GRADIENT CONTROL AND TREATMENT COMPONENTS

5.1 Introduction

The cleanup action includes pumping and treating groundwater within the SBCW to provide groundwater gradient control across the SBCW as introduced in Section 1.5. The groundwater gradient control and treatment process includes: a groundwater collection zone, treatment using ZVI, and flow controlled discharge piping to the King County sanitary sewer, each of which are described below, and in the Phase I construction documents.

5.2 Groundwater Collection Zone

The reactor vault (Section 5.3) will be surrounded by gravel to create a high permeability (specified minimum permeability of 0.5 cm/sec) collection zone , which will be connected by piping to the first chamber in the reactor vault at an elevation of 16.75 feet, approximately 11.5 feet below the top of the reactor vault. This elevation was selected to be approximately 1 foot below the lowest recorded Layer B water level.

In addition, two “interconnect” wells will be constructed proximate to the vault to ensure that groundwater from the lower portion of Layer B is hydraulically connected with the upper portion of Layer B and can migrate to the reactor vault. The interconnect wells will consist of approximately18-inch-diameter borings that are backfilled with 10 x20 silica sand to create a uniform zone of permeable material.

5.3 Groundwater Treatment

Groundwater will be treated in a structure, referred to as the ZVI reactor vault, which includes a series of six chambers that are connected in series. Groundwater will flow through all six chambers and sufficient ZVI will be placed into the chambers to ensure adequate contact time between contaminated groundwater and ZVI to effectively treat the groundwater to meet King County Industrial Waste (KCIW) screening levels.

As shown on Figure 10 and the Phase I construction drawings, the reactor vault is located in the northeast part of the Property. The reactor vault will have overall outside dimensions of 34 feet by 23 feet; however the foundation base slab will extend 3 feet beyond the reactor vault on all sides, and have overall dimensions of 40 feet by 29 feet. The base slab will be 2 feet thick and founded at an elevation of 10.25 feet, approximately 18 feet below the anticipated final grade.

The six chambers in the reactor vault are approximately 10 feet square and 16 feet deep. Each chamber will be fitted with a series of 4-inch-diameter horizontal perforated pipes set in an 8-inch thick gravel layer on the base of the chamber and a solid wall riser that is connected to the next chamber. This arrangement will ensure that water circulates from top to bottom in each chamber and cannot short circuit between the chambers. Flow through the chambers and pipes will be caused by the difference in groundwater levels in the collection zone, outside the reactor vault, and in the discharge riser in the final chamber.

The ZVI will be placed to a maximum depth of approximately 2.3 feet, so that the top of the layer is below the 16.75 foot elevation of the pipes that connect the chambers. Depending on the VOC concentrations in the groundwater and the flow rate through the chambers, ZVI may not need to be placed in each chamber to meet the KCIW discharge criteria.

To ensure that groundwater does not seep through the external walls of the reactor vault and contaminate treated water as it is flowing from chamber to chamber, the outside of the vault will be encapsulated (external walls and underside of foundation slab) in a waterproofing material. In addition each chamber will be covered with a concrete lid bedded in water proofing materials. The lids will be equipped with access hatches and monitoring ports to enable the treatment process to be monitored. However, the lids are also designed to be able to be removed if necessary.

5.3.1 Subsurface Conditions

The subsurface conditions at the proposed reactor vault location had been generally defined by the historical subsurface explorations performed at the site between 1980 and 2000 (PES, 2005). However, an additional seven borings were drilled by Cascade Drilling, Inc., in 2008 using hollow stem augers in the general area planned for the reactor vault. The boring locations are referenced as B-1 to B-7 on Figure 3 and Drawing 5 of the Phase I construction drawings. The purposes of these borings were to:

- Confirm stratigraphic information by advancing the borings to depths of 46 to 46.5 feet below the ground surface;
- Obtain standard penetration test (SPT) data (ASTM 1586) to assess the relative density and consistency of the soils, and to obtain disturbed samples for identification purposes; and
- Obtain undisturbed samples for laboratory testing (moisture content and dry density [ASTM D 2216], Atterberg limits [ASTM D 4318], particle size analysis [ASTM D 422], flexible wall permeability [ASTM D 5084], gradation [ASTM D 1140], and consolidation [ASTM D 2435]) tests.

The high groundwater table presented some problems with sample recovery and interpretation. However, sufficient samples were collected for laboratory testing purposes and the borings confirmed the general subsurface stratigraphy presented by PES (2005), as discussed in Section 2.1.1 above. The boring logs are presented in Appendix D, and the laboratory test results are presented in Appendix C.

The silt layer, Layer C, that the SBCW will key into was identified as an individual unit in borings B-1, B-4, B-5, and B-6; and recorded as a mixed sand and silt layer in the other borings. At the reactor vault location, the elevation of the top of Layer C was interpreted to be at an average elevation of -2.0 feet NAVD 88 and the bottom of Layer C was interpreted to be at an average elevation of -15 feet NAVD 88, with Layer C being approximately 13 feet thick.

Also, based on historical groundwater data, the piezometric elevation in the upper groundwater unit (groundwater unit in Layer B above Layer C) ranges from between 0.47 feet and 1.37 feet below the piezometric elevation in the lower groundwater unit (groundwater unit in Layer D below Layer C).

The information was used to assess geotechnical issues relating to settlement, excavation base stability, and hydrostatic uplift.

5.3.2 Settlement Considerations

It is not anticipated that any significant settlements will occur as a result of constructing the reactor vault since the imposed load of the vault and contents at the base of the foundation slab will be less than the preconstruction stress from the weight of soil at that depth. In addition, the differential settlements should not occur since the reactor vault is designed as a rigid monolithic structure.

5.3.3 Excavation Base Stability

The excavation for the reactor vault was designed to take place inside temporary sheet piles driven into the top of Layer C to prevent or minimize groundwater in Layer B from having direct communication into the excavation. However, the effect of uplift on the bottom of Layer C, due to the potentiometric elevation in Layer D being at approximately 21.5 feet, was evaluated in relation to the depth of excavation that could be achieved without base heave. Using a minimum factor of safety of 1.2 resulted in the selected foundation elevation of 10.25 feet for the reactor vault.

5.3.4 Hydrostatic Uplift

The potential for hydrostatic uplift on the reactor vault was evaluated to ensure stability during and after construction. The critical condition was determined to occur during construction when the sheet piles are withdrawn and the groundwater in Layer B is reestablished around the reactor vault. Under this condition, with the chambers empty and the lids not installed over the chambers, a factor of safety of over 2 was computed if the groundwater level is within 3 feet of the ground surface. Therefore, the reactor vault was determined to have an adequate factor of safety against hydrostatic uplift during short-term construction and long-term service conditions.

5.4 <u>Discharge to the Sewer</u>

The final (outlet) chamber (Chamber 6) in the reactor vault will be equipped with a transducer to monitor the level of water in the chamber and a riser pipe and pump. The riser pipe and pump will be connected with a new discharge line located above the top of the SBCW to the existing on-site sanitary side-sewer connection (Figure 10). The pump will be operated in such a way to discharge treated groundwater at a rate of flow that will ensure adequate residence time between the ZVI and groundwater in the chambers. Monitoring pipes in each chamber will enable the water quality in each chamber to be monitored as needed.

6.0 FINAL COVER DESIGN

6.1 Introduction

Approximately the southern half of the Property is covered with an asphalt cap installed in 1988 as part of the RCRA closure activities. The remaining, northern, portion of the Property is currently covered by a combination of asphalt (which is thought to have been constructed prior to 1980), concrete slabs, and gravel pads. The asphalt in the northern portion of the Property is severely cracked and numerous trees and shrubs are growing through the asphalt and gravel pads.

The proposed cap (PES, 2005) includes maintaining the existing asphalt cover over the southern portion of the Property (with appropriate repair of any portions damaged during the construction of the SBCW), and constructing a new asphalt cover over the northern portion of the Property in a manner that would essentially result in a continuous asphalt cover system over the whole Property. The design shown on the Phase II construction drawings is consistent with this approach.

The final cover design is discussed further below and referenced in the Phase II Construction Documents (Construction Drawings, Specifications and CQA Manual).

6.2 Cover Concept

The existing cover over the northern part of the Property generally slopes at 0.7 to 3 percent to the northeast, but contains flat areas and low spots where surface water ponds. The surface materials in this portion of the Property include distressed asphalt, concrete slabs, gravel pads and concrete curbs and walls. Numerous trees and shrubs are rooted in the underlying soils and are growing through the asphalt and gravel pads. Most of the existing asphalt in this part of the Property is not suitable for use as a final cover, and the surface grades are not suitable for stormwater management.

The ZVI reactor vault, new Property access, and utility crossings of the SBCW will all be constructed in the northern portion of the Property.

The asphalt cover in the southern part of the Property generally slopes at about 1.25 to 2.5 percent to the north without depressions and has good surface water drainage characteristics. This asphalt is in good condition and is suitable for continued used as a final cover. Therefore, it will be maintained intact, to the extent practicable with the activities associated with the installation of the SBCW and construction of the reactor vault.

The concept for the final cover includes the following elements.

- To the extent practicable, restrict general material and equipment staging to the northern part of the Property;
- Saw cut the edges of the SBCW working trench alignment prior to excavating the working trench, to minimize asphalt over-break;

- Regrade the northern part of the Property and some of the southern part of the Property, as illustrated on Drawing 10 of the Phase II Drawings, to achieve a minimum slope of about 0.6 percent (typical greater than 1 percent) and to eliminate flat and low areas. The design contours generally represent filling above existing grades;
- Grind the surface of the asphalt along the alignment where new asphalt, required in the northern portion of the Property, will grade into the southern portion to enable a smooth transition between the two portions of the Property;
- After backfilling the SBCW working trench, pave over the working trench with the asphalt cover system; and
- Adjust the elevations of the casings of groundwater monitoring wells/piezometers to match the final grades.

6.3 Cover System

Two final cover systems are proposed for designated portions of the new asphalt areas, as shown on the construction drawings and described below.

Type 1 Final Cover System. The Type 1 final cover system will have a total thickness of 6 inches consisting of, from top to bottom:

- 2-inch compacted thick layer of Class B hot mix asphalt; and
- 4-inch thick layer of ¾-inch minus crushed rock base.

This Type 1 final cover system is intended to provide a low-permeability cover that will be subjected to relatively light loads, and will be used over the majority of the paved area, including the working trench alignment in the southern part of the Property.

Type 2 Final Cover System. The Type 2 final cover system will have a total thickness of 12 inches consisting of, from top to bottom:

- 3-inch compacted thick layer of Class B hot mix asphalt;
- 3-inch thick layer of ¾-inch minus crushed rock base; and
- 6-inch thick layer of 1½-inch minus crushed rock subbase.

This Type 2 final cover is intended to provide a low-permeability cover that will be subjected to greater loads than the Type 1 system, and will used to create a new entrance to the Property and around the reactor vault. In this area higher loads are anticipated associated with ongoing construction needs (e.g. delivering and installing the ZVI material, and reactor vault lids), maintaining storage tanks and equipment, and providing long term maintenance activities at the vault.

7.0 CLEANUP ACTION IMPLEMENTATION

This section discusses implementation of the final cleanup action, including permits and approvals needed prior to implementation, health and safety, construction quality assurance/quality control (QA/QC), operations and maintenance, compliance monitoring, decontamination, and the handling of cleanup action residuals.

7.1 Permits and Approvals

7.1.1 State Environmental Policy Act

The State Environmental Policy Act (SEPA), Chapter 43.21C RCW, requires all governmental agencies to consider the environmental impacts of a proposal before making decisions. Ecology prepared a draft SEPA checklist for the cleanup and submitted it for public comment in April 2008 along with the Draft Consent Decree, Draft Cleanup Action Plan, and the Draft BSB Focused Remedial Investigation/ Feasibility Study. Following public review, Ecology issued a Determination of Nonsignificance on August 14, 2008 indicating that they did not identify any significant environmental impacts associated with implementing the final cleanup action.

7.1.2 Construction Stormwater General Permit

Because the construction of the cleanup action will disturb more than 1 acre of land, the contractor will be required to apply for coverage under Ecology's Construction Stormwater General Permit (CSWGP). The CSWGP will require that various best management practices (BMPs) be implemented to control runoff from the Property and minimize the transport of sediment and other contaminants to the stormwater conveyance system and receiving waters. These BMPs, along with monitoring and reporting requirements, will be documented in a Stormwater Pollution Prevention Plan (SWPPP) that will also be prepared by the Contractor.

7.1.3 Substantive Requirements of the City of Kent Code

The Cleanup Action will meet the applicable substantive requirements of the following exempt permits or approvals:

- **City of Kent Grade and Fill Permit.** The grade and fill work will meet the minimum substantive requirements of the City of Kent Design and Construction Standards and Kent City Code; traffic control and street use and cut work will meet the minimum substantive requirements of Development Assistance Brochure #6-5, Traffic Control Plans and the Development Assistance Brochure #11.

Throughout the construction process, BSB will determine whether additional permits or approvals are required for the cleanup actions components and work elements.

7.1.4 King County Industrial Waste Approvals

Groundwater and/or wastewater generated during implementation of the cleanup action (e.g., excavation dewatering) will be discharged to the sanitary sewer via underground piping in accordance with BSB's Waste Discharge Permit No. 7575-03 issued by KCIW. All discharges must either be tested to establish that they meet the screening levels in the revised KCIW waste discharge permit or treated to below the screening levels in the pretreatment system that was designed, permitted, and installed in the latter half of 2010.

The pretreatment system consists of a two-tray, low-profile air stripper to treat the groundwater and a vapor treatment system to treat the HVOC-containing vapor effluent from the air stripper. A chemical feed pump injects an antiscalent into the water stream before it enters the air stripper to prevent scale formation and fouling of the air stripper. The vapor treatment system consists of a moisture knockout drum followed by a vessel filled with zeolite media impregnated with potassium permanganate (Hydrosil HS600), then a final vessel filled with activated carbon prior to discharging the treated vapors to the atmosphere via a 4-inch-diameter stack mounted to the exterior of the treatment building. An electric heater raises the temperature of the air exiting the zeolite vessel to lower the relative humidity to the optimal level for adsorption by the activated carbon. The water and vapor treatment systems and controls are enclosed in a treatment building with ventilation and a heating fan for climate control. The treated water is discharged to the sanitary sewer through a side-sewer connection.

Once the cleanup action construction is completed, startup testing will begin as described in Section 7.4. Groundwater discharged during startup operations will meet the requirements of Waste Discharge Permit No. 7575-03. Data will be collected during startup operations to demonstrate the effectiveness of the ZVI reactor vault in meeting the KCIW screening levels. Once this demonstration has been made and accepted by KCIW, and given the relatively small quantity of groundwater to be discharged under routine operations, BSB anticipates applying to KCIW for a Major Discharge Authorization (MDA) to replace their existing waste discharge permit. In general, an MDA requires less oversight and monitoring than a permit.

7.1.5 City of Kent Water Hydrant Permit

Since the flow rate of water spigots at the Property are not sufficient for the volume of water required for preparation of the bentonite slurry to be injected as part of the SBCW construction, BSB or its contractor will obtain a permit and meter to allow use of a fire hydrant adjacent to the Property during injection events.

7.1.6 Ecology Well Abandonment and Installation Regulation

Well installation, piezometer installation, and well abandonment will comply with the Minimum Standards for Construction and Maintenance of Wells (WAC 173-160). WAC 173-160-451 prohibits the installation of resource protection wells (which includes piezometers) using the direct push drilling method in borings deeper than 30 feet. BSB will submit a variance request to Ecology to allow the intermediate-depth piezometers to be installed to depths greater than 30 feet.

7.2 Health and Safety

A HASP for the shallow aquifer cleanup action is provided in Appendix B. The HASP was prepared consistent with the requirements outlined in the Worker Health and Safety guidelines (WAC 173-340-810) and the Occupational Safety and Health Act (OSHA, 29 CFR 1900). All workers associated with the cleanup action will be required to read the HASP prior to starting work at the Property; however, only PES personnel will be responsible for signing the HASP associated with the cleanup action. Subcontractors and or other non-PES personnel will be responsible for preparing, providing, and signing their own project specific HASP. Health and safety meetings associated with the cleanup action will be conducted with all contractors, subcontractors, construction personal, and all other applicable personnel prior to the commencement of cleanup action activities at the Property.

7.3 Construction Quality Assurance/Quality Control

Construction Quality Assurance and Quality Control (CQA/CQC) will be conducted to ensure that the final cleanup action is implemented as designed.

7.3.1 Construction Quality Assurance

CQA represents a planned and systematic pattern of procedures and documentation designed to provide confidence that items of work or services meet the requirements of the contract documents. A third-party consultant independent of the Owner and Contractor must perform CQA. A CQA Manual (*Construction Quality Assurance Manual – Final Cleanup Action* [CQA Manual; Vista Consultants, 2011]) has been prepared to outline specific monitoring, testing, construction, and documentation procedures that will be implemented to ensure that the remedial action objectives of the project are met. The CQA Manual is provided in Appendix A and includes the following information:

- The CQA organization, roles, and responsibilities;
- General requirements for notifications, meetings, control of project records and documentation, and control of nonconforming work;
- Delineation of the detailed CQA requirements for specific work elements including:
  - Site clearing and preparation;
  - Shoring of the reactor vault excavation;
  - Excavation and water management associated with the vault;
  - Cast in place concrete work for the reactor vault;
  - Waterproofing and backfilling the reactor vault;
  - Installation of piping inside of the reactor vault;
  - Construction of the SBCW; and
  - Grading and construction of the final cover system.

- Monitoring and documentation requirements including daily record keeping, daily test reports and installation reports, nonconformance reports (as necessary), progress reports, drawing and specification revisions, requests for information, test data summaries and a Final Construction Report.

The CQA activities are separate from the construction quality control (CQC) activities identified in the Construction Drawings and Technical Specifications that the Contractor must perform.

7.3.2 Construction Quality Control

CQC activities provide a means to measure and regulate the characteristics of an item or service to comply with the requirements of the contract documents. CQC activities will be conducted by the Contractor, subcontractors, and equipment and materials suppliers. In general, the Contractor is responsible for coordinating the activities of its own forces and subcontractors, scheduling and performing the work within the timeframe and budget agreed to in the contract, performing the work in accordance with the Construction Drawings and Technical Specifications, and implementing QC procedures to document construction complies with the Technical Specifications. The Contractor is expected to cooperate with the Owner and its CQA representative in performing CQA activities to achieve a quality product.

7.4 Operations and Maintenance

Because operations of the cleanup action will begin with an extended period of startup pumping and testing, a startup plan was prepared and submitted to Ecology December 7, 2011 (PES, 2011b). This startup plan describes the tasks and methods used to evaluate the hydraulics and treatment efficiency of the reactor vault that will be used to treat groundwater pumped from within the containment system. Specifically, the Startup Plan combined relevant components of what is typically contained in an O&M Plan and a compliance monitoring plan (CMP) including:

- A description of the objectives and overall approach for startup of both the reactor vessel and containment systems;
- Reactor vault startup and performance testing procedures;
- The location and installation method for the additional shallow piezometers or groundwater monitoring wells needed for the compliance monitoring network;
- Groundwater sampling approach and procedures;
- Quality assurance procedures to ensure data quality;
- A description of the approach for evaluating and reporting the data collected during the startup period; and
- A schedule for the startup period.

Based on the information collected during the startup evaluation, a draft O&M plan will be prepared per WAC 173-340-400(4)(c). The draft O&M plan will include:

- The technical guidance and regulatory requirements to assure effective operations under both normal and emergency conditions;
- A discussion of the operating principles and processes involved in the cleanup action;
- Design criteria and operating parameters and limits;
- General operating procedures, including startup, normal operations, and emergency or contingency procedures;
- A discussion of the detailed operation of individual components of the cleanup action, including a description of various controls, recommended operating parameters, and safety features;
- Procedures and sample forms for collection and management of operating and maintenance records;
- Equipment maintenance schedules incorporating manufacturers recommendations; and
- Contingency procedures for spills, releases, and personnel accidents.

7.5 Compliance Monitoring

As with the O&M activities above, the compliance monitoring associated with startup is described in the Startup Plan (PES, 2011b). After completion of the startup testing and monitoring data evaluation, a draft CMP will be prepared outlining the procedures to be used to monitor the cleanup action after final startup. The draft CMP will be prepared consistent with WAC 173-340-410 describing monitoring to be performed during operation and maintenance, a sampling and analysis plan meeting the requirements of WAC 173—340-820, data evaluation procedures, and reporting of the compliance monitoring data. Compliance monitoring will entail protection monitoring, performance monitoring, and confirmational monitoring (WAC 173-340-410).

8.0 OTHER REQUIREMENTS

8.1 Institutional Controls

Institutional controls will be incorporated in the cleanup action since contaminants exceeding the MTCA Method B cleanup levels will remain on the Property (WAC 173-340-440(4)(a)). The intent of the institutional controls will be to preserve the integrity of the cleanup action. Institutional controls will include filing an environmental covenant under Chapter 64.70 RCW in the real property records to notify potential purchasers of the Property of this cleanup action. The environmental covenant will limit activities that may create a new exposure pathway (e.g., indoor air pathway or subsurface worker pathway), result in the release of hazardous substances, or interfere with the integrity of the cleanup action without Ecology's written approval. Any future development of the Property will have to consider the indoor air pathway and incorporate engineering controls (e.g., vapor barriers) as appropriate to control potential exposures, subject to Ecology's written approval.

8.2 Public Participation Plan

Consistent with the requirements of Section XXVII of Consent Decree No. 11-2-27288-5 between BSB and Ecology, a Public Participation Plan (PPP) is required for this Property. Ecology has prepared a PPP and shall review this periodically to determine its continued appropriateness and whether it requires amendment. BSB will assist Ecology in developing and implementing the PPP as requested by Ecology. This assistance may include the preparation of mailing lists, fact sheets, and public notices.

8.3 Financial Assurance

BSB provided a cost estimate for purposes of establishing financial assurance for the shallow aquifer cleanup at the Property to Ecology on December 8, 2011. This cost estimate was prepared consistent with the requirements of Section XXI, Paragraph3 of Consent Decree No. 11-2-27288-5 between BSB and Ecology, and reflects the current status of the shallow aquifer cleanup action and the estimated costs for startup activities and long-term operations, maintenance, and monitoring. Estimated costs for completion of the deep aquifer investigation and implementation of long-term deep aquifer monitoring are also included. BSB will provide Ecology documentation of financial assurance within 30 days of Ecology's approval of a final cost estimate.

9.0 REPORTING AND SCHEDULE

Project reporting will include preparation of a construction report, a draft O&M plan, a draft CMP, and cleanup progress reports.

9.1 Construction Report

A final cleanup action construction report will be submitted to Ecology 90 days after completion of construction to document how the cleanup action was constructed, the CQA procedures used, and the test data supporting compliance with the design.

9.2 Draft Plan Submittal

Based on the information collected during the startup evaluation, a draft O&M plan will be prepared and submitted for Ecology review. The O&M plan will include the components required per WAC 173-340-400(4)(c). After completion of the startup testing and monitoring data evaluation, a draft CMP will be prepared outlining the procedures to be used to monitor the cleanup action after final startup. The draft CMP will be prepared consistent with WAC 173-340-410 describing monitoring to be performed during operation and maintenance, a sampling and analysis plan meeting the requirements of WAC 173—340-820, data evaluation procedures, and reporting of the compliance monitoring data. The draft O&M plan and draft CMP will be submitted to Ecology within 45 days of the end of the startup testing. The startup testing results will be included in the draft plans.

9.3 Quarterly Progress Reports

Per Consent Decree 11-2-27288-5, Section XI, progress reports will be submitted to Ecology on a quarterly basis. Each report will include a list of activities that have taken place during the quarter, a detailed description of deviations from required tasks and the cleanup action plan, a schedule for recovering time lost due to deviations, raw data generated during the quarter, and a list of deliverables in the upcoming month if different than the schedule. The reports will be submitted to Ecology no later than 20 days after the end of the quarter. As stated in the consent decree, BSB may submit a request to Ecology to reduce the frequency of progress report preparation.

10.0 REFERENCES

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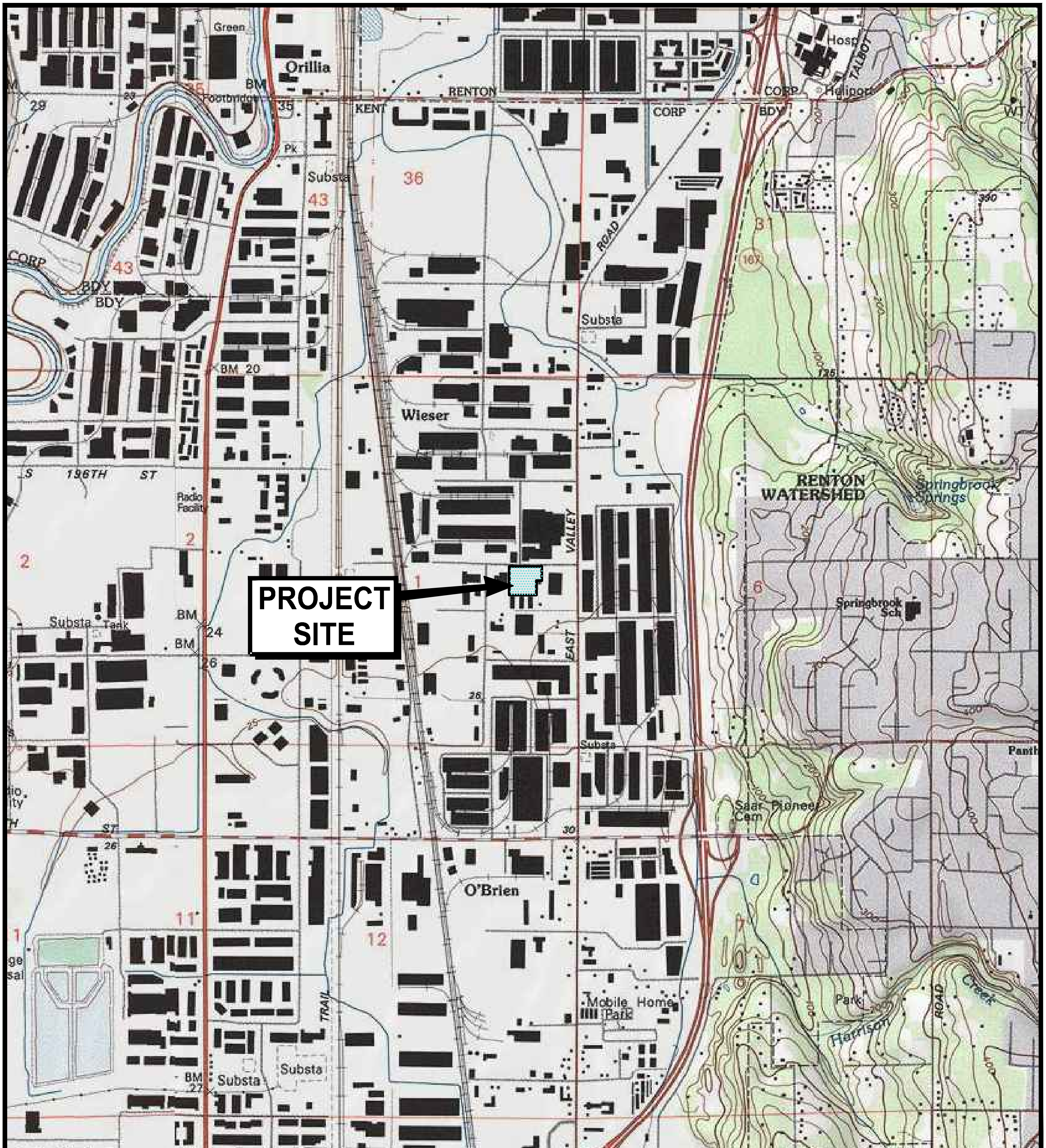
ILLUSTRATIONS



0 2000 4000

Scale in Feet

N

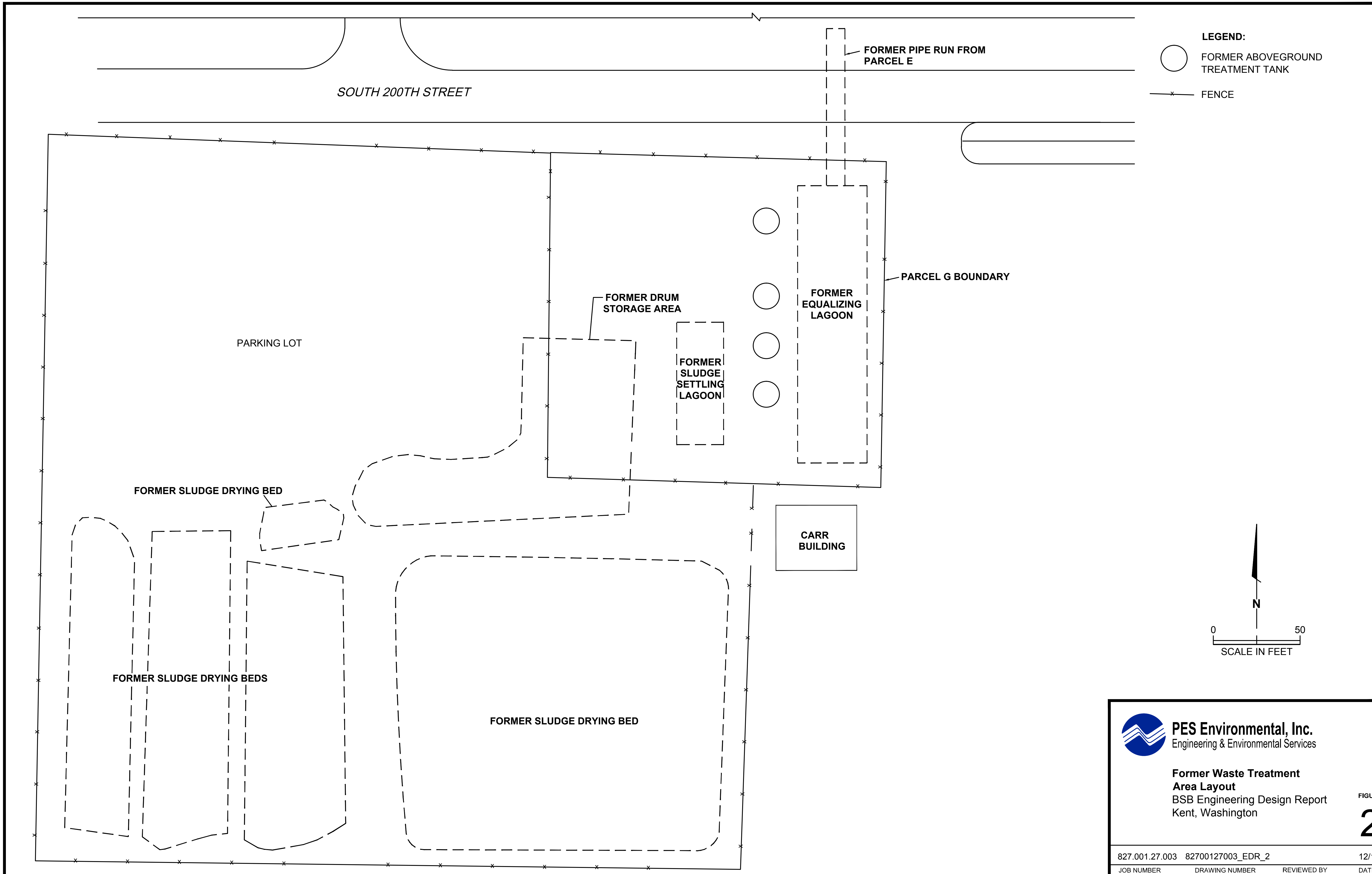
U.S.G.S. Topo Map - Renton, WA, 7.5-minute quadrangle.1949 revised 1994.

