# Final Remedial Action Report

The BNSF Oil Pipeline Site
Tacoma, Washington

*for*
**BNSF Railway Company**

May 28, 2010

Pursuant to Consent Decree #08-2-11105-04
(Pierce County Superior Court)

GeoEngineers
Earth Science + Technology

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# The BNSF Oil Pipeline Site
# Tacoma, Washington

**File No. 0506-141-03**

**May 28, 2010**

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## 1.0 INTRODUCTION

This Remedial Action Report is prepared and submitted pursuant to the Consent Decree between the Washington State Department of Ecology (Ecology), the BNSF Railway Company (BNSF), City of Tacoma (City), Home Electric Company, 1815 East D Street LLC and the Washington State Department of Transportation (WSDOT) that was entered on August 5, 2008 in Pierce County Superior Court Case No. 08-2-11105-4. The report presents a summary of remedial activities performed according to the Cleanup Action Plan (CAP) and related Engineering Design Reports, the objective of which was to remove bunker-range petroleum hydrocarbon (BRPH)[1] contaminated material to the maximum extent practicable at the Burlington Northern Santa Fe Railway Company (BNSF) Oil Pipeline Site (Site) in Tacoma, Washington. Remedial activities were performed from July 2008 to October 2008 and from July 2009 to December 2009. The Site is shown relative to surrounding physical features on the Location Map presented on Sheet G-1.

The Site includes four remedial areas as described in the Ecology-approved "Final Remedial Investigation/Feasibility Study (RI/FS), BNSF Oil Pipeline Site, Tacoma, Washington" (GeoEngineers 2007) and the "Final Cleanup Action Plan (CAP), BNSF Oil Pipeline Site, Tacoma, Washington" (GeoEngineers 2008). These areas are identified below and on Sheet C-1:

- Area A: The WSDOT Pond Area;
- Area B: The Nichols Trucking/Tacoma Fixtures (formerly Home Electric) Area, including the 19th Street underground storage tank (UST) area;
- Area C: The Tacoma Fixtures/SuperValu Area; and
- Area D: The SuperValu Area.

The activities described in this document pertain to all four remedial areas. The general scope of the remedial action is described in the Ecology-approved Engineering Design Report (EDR) titled "Engineering Design Report, The BNSF Oil Pipeline Site, Tacoma, Washington" (GeoEngineers, 2008) (2008, EDR), and the revised EDR titled "Revised Engineering Design Report, The BNSF Oil Pipeline Site, Tacoma, Washington" (GeoEngineers, 2009) (2009, EDR). The 2009 EDR revised the 2008 EDR to incorporate additional site-specific knowledge of conditions acquired during the 2008 remedial season, and to accommodate additional site utility reconstruction required by the City of Tacoma. For the reader's convenience, Final Plan Sheets originally provided with the 2008 EDR and the 2009 EDR are included with this report and identified with the notations "2008 EDR" or "2009 EDR" in the Plan Sheet title block.

Site remediation activities were performed in general accordance with the 2008 EDR and 2009 EDR to fully satisfy the requirements of the Washington State Model Toxics Control Act (MTCA) and the Consent Decree.

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[1] BRPH is a site-specific term indicating a Bunker C petroleum product with both diesel- and oil-range petroleum hydrocarbons. The concentration of BRPHs as discussed in this report indicates the concentration of petroleum hydrocarbons quantified during analysis relative to a Bunker C product laboratory standard.

## 1.1 Purpose and Scope

The purpose of this Remedial Action Report is to summarize the remedial activities completed at Areas A, B, C and D. This report also presents observations and analytical data obtained during Site remediation activities to document that the remediation was completed in general compliance with the plans and specifications for Site remediation as described in the 2008 EDR and 2009 EDR. The scope of services completed for this project included:

1. Completed the remedial activities in general accordance with Section 4.0 of the 2008 EDR and 2009 EDR;

2. Completed the remedial activities in general accordance with Section 6.0 and Appendix B (Specifications for Remedial Excavation of BRPH-Impacted Soil, The BNSF Oil Pipeline Site, Tacoma, Washington [Specifications]) of the 2008 EDR and 2009 EDR;

3. Completed characterization of contaminated soil for disposal, completed excavation of contaminated soil, coordinated transport of contaminated materials to an offsite licensed disposal facility, and completed confirmation sampling at the excavation limits in general accordance with Appendix B and Appendix C (Sampling and Analysis Plan [SAP]) of the 2008 EDR and 2009 EDR;

4. Completed backfilling, compacting, grading and other site restoration activities described in the Specifications;

5. Completed the remedial activities in general accordance with Section 7.0 (Project Schedule) of the 2008 EDR and 2009 EDR; and

6. Summarized and reported groundwater analytical data collected between the completion of the RI/FS and the completion of site remediation.

## 1.2 Site Information

### *1.2.1 General*

The Site consists of the location of the former BNSF oil pipeline between East 15$^{th}$ Street and the BNSF Tacoma rail yard, and is defined by Ecology as the pipeline alignment and adjacent areas, as shown in Sheet C-1. Current property uses at the Site consist of a variety of commercial manufacturing and warehousing operations.

### *1.2.2 Basis for Remedial Action*

Bunker-range petroleum hydrocarbons and carcinogenic polycyclic aromatic hydrocarbons (cPAHs) had been detected in soil and groundwater beneath portions of the Site during previous subsurface investigations and pipeline closure activities. The BNSF Oil Pipeline (pipeline) and the East 19$^{th}$ Street UST are identified as known sources of petroleum-related contamination within the Site limits. Ecology named BNSF, the City of Tacoma (City), WSDOT, Home Electric, Inc., Nichols Trucking and SuperValu as potentially liable parties (PLPs) for investigation and remediation at the Site.

BNSF entered into Agreed Order (AO) No. DE 04TCPSR-6034 with the State of Washington to:

- Develop an Interim Action (IA) plan,
- Implement an appropriate IA,
- Complete an RI/FS at the Site, and
- Prepare a draft final CAP for the Site.

An RI/FS was completed in accordance with the AO. A draft final CAP was prepared in conformance with the AO to comply with the requirements of Washington Administrative Code (WAC) 173-340-350. The results of the RI/FS are presented in the report titled "Final Remedial Investigation/Feasibility Study, BNSF Oil Pipeline Site, Tacoma, Washington" (GeoEngineers 2007), which Ecology accepted as final on July 24, 2007. The CAP is presented in the report titled "Revised Draft Final Cleanup Action Plan, BNSF Oil Pipeline Site, Tacoma, Washington" (GeoEngineers 2008), which Ecology adopted as the final CAP upon entry of the Consent Decree.

GeoEngineers prepared both the 2008 EDR and 2009 EDR in accordance with WAC 173-340-400(4a) after the completion of the CAP. The two versions of the EDR describe how the CAP would be implemented and provide the engineering drawings and specifications for the remedial action. The following sections describe the activities performed to implement the remedial action at the Site pursuant to the CAP and EDRs.

### *1.2.3 Site Cleanup Standards*

Site-specific cleanup levels (CULs) for the contaminants of concern (COCs) in soil and groundwater at the Site were selected in the CAP based on current zoning and existing and expected uses of the Site, as presented in the RI/FS.

#### 1.2.3.1 SOIL CRITERIA

The site-specific soil CULs for this Site are protective of the most conservative future uses of the Site based on current zoning (mixed-use commercial/industrial and shoreline) and are protective of groundwater. The CULs established for this Site are based on unrestricted site use, which Ecology considers the reasonable maximum exposure at sites in Washington and protective of groundwater quality. The CULs for BRPH were based on the MTCA CULs for similar petroleum hydrocarbon compounds. CULs for cPAHs were based on the MTCA CULs for unrestricted land use (ULU). Applicable soil CULs include:

- Petroleum hydrocarbons (quantified as BRPH): 2,000 mg/kg
- Total cPAHs (defined using toxicity equivalency methodology as required in WAC 173-340-708(8)): 0.1 mg/kg

#### 1.2.3.2 GROUNDWATER CRITERIA

CULs for groundwater selected for use at this Site are protective of the most sensitive future use of groundwater. The CULs for BRPH were based on the MTCA CULs for similar petroleum hydrocarbon compounds. CULs for cPAHs and naphthalene were based on the MTCA CULs for unrestricted groundwater use. These CULs are overly protective given that the Site area is used primarily for industrial and commercial purposes, and groundwater is not currently potable or expected to be a future source of drinking water.

Applicable groundwater CULs are to be achieved at the conditional point of compliance (D Street monitoring wells), and include:

- Petroleum hydrocarbons (quantified as BRPH): 0.5 mg/L
- Naphthalenes: 160 μg/L
- Total cPAHs (defined using toxicity equivalency methodology as required in WAC 173-340-708(8)): 0.1 μg/L

## 2.0 REMEDIAL ACTION IMPLEMENTATION

The following subsections summarize remedial activities and subsurface conditions encountered during the field activities at the remedial areas. Chemical analytical data obtained during the remedial action are summarized in Tables 1 through 7. A complete index of drawings is presented in Sheet G-1.

BNSF contracted Glacier Environmental Services (Glacier) of Mukilteo, Washington, to perform the remedial excavation at Areas A, B, C and D, the backfilling and paving of the excavated areas, and to provide utility reconstruction and relocation at Areas B and C. Remediation activities at Areas A and D were performed in 2008, and remediation activities at Areas B and C were performed in 2009.

Glacier began remedial excavation activities at Area A on July 21, 2008 and finished on September 19, 2008. Area D remedial excavation activities were performed from September 9 to September 16, 2008, concurrently with Glacier's contract with WSDOT to complete the stormwater pond rebuilding activities at Area A (as described below in Section 2.1.1 of this report).

The excavated material from Areas A and D was transported off-site for disposal at the LRI Landfill (LRI) in Graham, Washington, after approval by the Tacoma/Pierce County Health Department (TPCHD), under Waste Disposal Authorization (WDA) #1250 (Appendix C). Approximately 15,500 tons of BRPH-contaminated material was removed from the Area A and D excavations and transported to the LRI. The limits of the Area A and D excavations are shown in Sheets C-6 and C-35.

Construction at the Site continued in 2009, with Glacier beginning remedial excavation activities at Area B on August 14, 2009. Area B was completed on November 30, 2009. Area C remedial excavation activities were performed from July 28 to December 14, 2009. Approximately 33,400 tons of BRPH-contaminated material was removed from the Area B and C excavations and transported to LRI for disposal under the WDA #1332 (Appendix C). The limits of the Area B and C excavations are shown in Sheets C-15 and C-25.

Field methods are described in Appendix A. In the event that cultural resources or human skeletal remains may have been discovered, GeoEngineers had prepared an Unanticipated Discovery Plan, which is included in Appendix B. Permits acquired to complete remedial activities are included in Appendix C. Soil and groundwater analytical laboratory reports are presented in Appendix D. Disposal documentation for the excavated material is included in Appendix E. Certain other project-related communications are presented in Appendix F. Groundwater monitoring information is described in Appendix H and frozen soil shoring activities are described in Appendix I. Photos of site remediation are presented in Appendix J. Environmental covenants for properties with residual contamination above cleanup levels and related figures are provided in Appendix K.

## 2.1 Area A Remedial Activities

### *2.1.1 Area A Remedial Excavation Activities*

Sheet C-2 shows the pre-remediation grade and layout of Area A as presented in the 2008 EDR. Sheets C-3 and C-4 show the proposed excavation limit of BRPH-contaminated material in cross sectional and plan views, respectively, as specified in the 2008 EDR. Sheet C-5 show the Area A cross sectional views of the proposed backfill and grade as specified in the 2008 EDR.

The western limit of the BRPH-contaminated materials had not been identified before remedial activities began at Area A. During the installation of the WSDOT stormwater ponds in 1995, BRPH-related contamination was observed by Ecology in the eastern bank of the stormwater ponds. It was the opinion of both WSDOT and Ecology that BRPH-contaminated soil potentially extended beneath each stormwater pond. Both Ecology and WSDOT requested that the ponds be removed and rebuilt so that a more effective cleanup could be achieved.

Prior to Glacier beginning excavation activities at Area A, WSDOT installed a stormwater system bypass and a set of inflatable plugs in each stormwater line (northwest and southwest corners of the stormwater ponds) to prevent surface water runoff from the Washington State Highway 509 bridge from entering the work area during remedial activities. WSDOT also removed and disposed of the existing surface water from the stormwater ponds on July 21, 2008. The inflatable plugs within each stormwater pond were removed after completion of remedial excavation activities and pond reconstruction by Glacier on September 19, 2008.

Area A remedial activities began on July 21, 2008, with test pit excavation and sampling at seven locations within the remedial area. The test pits were excavated to depths ranging between 5 feet and 12 feet below surface grade to obtain soil samples from above and below the static water table. The chemical analytical results for the soil samples were used in developing a waste profile for subsurface soil as part of the process in receiving the Waste Disposal Authorization (WDA) from the TPCHD.

Five waste profile samples were obtained from the material above the water table, and seven were obtained below the water table. These samples were analyzed for the eight Resource Conservation and Recovery Act (RCRA) metals (arsenic, barium, cadmium, total chromium, lead, mercury, selenium and silver) as agreed with the TPCHD. The results of these analyses are summarized in Table 1. Previous soil and groundwater analytical data from the site (GeoEngineers, 2007) were also reviewed and accepted by the TPCHD as part of the WDA approval.

After completion of the WDA profiling and stormwater pond surface water removal activities, the surcharge material above the WSDOT stormwater ponds was removed and stockpiled to allow water to drain from this material prior to transport off site to LRI. The surcharge material included material placed over the liner in 1995 during construction of the pond plus sediment that had accumulated since the most recent pond maintenance performed by WSDOT personnel.

Upon receipt of the WDA on July 25, 2008, excavation activities began at the south end of the Area A boundary, adjacent to an access road for the BNSF Tacoma rail yard. Glacier removed the material above the groundwater table to an average depth of 7 feet. The material removed was stockpiled in the north end of the excavation area before being transported to LRI for disposal beginning on July 28, 2008. The fill material above the static groundwater table consisted of sand and silt containing brick and concrete debris. The abandoned sewer line that crossed Area A from north to south was removed, including the associated manhole vault along the east side of the north stormwater pond. The exposed ends of the abandoned sewer pipe in the north and south sidewalls of Area A were plugged with concrete.

Ecology had previously identified a white, powdery material (white material) at Area A, and historical field pH testing indicated this material had an approximate pH of 12. The white material was reported to be located in the vicinity of the former oil pipeline, east of the abandoned sanitary sewer vault in Area A. The white material was initially encountered during excavation on July 29, 2008, and the limits and thickness of this white material were established during removal of the material on August 5, 2008. All of the white material was located above the water table. The horizontal limits of the white material are shown in Sheet C-6. A sample of the white material was obtained and chemical analysis was performed to provide additional waste profile information to the TPCHD so the WDA could be amended to include disposal of the white material. These analytical results are presented in Table 1. The white material was found to be non-hazardous and was approved by TPCHD for disposal at LRI.

Subsurface conditions below the fill material consisted predominantly of BRPH-contaminated wood waste material (dimensional lumber, sawdust, wood blocks, bark, etc.). The wood waste was underlain by native tidal deposits. The native tidal deposits generally consisted of gray sand and silt laminated with shell fragments and occasional organic matter. BRPH was not observed in the native tidal deposits; therefore, the tidal deposits were identified as the deepest limit of the excavation effort. Most of the BRPH-contaminated material was removed immediately under and around the WSDOT stormwater ponds during remedial activities.

The access road along the east and north limits of Area A was used as the primary haul road from July 28 to August 18, 2008. The roadway was removed between the dates of August 18 and August 21, 2008. The northwest corner of Area A was excavated to the maximum extent practicable on August 21, 2008, to remove residual BRPH-contaminated material. Additional residual BRPH- contaminated material that was located under and adjacent to the dewatering equipment in the southeastern sidewall of Area A was removed at the request of Ecology on September 18 and 19, 2008, to the maximum extent practicable. The material was removed after the dewatering equipment was demobilized from the Site. As indicated in the attached September 8, 2008, letter from Ecology to WSDOT (Appendix F), removal of BRPH-contaminated material in both the northwest and southeast corners of the Area A excavation was completed to the satisfaction of Ecology.

The excavation limits achieved and the observed subsurface conditions are presented in Sheets C-6 and C-7. Area A excavation was completed to the maximum extent practicable as provided in the CAP and the 2008 EDR. Confirmation sampling and residual contamination after removal to the maximum extent practicable is discussed in Section 2.1.3.

#### *2.1.2 Area A Dewatering Activities*

Prior to removal of the wood waste material below the groundwater table, Glacier developed and implemented a dewatering plan to remove and treat groundwater from within the excavation area. The plan was developed and implemented to allow the removal of excess water from excavated material before it was transported off-site, to prevent excavation from being performed underwater, and to provide a stable working surface for equipment and personnel at the base of the excavation.

The 2008 EDR Specifications stated that groundwater encountered during remedial activities would be removed and transported off-site for treatment and disposal. Groundwater inflow into the test pits during the collection of the WDA profile samples indicated that the water volumes would be much greater than originally estimated and the associated costs would make off-site disposal economically unfeasible. Glacier proposed an on-site water treatment system that would direct discharge to the City's storm system, as shown in Appendix C. Once agreement was reached regarding the use and design of the treatment system, the system was installed and tested. Three water samples were collected: one from the influent, one from between the activated carbon canisters and one from the effluent. The analytical results for the effluent sample indicated that the concentrations of dissolved nickel were greater than the Washington surface water effects criteria, but less than the criteria for discharge to the City sanitary sewer, as shown in Table 4.

GeoEngineers, Glacier, Ecology and the City agreed that the City sanitary sewer system was acceptable for the treatment system discharge. On August 8, 2008, the City approved discharge to the sanitary sewer lift station located at East 19$^{th}$ Street and East D Street, immediately north of the Area A staging area. The discharge flow rate approved by the City was less than half of the dewatering and treatment pumping rate. Therefore, to handle the additional volume of water generated during the dewatering effort, the City also approved discharging to a sanitary sewer manhole in the BNSF Tacoma Rail Yard. A copy of the 2008 City's Special Authorization to Discharge (SAD) permit to discharge treated water to the sanitary sewer system, which contains the discharge and treatment system details, is presented in Appendix C.

The treatment system discharge piping was constructed to discharge to the above-mentioned lift station, and dewatering efforts began on August 8, 2008. Groundwater from the excavation area was drawn from three 6-inch-diameter polyvinyl chloride (PVC) temporary dewatering sumps using submersible pumps. An excavator was used to dig pits to install the dewatering sumps. A ⅜-inch pea gravel filter pack was placed around the sump screen. The filter pack reduced turbidity and oil entrainment in the water treatment system. The sumps were relocated as necessary to draw groundwater down to a working level. Dewatering and treatment continued until September 14, 2008, after the reconstruction and installation of the WSDOT stormwater ponds, liner and surcharge. During remedial activities at Area A, the dewatering and treatment system discharged approximately 2 million gallons of treated water to the sanitary sewer.

#### *2.1.3 Area A Confirmation Soil Sampling and Residual Contamination*

27 sidewall and 10 base confirmation soil samples were obtained from the excavation. Sidewall confirmation samples were collected on approximately 50-foot centers, and base confirmation samples on an approximately 50-foot square grid. The confirmation samples were obtained and analyzed in accordance with the 2008 EDR SAP. The approximate locations of the confirmation samples are shown in Sheet C-6, and chemical analytical data are presented in Table 3.

BRPH was detected at concentrations greater than the CULs in two confirmation samples (RE-A-28-8S and RE-A-29-8S) obtained from the north sidewall in an area near the northwest corner of the excavation. The wood waste material at these locations exhibited minor visual indication of BRPH contamination when compared to the other wood debris that was removed from this area of the excavation.

cPAHs were detected at concentrations greater than the CUL in 15 of the 27 sidewall samples taken at or just above the static groundwater table and at the top of the wood waste layer. GeoEngineers observed a consistently present layer of burnt organic material at the top of the wood waste across Area A. Burnt wood is a known source of cPAHs, and cPAHs in this burnt material may be partially responsible for exceedances of the CULs at this horizon. It is GeoEngineers' opinion that the cPAH detections in the burnt layer of organic material are largely unrelated to the oil releases from the former pipeline. With the exceptions of samples RE-A-28-8S and RE-A-29-8S, visible BRPHs were not observed at the 13 other sidewall sample locations where cPAHs were detected at concentrations greater than the CUL.

BRPH in the remaining sidewall samples was either not detected or was detected at concentrations less than the CUL.

Concentrations of cPAHs in the remaining sidewall samples were either not detected or detected at concentrations less than the CUL.

All samples obtained from the base of the excavation indicated that BRPH and cPAHs either were not detected or were detected at concentrations less than the CULs.

A data quality review was performed on the results for confirmation samples obtained at the limits of the excavation. The data was found to be acceptable for use. The results of the data quality review are provided in Appendix D, which also includes the laboratory analytical reports for the confirmation samples.

The approximate location of contamination remaining at Area A at concentrations greater than Ecology-approved CULs after removal to the maximum extent practicable are shown in Appendix K, Figure 1.

#### *2.1.4 Area A Excavation Backfill*

Backfilling activities at Area A began on August 12, 2008, and were completed on September 22, 2008. Miles Sand and Gravel (Miles) of Graham, Washington, supplied the bank run backfill and Washington Rock Quarries, Inc. (Washington Rock) of Orting, Washington provided the crushed base course, top course, ballast and quarry spalls.

Placement of the backfill materials was completed in general accordance with the 2008 EDR Specifications. Quarry spalls were used to stabilize the southwestern base of the Area A excavation, as shown in Sheet C-10, to provide suitable subgrade conditions for reconstruction of the stormwater pond. Subgrade conditions were observed to be unsuitable for backfill placement in this area after remedial excavation activities were completed. Import backfill material met the physical and chemical requirements of the specifications contained in the CAP/EDR and WSDOT Specifications. Chemical analytical data for the backfill materials are presented in Table 2.

Prior to backfilling the south to southeastern portion of the excavation, a 6-mil polyethylene plastic sheet was laid over the sidewall as a marker to separate imported fill from BRPH-contaminated material located under the water treatment system. Backfilling of the Area A excavation began after receipt of analytical results for confirmation soil samples obtained from the base of the excavation. The residual BRPH-contaminated material beneath the water treatment system was removed from the south to southeastern portion of the excavation as described in Section 2.1.1.

Confirmation soil sampling of the base of the excavation continued through August 14, 2008, ahead of backfilling efforts to prepare for the installation of the WSDOT stormwater ponds and a utility pole to support the nearby Tacoma Power overhead electrical lines adjacent to East D Street. In preparation for this utility pole installation, Glacier constructed a temporary bank run backfill ramp from the surface grade at the north end of the excavation area down to the southern base of the excavation. Tacoma Power used this ramp on August 16, 2008 to install the utility pole support and reconfigure the guy lines. After the utility pole support installation was complete, Glacier removed the temporary ramp to begin backfilling activities as generally described in the 2008 EDR.

Imported backfill was placed in approximately 12-inch lifts and compacted with a vibratory drum roller to at least 90 percent of the maximum dry density (MDD) as measured in general accordance with ASTM International (ASTM) D 698 from the excavation base to approximately 4 feet bgs. The backfill placed from approximately 4 feet bgs to the surface was compacted to at least 95 percent of the MDD. Compaction was measured with a nuclear densitometer in general accordance with ASTM D 2922. The imported backfill was placed and compacted in general accordance with the 2008 EDR Specifications.

#### *2.1.5 Area A Final Site Grading and Site Restoration*

One of the final grading requirements for Area A was to return the WSDOT stormwater ponds to "Liner-Ready" condition. "Liner-Ready" conditions consisted of a non-yielding subgrade of WSDOT-specified material compacted with no protrusions in excess of ½ inch or cracks/crevices any deeper than 1 inch. In order to meet the WSDOT conditions, Glacier placed 2 to 3 feet of 8- to 12-inch quarry spall material at locations where native subgrade soils appeared to be unsuitable for backfill. These quarry spalls were placed as described in Section 2.1.4. A 1- to 2-foot layer of 3-inch crushed ballast was placed over the quarry spalls, followed by 0.5- to 1-foot of bank run material compacted to WSDOT specifications.

WSDOT awarded Glacier the contract to complete the pond reconstruction, which included liner installation and placement of pond surcharge material. Glacier's pond reconstruction work took place concurrently with Area D excavation and restoration activities. Area A was restored to "Liner-Ready" condition as shown in Sheet C-8 in accordance with the access agreement between BNSF and WSDOT. WSDOT inspected the "Liner-Ready" conditions on September 8, 2008, and issued a letter of approval dated September 9, 2008, as presented in Appendix F.

In the process of grading the northern pond west embankment slope, Glacier discovered a 4-inch steel pipe with a boiler-type coupler protruding from the sidewall. It was observed that the pipe had been broken off, bent down parallel with the slope of the embankment and buried under the original stormwater pond liner. A similar pipe was discovered in place directly to the east, crossing over the BNSF oil pipeline and exiting Area A through the east sidewall. The purpose of this pipe is unknown, but visual observations of the relative age and condition of the pipe materials indicated that it was not likely in service at the time of its discovery. A soil sample (4IN-PIPE-SOIL-5) shown on Sheet C-6 was obtained to assess if petroleum-related contamination was present around this unknown pipe. Chemical analytical results are shown in Table 3, which indicate BRPH was detected at a concentration less than the CUL. The pipe was cut off and plugged with concrete at the limits of Area A.

Area A post-construction final grade and cross sections are presented in Sheets C-9 and C-10. The structural section for reconstruction of the BNSF Tacoma Rail Yard access road at Area A consisted of the following:

- Subbase: a 6- to 8-inch-thick base course of 1¼-inch minus crushed rock placed over the subgrade bank run material and compacted by vibratory drum roller;
- Base Course: a 3- to 4-inch-thick top course of ¾-inch minus crushed rock compacted by vibratory drum roller; and
- Surface Course: a 3-inch-thick single lift of compacted asphalt.

The subbase and base course were placed on September 4 and 5, 2008. The surface course was placed on October 1, 2008. The remainder of the Area A surface consisted of graded bank run material to the approximate final elevations indicated in the design drawings. Finish grade conditions consisted of topsoil and hydroseeding, with the exception of the access road installed on the east side of the WSDOT stormwater ponds. This access road consists of a 1-foot-thick section of quarry spalls overlain by a 3-inch lift of ¾-inch minus crushed rock. Fencing was replaced and other site restoration completed as provided in the access agreement between BNSF and WSDOT.

## 2.2 Area B Remedial Activities

### *2.2.1 Area B Remedial Excavation Activities*

The Area B remedial excavation activities began on August 14, 2009 and were completed on November 6, 2009. During the remedial excavation activities, Glacier excavated approximately 10,450 tons of material, which was transported to LRI. Sheets C-12 and C-13 show the estimated limit for remedial excavation activities at Area B as presented in the 2009 EDR. Sheet C-14 shows the Area B cross sectional view of the proposed backfill and grade as presented in the 2009 EDR.

Asphalt pavement was removed and transported to Woodworth and Company, Inc. in Tacoma, Washington, for recycling prior to beginning remedial excavation activities at Area B. Four waste profile soil samples were obtained from two test pits on August 14, 2009. These samples were analyzed for RCRA 8 metals as part of the soil disposal characterization for the WDA. The TPCHD approved the WDA on August 18, 2009. Chemical analytical data for this waste profile sample are presented in Table 1. The WDA is included in Appendix C.

Confirmation soil samples were obtained during excavation of Area B to confirm that material with COCs at concentrations greater than the CULs had been removed to the maximum extent practicable (sample locations are shown on Sheet C-15). If the confirmation soil sample analytical results indicated sidewall or excavation base material with COC concentrations greater than the CULs, Glacier was directed to over-excavate, to the maximum extent practicable, the area where any confirmation soil sample exceeded the CULs. After the over-excavation of a given area, additional confirmation samples were obtained and analyzed, and the results were compared to the CULs. This confirmation soil sampling and analysis process was repeated until confirmation soil sample results from the limits of the excavation indicated COC concentrations less than the CULs or removal of contaminated soil had been completed to the maximum extent practicable. If the analysis of confirmation soil samples indicated sidewall or excavation base material with COC concentrations greater than the CULs in an area where over-excavation could not be conducted without compromising existing structures, additional confirmation soil samples were obtained to assess the levels of BRPH-contaminated material that would remain on-site. The results of confirmation soil sampling and analysis, as well as approximate locations of residual contamination, are discussed further in Section 2.2.3. The total limits of excavation for Area B are presented in Sheet C-15.

Area B was divided into three excavation phases: the Safe Dig Area, the East 19th Street Right-of-Way (ROW) Excavation, and the Phoenix/Nichols Additional Excavation Area (Phoenix/Nichols). The Safe Dig Area was located along the south side of the Tacoma Fixtures building, north of the East 19th Street ROW, bound at the west by the 2004 Interim Action Excavation Area and continuing to the east loading bay door of the Tacoma Fixtures building.

The East 19th Street ROW Excavation consisted of the primary Area B excavation limits identified in the 2008 EDR and 2009 EDR (east of the intersection of East D Street and East 19th Street, and south of the Tacoma Fixtures building at 1815 East D Street, in the East 19th Street ROW).

Phoenix/Nichols was located between the Phoenix Environmental Building at 1901 East D Street and the southern limit of the East 19th Street ROW Excavation. This third excavation area extended from the sewer manhole northeast of the sanitary sewer lift station at the intersection of East 19th Street and East D Street, east to the sewer manhole northeast of the Phoenix Environmental lay down yard.

#### 2.2.1.1 SAFE DIG AREA

The excavation activities in the Safe Dig Area had three intended purposes:

- To safely remove BRPH-contaminated material from around the active utilities and adjacent to the Tacoma Fixtures building within that area to the maximum extent practicable;
- To document remaining BRPH-contaminated material that could not be removed safely because of proximity to the existing structures and utilities; and
- To remove existing contaminated soil along new utility corridors used for rerouting active utilities around the East 19th Street ROW. The removal of contaminated soil along these corridors was required by the various utility companies as a worker health and safety issue.

A vactor truck from Aqua Clean Jet-N-Vac (Aqua Clean) of Renton, Washington, was primarily used to excavate the Safe Dig Area. A trackhoe was used wherever utility conflicts were not present.

The Safe Dig Area extended from the southwest corner of the Tacoma Fixtures building to approximately 130 feet east and approximately 20 feet south. Sheet C-15 shows the approximate limits of the Safe Dig Area. Depths achieved within the Safe Dig Area ranged from 3 feet to 12 feet below grade. From August 17 to August 24, 2009, approximately 750 tons of material was removed from the Safe Dig Area. The material handled by the vactor truck was mixed with water generated during the removal process. The water needed to be drained from the material before disposal. Glacier excavated three containment pits within the Area C excavation footprint for temporary storage of the water removed from the vactor trucks. The containment pits were later removed as part of the excavation activities at Area C. The material that was removed with the trackhoe was stockpiled within the Area C excavation footprint until the TPCHD granted the WDA for disposal of Area B material at LRI on August 18, 2009.

Chemical analytical results for confirmatory soil samples obtained in the Safe Dig Area are presented in Table 5 and are further discussed in Section 2.2.3.

Before the Safe Dig Area excavation commenced, Tacoma Water (under subcontract with Glacier) installed an 8-inch temporary water main bypass along the south side of the Tacoma Fixtures building. The potable water services for the Tacoma Fixtures and Phoenix Environmental buildings were temporarily tapped into their fire service lines for the duration of the 2009 remedial activities. The water main and service lines with their respective meters and vaults were restored after remedial activities, as discussed in Section 2.2.5.

On August 11, 2009, during preparation to cut and cap the water main, Tacoma Water's backhoe severed an unmarked 1½-inch telecommunication line within the Safe Dig Area, at a point east of the eastern limit of Area B. The line was not marked by the "One Call" utility locators under the Tacoma Water locate request. None of the utility partners on the "One Call" list claimed ownership of this line, which was later discovered to belong to SuperValu as a private closed loop communication line linking several of their nearby buildings. SuperValu contracted the services of Communication Management Services of Seattle, Washington, to repair the damaged line.

Glacier subcontracted Tacoma Power to support the utility poles within the Safe Dig Area with a boom truck during removal of the BRPH-contaminated material. Tacoma Power requested that the bottom 2 feet of each pole remain in the ground and to maintain the width of the excavation to a 9-foot radius around the each pole. These requests resulted in a 5-foot-deep by 18-foot-diameter excavation around each utility pole. Confirmation soil samples were obtained from these excavations and they were backfilled and compacted with imported bank run material.

A concrete vault with an estimated capacity of 2,000 gallons was exposed within the Safe Dig Area, approximately 2 feet northwest of the western utility pole. The vault is approximately 5 feet wide by 10 feet long, with a base approximately 6 feet below grade and is located as shown on Sheet C-13. The purpose or past usage of this vault is unknown. The vault was filled with water, but BRPH contamination was not observed within the concrete vault. The vault could not be removed, as it would have compromised the integrity of the nearby utility pole. The vault was emptied using a vactor truck and left in place as it did not appear to be a source for BRPH-like contamination.

A UST with an approximate capacity of 12,800 gallons was located within the Safe Dig Area. This UST was identified in previous investigations as the 19$^{th}$ Street UST, and was located outside of and adjacent to the south side of the Tacoma Fixtures building. The UST was reportedly used for heating fuel oil storage. During the 2005 closure activities, the 19$^{th}$ Street UST was filled with an estimated 63 cubic yards of controlled density fill (CDF). On August 21, 2009, Glacier exposed the 19th Street UST with an excavator on the north and east sides within the Safe Dig Area to a depth of approximately 9 feet below surface grade, which was the maximum depth that could be achieved without compromising the nearby structures. The 19th Street UST was later removed and disposed of as described below in Section 2.2.1.2. Wood waste that contained BRPH-like material was observed on the north, west and east sidewalls of the UST excavation and in the material beneath the tank. UST disposal documentation is presented in Appendix E.

Four steel fuel lines associated with the 19th Street UST were uncovered in the Safe Dig Area. These fuel lines consisted of two ¾-inch, one 1½-inch and one 2-inch pipes buried from about 3 to 4.5 feet below the surface. These lines were removed to the limits of the Tacoma Fixtures building, where they were cut and plugged with concrete. The steel fuel lines are presented in the inset on Sheet C-15.

Corrosion, pitting, holes and breakage were observed on all of these fuel lines. The ¾-inch lines entered the side of the Tacoma Fixtures Building. After Glacier cut off the 2-inch line at the Tacoma Fixtures Building, approximately 0.5 gallons of diesel and water was observed to drain from this line from beneath the Tacoma Fixtures Building. A vactor truck was used to collect this fluid and to extract remaining fluid from the line. These steel fuel lines were plugged with concrete prior to backfilling the Safe Dig Area. Other utility lines that were abandoned or decommissioned in the Safe Dig Area such as former water lines, sewer lines and underground electrical conduit were removed and plugged with concrete at the limits of the excavation.

The 2-inch steel natural gas main that passed through Area B from east to west was cut and rerouted approximately 5 feet to the north after clean backfill was placed within the Safe Dig Area. The gas main reroute was constructed by Pilchuck Contractors, Inc. (subcontractor to Puget Sound Energy [PSE]) of Kent, Washington. The replaced gas line consisted of 4-inch welded plastic tubing with capped tees at the east and west ends for future upgrades.

Glacier contracted Godwin Pumps (Godwin) of Kent, Washington, to install a temporary sewer lateral bypass system for the Tacoma Fixtures building on August 30, 2009. The sewer bypass system consisted of a portable dry prime diesel-powered pump connected to the sewer lateral by hose and flow-through plug. This connection was made approximately 6 feet south of the Tacoma Fixtures building. The effluent hose was connected to the pump and was routed around Area B to the sewer manhole located southeast of the intersection of East 19th Street and East D Street. The pump operated continuously until the sewer lateral was reconstructed on October 19, 2009.

#### 2.2.1.2 EAST 19TH STREET ROW

After completion of the Safe Dig Area excavation on August 24, 2009, excavation efforts were moved to the East 19th Street ROW. This portion of the excavation activities continued through September 23, 2009. The excavation was approximately 50 feet wide by 170 feet long, with an average depth of 10 feet. Approximately 4,700 tons of material was transported off-site to LRI. Excavated material disposal documentation is provided in Appendix E.

The subsurface soil from the beneath the asphalt pavement down to the approximate depth of the groundwater (approximately 7 feet below grade) consisted of fine silty sand fill material with occasional shell fragments and brick, concrete, asphalt and wood debris. A 2- to 4-foot-thick layer of wood waste (dimensional lumber, sawdust, wood blocks, bark, etc.) mixed with sand and silt was encountered below the fill material. BRPH-like free product was observed to be predominantly confined to the void spaces within the wood waste material.

Native tidal deposits were observed beneath the wood waste layer. The native tidal deposit soils consisted of gray sand and silt, laminated with shell fragments and occasional organic debris. BRPH-like contamination was not observed in the native tidal deposits; therefore, the tidal deposits were identified as the deepest limit for excavation activities.

Several historical and active utilities passed through the East 19th Street ROW excavation area, including:

- Two 8-inch belled ductile iron water lines (one active and one abandoned);
- A 2-inch steel natural gas main;
- A 1½-inch private telecommunication line;
- A 12-inch belled concrete sewer main with one 6-inch PVC/concrete lateral; and
- A 16-inch belled ductile iron storm sewer line with one 6-inch PVC lateral.

The sections of active and abandoned water main piping that were removed as part of the remedial excavation were transported off-site for recycling at Schnitzer Steel of Tacoma, Washington. The steel recycling tickets are presented in Appendix E.

The section of cut natural gas main within the East 19th Street ROW was removed and recycled at Schnitzer Steel. The new natural gas main was permanently rerouted as shown on Sheet C-17.

The SuperValu telecommunication line remained operational and was supported on the north side of Area B during excavation activities. The line was buried during backfilling activities at a depth of approximately 2 feet below grade, and along the south side of the gas main reroute.

Sanitary and storm sewer construction plans were submitted to the City of Tacoma Construction Division for approval prior to excavating Area B. The plan set was approved by the City on August 14, 2009. The plans are provided in Appendix G, Utility and Pavement Restoration Plans. These plans show the layout of the sanitary and storm sewer lines that were reconstructed, including material, size, type and grade.

On August 27, 2009, Glacier constructed a 48-inch sanitary sewer manhole for the 12-inch sanitary sewer main east of the southeast corner of Area B. This manhole was constructed to facilitate a temporary sanitary sewer bypass system that was routed around the south side of Area B to the existing manhole located southeast of the intersection of East 19th Street and East D Street. Glacier also installed a temporary bypass system for the storm sewer line that routed stormwater from the type II catch basin in the southeast corner of Area B to the type II catch basin in the southwest corner of Area B. Godwin provided the necessary pumps, hoses and welded polyethylene piping for both of these bypass systems. The sanitary sewer bypass system operated from September 1 to September 24, 2009, and the storm sewer bypass system operated from September 1 to September 22, 2009. The sewer lines within the East 19th Street ROW were removed and either recycled at Schnitzer Steel or transported off-site to LRI.

Upon completion of the remedial excavation, Glacier reconstructed the sanitary sewer and storm lines in accordance with the City-approved plans. The utility reconstruction work was performed under the supervision of the City of Tacoma Public Works Construction Division.

The top and south side of the 19th Street UST, discussed in Section 2.2.1.1, was exposed during the East 19th Street ROW excavation. GeoEngineers and Ecology observed increasing BRPH-like contamination in the vicinity of the 19th Street UST location. Ecology identified the material surrounding the UST as a contaminant source, and requested that the UST be removed to allow removal of the BRPH-like contaminated material to the maximum extent practicable from areas adjacent to the tank. Removal of the tank was necessary to excavate source material adjacent to and below the tank.

Glacier exposed the top of the UST and discovered that there was an approximately 75-gallon void space above the CDF inside the tank. A marine chemist from Sound Testing Inc. of Seattle, Washington, tested the atmosphere within the tank and gave Glacier the approval to cut the top and sides with a cutting torch. The tank was cut open and the CDF was removed on September 14, 2009. The UST was removed and stored on site on September 15, 2009. GeoEngineers observed large holes along with extensive pitting and weld failures in the sides and ends of the tank prior to its removal. Photos documenting the condition of the UST are presented in Appendix J. Given the degree of corrosion and the relative short period of time since the tank was closed in place (July 2005), it is GeoEngineers' opinion that the tank integrity was compromised prior to July 2005 when it still contained BRPH-like product. A representative from the Tacoma Fire Department was on-site during UST cutting and CDF removal. The steel from the UST was transported off-site to Schnitzer Steel for recycling on September 17, 2009.

After the tank was removed, Glacier excavated material approximately 5 feet to the east, 2 feet to the west and 2 feet beneath the UST's former footprint. One confirmation soil sample was obtained from the native tidal deposits beneath the UST and three were obtained from the west, north and east sidewalls adjacent to the UST following its removal. The native tidal deposits did not exhibit visible BRPH-like contamination, while the wood waste material observed in the east, north and west sidewalls contained BRPH-like contamination.

Wood debris and some BRPH-contaminated soil remained in the excavation sidewalls at the East 19th Street ROW excavation as follows:

- The base of the north sidewall at the East 19th Street ROW excavation adjacent to the Safe Dig Area consisted of approximately 1 to 2 feet of BRPH-contaminated wood waste overlain by fill material. This wood waste was present from the northwest corner of the excavation to approximately 94 feet east of the northwest corner.
- The west sidewall from the northwest corner of Area B to the south side of the storm sewer alignment consisted of clean backfill (bank run, 2-inch ballast and CDF) placed during the 2004 IA. South of the storm line, the west sidewall consisted of sanitary sewer backfill underlain by approximately 2 feet of wood waste. The wood waste and the south side of the sanitary sewer backfill contained BRPH-like free product.
- The east sidewall consisted of approximately 7 feet of fill material, overlying approximately 1½ feet of wood waste mixed with sand and silt, with approximately 6 inches of native tidal

deposits exposed beneath the wood waste. The top of the south sidewall slope was approximately 3 feet higher than the other three sidewalls of the East 19th Street ROW excavation, where the top of slope aligned with the north side of the Phoenix Environmental Services lay down yard.

- The south sidewall consisted of approximately 4 feet of bank run fill, overlying the sand and silt fill described earlier in this section. The slope intersected the sanitary sewer trench backfill (consisting of gravel with coarse sand), which ran parallel to and approximately 10 feet below the top of slope. Wood waste contaminated with BRPH-like product was identified south of and beneath the sewer trench backfill. The wood waste was generally 3 feet thick in the south sidewall, underlain by native tidal deposits.

Analysis of confirmation soil samples obtained within the East 19th Street ROW excavation, as presented in Table 6, indicates that COC were successfully removed to the approximate limits shown in Sheet C-15.

Soil samples obtained from the south sidewall of the East 19th Street ROW excavation confirmed the presence of BRPH at concentrations greater than the CUL extending for an unknown distance beneath the northwest corner of the Nichols Trucking parking lot and the Phoenix lay down yard south of Area B, and along the sanitary sewer alignment to the west. Ecology requested during a meeting on September 23, 2009 that this BRPH-contaminated material south of the original Area B excavation extending beneath the Nichols Trucking and Phoenix yards be removed. Additional excavation of the area south of Area B, described in Section 2.2.1.3, began on October 10, 2009.

#### 2.2.1.3 PHOENIX/NICHOLS ADDITIONAL EXCAVATION

Additional excavation activities began in the northeast corner of the Phoenix lay down yard. From October 10 to October 12, 2009, 2,250 tons of material were excavated and transported to LRI for disposal. This portion of the additional excavation was approximately 40 feet wide by 80 feet long, with an average depth of 13 feet. The north sidewall consisted of backfill material placed in Area B in September 2009 underlain by native tidal deposits. The west, south and east sidewalls consisted of historical fill overlying wood waste, which had been deposited over native tidal deposits. The wood waste material within the limits of the Phoenix/Nichols excavation was removed down to the top of the native tidal deposits. BRPH-contaminated wood waste was observed in the north half of the east sidewall and the full width of the west sidewall. Six confirmation soil samples were obtained from the base and south sidewall prior to backfilling. One confirmation soil sample (RE-PX-2), obtained from the west end of the south sidewall at approximately 11 feet below surface grade, had BRPH concentrations greater than the CUL. BRPH-contaminated wood waste in the east and west sidewalls prompted removal of additional material from areas to the east, west and southwest of the Phoenix/Nichols excavation.

The additional excavation to the east, west and southwest of the Phoenix lay down yard began on November 2, 2009, and ended on November 6, 2009. This effort began in the northeast corner of the Phoenix yard and extended into the Nichols Trucking parking lot as shown on Sheet C-15 to an average depth of 10 feet. A total of 640 tons of material was removed from the Nichols Trucking property on November 2, 2009. BRPH-contaminated wood waste was observed along the west and south sides of this structure and was not observed to the east. Visible BRPH-contaminated wood waste was removed within the limits of this excavation area. Five confirmation soil samples were obtained from the base and sidewalls. The analytical data indicated that cPAHs and BRPHs either were not detected or were detected at concentrations less than the CULs as presented in Table 6.

BRPH concentrations from confirmation soil sample RE-PX-2 were greater than the CUL. Glacier removed additional material with visual indications of BRPH to the excavation limits shown on Sheet C-15.

As part of this additional excavation the sanitary sewer line crossing the north end of the excavation was removed on November 5, 2009. A sewer bypass system was then installed from the new sewer line in the northeast corner of the excavation to the sewer manhole southeast of the intersection of East D Street and East 19th Street. The sewer bypass system operated until the sanitary sewer line was reconstructed on November 6, 2009. Backfilling began on November 6, 2009. Eleven confirmation soil samples were obtained from the base and sidewalls of the west and southwest excavations. The analytical data (summarized in Table 5) indicated that cPAHs and BRPHs either were not detected or were detected at concentrations less than the CULs, with the exception of two samples: RE-PX-19 and RE-PX-22. Sample RE-PX-19 was obtained at approximately 7 feet below grade in the northwest corner of the excavation, and sample RE-PX-22 was obtained at approximately 7 feet below grade in the south sidewall near the southwest corner of the excavation.

Chemical analytical results for sample RE-PX-19 and RE-PX-22 indicated that BRPH concentrations were greater than the CUL. It is our opinion the BRPH- contaminated material was removed to the maximum extent practicable. Additional material removal would have required bypassing and reconstructing the sanitary sewer line located to the west of the excavation, which would: 1) incur a substantial and disproportionate cost relative the concentrations observed; and 2) be impracticable during the time of year the construction would have had to have taken place. Ecology supported our opinion as indicated in an email dated September 23, 2009 (Appendix F).

The Safe Dig Area, East 19th Street ROW and Phoenix/Nichols additional excavations were completed to the maximum extent practicable as provided in the CAP and EDR and the excavation limits are presented in Sheet C-15. Confirmation sampling and residual contamination after removal to the maximum extent practicable is discussed in Section 2.2.3.

#### *2.2.2 Area B Dewatering Activities*

Prior to removal of the BRPH-contaminated material below the groundwater table in Area B, Glacier used a dewatering system similar to the system used for Area A to remove and treat groundwater from within the excavation area. The water treatment system differed slightly from the system used in 2008. The combination of the pea gravel filter packs around the dewatering sumps and the weir tank chambers of the water treatment system provided acceptable oil/water separation to meet the discharge criteria of the City without an oil/water separator. The system was used to dewater the excavated material prior to being transported off-site, and to provide a stable working surface for excavation equipment and personnel at the base of the excavation. A copy of the 2009 SAD permit is presented in Appendix C.

On August 26, 2009, the City approved discharge to the same sanitary sewer lift station that was used in the 2008 Area A remedial excavation. Discharge from the treatment system to this lift station was limited to 25 gallons per minute or less. In order to handle the additional volume of water generated during the dewatering effort, the City also approved discharging to a sanitary sewer manhole in the BNSF Tacoma Rail Yard. The treatment system was constructed on-site and dewatering efforts began on August 26, 2009. The dewatering and treatment system discharged approximately 390,000 gallons of treated water to the sanitary sewer during the Area B remedial activity and Area B dewatering was terminated on September 22, 2009.

Dewatering of the Phoenix/Nichols excavation began on October 10, 2009 and continued until October 14, 2009. The water treatment system was dismantled and transported off-site between October 21 and October 30, 2009, after completion of the Phoenix/Nichols excavation.

Glacier removed approximately 57,450 gallons of water from the Phoenix/Nichols excavation area east and west of the Phoenix lay down yard using a combination of a 3-inch trash pump and Phoenix Environmental vacuum trucks. Water removed with the trash pump was pumped into a 6,500-gallon plastic tank that was offloaded into vacuum trucks owned and operated by PIR and transported to their water treatment facility in Auburn, Washington. PIR transported 32,200 gallons of water on November 3 and 4, 2009. On November 6, 2009, Phoenix Environmental Services pumped 25,250 gallons directly from the west excavation to draw down the water level to below the sanitary sewer line base grade during reconstruction of the sewer line. Water handled by Phoenix Environmental was offloaded into their treatment facility located immediately southeast of the excavation at 1901 East D Street.

#### *2.2.3 Area B Confirmation Soil Sampling and Residual Contamination*

Thirty three sidewall confirmation samples were obtained on an approximate 50-foot linear spacing, and 23 base confirmation soil samples on an approximately 50-foot square grid from the Area B remedial excavation. The confirmation samples were obtained and analyzed in accordance with the 2009 EDR SAP. The approximate locations of confirmation soil samples are shown in Sheet C-15, and chemical analytical data are presented in Table 6.

BRPH concentrations greater than the CUL were detected in 10 of the 33 sidewall confirmation samples. Visible BRPH-like contamination was observed in the wood waste material in areas where confirmation samples with BRPH concentrations greater than the CUL were detected. BRPH-like contaminated material was left in place at the maximum practicable excavation limits at Area B.

cPAHs were detected at concentrations greater than the CUL in 23 of the 27 sidewall samples obtained at or just above the static groundwater table within the wood waste layer. cPAH-contaminated material was left in place at the maximum practicable excavation limits at Area B. GeoEngineers observed burnt or charred material at the top and just above the wood waste material similar to that described in Section 2.1.3 of this report. Sidewall samples were collected within the wood waste material below any observed charred material to identify cPAHs potentially associated with the BRPH contamination rather than that of past regional burning activities. Past dredging activities in the Thea Foss Waterway generated a portion of the fill material that resided within the remedial excavation areas prior to the pipeline installation and operation. These dredge spoils are known to contain cPAHs as a result of historic industrial activities adjacent to the

Waterway. The cPAH-contaminated material detected at the excavation limits of Area B appears to be present region-wide and associated with sources independent of the BRPH contamination.

Samples obtained from the base of the excavation indicated that BRPH and cPAHs were either not detected or were detected at concentrations less than the CULs, with the exception of samples RE-B-2 and RE-B-3 within the Safe Dig Area. BRPH-like contaminated material in the vicinity of samples RE-B-2 and RE-B-3 was removed to the maximum extent practicable, with the removal being limited by nearby structures or active utilities.

The approximate location of contamination at concentrations greater than Ecology-approved CULs remaining at Area B after removal to the maximum extent practicable is shown in Appendix K, Figure 2.

A data quality review was performed on the results for confirmation samples obtained at the limits of the excavation. The data were found to be acceptable for use. The results of the data quality review are provided in Appendix D, which also includes the laboratory analytical reports for the confirmation samples.

#### *2.2.4 Area B Excavation Backfill*

Backfilling activities at Area B began on August 21, 2009 and were completed on November 13, 2009. Miles Sand and Gravel supplied the bank run backfill, and Washington Rock supplied the crushed base course, top course, ballast and quarry spalls.

Placement of the backfill materials was completed in general accordance with the 2009 EDR specifications. Quarry spalls were used to stabilize the base of the Area B excavation to provide suitable subgrade conditions for East 19th Street ROW reconstruction. Subgrade conditions were observed to be unsuitable for backfill placement after remedial excavation activities were completed. Import backfill met physical and chemical requirements of the specifications contained in the CAP/EDR and WSDOT Specifications. Chemical analytical data for the backfill materials are presented in Table 2.

Imported backfill was placed in approximately 12-inch lifts and compacted with a vibratory drum roller to at least 95 percent MDD. Compaction testing with a nuclear densitometer in general accordance with ASTM D 2922 indicated the compacted backfill was in general accordance with the 2009 EDR Specifications from the excavation base to the roadbed subgrade.

A 60-mil high density polyethylene (HDPE) liner was placed along the north sidewall, in general accordance with 2009 EDR, where confirmation soil samples indicated BRPH concentrations greater than the CULs and/or where BRPH-contaminated wood waste was observed. This liner was installed to limit potential BRPH migration into the clean backfill placed within Area B.

Glacier began the installation of the HDPE liner by excavating approximately 2 feet west into the IA excavation CDF backfill material in the northwest corner of the Area B excavation. Glacier then constructed a 1H:1V (horizontal to vertical) slope of compacted bank run material against the north sidewall, extending approximately 100 feet east of the northwest corner. After this was completed, an approximately 3-foot-wide bench was cut to approximately 3 feet below grade at the top of the north sidewall slope, and a 3-foot-wide anchor trench was excavated at the toe of the slope in the ballast and quarry spalls. This anchor trench extended down to the top of the native tidal deposits. A 60-mil HDPE liner was placed on the north sidewall slope on September 18, 2009, with the west end of the liner overlapping the CDF material by approximately 2 feet and extending approximately 5 feet east of the BRPH- contaminated wood waste. Wood waste in the north sidewall, east of the BRPH-contaminated wood waste, behind the liner was removed to the northeast corner of Area B, limiting the potential pathway for product migration to the east. Ballast was placed on the liner within the anchor trench, and then a 3-foot-wide layer of high total organic carbon (high TOC) material was placed and compacted against the south side of the liner to within 4 feet of surface grade. The 2009 EDR Specifications required a 2-foot-thick layer of high TOC material with 5 percent or greater organic carbon content. The high TOC material that was placed on-site contained 3.7 percent organic carbon, and therefore 1 foot of additional thickness was added to the material to compensate for the 1.3 percent variance from the 2009 EDR specification. The locations of the HDPE liner and high TOC material placed within Area B are shown on Sheet C-17.