PES Environmental, Inc.
Engineering & Environmental Services

Property Location Map
BSB Engineering Design Report
Kent, Washington

FIGURE
1

827.001.27.003	82700127003_EDR_1		12/11
JOB NUMBER	DRAWING NUMBER	REVIEWED BY	DATE

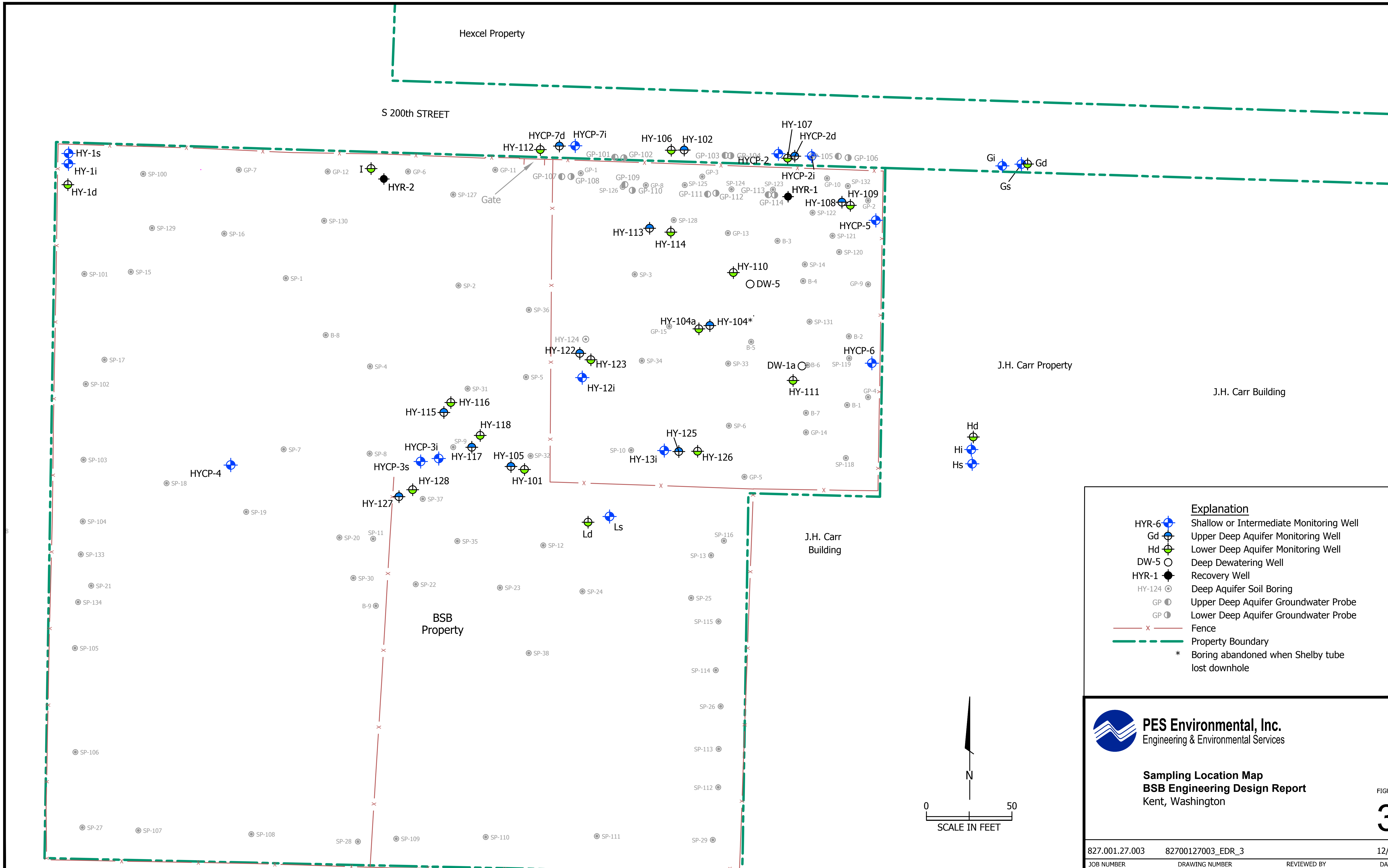


PES Environmental, Inc.
Engineering & Environmental Services

Former Waste Treatment Area Layout
BSB Engineering Design Report
Kent, Washington

FIGURE
2

JOB NUMBER	DRAWING NUMBER	REVIEWED BY	DATE
827.001.27.003	82700127003_EDR_2		12/11

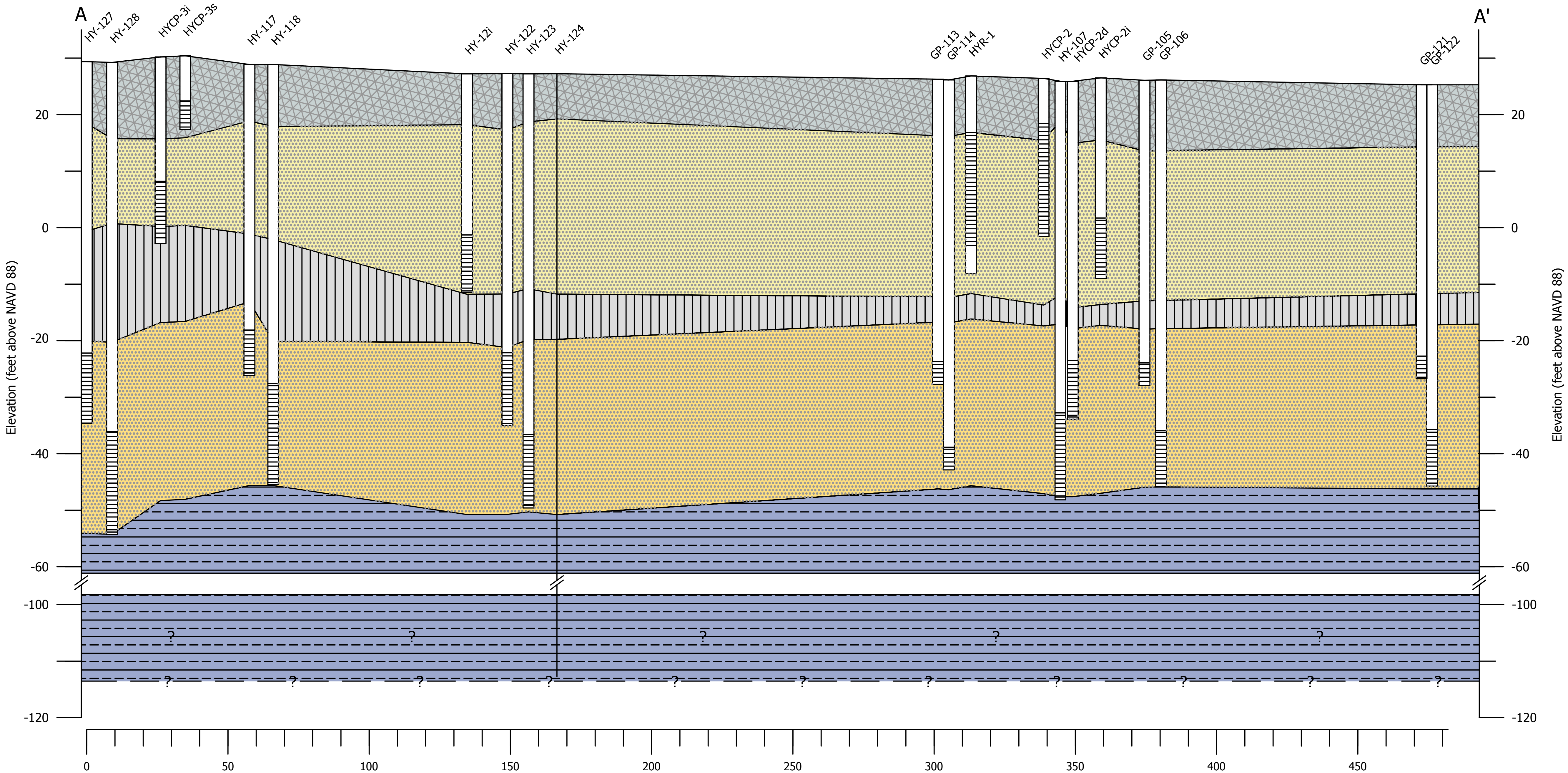


PES Environmental, Inc.
Engineering & Environmental Services

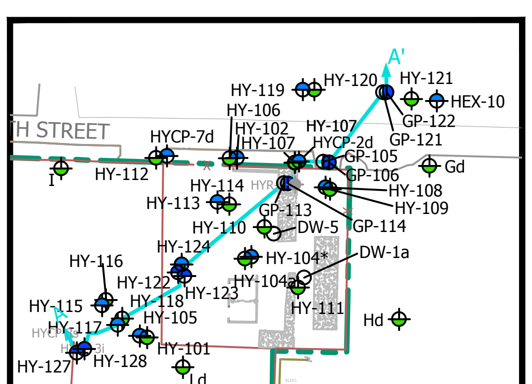
Sampling Location Map
BSB Engineering Design Report
Kent, Washington

FIGURE
3

JOB NUMBER	DRAWING NUMBER	REVIEWED BY	DATE
827.001.27.003	82700127003_EDR_3		12/11



Explanation



Well Screen

Soil Boring

— ? — Base of layer E/F not penetrated during drilling, thickness unknown.

Layer A

Layer B

Layer C

Layer D

Layer E/F

Note: the temporary GP screens were abandoned after sampling

20

0

Vertical Scale in Feet

0 40

Horizontal Scale in Feet

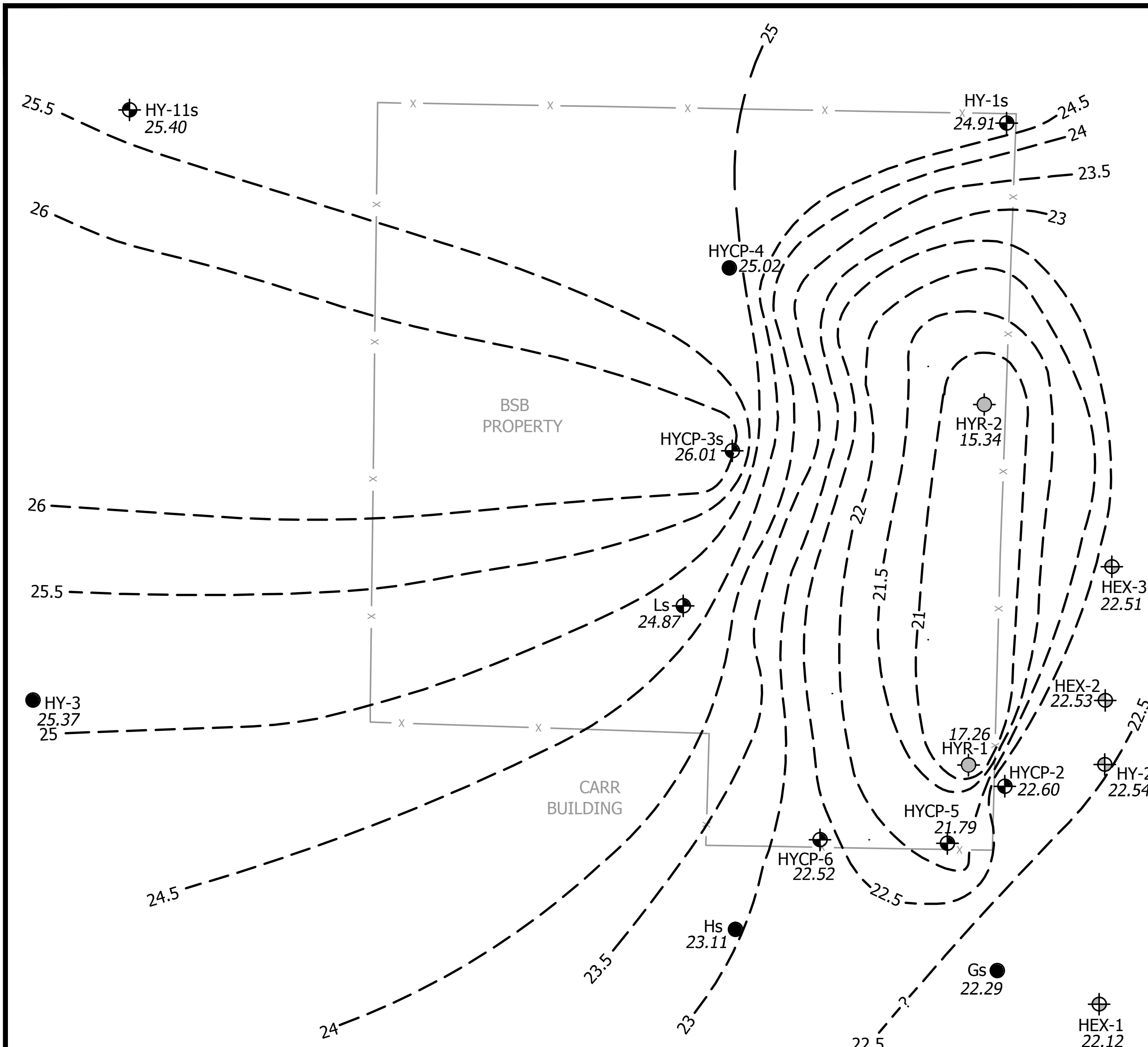
Vertical Exaggeration 2:1

PES Environmental, Inc.
Engineering & Environmental Services

Cross Section A-A'
BSB Engineering Design Report
Kent, Washington

FIGURE
4

827.001.27.003	82700127003_EDR_4		12/11
JOB NUMBER	DRAWING NUMBER	REVIEWED BY	DATE



Legend

HY-11s	⊕	Groundwater Sampling and Groundwater Level Monitoring Well
HYR-1	◉	Recovery Well
HYCP-4	●	Water Level Monitoring Well
HEX-1	⊕	Monitoring Well Installed and/or Monitored by Hexcel
	—x—	Fence
24	- - -	Groundwater Elevation Contour (feet above NAVD88)

N

0 100

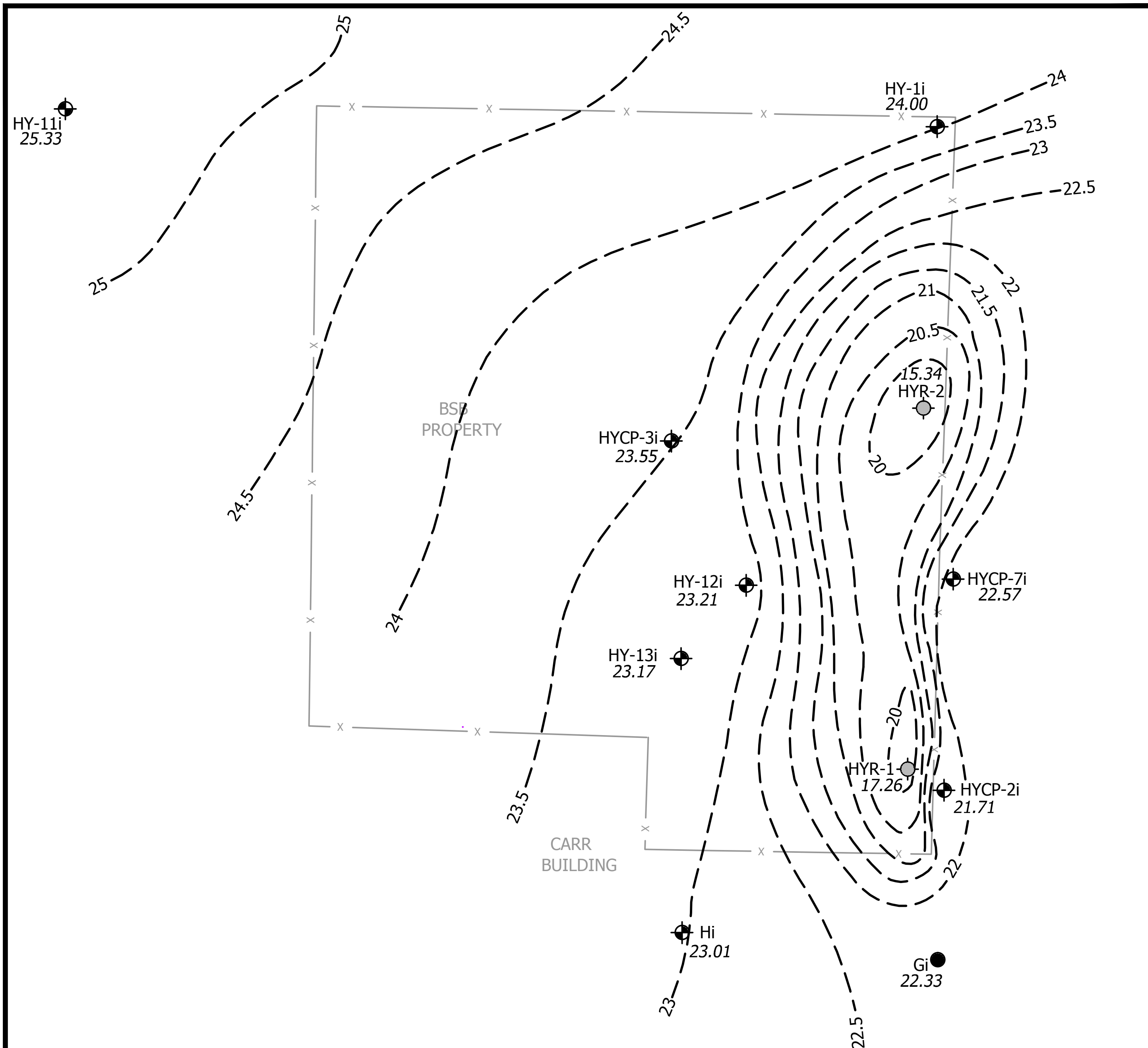
SCALE IN FEET

PES Environmental, Inc.
Engineering & Environmental Services

Water Table, Shallow Aquifer Zone
March 4, 2011
BSB Engineering Design Report
Kent, Washington

FIGURE
5

JOB NUMBER	DRAWING NUMBER	REVIEWED BY	DATE
827.001.27.003	82700127003_EDR_5		12/11



Legend

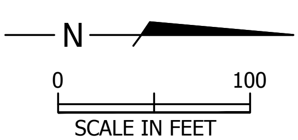
HY-11i — Groundwater Sampling and Groundwater Level Monitoring Well

HYR-1 — Recovery Well

HYCP-1i — Water Level Monitoring Well

— x — Fence

24 — Groundwater Elevation Contour (feet above NAVD88)

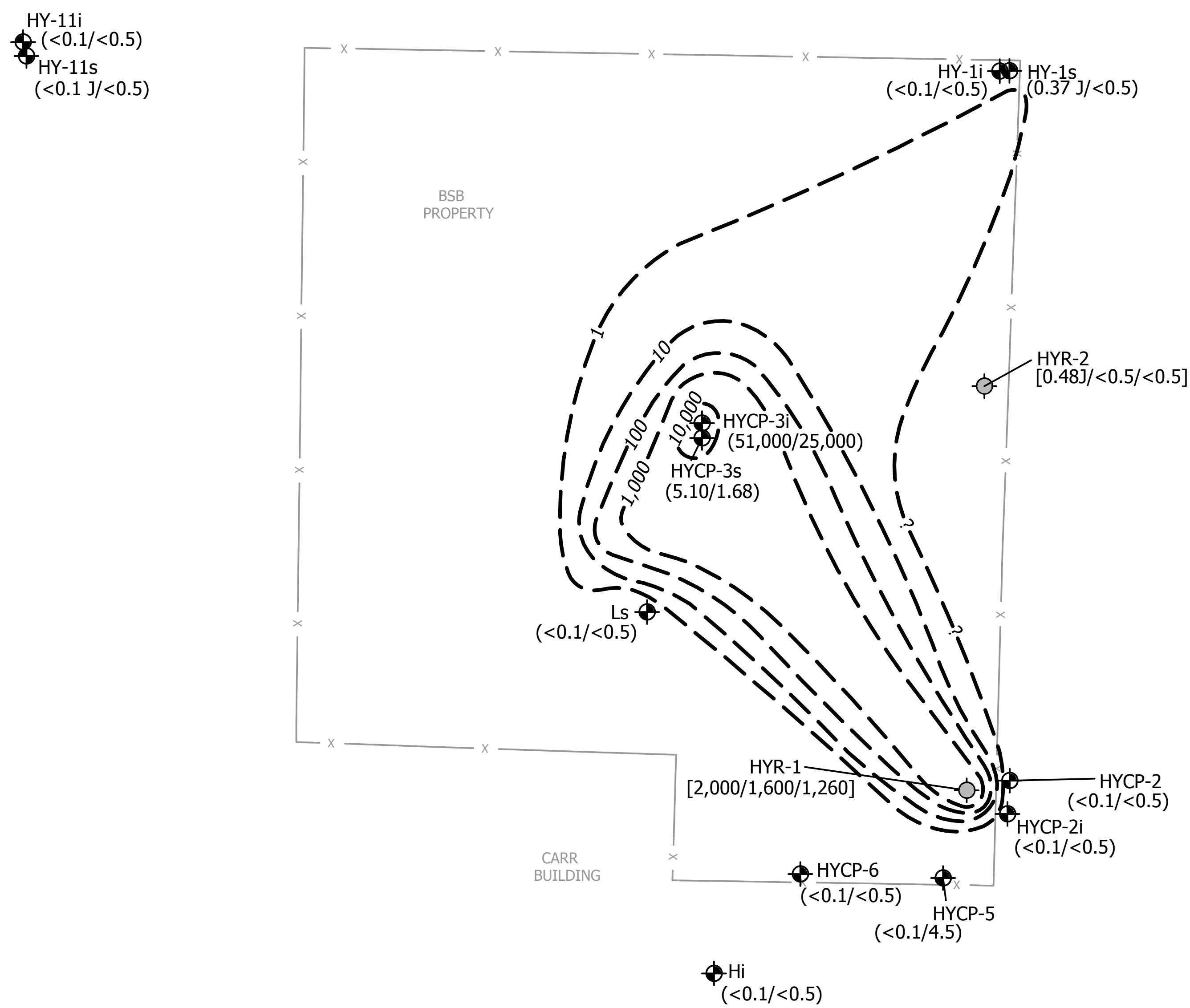


PES Environmental, Inc.
Engineering & Environmental Services

Potentiometric Surface, Intermediate Aquifer Zone, March 4, 2011
BSB Engineering Design Report
Kent, Washington

FIGURE
6

827.001.27.003	82700127003_EDR_6		12/11
JOB NUMBER	DRAWING NUMBER	REVIEWED BY	DATE



Legend

HY-11s — Groundwater Sampling and Groundwater Level Monitoring Well

HYR-2 — Recovery Well

1000 — Isoconcentration Contour, based on the highest detected concentration in each well

(<0.1/<0.5) — Concentration of Trichloroethene (micrograms per liter) in Groundwater (April/December 2010)

[0.48J/<0.5/<0.5] — Concentration of Trichloroethene (micrograms per liter) in Groundwater (February/June/December 2010)

J — Lab-assigned data qualifier indicating that the result is an estimated concentration less than the method reporting limit (MRL) but greater than or equal to the method detection limit (MDL)

—— x —— Fence

N

0 100

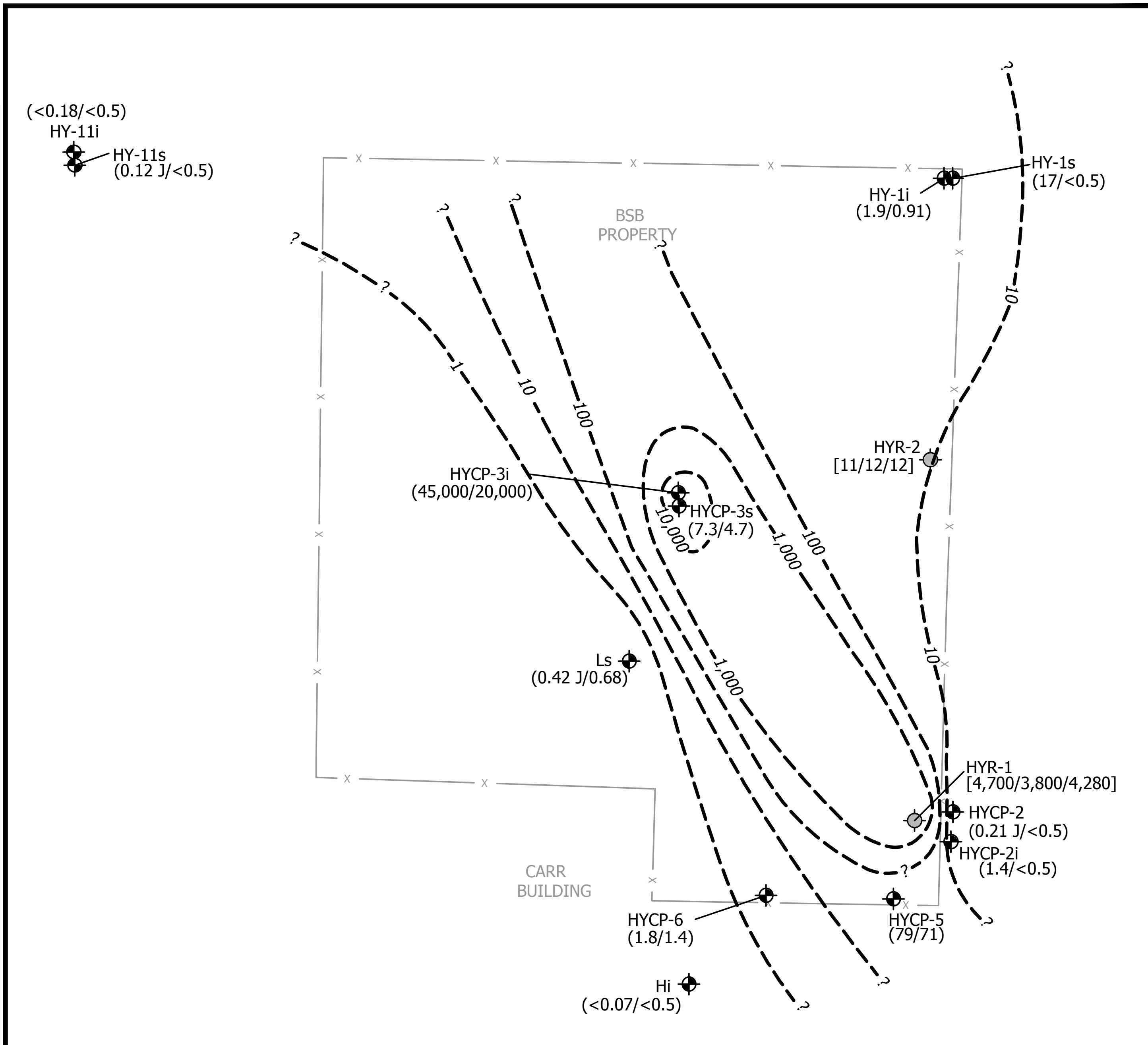
SCALE IN FEET

PES Environmental, Inc.
Engineering & Environmental Services

TCE
Isoconcentration Contours
in Layer B Groundwater
BSB Engineering Design Report
Kent, Washington

FIGURE
7

JOB NUMBER	DRAWING NUMBER	REVIEWED BY	DATE
827.001.27.003	82700127003_EDR_7		12/11



Legend

HY-11s	Current Monitoring Well
HYR-2	Recovery Well
1000	Isoconcentration Contour, based on the highest detected concentration in each well
(0.12 J/<0.5)	Concentration of cis-1,2-Dichloroethene (micrograms per liter) in Groundwater (April/December 2010)
[11/12/12]	Concentration of cis-1,2-Dichloroethene (micrograms per liter) in Groundwater (February/June/December 2010)
J	Lab-assigned data qualifier indicating that the result is an estimated concentration less than the method reporting limit (MRL) but greater than or equal to the method detection limit (MDL)
— x —	Fence

N

0 100

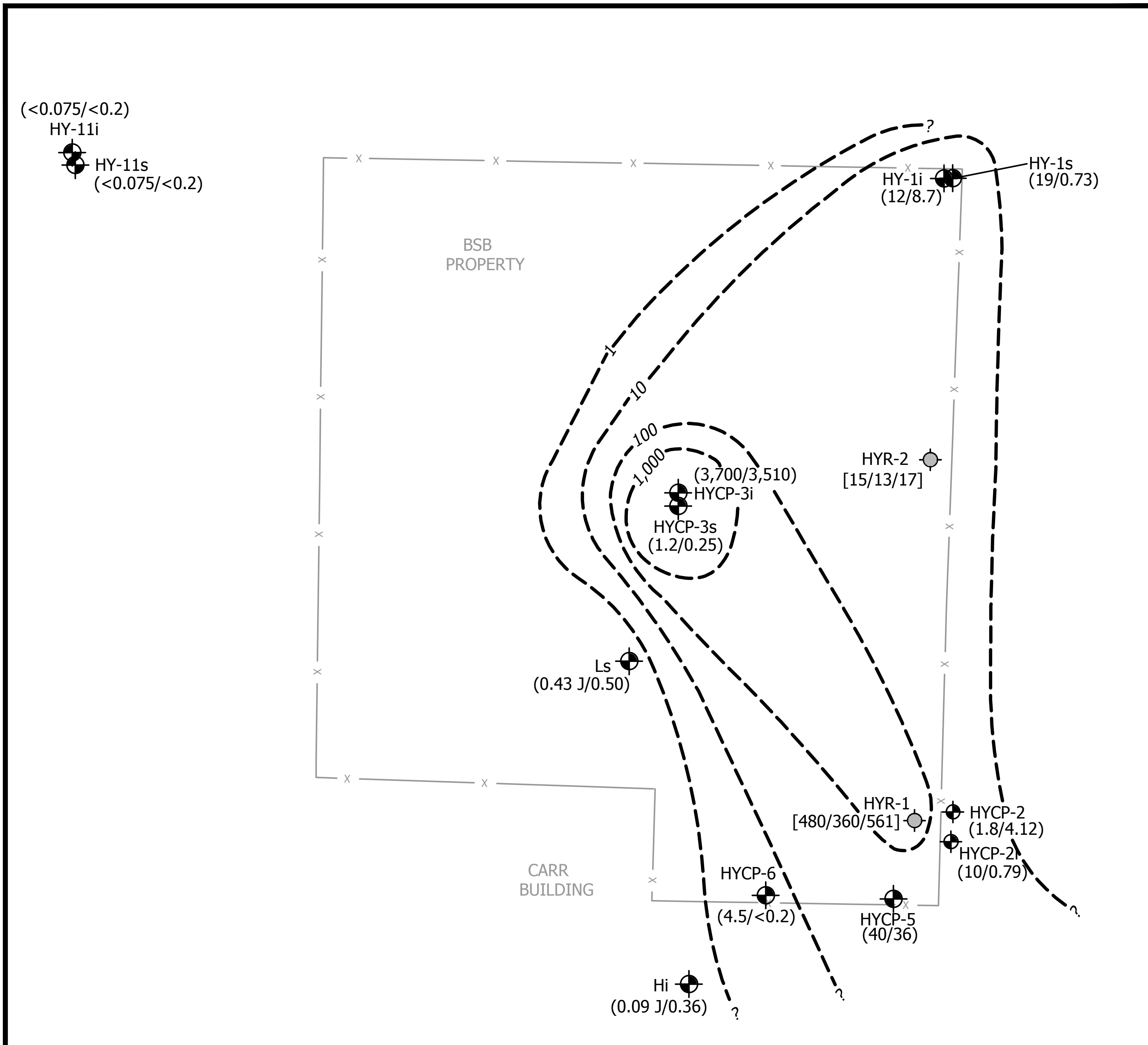
SCALE IN FEET

PES Environmental, Inc.
Engineering & Environmental Services

cDCE Isoconcentration Contours
in Layer B Groundwater
BSB Engineering Design Report
Kent, Washington

FIGURE
8

JOB NUMBER	DRAWING NUMBER	REVIEWED BY	DATE
827.001.27.003	82700127003_EDR_8		12/11



Legend

HY-11s — Current Monitoring Well

HYR-2 — Recovery Well

1,000 — Isoconcentration Contour, based on the highest detected concentration in each well

(<0.075/<0.2) — Concentration of Vinyl Chloride (micrograms per liter) in Groundwater (April/December 2010)

[15/13/17] — Concentration of Vinyl Chloride (micrograms per liter) in Groundwater (February/June/December 2010)

J — Lab-assigned data qualifier indicating that the result is an estimated concentration less than the method reporting limit (MRL) but greater than or equal to the method detection limit (MDL)

— x — Fence

N

0 100

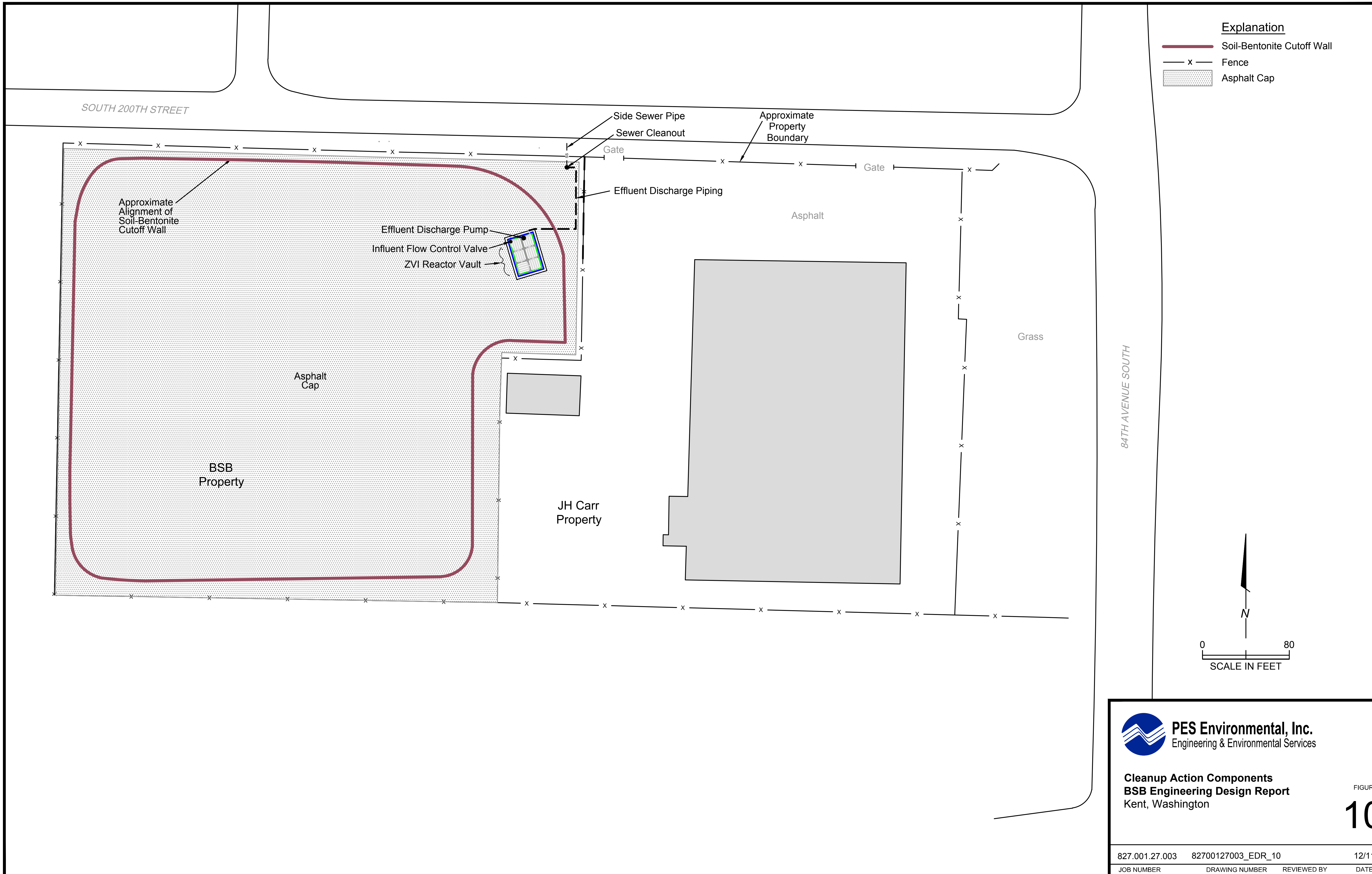
SCALE IN FEET

PES Environmental, Inc.
Engineering & Environmental Services

VC Isoconcentration Contours
in Layer B Groundwater
BSB Engineering Design Report
Kent, Washington

FIGURE
9

827.001.27.003	82700127003_EDR_9		12/11
JOB NUMBER	DRAWING NUMBER	REVIEWED BY	DATE



PES Environmental, Inc.
Engineering & Environmental Services

Cleanup Action Components
BSB Engineering Design Report
Kent, Washington

FIGURE
10

827.001.27.003	82700127003_EDR_10		12/11
JOB NUMBER	DRAWING NUMBER	REVIEWED BY	DATE

APPENDIX B

HEALTH AND SAFETY PLAN

PES Environmental,
Engineering & Environmental

SITE SPECIFIC HEALTH & SAFETY PLAN

Note: This Site Specific Health & Safety Plan must be re-evaluated and updated annually or when site conditions or scope of work changes.

SHALLOW AQUIFER CLEANUP ACTION CONSTRUCTION
BSB PROPERTY
KENT, WASHINGTON

Site Name: BSB Property **Date: August 1, 2011**
Location: 84th Avenue South and South 200th Street, Kent, WA **Projects: 827.001.28**

HASP Disclaimer –"This HASP has been designed for the methods presently contemplated by the company for execution of the proposed work. Therefore, the HASP may not be appropriate if the work is not performed by or using the methods presently contemplated by the company. In addition, as the work is performed, conditions different from those anticipated may be encountered and the HASP may have to be modified. Therefore, the company only makes representations of warranties as to the adequacy of this HASP for currently anticipated activities and conditions".

HASP Approvals: This HASP has been reviewed and approved by the project manager and the H&S representative.

Project Manager: ______________________ Signature ________ Date

Health and Safety Representative: ______________________ Signature ________ Date

CONTENTS

1 PROJECT INFORMATION

1.1 Address and Driving Directions

Address: **84th Avenue South and South 200th Street, Kent, WA**

Driving Directions: From Interstate 405, take State Route 167 South to South 180th Street exit. Turn South on East Valley Highway (84th Avenue South) to South 200th and right (west) to the BSB property (south side of street).

Special Instructions:
- Beware of traffic when crossing South 200th Street and 84th Avenue South;
- Beware of construction equipment active on site; and
- While on site, note any areas of hazard potential. At the end of the day, or at a convenient time, inform the Site Engineer of the situation.

1.2 Scope of Work

The purpose of this HASP is to address the following PES operations at this site:

- Site visits and oversight during cleanup action construction activities;
- Field oversight during well and piezometer abandonment, installation, and modification;
- Field oversight during pretreatment system O&M, monitoring, and modifications; and
- Reactor vault startup and testing;

Note: As the scope of work changes, this HASP will be modified to address any new hazards.

SITE DESCRIPTION

This site is an approximately 4-acre site located at 8202 South 200th Street in Kent, Washington. The site is flat, with more than 90 percent of the site covered with concrete/asphalt pavement. The BSB property, formerly a waste handling area, is a fenced vacant lot south of 200th Street.

The Hytek Finishes Company formerly operated a metal finishing and electroplating plant at the site. The plant was located north of 200th Street, and wastes were formerly treated and stored in a waste treatment area located south of 200th Street. The waste treatment area contained a wastewater holding lagoon, treatment tanks, a sludge holding lagoon, sludge drying beds, and a chemical storate area.

1.3 Employee and Contractor Responsibilities

Each person is responsible for his/her own health and safety, for completing tasks in a safe manner and for reporting any unsafe acts or conditions to his/her supervisor and the Project Manager (PM). All persons on site are responsible for continuous adherence to health and safety procedures during the performance of any project work. In no case may work be performed in a manner which conflicts with the intent of, or the inherent safety precautions expressed in, this HASP or the client's health and safety policies. After due warning, persons who violate procedure and work rules may be dismissed from the site, terminated, or have their contract revoked. Blatant disregard or repeated infractions of health and safety policies are grounds for disciplinary action up to, and including, dismissal, and/or removal from the project.

All PES and PES subcontractor personnel are required to read and acknowledge their understanding of this HASP. All project personnel are expected to abide by the requirements of this HASP and cooperate with project management and safety representatives in ensuring a safe and healthful work site. Site personnel are required to immediately report any of the following to the PM or Senior Engineer:

- Accidents and injuries, no matter how minor
- Unexpected or uncontrolled release of chemical substances
- Any sign or symptoms of chemical exposure
- Any unsafe or malfunctioning equipment
- Any changes in site conditions which may affect the health and safety of project personnel

1.3.1 Work Area Control

This project requires that access to the work area be controlled to protect both the worker and the public. This access control may require fences, barricades, traffic control devices, use of flaggers, caution tape, and other methods to keep the work area secure and provide a visual barrier to help keep the curious or unaware public from entering active work areas.

1.3.2 Training and Medical Surveillance Requirements

All personnel conducting site work involving intrusive activities where the potential exists for exposure to contaminated soils or groundwater (drilling, excavation, trench work, etc.) shall have completed 40 hours of classroom-style health and safety training and three days of on-site training, as required by OSHA 29 CFR 1910.120. In addition, the Project Manager and Senior Engineer have received an additional eight hours of supervisory training.

Forty-hour hazardous waste site trained personnel shall also be current in their annual refresher training and enrolled in a medical monitoring program in accordance with 29 CFR 1910.120(f) which shall include the employee's ability to wear respiratory protection devices.

Personnel performing work activities which are non-intrusive or otherwise not expected to expose them to hazardous chemicals, contaminated soils or groundwater (concrete cutting, electricians, plumbers, surveyors, etc.) are not required to hold the 40-hour hazardous waste training. They shall receive site-specific training concerning the potential hazards associated with this project site as detailed below.

1.3.2.1 Site-Specific Training

An initial site-specific training session or briefing shall be conducted by the PM or Senior Engineer prior to commencement of work and/or entering the site. During this initial training session, employees shall be instructed on the following topics:

- Personnel responsibilities;
- Content and implementation of the HASP;
- Site hazards and controls;
- Site-specific hazardous procedures (i.e., intrusive activities, etc.);
- Limited access to and around intrusive work activities (i.e., electricians, plumbers, etc.);
- Medical and training requirements;
- Use of direct reading monitoring equipment;
- Levels of protection;
- Action levels for upgrading/downgrading levels of PPE; and
- Emergency information, including local emergency response team phone numbers, route to nearest hospital, and emergency response procedures.

In addition to the initial site briefing conducted at the commencement of the project, supplemental brief safety meetings shall be conducted by the PM or Senior Engineer to discuss potential health and safety hazards associated with upcoming tasks, and necessary precautions to be taken.

2 SITE HEALTH AND SAFETY INFORMATION

2.1 Chemical Hazards

The chemical hazards associated with this site primarily involve chlorinated solvents. Exposure to chlorinated solvents and chlorinated phenols may occur via inhalation of vapors, skin absorption, inadvertent ingestion and inhalation of dust containing absorbed contaminants. Acute exposure may cause eye, nose, and throat irritation or dermatitis, dizziness, nausea, and headache.

Organic solvents constitute a chemically diverse group of liquids characterized by their ability to dissolve oils, fats, resins, rubber, and plastics. Solvents may be divided into a number of categories based on their chemical structures. Most solvents produce irritant effects on the mucous membranes of the eyes, nose, and throat. In general aromatic solvents are more potent irritants than aliphatic solvents. Heavy exposures are commonly associated with cough, chest tightness, and feeling of breathlessness. At very high exposures, a number of common solvents, such as toluene, xylene, and methylene chloride, can induce pulmonary edema or chemical pneumonitis. Short-term high exposures to organic solvents produce narcotic effects. Acute symptoms include headache, dizziness, confusion, a feeling of drunkenness, and if the exposure continues, unconsciousness and death. Acute symptoms are reversible after the discontinuation of exposure but may increase the sensitivity to future exposures. Studies involving chronic exposure to organic solvents have discovered a number of central nervous system effects. Chronic exposure symptoms include memory problems, concentration difficulties, affective changes (such as aggressiveness and depression), fatigue, vertigo, decreased libido, sleeping problems, and vegetative symptoms (such as palpitations and increased sweating). At least several years of exposure seem to be required for the symptoms to become chronic, even in heavily exposed occupations. Dermal contact should be avoided since solvents have a defatting action on the skin. Alcohols are claimed to be less irritating than the aldehydes or ketones. The potential to cause irritation decreases as the molecular size increases. The alcohols act as drying agents and provide irritant contact dermatitis. Ketones are mild skin irritants. Esters are, in general, more potent skin irritants than the corresponding alcohols. Specific organic solvents have their own exposure limits. When the types of solvents are unknown it is common to refer to the exposure limits developed for petroleum distillate (naphthas) solvents, which have a PEL of 100 ppm.

The following specific chemicals identified in the soil, groundwater, and soil-gas at this project pose the greatest health concerns:

1,1-Dichloroethylene (1,1-DCE, Vinylidene chloride) is a watery, colorless liquid that sinks to the bottom in bodies of water. Its sweet, chloroform-like odor is perceptible at 500 ppm. There is no information of its environmental fate by biodegradation, photolysis, sorption, oxidation, and chemical decomposition in water, but they are probable processes of degradation. 1,1-DCE evaporates within a half-hour from stirred water. In the troposphere it may undergo fairly rapid photoxidation. One oxidation product is formaldehyde. There may be bioaccumulation. 1,1-DCE is used as a chemical intermediate in the synthesis of methylchloroform, and in the production of polyvinyl chloride copolymers, which are used in cement latexes. It is used in barrier coating in the packaging industry, in interior coating for ship tanks, railroad cars, and fuel storage tanks, in the coating of steel pipes and structures, and in film coating lacquers, paper coatings and certain fibers.

1,1-DCE is considered to be highly toxic. Routes of harmful exposure include inhalation, ingestion, and skin contact. The odor is not a good warning property against excessive exposure. Symptoms of harmful exposure include irritation to the eyes, skin, and respiratory system, dizziness, and central nervous system depression. Chronic exposure to low concentrations by laboratory animals has resulted in liver cancer and kidney damage. It is a possible mutagen, carcinogen and teratogen. The PEL-TWA is 1.0 ppm (4.0 mg/m^3).

1,2-Dichloroethylene (1,2-DCE, Acetylene dichloride) is normally a mixture of two isomers. Technically the proportion is 60 percent cis isomer and 40 percent trans isomer, but the real proportions depend on production conditions. 1,2-DCE is a quite flammable, colorless, viscous liquid that sinks in water and is nearly insoluble. Its slightly acrid, ether-like odor is not a good warning property for overexposure. Gradually 1,2-DCE decomposes in the presence of air, light, and moisture. The half-life of the trans isomer in air is less than 1 day. Removal from water is almost entirely by evaporation. There is no bioaccumulation and no food chain contamination potential. 1,2-DCE is used as a general solvent for organic materials such as fats, phenols, and camphor. It is also used in dye and caffeine extraction, in the making of perfumes, lacquers, thermoplastics, and organic compounds. It is a by-product of chlorination reactions, and is recycled as an intermediate in the making of certain chlorinated compounds. In groundwater trichloroethylene (TCE) may be transformed into 1,2-DCE, which is 5 times more toxic than TCE.

1,2-DCE is considered to be highly toxic. Routes of harmful exposure to 1,2-DCE may occur through diet, inhalation and skin contact. The trans isomer is twice as toxic as the cis. Direct contact can burn the eyes and skin. Exposure to high concentrations of the vapor can cause weakness, dizziness, irritation of the respiratory system, pink eye, cramps, nausea, vomiting, tremor, central nervous system depression, and loss of consciousness. There is evidence of fatty degeneration of the liver in laboratory animals. Chronic or repeated exposures in any form may be hazardous. Carcinogenic risk in humans is unknown. 1,2-DCE is a possible mutagen. The OSHA PEL-TWA is 200 ppm (790 mg/m^3).

1,1-Dichloroethane (1,1-DCA, Ethylidene chloride) is a flammable, limited use solvent and chemical intermediate. It was formerly used as an anesthetic. It has a chloroform-like odor with an undetermined threshold perception level. Much less information has been published on the toxicity of 1,1-DCA than on its more toxic isomer 1,2-Dichloroethane (1,2-DCA). Available data indicates that 1,1-DCA is rather low in toxicity. It is capable of causing anesthesia, but has a relatively low capacity to cause liver or kidney injury even on repeated exposure. The OSHA PEL-TWA is 100 ppm (400 mg/m^3) based on its anesthetic properties.

Methylene Chloride (Dichloromethane) is a nonflammable colorless liquid that sinks and dissolves slowly with water. Its sweet, pleasant odor is perceptible at 300 ppm. It half-life in water due to evaporation 1 ½ hours. Its half-life in water due to chemical decomposition is 18 to 22 months. Its half-life in the troposphere is probably several months, indicating potential for ozone destruction. There is no bioaccumulation. Methylene chloride is used as a solvent in the metal manufacturing industries, as a solvent and inert ingredient in insecticides, as a solvent in paint removers (23 percent of use), as a processing solvent for pharmaceuticals (20 percent), as a refrigerant, as a degreasing and dewaxing solvent (8 percent of use), and in aerial sprays (20 percent of use). It is used in vehicle maintenance, in laboratories, in paper production, in printing, in chemical production, in furniture making and refinishing, in textile manufacturing, in paint shops, and as an insecticide for strawberries, citrus fruits, and a variety of grains. Methylene chloride is found at illegal drug laboratories, where MDA has been processed.

Methylene chloride is considered to be highly toxic. Routes of harmful exposure include inhalation, ingestion, and skin contact. The odor is not a good warning property. Methylene chloride is a narcotic above 500 ppm. Symptoms of harmful exposure include eye and upper respiratory tract irritation, skin burns, lassitude, headache, giddiness, stupor, irritability, numbness, tingling in the limbs, liver damage, central nervous system damage, loss of muscular coordination, lack of appetite, nausea, and vomiting. In severe cases, symptoms include brain dysfunction with hallucinations, pulmonary edema, loss of consciousness, and death from heart failure. Methylene chloride is a probable carcinogen, a neurotoxin, and not a teratogen, in laboratory mice it displays mutagenicity. The OSHA PEL-TWA is 25 ppm, with a STEL of 125 ppm.

Tetrachloroethylene (PCE, Carbon bichloride, Carbon dichloride, Ethylene tetrachloride, Perc, Perchloroethylene) is a nonflammable colorless liquid that sinks in water. Its sweetish chloroform odor is perceptible at a range of 5 to 50 ppm. Its half-life in water by evaporation is 24 minutes. By chemical decomposition and photolysis its half-life in water is 9 months. Fifty-one percent of the use of tetrachloroethylene occurs in the laundry and dry cleaning industries, 26 percent in the production of chlorofluorocarbons, 15 percent as a degreaser, and 8 percent for other uses.

Tetrachloroethylene is considered to be highly toxic. Routes of harmful exposure to tetrachloroethylene include ingestion, inhalation, and skin contact. The odor is not a good warning property for chronic exposures. Symptoms of harmful exposure include skin burning and reddening, and eye, nose, throat, and gastro-intestinal tract irritation (at 75 ppm). The following symptoms may start at around 100 ppm: headache, dizziness, sleepiness, fatigue, weakness, tiredness, sensory changes, exhilaration, feeling high, speech difficulty, confusion, flushed face and neck, abdominal pain, nausea, vomiting, constipation, diarrhea, bloody stools, incontinence, lack of coordination, liver and kidney injury, slowing of mental ability, central nervous system depression, and death. Long-term effects may include fatigue, decreased muscle coordination, difficulty in concentration, loss of short-term memory, and personality changes including increased anxiety, nervousness, and irritability. Tetrachloroethylene is a potential mutagen, carcinogen, and a possible fetotoxin. The OSHA PEL-TWA is 100 ppm, with a ceiling concentration of 200 ppm. The OR/OSHA PEL-TWA is 25 ppm (170 mg/m^3), with a STEL/C concentration of 100 ppm. The ACGIH TLV-TWA is also 25 ppm.

Toluene (Methyl benzene, Methyl benzol, Phenyl methane, Toluol, $C_6H_5CH_3$) is a clear, colorless, non-corrosive, flammable liquid with a sweet, pungent benzene-like odor. Toluene is used extensively as a solvent in the chemical, rubber, paint, and drug industries, as a thinner for inks, perfumes, and dyes. Toluene is readily absorbed by inhalation, ingestion, and somewhat through skin contact. Toluene resembles benzene closely in its toxicological properties; however, it is devoid of benzene's chronic hematopoietic effects. Severe dermatitis may result from the drying and defatting action of toluene. Human studies involving inhalation of varying concentrations of toluene have produced the following information: Inhalation concentrations of 200 ppm have resulted in mild upper respiratory tract irritation; 400 ppm produce mild eye irritation, lacrimation, and hilarity; 600 ppm produces lassitude, hilarity, and slight nausea; 800 ppm concentrations produce rapid irritation, nasal mucous secretion, metallic taste, drowsiness and impaired balance. High inhalation concentrations may result in paresthesia, disturbance of vision, dizziness, nausea, and narcosis. The OSHA PEL for toluene is 100 ppm, with a STEL of 150 ppm.

1,1,1-Trichloroethane (1,1,1-TCA, Methyl chloroform, Chlorothene, CH_3CCl_3) is a clear, non-flammable, chlorinated solvent. It sinks in bodies of water and it does not dissolve. Because it reacts with magnesium and aluminum, inhibitors often are added to increase TCA's stability. TCA is used as a dry cleaning solvent, a degreaser for cleaning metals, and as a propellant. It is also used in making cosmetics, in printing, in textile manufacturing, in vehicle maintenance and equipment repair, in paper production, and in chemical production. As a solvent, TCA achieved widespread use as a substitute for carbon tetrachloride. In the past it has been used as an anesthetic for humans and animals because of its low systemic toxicity. It can be detected in the air at levels of 400 ppm. At 500 ppm the odor becomes objectionable.