#### *2.2.5 Area B Utility Reconstruction*

The Area B excavation activities required rerouting, bypassing or working around utilities located within the excavation limits. Most utilities that were rerouted or bypassed were reconstructed during backfill and site restoration activities. The utilities within the Area B excavation limits include a 16-inch storm line, a 6-inch storm line lateral, a 48-inch sanitary sewer manhole for the sewer main, a 12-inch sanitary sewer main, a 6-inch sanitary sewer lateral for 1815 East D Street (Tacoma Fixtures building), a 48-inch manhole for 1901 East D Street (Phoenix Environmental building), a 2-inch sanitary sewer lateral, an 8-inch water main, an 8-inch fire service line with water meter for Tacoma Fixtures, a 1½-inch water service line with water meter for Tacoma Fixtures, a 1-inch water service line with water meter for Phoenix Environmental, a 2-inch natural gas main and a 1-inch natural gas service line for Tacoma Fixtures. The storm and sanitary sewer restoration plans are provided in Appendix G, and Sheet C-17 shows the final utility alignments after remedial activities in Area B.

The stormwater in the 16-inch storm line that crossed Area B was pumped from the catch basin in the southeast corner of the excavation (CB East) through an 8-inch pipe routed along the south side of Area B to the catch basin in the southwest corner of the excavation (CB West). The 16-inch belled end ductile iron pipe was removed to within approximately 13 feet west of CB East and 17 feet east of CB West. Glacier replaced the sections of removed pipe with 16-inch "Blue Brute" C900 PVC belled end pipe. The pipe was connected to the existing ductile iron pipe with mechanical joints. The storm line installation was inspected and approved on September 22, 2009, by Helene Vondettii of the City of Tacoma Public Works Department, Construction Division. After the inspection, Glacier backfilled the storm line trench with pea gravel to approximately 1 foot above the pipe then continued to backfill Area B with bank run backfill to the sanitary sewer pipe grade. CDF was placed in the trench around the storm line at the east and west limits of Area B to reduce the possibility for potential contaminant migration through the trench backfill. The locations of CDF placed within Area B are shown on Sheet C-17.

A 6-inch storm line lateral that drained the west side of the Nichols Trucking lot in the southeast corner of Area B and that was connected to CB East was cut and removed during the excavation activities. The line consisted of belled concrete pipe from the Nichols Trucking property to the catch basin off the northeast corner of the Phoenix Environmental lay down yard, and then a 6-inch schedule 35 belled end PVC pipe from this catch basin to CB East. Glacier cut and removed a portion of the PVC line to access the sanitary sewer main that passed under it, and then reconnected the line with Fernco-like couplers once the sewer main was reconstructed. The concrete sections of pipe were removed from the catch basin to approximately 50 feet south during the Nichols/Phoenix excavation and was reconstructed using 6-inch schedule 35 belled end PVC pipe. The pipe was installed into the catch basin with a grouted-in sand collar and connected to the concrete pipe in the south sidewall with a Fernco-like coupler.

A new 48-inch concrete sanitary sewer manhole (MH East) was installed by Glacier on August 27, 2009. MH East was installed on the sanitary sewer main approximately 205 feet east of the manhole located southeast of the East 19th Street and East D Street intersection (MH West). The new manhole was installed to facilitate the sewer bypass system necessary to excavate Area B. Glacier used ⅜-inch pea gravel as bedding material under and around the manhole. After placement of the base, Glacier subcontracted services to a channeling company to construct the concrete channel in the manhole base segment. The City's inspector, John Florenzen, inspected and approved the manhole on September 1, 2009.

The sewage in the 12-inch sanitary sewer main that crossed Area B was pumped from MH East through a 6-inch pipe routed along the south side of Area B to MH West. The 12-inch belled concrete pipe was removed to approximately 3 feet east of MH East and 5 feet east of MH West. Glacier bedded the replacement pipe with ⅜-inch washed pea gravel and replaced the sections of removed pipe with 12-inch schedule 35 PVC belled end pipe. The pipe was connected to the existing concrete pipe with a Fernco-like coupler at the east connection and a mechanical joint coupler at the west connection. A sanitary sewer connection tee (12-inch by 6-inch) was installed in the sewer main approximately 120 feet east of MH West to tie in a sanitary sewer lateral from Tacoma Fixtures. The sanitary sewer main installation was inspected and approved by the City on September 24, 2009. After the inspection, Glacier backfilled the sanitary sewer main trench with pea gravel to approximately 1 foot above the pipe then continued to backfill Area B with bank run backfill to the surface grade. CDF was placed in the trench around the sanitary sewer main at the east and west limits of Area B to reduce the possibility for potential contaminant migration through the trench backfill. The locations of CDF placed within Area B are shown on Sheet C-17.

Glacier installed a 6-inch sanitary sewer lateral from the south side of the Tacoma Fixtures building, running south approximately 70 feet to the 12-inch sanitary sewer main on October 19, 2009. The north connection was made with a Fernco-like coupler approximately 67 feet east of the southwest corner of the Tacoma Fixtures building and was directed south under the water main alignment described below. Glacier used 6-inch belled ductile iron pipe from the connection at the building to approximately 10 feet south of the water main crossing at the request of the City of Tacoma water department (Tacoma Water). Then Glacier used schedule 35 PVC belled end pipe with a Fernco-like coupler connected from the ductile iron pipe to the sewer main tee. Glacier used ⅜-inch pea gravel as bedding and cover for the sewer lateral to 6 inches above the pipe. Bank run backfill was placed and compacted with a vibratory drum roller in 6-inch lifts to the subgrade elevation.

The Phoenix Environmental facility's 2-inch treated water discharge line was required to have a 48-inch inspection manhole as part of a recently adopted city discharge ordinance. Reconstruction of the discharge line to existing conditions without the manhole would not have been permitted by the City, as this would require installing a structure out of compliance with the new discharge ordinance. Accordingly, as a part of the Phoenix lay down yard reconstruction, Glacier installed a 48-inch concrete manhole on the Phoenix waste discharge line on November 20, 2009. The manhole was installed along the west side of the lay down yard approximately 40 feet north of the northwest corner of the Phoenix building. Glacier used ⅜-inch pea gravel as bedding material under and around the manhole. The manhole base segment was pre-channeled by the manufacturer. The manhole installation was inspected and approved by the City on November 20, 2009.

The East 19th Street 8-inch ductile iron water main was rerouted by Tacoma Water to the north of Area B. The water main is fed from both directions along East 19th Street; therefore, Tacoma Fixtures was the only customer affected by the reroute. Tacoma Water cut the water main at the northwest corner of Area B and redirected it at a 45-degree angle to the northeast to tie in to the 8-inch fire service for the Tacoma Fixtures building. Tacoma Water then cut and capped the water main at the northeast corner of Area B for the duration of the Area B remedial excavation. After backfill of Area B and installation of the Tacoma Fixtures sewer lateral, Tacoma Water reconstructed the water main with a revised alignment. The line was reinstalled approximately 7 feet south of the original alignment to avoid a conflict with the HDPE liner. The 8-inch fire service line and water meter vault were reconstructed in the original alignment. The liner was sealed around the 8-inch fire service line by the liner subcontractor on November 2, 2009.

The 1½-inch potable water service line for Tacoma Fixtures was temporarily rerouted on the surface into the building from a tap in the temporary fire service line. The water meter was taken out of service for the duration of remedial excavation activities at Area B. Once remedial activities were completed, Tacoma Water reinstalled the water service line at a new tap location approximately 30 feet east of the original alignment. Tacoma Water returned water service to Tacoma Fixtures on November 2, 2009.

The 1-inch potable water service line for Phoenix Environmental was temporarily rerouted on the surface into the building from a tap in the fire service line on the west side of the building. The water meter was taken out of service for the duration of remedial excavation activities at Area B. Once remedial activities were completed, Tacoma Water reinstalled the water service line and meter at the same tap location as the original alignment and returned water service to Phoenix Environmental.

The 2-inch steel natural gas main along the north side of East 19th that passed through Area B from east to west was cut and rerouted approximately 5 feet to the north after clean backfill was placed to grade within the Safe Dig Area. The natural gas main reroute was constructed by Pilchuck Contractors, Inc. (subcontractor to PSE) of Kent, Washington. The section of new natural gas line was replaced with 4-inch welded plastic tubing with capped tees at the east and west ends for future upgrades. The new section of natural gas main was placed in a trench with 6 inches of bedding sand and 6 inches of cover sand for protection. The remaining trench was backfilled to surface with bank run backfill that was compacted in 6-inch lifts with a man-portable vibratory compactor. The 1-inch natural gas service line for Tacoma Fixtures was installed by Pilchuck

Contractors, Inc. at the time of the natural gas main reroute, and gas service was returned to Tacoma Fixtures on September 8, 2009.

#### *2.2.6 Area B Final Site Grading and Site Restoration*

Area B post-construction final grade and cross section are included as Sheets C-17 and C-18. The East 19th Street ROW within Area B was backfilled to match preexisting subgrade surface conditions between October 21 and November 30, 2009. After subgrade completion, Glacier initiated final grading consisting of three parts:

- Base Course: a 7-inch-thick base course of 1¼-inch minus crushed rock placed over the subgrade bank run material and satisfactorily compacted by a vibratory drum roller in general accordance with the 2009 EDR Plans and Specifications;
- Top Course: a grade-staked 2-inch-thick top course of ¾-inch minus crushed rock satisfactorily compacted by vibratory drum roller in general accordance with the 2009 EDR Plans and Specifications; and
- Surface Course: a 3-inch-thick single lift of compacted asphalt.

Base course and top course were placed and graded between November 13 and 18, 2009. The edges of the surrounding asphalt were trimmed and cleaned on November 10, 2009, in preparation for paving. On November 12, 2009, concrete curb and gutter were constructed along the south shoulder of East 19th Street. Approximately 12,000 square feet of asphalt was placed on November 25, 2009 in the ROW from the east side of the intersection of East D Street and East 19th Street to approximately 280 feet east along East 19th Street. The remainder of the Area B surface consisted of graded base course material to the approximate final elevations indicated in the design drawings. Other site restoration including but not limited to gravel shoulders, bay door concrete aprons, and transitions from 19th Street to the bay door concrete aprons was completed as provided in the access agreement between BNSF, the City and Home Electric.

### 2.3 Area C Remedial Activities

#### *2.3.1 Area C Remedial Excavation Activities*

The Area C remedial excavation activities began on July 28, 2009 and were completed on December 14, 2009. Sheets C-20, C-21 and C-22 show the estimated excavation limit of BRPH-contaminated material as presented in the 2009 EDR. Sheets C-23 and C-24 show the Area C cross sectional views of the proposed backfill and grade as specified in the 2009 EDR. The Area C excavation was located in the Tacoma Fixtures (formerly Home Electric) and SuperValu parking lots adjacent to East D Street from East 18th Street south to East 19th Street.

Asphalt pavement was removed from the perimeter of the shoring alignment on July 28, 2009. The remaining asphalt was removed in stages throughout the excavation process in order to maintain a stabilized truck route through the Site. The asphalt was transported to Woodworth and Company, Inc. in Tacoma, Washington, for recycling. On July 31, 2009, 20 waste profile soil samples were obtained from 14 test pits within Area C and analyzed for RCRA 8 metals as part of the soil disposal characterization for the WDA granted by TPCHD on August 18, 2009. Chemical analytical data for this waste profile samples are presented in Table 1.

Glacier contracted the services of Soil Freeze of Redmond, Washington, to provide engineered structural shoring for the perimeter of Area C. The shoring design was intended to provide vertical shoring to a maximum depth of 15 feet to maximize the volume of BRPH-contaminated material that could be practicably removed while also minimizing groundwater infiltration into the excavation.

The shoring methodology consisted of installing 3-inch vertical capped steel pipes to a depth of approximately 20 feet below grade with an approximate 3-foot spacing around Area C. One pipe was installed 18 degrees out of vertical for every 10 vertical pipes. These pipes were manifolded in groups of 12 to 14 and connected to the chiller units. Dutton Electric of Lynnwood, Washington, installed an electrical control panel, transformer pad and associated wiring, and Tacoma Power installed a new power pole, service drop, transformer and meter to energize the soil freeze shoring system.

The pipes were filled with calcium chloride brine that the chiller units cooled to approximately negative 15 to 20 degrees Fahrenheit. The brine circulated through the shoring system to reduce the temperature of the soil and groundwater surrounding the pipes to below freezing. The result was a frozen wall approximately 4 feet thick and 20 feet deep. Three chillers were placed into service on August 21, 2009, and a fourth chiller was added on September 18, 2009, to accelerate the freeze down process. Details on this shoring system are provided in Appendix I.

From August 22 to October 14, 2009, Glacier excavated approximately 27,600 tons of material from Area C. Once the shoring was installed the excavation progressed from north to south. From the northern limit of Area C to approximately 50 feet south, the subgrade soils consisted of gray fine sand laminated with shell fragments, carbonized wood fragments and occasional organic matter. The sandy material appears to be dredge fill placed during the construction of the Tideflat area during the late 1800s and early 1900s. This northern portion of Area C was excavated to a depth of approximately 8 and 10 feet below grade. The subgrade from the surface to the approximate depth of the groundwater (approximately 6 to 8 feet below grade) beginning approximately 50 feet south of the northern limit to the southern limit of Area C consisted of fine silty sand fill with occasional shell fragments and brick, concrete, asphalt and wood debris. Wood waste was observed beneath the fill material at the water table beginning approximately 50 feet south of the north freeze wall to the south freeze wall within Area C. The wood waste in Area C was approximately 11 feet thick at the northern extent, and decreased to approximately 3 feet thick in the southwest corner and approximately 5 feet thick in the southeast corner.

Native tidal deposits were observed beneath the wood waste layer. The tidal deposits consisted of gray, laminated sand and silt, with shell fragments and occasional organic matter. BRPH was not observed in the native tidal deposits; therefore, the tidal deposits were identified as the deepest limit of the excavation effort. Twenty confirmation soil samples were obtained from the excavation base to determine clean vertical limits. Of these samples, only one (RE-C-32), which was obtained at approximately 10 feet below grade and approximately 40 feet south of the former monitoring well MW-14, had a concentration of BRPH above the CUL. An area approximately 15 feet by 15 feet around this sample location and extending down 1 foot into the tidal deposit was excavated, and the location was resampled as RE-C-35 at approximately 11 feet below grade. The laboratory results for this location indicated that BRPH and cPAHs were not detected.

The east sidewall located under the SuperValu building approximately 20 feet south of confirmation sample RE-C-5 to approximately 3 feet south of confirmation sample RE-C-14 consisted of bank run backfill. This material extended approximately 5 feet west into the Area C excavation and was approximately 17 feet thick. No wood waste was observed within the bank run backfill, and native tidal deposits were observed at the base. The east sidewall north of the bank run backfill consisted of dredge fill sand. Approximately 5 to 7 feet of silty sand fill overlying approximately 5 to 6 feet of wood waste was encountered south of the bank run backfill to the southeast corner of the excavation. BRPH-contaminated material was observed in the wood waste of the east sidewall.

Eight confirmation soil samples were obtained approximately 9 feet below grade from the east sidewall, with five obtained from within the wood waste layer. The three samples obtained from the dredge fill sand and bank run backfill indicated that cPAHs and BRPHs either were not detected or were detected at concentrations less than the CULs. The five samples obtained from the wood waste indicated that cPAHs and BRPHs were detected at concentrations greater than the CULs.

The west sidewall from the northwest corner of Area C to approximately 50 feet south consisted of dredge fill sand. The west sidewall south of the dredge fill sand to the southwest corner of Area C consisted of 5 to 7 feet of silty sand fill overlying wood waste that ranged from approximately 11 feet thick in the north to approximately 3 feet thick in the southwest corner. BRPH-contaminated material was observed in the wood waste of the west sidewall. Ten soil samples were obtained from the west sidewall. One sample was obtained from the dredge fill sand, and laboratory results indicated that BRPH concentration was not detected at a concentration greater than the CUL. However, cPAHs were detected at a concentration greater than the CUL. Without BRPH detected in this sample, it is our opinion that this cPAH exceedance may be related to the fill material itself rather than BRPH released from the BNSF oil pipeline.

The remaining nine samples were obtained from within the wood waste layer. Chemical analytical results indicated that cPAHs and BRPHs were detected at concentrations greater than the CULs with the exception of sample RE-C-18. CPAHs were not detected at a concentration greater than the CUL in RE-C-18.

The south sidewall consisted of approximately 5 feet of silty sand fill overlying wood waste that ranged from 3 feet thick in the southwest corner to 5 feet thick in the southeast corner, with the exception of the IA excavation backfill material consisting of CDF and bank run sand and gravel. The IA backfill is approximately 25 feet wide by 12 feet deep and located approximately 9 feet west of the southeast corner of Area C. BRPH-contaminated materials were observed in the wood waste of the south sidewall. Confirmation soil sample RE-C-30 was obtained from the wood waste in the center of the south sidewall at a depth approximately 7 feet below grade. The results of the sample indicated that cPAHs and BRPHs were detected at concentrations greater than the CULs.

Several active utilities passed through the excavation area, including:

- A historical 6-inch ductile iron fuel oil pipeline (BNSF oil pipeline);
- A 1½-inch steel natural gas service line;

- A 1-inch private telecommunication line;
- A 12-inch belled concrete sewer main with two 6-inch lateral lines (one PVC and one concrete);
- A 48-inch sewer manhole; and
- Two private storm sewer catch basins with 280 feet of 6-inch belled concrete lines.

See Section 2.3.5 and Appendix I for utility reconstruction details.

The BNSF oil pipeline was encountered at a depth of 3.5 feet bgs in the northeast corner of Area C. The pipeline was removed within the limits of Area C. The exposed pipe in the northeast corner was plugged with approximately 3 feet of quick set cement prior to backfilling.

The 1½-inch steel natural gas service line crossed Area C from the 4-inch gas main located along the east side of East D Street to the east side of the SuperValu building at 1801 East D Street. In order to avoid disrupting the gas service to SuperValu, Glacier contracted Pilchuck Contractors, Inc. to reroute the natural gas service to the 4-inch gas main in East 18th Street into a new natural gas meter at the northwest corner of the SuperValu building. Glacier contracted Puget Sound Gas Piping of Tacoma, Washington, to reconfigure the natural gas lines inside the SuperValu building to connect to the new meter location. The new natural gas line and meter were put in service and the gas line crossing Area C was cut and capped at the East D Street natural gas main on September 11, 2009.

The 1-inch private telecommunication line crossed the northeast corner of the freeze wall alignment from the northwest corner of the SuperValu building to the landscaping planter at the north end of Area C. Glacier potholed the telecommunication line to determine depth and alignment during the freeze wall installation. The freeze pipe locations were adjusted accordingly to incorporate the line into the shoring wall to protect it from damage during excavation activities.

The 12-inch East D Street sanitary sewer main passed through the north and south sidewalls of Area C, requiring the sewer main to be temporarily bypassed around the excavation. Glacier contracted Godwin to install an electric bypass pump and supply an 8-inch HDPE line that Glacier installed along the west side of Area C from the sewer manhole in East 18th Street to the manhole south of East 19th Street. Godwin installed an electric bypass pump and delivery hose for the SuperValu sewer lateral. The hose was directed around the north side of Area C and connected into the 8-inch bypass line for the sewer main. The electric pumps were connected to the electrical service supplied for the soil freeze shoring chillers, and a diesel bypass pump was provided as backup in case the Site lost power. Godwin installed a diesel bypass pump and delivery hose for the Johnny's Dock Restaurant sewer lateral that passed under East D Street from the west and connected to the sewer main within the Area C excavation limits. The Johnny's Dock Restaurant sewer bypass hose was connected to the 8-inch sewer main bypass line. Glacier operated the sewer bypass systems from September 11, 2009 until October 27, 2009, when the sewer main and laterals were reconstructed and placed back into service.

The two private storm sewer catch basins and associated 6-inch lines were removed during the Area C excavation. An additional storm line was identified during the remedial excavation that connected the downspouts on the south side of the SuperValu building to the catch basin in the

SuperValu parking lot. Stormwater runoff into the excavation area was contained and treated by the dewatering pumps and water treatment system before being discharged to the sanitary sewer.

The Area C excavation was completed to the maximum extent practicable as provided in the CAP and EDR and the excavation limits are presented in Sheet C-25. Confirmation sampling and residual contamination after removal to the maximum extent practicable is discussed in Section 2.3.3.

#### *2.3.2 Area C Dewatering Activities*

Glacier used the Area B dewatering system to remove and treat groundwater from within the Area C excavation. The system was used to dewater the excavated material prior to being transported off-site, and to provide a stable working surface for excavation equipment and personnel at the base of the excavation. A copy of the 2009 SAD permit is presented in Appendix C.

On August 26, 2009, the City approved discharge to the same sanitary sewer lift station that was used in the 2008 Area A remedial excavation. Dewatering efforts for Area C began on September 25, 2009. Discharge from the treatment system to this lift station was limited to 25 gallons per minute or less. Dewatering continued until October 12, 2009. A total of approximately 280,000 gallons of water was treated and discharged to the sanitary sewer.

#### *2.3.3 Area C Confirmation Soil Sampling and Residual Contamination*

Nineteen sidewall samples and 20 base confirmation soil samples were obtained from the excavation on an approximately 50-foot square grid. The confirmation samples were collected and analyzed in general accordance with the 2009 EDR SAP. The approximate locations of confirmation soil samples are shown in Sheet C-25, and chemical analytical data is presented in Table 7.

BRPH was detected at a concentration greater than the CUL in 15 of the 19 sidewall samples collected. BRPH-contaminated material was observed in the wood waste material in areas where confirmation samples with BRPH concentrations greater than the CUL were detected.

cPAHs were detected at concentrations greater than CUL in 15 of the 19 sidewall samples collected at or just above the static groundwater table within the wood waste layer. cPAH-contaminated material was left in place at the maximum practicable excavation limits at Area C. GeoEngineers observed burnt or charred material at the top and just above the wood waste material similar to that described in Sections 2.1.3 and 2.2.3 of this report. Sidewall samples were collected within the wood waste material below any observed charred material to identify cPAHs potentially associated with the BRPH contamination rather than that of past regional burning activities. Past dredging activities in the Thea Foss Waterway generated a portion of the fill material that resided within the remedial excavation areas prior to the pipeline installation and operation. These dredge spoils are known to contain cPAHs as a result of historic industrial activities adjacent to the Waterway. cPAH-contaminated material detected at the limits of Area C appears to be present region-wide and associated with sources independent of the BRPH contamination.

Analytical results of confirmation samples obtained from the base of the excavation indicated that cPAHs and BRPHs either were not detected or were detected at concentrations less than the CULs, with the exception of sample RE-C-32. Sample RE-C-35 was obtained at the same location as RE-C-32 after Glacier removed an area of additional material with approximate dimensions of 15 feet by 15 feet by 1 foot deep. The RE-C-35 confirmation sample results indicated that BRPHs and cPAHs were not detected.

BRPH- and cPAH-contaminated material was left in place at the maximum practicable excavation limits for Area C. The approximate location of contamination remaining at Area C at concentrations greater than Ecology-approved CULs after removal to the maximum extent practicable is shown in Appendix K, Figure 3.

A data quality review was performed on the results for confirmation samples obtained at the limits of the excavation. The data were found to be acceptable for use. The results of the data quality review are provided in Appendix D, which also includes the laboratory analytical reports for the confirmation samples.

#### *2.3.4 Area C Excavation Backfill*

Backfilling operations of Area C began on September 30, 2009 and were completed on October 30, 2009. Miles Sand and Gravel supplied the bank run backfill, and Washington Rock supplied the crushed base course, top course, ballast and quarry spall materials.

Placement of the backfill materials was completed in general accordance with the revised 2009 EDR Specifications. Quarry spall and ballast materials were used to stabilize the base of the Area C excavation to provide suitable subgrade conditions for East 19th Street ROW reconstruction. Subgrade conditions were observed to be unsuitable for bank run backfill placement after remedial excavation activities were completed. Import backfill met the physical and chemical requirements of the specifications contained in the CAP/EDR and WSDOT Specifications. Chemical analytical data for the backfill materials are presented in Table 2.

Imported bank run backfill was placed in approximately 12-inch lifts and compacted with a vibratory drum roller to at least 95 percent MDD from the excavation base to the roadbed subgrade. The backfill was placed and compacted in general accordance with the 2009 EDR Specifications. In-place moisture density tests (ASTM D 2922) were performed after placement and compaction of backfill lifts at locations identified by GeoEngineers.

A 60-mil HDPE liner was placed along the east sidewall, in general accordance with 2009 EDR, where the confirmation soil samples indicated BRPH concentrations greater than the CULs and where BRPH-contaminated wood waste was observed. This liner was installed to prevent the BRPH from migrating from upgradient areas into the clean backfill placed within Area C.

Glacier began the installation of the HDPE liner by constructing a 1H:1V slope of compacted bank run material against the east sidewall from approximately 25 feet north of the southeast corner of Area C to approximately 140 feet north of the southeast corner. The sidewall to the north remained vertical for liner placement. Glacier cut an approximately 3-foot-wide bench 3 feet below grade at the top of the east sidewall slope and excavated an approximately 3-foot-wide anchor trench approximately 260 feet long at the toe of the east sidewall in the ballast and quarry spalls down to the top of the native tidal deposits. A 60-mil HDPE liner was placed on the east sidewall on October 13, 2009, with the north end of the liner extending approximately 10 feet north of the BRPH-contaminated wood waste. Approximately 50 feet of additional liner was placed in the southeast corner of Area C on October 14, 2009. The additional liner overlapped the liner installed to the north by 3 feet and tied into the CDF backfill of the IA excavation. Ballast was placed on the liner within the anchor trench, and then a 3-foot-wide layer of high TOC material was placed and compacted against the west side of the liner to within 4 feet of surface grade. The locations of the HDPE liner and high TOC material placed within Area C are shown on Sheet C-28.

#### *2.3.5 Area C Utility Reconstruction*

The Area C excavation activities required rerouting, bypassing or working around utilities located within the excavation limits. Most utilities that were rerouted or bypassed were reconstructed during backfill and site restoration activities. The utilities within the Area C excavation limits include a 6-inch storm line lateral, two private catch basins, two 48-inch sanitary sewer manholes for the sewer main, a 12-inch sanitary sewer main, a 6-inch sanitary sewer lateral for 1801 East D Street (SuperValu building), a 6-inch sanitary sewer lateral for 1900 East D Street (Johnny's Dock Restaurant and Marina), and a 1½-inch natural gas service line and meter for the SuperValu building. The storm and sanitary sewer restoration plans are provided in Appendix G, and Sheet C-28 shows the final utility alignments after remedial activities in Area C.

A 6-inch storm line lateral with two catch basins drains the SuperValu and Tacoma Fixtures parking lots in Area C. The storm lines and catch basins were cut and removed during the excavation activities. The line consisted of belled concrete pipe connected to the downspouts along the south side of the SuperValu building to the point where it passed through the west sidewall. The line was reconstructed during backfilling activities in Area C, with two new Type I parking lot catch basins set in the original locations. Glacier used 6-inch schedule 35 belled end PVC pipe and connected it to the existing concrete lines in the sidewalls with Fernco-like couplers. CDF was placed in the trench around the 6-inch storm line lateral where it crossed the west and east limits of Area C to reduce the possibility for potential contaminant migration through the trench backfill. The locations of CDF placed within Area C are shown on Sheet C-28.