TCA can be absorbed through the skin, but its chief route of entry into the body is through inhalation. It is poorly metabolized by the body and is excreted unchanged. Symptoms of harmful exposure, chronic as well as acute, include eye irritation, dry, scaly, fissured and inflamed skin, impaired judgment, drowsiness, dizziness, breathing congestion, loss of coordination, central nervous system depression, loss of consciousness, and death due to respiratory failure. The OSHA TWA-PEL has been set at 350 ppm (1,900 mg/m^3) because repetitive exposures to this level have not been shown to cause health effects. At levels of 500 ppm, anesthetic effects begin to occur. Death can occur at levels of 14,000 to 15,000 ppm. OSHA had also established a STEL of 450 ppm (2,450 mg/m^3) while NIOSH recommends a ceiling limit of 350 ppm (1,900 mg/m^3). Because TCA defats the skin, prolonged dermal exposure cause redness and scaliness. Animal studies have not shown TCA to be carcinogenic or teratogenic. However, NIOSH recommends that TCA be treated with caution in the workplace since it has a similar structure to four other chloroethanes (ethylene dichloride, hexachloroethane, 1,1,2,2-tetrachloroethane, and 1,1,2-trichloroethane) that have been shown to be carcinogenic in animals.

Trichloroethylene (TCE, Ethylene trichloride, Trichloroethene, Trilene, $ClCH=CCl_2$) is a slightly flammable, chlorinated solvent that sinks in bodies of water and dissolves very, very slowly. It is highly mobile in soil and liable to leach through the ground. Commonly it is used in dry cleaning and vapor degreasing. Also used as a refrigerant, heat-exchange fluid, and as a chemical intermediate in the production of pesticides. It is used in the manufacture of paper, waxes, gums, tars, resins, paints, varnishes, and other chemicals. In the past it has been used as a surgical anesthetic at levels ranging from 5,000 to 20,000 ppm. In the environment trichloroethylene may be transformed into vinyl chloride or 1,2-dichloroethylene, substances that are 2.5 and 5 times more potent than trichloroethylene itself. Trichloroethylene is a degradation product of 1,1,2-trichloroethane in water.

Routes of harmful exposure to trichloroethylene include inhalation, ingestion, and skin contact. It has a chloroform-like smell, which can be detected at levels of 28 ppm. At levels of approximately 1,000 ppm, TCE can cause central nervous system (CNS) effects such as euphoria, analgesia, impaired motor skills, and reduced motor skills, and reduced visual perception. The consumption of alcohol can increase these effects. Symptoms of chronic exposure include irritation of the eyes, nose, and throat (at 27 ppm), sleepiness, acne-like rash, headache (at 81 ppm in 4 hours). The PEL TWA has been set at 50 ppm (270 mg/m^3) to protect heavy drinkers from CNS effects. OSHA has also established a STEL of 200 ppm (1,080 mg/m^3). The ACGIH recommends a STEL of 100 ppm. NIOSH considers TCE to be a potential occupational carcinogen and recommends a REL of 2 ppm (as a 60-minute ceiling) during the usage of TCE as an anesthetic agent and 25 ppm (as a 10-hour TWA) during all other exposures. NIOSH also recommends a 5-minute maximum peak exposure of 300 ppm in any 2-hour period. Contact with TCE can cause eye irritation and dermatitis. Studies have shown that long-term industrial exposure to high concentrations (200 ppm) can cause liver and kidney damage from the breakdown products it forms in the body.

Vinyl Chloride (Chloroethene, Chloroethylene, Ethylene monochloride, Monochloroethene, Monochloroethylene, VC, Vinyl chloride monomer, VCM; $CH_2=CHCl$) is believed to be a decomposition product from bacteriological activities on chlorinated solvents. This may explain why it is found in many landfills. It is practically odorless (3,000 ppm is a published odor threshold), colorless, highly flammable, slightly soluble in water, and is always a gas at room temperature and pressure. VC evaporates from water very quickly, and polymerizes in the presence of air, oxygen, sunlight, and heat. Its half-life in air ranges from 1.2 to 1.8 days. Its half-life in water by chemical degradation is estimated to be around 10 years. Its half-life in soil is estimated to be 12 hours. VC is estimated to be very mobile in soil, thus having the ability to leach into ground water.

VC was once used as an anesthetic gas. Most of the vinyl chloride produced in the United States is used to make polyvinyl chloride (PVC). This material is used to manufacture a variety of plastic and vinyl products including pipes, wire and cable coatings, packaging materials, furniture and automobile upholstery, wall coverings, house wares, and automotive parts. Levels up to 10,000 ppm produce little acute effect on humans. High acute exposures are capable of producing headaches, respiratory irritation, dizziness, loss of muscular coordination, central nervous system depression, and loss of consciousness. Chronic exposures to VC have been associated with the production of a rare type of liver cancer. Because of its qualities as a carcinogen and mutagen VC is considered to be highly toxic. Studies have shown that the cancer response is dependent on dose amount and length of exposure. Chronic exposure can also produce “vinyl chloride disease”, of which the symptoms include severe liver damage (at 10,000 ppm for up to 14 days and at 10 ppm for more than 14 days, in animals), effects on the lungs, poor circulation in the fingers, bone and circulatory changes (at 10 ppm for more than 14 days, in animals), and thickening of the skin. There are still considerable gaps in our knowledge about the chronic effects of VC. The OSHA PEL is 1 ppm with a ceiling limit of 5 ppm.

Xylenes occur in three isometric forms, namely as the *o*-, *m*-, or *p*-xylene. Xylene occurs in many petroleum products, in coal naphthas, and as an impurity in petrochemicals, such as benzene, toluene, and similar materials. The three isomers possess similar properties. Xylene is widely used as a thinner, solvent for inks, rubber, gums, resins, adhesives, and as a paint remover. Xylene has been utilized widely as a replacement for benzene. In direct contact with intact skin, xylene is an irritant and causes defatting, which may lead to dryness, cracking, blistering, or dermatitis. When inhaled at high concentrations, human acute signs may include a flushing and reddening of the face and a feeling of increased body heat, owing to the dilation of the superficial blood vessels. In addition, disturbed vision, dizziness, tremors, salivation, cardiac stress, CNS depression, confusion, coma, as well as respiratory difficulties may be apparent. Acute inhalation of lower concentrations cause upper respiratory irritation. Chronic exposures to xylene vapors have produced conjunctivitis of the eye and dryness of the nose, throat, and skin. Chronic inhalation of vapors may cause CNS excitation, then depression, characterized by paresthesia, tremors, apprehension, impaired memory, weakness, nervous irritation, vertigo, headache, anorexia, nausea, and flatulence. The PEL for xylenes is 100 ppm, with a STEL of 150 ppm.

2.1.1 Potential Site Contaminants

Table 1
Maximum Concentration Encountered or Anticipated On Site

Potential Site Contaminants	Concentration in Groundwater (ppm)	Concentration in Soil-Gas (ppm)	PEL-TWA (STEL or Ceiling)
Total VOCs	115	Unknown	100 ppm (naphtha limit)
1,1-Dichloroethylene (1,1-DCE)	0.05	Unknown	None
cis-1,2-Dichloroethylene (1,2-DCE)	42	Unknown	200 ppm
1,1-Dichloroethane (1,1-DCA)	0.067	Unknown	100 ppm
Methylene chloride	0.027	Unknown	25 ppm (ST = 125 ppm)
Tetrachloroethylene (PCE)	0.004	Unknown	100 ppm (C = 200 ppm)
Toluene	0.180	Unknown	200 ppm (C = 300 ppm)
1,1,1-Trichloroethane (1,1,1-TCA)	0.005	Unknown	350 ppm (ST = 450 ppm)
Trichloroethylene (TCE)	77	Unknown	100 ppm (ST = 200 ppm)
Vinyl chloride	8.2	Unknown	1 ppm (ST = 5 ppm)
Benzene	0.002	Unknown	1 ppm (ST = 5 ppm)
Xylenes	0.130	Unknown	100 ppm

The chemicals that pose the primary health concerns due to their low permissible exposure limits and carcinogenic properties are benzene, methylene chloride, and vinyl chloride.

2.2 Physical Hazards

The physical hazards associated with the project scope primarily involve exposure to traffic hazards, electrical equipment, noise, slip/trip/fall hazards, and temperature stress. Safety procedures and guidelines for these hazards are attached to this plan in Section 3.

2.2.1 Site Personal Protection Requirements

As site activities progress, levels of PPE are subject to change or to modification. Upgrading of PPE can occur when action levels are exceeded or whenever the need arises to protect the safety and health of site personnel. Levels of PPE will not be downgraded without prior approval from the Project Health and Safety Manager or Technician.

If feasible, use intrinsically safe portable fans to control the concentration of volatile organic compounds in the employee's breathing zone prior to the use of respiratory protection devices.

The client requires eye protection to be worn at all times at this project site. Smoking is also not allowed on site. Do not engage in any hot work without proper approval from the client, and without monitoring the atmosphere for explosive conditions.

Avoid exposure to vapors and contaminated dust by working upwind of excavations, borings, wells, and other sources of contamination whenever possible. Avoid skin contact with contaminants by wearing nitrile gloves, eye protection, and coveralls when working near contaminated soil or water. Avoid exposure via inadvertent ingestion by refraining from eating, drinking, smoking, or chewing gum while working, and by washing hands and face thoroughly before breaks and at the end of the shift. Avoid or eliminate activities that may cause generation of contaminated soil dust. The initial protection level for all site activities is Level D.

Table 2
Protection Levels

Activity	Initial Level of Protection	Equipment Requirements
General Site Activities	D	Work clothing, hard hat, steel-toed work boots, and eye protection, Wear traffic vests on site if working during vehicular traffic hours.
Installation of piping, pumps, fittings, flow meters, etc.	D	Per General Site Activities, plus wear nitrile gloves when the possibility exists for contact with contaminated water or soil. Change gloves frequently to minimize the chance for breakthrough.
Drilling oversight, groundwater monitoring and sampling	D	Per General Site Activities, plus wear nitrile gloves when the possibility exists for contact with contaminated water or soil. Change gloves frequently to minimize the chance for breakthrough. Use a face-shield if the chance exists for splash onto face or clothing. Upgrade to Level C protection if exposure monitoring results warrant.
	C	In addition to Level D requirements, full or half-faced air-purifying respirator (APR) equipped with organic vapor, acid gas combination cartridge with attached HEPA filter, Neoprene outer gloves, Nitrile inner gloves, and chemical-resistant boot covers or steel-toed rubber boots when work boots are exposed to contaminated liquids.

Table 3
Task Hazard Analysis Table

Work Activity	Hazard	Risk	Recommended Controls
Walking at the site	Slips, trips, and falls	High	Be aware of uneven terrain at the site, open holes, trenches. Be aware of unstable slope edges and stockpiled soils and materials.
Tools and equipment	Physical injury/noise	Moderate	Wear PPE equipment - hard hats, steel-toed boots, safety glasses with side shields, and hearing protection. Equipment must be in good working order, be the correct tool for the task, and have required safety features (e.g., backup alarm, guards). Proper energy isolation; lock-out/tag-out, tagging and flagging must be applied when repairing tools and equipment. Operators will be made aware of ground personnel in their operating range. Additional precautions will be made if the lighting or visibility conditions are poor. All equipment will have backup alarms. All operators are required to wear safety belts while operating equipment.
Water sampling	Water contaminants	Moderate	Level D PPE will be worn if soil/water-sampling activities are performed. If contact with refuse/leachate is anticipated wear Tyvek or Kleenguard suit with neoprene or Nitrile gloves.
	Dusty, windy conditions	Moderate	Air purifying respirators with organic vapor/HEPA cartridges will be donned when dusty, windy conditions exist and dust ingestion is likely.

Work Activity	Hazard	Risk	Recommended Controls
Severe weather conditions	Poor visibility, temperature extremes, and high winds will increase the risk of physical hazards	High	The PM will determine when work should be minimized or postponed due to weather conditions.
Cold/heat stress	Skin and extremities	High	The PM will verify that personnel have proper clothing for the environment in which they are working and that drinking water is available.
Confined spaces	Hazardous atmospheres	High	Identify confined spaces that might be located on the site. Level C work. Check that proper entry/egress is available, including backup personnel and system, lockout/tagout. All work will be performed under the direct supervision of the PM. Check for heat stress and dehydration. Continuous LEL monitoring.
Confined spaces	Explosion	Moderate	Use only intrinsically safe electronic equipment inside confined spaces until monitoring proves safe for other types of equipment. Check atmosphere with explosivity meter. Enter only if below 5% of LEL. Use air movers to maintain atmosphere below 10% of LEL. Check LEL continuously while work is being conducted in confined space. Use only intrinsically safe and explosion-proof equipment in the exclusion zone of the confined space.
Hot Work	Burns, explosions	High	Always test the atmosphere for explosive levels before performing hot work. Use welding gloves, jackets, and glasses.
Pump Repairs	Hazardous energy, potential confined space entry, and contaminated water exposure	Moderate	Lockout/tagout, follow confined space entry procedures, and wear appropriate PPE
Surface monitoring and water level measurements	Potential chemical exposures	Moderate	Exposure monitoring and wear appropriate PPE
Monitoring and maintenance of extraction wells	Potential chemical exposure	Moderate	Lockout/tagout, air monitoring, and wear appropriate PPE

2.3 Biological Hazards

Specific activities that involve potential contact with leachate (groundwater) or site walkovers in highly vegetated areas may pose potential exposure to insects, plants, and bacteria. Information on these biological hazards that includes preventive measures is attached to this plan.

Blood poisoning is a term used to indicate a large number of bacteria present in the circulating blood. The most common symptom of blood poisoning is the reddening of skin, which advances towards the heart. For example, if the point of contact is the hand than a red line will appear at the hand and extended up the arm.

Personal protective equipment shall be worn to prevent direct contact with media, which may be contaminated with bacteria or viral agents.

Signs and symptoms include swelling, stiffness and tenderness in the affected area, fatigue, chills and fever, pustules, and abscesses. If allowed to progress, the organisms may multiply and cause an overwhelming infection and death.

2.4 Exposure Monitoring

Exposure monitoring shall be conducted using a photoionization detector (PID) whenever visible sheens or product odors are present. The exposure monitoring shall be conducted in the worker's BZ every 15 minutes while odors or visible sheens exist, and readings recorded in a field notebook. Exposure monitoring shall be performed every five minutes if PID readings approach 5 ppm in the BZ.

If air concentrations of organic vapors in the worker's BZ should meet or exceed 5 ppm for a time period greater than five minutes, workers will be required to upgrade to Level C personal protective equipment, including the use of air-purifying respirators (equipped with organic vapor/HEPA cartridges), unless the non-presence of vinyl chloride is confirmed through the use of Draeger tubes.

Upgrade to Level C protection immediately if VOC concentrations exceed 10 ppm in the worker's BZ. If organic vapor concentrations drop back down below 5 ppm, the level of personal protective equipment can be downgraded to Level D protection.

If VOC concentrations in the worker's BZ exceed 25 ppm, the area must be evacuated and allowed to ventilate to less than 25 ppm in the BZ, or Level B protection must be used to continue work when BZ VOC concentrations are greater than 25 ppm. If VOC concentrations exceed 100 ppm in the worker's BZ, the area will be evacuated.

Table 4
Exposure Monitoring Action Levels

Activity	Instrument*	Action Level**	Level of Protection
General site activities, excavation, drilling, and well installation / abandonment activities	Use a PID to conduct exposure monitoring whenever product odors or visible sheens are present.	5 ppm or greater in the BZ for > 5 minutes	Level C unless the non-presence of vinyl chloride is confirmed using Draeger tubes.
		> 10 ppm in the BZ	C
		> 25 ppm in the BZ	Evacuate area, contact Project H&S Manager, allow area to ventilate or upgrade to level B protection prior to continuing
		> 100 ppm in the BZ	Evacuate area
Any type of hot work, or work that produces sparks	LEL meter	LEL < 10%	Continue work
		LEL 10 to 20%	Continue work, work upwind or ventilate to reduce LEL
		LEL > 20%	Stop any hot work or spark producing activity, evacuate area until levels are below 20%

NOTE: * = monitoring instruments shall be calibrated and maintained according to manufacturers' specifications and at a minimum calibration shall occur once daily.
** = action levels should be based on OSHA PELs.

The discovery of any condition that would suggest the existence of a situation more hazardous than anticipated shall result in the evacuation of site personnel and re-evaluation by the safety officer and project manager of the hazard and the level of protection.

2.5 Decontamination

Procedures for decontamination must be followed to prevent the spread of contamination and to eliminate the potential for chemical exposure.

1. **Equipment:** All equipment must be decontaminated or discarded upon exit from the exclusion zone.

2. **Personnel:** Decontamination will take place prior to exiting the exclusion zone.

LEVEL D Decontamination: Wash and rinse gloves (if any) and remove. Wash hands and face.

LEVEL C & B Decontamination: Wash and rinse outer gloves, boots and suit, and air-purifying respirator; wash respirator; remove inner gloves (if any) and dispose. Wash hands and face. Handle all clothing inside out when possible.

2.6 Emergency Response

Emergencies can range from minor to serious conditions. Various procedures for responding to site emergencies are listed in this section. The Site Superintendent (SS) is responsible for contacting local emergency services in emergency situations. Various individual site characteristics will determine preliminary action to be taken to assure that these emergency procedures are successfully implemented in the event of an emergency. Emergency contact information is in subsection 2.5 of this HASP and posted in the job site office.

2.6.1 Accident, Injury, and Illness Reporting and Investigation

PES employees are required to immediately report to their direct supervisor all occupational injuries, illnesses, accidents, and near miss incidents having the potential for injury. Any supervisor (but preferably the supervisor directly responsible for the involved employees) with first-hand knowledge of an incident is required to:

- Immediately arrange for appropriate medical attention and notify the responsible health and safety representative.
- Refer to Attachment 1 for ON-THE-JOB INJURY OR ILLNESS FLOWCHART OF ACTION REQUIRED

Subcontractor employees shall notify their supervisors and the associated PES Project Manager of any incidents or injuries while engaged in an PES project.

2.6.2 Emergency Procedures for Contaminated Personnel

Whenever possible, personnel should be decontaminated in the contamination reduction zone before administering first aid.

Skin Contact — Remove contaminated clothing, wash immediately with water, use soap, if available.

Inhalation — Remove victim from contaminated atmosphere. Remove any respiratory protection equipment. Initiate artificial respiration, if necessary. Transport to the hospital.

Ingestion — Remove from contaminated atmosphere. Do not induce vomiting if victim is unconscious. Also never induce vomiting when acids, alkalis, or petroleum products are suspected. Transport to the hospital, if necessary.

2.6.3 Emergency Equipment/First Aid

The emergency equipment to be located on site either in site trailers or company vehicles include a first aid kit, emergency alarm (i.e., air horn), emergency eyewash, an ABC fire extinguisher, potable water, anti-bacterial soap, and telephone/two-way radios.

2.6.4 Site Evacuation

In the event of an emergency situation such as fire, explosion, significant release of toxic gases, etc., an air horn or other appropriate device will be sounded for approximately 10 seconds indicating the initiation of evacuation procedures. Personnel in the field will be notified through radio communications to evacuate the area. All personnel in both the restricted and non-restricted area will evacuate and assemble near the Support Zone or other safe area as identified by the SM prior to the beginning of field operations. The location shall be upwind of the site, if possible.

2.6.5 Spill and Release Contingencies

If a spill has occurred, the first step is controlling the spread of contamination if possible. The site Supervisor will immediately contact site Project Management to inform them of the spill and activate emergency spill procedures.

2.7 Emergency Contact Information

<table>
<tr><th colspan="3">EMERGENCY INFORMATION</th></tr>
<tr><th>Contact</th><th>Phone Number</th><th>Hospital Directions</th></tr>
<tr><td>Local Police</td><td>911</td><td rowspan="4">Hospital: Valley Medical Center
400 South 43rd Street, Renton, Washington

Hospital Directions and Route Maps on next page.</td></tr>
<tr><td>Fire Department</td><td>911</td></tr>
<tr><td>Ambulance</td><td>911</td></tr>
<tr><td>Local Hospital: Valley Medical Center</td><td>(425) 229-7711</td></tr>
<tr><td>Health & Safety Tech., PES
Health & Safety Officer; Primary Contact
Bill Haldeman Work
Home

HASP
Review: ___________________________</td><td>

(206) 529-3980
(425) 402-1737</td><td rowspan="4">Emergency Response
-----Call for Aid FIRST------
• BSB Property 8202 South 200th Street, Kent, WA
• Meet emergency responder at the entrance
• Contact Project Manager
• Contact Health & Safety
<u>INCIDENT REPORTING SYSTEM</u>
• Refer to Attachment 1
Complete Supervisor’s Employee Incident/Injury Report (Attachment 2)</td></tr>
<tr><td>Project Manager, PES
Bill Haldeman Work
Bill Haldeman Cell</td><td>
(206) 529-3980
(425) 922-0254</td></tr>
<tr><td>Senior Engineer, PES
Brian O’Neal Work
Brian O’Neal Cell</td><td>
(206) 529-3980
(425) 241-2627</td></tr>
<tr><td></td><td></td></tr>
</table>

2.7.1 Hospital Directions and Route Maps

Driving Direction:

1. Begin at **BSB Property** on **S 200th St** and go North 2.5 miles.
2. Turn east on **S. 180th St.** and go east 0.25 miles to **Valley Medical Center**

HEALTH AND SAFETY PLAN
SIGN-OFF FORM

PROJECT: BSB PROPERTY, KENT, WASHINGTON
PROJECT NO. 827.001.28

The Project Manager or Senior Engineer shall sign this form after she/he has conducted a pre-entry briefing.

Each PES Environmental, Inc. (PES), employee, and subcontractor, conducting field work shall sign this form after the pre-entry briefing is completed and prior to commencing work on site. A copy of this signed form shall be kept at the site, and the original sent to the project manager, for inclusion into the project file.

Site Personnel Sign-off

☐ I have received a copy of the Site-Specific Health and Safety Plan.

☐ I have read the Plan and will comply with the provisions contained therein.

☐ I have attended a pre-entry briefing outlining the specific health and safety provisions on this site.

Name: ______________________________________ Date: ______________

______________________________________ Date: ______________

______________________________________ Date: ______________

______________________________________ Date: ______________

______________________________________ Date: ______________

______________________________________ Date: ______________

PES ENVIRONMENTAL, INC. Project Manager

☐ A pre-entry briefing has been conducted by myself on _____________.

☐ I deferred the pre-entry briefing responsibility to the Health and Safety Officer.

Name: ______________________________________ Date: ______________

3 SAFETY PRACTICES FOR FIELD PERSONNEL

Field operations for this project shall be conducted in accordance with the minimum safety practices described below required for all PES employees.

- Eating, drinking, chewing gum or tobacco, smoking, or any practice that increase the probability of hand-to-mouth transfer and ingestion of materials is prohibited in any area where the possibility of contamination exists.

- Hands must be thoroughly washed when leaving a contaminated or suspected contaminated area before eating, drinking, or any other activities.

- Contaminated protective equipment shall not be removed from the work area until it has been properly decontaminated or containerized on site.

- Avoid activities that may cause dust. Removal of materials from protective clothing or equipment by blowing, shaking, or any means which may disperse materials into the air is prohibited.

- Field personnel must use the "buddy system" when wearing any respiratory protective devices. Communications between members must be maintained at all times. Emergency communications shall be prearranged in case unexpected situations arise. Visual contact must be maintained between pairs on site, and team members should stay close enough to assist each other in the event of an emergency.

- Personnel should be cautioned to inform each other of subjective symptoms of chemical exposure such as headache, dizziness, nausea, and irritation of the respiratory tract.

- No excessive facial hair that interferes with a satisfactory fit of the face piece-to-face seal will be allowed on personnel required to wear respiratory protective equipment.

- The selection, use, and maintenance of respiratory protective equipment shall meet the requirements of established PES procedures, recognized consensus standards (AIHA, ANSI, NIOSH), and shall comply with the requirements set forth in 29 CFR 1910.134.

- At sites with known or suspected contamination, appropriate work areas for field personnel support, contaminant reduction, and exclusion will be designated and maintained.

- PES field personnel are to be thoroughly briefed on the anticipated hazards, equipment requirements, safety practices, emergency procedures, and communications methods, both initially and in daily briefings.

- All PES field vehicles shall contain a first aid kit and multipurpose portable fire extinguisher.

- All field personnel will, whenever possible, remain upwind of drilling rigs, open excavations, boreholes, etc.

- Subsurface work shall not be performed at any location until the area has been cleared by a utility locating firm to be free of underground utilities or other obstructions.

- Field personnel are specifically prohibited from entering into excavations, trenches, or other confined spaces deeper than 4 feet. Unattended boreholes must be properly covered or otherwise protected.

3.1 Site Safety Procedures

3.1.1 Drilling Safety

Drilling personnel shall adhere to the following practices:

- Equipment shall be inspected daily by the operator to ensure that there are no operational problems.

- Before leaving the controls, shift the transmission controlling the rotary drive into neutral and place the feed level in neutral. Before leaving the vicinity of the drill, shut down the drill engine.

- Do not drive the drill rig with the mast in the raised position.

- Before raising the mast, check for overhead obstructions.

- Before the mast of a drill rig is raised, the drill rig must first be leveled and stabilized with leveling jacks and/or cribbing. Re-level the drill rig if it settles after initial set up. Lower the mast only when the leveling jacks are down, and do not raise the leveling jack pads until the mast is lowered completely.

- Employees involved in the operation shall not wear any loose-fitting clothing that has the potential to catch in moving machinery.

- During freezing weather, do not touch any metal parts of the drill rig with exposed flesh. Freezing of moist skin to metal can occur almost instantaneously.

- Adequately cover or protect all unattended boreholes to prevent drill rig personnel or site visitors from stepping or falling into the borehole.

- Personnel shall wear steel-toed shoes, safety glasses, hearing protection and hard hats during drilling operations.

- The area shall be roped off, marked or posted, to keep the area clear of pedestrian traffic or spectators.

- All personnel should be instructed in the use of the emergency kill switch on the drill rig.

3.1.2 Utility Clearance

- Elevated superstructures (e.g., drill rig, backhoe, scaffolding, ladders, cranes) shall remain a distance of 10 feet away from utility lines and 20 feet away from power lines. Distance from utility lines may be adjusted by the SM or request information from the project Health & Safety, depending on actual voltage of the lines.

- During all intrusive activities (e.g., drilling, excavating, probing), the locator line service shall be contacted to mark underground lines before any work is started.

- Personnel involved in intrusive work shall determine the minimum distance from marked utilities which work can be conducted with the assistance of the locator line service.

3.1.3 Heavy Equipment Operations

Working around heavy equipment can be dangerous because of the size and power of the equipment, the limited operator field of vision and the noise levels that can be produced by the equipment. Heavy equipment to be utilized at the site shall include a variety of backhoes, dozers, track loaders, and off-road trucks.

Operators when using heavy equipment shall follow the following practices:

- Equipment shall be inspected daily by the operator to ensure that the equipment is in safe operating condition.

- When not in use, hydraulic components should be left in down or "dead" position.

- Rollover protection shall be provided on hilly sites.

- No riding on vehicles or equipment except in fixed seats.

- Seat belts shall be worn at all times.

- Backup alarms, automatically activated and loud enough to be heard above background noise are required on all heavy equipment.
- Parking brakes should always be applied on parked equipment.
- Equipment should never be operated closer than 10 feet from utility lines.
- Windshields must be maintained clean and free of visual obstructions.

To ensure the safety of PES personnel in the work area, the following safety procedures regarding heavy equipment must be reviewed prior to and followed during work activities:

- Ensure that equipment operators are trained and/or experienced in the operation of the specific equipment.
- Personnel should never approach a piece of heavy equipment without the operator's acknowledgment and stoppage of work or yielding to the employee.
- Never walk under the load of a bucket or stand beside an opening truck bed.
- Maintain visual contact with the operator when in close proximity to the heavy equipment.
- Wear hearing protection while on or around heavy equipment, when normal conversation cannot be heard above work operations.
- Steel-toed shoes, safety glasses, and a hard hat shall be worn for all work conducted near heavy equipment.

3.1.4 Facility/Traffic

Cargo/transfer terminal sites and other work sites with high traffic flow and limited visibility present a significant hazard to PES field staff. Since this is an area of extremely high risk, it is important that the following H&S policies and procedures are followed. While visual devices are generally effective, the use of a structural barrier (such as a company vehicle) is a more sure method of protection should a vehicle driver fail to see an employee. Barriers shall be used on work sites when it is possible to do so without adversely affecting the project work or other client considerations. Employees are reminded to maintain a high degree of awareness of moving vehicles on the site. The following guidelines concerning traffic warning devices should be followed when working in traffic flow areas:

- Meet with the Facility Manger or Client Contact at the start of fieldwork to discuss equipment and personnel access to the work area.
- Obtain any facility-related emergency information, i.e., facility alarms, evacuation areas, and special hazards.

- Employees when working around traffic flow areas shall wear fluorescent orange vests. Ensure that there is a clear line of sight between approaching traffic and the work area.

- Orange cones, at least 28 inches high, are typically used to direct traffic flow on roadways, but are not always appropriate as a flagging device on PES project sites. Due to the low height, a cone can be easily overlooked, especially when a motorist is backing up. Tubular markers at least 4-feet high with flags attached at the top to be more visible. Alternatively, type I barricade with flagging at the top may be used. One option often used with cones is to place an object on the cones that will make noise if struck by a car.

- When two or more PES employees are together on a site and a site specific activity has a high risk of impact from vehicular traffic, one employee shall act as a lookout for the other employee performing the specific work activity.

3.2 Standard Safety Procedures

3.2.1 Hand Tools

Use of hand tools may expose workers to cuts, lacerations or puncture wounds if adequate hand protection is not worn or tools are improperly used or stored. Damaged hand tools may also expose employees to injuries from shattered tools and flying debris.

The following safe work practices apply to the use of hand tools:

- Only use a tool for its designed use.

- Do not use damaged tools.

- Driving faces of hammers, chisels, drift pins, bars, and similar tools must be inspected to eliminate mushroomed heads, broken faces and other defects.

- Tools must be returned to their proper storage place.

- Sharp tools must not be carried in pockets.

- Wood handles must be sound and securely wedged or fastened to the tool. Tape must not be used to cover defects such as cracks.

- When hand tools are being used overhead, those working or standing below must be notified.

- Pipe wrenches must be inspected regularly. Replace the heel and jaw sections if found to be defective or worn out.

- Pipe wrenches must not be used to bend, raise or lift pipe.
- Always wear safety glasses to protect the eyes.

3.2.2 Noise

Excessive noise is hazardous not only for its potential to damage hearing, but also its potential to disrupt communications and instructions.

- All employees will have access to disposal earplugs with a Noise Reduction Rating of not less than 30.
- Earplugs must be worn in any environment where workers must raise their voices to be heard while standing at a distance of 3 feet or less.
- Earplugs must be worn by any personnel operating concrete cutting or sawing equipment.

3.2.3 Power Tools

- All power tools must be in good condition and free of any damage.
- All power tools must be double insulated or equipped with a grounding plug. Grounding features (three-prong plugs) must not be defeated by use of adapters unless the adapter is appropriately grounded.
- All power cords and extension cords must be in good condition with undamaged insulation. Plugs and boots must also be in good condition and undamaged.
- Power tools must be unplugged whenever serviced or when not being used.

3.2.4 Back Injury Prevention

Lifting; Carrying; Pushing and Pulling; Shoveling; and Drum Handling Techniques

Back injuries on the job are costing employers in the U.S.A. approximately 6.5 billion annually. Eight out of ten people will suffer a back injury during their lifetime, either on or off the job. Adhering to the following proper lifting concepts could prevent many of these injuries:

- Keep the load close to the body. Arrange tasks so that the load will be close to the body and at a proper and safe height that will not require bending or stooping. Tighten stomach muscles to offset the force of the load.

- Keep the load within reach. Try to arrange tasks to eliminate handling loads below 20 inches or above 50 inches. Try to keep the lifting zone between your shoulders and the knuckles.

- Control the load size. Loads that extend beyond 16 inches in front of the body put excessive lifting stress on the body and should be handled by two people or lifting aids should be employed.

- Maintain proper alignment of body. The task should be designed so that twisting of the body is minimized or eliminated. Twisting while carrying a load increases injury potential significantly.

- Lift with your legs. Your leg muscles are the strongest in your body. Always bend your knees and use your leg muscles when you go toward the floor whether you have a load or not. Do not bend at your waist if it can be avoided.

- Balance your load if possible. An evenly balanced load is much easier and much safer to handle than an off balance load. Grasp the object at opposite corners if possible.

- Avoid excessive weights if possible. Mechanical aids should be used for loads that are greater than those which can be handled safely by one person.

- Lift in a comfortable manner. Workers should use a lifting position that feels comfortable for them; however, they should bend their knees and keep their back as straight as possible when performing a lift. Your feet should be shoulder width apart in order to get the best footing possible.

- Lift smoothly and gradually. Quick jerking lifting motions increase sudden and abrupt stress to the back. This type of aggressive movement can affect the discs, muscles, and the ligaments. A well-controlled and smooth lifting motion will reduce the likelihood of injury.

- Most importantly, think before lifting.

In addition to these lifting techniques it is also important to implement the proper carrying techniques as follows:

- Eliminate carrying where possible. If possible, conveyors, trucks, small loaders, and other mechanical equipment should be considered. Carts and dollies should be employed when surface conditions permit. Surface conditions can be altered with plywood or other materials.

- Use two-handed carries where possible. Using a two handed carry method helps to balance the load even out the body stress.

- Keep the load close to the body. Keeping the load in close and lifting in as erect a position as possible helps to reduce the stress to the lower spine.

- Keep your arms straight. Less stress is created on the muscles and ligaments when your arms are kept straight during a carry. Contraction of the muscles will quickly increase fatigue and the possibility of an accident.

- Balance the load. A balanced load is similar to the two handed carry. The load is evenly distributed across the body and the stress is also evenly shared.

- Avoid carrying any material on stairs. Carrying on stairs will obstruct your vision and increase the likelihood of slip and fall. The bumping of the load on your leg as you climb or descend increases the chance of an injury.

- Reduce the weight if possible. When the weight of the lifts is high look for ways to reduce the weight. Use smaller containers, put less in containers, indicate fill levels, and locate lighter containers.

- Use handles. Make the task easier by adding handles where possible. If numerous repetitions are required, it may be possible to design a handled device to accommodate a two handed carrying task.

In addition to these lifting and carrying techniques it is also important to consider pushing and pulling tasks:

- Eliminate manual pushing and pulling where possible. Look at those tasks that are repeated often to see if they can be modified or altered in a way that reduces pushing and pulling. Consider mechanical aids, powered conveyors, gravity slides, and chutes.

- Reduce the necessary force. Force required is a function of weight, gravity and friction. Look for opportunities to reduce these factors. Improved bearings, larger wheels, reduced weight, improved rolling surfaces, lubrication, and improved regular maintenance are all opportunities for reducing work force and stress.

- Push load instead of pulling. Studies indicate that pushing loads rather than pulling them is the safest approach. There is less stress on muscles, joints, and ligaments. As in lifting, pushing pressure should be applied firmly, but gradually. Avoid aggressive impacts.

There are also a number of guidelines to follow when addressing tasks that involve shoveling operations:

- Choose correct shovel type. The shovel should be appropriate for the material and the project. Light, loose, and fluffy materials should be handled with a scoop type shovel. A smaller shovel like a spade should be used for more dense material.

- Use a long-handled shovel. A long handled shovel should be provided to avoid stooping during shoveling activities. Take the time to obtain the correct tool for the job.

- Maintain load to 10 pounds per shovelful. The general rule of thumb for the average work situation is 10 pounds per shovel load. Work performed is a function of repetition and load. Increasing shovel loads will increase fatigue as repetitions increase and it will also increase the potential for injury.

Drum handling operations can be made safer by considering the following techniques:

- Use a drum cart where feasible. A four-wheel cart is preferred for drum handling because it is more stable, better latched, and has a better handle positioning. In addition, it is more easily tipped back and held in place when the drums are loaded.

- Do not rotate from horizontal to vertical unless nearly empty. Only empty or nearly empty drums should be rotated from horizontal to vertical. A tipster or forklift with a proper drum handling attachment is the preferred method.

- Use handling equipment for moving drums from one level to another. Whenever possible pallets, scales, and conveyors should be recessed in the floor to avoid raising drums to another level. If not, drums should be handled on a low platform or an incline adapter should be provided.

- Limit drum weight to 450 to 500 pounds. Regardless of the material involved, drums should only be filled to a maximum weight of 700 pounds. Drums over 300 pounds shall not be handled by hand. Use of mechanical equipment is required. *(Example: water = 8.6 lb per gallon x 52 gallons = 447.2 lbs)*

- Limit travel distance to 30 feet. The other general guideline regarding drum handling involves keeping drum transport to a maximum of thirty feet.

3.2.5 Slip / Trip / Hit / Fall Hazards

Slip/trip/hit and fall injuries are the most frequent of all injuries to workers. They occur for a wide variety of reasons, but can be minimized by the following prudent practices:

- Spot check the work area to identify hazards.

- Establish and utilized a pathway which is most free of slip and trip hazards.

- Beware of trip hazards such as wet floors, slippery surfaces, and uneven surfaces or terrain.

- Carry loads that you can see over.

- Keep work area clean and free of clutter, especially in storage rooms and walkways.

- Communicate hazards to on-site personnel.

- Secure all loose clothing, ties, and remove jewelry while around machinery.
- Report and/or remove hazards.
- Keep a safe buffer zone between workers using equipment and tools.

3.2.6 Heat Stress

Heat-related illness can cause physical discomfort, loss of efficiency and attention to safety, and personal injury. Age, weight, degree of physical fitness, degree of acclimatization, metabolism, use of alcohol or drugs, and a variety of medical conditions such as hypertension all affect a person's sensitivity to heat. The elderly are at higher risk because of impaired cardiac output and decreased ability to sweat. Infants and young children also are susceptible to heat stress, as well. Even the type of clothing worn must be considered. Prior heat injury predisposes an individual to additional injury.

The fluid loss and dehydration resulting from physical activity puts outdoors laborers at particular risk. Certain medications predispose individuals to heat stress, such as drugs that alter sweat production (antihistamines, anti-psychotics, antidepressants) or interfere with the body's ability to regulate temperature. Persons with heart or circulatory diseases or those who are on "low salt" diets should consult with their physicians prior to working in hot environments.

It is difficult to predict just who will be affected and when, because individual susceptibility varies. In addition, environmental factors include more than the ambient air temperature. Radiant heat, air movement, conduction, and relative humidity all affect an individual's response to heat.

Heat-Related Illnesses

Heat rash, also known as prickly heat, may occur in hot and humid environments where sweat is not easily removed from the surface of the skin by evaporation. Resting in a cool place and allowing the skin to dry can normally prevent it.

Fainting (heat syncope) may be a problem for the worker unacclimatized to a hot environment who simply stands still in the heat. Victims usually recover quickly after a brief period of lying down. Moving around, rather than standing still, will usually reduce the possibility of fainting.

Heat cramps, painful spasms of the muscles, are caused when workers drink large quantities of water but fail to replace their bodies' salt loss. Tired muscles, those used for performing the work, are usually the ones most susceptible to cramps. Cramps may occur during or after working hours and may be relieved by taking liquids by mouth or saline solutions intravenously for quicker relief, if medically determined to be required.

Heat exhaustion results from loss of fluid through sweating when a worker has failed to drink enough fluids or take in enough salt or both. The worker with heat exhaustion still sweats but experiences extreme weakness or fatigue, giddiness, nausea, or headache. The skin is clammy and moist, the complexion pale or flushed, and the body temperature is normal or slightly higher. Treatment is usually simple: the victim should rest in a cool place and drink an electrolyte solution (a beverage used by athletes to quickly restore potassium, calcium, and magnesium salts) such as Gatorade®. Severe cases involving victims who vomit or lose consciousness may require longer treatment under medical supervision.

Heat stroke, the most serious health problem for workers in hot environments, is caused by the failure of the body's internal mechanism to regulate its core temperature. Sweating stops and the body can no longer rid itself of excess heat. Signs include mental confusion, delirium, loss of consciousness, convulsions or coma; a body temperature of 106 ^{o}F or higher; and hot dry skin which may be red, mottled, or bluish. Victims of heat stroke will die unless treated promptly. While awaiting medical help, the victim must be removed to a cool area and his or her clothing soaked with cool water. He or she should be fanned vigorously to increase cooling. Prompt first aid can prevent permanent injury to the brain and other vital organs.

Protection and Controls

Chapter 296-62-095 WAC requires protective measures and controls between May 1 and September 30 if employees work at least 45 minutes per hour when the temperature is at or above 89 ^{o}F, at or above 77 ^{o}F if double-layer woven clothing are worn, and at or above 52 ^{o}F if non-breathable clothing are worn. If these conditions apply, employers are required to provide the opportunity for employees to drink at least 1 quart of water per hour, and employees are responsible for staying hydrated and monitoring themselves for potential heat-related illness. Following are prudent practices for reducing heat stress:

- **Drink a lot of cool water all day - before you feel thirsty.** Every 15 or 20 minutes, you should drink a cup of water, Gatorade, or equivalent (5 to 7 ounces). These liquids should contain electrolytes to help replace those lost during sweating. Most workers exposed to hot conditions drink less fluid than needed because of an insufficient thirst drive. A worker, therefore, should not depend on thirst to signal when and how much to drink. If you drink only when you are thirsty you are dehydrated already. Caffeinated fluids should be minimized as they can lead to dehydration.

- **Take rest breaks.** Establish work and rest regimes. Rest in a cool, shady spot. Use fans. Provide a supply of salty foods that can be eaten during rest periods. Supervisors should be aware of the early signs of heat stress and should permit workers to interrupt their work if they are extremely uncomfortable.

- **Do the heaviest work in the coolest time of the day.**

- **Work in the shade.** Use a beach umbrella or string a tarp from your vehicle.

- **Ice vests.** Vests, coats and bandannas containing ice packs are commercially available which help to minimize heat stress. These may be necessary especially if working in protective clothing such as Tyvek or Saranex suits which prevent heat from the body from escaping.

- **Maintain shower sprinkler on site.** If water and sprinkler facilities are available this is a good method for quickly cooling down workers on a regular basis.
- **For heavy work in hot areas,** take turns with other workers, so some can rest.
- **If you travel to a warm area for a new job,** you need time for your body to get used to the heat. Acclimatization to the heat through short exposures followed by longer periods of work in the hot environment can reduce heat stress. New employees and workers returning from an absence of two weeks or more should have a five-day period of acclimatization. This period should begin with 50 percent of the normal workload and time exposure the first day and gradually building up to 100 percent on the fifth day.
- **If you work in protective clothing**, you need more rest breaks. You may also need to check your temperature and heart rate. When semipermeable or impermeable clothing is being used and the temperature is 70 ^{o}F or more, the EPA says that a health professional should be present to monitor worker's body weight, temperature, and heart rate.
- **A buddy system** should be implemented during field activities involving work in hot environments, especially while wearing Level C and B protective clothing. The buddy shall be able to provide his or her partner with assistance, observe his or her partner for signs of heat stress disorders, aid in the treatment of heat stress should the need occur, and notify emergency personnel if emergency help is needed.
- **If you think someone has heat stroke, call 911.** Move the person to the shade, wipe his/her skin with cool water, and loosen his/her clothes. Use a piece of cardboard or other material to fan them.

Work and Rest Regimes to Prevent Heat Stress

Work and rest regimes are designed to aid in the prevention of heat stress. The following table shows the work and rest regimes for D, C, and B levels of protection, according to the WBGT, acclimatization and the use of personal protective equipment (PPE). Non-acclimatized personnel should begin with 50 percent of the normal workload and time exposure the first day and gradually build up to 100 percent over a five-day period. The specific ranges for the work and rest regime should be determined by the site superintendent or site safety officer based on environmental conditions encountered, difficulty of the work being performed, and the health and fitness of the workers involved.

Work/Rest Regime for Heat Stress			
WBGT (Acclimatized workers)	Work and Rest Regime/hour (percent) Level D	Work/Rest Regime/hour (percent) Level C[a]	Work/Rest Regime/hour (percent) Level B[b]
77 °F	Continuous	Continuous	75/25 or Continuous
84 °F	Continuous	75/25 or Continuous	50/50 or 75/25
88 °F	75/25 or Continuous	50/50 or 75/25	25/75 or 50/50
90 °F[c]	50/50 or 75/25	25/75 or 50/50	No work or 25/75
94 °F[d]	25/75 or 50/50	No Work or 25/75	No Work
98 °F[e]	No Work or 25/75	No Work	No Work

NOTE: WBGT = wet bulb globe temperature.
[a] Used also for all Level B work using Saranex/Tyvek suits and ice vests.
[b] Used also for all Level B work using Saranex/Tyvek suits, no ice vests.
[c] No Level B work conducted in temperatures above 90 °F.
[d] No Level C work conducted in temperatures above 94 °F.
[e] No Level D work conducted in temperatures above 98 °F.

3.2.7 Cold-Related Illnesses

Cold temperatures can also pose health hazards to site workers. Exposure to cold is classified into two categories: local or general. Local injuries include frostnip, frostbite, chilblain and trenchfoot. General injuries include hypothermia and blood vessel abnormalities (genetically or chemically induced). Major factors contributing to cold injury are exposure to humidity and high winds, contact with wetness or metal, inadequate clothing, age and general health. Allergies, vascular disease, excessive smoking or drinking, and certain drugs and medicines are physical conditions that can compound the effects of exposure to a cold environment. A cold stress guidelines table is included at the end of this section for quick reference.

Signs and Symptoms

Hypothermia. Hypothermia is a condition of reduced body temperature. Most cases develop in air temperatures between 30-50° F, not taking wind-chill factor into consideration. Symptoms of hypothermia include personality changes, reduced mental alertness, irrationality, and uncontrollable shivering. The heartbeat slows and sometimes becomes irregular, weakening the pulse and changing blood pressure. Changes in the body chemistry cause severe shaking or rigid muscles, vague or slow speech, memory lapses, incoherence, and drowsiness. Cool skin, slow irregular breathing, low blood pressure, apparent exhaustion, and fatigue after rest may precede complete collapse.

As the core body temperature drops, the victim can become listless, confused, and make little or no effort to keep warm. Pain in the extremities can be the first warning of dangerous exposures to cold. At a core body temperature of about 85° F, serious problems develop due to significant drops in blood pressure, pulse rate and respiration.

Sedative drugs and alcohol increase the risk of hypothermia. Sedative drugs interfere with the transmission of impulses to the brain. Alcohol dilates blood vessels near the skin's surface, increasing heat loss and lowering body temperature.

First aid treatment includes removal of the victim to a warm and dry location, removal of cold and damp clothing, wrapping the victim in warm blankets or clothing, and rewarming the victim from the core, not from the extremities. A medical professional must treat severe hypothermia.

Symptoms of frostbite include numbness and whitening of the skin. First aid treatment includes warming with blankets, warm compresses, or lukewarm water. A medical professional must treat severe frostbite.

Raynaud's Phenomenon. Raynaud's Phenomenon is the abnormal constriction of the blood vessels of the finger on exposure to cold temperatures, resulting in blanching of the fingertips. Numbness, itching, tingling, or a burning sensation may occur during related attacks. The disease is also associated with the use of vibrating hand tools in a condition sometimes called White Finger Disease. Persistent cold sensitivity, ulceration, and amputations can occur in severe cases.

Frostnip occurs when the face or extremities are exposed to a cold wind, causing the skin to turn white.

Frostbite is the freezing of the body tissues due to exposure to extremely low temperatures, resulting in damage to and loss of tissue. Frostbite occurs because of inadequate circulation or insulation, resulting in freezing of fluids around the cells of the body tissues. Most vulnerable parts of the body are the nose, cheeks, ears, fingers, and toes.

Frostbite can affect outer layers of skin or can include the tissues beneath. Damage can be serious, with permanent loss of movement in the affected parts, scarring, necrotic tissue, and amputation resulting. Skin and nails that slough off may grow back.

The freezing point of the skin is about 30° F. As wind velocity increases, heat loss is greater and frostbite will set in more rapidly.

There are three degrees of frostbite. First degree is freezing without blistering and peeling; second degree is freezing with blistering and peeling; and third degree is freezing with death of skin tissues and possibly the deeper tissues.

The following are symptoms of frostbite:

- Skin changes color to white or grayish-yellow, progresses to reddish-violet, and finally turns black as the tissue dies.
- Pain may be felt at first, but subsides.
- Blisters may appear.

- Affected part is cold and numb.

The first symptom of frostbite is usually an uncomfortable sensation of coldness, followed by numbness. Tingling, stinging, cramping and aching feelings will follow. Frostbite of the outer layer of the skin has a waxy or whitish look and is firm to the touch. Cases of deep frostbite cause severe injury. The victim is often unaware of the frostbite until someone else observes these symptoms. It is therefore important to use the “buddy system” when working in cold environments, so that symptoms of overexposure can be monitored.

Wind chill, or the cooling effect of moving air, is of critical importance when evaluating the cold exposure of site workers. The potential for frostbite and hypothermia increases greatly with combined cold temperatures and high wind speeds. Workers should inform the site superintendent, or site safety officer, if their hands, face, or feet feel numb, and workers should monitor each other for patches of pale or white skin on the face and ears.

The following table describes the cooling power of wind on exposed flesh. This information can be used as a guide for determining equivalent chill temperatures when the wind is present in cold environments.

Cooling Power of Wind on Exposed Flesh Expressed as an Equivalent Temperature*

Estimated Wind Speed (in mph)	Actual Temperature Reading (^{0}F)											
	50	40	30	20	10	0	-10	-20	-30	-40	-50	-60
	Equivalent Chill Temperature (^{0}F)											
Calm	50	40	30	20	10	0	-10	-20	-30	-40	-50	-60
5	48	37	27	16	6	-5	-15	-26	-36	-47	-57	-68
10	40	28	16	4	-9	-24	-33	-46	-58	-70	-83	-95
15	36	22	9	-5	-18	-32	-45	-58	-72	-85	-99	-112
20	32	18	4	-10	-25	-39	-53	-67	-82	-96	-110	-121
25	30	16	0	-15	-29	-44	-59	-74	-82	-104	-118	-133
30	28	13	-2	-18	-33	-48	-63	-79	-94	-109	-129	-140
35	27	11	-4	-20	-35	-51	-67	-82	-98	-113	-129	-145
40	26	10	-6	-21	-37	-53	-69	-85	-100	-116	-132	-148
(Wind speeds greater than 40 mph have little additional effect)	**LITTLE DANGER** In less than an hour with dry skin. Maximum danger of false sense of security.				**INCREASING DANGER** Danger from freezing of exposed flesh within one minute.			**GREAT DANGER** Flesh may freeze within 30 seconds.				
	Trench foot may occur at any point on this chart.											

* Developed by U.S. Army Research Institute of Environmental Medicine, Natick, MA.

Trench Foot and Chilblains. Trench foot is swelling of the foot caused by long continuous exposure to cold without freezing, combined with persistent dampness or immersion in water. Edema (swelling), tingling, itching and severe pain occurs, followed by blistering, necrotic tissue and ulcerations. Chilblains have similar symptoms as trench foot, except that other areas of the body are affected.

Treatment

Remove the patient to a warm, dry place. If clothing is wet, remove and replace with dry clothing. Keep patient warm. Rewarming of patient should be gradual to avoid stroke symptoms. Patient dehydration may result in cold injury due to a significant change in blood flow to the extremities. If patient is conscious and alert, warm, sweet liquids should be provided. Coffee and other caffeinated liquids should be avoided because of diuretic and circulatory effects. Extremities affected by frostbite should be gradually warmed up and returned to normal temperature. Moist compresses should be applied; begin with lukewarm compresses and slowly increase the temperature as changes in skin temperature are detected. Keep patient warm and calm. Remove to a medical facility as soon as possible.

Prevention and Controls

The reduction of adverse health effects from cold exposure is achieved by adopting the following work practices:

- Providing adequate dry insulating clothing to maintain core temperature above 98.6°F to workers if work is performed in air temperature below 40° F. Wind chill cooling rates and the cooling power of air are critical factors. The higher the wind speed and the lower the temperature in the work area, the greater the insulation value of the protective clothing required.

- If the air temperature is of 32° F or less, hands should be protected by gloves or mittens.

- If only light work is involved and the worker’s clothing becomes wet on the job site, the outer layer of clothing should be impermeable to water. With more severe work under such conditions, the outer layer should be water repellent, and the outer wear should be changed as it becomes wet. The outer garments should include provisions for easy ventilation in order to prevent wetting of the inner layer of sweat.

- If available clothing does not give adequate protection to prevent cold injury, work should be modified or suspended until adequate clothing is made available, or until weather conditions improve.

- Use heated warming shelters available nearby (e.g., on-site trailer) at regular intervals, the frequency depending on the severity of the environmental exposure.

When entering the heated shelter, remove the outer layer of clothing and loosen the remainder of clothing to permit heat evaporation or change to dry work clothing.

- Provide warm, sweet drinks (e.g., hot chocolate) and soups at the work site for calorie intake and fluid volume. Limit the intake of coffee because of the diuretic and circulatory effect.

- Include the weight and bulk of clothing in estimating the required work performance and weights to be lifted by the worker.

- Implement a buddy system in which workers are responsible for observing fellow workers for early signs and symptoms of cold stress.

- Unacclimatized employees should not work full-time in cold until they become accustomed to the working conditions and required protective clothing.

- Observe work and warming regimen as shown in the following table.

The following table shows the recommended number of breaks that should be taken per hour based upon the air temperature and wind speeds encountered. This table also lists the maximum sustained work period (in minutes) allowed when working under these conditions.

Work/Warming Regimen

Air Temperature - Sunny Sky		No Noticeable Wind		5 mph Wind		10 mph Wind		15 mph Wind		20 mph Wind	
^{0}C (approx.)	^{0}F (approx.)	Max Work Period	# of breaks	Max Work Period	# of breaks	Max Work Period	# of breaks	Max Work Period	# of breaks	Max Work Period	# of breaks
-26 to -28	-15 to -19	(Norm Breaks) 1		(Norm Breaks) 1		75 min.	2	55 min.	3	40 min.	4
-29 to – 31	-20 to -24	(Norm Breaks) 1		75 min.	2	55 min.	3	40 min.	4	30 min.	5
-32 to – 34	-25 to -29	75 min.	2	55 min.	3	40 min.	4	30 min.	5	non-emergency work should cease	
-35 to – 37	-30 to -34	55 min.	3	40 min.	4	30 min.	5	non-emergency work should cease		non-emergency work should cease	
-38 to – 39	-35 to -39	40 min.	4	30 min.	5	non-emergency work should cease		non-emergency work should cease		non-emergency work should cease	
-40 to – 42	-40 to -44	30 min.	5	non-emergency work should cease		non-emergency work should cease		non-emergency work should cease		non-emergency work should cease	
-43 and below	-45 and below	non-emergency work should cease		non-emergency work should cease		non-emergency work should cease		non-emergency work should cease		non-emergency work should cease	

ATTACHMENT 1

ON-THE-JOB INJURY OR ILLNESS FLOWCHART OF ACTION REQUIRED

1. Reporting the On-the-Job Injury or Illness:

For reporting **AFTER HOURS** accidents and injuries, call:

Novato Office

William Frizzell – (415) 897-0125
Nicholas Pogoncheff – (415) 459-5727

Seattle Office

Daniel Balbiani – (425) 466-0770

1a. All On-the-Job Incidents:
1. Report incident to Supervisor
2. Report incident to Project Manager immediately
3. Report incident to CHSO immediately
4. Supervisor documents incident investigation

lb. Incidents Requiring Medical Attention:
1. When possible, use medical facility listed on Job Safety Plan
2. Provide Physician with:
   - INSURANCE CARRIER
   - Return to Work Authorization Form

1c. Serious Injury Incidents:
Incidents involving 24-hour hospitalization; permanent disfiguration or dismemberment; a fatality
In addition to steps la. and lb., immediately contact CHSO, so incident can be reported to the appropriate state agency.

2. Returning to Work After An On-the-Job Injury or Illness

2a. When Incident Required Layman First Aid Only:

Supervisor shall evaluate employee's ability to return to work after administration of first aid. Employee shall return to work or follow steps 1a., 1b., and 2b. Supervisors do not determine lost time injuries. Time off due to on-the-job injury or illness, can be authorized only by a licensed physician.

2b. When Incident Involved Medical Treatment:

1. Report health status to CHSO.
2. Employee shall return/not return to work as instructed on the "Return to Work Authorization" form signed by the attending physician.
3. Supervisor shall complete Section 3 of the "Return to Work Authorization" form verifying return to work status.

ATTACHMENT 2

PES ENVIRONMENTAL INC.
SUPERVISOR'S EMPLOYEE INCIDENT/INJURY REPORT

EMPLOYEE

This report is to be initiated by the employee's supervisor. Please answer all questions completely. This report must be forwarded to the appropriate health and safety representative within 24 HOURS of the injury/illness.

Injured's Name ______________ Sex _____ S.S No. ______________ Birth Date ______________
Home Address ______________
City ______________ State ________ Zip ______________ Phone ( ) ______________
Job Title ______________ Hire Date ______________ Hourly Wage ______________

SUPERVISOR

Date of Incident ______________ Time __________ Time Reported __________ To Whom? ______________
Project/Location Name ______________ Address ______________
Project No. __________ Time Shift Began __________ Did the Employee Leave Work? ☐No ☐Yes When ______________
Has employee returned to work? ☐ No ☐ Yes When ____________ Did employee miss a regularly scheduled shift? ☐No ☐ Yes
Doctor/Hospital ______________ Name Address ______________
Witness Name(s) ______________ Statement Attached? ☐No ☐Yes
Nature of injury ______________ Exact Body Part ______________
Medical Attention: ☐ None ☐ First Aid On Site ☐Doctor's Office ☐Hospital ER ☐Hospitalized
Job Assignment at Time of Incident ______________
Describe Incident ______________

What Unsafe Condition and/or Act Contributed to the Incident? ______________

What Corrective Action Has Been Taken to Prevent Recurrence? ______________

Supervisor ______________ ______________ ______________
(Print) Signature Date

MANAGER

Comments on Incident and Corrective Action ______________

Project/Location Mgr. ______________ ______________ ______________
(Print) Signature Date

HEALTH AND SAFETY

Concur With Action Taken? ☐No ☐Yes Remarks ______________

OSHA Classification:
☐ First Aid ☐Recordable, No Lost/Restricted Workdays ☐Recordable, Lost Workdays ☐Recordable, Restricted Activity ☐Fatality

Days Away From Work ______________ Days Restricted Work ______________

All injuries/illnesses requiring outside medical treatment must be reported to the CHSO by calling 1-800-737-4450 within 24 hours of the incident.