Two new 48-inch concrete sanitary sewer manholes were installed by Glacier from October 22 to October 24, 2009. The first manhole (MH South) was installed approximately 7 feet north of the south sidewall of Area C on the sanitary sewer main. The second manhole (MH North) was installed on the sanitary sewer main approximately 105 feet north of MH South. MH North was installed to replace the manhole that was removed from Area C during remedial excavation activities, but was relocated to the Tacoma Fixtures parking lot approximately 110 feet south of the original location in the SuperValu parking lot. The purpose of the relocation was to avoid installing the manhole in a low area where stormwater could potentially pond. MH South was constructed to facilitate an alignment adjustment between MH North and the manhole southeast of the East 19$^{th}$ Street and East D Street intersection (MH West described above in Section 2.2.5). Glacier used ⅜-inch pea gravel as bedding material under and around each manhole. The manhole bases were pre-channeled by the manufacturer prior to delivery.

The sewage in the 12-inch sanitary sewer main that crossed Area C was pumped from the north end of Area C through an 8-inch pipe routed along the west side of Area C to MH West. The 12-inch belled concrete pipe was removed between the north and south sidewalls of Area C. Glacier reinstalled the sanitary sewer main during Area C backfilling activities. Glacier replaced the sections of concrete pipe with 12-inch schedule 35 PVC belled end pipe. The pipe was bedded with ⅜-inch washed pea gravel. The pipe was connected to the existing concrete pipe with mechanical joint couplers at the north and south connections. Two sanitary sewer connection tees (12 inches by 6 inches) were installed in the sewer main to connect sanitary sewer laterals from SuperValu and Johnny's Dock Restaurant. The sanitary sewer main installation was inspected and approved by the City on October 26, 2009. After inspection, Glacier backfilled the sanitary sewer main trench with pea gravel to approximately 1 foot above the pipe then continued to backfill the trench with bank run backfill to the surface grade. CDF was placed in the trenches around the sanitary sewer main at the north and south limits of Area C and where the Johnny's Dock sanitary sewer lateral exits the west side of Area C to reduce the possibility for potential contaminant migration through the trench backfill. The locations of CDF placed within Area C are shown on Sheet C-28.

Glacier reconstructed the Johnny's Dock Restaurant 6-inch sanitary sewer lateral from the west sidewall of Area C, approximately 16 feet east to the 12-inch sanitary sewer main on October 23, 2009. Glacier used schedule 35 belled end PVC pipe with a Fernco-like coupler connected to the 6-inch concrete pipe in the west sidewall. The lateral connected to the sewer main with an inline slip joint 12-inch by 6-inch tee. Glacier used ⅜-inch pea gravel as bedding and cover for the sewer lateral to 6 inches above the pipe and used bank run backfill compacted with a vibratory drum roller in 6-inch lifts to the subgrade elevation.

The 1½-inch steel natural gas service line for the SuperValu building that passed through Area C from east to west was cut and capped at the 4-inch natural gas main along the east side of East D Street by Pilchuck Contractors, Inc. on September 8, 2009. The service line and meter were relocated to the north side of the SuperValu northwest building corner and were tapped into the 2-inch natural gas main along the south side of East 18$^{th}$ Street. The section of new natural gas line was replaced with 1-inch welded plastic tubing and was placed in a trench with 6 inches of bedding sand and 6 inches of cover sand for protection. The remaining trench was backfilled to the asphalt subgrade surface with bank run backfill that was compacted in 6-inch lifts with a jumping jack compactor.

#### *2.3.6 Area C Final Site Grading and Site Restoration*

The Area C excavation was backfilled between October 31 and November 30, 2009 to generally match pre-existing subgrade elevations. Prior to paving, the backfill was graded to accommodate 7 inches of base course consisting of 1¼-inch minus crushed rock. The base course was compacted with a vibratory drum roller in general accordance with the 2009 EDR Specifications. A 2-inch lift of ¾-inch minus crushed rock top course compacted by vibratory plate compactor. The edges of the surrounding asphalt were trimmed and cleaned on November 10, 2009, in preparation for paving. Approximately 41,000 square feet of asphalt were placed on December 14, 2009. Area C post-construction grade and cross sections are shown in Sheets C-28, C-29 and C-30. Other site restoration was completed as provided in the access agreements between BNSF, the City, Home Electric and SuperValu.

## 2.4 Area D Remedial Activities

### *2.4.1 Area D Remedial Excavation Activities*

The Area D remedial excavation activities began on September 3, 2008, and were completed on September 16, 2008. Sheets C-32 and C-33 show the estimated excavation limit for remedial excavation activities at Area D as presented in the 2009 EDR. Sheet C-34 shows the Area D cross sectional views of the proposed backfill and grade as specified in the 2008 EDR. The Area D excavation was located in the SuperValu parking lot adjacent to East D Street and East 15th Street to the southeast of the intersection.

Asphalt pavement was removed and transported to Woodworth and Company, Inc. in Tacoma, Washington, for recycling prior to excavation in Area D. One waste profile soil sample was collected from the excavation on September 4, 2008, and analyzed for RCRA 8 metals as part of the soil disposal characterization for the WDA. Chemical analytical data for this waste profile sample are presented in Table 1.

Glacier began excavating Area D on September 4, 2008. A total of 360 tons of material was excavated and transported to LRI by September 5, 2008. The soils within the Area D excavation consisted of a 3 to 4 feet of sand with gravel fill with brick and concrete debris underlain by native gray fine to medium sand, laminated with shell fragments and occasional organic debris. No wood waste was observed at Area D.

The oil pipeline was discovered at a depth of 3.5 feet bgs in the northeast corner of Area D. A clay tile pipe was also encountered passing beneath the oil pipeline and across the excavation, oriented approximately east to west. This pipe was damaged during excavation activities and appeared to be in line with a surface patch in the asphalt parking lot extending to the east-southeast of the excavation area. The current use of this pipe was unknown, but running water was initially heard within the pipe (indicating that it was most likely connected to the active storm sewer system to the west). The section of damaged pipe was replaced with 6-inch PVC pipe with Fernco-type couplers prior to backfilling the excavation.

A 6-inch-thick layer of oily material was also found east of the oil pipeline at a depth of 1 foot bgs. The soil/oil mixture appeared to be compacted to an asphalt-like consistency, which may represent a former paved surface prior to the installation of the SuperValu parking lot. Visual limits of this oily material were reached at the excavation limits, and the oily material was removed to an approximate depth of 3 feet bgs. West of the pipeline, a layer of burnt material was identified, and was also removed to an approximate depth of 3 feet. The southern limit of this burnt material was identified approximately 6 feet short of the southern excavation limit.

BRPH-contaminated material was observed to be localized beginning at approximately 4 feet bgs. BPRH-contaminated soil was confined to an area approximately 6 feet in diameter by 30 feet long immediately adjacent to and below the pipeline to a depth of approximately 8.5 feet bgs at the observed static groundwater table. The excavated limits and associated cross sections of Area D are shown in Sheets C-35 and C-36.

When the pipeline was cut at the northern limit of the excavation, it was observed that the pipeline did not contain CDF from approximately 2 feet south of the cut to an unknown distance to the north. The pipeline was removed within the excavation area. The pipe remaining in the northern sidewall was plugged with concrete prior to backfilling.

As discussed in Section 2.4.3, contamination at concentrations greater than Ecology-approved CULs was completely removed at Area D.

#### *2.4.2 Area D Dewatering Activities*

Dewatering was not required at Area D because BRPH-contaminated material did not extend below the groundwater table.

#### *2.4.3 Area D Confirmation Soil Sampling*

Seventeen confirmation soil samples were obtained from the excavation sidewalls and base. The approximate locations of confirmation soil samples are shown in Sheet C-35, and chemical analytical data are shown in Table 5. The confirmation samples were obtained and analyzed in accordance with the 2008 EDR SAP. All confirmation soil samples indicated that cPAHs and BRPHs either were not detected or were detected at concentrations less than the CULs.

#### *2.4.4 Area D Excavation Backfill*

Backfilling operations for Area D occurred on September 9 and 11, 2008. Import backfill materials for Area D were provided by Miles Sand and Gravel and Washington Rock. Miles Sand and Gravel supplied the bank run backfill and Washington Rock supplied the crushed base course/top course materials. The imported backfill met the physical and chemical requirements of the 2008 EDR Specifications. Chemical analytical data for the backfill materials are presented in Table 2.

The Area D excavation was backfilled after receipt of analytical data from base and sidewall confirmation samples on September 9, 2008. Imported backfill material was placed in approximately 1-foot-thick lifts and compacted with a vibratory drum roller up to subgrade elevation. The backfilled material was placed and compacted in general accordance with the 2008 EDR Specifications.

#### *2.4.5 Area D Final Site Grading and Site Restoration*

The Area D excavation was returned to match existing subgrade conditions and asphalt parking lot elevation. Between 6 and 12 inches of 1¼-inch minus crushed rock base course and 3 to 4 inches of ¾-inch minus crushed top course was placed and compacted in general accordance with the 2008 EDR Specifications. The edges of the surrounding asphalt was trimmed and cleaned on September 12, 2008. Paving was completed on September 15, 2008. Area D post-construction grade and cross section are included as Sheets C-37 and C-38. Other site restoration was completed as provided in the access agreement between BNSF and SuperValu.

## 3.0 POTENTIAL VAPOR INTRUSTION PATHWAYS

As described in WAC 173-340-745(5)(b)(iii)(C)(II), the soil to vapor pathway shall be evaluated if "diesel range organics are present, whenever the total petroleum hydrocarbon (TPH) concentration is greater than 10,000 mg/kg." BRPHs were detected in soil samples obtained adjacent to the Tacoma Fixtures building (at concentrations as high as 91,000 milligrams per kilogram [mg/kg]) and the SuperValu building (at a concentration of 570,000 mg/kg). However, the petroleum hydrocarbons present at the BNSF Oil Pipeline Site consist of heavy oil-range petroleum hydrocarbons, based on NWTPH-HCID and extractable petroleum hydrocarbon (EPH) analyses, and are generally considered not volatile.

For example, soil samples were obtained in 2004 from the soil borings for monitoring wells MW-13 and MW-14, which are located near the Tacoma Fixture and SuperValu buildings. These soil samples were analyzed for multiple contaminants, including heavy oil-range petroleum hydrocarbons, diesel-range petroleum hydrocarbons (quantified as BRPH), EPH, and benzene, toluene, ethylbenzene and xylenes (BTEX). The hydrocarbon identification (HCID) analysis identified the TPH as heavy oil-range petroleum hydrocarbons. Ecology's October 2009 Draft Vapor Intrusion Guidance (Publication No. 09-09-047) recommends evaluating vapor intrusion potential for carbon fractions ranging from C5 to C12 (see Appendix B, Table B-1 of the draft guidance), and the EPH analyses of the samples identified the TPH as containing heavier end carbon fractions (C12 to C34 in MW-13, and C21 to C34 in MW-14). Additionally, BTEX compounds were not detected in soil samples obtained from MW-13 or MW-14.

These results indicate that, although the TPH soil concentrations adjacent to the Tacoma Fixtures and SuperValu buildings are above 10,000 mg/kg, in our opinion, the nature of the TPH present at the Site makes site-related vapor intrusion an incomplete exposure pathway.

## 4.0 CONCLUSION

Remedial activities at the BNSF Oil Pipeline Site in Tacoma, Washington were performed between July 2008 and October 2008 (Areas A and D), between July 2009 and December 2009 (Areas B and C). The remedial activities at these four areas removed a total of approximately 48,900 tons of soil and approximately 2.7 million gallons of groundwater.

It is our opinion, based on observations and analytical data that the remedial action performed at Areas A, B, C and D during this time period was completed in general accordance with the design and the remedial action objectives presented in the CAP and EDRs. Modifications to the proposed remedial actions were discussed and agreed upon with Ecology during the excavation activities.

Soil contaminated with BRPH and cPAHs was removed to the maximum extent practicable at Areas A, B and C, and was completely removed at Area D. Some observed contaminated soil was left in place at Areas A, B and C because adjacent structures and utilities made it impracticable to remove this material. It is our opinion that the remaining contamination under structures and roadways likely will not pose a risk to human health and the environment.

As provided in the Institutional Controls Plan (2008 EDR), attached as Appendix K to this report are the Ecology-approved Environmental Covenants to be recorded, along with figures indicating the approximate location of residual contamination at concentrations greater than CULs at Areas A, B and C. As provided by the Consent Decree, BNSF, the City, and 1815 East D Street LLC must record these covenants on properties they own that are affected by the residual contamination within 30 days of Ecology's approval of the Final Remedial Action Report. Consistent with the Consent Decree and pursuant to its access agreement with John D. Nichols, BNSF will coordinate execution and record the covenant for the Nichols property. Residual contamination is not present on any other properties.

As part of monitoring the performance of this remedial action and assessing future risk from residual contamination at the site, GeoEngineers will be implementing compliance monitoring as described in Appendix F of the 2009 EDR, "Compliance Monitoring Plan, Remedial Excavation, BNSF Oil Pipeline Site, Tacoma, Washington."

Compliance monitoring will be conducted annually, using the "D" Street wells that comprise the CPOC, for five years, unless otherwise determined by Ecology. The compliance monitoring program is intended to monitor COCs and natural attenuation parameters in groundwater after the final remedial action for the Site. The first compliance monitoring event was completed during February 2010.

## 5.0 REFERENCES

GeoEngineers. 2007. "Final Remedial Investigation/Feasibility Study, BNSF Oil Pipeline Site," Tacoma, Washington.

GeoEngineers. 2008. "Revised Draft Final Cleanup Action Plan, The BNSF Oil Pipeline Site," Tacoma, Washington.

GeoEngineers. 2008a Engineering Design Report The BNSF Oil Pipeline Site Tacoma, Washington. July 9, 2008.

GeoEngineers. 2009. Revised Engineering Design Report The BNSF Oil Pipeline Site Tacoma, Washington March 27, 2009.

# TABLE 1

## SUMMARY OF WASTE CHARACTERIZATION RESULTS[1] FOR METALS AND PETROLEUM HYDROCARBONS - SOIL

THE BNSF OIL PIPELINE SITE

TACOMA, WASHINGTON

| Remedial Area | Sample ID | Sample Date | Approximate Sample Depth (feet bgs) | RCRA [2] Metals (mg/kg) | | | | | | | | VOCs [3] (µg/kg) | | | | pH |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Arsenic | Barium | Cadmium | Total Chromium | Lead | Mercury | Selenium | Silver | Methylene chloride [4] | Tetrachloro-ethene | 1,1,1-Trichloro-ethane | Trichloro-ethene | |
| Area A | TP1-072108-5 | 07/21/2008 | 5 | 7.19 | 269 | U(0.674) | 14.6 | 84.3 | U(0.130) | U(1.35) | U(0.674) | -- | -- | -- | -- | -- |
| Area A | TP2-072108-12 | 07/21/2008 | 12 | 1.67 | 18.9 | U(0.660) | 10.2 | 5.40 | U(0.120) | U(1.32) | U(0.660) | -- | -- | -- | -- | -- |
| Area A | TP2-072108-5 | 07/21/2008 | 5 | 2.00 | 22.5 | U(0.593) | 17.4 | 6.85 | U(0.113) | U(1.19) | U(0.593) | -- | -- | -- | -- | -- |
| Area A | TP3-072108-5 | 07/21/2008 | 5 | 3.94 | 21.7 | U(0.563) | 13.3 | 17.5 | U(0.103) | U(1.13) | U(0.563) | -- | -- | -- | -- | -- |
| Area A | TP4-072108-5 | 07/21/2008 | 5 | 17.1 | 80.6 | 0.957 | 21.4 | 80.4 | U(0.101) | U(1.14) | U(0.570) | -- | -- | -- | -- | -- |
| Area A | TP4-072108-9 | 07/21/2008 | 9 | 2.72 | 28.7 | U(0.436) | 16.8 | 5.17 | U(0.114) | U(0.872) | U(0.436) | -- | -- | -- | -- | -- |
| Area A | TP5-072108-5 | 07/21/2008 | 5 | 9.16 | 50.2 | U(0.557) | 16.7 | 41.8 | U(0.106) | U(1.11) | U(0.557) | -- | -- | -- | -- | -- |
| Area A | TP5-072108-9 | 07/21/2008 | 9 | 13.8 | 56.6 | 0.616 | 15.6 | 54.5 | U(0.128) | U(0.855) | U(0.428) | -- | -- | -- | -- | -- |
| Area A | TP6-072108-5 | 07/21/2008 | 5 | 7.40 | 65.4 | U(0.635) | 19.9 | 79.3 | U()0.119) | U(1.27) | U(0.635) | -- | -- | -- | -- | -- |
| Area A | TP6-072108-9 | 07/21/2008 | 9 | 11.7 | 48.6 | **2.54** | 18.8 | 53.2 | 0.239 | U(0.962) | 0.544 | -- | -- | -- | -- | -- |
| Area A | TP7-072108-5 | 07/21/2008 | 5 | 12.1 | 49.5 | U(0.546) | 19.5 | 26.2 | U(0.110) | U(1.09) | U(0.546) | -- | -- | -- | -- | -- |
| Area A | TP7-072108-9 | 07/21/2008 | 9 | **24.1** | 95.6 | **2.05** | 31.6 | 80.4 | 0.529 | U(2.00) | U(0.998) | -- | -- | -- | -- | -- |
| Area A | RE-A-WP1-4 | 07/30/2008 | 4 | 3.01 | 25.8 | U(0.681) | 3.03 | 53.7 | U(0.148) | 3.16 | U(0.681) | **10.7** | U(4.42) | U(4.42) | U(4.42) | 12.4 |
| Area A | DUP1-072108 | 07/21/2008 | 9 | **32.5** | 49.0 | 0.712 | 19.4 | 55.0 | U(0.115) | U(0.774) | U(0.387) | -- | -- | -- | -- | -- |
| Area A | DUP2-072108 | 07/21/2008 | 9 | 13.7 | 60.4 | **2.28** | 21.5 | 59.3 | 0.269 | U(1.17) | U(0.584) | -- | -- | -- | -- | -- |
| Area B | RE-B-WP-1-3 | 08/14/2009 | 3 | 2.7 | 17 | 0.36 | 13 | 18 | 0.18 | U(0.65) | 0.45 | -- | -- | -- | -- | -- |
| Area B | RE-B-WP-2-10 | 08/14/2009 | 10 | 2.2 | 24 | U(0.27) | 15 | 4.2 | U(0.024) | U(0.67) | U(0.27) | -- | -- | -- | -- | -- |
| Area B | RE-B-WP-3-3 | 08/14/2009 | 3 | 2.3 | 10 | 1.0 | 12 | 5.4 | 0.074 | U(0.58) | U(0.23) | -- | -- | -- | -- | -- |
| Area B | RE-B-WP-4-10 | 08/14/2009 | 10 | 10 | 66 | 1.3 | 22 | 84 | 0.43 | U(1.2) | 0.90 | -- | -- | -- | -- | -- |
| Area B | WP-Dupe1 | 08/14/2009 | -- | 2.7 | 13 | 0.93 | 13 | 8.5 | 0.064 | U(0.66) | U(0.26) | -- | -- | -- | -- | -- |
| Area C | RE-C-WP-1-3' | 07/31/2009 | 3 | 3.3 | 8.2 | U(0.20) | 12 | 2.5 | U(0.021) | U(0.50) | U(0.20) | -- | -- | -- | -- | -- |
| Area C | RE-C-WP-2-3' | 07/31/2009 | 3 | 3.1 | 8.7 | U(0.19) | 15 | 2.4 | U(0.020) | U(0.48) | U(0.19) | -- | -- | -- | -- | -- |
| Area C | RE-C-WP-3-3' | 07/31/2009 | 3 | 5.1 | 48 | U(0.21) | 18 | 35 | 0.046 | U(0.54) | U(0.21) | -- | -- | -- | -- | -- |
| Area C | RE-C-WP-3-14' | 07/31/2009 | 14 | 5.0 | 170 | U(0.29) | 18 | 53 | 0.19 | U(0.73) | U(0.29) | -- | -- | -- | -- | -- |
| Area C | RE-C-WP-4-3' | 07/31/2009 | 3 | 1.3 | 44 | U(0.21) | 20 | 1.9 | U(0.019) | U(0.52) | U(0.21) | -- | -- | -- | -- | -- |
| Area C | RE-C-WP-4-16' | 07/31/2009 | 16 | 1.8 | 15 | U(0.25) | 16 | 2.4 | U(0.024) | U(0.63) | U(0.25) | -- | -- | -- | -- | -- |
| Area C | RE-C-WP-5-3' | 07/31/2009 | 3 | 1.7 | 46 | U(0.20) | 22 | 3.0 | U(0.019) | U(0.50) | U(0.20) | -- | -- | -- | -- | -- |
| Area C | RE-C-WP-5-10' | 07/31/2009 | 10 | 4.5 | 34 | U(0.73) | 19 | 26 | 0.51 | U(1.8) | U(0.73) | -- | -- | -- | -- | -- |
| Area C | RE-C-WP-6-3' | 07/31/2009 | 3 | 6.4 | 720 | U(0.59) | 20 | 40 | U(0.057) | U(1.5) | U(0.59) | -- | -- | -- | -- | -- |
| Area C | RE-C-WP-6-9' | 07/31/2009 | 9 | 2.3 | 25 | U(0.28) | 18 | 6.8 | 0.095 | U(0.70) | U(0.28) | -- | -- | -- | -- | -- |
| Area C | RE-C-WP-7-3' | 07/31/2009 | 3 | 1.9 | 260 | U(0.64) | 10 | 15 | U(0.064) | U(1.6) | U(0.64) | -- | -- | -- | -- | -- |
| Area C | RE-C-WP-8-3' | 07/31/2009 | 3 | 0.91 | 10 | U(0.25) | 12 | 4.2 | U(0.024) | U(0.61) | U(0.25) | -- | -- | -- | -- | -- |
| Area C | RE-C-WP-9-3' | 07/31/2009 | 3 | 3.4 | 30 | 0.45 | 22 | 39 | 0.32 | U(0.87) | 0.94 | -- | -- | -- | -- | -- |
| Area C | RE-C-WP-9-11' | 07/31/2009 | 11 | 0.87 | 8.9 | U(0.27) | 11 | 1.7 | U(0.025) | U(0.67) | U(0.27) | -- | -- | -- | -- | -- |
| Area C | RE-C-WP-10-3' | 07/31/2009 | 3 | 2.4 | 29 | U(0.38) | 23 | 32 | 0.27 | U(0.94) | 0.81 | -- | -- | -- | -- | -- |
| Area C | RE-C-WP-11-3' | 07/31/2009 | 3 | 3.5 | 34 | 0.62 | 25 | 52 | 0.11 | U(0.72) | 1.3 | -- | -- | -- | -- | -- |
| Area C | RE-C-WP-12-3' | 07/31/2009 | 3 | 0.91 | 7.6 | U(0.20) | 11 | 5.8 | U(0.018) | U(0.51) | U(0.20) | -- | -- | -- | -- | -- |
| Area C | RE-C-WP-12-11' | 07/31/2009 | 11 | 0.86 | 9.6 | U(0.26) | 15 | 2.1 | U(0.025) | U(0.65) | U(0.26) | -- | -- | -- | -- | -- |
| Area C | RE-C-WP-13-3' | 07/31/2009 | 3 | 5.1 | 54 | 1.1 | 32 | 75 | 0.95 | U(0.78) | 1.9 | -- | -- | -- | -- | -- |
| Area C | RE-C-WP-14-3' | 07/31/2009 | 3 | 4.5 | 38 | 0.97 | 26 | 65 | 0.73 | U(0.75) | 1.7 | -- | -- | -- | -- | -- |
| Area D | AREA D WASTE PROFILE | 09/04/2008 | -- | 1.27 | 14.5 | U(0.570) | 9.04 | 1.72 | U(0.0974) | U(1.14) | U(0.570) | -- | -- | -- | -- | -- |
| MTCA Method A Soil Cleanup Levels for Unrestricted Land Use (ULU) | | | | 20 | 5,600 [5] | 2.0 | 2,000 | 250 | 2.0 | 400 [5] | 400 [5] | 0.02 | 0.05 | 2.0 | 0.03 | NE |

Notes:

[1] Chemical analysis performed by Test America of Seattle, Washington.

[2] Resource Conservation Recovery Act (RCRA) metals analyzed by EPA 6000/7000 Series Method.

[3] Volatile organic compounds (VOCs) were analyzed by EPA Method (Special List) 8260B. Other VOCs were analyzed but not detected.

[4] Methylene chloride is a common laboratory contaminant.

[5] MTCA Method B cleanup level represented because Method A value has not been established.