Workers' Compensation Claim Number (if applicable) ______________

Health and Safety Representative:

______________ ______________ ______________
(Print) Signature Date

APPENDIX C

TEST DATA USED IN DESIGN

Northwest Testing, Inc.
A Division of Northwest Geotech, Inc.
9120 SW Pioneer Court, Suite B • Wilsonville, Oregon 97070 503/682-1880 FAX: 503/682-2753

TECHNICAL REPORT

Report To: Mr. Roger B. North, P.E.
Kennec, Inc.
12725 SW 66th Avenue, Suite 302
Portland, Oregon 97223

Date: 3/12/08

Lab No.: 08-056

Project: Laboratory Testing
BSB Diversified

Project No.: 2012.1.1

Report of: Atterberg limits and sieve analysis

Sample Identification

As requested, NTI determined Atterberg limits and sieve analysis of bulk samples of soil delivered to our laboratory on March 6, 2008 by a Kennec, Inc. representative. All testing was performed in general accordance with the methods indicated. Our laboratory's test results are summarized on the following table and attached page.

Laboratory Test Results

Atterberg Limits (ASTM D 4318)			
Sample ID	**Liquid Limit**	**Plastic Limit**	**Plasticity Index**
SP-103	NP	NP	NP
SP-109	23	20	3
SP-121	NP	NP	NP
SP-127	NP	NP	NP

Attachments: Laboratory Test Results – Sieve Analysis

Copies: Addressee

Northwest Testing, Inc.
A Division of Northwest Geotech, Inc.
9120 SW Pioneer Court, Suite B • Wilsonville, Oregon 97070 503/682-1880 FAX: 503/682-2753

TECHNICAL REPORT

Report To: Mr. Roger B. North, P.E.
Kennec, Inc.
12725 SW 66th Avenue, Suite 302
Portland, Oregon 97223

Date: 3/12/08

Lab No.: 08-056

Project: Laboratory Testing
BSB Diversified

Project No.: 2012.1.1

Laboratory Testing

Sieve Analysis of Aggregate (ASTM C117/C136)				
Sieve Size	**SP-103 Percent Passing**	**SP-109 Percent Passing**	**SP-121 Percent Passing**	**SP-127 Percent Passing**
1"	100	100	100	100
¾"	92	99	100	100
½"	91	98	96	100
⅜"	90	98	95	100
¼"	89	97	94	99
#4	88	96	92	98
#8	87	94	90	97
#10	87	92	89	96
#16	85	89	86	93
#30	80	73	78	80
#40	72	61	69	69
#50	58	51	54	54
#100	35	38	33	35
#200	25.5	27.8	23.1	24.3

VECTOR ENGINEERING, INC.

DATE: April 29, 2008

TO: Roger B. North
Kennec Inc.
12725 SW 66th Ave., Suite 202
Portland, OR 97223

e-mail: rnorth@kennecc.com

JOB NO: 081706.00
LAB LOG: 2508.0

RE: **Lab Report: BSB Slurry Wall / C016.001.0801**

Enclosed are results for: Samples Received - April 21, 2008

Code	Item	Quantity
19544	Water Content, ASTM D-2216	2
19522	Percent Finer than # 200 Sieve, ASTM D-1140 (C-117)	2
21552	Soil / Bentonite, Mix Evaluation	6
18568	Hydraulic Conductivity-Flex-wall, Remolded, ASTM D-5084	6

Thank you for consulting Vector Engineering for your material testing requirements. We look forward to working with you again. If you have any questions or require any additional information, please call us at 1-530-272-2448.

Sincerely,

Prepared By: Sherrol Casner
Laboratory Technician

Reviewed By: Kenneth R. Criley
Technical Director

Vector Engineering Inc.

143E Spring Hill Drive, Grass Valley, CA 95945 (530) 272-2448

LABORATORY SERVICES

WATER CONTENT & MINUS # 200 % with GRAVEL

Client : Kennec Inc.
Project No: 081706.00
Lab Log: **2508**

Project Name: BSB Slurry Wall Mix
Report Date: April 19, 2008

LSN	Sample ID	Soil Classification **	Water Content (%)	Percent Minus #200	Percent Sand	Percent Gravel
2805A	SP-121	Gray Silty Sand	2.8	27.2	65.2	7.6
2805B	SP-103	Gray Silty Sand	5.3	31.9	62.2	5.9

Notes: ** Classifications are based on ASTM D-2487 when appropriate test results are available and per ASTM D-2488 when visual

Entered By: SMC
Rev. By: [signature]
Lab Log: **2508**

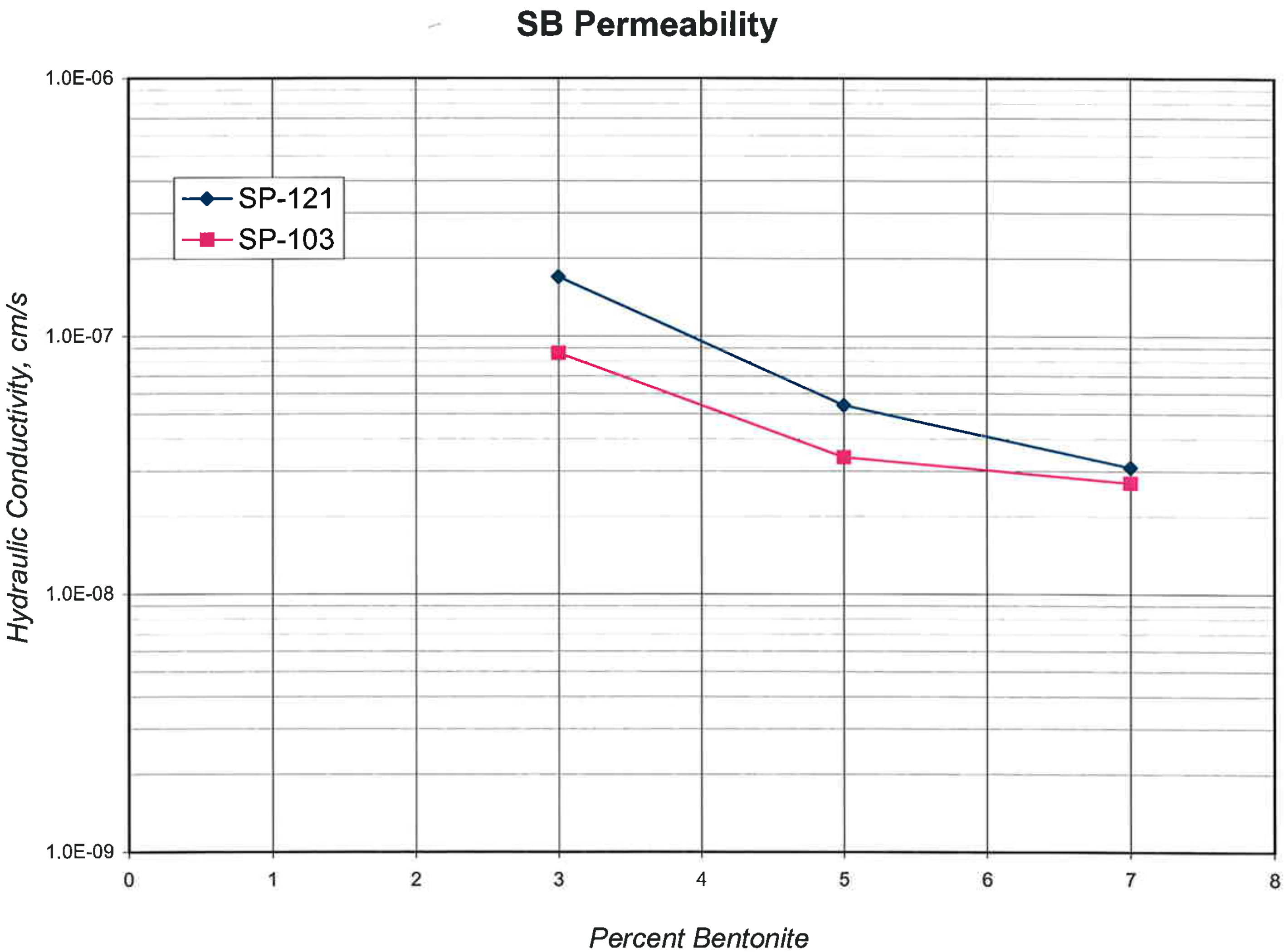
Vector Engineering Inc.

143E, Spring Hill Dr., Grass Valley, CA, 530-272-2448

LABORATORY SERVICES

HYDRAULIC CONDUCTIVITY vs % BENTONITE

Client:	Project No:	Lab Log:
Kennec Inc.	**081706.00**	**2508**
Project Name:	Description:	
BSB Slurry Wall / C016.001.0801	**Soil Bentonite Mix**	



% Bentonite	**SP-121** k, cm/s	**SP-103** k, cm/s
3	1.7E-07	8.6E-08
5	5.4E-08	3.4E-08
7	3.1E-08	2.7E-08

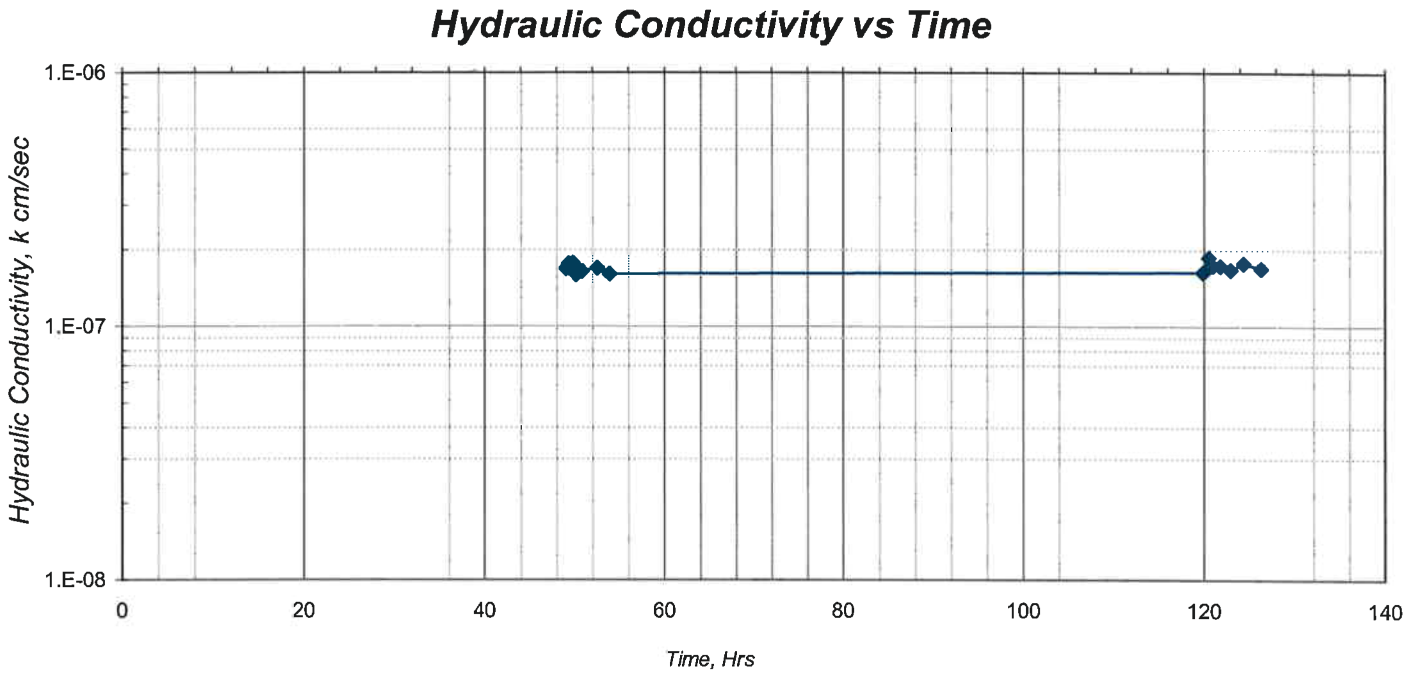
Vector Engineering Inc.
143E Spring Hill Drive, Grass Valley, CA 95945 (530) 272-2448
LABORATORY SERVICES

HYDRAULIC CONDUCTIVITY REPORT

Client / Project Name:	Project No:	Lab Sample Number:
Kennec Inc. / BSB Slurry Wall / C016.001.0801	081706.00	2508E

Sample ID:	Report Date:
SP-121 w/ 3% Bentonite	April 29, 2008

Hydraulic Conductivity vs Time



SPECIMEN DATA

SAMPLE ID: **SP-121 w/ 3% Bentonite**

DESCRIPTION: Soil Bentonite Mix

	INITIAL	FINAL
HEIGHT, in.	1.5	1.3
DIAMETER, in.	4.0	4.0
WATER CONTENT, %	29.1	23.3
DRY DENSITY, pcf	92	101
SATURATION, %	99	100
(Specific Gravity assumed as 2.6)		
MAXIMUM DRY DENSITY, pcf		
OPTIMUM WATER CONTENT, %		
SPECIFIED COMPACTION, %		
ACHIEVED COMPACTION, %		

COMMENTS:

Site water used as permeant .

TEST DATA

ASTM D-5084, Method C

EFFECTIVE STRESS:	2 psi
GRADIENT RANGE:	14 - 24
IN / OUT RATIO:	0.99
"B" PARAMETER:	0.95

TRIAL nos.	TIME hrs.	HYDRAULIC CONDUCTIVITY cm / sec
8	120.0	1.6E-07
9	120.6	1.9E-07
10	121.0	1.7E-07
11	121.9	1.7E-07
12	123.0	1.7E-07
13	124.4	1.8E-07
14	126.4	1.7E-07

AVERAGE LAST 4 : **1.7E-07**

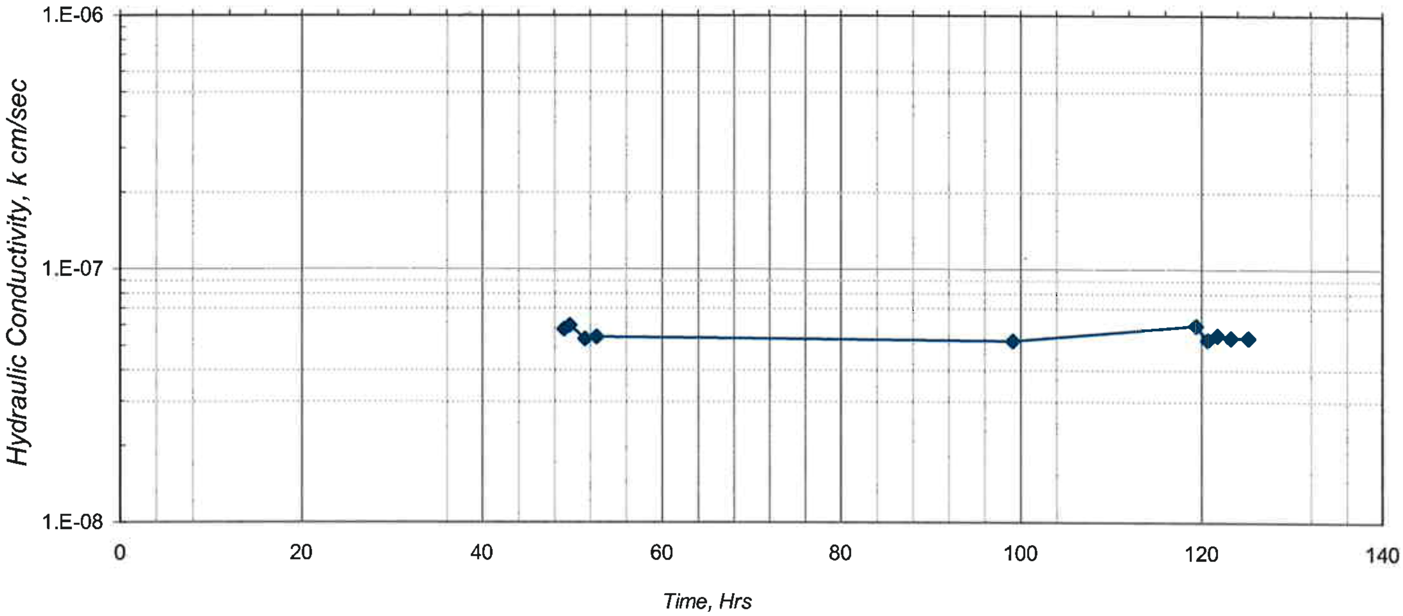
Vector Engineering Inc.
143E Spring Hill Drive, Grass Valley, CA 95945 (530) 272-2448
LABORATORY SERVICES

HYDRAULIC CONDUCTIVITY REPORT

Client / Project Name:	Project No:	Lab Sample Number:
Kennec Inc. / BSB Slurry Wall / C016.001.0801	081706.00	2508F

Sample ID:	Report Date:
SP-121 w/ 5% Bentonite	April 29, 2008

Hydraulic Conductivity vs Time



SPECIMEN DATA

SAMPLE ID:	SP-121 w/ 5% Bentonite	
DESCRIPTION:	Soil Bentonite Mix	
	INITIAL	FINAL
HEIGHT, in.	1.4	1.3
DIAMETER, in.	4.0	4.0
WATER CONTENT, %	31.4	25.5
DRY DENSITY, pcf	87	97
SATURATION, %	94	99
(Specific Gravity assumed as 2.6)		
MAXIMUM DRY DENSITY, pcf		
OPTIMUM WATER CONTENT, %		
SPECIFIED COMPACTION, %		
ACHIEVED COMPACTION, %		

COMMENTS:
Site water used as permeant .

TEST DATA

ASTM D-5084, Method C

EFFECTIVE STRESS:	2 psi
GRADIENT RANGE:	6 - 25
IN / OUT RATIO:	0.93
"B" PARAMETER:	0.95

TRIAL nos.	TIME hrs.	HYDRAULIC CONDUCTIVITY cm / sec
4	52.8	5.4E-08
5	99.2	5.2E-08
6	119.4	6.0E-08
7	120.7	5.3E-08
8	121.8	5.5E-08
9	123.3	5.4E-08
10	125.2	5.3E-08

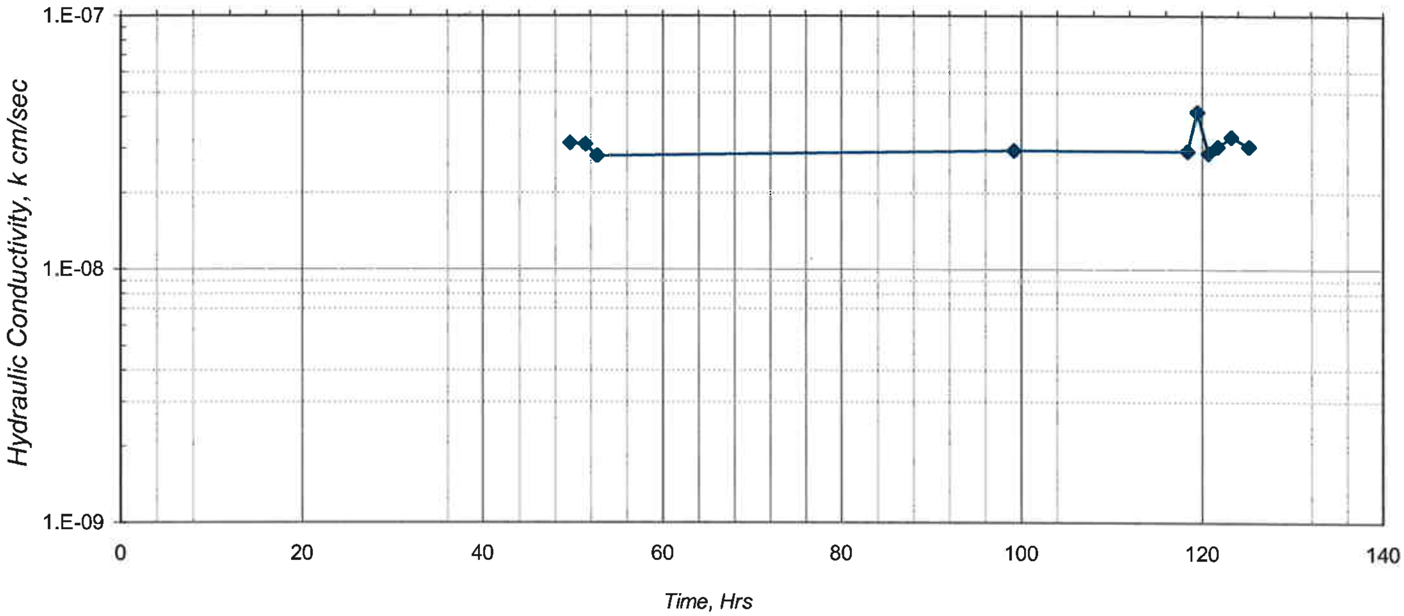
AVERAGE LAST 4 : **5.4E-08**

Vector Engineering Inc.
143E Spring Hill Drive, Grass Valley, CA 95945 (530) 272-2448
LABORATORY SERVICES

HYDRAULIC CONDUCTIVITY REPORT

Client / Project Name: **Kennec Inc. / BSB Slurry Wall / C016.001.0801**
Project No: **081706.00**
Lab Sample Number: **2508G**
Sample ID: **SP-121 w/ 7% Bentonite**
Report Date: **April 29, 2008**

Hydraulic Conductivity vs Time



SPECIMEN DATA

SAMPLE ID:	SP-121 w/ 7% Bentonite	
DESCRIPTION:	Soil Bentonite Mix	
	INITIAL	FINAL
HEIGHT, in.	1.2	1.1
DIAMETER, in.	4.0	4.0
WATER CONTENT, %	35.1	29.4
DRY DENSITY, pcf	84	92
SATURATION, %	98	99
(Specific Gravity assumed as 2.6)		
MAXIMUM DRY DENSITY, pcf		
OPTIMUM WATER CONTENT, %		
SPECIFIED COMPACTION, %		
ACHIEVED COMPACTION, %		

COMMENTS:
Site water used as permeant .

TEST DATA

ASTM D-5084, Method C

EFFECTIVE STRESS:	2 psi
GRADIENT RANGE:	7 - 30
IN / OUT RATIO:	0.91
"B" PARAMETER:	0.95

TRIAL nos.	TIME hrs.	HYDRAULIC CONDUCTIVITY cm / sec
4	99.2	2.9E-08
5	118.5	2.9E-08
6	119.5	4.2E-08
7	120.7	2.9E-08
8	121.8	3.0E-08
9	123.3	3.3E-08
10	125.2	3.1E-08

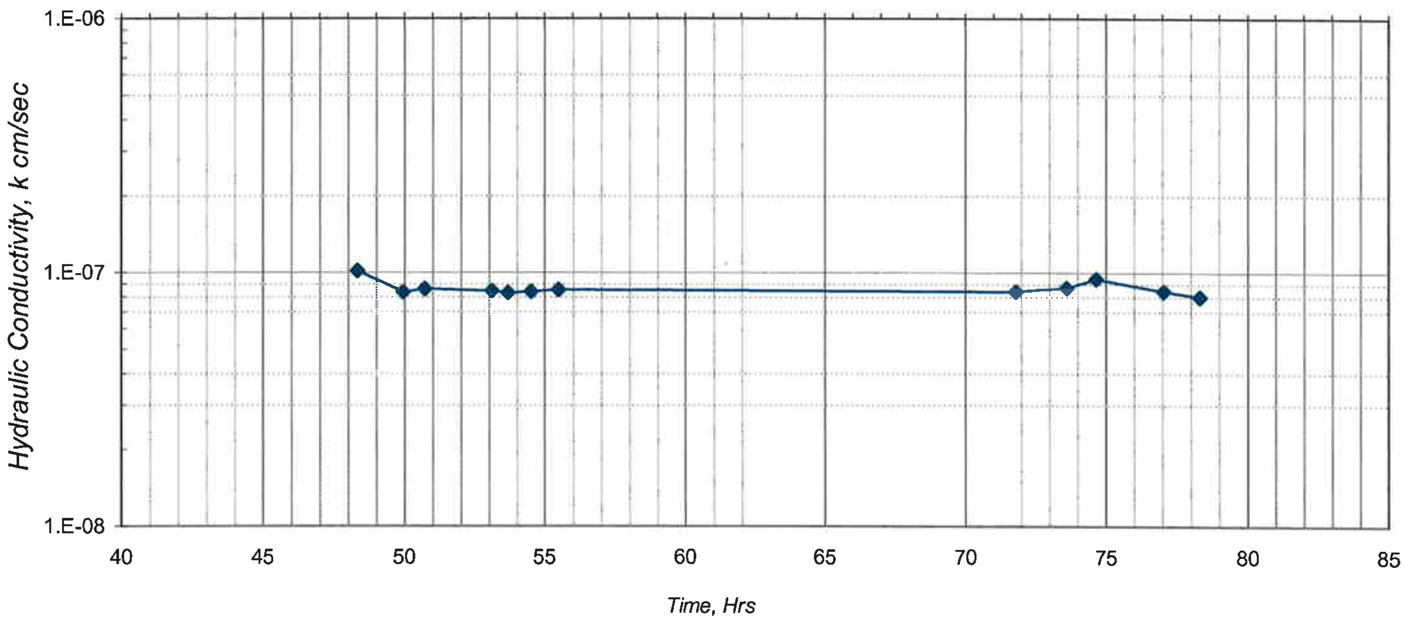
AVERAGE LAST 4 : **3.1E-08**

Vector Engineering Inc.
143E Spring Hill Drive, Grass Valley, CA 95945 (530) 272-2448
LABORATORY SERVICES

HYDRAULIC CONDUCTIVITY REPORT

Client / Project Name: **Kennec Inc. / BSB Slurry Wall / C016.001.0801**
Project No: **081706.00**
Lab Sample Number: **2508H**
Sample ID: **SP-103 w/ 3% Bentonite**
Report Date: **April 28, 2008**

Hydraulic Conductivity vs Time



SPECIMEN DATA

SAMPLE ID: **SP-103 w/ 3% Bentonite**
DESCRIPTION: Soil Bentonite Mix

	INITIAL	FINAL
HEIGHT, in.	1.4	1.2
DIAMETER, in.	4.0	3.9
WATER CONTENT, %	31.1	24.6
DRY DENSITY, pcf	82	99
SATURATION, %	83	99
(Specific Gravity assumed as 2.6)		
MAXIMUM DRY DENSITY, pcf		
OPTIMUM WATER CONTENT, %		
SPECIFIED COMPACTION, %		
ACHIEVED COMPACTION, %		

COMMENTS:
Site water used as permeant .