MTCA = Model Toxics Control Act

-- = Not Analyzed/Not Applicable

mg/kg = milligram per kilogram

µg/kg = microgram per kilogram

bgs = below ground surface

U = Analyte was not detected at or greater than the listed reporting limit

**Bold** = Detected concentration is greater than the MTCA cleanup level

NE = Cleanup level not established for this compound

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# TABLE 2

## SUMMARY OF IMPORT MATERIAL CHARACTERIZATION RESULTS - SOIL[1]

THE BNSF OIL PIPELINE SITE

TACOMA, WASHINGTON

| Sample Identification | Miles S&G Bank Run-01 [2] | Wash Rock Quarry-02 [2] | 3" Ballast | Import 2 | Canyon Pit-01-073109 | Canyon Pit-02-073109 | Canyon Pit-01-080509 | Canyon Pit-02-080509 | King Creek Pit TOC 2 | Canyon Pit-100109 | Canyon Pit-100509 | Canyon Pit-101409 | MTCA Method A ULU Cleanup Level |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NWTPH-HCID[3] (mg/kg) | | | | | | | | | | | | | |
| Gasoline Range | U(20) | U(20) | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | NE |
| Diesel Range | U(50) | U(50) | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | NE |
| Lube Oil Range | U(100) | U(100) | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | NE |
| NWTPH-Dx[4] (mg/kg) | | | | | | | | | | | | | |
| Diesel Range | U(25) | U(25) | -- | U(10.6) | 97 | 89 | U(26) | U(26) | U(29) | U(25) | U(26) | U(27) | 2,000 |
| Lube-Oil Range | U(50) | U(50) | -- | U(26.5) | U(49) | U(52) | U(51) | U(56) | U(58) | U(51) | U(53) | U(54) | 2,000 |
| NWTPH-G[5] (mg/kg) | | | | | | | | | | | | | |
| Gasoline Range | -- | -- | -- | U(4.08) | U(4.1) | U(4.1) | -- | -- | U(5.6) | U(3.9) | U(4.2) | U(3.9) | 100 |
| RCRA Metals[6] (mg/kg) | | | | | | | | | | | | | |
| Arsenic | U(5.0) | 32 | 17 | 3.69 | 2.3 | 3.6 | -- | -- | 2.7 | 4 | 2.9 | 4.1 | 20 |
| Antimony | -- | -- | -- | -- | -- | -- | -- | -- | 0.23 | U(0.21) | U(0.21) | U(0.31) | 32 [11] |
| Beryllium | -- | -- | -- | -- | -- | -- | -- | -- | U(0.23) | 0.28 | 0.28 | U(0.27) | 160 [11] |
| Cadmium | U(1.0) | U(1.0) | -- | U(0.509) | U(0.20) | U(0.20) | -- | -- | U(0.23) | U(0.21) | U(0.21) | U(0.22) | 2.0 |
| Total Chromium | 28 | 12 | -- | 20.7 | 18 | 32 | -- | -- | 18 | 27 | 20 | 22 | 2,000 [12] |
| Hexavalent Chromium | -- | -- | -- | -- | -- | U(0.28) | -- | -- | -- | -- | -- | -- | 19 |
| Copper | -- | -- | -- | -- | -- | -- | -- | -- | 24 | 18 | 18 | 19 | 3,000 [11] |
| Lead | 6 | 13 | -- | 2.40 | 3.0 | 5.5 | -- | -- | 7.5 | 3.2 | 4.1 | 5.8 | 250 |
| Mercury | 0.03 | U(0.02) | -- | U(0.105) | 0.022 | 0.026 | -- | -- | 0.032 | 0.022 | 0.027 | U(0.019) | 2.0 |
| Nickel | -- | -- | -- | -- | -- | -- | -- | -- | 23 | 28 | 26 | 28 | 1,600 [11] |
| Selenium | -- | -- | -- | -- | -- | -- | -- | -- | U(0.57) | U(0.52) | U(0.53) | U(0.54) | 400 [11] |
| Silver | -- | -- | -- | -- | -- | -- | -- | -- | U(0.23) | U(0.21) | U(0.21) | U(0.22) | 400 [11] |
| Thallium | -- | -- | -- | -- | -- | -- | -- | -- | U(0.46) | U(0.41) | U(0.43) | U(0.43) | 5.6 [11] |
| Zinc | -- | -- | -- | -- | -- | -- | -- | -- | 51 | 30 | 28 | 32 | 24,000 [11] |
| VOCs[7] (µg/kg) | | | | | | | | | | | | | |
| Benzene | U(10) | U(10) | -- | U(1.34) | U(16) | U(16) | -- | -- | U(1.2) | U(0.95) | U(1.1) | U(0.90) | 30 |
| Toluene | U(10) | U(10) | -- | U(1.34) | U(41) | U(41) | -- | -- | U(1.2) | U(0.95) | U(1.1) | U(0.90) | 7,000 |
| Ethylbenzene | U(10) | U(10) | -- | U(3.56) | U(41) | U(41) | -- | -- | 1.4 | U(0.95) | U(1.1) | U(0.90) | 6,000 |
| Total Xylenes | U(20) | U(20) | -- | U(8.90) | U(41) | U(41) | -- | -- | U(2.5) | U(1.9) | U(2.1) | U(1.8) | 9,000 |
| Ethylene Dibromide | U(5) | U(5) | -- | U(4.45) | U(41) | U(41) | -- | -- | U(1.2) | U(0.95) | U(1.1) | U(0.90) | 5 |
| Tetrachroloethene | U(10) | U(10) | -- | U(1.78) | U(21) | U(20) | -- | -- | U(1.2) | U(0.95) | U(1.1) | U(0.90) | 50 |
| Trichloroethene | U(10) | U(10) | -- | U(2.23) | U(16) | U(16) | -- | -- | U(1.2) | U(0.95) | U(1.1) | U(0.90) | 30 |
| Methylene chloride | U(10) | U(10) | -- | U(3.12) | U(41) | U(41) | -- | -- | U(1.2) | U(0.95) | U(1.1) | U(0.90) | 20 |
| 4-Isopropyltoluene | U(10) | U(10) | -- | U(4.45) | U(41) | U(41) | -- | -- | 3.2 | U(0.95) | U(1.1) | U(0.90) | NE |
| n-Butylbenzene | U(10) | U(10) | -- | U(4.45) | U(41) | U(41) | -- | -- | 1.4 | U(0.95) | U(1.1) | U(0.90) | NE |
| Hexachlorobutadiene | U(10) | U(10) | -- | U(8.90) | U(41) | U(41) | -- | -- | 1.6 | U(0.95) | U(1.1) | U(0.90) | 13,000 [11] |
| SVOCs[8] (µg/kg) | | | | | | | | | | | | | |
| 1-Methylnaphthalene | U(100) | U(100) | -- | U(348) | U(30) | U(31) | -- | -- | U(35) | U(31) | U(31) | U(31) | 5,000 [13] |
| 2-Methylnaphthalene | U(100) | U(100) | -- | U(348) | U(20) | U(21) | -- | -- | U(23) | U(21) | U(21) | U(21) | 5,000 [13] |
| Naphthalene | U(100) | U(100) | -- | U(348) | U(20) | U(21) | -- | -- | 8.1 | U(21) | U(21) | U(21) | 5,000 [13] |
| Phenanthrene | U(100) | U(100) | -- | U(348) | U(20) | U(21) | -- | -- | 31 | U(21) | U(21) | U(21) | NE |
| Fluoranthene | U(100) | U(100) | -- | U(348) | U(20) | U(21) | -- | -- | 30 | U(21) | U(21) | U(21) | 3,200,000 |
| Pyrene | U(100) | U(100) | -- | U(348) | U(20) | U(21) | -- | -- | U(23) | U(21) | U(21) | U(21) | 2,400,000 |
| 3 & 4 Methylphenol | U(100) | U(100) | -- | U(348) | U(200) | U(210) | -- | -- | 420 | U(210) | U(210) | U(210) | 400,000 [11] |

| Sample Identification | Miles S&G Bank Run-01 [2] | Wash Rock Quarry-02 [2] | 3" Ballast | Import 2 | Canyon Pit-01-073109 | Canyon Pit-02-073109 | Canyon Pit-01-080509 | Canyon Pit-02-080509 | King Creek Pit TOC 2 | Canyon Pit-100109 | Canyon Pit-100509 | Canyon Pit-101409 | MTCA Method A ULU Cleanup Level |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| cPAHs[8] (µg/kg) | | | | | | | | | | | | | |
| Benzo (a) anthracene (TEF 0.1) | U(100) | U(100) | -- | U(348) | U(25) | U(26) | -- | -- | U(29) | U(26) | U(26) | U(26) | MTCA ULU cleanup level for the sum of all cPAH TTECs is 100 µg/kg |
| Benzo (a) pyrene (TEF 1) | U(100) | U(100) | -- | U(348) | U(30) | U(31) | -- | -- | U(35) | U(31) | U(31) | U(31) | |
| Benzo (b) fluoranthene (TEF 0.1) | U(100) | U(100) | -- | U(348) | U(20) | U(21) | -- | -- | U(23) | U(21) | U(21) | U(21) | |
| Benzo (k) fluoranthene (TEF 0.1) | U(100) | U(100) | -- | U(348) | U(25) | U(26) | -- | -- | U(29) | U(26) | U(26) | U(26) | |
| Chrysene (TEF 0.01) | U(100) | U(100) | -- | U(348) | U(25) | U(26) | -- | -- | U(29) | U(26) | U(26) | U(26) | |
| Dibenz (a,h) anthracene (TEF 0.1) | U(100) | U(100) | -- | U(348) | U(40) | U(41) | -- | -- | U(47) | U(42) | U(42) | U(41) | |
| Indeno (1,2,3-cd) pyrene (TEF 0.1) | U(100) | U(100) | -- | U(348) | U(40) | U(41) | -- | -- | U(47) | U(42) | U(42) | U(41) | |
| Total TEF of cPAHs (detect only) | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 100 |
| Organochlorine Pesticides[9] (µg/kg) | | | | | | | | | | | | | |
| gamma -BHC | U(10) | U(10) | -- | U(1.05) | U(1.0) | U(0.99) | -- | -- | U(1.1) | U(1.0) | U(1.0) | U(1.1) | 10 |
| Dieldrin | U(10) | U(10) | -- | U(2.10) | U(2.1) | U(2.0) | -- | -- | U(2.2) | U(2.0) | U(2.0) | U(2.1) | 63 [11] |
| 4, 4' - DDE | U(10) | U(10) | -- | U(2.10) | U(2.1) | U(2.0) | -- | -- | U(2.2) | U(2.0) | U(2.0) | U(2.1) | 2,900[11] |
| 4, 4' - DDT | U(10) | U(10) | -- | U(2.10) | U(2.1) | U(2.0) | -- | -- | U(2.2) | U(2.0) | U(2.0) | U(2.1) | 3,000 |
| PCBs[10] (mg/kg) | | | | | | | | | | | | | |
| Aroclor 1016 | U(0.1) | U(0.1) | -- | U(0.0263) | U(0.010) | U(0.010) | -- | -- | U(0.011) | U(0.010) | U(0.010) | U(0.011) | MTCA ULU cleanup level for the sum of all PCBs is 1 mg/kg |
| Aroclor 1242 | U(0.1) | U(0.1) | -- | U(0.0526) | U(0.010) | U(0.010) | -- | -- | U(0.011) | U(0.010) | U(0.010) | U(0.011) | |
| Aroclor 1248 | U(0.1) | U(0.1) | -- | U(0.0263) | U(0.010) | U(0.010) | -- | -- | U(0.011) | U(0.010) | U(0.010) | U(0.011) | |
| Aroclor 1254 | U(0.1) | U(0.1) | -- | U(0.0263) | U(0.010) | U(0.010) | -- | -- | U(0.011) | U(0.010) | U(0.010) | U(0.011) | |
| Aroclor 1260 | U(0.1) | U(0.1) | -- | U(0.0263) | U(0.010) | U(0.010) | -- | -- | U(0.011) | U(0.010) | U(0.010) | U(0.011) | |
| Aroclor 1221 | U(0.1) | U(0.1) | -- | U(0.0263) | U(0.010) | U(0.010) | -- | -- | U(0.011) | U(0.010) | U(0.010) | U(0.011) | |
| Aroclor 1232 | U(0.1) | U(0.1) | -- | U(0.0263) | U(0.010) | U(0.010) | -- | -- | U(0.011) | U(0.010) | U(0.010) | U(0.011) | |

**Notes:**

[1] Chemical analysis performed by Test America of Seattle, Washington.

[2] Chemical analysis performed by CCI Analytical Laboratories of Everett, Washington.

[3] Hydrocarbon Identification by Washington State Department of Ecology NWTPH-HCID.

[4] Diesel Range Petroleum Hydrocarbons by Washington Department of Ecology Method NWTPH-Dx with acid/silica gel cleanup.

[5] Gasoline Range Petroleum Hydrocarbons by Washington State Department of Ecology Method NWTPH-G.

[6] Total metals analyzed by EPA 6000/7000 Series Method.

[7] Volatile organic compounds (VOCs) were analyzed by EPA Method 5035/8260B. Other VOCs were analyzed but not detected.

[8] Semivolatile organic compounds (SVOCs) were analyzed by EPA Method 8270C. Other SVOCs were analyzed but not detected.

[9] Pesticides were analyzed by EPA Method 8010B. Other pesticides were analyzed but not detected.

[10] PCBs were analyzed by EPA Method 8020.

[11] Method B ULU cleanup level represented because MTCA Method A cleanup level has not been established.

[12] MCTA Method A Cleanup Level for Trivalent Chromium.

[13] MTCA Method A ULU CUL for the sum of all Naphthalenes is 5,000 µg/kg.

MTCA = Model Toxics Control Act

ULU = Unrestricted Land Use

-- = Not Analyzed/Not Applicable

mg/kg = milligram per kilogram

µg/kg = microgram per kilogram

U = Analyte was not detected at or greater than the listed reporting limit

TEF = Toxicity Equivalency Factor as defined in WAC 173-340-900 Table 708-2

Total Toxic Equivalent Concentration (TTEC) is the sum of each individual cPAH concentration multiplied by its corresponding TEF

**Bold** = Detected concentration is greater than the MTCA Method A ULU cleanup level

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# TABLE 3

## SUMMARY OF CONFIRMATION SAMPLE RESULTS[1] FOR PETROLEUM HYDROCARBONS - SOIL

AREA A

THE BNSF OIL PIPELINE SITE

TACOMA, WASHINGTON

| Sample | Date | Sample Depth (feet bgs) | NWTPH-Dx [2] (mg/kg) | CPAHs [4] (mg/kg) | | | | | | | Total TTEC of cPAHs (detect only) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | BRPH[3] | Benzo (a) anthracene (TEF 0.1) | Benzo (a) pyrene (TEF 1) | Benzo (b) fluoranthene (TEF 0.1) | Benzo (k) fluoranthene (TEF 0.1) | Chrysene (TEF 0.01) | Dibenz (a,h) anthracene (TEF 0.1) | Indeno (1,2,3-cd) pyrene (TEF 0.1) | |
| RE-A-1-7.5S | 7/24/2008 | 7.5 | 616 | 0.190 | 0.271 | 0.142 | 0.202 | U (0.141) | 0.190 | 0.207 | 0.364 |
| RE-A-2-3S | 7/24/2008 | 3.0 | 389 | 0.240 | 0.296 | 0.151 | 0.228 | 0.213 | 0.171 | 0.216 | 0.399 |
| RE-A-3-4S | 7/24/2008 | 4.0 | 246 | 0.244 | 0.310 | 0.169 | 0.245 | 0.158 | 0.218 | 0.245 | 0.424 |
| RE-A-4-7.5S | 7/24/2008 | 7.5 | 491 | 0.320 | 0.410 | 0.248 | 0.324 | 0.270 | 0.246 | 0.298 | 0.556 |
| RE-A-5-16B | 8/9/2008 | 16.0 | U(32.1) | U(0.0129) | U(0.0129) | U(0.0129) | U(0.0129) | U(0.0129) | U(0.0129) | U(0.0129) | -- |
| RE-A-6-14B | 8/11/2008 | 14.0 | U(33.8) | U(0.0136) | U(0.0136) | U(0.0136) | U(0.0136) | U(0.0136) | U(0.0136) | U(0.0136) | -- |
| RE-A-7-15B | 8/11/2008 | 15.0 | U(33.9) | U(0.0136) | U(0.0136) | U(0.0136) | U(0.0136) | U(0.0136) | U(0.0136) | U(0.0136) | -- |
| RE-A-8-4S | 8/12/2008 | 4.0 | 169 | 0.161 | 0.171 | 0.146 | U(0.138) | 0.188 | U(0.138) | U(0.138) | 0.204 |
| RE-A-9-8S | 8/12/2008 | 8.0 | U(33.4) | U(0.0135) | U(0.0135) | U(0.0135) | U(0.0135) | U(0.0135) | U(0.0135) | U(0.0135) | -- |
| RE-A-10-13B | 8/12/2008 | 13.0 | U(34.6) | U(0.0140) | U(0.0140) | U(0.0140) | U(0.0140) | U(0.0140) | U(0.0140) | U(0.0140) | -- |
| RE-A-11-15B | 8/12/2008 | 15.0 | U(33.1) | U(0.0133) | U(0.0133) | U(0.0133) | U(0.0133) | U(0.0133) | U(0.0133) | U(0.0133) | -- |
| RE-A-12-15B | 8/13/2008 | 15.0 | U(33.5) | U(0.0131) | 0.0170 | 0.0169 | U(0.0131) | U(0.0131) | U(0.0131) | U(0.0131) | 0.0187 |
| RE-A-13-3S | 8/13/2008 | 3.0 | 1,070 | 0.0883 | 0.129 | 0.107 | 0.0617 | 0.103 | U(0.0498) | U(0.0498) | 0.1557 |
| RE-A-14-9B | 8/13/2008 | 9.0 | U(35.6) | U(0.0140) | U(0.0140) | U(0.0140) | U(0.0140) | U(0.0140) | U(0.0140) | U(0.0140) | -- |
| RE-A-15-3S | 8/13/2008 | 3.0 | 137 | 0.0136 | 0.0196 | 0.0157 | U(0.0113) | U(0.0113) | U(0.0113) | U(0.0113) | 0.0225 |
| RE-A-16-11B | 8/14/2008 | 11.0 | U(32.1) | U(0.0128) | U(0.0128) | U(0.0128) | U(0.0128) | U(0.0128) | U(0.0128) | U(0.0128) | -- |
| RE-A-17-11B | 8/14/2008 | 11.0 | U(33.8) | U(0.0135) | U(0.0135) | U(0.0135) | U(0.0135) | U(0.0135) | U(0.0135) | U(0.0135) | -- |
| RE-A-18-14B | 8/14/2008 | 14.0 | U(31.7) | U(0.0128) | U(0.0128) | U(0.0128) | U(0.0128) | U(0.0128) | U(0.0128) | U(0.0128) | -- |
| RE-A-19-3S | 8/19/2008 | 3.0 | 169 | 0.315 | 0.477 | 0.431 | 0.339 | 0.439 | 0.117 | 0.348 | 0.6364 |
| RE-A-20-9S | 8/19/2008 | 9.0 | U(29.1) | U(0.0115) | U(0.0115) | 0.0119 | U(0.0115) | U(0.0115) | U(0.0115) | U(0.0115) | 0.0012 |
| RE-A-21-10S | 8/19/2008 | 10.0 | 45.9 | 0.133 | 0.191 | 0.140 | 0.126 | 0.176 | 0.0309 | 0.119 | 0.2477 |
| RE-A-22-3S | 8/19/2008 | 3.0 | U(26.6) | U(0.0107) | U(0.0107) | U(0.0107) | U(0.0107) | U(0.0107) | U(0.0107) | U(0.0107) | -- |
| RE-A-23-3S | 8/20/2008 | 3.0 | U(27.0) | U(0.0110) | U(0.0110) | U(0.0110) | U(0.0110) | U(0.0110) | U(0.0110) | U(0.0110) | -- |
| RE-A-24-10S | 8/20/2008 | 10.0 | U(30.6) | U(0.0120) | U(0.0120) | U(0.0120) | U(0.0120) | U(0.0120) | U(0.0120) | U(0.0120) | -- |
| RE-A-25-10S | 8/20/2008 | 10.0 | U(27.2) | 0.0359 | 0.0410 | 0.0392 | 0.0299 | 0.0378 | U(0.0109) | 0.0210 | 0.0540 |
| RE-A-26-10S | 8/20/2008 | 10.0 | U(27.4) | 0.0394 | 0.0447 | 0.0416 | 0.0330 | 0.0413 | U(0.0111) | 0.0237 | 0.0589 |
| RE-A-27-8S | 8/22/2008 | 8.0 | U(28.6) | U(0.0114) | U(0.0114) | U(0.0114) | U(0.0114) | U(0.0114) | U(0.0114) | U(0.0114) | -- |
| RE-A-28-8S | 8/22/2008 | 8.0 | 11,000 | 2.68 | 3.04 | 1.78 | 1.38 | 4.54 | U(0.654) | 0.837 | 3.753 |
| RE-A-29-8S | 8/22/2008 | 8.0 | 11,500 | 0.522 | 0.732 | 0.492 | U(0.271) | 1.040 | U(0.271) | U(0.271) | 0.844 |
| RE-A-30-8S | 8/22/2008 | 8.0 | 116 | 0.203 | 0.242 | 0.137 | 0.146 | 0.216 | U(0.0427) | 0.0903 | 0.302 |
| RE-A-31-8S | 8/22/2008 | 8.0 | 129 | 0.299 | 0.378 | 0.195 | 0.234 | 0.352 | 0.057 | 0.136 | 0.474 |
| RE-A-32-8S | 8/22/2008 | 8.0 | U(39.0) | 0.165 | 0.181 | 0.109 | 0.118 | 0.190 | U(0.0306) | 0.0661 | 0.229 |
| 4IN-PIPE-SOIL-5 | 9/3/2008 | 5.0 | 152 | -- | -- | -- | -- | -- | -- | -- | -- |
| RE-A-33-14B | 9/18/2008 | 14.0 | U(31.4) | U(0.0125) | U(0.0125) | U(0.0125) | U(0.0125) | U(0.0125) | U(0.0125) | U(0.0125) | -- |
| RE-A-34-7S | 9/18/2008 | 7.0 | 325 | 0.245 | 0.285 | 0.174 | 0.225 | 0.350 | 0.105 | 0.148 | 0.378 |
| RE-A-35-7.5S | 9/18/2008 | 7.5 | U(71.5) | 0.312 | 0.285 | 0.244 | 0.297 | 0.381 | U(0.143) | 0.187 | 0.393 |
| RE-A-36-7.5S | 9/18/2008 | 7.5 | 31.2 | 0.0437 | 0.0574 | 0.0414 | 0.0528 | 0.0637 | 0.0173 | 0.0332 | 0.0769 |
| RE-A-37-7.5S | 9/18/2008 | 7.5 | U(35.9) | 0.0510 | 0.0650 | 0.0536 | 0.0559 | 0.0691 | 0.0168 | 0.0350 | 0.0869 |
| MTCA Method A ULU Cleanup Level | | | 2,000 | MTCA Method A ULU cleanup level for the sum of all cPAHs is 0.1 mg/kg | | | | | | | 0.1 |

Notes:

[1] Chemical analysis performed by Test America of Seattle, Washington.

[2] Washington Department of Ecology Method NWTPH-Dx with acid/silica gel cleanup.

[3] BRPH = Bunker Range Petroleum Hydrocarbons equivalent to Bunker-C fuel oil.

[4] Carcinogenic polycyclic aromatic hydrocarbons (cPAHs) were analyzed by Method 8270-SIM.

MTCA = Model Toxics Control Act

TEF = Toxicity Equivalency Factor as defined in WAC 173-340-900 Table 708-2

Total Toxic Equivalent Concentration (TTEC) is the sum of each individual cPAH concentration multiplied by its corresponding TEF

ULU = Unrestricted Land Use

-- = Not Analyzed/Not Applicable

mg/kg = milligram per kilogram

bgs = below ground surface

U = Analyte was not detected at or greater than the listed reporting limit

**Bold** = Detected concentration is greater than the MTCA cleanup level

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# TABLE 4

## SUMMARY OF WATER TREATMENT SYSTEM SAMPLE RESULTS[1] FOR DISSOLVED METALS - WATER

AREA A
THE BNSF OIL PIPELINE SITE
TACOMA, WASHINGTON

| Sample ID | Sample Date | Total Metals [2] (mg/L) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Arsenic | Total Chromium | Copper | Lead | Mercury | Nickel | Selenium | Zinc |
| INF-080508-W | 8/5/2008 | U(0.100) | U(0.0100) | U(0.0100) | U(0.0500) | U(0.000200) | 0.0226 | U(0.150) | U(0.0200) |
| First tank-080508-W | 8/5/2008 | U(0.100) | U(0.0100) | 0.0569 | U(0.0500) | U(0.000200) | 0.0199 | U(0.150) | 0.0633 |
| Second tank-080508-W | 8/5/2008 | U(0.100) | U(0.0100) | U(0.0100) | U(0.0500) | U(0.000200) | 0.0290 | U(0.150) | U(0.0200) |
| Post OWS-080508-W | 8/5/2008 | U(0.100) | U(0.0100) | 0.209 | U(0.0500) | U(0.000200) | 0.0572 | U(0.150) | 0.163 |
| Pre25-080508-W | 8/5/2008 | U(0.100) | U(0.0100) | U(0.0100) | U(0.0500) | U(0.000200) | 0.0250 | U(0.150) | 0.0348 |
| Pre5-080508-W | 8/5/2008 | U(0.100) | U(0.0100) | U(0.0100) | U(0.0500) | U(0.000200) | 0.0383 | U(0.150) | 0.135 |
| Pre GAC-080508-W | 8/5/2008 | U(0.100) | U(0.0100) | 0.0712 | U(0.0500) | U(0.000200) | 0.0264 | U(0.150) | 0.122 |
| Mid GAC-080508-W | 8/5/2008 | U(0.100) | U(0.0100) | 0.0935 | U(0.0500) | U(0.000200) | 0.0532 | U(0.150) | 0.130 |
| Eff-080508-W | 8/5/2008 | U(0.100) | U(0.0100) | U(0.0100) | U(0.0500) | U(0.000200) | 0.0873 | U(0.150) | 0.0517 |
| Pollutant Limits for Discharge to the Sanitary Sewer – Chapter 12.08.040 TMC | | 0.1 | 1.0 | 1.0 | 0.4 | 0.05 | 0.1 | 0.08 [3] | 2.0 |

**Notes:**

[1] Chemical analysis performed by Test America of Seattle, Washington.

[2] Total metals analyzed by EPA 6000/7000 Series Method.

[3] MTCA Method B Cleanup Level represented since Chapter 12.08.040 TMC value not established.

MTCA = Model Toxics Control Act

mg/L = milligram per liter

U = Analyte was not detected at or greater than the listed reporting limit

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# TABLE 5

## SUMMARY OF CONFIRMATION SAMPLE RESULTS[1] FOR PETROLEUM HYDROCARBONS - SOIL

AREA D

THE BNSF OIL PIPELINE SITE

TACOMA, WASHINGTON

| Sample | Date | Depth (feet bgs) | NWTPH-Dx [2] (mg/kg) | CPAHs [4] (mg/kg) | | | | | | | Total TTEC of cPAHs (detect only) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | BRPH[3] | Benzo (a) anthracene (TEF 0.1) | Benzo (a) pyrene (TEF 1) | Benzo (b) fluoranthene (TEF 0.1) | Benzo (k) fluoranthene (TEF 0.1) | Chrysene (TEF 0.01) | Dibenz (a,h) anthracene (TEF 0.1) | Indeno (1,2,3-cd) pyrene (TEF 0.1) | |
| RE-D-1-9B | 9/4/2008 | 9.0 | 340 | 0.0159 | 0.0171 | 0.0145 | U(0.0121) | 0.0286 | U(0.0121) | U(0.0121) | 0.0204 |
| RE-D-2-8.5B | 9/4/2008 | 8.5 | U(32.9) | U(0.0132) | U(0.0132) | U(0.0132) | U(0.0132) | U(0.0132) | U(0.0132) | U(0.0132) | -- |
| RE-D-3-8.5B | 9/4/2008 | 8.5 | U(30.4) | U(0.0121) | U(0.0121) | U(0.0121) | U(0.0121) | U(0.0121) | U(0.0121) | U(0.0121) | -- |
| RE-D-4-8.5S | 9/4/2008 | 8.5 | U(32.1) | U(0.0130) | U(0.0130) | U(0.0130) | U(0.0130) | U(0.0130) | U(0.0130) | U(0.0130) | -- |
| RE-D-5-2.5S | 9/5/2008 | 2.5 | U(25.5) | U(0.0101) | 0.0125 | 0.0131 | U(0.0101) | U(0.0101) | U(0.0101) | U(0.0101) | 0.0138 |
| RE-D-6-2S | 9/5/2008 | 2.0 | U(27.6) | U(0.0112) | 0.0121 | 0.0127 | U(0.0112) | U(0.0112) | U(0.0112) | U(0.0112) | 0.0134 |
| RE-D-7-2S | 9/5/2008 | 2.0 | U(26.1) | U(0.0104) | U(0.0104) | U(0.0104) | U(0.0104) | U(0.0104) | U(0.0104) | U(0.0104) | -- |
| RE-D-8-4B | 9/5/2008 | 4.0 | U(25.7) | U(0.0103) | U(0.0103) | 0.0105 | U(0.0103) | U(0.0103) | U(0.0103) | U(0.0103) | 0.0011 |
| RE-D-9-8.5B | 9/5/2008 | 8.5 | U(32.1) | U(0.0129) | U(0.0129) | U(0.0129) | U(0.0129) | U(0.0129) | U(0.0129) | U(0.0129) | -- |
| RE-D-10-5S | 9/5/2008 | 5.0 | U(26.2) | U(0.0105) | 0.0110 | 0.0110 | U(0.0105) | U(0.0105) | U(0.0105) | U(0.0105) | 0.0121 |
| RE-D-11-5S | 9/5/2008 | 5.0 | U(25.7) | U(0.0104) | U(0.0104) | U(0.0104) | U(0.0104) | U(0.0104) | U(0.0104) | U(0.0104) | -- |
| RE-D-12-8.5B | 9/5/2008 | 8.5 | U(31.3) | U(0.0127) | U(0.0127) | U(0.0127) | U(0.0127) | U(0.0127) | U(0.0127) | U(0.0127) | -- |
| RE-D-13-5S | 9/5/2008 | 5.0 | U(25.9) | U(0.0105) | U(0.0105) | U(0.0105) | U(0.0105) | U(0.0105) | U(0.0105) | U(0.0105) | -- |
| RE-D-14-5S | 9/5/2008 | 5.0 | U(25.9) | U(0.0103) | U(0.0103) | U(0.0103) | U(0.0103) | U(0.0103) | U(0.0103) | U(0.0103) | -- |
| RE-D-15-4S | 9/5/2008 | 4.0 | U(26.1) | U(0.0104) | U(0.0104) | U(0.0104) | U(0.0104) | U(0.0104) | U(0.0104) | U(0.0104) | -- |
| RE-D-16-4S | 9/5/2008 | 4.0 | 262 | U(0.0104) | U(0.0104) | U(0.0104) | U(0.0104) | U(0.0104) | U(0.0104) | U(0.0104) | -- |
| RE-D-17-3B | 9/5/2008 | 3.0 | U(25.9) | U(0.0104) | 0.0161 | 0.0143 | U(0.0104) | U(0.0104) | U(0.0104) | U(0.0104) | 0.0175 |
| MTCA Method A ULU Cleanup Level | | | 2,000 | MTCA Method A ULU cleanup level for the sum of all cPAHs is 0.1 mg/kg | | | | | | | 0.1 |

**Notes:**

[1] Chemical analysis performed by Test America of Seattle, Washington.