TEST DATA

ASTM D-5084, Method C

EFFECTIVE STRESS: 2 psi
GRADIENT RANGE: 9 - 29
IN / OUT RATIO: 0.98

TRIAL nos.	TIME hrs.	HYDRAULIC CONDUCTIVITY cm / sec
6	54.5	8.4E-08
7	55.5	8.5E-08
8	71.8	8.4E-08
9	73.6	8.7E-08
10	74.7	9.4E-08
11	77.1	8.4E-08
12	78.3	8.0E-08

AVERAGE LAST 4 : **8.6E-08**

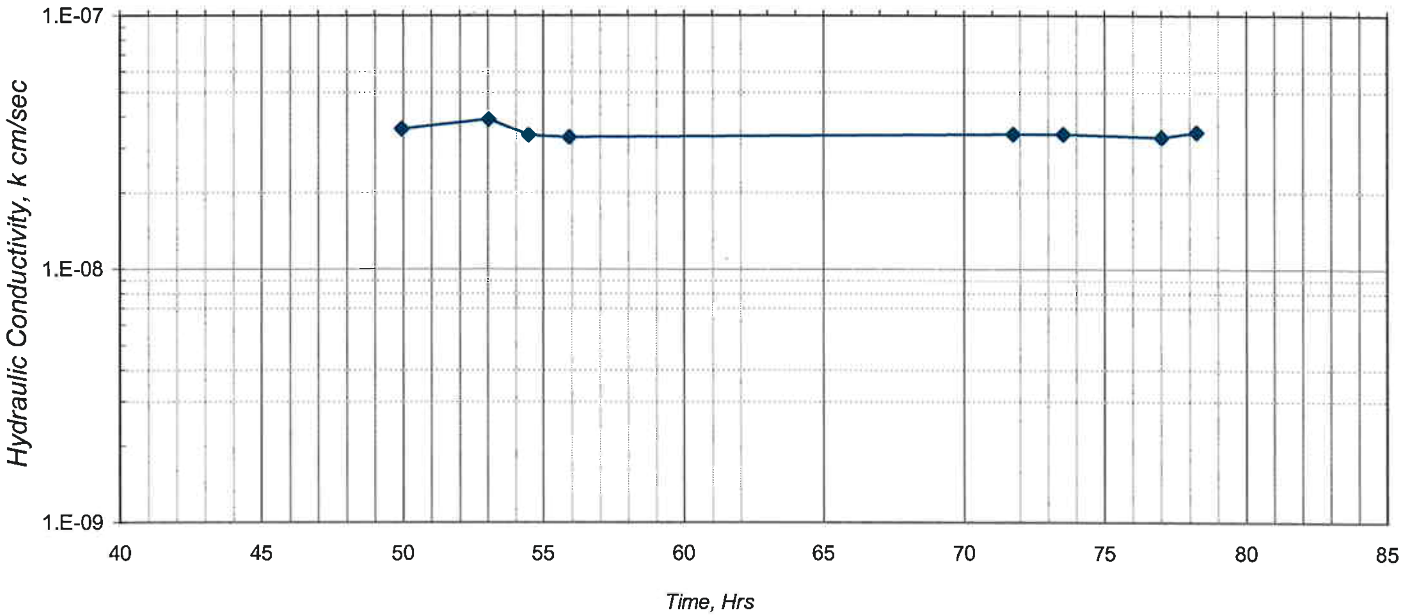
Vector Engineering Inc.
143E Spring Hill Drive, Grass Valley, CA 95945 (530) 272-2448
LABORATORY SERVICES

HYDRAULIC CONDUCTIVITY REPORT

Client / Project Name:	Project No:	Lab Sample Number:
Kennec Inc. / BSB Slurry Wall / C016.001.0801	081706.00	2508I

Sample ID:	Report Date:
SP-103 w/ 5% Bentonite	April 28, 2008

Hydraulic Conductivity vs Time



SPECIMEN DATA

SAMPLE ID: **SP-103 w/ 5% Bentonite**

DESCRIPTION: Soil Bentonite Mix

	INITIAL	FINAL
HEIGHT, in.	1.4	1.3
DIAMETER, in.	4.0	4.0
WATER CONTENT, %	37.9	30.9
DRY DENSITY, pcf	82	90
SATURATION, %	100	100
(Specific Gravity assumed as 2.6)		
MAXIMUM DRY DENSITY, pcf		
OPTIMUM WATER CONTENT, %		
SPECIFIED COMPACTION, %		
ACHIEVED COMPACTION, %		

COMMENTS:

Site water used as permeant .

TEST DATA

ASTM D-5084, Method C

EFFECTIVE STRESS: 2 psi

GRADIENT RANGE: 16 - 27

IN / OUT RATIO: 0.78

TRIAL nos.	TIME hrs.	HYDRAULIC CONDUCTIVITY cm / sec
2	53.1	3.9E-08
3	54.5	3.4E-08
4	55.9	3.3E-08
5	71.8	3.4E-08
6	73.5	3.4E-08
7	77.0	3.3E-08
8	78.3	3.5E-08

AVERAGE LAST 4 : **3.4E-08**

Vector Engineering Inc.

143E Spring Hill Drive, Grass Valley, CA 95945 (530) 272-2448

LABORATORY SERVICES

HYDRAULIC CONDUCTIVITY REPORT

Client / Project Name: **Kennec Inc. / BSB Slurry Wall / C016.001.0801**

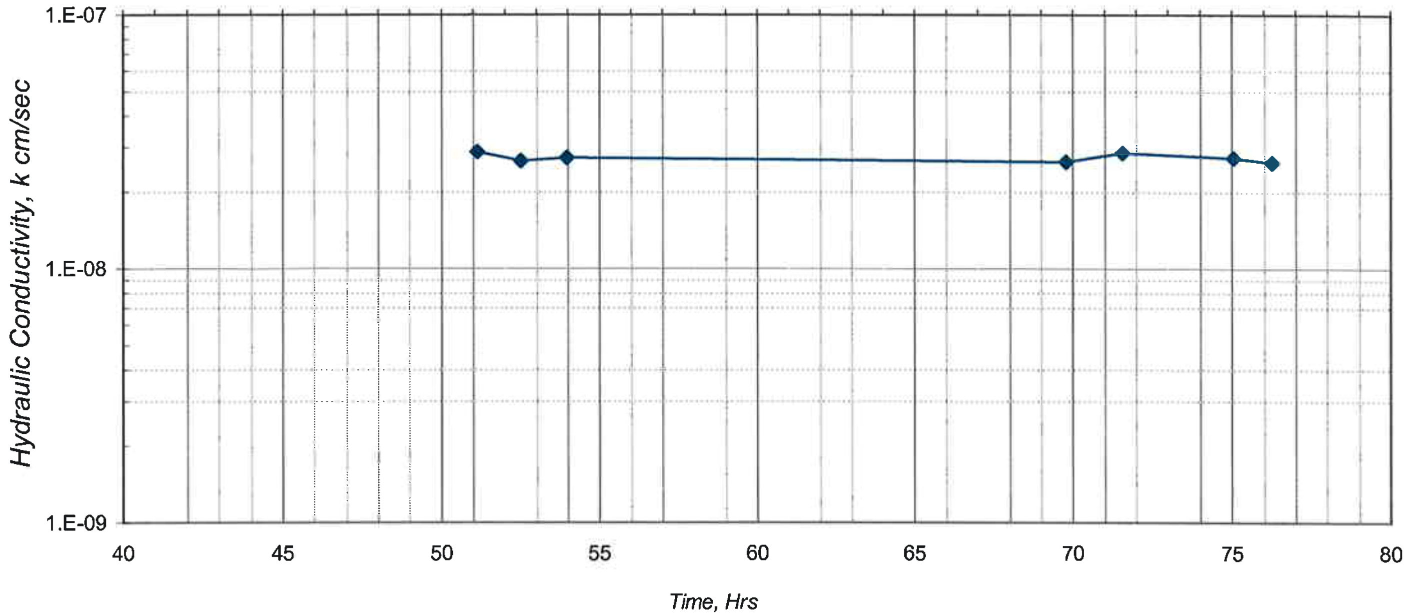
Project No: **081706.00**

Lab Sample Number: **2508J**

Sample ID: **SP-103 w/ 7% Bentonite**

Report Date: **April 28, 2008**

Hydraulic Conductivity vs Time



SPECIMEN DATA

SAMPLE ID: **SP-103 w/ 7% Bentonite**

DESCRIPTION: Soil Bentonite Mix

	INITIAL	FINAL
HEIGHT, in.	1.5	1.3
DIAMETER, in.	4.0	4.0
WATER CONTENT, %	39.9	35.8
DRY DENSITY, pcf	75	84
SATURATION, %	89	99

(Specific Gravity assumed as 2.6)

MAXIMUM DRY DENSITY, pcf

OPTIMUM WATER CONTENT, %

SPECIFIED COMPACTION, %

ACHIEVED COMPACTION, %

COMMENTS:

Site water used as permeant .

TEST DATA

ASTM D-5084, Method C

EFFECTIVE STRESS: 2 psi

GRADIENT RANGE: 18 - 26

IN / OUT RATIO: 0.84

TRIAL nos.	TIME hrs.	HYDRAULIC CONDUCTIVITY cm / sec
1	51.1	2.9E-08
2	52.5	2.7E-08
3	54.0	2.7E-08
4	69.8	2.6E-08
5	71.6	2.9E-08
6	75.1	2.7E-08
7	76.3	2.6E-08

AVERAGE LAST 4 : **2.7E-08**

Northwest Testing, Inc.
A Division of Northwest Geotech, Inc.
9120 SW Pioneer Court, Suite B • Wilsonville, Oregon 97070 503/682-1880 FAX: 503/682-2753

TECHNICAL REPORT

Report To: Mr. Roger B. North, P.E.
Kennec, Inc.
12725 SW 66th Avenue, Suite 302
Portland, Oregon 97223

Date: 5/1/08

Lab No.: 08-083

Project: Laboratory Testing
BSB Diversified

Project No.: 2012.1.1

Report of: Atterberg limits, particle size analysis, unit weight of soil, flexible wall permeability, and consolidation of soil

Sample Identification

As requested, NTI determined Atterberg limits, particle size analysis, unit weight of soil, flexible wall permeability, and consolidation of soil on samples delivered to our laboratory on March 6, 2008 by a Kennec, Inc. representative. All testing was performed in general accordance with the methods indicated. Our laboratory's test results are summarized on the following table and attached pages.

Laboratory Test Results

Moisture Content of Soil and Dry Density of Soil (ASTM D 2216)		
Sample ID	**Moisture Content (Percent)**	**Dry Density (pcf)**
B-4 S-7 @ 20 – 22 ft.	35.4	87.3
B-4 S-14 @ 37.5 – 39.5 ft.	36.3	80.1
B-5 S-11 @ 40 – 42 ft.	39.2	86.1
B-6 S-7 @ 20 – 22 ft.	39.5	74.7
B-6 S-12 @ 32 – 34 ft.	41.3	75.9
B-7 S-7 @ 24.5 – 26.5 ft.	23.9	98.5
B-7 S-8 @ 40 – 42 ft.	36.6	85.6

Atterberg Limits (ASTM D 4318)			
Sample ID	**Liquid Limit**	**Plastic Limit**	**Plasticity Index**
B-4 S-7 @ 20 – 22 ft.	NP	NP	NP
B-4 S-14 @ 37.5 – 39.5 ft.	NP	NP	NP
B-5 S-11 @ 40 – 42 ft.	26	24	2
B-6 S-7 @ 20 – 22 ft.	29	27	2
B-6 S-12 @ 32 – 34 ft.	NP	NP	NP
B-7 S-7 @ 24.5 – 26.5 ft.	20	19	1
B-7 S-8 @ 40 – 42 ft.	30	22	8

Attachments: Laboratory Test Results – Sieve Analysis
Consolidation Test Results

Copies: Addressee

Northwest Testing, Inc.
A Division of Northwest Geotech, Inc.
9120 SW Pioneer Court, Suite B • Wilsonville, Oregon 97070 503/682-1880 FAX: 503/682-2753

TECHNICAL REPORT

Report To: Mr. Roger B. North, P.E.
Kennec, Inc.
12725 SW 66th Avenue, Suite 302
Portland, Oregon 97223

Date: 5/1/08

Lab No.: 08-083

Project: Laboratory Testing
BSB Diversified

Project No.: 2012.1.1

Laboratory Testing

Particle Size Analysis of Soil – Sieve Analysis (ASTM D422)

Sieve Size	B-4 S-7 @ 20 – 22 ft. Percent Passing	B-4 S-14 @ 37.5 – 39.5 ft. Percent Passing	B-5 S-11 @ 40 – 42 ft. Percent Passing	B-6 S-7 @ 20 – 22 ft. Percent Passing
¼"	100	100	100	100
#4	100	100	100	99
#8	100	100	100	99
#10	100	100	100	99
#16	100	100	100	99
#30	100	100	99	98
#40	99	100	99	98
#50	99	100	99	97
#100	90	98	97	97
#200	50.3	93.2	80.5	96.5

Particle Size Analysis of Soil – Sieve Analysis (ASTM D422)

Sieve Size	B-6 S-12 @ 32 – 34 ft. Percent Passing	B-7 S-7 @ 24.5 – 26.5 ft. Percent Passing	B-7 S-8 @ 40 – 42 ft. Percent Passing
¼"	100	100	100
#4	100	100	100
#8	100	100	100
#10	100	100	100
#16	99	99	100
#30	97	95	99
#40	96	87	99
#50	94	71	98
#100	90	39	91
#200	84.8	27.6	70.5

 REVIEWED BY: Bridgett Adame

Northwest Testing, Inc.
A Division of Northwest Geotech, Inc.
9120 SW Pioneer Court, Suite B • Wilsonville, Oregon 97070 503/682-1880 FAX: 503/682-2753

TECHNICAL REPORT

Report To:	Mr. Roger B. North, P.E. Kennec, Inc. 12725 SW 66th Avenue, Suite 302 Portland, Oregon 97223	**Date:** **Lab No.:**	5/1/08 08-083
Project:	Laboratory Testing BSB Diversified	**Project No.:**	2012.1.1

Laboratory Test Results

Sample ID: B-6 S-7 @ 20 – 22 ft.

Flexible Wall Permeability – Sample Data (ASTM D5084)					
Mass (grams)	**Length (inches)**	**Diameter (inches)**	**Area (inches)**	**Moisture Content (percent)**	**Dry Density (pcf)**
444.84	2.930	2.853	6.393	39.5	64.9

Flexible Wall Permeability – Test Data (ASTM D5084)			
Sample Condition	**Saturation at Time of Testing (percent)**	**Head (psi)**	**Hydraulic Gradient (in/in)**
As received	96	1.5	14.18

Flexible Wall Permeability – Test Results (ASTM D5084)				
Test 1 k (cm/sec)	**Test 2 k (cm/sec)**	**Test 3 k (cm/sec)**	**Test 4 k (cm/sec)**	**Average k (cm/sec)**
6.54×10^{-7}	6.64×10^{-7}	6.58×10^{-7}	6.64×10^{-7}	6.60×10^{-7}

Northwest Testing, Inc.
A Division of Northwest Geotech, Inc.
9120 SW Pioneer Court, Suite B • Wilsonville, Oregon 97070 503/682-1880 FAX: 503/682-2753

TECHNICAL REPORT

Report To:	Mr. Roger B. North, P.E. Kennec, Inc. 12725 SW 66th Avenue, Suite 302 Portland, Oregon 97223	**Date:** **Lab No.:**	5/1/08 08-083
Project:	Laboratory Testing BSB Diversified	**Project No.:**	2012.1.1

Laboratory Test Results

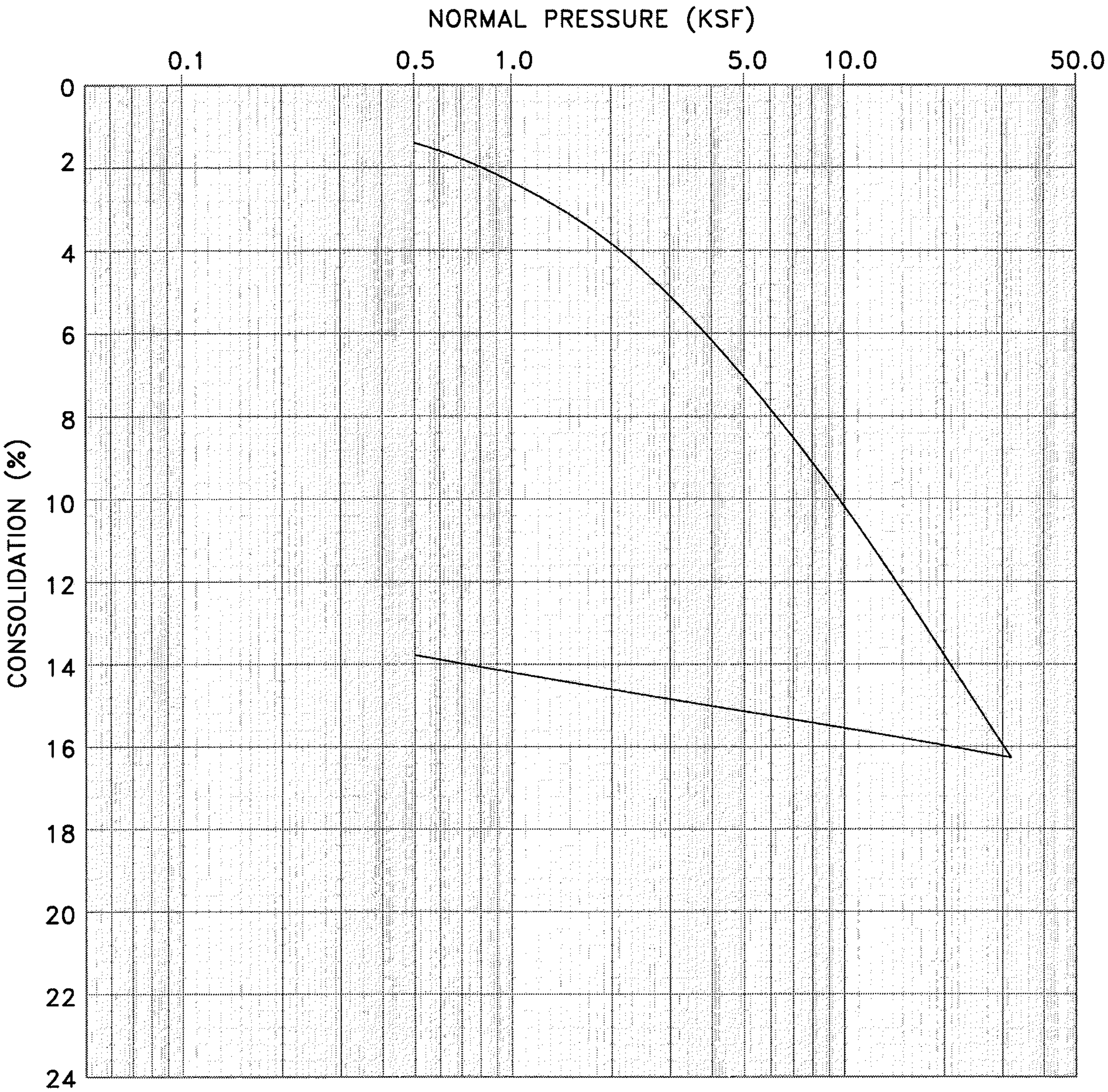
Sample ID: B-7 S-8 @ 40 –42 ft.

Flexible Wall Permeability – Sample Data (ASTM D5084)					
Mass (grams)	**Length (inches)**	**Diameter (inches)**	**Area (inches)**	**Moisture Content (percent)**	**Dry Density (pcf)**
417.44	2.110	2.922	6.706	35.4	83.0

Flexible Wall Permeability – Test Data (ASTM D5084)			
Sample Condition	**Saturation at Time of Testing (percent)**	**Head (psi)**	**Hydraulic Gradient (in/in)**
As received	97	1.0	13.1

Flexible Wall Permeability – Test Results (ASTM D5084)				
Test 1 k (cm/sec)	**Test 2 k (cm/sec)**	**Test 3 k (cm/sec)**	**Test 4 k (cm/sec)**	**Average k (cm/sec)**
9.86×10^{-6}	9.08×10^{-6}	9.36×10^{-6}	9.06×10^{-6}	9.34×10^{-6}

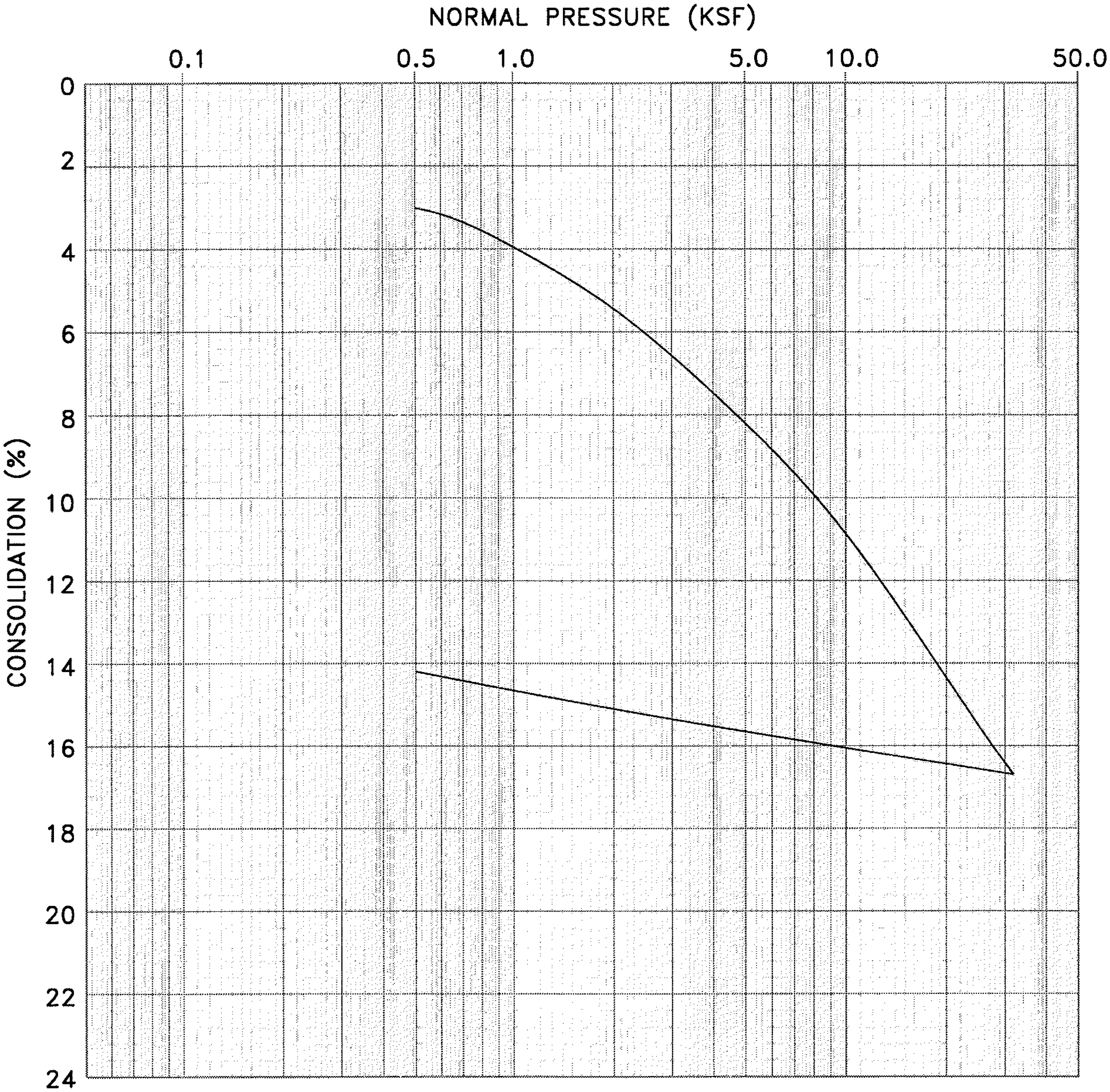
REVIEWED BY: Bridgett Adame



SYMBOL	SAMPLE LOCATION	NORMAL PRESSURE AT SATURATION (KSF)
————	B-4 S-14 @ 37.5 - 39.5 FT.	0.25

CONSOLIDATION TEST RESULTS

PROJECT NO. 2012.1.1	KENNIC, INC. LABORATORY TESTING BSB DIVERSIFIED	LAB NO. 08-083



SYMBOL	SAMPLE LOCATION	NORMAL PRESSURE AT SATURATION (KSF)
———	B-6 S-12 @ 32 - 34 FT.	0.25

CONSOLIDATION TEST RESULTS

PROJECT NO. 2012.1.1	KENNIC, INC. LABORATORY TESTING BSB DIVERSIFIED	LAB NO. 08-083

APPENDIX D

GEOTECHNICAL BORING LOGS

BSB DIVERSIFIED SITE
KENT, WASHINGTON

BORING NUMBER B-1

BORING STARTED: 1/10/2008 **FINISHED:** 1/10/2008
DRILLING CONTRACTOR: CASCADE
DRILLING METHOD: HOLLOW STEM AUGER
BORING DIAMETER (in.): 6
LOGGED: A. MURPHY **REVIEWED:** R. NORTH

ELEVATION (FT-MSL): 27.73
TOTAL DEPTH (FT): 46.5
NORTHING: 157,223.5
EASTING: 1,294,657.7

LOG DEPTH & *ELEVATION* (FT)	LAYER DEPTH & *ELEVATION* (FT)	USCS CLASSIFICATION	MATERIAL DESCRIPTION	SAMPLE TYPE	SAMPLE INTERVAL (FT)	SAMPLE RECOVERY (%)	SPT SPLIT SPOON BLOW COUNT PER 6"	SPT SPLIT SPOON N-VALUE
27.7		GW-GM	WELL-GRADED GRAVEL WITH SILT AND SAND: Light brown. Moist. Aggregate base. Material underlays 5-in. thick concrete surface. FILL	SPT	0 - 1.5	47	8 9 8	17
	1.5 *26.2*	SW	WELL-GRADED SAND: Light brown. Moist. Coarse sand, generally <15% gravel. Layer of grey sand at 7.5 ft. Very moist.	SPT	2.5 - 4.0	47	9 9 11	20
5 *22.7*				SPT	5.0 - 6.5	53	10 10 11	21
				SPT	7.5 - 9.0	53	10 10 10	20
10 *17.7*	10 *17.7*	SM	SILTY SAND: Grey. Moist. Fine silty sand with silt interbedding.	SPT	10.0 - 11.5	80	4 4 6	10
15 *12.7*	15 *12.7*	SP-SM	POORLY GRADED SAND WITH SILT: Grey. Wet. Interbedded with silt.	SPT	15.0 - 16.5	100	2 2 3	5
20 *7.73*	20 *7.73*	ML	SILT: Brownish-grey. Wet.	SPT	20.0 - 21.5	100	2 1 3	4
25 *2.73*	25 *2.73*	SP	POORLY GRADED SAND: Dark grey. Wet. Fine sand with interbedded silt.	SPT	25.0 - 26.5	100	2 3 2	5
30 *-2.3*	30 *-2.3*							

BSB DIVERSIFIED SITE KENT, WASHINGTON	BORING NUMBER B-1 PAGE 2 OF 2
BORING STARTED: 1/10/2008 **FINISHED:** 1/10/2008	**ELEVATION (FT-MSL):** 27.73
DRILLING CONTRACTOR: CASCADE	**TOTAL DEPTH (FT):** 46.5
DRILLING METHOD: HOLLOW STEM AUGER	**NORTHING:** 157,223.5
BORING DIAMETER (in.): 6	**EASTING:** 1,294,657.7
LOGGED: A. MURPHY **REVIEWED:** R. NORTH	

LOG DEPTH & *ELEVATION* (FT)	LAYER DEPTH & *ELEVATION* (FT)	USCS CLASSIFICATION	MATERIAL DESCRIPTION	SAMPLE TYPE	SAMPLE INTERVAL (FT)	SAMPLE RECOVERY (%)	SPT SPLIT SPOON BLOW COUNT PER 6"	SPT SPLIT SPOON N-VALUE
-2.3		ML	SILT: Grey. Vey moist, wet at 40 ft. Thin layer of peat at 30 ft.	SPT	30.0 - 31.5	100	2 3 3	6
35 *-7.3*				SPT	35.0 - 36.5	100	2 2 4	6
40 *-12.3*				SPT	40.0 - 41.5	100	3 3 3	6
45 *-17.3*	46 *-18.3*	SM	SILTY SAND: Grey. Very moist.	SPT	45.0 - 46.5	100	3 4 7	12

Bottom of boring at 46.5 ft. Elevation -18.8 ft-msl.