[2] Washington Department of Ecology Method NWTPH-Dx with acid/silica gel cleanup.

[3] BRPH = Bunker Range Petroleum Hydrocarbons equivalent to Bunker-C fuel oil.

[4] Carcinogenic polycyclic aromatic hydrocarbons (cPAHs) were analyzed by Method 8270-SIM.

MTCA = Model Toxics Control Act

TEF = Toxicity Equivalency Factor as defined in WAC 173-340-900 Table 708-2

Total Toxic Equivalent Concentration (TTEC) is the sum of each individual cPAH concentration multiplied by its corresponding TEF

ULU = Unrestricted Land Use

-- = Not Analyzed/Not Applicable

mg/kg = milligram per kilogram

bgs = below ground surface

U = Analyte was not detected at or greater than the listed reporting limit

**Bold** = Detected concentration is greater than the MTCA cleanup level

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# TABLE 6

## SUMMARY OF CONFIRMATION SAMPLE RESULTS[1] FOR PETROLEUM HYDROCARBONS - SOIL

AREA B
THE BNSF OIL PIPELINE SITE
TACOMA, WASHINGTON

| Sample | Date | Depth (feet bgs) | NWTPH-Dx [2] (mg/kg) BRPH[3] | CPAHs [4] (mg/kg) Benzo (a) anthracene (TEF 0.1) | Benzo (a) pyrene (TEF 1) | Benzo (b) fluoranthene (TEF 0.1) | Benzo (k) fluoranthene (TEF 0.1) | Chrysene (TEF 0.01) | Dibenz (a,h) anthracene (TEF 0.1) | Indeno (1,2,3-cd) pyrene (TEF 0.1) | Total TTEC of cPAHs (detect only) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| RE-B-1-5.5S | 08/18/2009 | 5.5 | 260 | 1.1 | 1.4 | 1.3 | 0.46 | 1.3 | 0.23 | 0.65 | **1.79** |
| RE-B-2-6.5B | 08/18/2009 | 6.5 | **3,200** | 0.47 | 0.34 | 0.4 | 0.16 | 0.56 | U(0.083) | 0.18 | **0.47** |
| RE-B-3-6B | 08/19/2009 | 6 | **2,800** | 1.3 | 1.2 | 0.98 | 0.35 | 1.4 | 0.17 | 0.52 | **1.55** |
| RE-B-4-7S | 08/20/2009 | 7 | 82 | 0.016 | 0.018 | 0.015 | 0.0062 | 0.016 | U(0.0052) | 0.0091 | 0.023 |
| RE-B-5-4.5S | 08/20/2009 | 4.5 | 560 | 0.15 | 0.17 | 0.14 | 0.046 | 0.19 | 0.027 | 0.083 | **0.22** |
| RE-B-6-6B | 08/20/2009 | 6 | 1,100 | 2.6 | 2.1 | 2.1 | 0.8 | 2.9 | 0.28 | 1.1 | **2.82** |
| RE-B-7-9B | 08/21/2009 | 9 | **63,000** | 10 | 9.2 | 4.2 | 1.1 | 12 | 0.35 | 1.9 | **11** |
| RE-B-8-9B | 08/21/2009 | 9 | **53,000** | 0.55 | 0.56 | 0.63 | 0.19 | 0.91 | U(0.1) | 0.28 | **0.73** |
| RE-B-9-4.5S | 08/21/2009 | 4.5 | **15,000** | 2 | 1.2 | 0.63 | 0.13 | 3 | U(0.067) | 0.28 | **1.53** |
| RE-B-10-3.5S | 08/21/2009 | 3.5 | 77 | 0.52 | 0.37 | 0.38 | 0.13 | 0.49 | 0.06 | 0.19 | **0.50** |
| RE-B-11-11.5S | 08/22/2009 | 11.5 | U(32) | U(0.0066) | U(0.0066) | U(0.0066) | U(0.0066) | U(0.0066) | U(0.0066) | U(0.0066) | -- |
| RE-B-12-11.8S | 08/22/2009 | 11.8 | U(33) | U(0.0066) | U(0.0066) | U(0.0066) | U(0.0066) | U(0.0066) | U(0.0066) | U(0.0066) | -- |
| RE-B-13-3.5S | 08/24/2009 | 3.5 | 540 | 0.8 | 0.74 | 0.71 | 0.24 | 0.91 | 0.11 | 0.36 | **0.97** |
| RE-B-14-7S | 09/09/2009 | 7 | 260 | 0.41 | 0.49 | 0.4 | 0.18 | 0.46 | 0.066 | 0.23 | **0.62** |
| RE-B-15-7S | 09/09/2009 | 7 | 210 | 0.19 | 0.21 | 0.2 | 0.084 | 0.2 | 0.026 | 0.1 | **0.28** |
| RE-B-16-9B | 09/09/2009 | 9 | U(34) | U(0.0063) | U(0.0063) | U(0.0063) | U(0.0063) | U(0.0063) | U(0.0063) | U(0.0063) | -- |
| RE-B-17-10.5B | 09/09/2009 | 10.5 | U(35) | U(0.0067) | U(0.0067) | U(0.0067) | U(0.0067) | U(0.0067) | U(0.0067) | U(0.0067) | -- |
| RE-B-18-10B | 09/09/2009 | 10 | U(31) | U(0.0063) | U(0.0063) | U(0.0063) | U(0.0063) | U(0.0063) | U(0.0063) | U(0.0063) | -- |
| RE-B-19-9B | 09/11/2009 | 9 | U(120) | U(0.0060) | U(0.0060) | U(0.0060) | U(0.0060) | U(0.0060) | U(0.0060) | U(0.0060) | -- |
| RE-B-20-9B | 09/11/2009 | 9 | U(120) | U(0.0060) | U(0.0060) | U(0.0060) | U(0.0060) | U(0.0060) | U(0.0060) | U(0.0060) | -- |
| RE-B-21-7S | 09/11/2009 | 7 | U(140) | U(0.0066) | U(0.0066) | U(0.0066) | U(0.0066) | U(0.0066) | U(0.0066) | U(0.0066) | -- |
| RE-B-22-8.5B | 09/11/2009 | 8.5 | U(120) | U(0.0066) | U(0.0066) | U(0.0066) | U(0.0066) | U(0.0066) | U(0.0066) | U(0.0066) | -- |
| RE-B-23-6S | 09/11/2009 | 6 | U(100) | U(0.0051) | U(0.0051) | U(0.0051) | U(0.0051) | U(0.0051) | U(0.0051) | U(0.0051) | -- |
| RE-B-24-9B | 09/11/2009 | 9 | U(130) | U(0.0063) | U(0.0063) | U(0.0063) | U(0.0063) | U(0.0063) | U(0.0063) | U(0.0063) | -- |
| RE-B-25-10S | 09/11/2009 | 10 | **6,300** | 0.12 | 0.023 | 0.068 | 0.091 | 0.022 | 0.015 | 0.019 | 0.055 |
| RE-B-26-11S | 09/11/2009 | 11 | 1,700 | 0.063 | 0.0080 | 0.02 | 0.031 | 0.0096 | U(0.0064) | U(0.0064) | 0.019 |
| RE-B-27-9S | 09/15/2009 | 9 | **18,000** | 1.9 | 0.96 | 0.66 | 0.17 | 2.6 | 0.13 | 0.23 | **1.295** |
| RE-B-28-9S | 09/15/2009 | 9 | 1,600 | 0.25 | 0.22 | 0.18 | 0.064 | 0.21 | 0.024 | 0.08 | **0.28** |
| RE-B-29-9S | 09/15/2009 | 9 | **4,700** | 0.081 | 0.085 | 0.094 | 0.025 | 0.092 | 0.018 | 0.044 | **0.11** |
| RE-B-30-11.5B | 09/15/2009 | 11.5 | 140 | U(0.0066) | U(0.0066) | U(0.0066) | U(0.0066) | U(0.0066) | U(0.0066) | U(0.0066) | -- |
| RE-B-31-7S | 09/17/2009 | 7 | **6,800** | 0.45 | 0.72 | 0.57 | 0.19 | 0.62 | U(0.1) | 0.25 | **0.87** |
| RE-B-32-7S | 09/17/2009 | 7 | **62,000** | 0.42 | 0.52 | 0.73 | 0.19 | 1.5 | 0.17 | 0.23 | **0.71** |
| RE-B-DUPE1 | 09/11/2009 | 9 | U(120) | U(0.0061) | U(0.0061) | U(0.0061) | U(0.0061) | U(0.0061) | U(0.0061) | U(0.0061) | -- |
| RE-PX-1-13B | 10/12/2009 | 13 | U(140) | U(0.0069) | 0.011 | 0.016 | 0.014 | U(0.0069) | U(0.0069) | 0.02 | 0.016 |
| RE-PX-2-11S | 10/12/2009 | 11 | **9,500** | 0.24 | 0.21 | 0.21 | 0.081 | 0.28 | 0.019 | 0.071 | **0.27** |
| RE-PX-3-11S | 10/12/2009 | 11 | **2,000** | 0.12 | 0.12 | 0.11 | 0.046 | 0.15 | 0.01 | 0.039 | **0.16** |
| RE-PX-4-14B | 10/12/2009 | 14 | U(130) | U(0.0066) | U(0.0066) | U(0.0066) | U(0.0066) | U(0.0066) | U(0.0066) | U(0.0066) | -- |
| RE-PX-5-13B | 10/12/2009 | 13 | U(140) | U(0.0068) | U(0.0068) | U(0.0068) | U(0.0068) | U(0.0068) | U(0.0068) | U(0.0068) | -- |
| RE-PX-6-11S | 10/12/2009 | 11 | 1,500 | 0.83 | 0.7 | 0.71 | 0.26 | 0.84 | 0.074 | 0.26 | **0.92** |
| RE-PX-7-7.5S | 11/02/2009 | 7.5 | 880 | 0.21 | 0.25 | 0.19 | 0.079 | 0.24 | 0.033 | 0.11 | **0.31** |
| RE-PX-8-7.5S | 11/02/2009 | 7.5 | 530 | 0.11 | 0.14 | 0.11 | 0.047 | 0.12 | 0.021 | 0.066 | **0.18** |
| RE-PX-9-7.5S | 11/02/2009 | 7.5 | 1,000 | 0.24 | 0.33 | 0.28 | 0.12 | 0.28 | 0.046 | 0.15 | **0.42** |

| Sample | Date | Depth (feet bgs) | NWTPH-Dx [2] (mg/kg) | CPAHs [4] (mg/kg) | | | | | | | Total TTEC of cPAHs (detect only) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | BRPH[3] | Benzo (a) anthracene (TEF 0.1) | Benzo (a) pyrene (TEF 1) | Benzo (b) fluoranthene (TEF 0.1) | Benzo (k) fluoranthene (TEF 0.1) | Chrysene (TEF 0.01) | Dibenz (a,h) anthracene (TEF 0.1) | Indeno (1,2,3-cd) pyrene (TEF 0.1) | |
| RE-PX-10-9.5B | 11/02/2009 | 9.5 | U(140) | U(0.0068) | U(0.0068) | U(0.0068) | U(0.0068) | U(0.0068) | U(0.0068) | U(0.0068) | -- |
| RE-PX-11-9.5B | 11/02/2009 | 9.5 | U(140) | U(0.0067) | U(0.0067) | U(0.0067) | U(0.0067) | U(0.0067) | U(0.0067) | U(0.0067) | -- |
| RE-PX-12-13B | 11/03/2009 | 13 | U(130) | U(0.0066) | 0.0066 U | U(0.0066) | U(0.0066) | U(0.0066) | U(0.0066) | U(0.0066) | -- |
| RE-PX-13-11S | 11/03/2009 | 11 | 550 | 0.17 | 0.19 | 0.15 | 0.063 | 0.17 | 0.03 | 0.084 | **0.24** |
| RE-PX-14-11S | 11/03/2009 | 11 | 610 | 0.37 | 0.43 | 0.33 | 0.14 | 0.39 | 0.066 | 0.19 | **0.54** |
| RE-PX-15-8S | 11/03/2009 | 8 | 330 | 0.27 | 0.32 | 0.24 | 0.11 | 0.31 | 0.055 | 0.15 | **0.41** |
| RE-PX-16-10B | 11/03/2009 | 10 | U(140) | U(0.0067) | U(0.0067) | U(0.0067) | U(0.0067) | U(0.0067) | U(0.0067) | U(0.0067) | -- |
| RE-PX-17-10B | 11/03/2009 | 10 | U(120) | U(0.0066) | U(0.0066) | U(0.0066) | U(0.0066) | U(0.0066) | U(0.0066) | U(0.0066) | -- |
| RE-PX-18-9B | 11/06/2009 | 9 | 340 | 0.021 | 0.02 | 0.019 | 0.0091 | 0.028 | 0.0068 | 0.014 | 0.029 |
| RE-PX-19-7S | 11/06/2009 | 7 | **3,300** | 1.1 | 0.88 | 0.77 | 0.27 | 0.95 | 0.11 | 0.35 | **1.15** |
| RE-PX-20-10B | 11/06/2009 | 10 | 120 | 0.0062 | 0.0062 | 0.0062 | 0.0062 | 0.0062 | 0.0062 | 0.0062 | 0.011 |
| RE-PX-21-7S | 11/06/2009 | 7 | 110 | 0.0059 | 0.0059 | 0.0059 | 0.0059 | 0.0059 | 0.0059 | 0.0059 | 0.011 |
| RE-PX-22-7S | 11/06/2009 | 7 | **2,300** | 0.85 | 0.75 | 0.69 | 0.22 | 0.89 | 0.093 | 0.29 | **0.97** |
| MTCA Method A ULU Cleanup Level | | | 2,000 | MTCA Method A ULU cleanup level for the sum of all cPAHs is 0.1 mg/kg | | | | | | | 0.1 |

Notes:

[1] Chemical analysis performed by Test America of Seattle, Washington.

[2] Washington Department of Ecology Method NWTPH-Dx with acid/silica gel cleanup.

[3] BRPH = Bunker Range Petroleum Hydrocarbons equivalent to Bunker-C fuel oil.

[4] Carcinogenic polycyclic aromatic hydrocarbons (CPAHs) were analyzed by Method 8270-SIM. Other PAHs were analyzed but not detected.

MTCA = Model Toxics Control Act

TEF = Toxicity Equivalency Factor as defined in WAC 173-340-900 Table 708-2

Total Toxic Equivalent Concentration (TTEC) is the sum of each individual cPAH concentration multiplied by its corresponding TEF

ULU = Unrestricted Land Use

-- = Not Analyzed/Not Applicable

mg/kg = milligram per kilogram

bgs = below ground surface

U = Analyte was not detected at or greater than the listed reporting limit

**Bold** = Detected concentration is greater than the MTCA Method A ULU cleanup level

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# TABLE 7

## SUMMARY OF CONFIRMATION SAMPLE RESULTS[1] FOR PETROLEUM HYDROCARBONS - SOIL

AREA C

THE BNSF OIL PIPELINE SITE

TACOMA, WASHINGTON

| Sample | Date | Depth (feet bgs) | NWTPH-Dx [2] (mg/kg) | CPAHs [4] (mg/kg) | | | | | | | Total TEF of cPAHs (detect only) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | BRPH[3] | Benzo (a) anthracene (TEF 0.1) | Benzo (a) pyrene (TEF 1) | Benzo (b) fluoranthene (TEF 0.1) | Benzo (k) fluoranthene (TEF 0.1) | Chrysene (TEF 0.01) | Dibenz (a,h) anthracene (TEF 0.1) | Indeno (1,2,3-cd) pyrene (TEF 0.1) | |
| RE-C-1-8B | 09/25/2009 | 8 | U(120) | 0.014 | 0.014 | 0.015 | 0.0063 | 0.019 | U(0.0059) | 0.0064 | 0.018 |
| RE-C-2-8B | 09/25/2009 | 8 | U(130) | U(0.0062) | U(0.0062) | U(0.0062) | U(0.0062) | U(0.0062) | U(0.0062) | U(0.0062) | -- |
| RE-C-3-8B | 09/25/2009 | 8 | U(130) | U(0.0064) | U(0.0064) | U(0.0064) | U(0.0064) | U(0.0064) | U(0.0064) | U(0.0064) | -- |
| RE - C - 4 - 9S | 09/28/2009 | 9 | U(110) | 0.29 | 0.3 | 0.26 | 0.11 | 0.38 | 0.032 | 0.13 | 0.39 |
| RE - C - 5 - 9S | 09/28/2009 | 9 | U(110) | 0.0085 | 0.0091 | 0.0083 | U(0.0052) | 0.0075 | U(0.0052) | U(0.0052) | -- |
| RE - C - 6 - 16B | 09/28/2009 | 16 | U(130) | U(0.0064) | U(0.0064) | U(0.0064) | U(0.0064) | U(0.0064) | U(0.0064) | U(0.0064) | -- |
| RE - C - 7 - 16B | 09/28/2009 | 16 | U(130) | U(0.0066) | U(0.0066) | U(0.0066) | U(0.0066) | U(0.0066) | U(0.0066) | U(0.0066) | -- |
| RE - C - 8 - 9S | 09/28/2009 | 9 | **170,000** | 0.32 | 0.59 | 1.1 | U(0.21) | 2.3 | U(0.21) | 0.34 | 0.79 |
| RE - C - 9 - 9S | 09/28/2009 | 9 | U(100) | U(0.0054) | U(0.0054) | U(0.0054) | U(0.0054) | U(0.0054) | U(0.0054) | U(0.0054) | -- |
| RE-C-10-9S | 09/30/2009 | 9 | **340,000** | 1.2 | 0.79 | 4 | 1.7 | 3.4 | 0.35 | U(0.21) | 1.5 |
| RE-C-11-11B | 09/30/2009 | 11 | U(140) | U(0.0068) | U(0.0068) | U(0.0068) | U(0.0068) | U(0.0068) | U(0.0068) | U(0.0068) | -- |
| RE-C-12-12B | 09/30/2009 | 12 | U(130) | U(0.0066) | U(0.0066) | U(0.0066) | U(0.0066) | U(0.0066) | U(0.0066) | U(0.0066) | -- |
| RE-C-13-19B | 09/30/2009 | 19 | U(130) | U(0.0062) | U(0.0062) | U(0.0062) | U(0.0062) | U(0.0062) | U(0.0062) | U(0.0062) | -- |
| RE-C-14-9S | 09/30/2009 | 9 | U(110) | U(0.0055) | U(0.0055) | U(0.0055) | U(0.0055) | U(0.0055) | U(0.0055) | U(0.0055) | -- |
| RE-C-15-9S | 09/30/2009 | 9 | **570,000** | 1.5 | 1.4 | 4.4 | U(0.17) | 6.8 | 0.55 | 0.32 | 2.1 |
| RE-C-16-9S | 10/01/2009 | 9 | **89,000** | U(0.44) | 0.68 | 1.3 | U(0.44) | 2.2 | U(0.44) | U(0.44) | 0.83 |
| RE-C-17-9S | 10/01/2009 | 9 | **99,000** | U(0.56) | 0.59 | 1.2 | U(0.56) | 1.1 | U(0.56) | U(0.56) | 0.72 |
| RE-C-18-9S | 10/01/2009 | 9 | **9,800** | U(0.13) | U(0.13) | 0.22 | U(0.13) | 0.38 | U(0.13) | U(0.13) | 0.03 |
| RE-C-19-10B | 10/05/2009 | 10 | U(140) | U(0.0065) | U(0.0065) | U(0.0065) | U(0.0065) | U(0.0065) | U(0.0065) | U(0.0065) | -- |
| RE-C-20-6S | 10/05/2009 | 6 | **90,000** | U(0.23) | 0.54 | 0.97 | U(0.23) | 1.1 | U(0.23) | U(0.23) | 0.65 |
| RE-C-21-10B | 10/05/2009 | 10 | U(120) | U(0.0062) | U(0.0062) | U(0.0062) | U(0.0062) | U(0.0062) | U(0.0062) | U(0.0062) | -- |
| RE-C-22-10B | 10/05/2009 | 10 | U(120) | U(0.0061) | U(0.0061) | U(0.0061) | U(0.0061) | U(0.0061) | U(0.0061) | U(0.0061) | -- |
| RE-C-23-7S | 10/05/2009 | 7 | **89,000** | 0.27 | 0.63 | 1.1 | 0.25 | 0.62 | 0.25 | U(0.25) | 0.82 |
| RE-C-24-10B | 10/05/2009 | 10 | U(120) | U(0.0061) | U(0.0061) | U(0.0061) | U(0.0061) | U(0.0061) | U(0.0061) | U(0.0061) | -- |
| RE-C-25-7S | 10/05/2009 | 7 | **85,000** | 0.8 | 0.84 | 1.3 | 0.26 | 0.94 | 0.23 | 0.32 | 1.14 |
| RE-C-26-8.5B | 10/06/2009 | 8.5 | 170 | U(0.0065) | U(0.0065) | U(0.0065) | U(0.0065) | U(0.0065) | U(0.0065) | U(0.0065) | -- |
| RE-C-27-6.5S | 10/06/2009 | 6.5 | **23,000** | 0.34 | 0.37 | 0.42 | 0.12 | 0.45 | 0.055 | 0.14 | 0.48 |
| RE-C-28-10B | 10/06/2009 | 10 | 310 | U(0.0071) | U(0.0071) | U(0.0071) | U(0.0071) | U(0.0071) | U(0.0071) | U(0.0071) | -- |
| RE-C-29-11B | 10/06/2009 | 11 | U(130) | U(0.0065) | U(0.0065) | U(0.0065) | U(0.0065) | U(0.0065) | U(0.0065) | U(0.0065) | -- |
| RE-C-30-7S | 10/07/2009 | 7 | **180,000** | 1.7 | 0.82 | 2.9 | 4.8 | 9.2 | U(0.37) | 0.43 | 1.9 |
| RE-C-31-11B | 10/08/2009 | 11 | U(130) | U(0.0064) | U(0.0064) | U(0.0064) | U(0.0064) | U(0.0064) | U(0.0064) | U(0.0064) | -- |
| RE-C-32-10B | 10/08/2009 | 10 | **2,100** | U(0.0065) | U(0.0065) | U(0.0065) | U(0.0065) | U(0.0065) | U(0.0065) | U(0.0065) | -- |
| RE-C-33-9S | 10/08/2009 | 9 | **43,000** | U(0.24) | U(0.24) | 0.74 | 1.3 | 1.9 | U(0.24) | U(0.24) | 0.22 |
| RE-C-34-9S | 10/08/2009 | 9 | **28,000** | 0.21 | 0.38 | 0.55 | 0.82 | 0.94 | U(0.11) | 0.16 | 0.56 |
| RE-C-35-11B | 10/12/2009 | 11 | U(130) | U(0.0065) | U(0.0065) | U(0.0065) | U(0.0065) | U(0.0065) | U(0.0065) | U(0.0065) | -- |
| RE-C-36-12B | 10/12/2009 | 12 | U(130) | U(0.0062) | U(0.0062) | U(0.0062) | U(0.0062) | U(0.0062) | U(0.0062) | U(0.0062) | -- |
| RE-C-37-9S | 10/12/2009 | 9 | **91,000** | 0.55 | 0.45 | 0.79 | 0.15 | 1.7 | 0.14 | 0.093 | 0.64 |
| RE-C-38-9S | 10/12/2009 | 9 | **11,000** | 0.52 | 0.44 | 0.49 | 0.13 | 0.64 | 0.062 | 0.16 | 0.58 |
| RE-C-39-13B | 10/14/2009 | 13 | U(130) | U(0.0064) | U(0.0064) | U(0.0064) | U(0.0064) | U(0.0064) | U(0.0064) | U(0.0064) | -- |
| RE-C-DUPE-1 | 10/01/2009 | 9 | **11,000** | 0.21 | 0.12 | 0.18 | U(0.11) | 0.4 | U(0.11) | U(0.11) | 0.2 |
| RE-C-DUPE-2 | 10/14/2009 | 13 | U(130) | U(0.0064) | U(0.0064) | U(0.0064) | U(0.0064) | U(0.0064) | U(0.0064) | U(0.0064) | -- |
| MTCA Method A ULU Cleanup Level | | | 2,000 | MTCA Method A ULU cleanup level for the sum of all cPAHs is 0.1 mg/kg | | | | | | | 0.1 |

Notes:

[1] Chemical analysis performed by Test America of Seattle, Washington.

[2] Washington Department of Ecology Method NWTPH-Dx with acid/silica gel cleanup.

[3] BRPH = Bunker Range Petroleum Hydrocarbons equivalent to Bunker-C fuel oil.

[4] Carcinogenic polycyclic aromatic hydrocarbons (CPAHs) were analyzed by Method 8270-SIM.

MTCA = Model Toxics Control Act

TEF = Toxicity Equivalency Factor as defined in WAC 173-340-900 Table 708-2

Total Toxic Equivalent Concentration (TTEC) is the sum of each individual cPAH concentration multiplied by its corresponding TEF

ULU = Unrestricted Land Use

-- = Not Analyzed/Not Applicable

mg/kg = milligram per kilogram

bgs = below ground surface

U = Analyte was not detected at or greater than the listed reporting limit

**Bold** = Detected concentration is greater than the MTCA Method A ULU cleanup level

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# Appendix A
## Field Methods

# APPENDIX A
# FIELD METHODS

## Soil Sampling Procedures

Field activities performed during the remedial action within the boundaries of the remedial areas were completed in general accordance with the CAP and the EDR. Confirmation and waste profile samples were obtained during construction in general accordance with the Sampling and Analysis Plan (SAP). Samples were properly documented following appropriate chain-of-custody procedures and transported to TestAmerica in Bothell (2008) and Fife (2009), Washington, for analysis. Chemical analytical data are included in Appendix D.

### *Excavation Sampling*

Confirmation soil samples from the remedial excavation were generally obtained as grab samples. The Site Safety Officer inspected and approved all excavation slopes prior to the collection of samples. The locations and number of samples obtained were determined by specifications set forth in the EDR. Samples were obtained from the excavation sidewalls (S) and base (B) during the remedial action.

Confirmation samples were obtained using a stainless steel spoon. All surface materials that were not to be included in the sample, such as rocks, twigs and leaves, were removed from the sampling area. Samples were placed directly into laboratory-provided jars, filled completely to minimize headspace, appropriately labeled and placed on ice in a cooler for transport to the laboratory. The stainless steel sampling spoon was decontaminated after each sampling event using Alconox soap and double rinse with distilled water. Waste products from sampler decontamination were disposed in the on-site water treatment system.

### *Waste Profile Sampling*

Samples were obtained in general accordance with the EDR/SAP and/or as indicated by the Ecology and the TPCHD. All waste profile samples were grab samples obtained from within the center of material in the excavator bucket during test pitting activities.

## Field Screening Methods

Field screening was completed on the soil samples obtained from the excavation and waste profiling efforts. Field screening results were used as a general guideline to delineate areas of potential contamination in soils. The screening methods employed included visual examination, headspace vapor and water sheen testing.

### *Visual Examination*

The soil samples were logged in general accordance with the Unified Soil Classification System (USCS) and ASTM International (ASTM) D 2488. The color, moisture content, and visual and/or olfactory evidence of hydrocarbon impacts were documented in the field log.

#### ***Headspace Vapor Testing***

The soil samples were screened for volatile organic compounds (VOCs) using a photoionization detector (PID). Headspace vapor testing consisted of placement of the soil into plastic sample bags, heating the soil to room temperature to allow partitioning of vapors and inserting the probe of the PID into the bag headspace. The peak VOC reading was recorded in the sampling logs.

#### ***Water Sheen Testing***

The soil samples were screened for the presence of petroleum hydrocarbons by water sheen testing. Water sheen testing involves placing soil in water and observing the water surface for signs of sheen. Sheens are classified as follows:

| | |
|---|---|
| No Sheen (NS) | No visible sheen on the water surface. |
| Slight Sheen (SS) | Light, colorless, dull sheen; spread is irregular, not rapid; sheen dissipates rapidly. |
| Moderate Sheen (MS) | Light to heavy sheen; may have some color/iridescence; spread is irregular to flowing, may be rapid; few remaining areas of no sheen on the water surface. |
| Heavy Sheen (HS) | Heavy sheen with color/iridescence; spread is rapid; entire water surface may be covered with sheen. |

The presence and sheen type was recorded in the sampling logs. Field screening results are site-specific. The results may vary with temperature, moisture content, soil lithology, organic content and type of contaminant.

### Quality Control of Soil Sample Collection

A minimum of one soil sample in every ten was obtained in duplicate for chemical analysis. Duplicate samples were obtained by splitting the soil sample and filling two sets of sample containers with the soils obtained. Soils were not mixed prior to splitting because of the potential loss of volatile organic constituents during the mixing process. Samples obtained for volatile analysis were placed in containers with no headspace. Field duplicate samples were not identified as duplicates on the sample labels or chain-of-custody forms but were identified as such in the field notebook and the sample logs.

### Groundwater Sampling

Groundwater sampling was performed prior to and during excavation activities to characterize for disposal into the City of Tacoma sanitary sewer. Monitoring wells MW-1 and MW-15 were used for the characterization sampling effort. These monitoring wells were decommissioned as part of the excavation activities at Area A.

#### ***Groundwater Level Measurement***

Groundwater level measurements were obtained to estimate the volume of water to be purged from a well prior to the collection of a representative sample. A measuring point location was clearly marked on the inner casing of each on-site well to provide a consistent reference point to obtain groundwater level measurements. A decontaminated water level indicator was used to obtain measurement data from each on-site well. The total depth of the well was also measured using the above method to provide an indication of sediment buildup in the well. Groundwater level measurements were obtained prior to sampling.

***Purging***

Purging of the Site wells was completed to induce "fresh" groundwater flow into the wells prior to sample collection. Purging was considered complete when three consecutive measurements of turbidity, dissolved oxygen, oxidation-reduction potential, pH and temperature were within 10 percent of the previous measurement, and when consecutive measurements of conductivity were within 3 percent. The purge rate of each well was maintained at less than 500 milliliters (mL) per minute throughout the stabilization of parameters.

***Low Flow Method Sample Collection***

Samples were obtained using dedicated submersible Whale pumps and tubing. Upon stabilization of parameters, the purge rate was reduced to approximately 100 to 200 mL per minute. Samples were obtained from the discharge tube of the pump into appropriate sample containers provided by TestAmerica. Samples obtained for analysis of dissolved metals were filtered in the field using a 0.5-micron filter prior to filling the sample container.

## Documentation

Various documents were completed and maintained as a part of soil and groundwater sample collection. These documents provide a summary of the sample collection procedures and conditions, shipment method, analysis requested and the custody history. These documents are stored in the project file and include:

- Field log books;
- Groundwater sampling forms; and
- Chain-of-custody forms.

# APPENDIX B
## Unanticipated Discovery Plan

**UNANTICIPATED DISCOVERY PLAN**
**BNSF OIL PIPELINE REMEDIATION ACTIVITIES**
**CITY OF TACOMA**
**PIERCE COUNTY, WASHINGTON**

**JANUARY 14, 2009**

**FOR**
**BNSF RAILWAY COMPANY**

GEOENGINEERS

*File No. 0506-141-03*

# Unanticipated Discovery Plan
# File No. 0506-141-03

## January 14, 2009

**Prepared for:**

**BNSF Railway Company**
**2454 Occidental Avenue South, Suite 1A**
**Seattle, Washington 98134**

**Attention: Bruce Sheppard**

**Prepared by:**


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**BNSF OIL PIPELINE REMEDIATION ACTIVITIES**
**CITY OF TACOMA, PIERCE COUNTY, WASHINGTON**
**FOR**
**BNSF RAILWAY COMPANY**

## 1.0 INTRODUCTION

The BNSF Railway Company (BNSF) will conduct remedial excavation activities at the D Street Oil Pipeline site located in Tacoma, Washington, as required under a Consent Decree with the Washington State Department of Ecology (Ecology) (Pierce County Superior Court Action No. 082111054). The purpose of this remedial action is to remove petroleum-contaminated soil and wood waste in accordance with the Cleanup Action Plan as required under the Consent Decree. The following Unanticipated Discovery Plan (UDP) outlines procedures to follow, in accordance with state and federal laws, if archaeological materials or human remains are discovered.

## 2.0 RECOGNIZING CULTURAL RESOURCES

A cultural resource discovery could be prehistoric or historic. Examples include:

- An accumulation of shell, burned rocks or other food-related materials;
- Bones or small pieces of bone;
- An area of charcoal or very dark stained soil with artifacts;
- Stone tools or waste flakes (i.e., an arrowhead or stone chips);
- Clusters of tin cans or bottles, logging or agricultural equipment that appears to be older than 50 years;
- Buried railroad tracks, decking or other industrial materials other than the known wood waste fill material present at the site.

When in doubt, we will assume the material is a cultural resource.

## 3.0 ON-SITE RESPONSIBILITIES

### 3.1 STEP 1: STOP WORK

If any GeoEngineers employee, contractor or subcontractor believes that they have uncovered a cultural resource at any point in the project, all work adjacent to the discovery will stop. The discovery location will be secured at all times and a 20-foot exclusion zone radius shall be implemented around the find.

### 3.2 STEP 2: NOTIFY GEOENGINEERS' PROJECT MANAGEMENT

Contact the GeoEngineers Project Manager:

Name: Nick Rohrbach
Phone: (253) 732-2138
Email: nrohrbach@geoengineers.com

Alternate Contact:
Name: John Biggane
Phone: (971) 825-1556
Email: jbiggane@geoengineers.com

The Project Manager will make all other calls and notifications.

If human remains are encountered, they will be treated with dignity and respect at all times. The remains will be covered with a tarp or other materials (not soil or rocks) for temporary protection in place and to shield them from being photographed. Do not speak with the media.

## 4.0 FURTHER CONTACTS AND CONSULTATION

### 4.1 PROJECT MANAGER'S RESPONSIBILITIES

- **Protect Find:** The GeoEngineers Project Manager is responsible for taking appropriate steps to protect the discovery site. All work will stop in an area adequate to provide for the security, protection and integrity of the resource. Vehicles, equipment and unauthorized personnel will not be permitted to traverse the discovery site. Work in the immediate area will not resume until treatment of the discovery has been completed following provisions for treating archaeological/ cultural material as set forth in this document.
- **Direct Remedial Activities Elsewhere On Site:** The GeoEngineers Project Manager may direct remedial activities away from cultural resources to work in other areas prior to contacting the concerned parties.
- **Identify Find:** The GeoEngineers' Project Manager will ensure that a qualified professional archaeologist examines the find to determine if it is archaeological. As indicated in Section 3.1, a 20-foot exclusion zone radius shall be implemented around the find.
    - If it is determined not archaeological, work may proceed without notification and with no further delay.
    - If it is determined to be archaeological, the GeoEngineers' Project Manager will continue with notification.
    - If the find may be human remains or funerary objects, the GeoEngineers' Project Manager will ensure that a qualified physical anthropologist examines the find. If it is determined to be human remains, the procedure described in Section 5 will be followed.
- **Notify DAHP:** The GeoEngineers' Project Manager will contact the involved federal agencies (if any) and the Department of Archaeology and Historic Preservation (DAHP).
- **Notify Tribes:** If the discovery may relate to Native American interests, the Project Manager will also contact the Governor's Office of Indian Affairs (GOIA) and the Puyallup Tribe.

    Department of Archaeology and Historic Preservation
    Dr. Allyson Brooks, State Historic Preservation Officer
    Phone: (360) 586-3066

Governor's Office of Indian Affairs
Mystique Hurtado, Executive Assistant
Phone: (360) 902-8825
FAX: (360) 902-8829
E-Mail: mhurtad@goia.wa.gov

Puyallup Tribe
Thomas Edward, Tribe Historic Preservationist
Phone: (253) 573-7887

### 4.2 FURTHER ACTIVITIES

- Archaeological discoveries will be documented as described in Section 6.
- Remedial activities in the discovery area may resume as described in Section 7.

## 5.0 SPECIAL PROCEDURES FOR THE DISCOVERY OF HUMAN SKELETAL MATERIAL

Any human skeletal remains, regardless of antiquity or ethnic origin, will at all times be treated with dignity and respect.

GeoEngineers will comply with applicable state and federal laws, and the following procedure:

### 5.1 NOTIFY LAW ENFORCEMENT AGENCY OR CORONER'S OFFICE

In addition to the actions described in Sections 3 and 4, the Project Manager will immediately notify the local law enforcement agency or coroner's office.

The coroner (with assistance of law enforcement personnel) will determine if the remains are human, whether the discovery site constitutes a crime scene, and will notify DAHP.

Agency: City of Tacoma Police Department
Phone: (253) 591-5900

### 5.2 PARTICIPATE IN CONSULTATION

Per Revised Code of Washington (RCW) 27.53.030, RCW 68.50, and RCW 68.60, DAHP will have jurisdiction over non-forensic human remains. GeoEngineers personnel will participate in consultation.

### 5.3 FURTHER ACTIVITIES

- Documentation of human skeletal remains and funerary objects will be agreed upon through the consultation process described in RCW 27.53.030, RCW 68.50 and RCW 68.60.
- When consultation and documentation activities are complete, remediation activities in the discovery area may resume as described in Section 7.

## 6.0 DOCUMENTATION OF ARCHAEOLOGICAL MATERIALS

Cultural Resources Program staff will ensure the proper documentation and assessment of any discovered cultural resources in cooperation with the DAHP, affected tribes and a contracted consultant (if any).

All prehistoric and historic cultural material discovered during remediation activities will be recorded by a professional archaeologist on State of Washington cultural resource site or isolate form using standard techniques. Site overviews, features, and artifacts will be photographed; stratigraphic profiles and soil/ sediment descriptions will be prepared for subsurface exposures. Discovery locations will be documented on scaled site plans and site location maps.

If assessment activity exposes human remains (burials, isolated teeth or bones), the process described in Section 5 above will be followed.

## 7.0 PROCEEDING WITH REMEDIATION ACTIVITIES

Remediation activities outside the discovery location may continue while documentation and assessment of the cultural resources proceed. An archaeological specialist must determine the boundaries of the discovery location. In consultation with DAHP and affected tribes, the Project Manager will determine the appropriate level of documentation and treatment of the resource.

Remediation activities may continue at the discovery location only after the process outlined in this plan is followed and GeoEngineers (and the federal agencies, if any) determine that compliance with state and federal laws is complete.

## 8.0 REFERENCE

This Discovery Plan has been created using the Washington State Department of Transportation Discovery Form template.

# APPENDIX C
**Permits Acquired**
**(Included on Attached CD)**

# Appendix D
## Chemical Analytical Reports
## (Included on Attached CD)

# Appendix E
## Disposal Documentation
## (Included on Attached CD)

# APPENDIX F
## Communication Records
## (Included on Attached CD)

# Appendix G

## Utility and Pavement Restoration Plans
## (Included on Attached CD)

# Appendix H
## Quarterly Groundwater Monitoring Program

## APPENDIX H
## QUARTERLY GROUNDWATER MONITORING PROGRAM

### 1.0 INTRODUCTION

The quarterly groundwater monitoring program was initiated at the BNSF D Street Oil Pipeline Site (Site) in May 2006 to assess concentration trends for chemicals of concern (COC) and to monitor natural attenuation parameters until the final remedial action was completed. The concentrations of COC were evaluated at the Conditional Point of Compliance (CPOC) relative to compliance criteria identified in the Final Remedial Investigation (RI)/Feasibility Study (FS) Report dated April 4, 2007 and the Draft Final Cleanup Action Plan (CAP) dated November 14, 2007.

Groundwater samples were collected for analysis from monitoring wells MW-2 through MW-5, MW-8, MW-9 and MW-11 (the "D" Street wells). The "D" Street wells serve to define the CPOC. Groundwater was also collected and analyzed from MW-7 and MW-14, which were located upgradient of the CPOC at the Site. The last quarterly groundwater monitoring event was performed in November 2009 after substantial completion of the final remedial action.

### 2.0 BACKGROUND AND PURPOSE

A total of 15 groundwater monitoring wells were installed during 2004 to evaluate potential petroleum-related impacts to groundwater at the Site. Twelve monitoring wells (MW-1 through MW-12) were installed on the site in April 2004 to define the lateral limits of contaminated groundwater associated with bunker range petroleum-related contamination in soil at the Site. These monitoring wells were generally installed at locations observed to be the upgradient and downgradient limits of the COC impacts to soil.

Three additional monitoring wells (MW-13 through MW-15) were installed during October 2004. Monitoring well MW-13 was installed in the clean backfill in the 2004 interim action (IA) area to monitor potential migration of petroleum-contaminated groundwater into the IA area from upgradient sources and/or the potential impacts of residual petroleum hydrocarbons remaining in soil adjacent to the IA area. Monitoring wells MW-14 and MW-15 were installed in areas with the highest concentrations of petroleum hydrocarbons in soil in the Tacoma Fixtures Area and the WSDOT Pond Areas (respectively) to better characterize potential groundwater impacts at the Site.

As part of the Remedial Investigation, four quarters of groundwater monitoring were completed at monitoring wells MW-1 through MW-12 between April 2004 and January 2005. Two additional quarters of groundwater monitoring were completed at monitoring wells MW-2 through MW-5, MW-8, MW-9 and MW-11 between April 2005 and July 2005. Four quarters of groundwater monitoring were completed at monitoring wells MW-13, MW-14 and MW-15 between October 2004 and July 2005. An additional round of groundwater monitoring was performed in all Site monitoring wells during the 2006 groundwater investigation and these results were reported in the RI.

Groundwater monitoring at monitoring wells MW-1, MW-6, MW-10, MW-12, MW-13 and MW-15 ended after the completion of the 2006 groundwater investigation because COCs were either not detected or were detected at concentrations less than the Model Toxics Control Act (MTCA) cleanup levels (CULs). The quarterly groundwater monitoring program at monitoring wells MW-2 through MW-5, MW-7, MW-8, MW-9, MW-11 and MW-14 began after the completion 2006 groundwater investigation.

Monitoring wells MW-1 and MW-15 were abandoned in July 2008 during remedial actions at Area A. Monitoring wells MW-6, MW-7, MW-13 and MW-14 were decommissioned in August 2009 during remedial actions at Areas B and C.

Monitoring wells MW-10, MW-12, and the "D" Street wells will be decommissioned after Ecology determines that groundwater compliance monitoring activities have satisfied the requirements of the Consent Decree.

Chemical analytical data for the monitoring wells, and time periods described in this document, are presented on Tables 1 and 2.

## 3.0 METHODS

The RI and CAP identified COC for groundwater at the Site as petroleum hydrocarbons (quantified as bunker-range petroleum hydrocarbons [BRPH]), total carcinogenic polycyclic aromatic hydrocarbons (cPAHs) and naphthalene.

The MTCA cleanup levels for groundwater were selected for the Site because they are protective of human health and the environment

Applicable groundwater MTCA CULs include:

- Petroleum hydrocarbons (quantified as BRPH): 0.5 mg/l.
- Total cPAHs (as determined using toxicity equivalency methodology as required in WAC 173-340-708(8)): 0.1 µg/l.
- Naphthalene: 160 µg/l.

Natural attenuation parameter data was collected during the 2006 groundwater investigation and during the quarterly groundwater monitoring program to assess whether natural attenuation is occurring at the Site. The results collected as part of the 2006 groundwater investigation were reported in the RI.

The quarterly groundwater monitoring program samples were obtained during slack tide periods at a tidal stage that approximated the average tidal stage for the Thea Foss Waterway to limit the potential for tidally induced groundwater gradients or flows that could potentially bias chemical concentrations observed at the CPOC. Appropriate slack tide periods were identified using published tidal stage prediction information for Commencement Bay in Tacoma, Washington. Each sample was collected using low-flow/low-turbidity sampling techniques to minimize the suspension of particulates in the samples. Groundwater samples were obtained from the monitoring wells using dedicated self-venting submersible electric pumps (Whale Pump Brand or equivalent) with flexible, dedicated vinyl tubing. Groundwater was pumped at approximately 0.5 liters per minute from the approximate mid-point of the screened interval.

A water quality measuring system (such as a Horiba U-22) with a flow-through-cell was used to monitor the following water quality parameters during purging: electrical conductivity, dissolved oxygen (DO), pH, turbidity, oxidation-reduction potential (ORP) and temperature. Ambient groundwater conditions were assumed to have been reached once these parameters varied by less than 10 percent on three consecutive measurements and turbidity was below 5 NTUs for at least two consecutive readings. If after 1 hour the turbidity is was still above 5 NTU, the sample was collected and a note placed on the Chain-of-Custody (CC) instructing the analytical laboratory to allow particulate material to settle in the BRPH and cPAH samples before analysis. All field measurements were documented on the field logs.

Following well purging, the flow-through-cell was disconnected and the groundwater samples were collected in appropriate laboratory-provided and prepared containers. The samples were placed into a cooler with ice and delivered to TestAmerica for analysis following appropriate CC procedures. Purge water was stored in labeled 55-gallon drums for off-site disposal. Groundwater samples collected were submitted for the following analyses:

- NWTPH-Dx calibrated to Bunker-C with silica gel cleanup,
- cPAHs by Environmental Protection Agency (EPA) Method GC/MS for low-level detection limits,
- Naphthalene by Environmental Protection Agency (EPA) Method GC/MS for low-level detection limits,
- Salinity by EPA Method 2520B,
- Manganese by EPA Method 200.8 with a detection limit of 0.01 mg/l,
- Nitrates by EPA Method 300 with a detection limit of 0.2 mg/l,
- Sulfates by EPA Method 300 with a detection limit of 0.4 mg/l, and
- Total Alkalinity by EPA Method 310.1 with a detection limit of 5.0 mg/l.

Ferrous iron was measured using a Hach field test kit and the results were recorded on the field logs prior to sample collection.

## 4.0 RESULTS

Monitoring wells MW-2 through MW-5 and MW-8 through MW-11 (“D” Street wells) are located on East “D” Street, between the petroleum-contaminated areas and the Waterway. Monitoring wells MW-6, MW-7 and MW-14 were located in or upgradient of BRPH-contaminated areas.

### 4.1 Bunker Range Petroleum Hydrocarbons

BRPH was not detected in any of the “D” Street wells and MW-7 during the quarterly groundwater monitoring program (May 2006 to November 2009).

BRPH was detected in groundwater samples from MW-14 at concentrations greater than the MTCA CUL of 0.5 milligram per liter (mg/l) during the May 2006 (1.76 mg/l), April 2008 (1.60 mg/l) and the July 2009 (0.97 mg/l) sampling events. BRPH was detected in groundwater samples from MW-14 at concentrations less than the MTCA CUL during the October 2007 event. BRPH was not detected in groundwater samples from MW-14 during other sampling events conducted for the quarterly groundwater monitoring program. Exceedances of groundwater standards observed during quarterly monitoring at MW-14 were likely due to the well being installed in the BRPH source area and the groundwater samples were collected prior to the removal of the contaminated material in the source area.

### 4.2 cPAHs

Total cPAHs were detected at concentrations less than the MTCA CUL (0.1 microgram per liter [μg/l]) in groundwater samples from MW-2 during the May 2006 and April 2007 sampling events and in groundwater samples from MW-9 during the July 2009 sampling event. Total cPAHs were not detected in groundwater samples from the other "D" Street wells during the quarterly monitoring program.

Total cPAHs were detected at concentrations less than the MTCA CUL in groundwater samples from MW-7 during the May and October 2006, May 2008 and May 2009 sampling events.

Total cPAHs were detected at concentrations less than the MTCA CUL in groundwater samples from MW-14 during the July 2007, January and July 2009 sampling events. Total cPAHs were detected at concentrations greater than the MTCA CUL in groundwater samples from MW-14 during the May 2006 (0.827 μg/l) sampling event.

Total cPAHs were not detected in groundwater samples from MW-7 or MW-14 during the other sampling events conducted for the quarterly groundwater monitoring program.

### 4.3 Naphthalene

Naphthalene was detected at concentrations less than the MTCA CUL (160 μg/l) in groundwater samples from MW-7 and MW-9 during the May 2008 sampling event, in groundwater samples from MW-4, MW-5 and MW8 during the October 2008 sampling event, and in groundwater samples from MW-2, MW-4, MW-5, MW-8 and MW-11 during the November 2009 sampling event. Naphthalene was not detected during any other sampling events for the quarterly groundwater monitoring program.

### 4.4 Natural Attenuation Parameters

Natural attenuation parameters were collected during the quarterly groundwater monitoring program to assess whether natural attenuation is occurring at the Site. The processes of natural attenuation include biodegradation, dispersion, dilution, sorption, chemical or biological stabilization and transformation or destruction of contaminants.

Geochemical data indicative of the presence of biodegradation processes acting in the groundwater can be used to demonstrate that natural attenuation is occurring at the Site. Natural attenuation parameters for petroleum based contamination typically include nitrates, sulfates, manganese ($Mn^{+2}$), ferrous iron ($Fe^{+2}$), dissolved oxygen (DO) and oxidation-reduction potential (ORP). These parameters are indicative of the presence of biodegradation processes that use terminal electron acceptors (TEA) as microorganisms consume petroleum contaminants. The sequential order of use of TEA by microorganisms is shown below:

dissolved oxygen (DO)>nitrate ($NO_3^-$)>manganese ($Mn^{+4}$)>ferric iron ($Fe^{+3}$)>sulfate ($SO_4^{-2}$)

The amount of DO, nitrate and sulfate that is present in groundwater is related to the availability of TEA and these indicators exist at low concentrations in areas of increased microbial activity and natural attenuation. Ferrous iron ($Fe^{+2}$) and manganese ($Mn^{+2}$) are the metabolic byproducts of the metabolized TEA and manganese ($Mn^{+2}$) and ferrous iron ($Fe^{+2}$) exist at higher concentrations in areas of increased microbial activity and natural attenuation. Observations regarding the data are described below.

#### *4.4.1 Dissolved Oxygen*

Oxygen is the most common electron acceptor utilized during biodegradation of petroleum hydrocarbons. Petroleum hydrocarbons are broken down most rapidly by indigenous microorganisms under aerobic conditions. Dissolved oxygen is the terminal electron acceptor (oxidant) under aerobic conditions.

DO is an indicator of aerobic/anaerobic activity. DO concentrations greater than 2 mg/l are generally indicative of aerobic conditions. An aerobic breakdown pathway is preferable to an anaerobic breakdown pathway for the biodegradation of petroleum hydrocarbons.

The DO concentrations measured during the quarterly groundwater monitoring program indicate that aerobic groundwater conditions may exist at the Site, except for MW-3. The DO concentrations measured at MW-3 appear to be typical of anaerobic groundwater conditions.

#### *4.4.2 Oxidation/Reduction Potential*

The oxidation/reduction potential of groundwater is an indicator of the relative tendency of a solution to accept or transfer electrons. Oxidation is defined as the loss of an electron(s) from a species, while reduction is the gain of an electron(s) from a species. Oxidation/Reduction reactions in groundwater are usually biologically mediated and, therefore, the ORP depends upon and influences rates of biodegradation. An ORP of less than 50 mVolts indicates that a reductive pathway is possible. An ORP potential of less than –100 mVolts indicates that a reductive pathway is likely.

The relatively low ORP observed during the quarterly groundwater monitoring program suggests that a reductive pathway is likely and that oxygen is being depleted in the biodegradation of petroleum hydrocarbons at the Site.

#### *4.4.3 Nitrate*

Nitrate serves as an electron acceptor through the processes of denitrification and nitrate reduction. Denitrification occurs when nitrate ($NO_3^-$) is converted to nitrogen ($N_2$). Nitrate reduction is the process of converting nitrate ($NO_3^-$) to nitrite ($NO_2^-$) to ammonia ($NH_4^+$). In oxidation/reduction reactions, denitrification is favored over nitrate reduction because microorganisms generate more energy through denitrification. Changes in nitrate concentrations across a contaminant source area can be used as an indicator of microbial activity.

Nitrate was occasionally detected at low levels in MW-2, MW-3 and MW-9 and not detected in any other monitoring wells during the quarterly groundwater monitoring program. The lack of nitrate suggests that denitrification is not occurring at the site, but the low concentrations of nitrate detected appear to be typical of anaerobic conditions.

#### *4.4.4 Manganese*

Manganese compounds are used as electron acceptors for anaerobic biodegradation of petroleum hydrocarbons and other organic compounds under anaerobic conditions. Manganese (+4) is reduced to soluble manganese (+2) by microbial activity. The concentration of dissolved manganese across a contaminant source can be used as an indicator of microbial activity.

No obvious pattern of manganese concentrations were observed in samples collected during the quarterly groundwater monitoring program.

#### *4.4.5 Ferrous Iron*

Ferric iron serves as an electron acceptor and is reduced to soluble ferrous iron during biodegradation of petroleum hydrocarbons under anaerobic conditions. Ferrous iron is an indicator of reducing conditions and microbial activity, but is very sensitive to the presence of oxygen and readily oxidizes to the ferric form.

No obvious pattern of ferrous iron concentrations were observed in samples collected during the quarterly groundwater monitoring program.

#### *4.4.6 Sulfate*

Sulfate is reduced to sulfide during anaerobic microbial metabolism, which subsequently forms metal sulfide precipitates.