BSB DIVERSIFIED SITE
KENT, WASHINGTON

BORING NUMBER B-2

BORING STARTED: 1/10/2008 **FINISHED:** 1/10/2008
DRILLING CONTRACTOR: CASCADE
DRILLING METHOD: HOLLOW STEM AUGER
BORING DIAMETER (in.): 6
LOGGED: A. MURPHY **REVIEWED:** R. NORTH

ELEVATION (FT-MSL): 27.76
TOTAL DEPTH (FT): 46.5
NORTHING: 157,263.6
EASTING: 1,294,658.8

LOG DEPTH & *ELEVATION* (FT)	LAYER DEPTH & *ELEVATION* (FT)	USCS CLASSIFICATION	MATERIAL DESCRIPTION	SAMPLE TYPE	SAMPLE INTERVAL (FT)	SAMPLE RECOVERY (%)	SPT SPLIT SPOON BLOW COUNT PER 6"	SPT SPLIT SPOON N-VALUE
27.8	1.5	GP	WELL-GRADED GRAVEL: Light brown. Moist. Coarse grained gravel and sandy gravel with 3/4-inch minus. FILL	SPT	0 - 1.5	53	14 16 16	32
	26.3 / 6.5	SW	WELL-GRADED SAND: Greyish brown. Moist. Medium sand with well graded gravel. FILL.	SPT	2.5 - 4.0	53	16 17 16	33
5 *22.8*				SPT	5.0 - 6.5	0	3 6 6	12
	21.3 / 8.5	ML	SILT: Light brown and grey. Very moist.	SPT	7.5 - 9.0	100	0 0 1	1
	9.0	SP	POORLY-GRADED SAND: Fine grained.					
10 *17.8*	*18.8* / 20	SP-SM	POORLY-GRADED SAND WITH SILT: Brownish grey. Wet. @ 11 ft - Fine grained sand and silt. Wet to saturated.	SPT	10.0 - 11.5	100	3 3 3	6
15 *12.8*			@ 15 ft - Fine to medium grained sand with silt. Dark grey. Moist.	SPT	15.0 - 16.5	100	2 1 2	3
20 *7.8*	*7.8*	SP	POORLY-GRADED SAND: Brown. Moist. Fine to coarse grained.	SPT	20.0 - 21.5	100	1 1 1	2
		ML	SILT.					
		SP	POORLY-GRADED SAND: Dark grey. Moist to wet. Fine to coarse grained with interbedded layers of silt.					
25 *2.8*			@25.5 - 26 ft - (ML) SILT.	SPT	25.0 - 26.5	100	4 4 5	5
30 *-2.2*								

BSB DIVERSIFIED SITE
KENT, WASHINGTON

BORING NUMBER B-2

BORING STARTED: 1/10/2008 **FINISHED:** 1/10/2008
ELEVATION (FT-MSL): 27.76
DRILLING CONTRACTOR: CASCADE
TOTAL DEPTH (FT): 46.5
DRILLING METHOD: HOLLOW STEM AUGER
NORTHING: 157,263.6
BORING DIAMETER (in.): 6
EASTING: 1,294,658.8
LOGGED: A. MURPHY **REVIEWED:** R. NORTH

LOG DEPTH & *ELEVATION* (FT)	LAYER DEPTH & *ELEVATION* (FT)	USCS CLASSIFICATION	MATERIAL DESCRIPTION	SAMPLE TYPE	SAMPLE INTERVAL (FT)	SAMPLE RECOVERY (%)	SPT SPLIT SPOON BLOW COUNT PER 6"	SPT SPLIT SPOON N-VALUE
-2.2		SP	POORLY-GRADED SAND: Dark grey. Moist to wet. Fine to coarse grained with interbedded layers of silt. *(Continued)* @31 - 31.5 ft - (ML) SILT.	SPT	30.0 - 31.5	100	2 3 3	6
35 *-7.2*			@35.5 - 36.5 ft - (ML) SILT. Flowing sand below 36.5 ft.	SPT	35.0 - 36.5	100	0 0 1	1
40 *-12.2*				SPT	40.0 - 41.5	0	0 0 0	0
45 *-17.2*	45.5 *-17.7*	ML	SILT: Dark grey. Wet.	SPT	45.0 - 46.5	100	2 3 4	7

Bottom of boring at 46.5 ft. Elevation -18.7 ft-msl.

BSB DIVERSIFIED SITE **KENT, WASHINGTON**				**BORING NUMBER B-3** PAGE 1 OF 2	
BORING STARTED:	1/10/2008	**FINISHED:** 1/10/2008		**ELEVATION (FT-MSL):**	26.91
DRILLING CONTRACTOR:	CASCADE			**TOTAL DEPTH (FT):**	46.5
DRILLING METHOD:	HOLLOW STEM AUGER			**NORTHING:**	157,319.4
BORING DIAMETER (in.):	6			**EASTING:**	1,294,617.0
LOGGED: A. MURPHY	**REVIEWED:** R. NORTH				

LOG DEPTH & *ELEVATION* (FT)	LAYER DEPTH & *ELEVATION* (FT)	USCS CLASSIFICATION	MATERIAL DESCRIPTION	SAMPLE TYPE	SAMPLE INTERVAL (FT)	SAMPLE RECOVERY (%)	SPT SPLIT SPOON BLOW COUNT PER 6"	SPT SPLIT SPOON N-VALUE
26.9	0.8	GP-GM	POORLY-GRADED GRAVEL WITH SILT: Brown. Moist. Angular. FILL.	SPT	0 - 1.5	47	7 9 12	21
	26.1	ML	SILT: Reddish brown. Moist. Low to sightly plastic. Slow dilatancy.	SPT	2.5 - 4.0	100	2 2 2	4
5 *21.9*	6 *20.9*	SM	SILTY SAND: Reddish brown. Moist.	SPT	5.0 - 6.5	100	2 2 2	4
	7.5 *19.4*	ML	SILT: Black, Very moist. Chemical odor. Silty sand at lower depth.	SPT	7.5 - 9.0	93	1 1 1	2
10 *16.9*	9.0 *17.9*	SM	SILTY SAND: Dark grey. Wet. Medium grained.	SPT	11.0 - 12.5	100	2 3 4	7
15 *11.9*	15 *11.9*	SP-SM	POORLY-GRADED SAND: Brownish grey. Very moist. Fine grained. Interbedded with silty sand.	SPT	15.0 - 16.5	100	7 9 7	16
20 *6.9*			@ 20 ft - Wet. Medium grained.	SPT	20.0 - 21.5	100	7 9 9	18
	21.5 *5.4*	SP	POORLY-GRADED SAND: Dark grey. Moist. Medium to coarse grained.					
25 *1.9*				SPT	25.0 - 26.5	80	2 7 12	19
30 *-3.1*								

BSB DIVERSIFIED SITE
KENT, WASHINGTON

BORING NUMBER B-3

BORING STARTED: 1/10/2008 **FINISHED:** 1/10/2008
ELEVATION (FT-MSL): 26.91
DRILLING CONTRACTOR: CASCADE
TOTAL DEPTH (FT): 46.5
DRILLING METHOD: HOLLOW STEM AUGER
NORTHING: 157,319.4
BORING DIAMETER (in.): 6
EASTING: 1,294,617.0
LOGGED: A. MURPHY **REVIEWED:** R. NORTH

LOG DEPTH & *ELEVATION* (FT)	LAYER DEPTH & ELEVATION (FT)	USCS CLASSIFICATION	MATERIAL DESCRIPTION	SAMPLE TYPE	SAMPLE INTERVAL (FT)	SAMPLE RECOVERY (%)	SPT SPLIT SPOON BLOW COUNT PER 6"	SPT SPLIT SPOON N-VALUE
-3.1		SP	POORLY-GRADED SAND: Brownish grey. Very moist. Fine grained. Interbedded with silty sand. *(Continued)*	SPT	30.0 - 31.5	100	10 12 19	31
35 *-8.1*	35.5 *-8.6*	ML	SILT: Brownish grey. Moist.	SPT	35.0 - 36.5	100	8 10 8	18
	36.5 *-9.6*	SP-SM	POORLY-GRADED SAND: Brownish grey. Medium grained, with zones of fine grained silty sand.					
40 *-13.1*			@ 40 ft- Wet.	SPT	40.0 - 41.5	100	3 5 5	10
45 *-18.1*	45 *-18.1*	ML	SILT: Shells present.	SPT	45.0 - 46.5	100	5 13 16	29
	46.0 *-19.1*	SP-SM	POORLY-GRADED SAND WITH SILT: Grey. Moist. Medium grained.					

Bottom of boring at 46.5 ft. Elevation -18.6 ft-msl.

BSB DIVERSIFIED SITE KENT, WASHINGTON	BORING NUMBER B-4
BORING STARTED: 1/10/2008 **FINISHED:** 1/10/2008	**ELEVATION (FT-MSL):** 27.22
DRILLING CONTRACTOR: CASCADE	**TOTAL DEPTH (FT):** 46.5
DRILLING METHOD: HOLLOW STEM AUGER	**NORTHING:** 157,295.9
BORING DIAMETER (in.): 6	**EASTING:** 1,294,632.0
LOGGED: A. MURPHY **REVIEWED:** R. NORTH	

LOG DEPTH & *ELEVATION* (FT)	LAYER DEPTH & *ELEVATION* (FT)	USCS CLASSIFICATION	MATERIAL DESCRIPTION	SAMPLE TYPE	SAMPLE INTERVAL (FT)	SAMPLE RECOVERY (%)	SPT SPLIT SPOON BLOW COUNT PER 6"	SPT SPLIT SPOON N-VALUE
27.2		GW	WELL-GRADED GRAVEL WITH SAND: Brown AND GREY. Moist. Coarse sand. FILL.	SPT	0 - 1.5	73	19 24 16	40
				SPT	2.5 - 4.0	67	14 16 16	32
5 *22.2*				SPT	5.0 - 6.5	33	3 3 9	12
				SPT	7.5 - 9.0	60	7 7 9	16
10 *17.2*	11			SPT	10.0 - 11.5	100	4 3 2	5
	11.5 *15.7*	CL	LEAN TO FAT CLAY: Brown. Very moist. Medium plasticity, slow to no dilatancy.					
		SP-SM	POORLY-GRADED SAND WITH SILT: Brown to dark grey. Wet. Fine to medium grained, interbedded with silt.	SPT	12.5 - 14.0	100	1 3 2	5
15 *12.2*				SPT	15.0 - 16.5	100	4 6 7	13
				SPT	17.5 - 19.0	100	2 3 2	5
20 *7.2*				SHELBY TUBE	20.0 - 22.0			
	23 *4.2*	ML	SILT: Brown. Moist.	SPT	23.0 - 24.5	100	3 9 9	18
25 *2.2*	24 *3.2*	SP-SM	POORLY-GRADED SAND WITH SILT: Dark grey. Moist. Fine to medium grained.					
			@ 26.5 ft - Peat present.	SPT	25.5 - 27.0	100	3 3 6	9
				SPT	28.0 - 29.5	100	2 3 5	8
30 *-2.8*	29 *-1.8*	ML	SILT: Brown to grey. Moist.					

BSB DIVERSIFIED SITE
KENT, WASHINGTON

BORING NUMBER B-4

BORING STARTED: 1/10/2008 **FINISHED:** 1/10/2008
ELEVATION (FT-MSL): 27.22
DRILLING CONTRACTOR: CASCADE
TOTAL DEPTH (FT): 46.5
DRILLING METHOD: HOLLOW STEM AUGER
NORTHING: 157,295.9
BORING DIAMETER (in.): 6
EASTING: 1,294,632.0
LOGGED: A. MURPHY **REVIEWED:** R. NORTH

LOG DEPTH & *ELEVATION* (FT)	LAYER DEPTH & *ELEVATION* (FT)	USCS CLASSIFICATION	MATERIAL DESCRIPTION	SAMPLE TYPE	SAMPLE INTERVAL (FT)	SAMPLE RECOVERY (%)	SPT SPLIT SPOON BLOW COUNT PER 6"	SPT SPLIT SPOON N-VALUE
-2.8		ML	SILT: Brown to grey. Moist. *(continued)*					
				SPT	31.5 - 33.0	100	5 3 2	5
				SPT	33.0 - 34.5	100	2 3 5	8
			@34 ft - Peat present.					
35 *-7.8*								
				SPT	35.5 - 37.0	100	1 1 5	6
				SHELBY TUBE	38.0 - 40.0			
40 *-12.8*				SPT	40.0 - 41.5	100	1 2 1	3
			@ 41 ft - Fine grained sand present.					
				SPT	42.5 - 44.0	100	1 2 2	4
			@ 43 ft - Shells present.					
45 *-17.8*	*45.5* *-18.3*	SP	POORLY-GRADED SAND: Dark-grey. Moist. Medium grained.	SPT	45.0 - 46.5	100	4 6 5	11

Bottom of boring at 46.5 ft. Elevation -18.8 ft-msl.

BSB DIVERSIFIED SITE
KENT, WASHINGTON

BORING NUMBER B-5

BORING STARTED: 1/9/2008 **FINISHED:** 1/9/2008
DRILLING CONTRACTOR: CASCADE
DRILLING METHOD: HOLLOW STEM AUGER
BORING DIAMETER (in.): 6
LOGGED: A. MURPHY **REVIEWED:** R. NORTH

ELEVATION (FT-MSL): 27.84
TOTAL DEPTH (FT): 46.5
NORTHING: 157,260.4
EASTING: 1,294,601.6

LOG DEPTH & *ELEVATION* (FT)	LAYER DEPTH & *ELEVATION* (FT)	USCS CLASSIFICATION	MATERIAL DESCRIPTION	SAMPLE TYPE	SAMPLE INTERVAL (FT)	SAMPLE RECOVERY (%)	SPT SPLIT SPOON BLOW COUNT PER 6"	SPT SPLIT SPOON N-VALUE
27.8	1.5	GP	GRAVEL: Fill. No recovery.	SPT	0 - 1.5	0	6, 7, 10	17
	26.3	ML	SILT: Reddish brown to brown. Moist.	SPT	2.5 - 4.0	100	4, 4, 5	9
5 *22.8*	6.0			SPT	5.0 - 6.5	67	2, 3, 5	8
	6.5	SM	SILTY SAND: Grey. Very moist. Trace amount of coarse sand.					
	21.3	ML	SILT: Grey. Very moist. Trace amount of coarse sand.	SPT	7.5 - 9.0	100	1, 0, 0	0
10 *17.8*	10 *17.8*	SP-SM	POORLY-GRADED SILTY SAND: Grey. Wet. Fine ot medium grained.	SPT	10.0 - 11.5	100	1, 1, 1	2
15 *12.8*				SPT	15.0 - 16.5	100	1, 2, 1	3
20 *7.8*				SHELBY TUBE	20.0 - 22.0			
25 *2.8*	25.5			SPT	25.0 - 26.5	100	1, 3, 1	4
	2.3	ML	SILT: Grey.					
30 *-2.2*	30							

BSB DIVERSIFIED SITE KENT, WASHINGTON	BORING NUMBER B-5
	PAGE 2 OF 2

BORING STARTED: 1/9/2008 **FINISHED:** 1/9/2008
DRILLING CONTRACTOR: CASCADE
DRILLING METHOD: HOLLOW STEM AUGER
BORING DIAMETER (in.): 6
LOGGED: A. MURPHY **REVIEWED:** R. NORTH
ELEVATION (FT-MSL): 27.84
TOTAL DEPTH (FT): 46.5
NORTHING: 157,260.4
EASTING: 1,294,601.6

LOG DEPTH & *ELEVATION* (FT)	LAYER DEPTH & *ELEVATION* (FT)	USCS CLASSIFICATION	MATERIAL DESCRIPTION	SAMPLE TYPE	SAMPLE INTERVAL (FT)	SAMPLE RECOVERY (%)	SPT SPLIT SPOON BLOW COUNT PER 6"	SPT SPLIT SPOON N-VALUE
-2.2		SP	POORLY-GRADED SAND: Grey. Moist. Medium grained.	SPT	30.0 - 31.5	100	2 2 1	3
35 *-7.2*	35.5 *-7.7*		*NOTE: SPT blow counts not recorded.*	SPT	35.0 - 36.5	100		
		ML	SILT: Grey. Vey moist.					
40 *-12.2*				SHELBY TUBE	38.0 - 40.0			
	42 *-14.2*	SM	SILTY SAND: Grey. Very moist. Medium grained, some peat present.					
45 *-17.2*				SPT	45.0 - 46.5	100	2 2 4	6

Bottom of boring at 46.5 ft. Elevation -18.7 ft-msl.

BSB DIVERSIFIED SITE
KENT, WASHINGTON

BORING NUMBER B-6

BORING STARTED: 1/9/2008 **FINISHED:** 1/9/2008
ELEVATION (FT-MSL): 27.84
DRILLING CONTRACTOR: CASCADE
TOTAL DEPTH (FT): 46.5
DRILLING METHOD: HOLLOW STEM AUGER
NORTHING: 157,246.7
BORING DIAMETER (in.): 6
EASTING: 1,294,634.6
LOGGED: A. MURPHY **REVIEWED:** R. NORTH

LOG DEPTH & *ELEVATION* (FT)	LAYER DEPTH & *ELEVATION* (FT)	USCS CLASSIFICATION	MATERIAL DESCRIPTION	SAMPLE TYPE	SAMPLE INTERVAL (FT)	SAMPLE RECOVERY (%)	SPT SPLIT SPOON BLOW COUNT PER 6"	SPT SPLIT SPOON N-VALUE
27.8		GW	WELL-GRADED GRAVEL WITH SAND: Brown. Moist. Well graded gravel; coarse grained sand.	SPT	0 - 0.15	0	30/2"	
				SPT	2.5 - 4.0	67	14 16 18	34
5 *22.8*	6.5			SPT	5.0 - 6.5	53	10 17 21	38
	21.3	SP	POORLY-GRADED SAND: Grey. Very moist and wet below 10 ft. Fine grained. *No sample recovery above 10 ft, only cuttings.*	SPT	7.5 - 9.0	0	13 14 18	32
10 *17.8*	10.7			SPT	10.0 - 11.5	100	1 1 1	2
	17.1 11.5	ML	SILT: Brown. Very moist.					
	16.3	SP	POORLY-GRADED SAND: Grey. Very moist. Fine grained.	SPT	12.5 - 14.0	100	2 3 3	6
15 *12.8*	15 *12.8*	SP-SM	POORLY-GRADED SAND WITH SILT: Grey and brown. Very moist. Fine grained sand with 2-in. thick interbedded silt layers.	SPT	15.0 - 16.5		2 2 9	11
				SPT	17.5 - 19.0	100	3 3 7	10
20 *7.8*	22.0			SHELBY TUBE	20.0 - 22.0			
	5.8	SP	POORLY-GRADED SAND: Greyish brown. Very moist. Medium grained sand with interbedded peat layers.	SPT	22.5 - 24.0		3 7 12	19
25 *2.8*				SPT	25.0 - 26.5	100	7 9 9	18
				SPT	27.5 - 29.0	100	3 8 7	15
30 *-2.2*	30 *-2.2*							

BSB DIVERSIFIED SITE

KENT, WASHINGTON

BORING NUMBER B-6

BORING STARTED: 1/9/2008 **FINISHED:** 1/9/2008
DRILLING CONTRACTOR: CASCADE
DRILLING METHOD: HOLLOW STEM AUGER
BORING DIAMETER (in.): 6
LOGGED: A. MURPHY **REVIEWED:** R. NORTH

ELEVATION (FT-MSL): 27.84
TOTAL DEPTH (FT): 46.5
NORTHING: 157,246.7
EASTING: 1,294,634.6

LOG DEPTH & *ELEVATION* (FT)	LAYER DEPTH & *ELEVATION* (FT)	USCS CLASSIFICATION	MATERIAL DESCRIPTION	SAMPLE TYPE	SAMPLE INTERVAL (FT)	SAMPLE RECOVERY (%)	SPT SPLIT SPOON BLOW COUNT PER 6"	SPT SPLIT SPOON N-VALUE
-2.2		ML	SILT: Greyish brown. Moist. Trace amounts (<5%) peat.	SPT	30.0 - 31.5	100	1 1 1	2
				SHELBY TUBE	32.0 - 34.0			
35 *-7.2*				SPT	35.0 - 36.5	100	2 3 2	5
	37.5 *-9.7*	SM	SILT: Grey. Vey moist.	SPT	37.5 - 39.0	100	2 3 9	12
40 *-12.2*	40 *-12.2*	ML	SILT: Grey. Moist.	SPT	40.0 - 41.5	100	3 5 9	14
	43			SPT	42.5 - 44.0	100	3 7 7	14
	43.5	SP	POORLY-GRADED SAND: Greyish brown. Very moist. Fine grained.					
	-15.7	ML	SILT: Greyish brown. Moist.					
45 *-17.2*				SPT	45.0 - 46.5	100	2 3 4	7
	46.0 *-18.2*	SP	POORLY-GRADED SAND: Greyish brown. Moist. Fine grained.					

Bottom of boring at 46.5 ft. Elevation -18.7 ft-msl.

BSB DIVERSIFIED SITE	**BORING NUMBER B-7**
KENT, WASHINGTON	PAGE 1 OF 2
BORING STARTED: 1/9/2008 **FINISHED:** 1/9/2008	**ELEVATION (FT-MSL):** 27.82
DRILLING CONTRACTOR: CASCADE	**TOTAL DEPTH (FT):** 46.5
DRILLING METHOD: HOLLOW STEM AUGER	**NORTHING:** 157,295.9
BORING DIAMETER (in.): 6	**EASTING:** 1,294,632.0
LOGGED: A. MURPHY **REVIEWED:** R. NORTH	

LOG DEPTH & *ELEVATION* (FT)	LAYER DEPTH & *ELEVATION* (FT)	USCS CLASSIFICATION	MATERIAL DESCRIPTION	SAMPLE			SPT SPLIT SPOON	
				TYPE	INTERVAL (FT)	RECOVERY (%)	BLOW COUNT PER 6"	N-VALUE
27.8		GW	WELL-GRADED GRAVEL WITH SAND: Light brown. Moist. Fill.	SPT	0 - 1.5	80	8 16 24	40
				SPT	2.5 - 4.0	60	5 9 12	21
5 *22.8*				SPT	5.0 - 6.5	83	7 12 19	31
	7.5 *20.3*	SM	SILTY SAND: Light grey. Moist. Fine grained.	SPT	7.5 - 9.0	87	3 3 2	5
10 *17.8*	10 *17.8*	ML	SILT: Brownish grey. Moist.	SPT	10.0 - 11.5	100	1 1 6	7
	11 *16.8*	SP / SP-SM	POORLY-GRADED SAND TO POORLY-GRADED SAND WITH SILT: Grey. Moist becoming wet at 15 ft. Fine to medium grained, with interbedded silt layers. Description based on limited sample recovery.					
15 *12.8*			@ 15.5 ft - 2" layer of interbedded silt.	SPT	15.0 - 16.5	100	2 2 4	6
20 *7.8*								
				SHELBY TUBE	22.5 - 24.5			
25 *2.8*				SHELBY TUBE	24.5 - 26.5			
30 *-2.2*	30 *-2.2*							

BSB DIVERSIFIED SITE **KENT, WASHINGTON**				**BORING NUMBER B-7** PAGE 2 OF 2
BORING STARTED:	1/9/2008	**FINISHED:** 1/9/2008	**ELEVATION (FT-MSL):**	27.82
DRILLING CONTRACTOR:	CASCADE		**TOTAL DEPTH (FT):**	46.5
DRILLING METHOD:	HOLLOW STEM AUGER		**NORTHING:**	157,218.9
BORING DIAMETER (in.):	6		**EASTING:**	1,294,633.7
LOGGED: A. MURPHY	**REVIEWED:** R. NORTH			

LOG DEPTH & *ELEVATION* (FT)	LAYER DEPTH & *ELEVATION* (FT)	USCS CLASSIFICATION	MATERIAL DESCRIPTION	SAMPLE TYPE	SAMPLE INTERVAL (FT)	SAMPLE RECOVERY (%)	SPT SPLIT SPOON BLOW COUNT PER 6"	SPT SPLIT SPOON N-VALUE
-2.2		SP / SP-SM	POORLY-GRADED SAND TO POORLY-GRADED SAND WITH SILT: Grey. Moist becoming wet at 15 ft. Fine to medium grained, with interbedded silt layers. Description based on limited sample recovery. *(continued)*	SHELBY TUBE	32.0 - 34.0			
35 *-7.2*			@ 34.5 - Shelby tube pushed easily.					
40 *-12.2*			@ 39 to 40 ft - Clam shells present. SPT - split spoon only advanced 12 in.	SPT	39.0 - 40.0	100	2 3	N/A
				SHELBY TUBE	40.0 - 42.0			
45 *-17.2*			@ 45 to 46.5 - Moist. Trace shells and peat present.	SPT	45.0 - 46.5	100	1 2 2	4

Bottom of boring at 46.5 ft. Elevation -18.7 ft-msl.

BSB DIVERSIFIED SITE

KENT, WASHINGTON

BORING NUMBER B-8

BORING STARTED:	1/9/2008 **FINISHED:** 1/9/2008	**ELEVATION (FT-MSL):**	29.16
DRILLING CONTRACTOR:	CASCADE	**TOTAL DEPTH (FT):**	21.5
DRILLING METHOD:	HOLLOW STEM AUGER	**NORTHING:**	157,264.4
BORING DIAMETER (in.):	6	**EASTING:**	1,294,352.8
LOGGED: A. MURPHY	**REVIEWED:** R. NORTH		

LOG DEPTH & *ELEVATION* (FT)	LAYER DEPTH & *ELEVATION* (FT)	USCS CLASSIFICATION	MATERIAL DESCRIPTION	SAMPLE TYPE	SAMPLE INTERVAL (FT)	SAMPLE RECOVERY (%)	SPT SPLIT SPOON BLOW COUNT PER 6"	SPT SPLIT SPOON N-VALUE
29.2	0.5	GW	GRAVEL: Brown. Moist. Fill.	SPT	0 - 1.5	56	8 8 30	38
	2.5	SP-SM	POORLY-GRADED SAND WITH SILT.					
5	*26.7* 5	ML	SILT: Reddish brown. Moist. Nonplastic.	SPT	2.5 - 4.0	100	8 6 6	12
24.2	*24.2*	CL-CH	CLAY: Moist, and wet at 7 ft. Medium to high plasticity, no dilatancy.	SPT	5.0 - 6.5	100	2 1 1	2
10	10			SPT	7.5 - 9.0	100	1 0 0	0
19.2	*19.2*	SP	POORLY-GRADED SAND: Grey to reddish brown. Moist. Fine grained.	SPT	10.0 - 11.5	100	3 6 8	14
15	15							
14.2	*14.2*	SP-SM	POORLY-GRADED SAND WITH SILT: Brownish grey. Wet to moist. Fine grained sand, with about 5% to 12% silty sand.	SPT	15.0 - 16.5	100	4 4 4	8
20 *9.2*				SPT	20.0 - 21.5	100	6 8 12	20

Bottom of boring at 21.5 ft. Elevation 7.7 ft-msl.

BSB DIVERSIFIED SITE
KENT, WASHINGTON

BORING NUMBER B-8A

BORING STARTED: 1/9/2008	**FINISHED:** 1/9/2008	**ELEVATION (FT-MSL):**	29.16
DRILLING CONTRACTOR:	CASCADE	**TOTAL DEPTH (FT):**	7.0
DRILLING METHOD:	HOLLOW STEM AUGER	**NORTHING:**	157,264.4
BORING DIAMETER (in.):	6	**EASTING:**	1,294,352.8
LOGGED: A. MURPHY	**REVIEWED:** R. NORTH		

LOG DEPTH & *ELEVATION* (FT)	LAYER DEPTH & *ELEVATION* (FT)	USCS CLASSIFICATION	MATERIAL DESCRIPTION	SAMPLE			SPT SPLIT SPOON	
				TYPE	INTERVAL (FT)	RECOVERY (%)	BLOW COUNT PER 6"	N-VALUE
29.2			Boring advanced to collect shelby tube at 5 ft. No other samples. See Boring B-8.					
5 *24.2*		CL	CLAY	SHELBY TUBE	5.0 - 7.0	100		
		ML	SILT					

Bottom of boring at 7 ft. Elevation 22.2 ft-msl.

BSB DIVERSIFIED SITE
KENT, WASHINGTON

BORING NUMBER B-9

BORING STARTED: 1/9/2008 **FINISHED:** 1/9/2008
DRILLING CONTRACTOR: CASCADE
DRILLING METHOD: HOLLOW STEM AUGER
BORING DIAMETER (in.): 6
LOGGED: A. MURPHY **REVIEWED:** R. NORTH

ELEVATION (FT-MSL): 29.16
TOTAL DEPTH (FT): 21.5
NORTHING: 157,106.0
EASTING: 1,294,382.2

LOG DEPTH & *ELEVATION* (FT)	LAYER DEPTH & *ELEVATION* (FT)	USCS CLASSIFICATION	MATERIAL DESCRIPTION	SAMPLE TYPE	SAMPLE INTERVAL (FT)	SAMPLE RECOVERY (%)	SPT SPLIT SPOON BLOW COUNT PER 6"	SPT SPLIT SPOON N-VALUE
29.2	1	GW	WELL-GRADED GRAVEL WITH SAND. Brownish grey. Damp. Fill.	SPT	0 - 1.5	93	14 10 32	42
	28.2 2	SM	SILTY SAND WITH GRAVEL: Coarse grained sand. Fill. Material may have originated from layer above.					
	27.2	ML	SILT: Brownish grey. Moist. No recovery above 5 ft.	SPT	2.5 - 4.0	33	10 12 10	22
5 *24.2*				SPT	5.0 - 6.5	93	5 5 7	12
	7.5 *21.7*	CL-CH	CLAY: Grey. Moist. Medium to high plasticity, dilatancy slow.	SPT	7.5 - 9.0	80	1 0 0	0
10 *19.2*				SPT	10.0 - 11.5	100	0 1 1	2
				SPT				
15 *14.2*	15 *14.2* 16	SP	POORLY-GRADED SAND: Dark grey. Moist. Medium grained.	SPT	15.0 - 16.5	100	6 7 11	18
	13.2	SM	SILTY SAND: Fine grained.					
20 *9.2*	20 *9.2*	SP	POORLY-GRADED SAND: Dark grey. Moist. Medium grained, with 1-2-in. thick layer of peat/organic matter and silt interbeds.	SPT	20.0 - 21.5	100	2 5 7	12

Bottom of boring at 21.5 ft. Elevation 7.7 ft-msl.