No obvious pattern of sulfate concentrations were observed in samples collected during the quarterly groundwater monitoring program.

## 5.0 DISCUSSION

### 5.1 Contaminates of Concern

#### *5.1.1 BRPH*

- BRPH was not detected in any of the samples collected at the CPOC during the quarterly groundwater monitoring program.
- BRPH was detected at concentrations less than the MTCA CUL at MW-14 during three sampling events. MW-14 was located within the source area material at Area C and was sampled prior to completion of the Area C remedial excavation.

#### *5.1.2 cPAHs*

- cPAHs were not detected in 102 out of 105 samples collected at the CPOC during the quarterly groundwater monitoring program. cPAHs were detected at concentrations less than the MTCA

CUL twice at MW-2 and once at MW-9. The infrequent detections and observed concentrations do not appear to be indicative of continual cPAH migration beyond the CPOC.

- Total cPAHs were detected at concentrations less than the MTCA CUL four times at MW-7 and three times at MW-14. Total cPAHs were detected at a concentration greater than the MCTA CUL during one sampling event at MW-14. MW-7 and MW-14 were located within the source area material at Area C and were sampled prior to completion of the Area C remedial excavation.

#### *5.1.3 Naphthalene*

- Naphthalene was not detected in 90 of the 105 samples collected from the monitoring wells included as part of this groundwater monitoring program. Of the 15 samples with naphthalene detections, none of these detections were greater than the MTCA CUL. These detections were observed at various monitoring wells comprising the CPOC. However, given the observed concentrations and infrequent detections, this does not appear to be indicative of continual migration of naphthalene beyond the CPOC.
- Naphthalene was detected twice at MW-7 and once at MW-14 at concentrations less than the MTCA CUL during the quarterly groundwater monitoring program. MW-7 and MW-14 were located in the source area at Area C.

As described above, the chemical analytical data for COCs collected during the quarterly groundwater program indicate that the observed groundwater contamination does not appear to be migrating off-site at this time.

### 5.2 Natural Attenuation Parameters

ORP measurements collected during the quarterly groundwater monitoring program indicate that anaerobic groundwater conditions exist and that a reductive pathway is likely at the Site.

Dissolved oxygen, nitrate, manganese, ferrous iron and sulfate concentrations during the quarterly groundwater monitoring program are variable and do not exhibit as clear pattern to determine if natural attenuation is occurring at the Site. The variability of the parameters may be related to tidal influence of groundwater flow and to the complex subsurface conditions of the Site. Subsurface conditions are highly variable and have been disturbed in areas due to installation/repair of subsurface utilities and excavation/backfilling during the 2004 IA and remedial actions in 2008/2009.

Overall, trends in monitored natural attenuation (MNA) parameters have been difficult to determine based on the varied previous analytical and measured results. It is possible that future compliance groundwater sampling may indicate that MNA indicator parameters will be different because subsurface conditions at the Site have been modified during recent interim and remedial actions.

### 5.3 Compliance Monitoring

As part of monitoring the performance of this remedial action and assessing future risk from residual contamination at the site, GeoEngineers will be implementing compliance monitoring as described in Appendix F of the 2009 EDR, "Compliance Monitoring Plan, Remedial Excavation, BNSF Oil Pipeline Site, Tacoma, Washington."

Compliance monitoring will be conducted annually, using the "D" Street wells that comprise the CPOC, for five years, unless otherwise determined by Ecology. The compliance monitoring program is intended to monitor COCs and natural attenuation parameters in groundwater after the final remedial action for the Site. The first compliance monitoring event was completed during February 2010.

## 6.0 REFERENCES

GeoEngineers, Inc., *Draft Final Cleanup Action Plan, BNSF Oil Pipeline Site, Tacoma, Washington*. November 14, 2007.

GeoEngineers, Inc., *Final Remedial Investigation/Feasibility Study, BNSF Oil Pipeline Site, Tacoma, Washington.* April 4, 2007.

Model Toxics Control Act (MTCA) Cleanup Regulations*, Washington Administrative Code, Chapter 173-340.* Washington State Department of Ecology.

# TABLE H-1

## SUMMARY OF QUARTERLY GROUNDWATER ANALYTICAL RESULTS[1]

THE BNSF OIL PIPELINE SITE
TACOMA, WASHINGTON

| Sample ID | Sample Date | NWTPH-Dx[2] (mg/l) | Carcinogenic PAHs[4] (µg/l) | | | | | | | | PAHs[4] (µg/l) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | BRPH[3] | Benzo (a) anthracene | Benzo (a) pyrene | Benzo (b) flouranthene | Benzo (k) flouranthene | Chrysene | Dibenz (a,h) anthracene | Indeno (1,2,3-cd) pyrene | Total TEF of cPAHs (detect only) | 1-Methyl-naphthalene | 2-Methyl-naphthalene | Naphthalene |
| MW-2 | 05/04/06 | U(0.481) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | -- | U(0.0943) | U(0.0943) | U(0.0943) |
| | 08/03/06 | U(0.472) | 0.0207 | U(0.00943) | U(0.00943) | 0.0244 | 0.0192 | U(0.00943) | U(0.00943) | 0.0047 | U(0.0943) | U(0.0943) | U(0.0943) |
| | 10/26/06 | U(0.472) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | -- | U(0.0943) | U(0.0943) | U(0.0943) |
| | 01/29/07 | U(0.472) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | -- | U(0.0943) | U(0.0943) | U(0.0943) |
| | 04/23/07 | U(0.476) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | -- | U(0.0943) | U(0.0943) | U(0.0943) |
| | 07/12/07 | U(0.500) | 0.00974 | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | 0.00097 | U(0.0943) | U(0.0943) | U(0.0943) |
| | 10/30/07 | U(0.476) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | -- | U(0.0943) | U(0.0943) | U(0.0943) |
| | 01/21/08 | U(0.476) | U(0.00952) | U(0.00952) | U(0.00952) | U(0.00952) | U(0.00952) | U(0.00952) | U(0.00952) | -- | U(0.0952) | U(0.0952) | U(0.0952) |
| | 04/23/08 | U(0.472) | U(0.00952) | U(0.00952) | U(0.00952) | U(0.00952) | U(0.00952) | U(0.00952) | U(0.00952) | -- | U(0.0952) | U(0.0952) | U(0.0952) |
| | 07/14/08 | U(0.481) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | -- | U(0.0943) | U(0.0943) | U(0.0943) |
| | 10/06/08 | U(0.472) | U(0.00962) | U(0.00962) | U(0.00962) | U(0.00962) | U(0.00962) | U(0.00962) | U(0.00962) | -- | U(0.0962) | U(0.0962) | U(0.0962) |
| | 01/21/09 | U(0.472) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | -- | U(0.0943) | U(0.0943) | U(0.0943) |
| | 04/16/09 | U(0.481) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | -- | U(0.0943) | U(0.0943) | U(0.0943) |
| | 07/16/09 | U(0.48) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | -- | U(0.0943) | U(0.0943) | U(0.0943) |
| | 11/18/09 | U(0.47) | U(0.0095) | U(0.019) | U(0.0095) | U(0.0095) | U(0.0095) | U(0.0095) | U(0.0095) | -- | U(0.095) | U(0.12) | 0.11 |
| MW-3 | 05/04/06 | U(0.472) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | -- | U(0.0943) | U(0.0943) | U(0.0943) |
| | 08/03/06 | U(0.472) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | -- | U(0.0943) | U(0.0943) | U(0.0943) |
| | 10/26/06 | U(0.472) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | -- | U(0.0943) | U(0.0943) | U(0.0943) |
| | 01/29/07 | U(0.472) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | -- | U(0.0943) | U(0.0943) | U(0.0943) |
| | 04/23/07 | U(0.472) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | -- | U(0.0943) | U(0.0943) | U(0.0943) |
| | 07/12/07 | U(0.472) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | -- | U(0.0943) | U(0.0943) | U(0.0943) |
| | 10/30/07 | U(0.472) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | -- | U(0.0943) | U(0.0943) | U(0.0943) |
| | 01/21/08 | U(0.495) | U(0.00980) | U(0.00980) | U(0.00980) | U(0.00980) | U(0.00980) | U(0.00980) | U(0.00980) | -- | U(0.0980) | U(0.0980) | U(0.0980) |
| | 04/23/08 | U(0.485) | U(0.00952) | U(0.00952) | U(0.00952) | U(0.00952) | U(0.00952) | U(0.00952) | U(0.00952) | -- | U(0.0952) | U(0.0952) | U(0.0952) |
| | 07/14/08 | U(0.485) | U(0.00962) | U(0.00962) | U(0.00962) | U(0.00962) | U(0.00962) | U(0.00962) | U(0.00962) | -- | U(0.0962) | U(0.0962) | U(0.0962) |
| | 10/06/08 | U(0.476) | U(0.00952) | U(0.00952) | U(0.00952) | U(0.00952) | U(0.00952) | U(0.00952) | U(0.00952) | -- | U(0.0952) | U(0.0952) | U(0.0952) |
| | 01/21/09 | U(0.472) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | -- | U(0.0943) | U(0.0943) | U(0.0943) |
| | 04/16/09 | U(0.495) | U(0.00952) | U(0.00952) | U(0.00952) | U(0.00952) | U(0.00952) | U(0.00952) | U(0.00952) | -- | U(0.0952) | U(0.0952) | U(0.0952) |
| | 07/16/09 | U(0.47) | U(0.0094) | U(0.019) | U(0.0094) | U(0.0094) | U(0.0094) | U(0.0094) | U(0.0094) | -- | U(0.094) | U(0.12) | 0.13 |
| | 11/18/09 | U(0.47) | U(0.0094) | U(0.019) | U(0.0094) | U(0.0094) | U(0.0094) | U(0.0094) | U(0.0094) | -- | U(0.0094) | U(0.12) | U(0.0094) |
| MW-4 | 05/04/06 | U(0.472) | U(0.00971) | U(0.00971) | U(0.00971) | U(0.00971) | U(0.00971) | U(0.00971) | U(0.00971) | -- | U(0.0971) | U(0.0971) | U(0.0971) |
| | 08/03/06 | U(0.472) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | -- | U(0.0943) | U(0.0943) | U(0.0943) |
| | 10/26/06 | U(0.472) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | -- | U(0.0943) | U(0.0943) | U(0.0943) |
| | 01/29/07 | U(0.472) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | -- | U(0.0943) | U(0.0943) | U(0.0943) |
| | 04/23/07 | U(0.472) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | -- | U(0.0943) | U(0.0943) | U(0.0943) |
| | 07/11/07 | U(0.500) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | -- | U(0.0943) | U(0.0943) | U(0.0943) |
| | 10/30/07 | U(0.476) | U(0.00952) | U(0.00952) | U(0.00952) | U(0.00952) | U(0.00952) | U(0.00952) | U(0.00952) | -- | U(0.0952) | U(0.0952) | U(0.0952) |
| | 01/21/08 | U(0.476) | U(0.00971) | U(0.00971) | U(0.00971) | U(0.00971) | U(0.00971) | U(0.00971) | U(0.00971) | -- | U(0.0971) | U(0.0971) | U(0.0971) |
| | 04/23/08 | U(0.481) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | -- | U(0.0943) | U(0.0943) | U(0.0943) |
| | 07/15/08 | U(0.476) | U(0.00962) | U(0.00962) | U(0.00962) | U(0.00962) | U(0.00962) | U(0.00962) | U(0.00962) | -- | U(0.0962) | U(0.0962) | U(0.0962) |
| | 10/06/08 | U(0.472) | U(0.00971) | U(0.00971) | U(0.00971) | U(0.00971) | U(0.00971) | U(0.00971) | U(0.00971) | -- | 1.75 | 0.169 | 1.05 |
| | 01/21/09 | U(0.472) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | -- | U(0.0943) | U(0.0943) | U(0.0943) |
| | 04/16/09 | U(0.481) | U(0.00952) | U(0.00952) | U(0.00952) | U(0.00952) | U(0.00952) | U(0.00952) | U(0.00952) | -- | U(0.0952) | U(0.0952) | U(0.0952) |
| | 07/16/09 | U(0.47) | U(0.0094) | U(0.019) | U(0.0094) | U(0.0094) | U(0.0094) | U(0.0094) | U(0.0094) | -- | U(0.095) | U(0.12) | 0.12 |
| | 11/18/09 | U(0.47) | U(0.0094) | U(0.019) | U(0.0094) | U(0.0094) | U(0.0094) | U(0.0094) | U(0.0094) | -- | U(0.0094) | U(0.12) | 0.0098 |

| Sample ID | Sample Date | NWTPH-Dx[2] (mg/l) | Carcinogenic PAHs[4] (µg/l) | | | | | | | | PAHs[4] (µg/l) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | BRPH[3] | Benzo (a) anthracene | Benzo (a) pyrene | Benzo (b) flouranthene | Benzo (k) flouranthene | Chrysene | Dibenz (a,h) anthracene | Indeno (1,2,3-cd) pyrene | Total TEF of cPAHs (detect only) | 1-Methyl-naphthalene | 2-Methyl-naphthalene | Naphthalene |
| MW-5 | 05/04/06 | U(0.476) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | -- | U(0.0943) | U(0.0943) | U(0.0943) |
| | 08/03/06 | U(0.472) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | -- | U(0.0943) | U(0.0943) | U(0.0943) |
| | 10/27/06 | U(0.472) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | -- | U(0.0943) | U(0.0943) | U(0.0943) |
| | 01/29/07 | U(0.476) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | -- | U(0.0943) | U(0.0943) | U(0.0943) |
| | 04/23/07 | U(0.481) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | -- | U(0.0943) | U(0.0943) | U(0.0943) |
| | 07/11/07 | U(0.476) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | -- | U(0.0943) | U(0.0943) | U(0.0943) |
| | 10/30/07 | U(0.472) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | -- | U(0.0943) | U(0.0943) | U(0.0943) |
| | 01/21/08 | U(0.481) | U(0.00952) | U(0.00952) | U(0.00952) | U(0.00952) | U(0.00952) | U(0.00952) | U(0.00952) | -- | U(0.0952) | U(0.0952) | U(0.0952) |
| | 04/23/08 | U(0.481) | U(0.00952) | U(0.00952) | U(0.00952) | U(0.00952) | U(0.00952) | U(0.00952) | U(0.00952) | -- | U(0.0952) | U(0.0952) | U(0.0952) |
| | 07/14/08 | U(0.481) | U(0.00962) | U(0.00962) | U(0.00962) | U(0.00962) | U(0.00962) | U(0.00962) | U(0.00962) | -- | U(0.0962) | U(0.0962) | U(0.0962) |
| | 10/06/08 | U(0.472) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | -- | U(0.0943) | U(0.0943) | 0.157 |
| | 01/21/09 | U(0.472) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | -- | U(0.0943) | U(0.0943) | U(0.0943) |
| | 04/16/09 | U(0.485) | U(0.00962) | U(0.00962) | U(0.00962) | U(0.00962) | U(0.00962) | U(0.00962) | U(0.00962) | -- | U(0.0962) | U(0.0962) | U(0.0962) |
| | 07/16/09 | U(0.47) | U(0.0093) | U(0.019) | U(0.0093) | U(0.0093) | U(0.0093) | U(0.0093) | U(0.0093) | -- | U(0.093) | U(0.12) | 0.11 |
| | 11/18/09 | U(0.47) | U(0.0094) | U(0.019) | U(0.0094) | U(0.0094) | U(0.0094) | U(0.0094) | U(0.0094) | -- | U(0.0094) | U(0.12) | 0.012 |
| MW-7 | 05/05/06 | U(0.472) | 0.0158 | U(0.00943) | U(0.00943) | U(0.00943) | 0.0159 | U(0.00943) | U(0.00943) | 0.0016 | U(0.0943) | U(0.0943) | U(0.0943) |
| | 08/03/06 | U(0.472) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | -- | U(0.0943) | U(0.0943) | U(0.0943) |
| | 10/26/06 | U(0.472) | 0.0591 | 0.0697 | 0.0390 | 0.0507 | 0.0767 | U(0.00952) | 0.0717 | 0.0925 | U(0.0952) | U(0.0952) | U(0.0952) |
| | 01/30/07 | U(0.472) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | -- | U(0.0943) | U(0.0943) | U(0.0943) |
| | 04/24/07 | U(0.481) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | -- | U(0.0943) | U(0.0943) | U(0.0943) |
| | 07/12/07 | U(0.500) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | -- | U(0.0943) | U(0.0943) | U(0.0943) |
| | 10/31/07 | U(0.476) | U(0.00962) | U(0.00962) | U(0.00962) | U(0.00962) | U(0.00962) | U(0.00962) | U(0.00962) | -- | U(0.0962) | U(0.0962) | U(0.0962) |
| | 01/22/08 | U(0.476) | U(0.00980) | U(0.00980) | U(0.00980) | U(0.00980) | U(0.00980) | U(0.00980) | U(0.00980) | -- | U(0.0980) | U(0.0980) | U(0.0980) |
| | 04/24/08 | U(0.472) | U(0.0476) | U(0.0476) | U(0.0476) | U(0.0476) | U(0.0476) | 0.241 | 0.164 | 0.0405 | 0.675 | 1.63 | 1.54 |
| | 07/15/08 | U(0.476) | U(0.00971) | U(0.00971) | U(0.00971) | U(0.00971) | U(0.00971) | U(0.00971) | U(0.00971) | -- | U(0.0971) | U(0.0971) | U(0.0971) |
| | 10/06/08 | U(0.472) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | -- | U(0.0943) | U(0.0943) | U(0.0943) |
| | 01/22/09 | U(0.481) | U(0.00962) | U(0.00962) | U(0.00962) | U(0.00962) | U(0.00962) | U(0.00962) | U(0.00962) | -- | U(0.0962) | U(0.0962) | U(0.0962) |
| | 04/17/09 | U(0.490) | U(0.00952) | U(0.00952) | U(0.00952) | U(0.00952) | 0.00985 | U(0.00952) | U(0.00952) | 0.00010 | U(0.0952) | U(0.0952) | U(0.0952) |
| | 07/16/09 | U(0.48) | U(0.010) | U(0.020) | U(0.010) | U(0.010) | U(0.010) | U(0.010) | U(0.010) | -- | U(0.10) | U(0.13) | 0.11 |
| | 11/19/09 | Well Abandoned August 2009 | | | | | | | | | | | |
| MW-8 | 05/04/06 | U(0.472) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | -- | U(0.0943) | U(0.0943) | U(0.0943) |
| | 08/04/09 | U(0.472) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | -- | U(0.0943) | U(0.0943) | U(0.0943) |
| | 10/27/06 | U(0.472) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | -- | U(0.0943) | U(0.0943) | U(0.0943) |
| | 01/29/07 | U(0.472) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | -- | U(0.0943) | U(0.0943) | U(0.0943) |
| | 04/23/07 | U(0.476) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | -- | U(0.0943) | U(0.0943) | U(0.0943) |
| | 07/11/07 | U(0.472) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | -- | U(0.0943) | U(0.0943) | U(0.0943) |
| | 10/30/07 | U(0.472) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | -- | U(0.0943) | U(0.0943) | U(0.0943) |
| | 01/21/08 | U(0.472) | U(0.00952) | U(0.00952) | U(0.00952) | U(0.00952) | U(0.00952) | U(0.00952) | U(0.00952) | -- | U(0.0952) | U(0.0952) | U(0.0952) |
| | 04/23/08 | U(0.476) | U(0.00952) | U(0.00952) | U(0.00952) | U(0.00952) | U(0.00952) | U(0.00952) | U(0.00952) | -- | U(0.0952) | U(0.0952) | U(0.0952) |
| | 07/14/08 | U(0.481) | U(0.00962) | U(0.00962) | U(0.00962) | U(0.00962) | U(0.00962) | U(0.00962) | U(0.00962) | -- | U(0.0962) | U(0.0962) | U(0.0962) |
| | 10/06/08 | U(0.472) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | -- | U(0.0943) | U(0.0943) | 0.104 |
| | 01/21/09 | U(0.472) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | -- | U(0.0943) | U(0.0943) | U(0.0943) |
| | 04/16/09 | U(0.490) | U(0.00952) | U(0.00952) | U(0.00952) | U(0.00952) | U(0.00952) | U(0.00952) | U(0.00952) | -- | U(0.0952) | U(0.0952) | U(0.0952) |
| | 07/16/09 | U(0.47) | U(0.0094) | U(0.019) | U(0.0094) | U(0.0094) | U(0.0094) | U(0.0094) | U(0.0094) | -- | U(0.094) | U(0.12) | 0.17 |
| | 11/18/09 | U(0.47) | U(0.019) | U(0.0094) | U(0.0094) | U(0.0094) | U(0.0094) | U(0.0094) | U(0.0094) | -- | U(0.0094) | U(0.012) | 0.012 |
| MW-9 | 05/05/06 | U(0.472) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | -- | U(0.0943) | U(0.0943) | U(0.0943) |
| | 08/04/06 | U(0.472) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | -- | U(0.0943) | U(0.0943) | U(0.0943) |
| | 10/27/06 | U(0.472) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | -- | U(0.0943) | U(0.0943) | U(0.0943) |
| | 01/30/07 | U(0.472) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | -- | U(0.0943) | U(0.0943) | U(0.0943) |
| | 04/24/07 | U(0.472) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | -- | U(0.0943) | U(0.0943) | U(0.0943) |
| | 07/11/07 | U(0.500) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | -- | U(0.0943) | U(0.0943) | U(0.0943) |

| Sample ID | Sample Date | NWTPH-Dx[2] (mg/l) | Carcinogenic PAHs[4] (µg/l) | | | | | | | | PAHs[4] (µg/l) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | BRPH[3] | Benzo (a) anthracene | Benzo (a) pyrene | Benzo (b) flouranthene | Benzo (k) flouranthene | Chrysene | Dibenz (a,h) anthracene | Indeno (1,2,3-cd) pyrene | Total TEF of cPAHs (detect only) | 1-Methyl-naphthalene | 2-Methyl-naphthalene | Naphthalene |
| MW-9 | 10/31/07 | U(0.472) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | -- | U(0.0943) | U(0.0943) | U(0.0943) |
| | 01/22/08 | U(0.476) | U(0.00952) | U(0.00952) | U(0.00952) | U(0.00952) | U(0.00952) | U(0.00952) | U(0.00952) | -- | U(0.0952) | U(0.0952) | U(0.0952) |
| | 04/24/08 | U(0.481) | U(0.0952) | U(0.0952) | U(0.0952) | U(0.0952) | U(0.0952) | U(0.0952) | U(0.0952) | -- | 1.32 | 3.35 | 3.19 |
| | 07/14/08 | U(0.481) | U(0.00962) | U(0.00962) | U(0.00962) | U(0.00962) | U(0.00962) | U(0.00962) | U(0.00962) | -- | U(0.0962) | U(0.0962) | U(0.0962) |
| | 10/07/08 | U(0.472) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | -- | U(0.0943) | U(0.0943) | U(0.0943) |
| | 01/22/09 | U(0.472) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | -- | U(0.0943) | U(0.0943) | U(0.0943) |
| | 04/16/09 | U(0.481) | U(0.00952) | U(0.00952) | U(0.00952) | U(0.00952) | U(0.00952) | U(0.00952) | U(0.00952) | -- | U(0.0952) | U(0.0952) | U(0.0952) |
| | 07/16/09 | U(0.47) | 0.0096 | U(0.019) | U(0.0094) | U(0.0094) | U(0.0094) | U(0.0094) | U(0.0094) | 0.0010 | U(0.094) | U(0.12) | 0.23 |
| | 11/18/09 | U(0.48) | U(0.0095) | U(0.019) | U(0.0095) | U(0.0095) | U(0.0095) | U(0.0095) | U(0.0095) | -- | U(0.0095) | U(0.12) | U(0.0095) |
| MW-11 | 05/04/06 | U(0.481) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | -- | U(0.0943) | U(0.0943) | U(0.0943) |
| | 08/03/06 | U(0.472) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | -- | U(0.0943) | U(0.0943) | U(0.0943) |
| | 10/26/06 | U(0.472) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | -- | U(0.0943) | U(0.0943) | U(0.0943) |
| | 01/29/07 | U(0.472) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | -- | U(0.0943) | U(0.0943) | U(0.0943) |
| | 04/23/07 | U(0.472) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | -- | U(0.0943) | U(0.0943) | U(0.0943) |
| | 07/11/07 | U(0.500) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | -- | U(0.0943) | U(0.0943) | U(0.0943) |
| | 10/30/07 | U(0.472) | U(0.0125) | U(0.0125) | U(0.0125) | U(0.0125) | U(0.0125) | U(0.0125) | U(0.0125) | -- | U(0.125) | U(0.125) | U(0.125) |
| | 01/21/08 | U(0.485) | U(0.00971) | U(0.00971) | U(0.00971) | U(0.00971) | U(0.00971) | U(0.00971) | U(0.00971) | -- | U(0.0971) | U(0.0971) | U(0.0971) |
| | 04/23/08 | U(0.476) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | -- | U(0.0943) | U(0.0943) | U(0.0943) |
| | 07/15/08 | U(0.485) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | -- | U(0.0943) | U(0.0943) | U(0.0943) |
| | 10/06/08 | U(0.481) | U(0.00962) | U(0.00962) | U(0.00962) | U(0.00962) | U(0.00962) | U(0.00962) | U(0.00962) | -- | U(0.0962) | U(0.0962) | U(0.0962) |
| | 01/21/09 | U(0.472) | U(0.00952) | U(0.00952) | U(0.00952) | U(0.00952) | U(0.00952) | U(0.00952) | U(0.00952) | -- | U(0.0952) | U(0.0952) | U(0.0952) |
| | 04/16/09 | U(0.476) | U(0.00952) | U(0.00952) | U(0.00952) | U(0.00952) | U(0.00952) | U(0.00952) | U(0.00952) | -- | U(0.0952) | U(0.0952) | U(0.0952) |
| | 07/16/09 | U(0.47) | U(0.0093) | U(0.019) | U(0.0093) | U(0.0093) | U(0.0093) | U(0.0093) | U(0.0093) | -- | 0.11 | 0.23 | 0.61 |
| | 11/18/09 | U(0.47) | U(0.0095) | U(0.019) | U(0.0095) | U(0.0095) | U(0.0095) | U(0.0095) | U(0.0095) | -- | U(0.0095) | U(0.12) | 0.018 |
| MW-14 | 05/05/06 | **1.76** | 0.503 | 0.653 | 0.302 | 0.606 | 0.457 | 0.0979 | 0.181 | **0.8266** | U(0.943) | U(0.943) | U(0.943) |
| | 08/03/06 | U(0.472) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | -- | U(0.0943) | U(0.0943) | U(0.0943) |
| | 10/26/06 | U(0.476) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | -- | U(0.0943) | U(0.0943) | U(0.0943) |
| | 01/30/07 | U(0.472) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | -- | U(0.0943) | U(0.0943) | U(0.0943) |
| | 04/24/07 | U(0.472) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | -- | U(0.0943) | U(0.0943) | U(0.0943) |
| | 07/12/07 | U(0.476) | U(0.00943) | 0.0148 | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | 0.0148 | U(0.0943) | U(0.0943) | U(0.0943) |
| | 10/31/07 | 0.494 | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | -- | U(0.0943) | U(0.0943) | U(0.0943) |
| | 01/22/08 | U(0.472) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | -- | U(0.0943) | U(0.0943) | U(0.0943) |
| | 04/24/08 | **1.60** | U(0.0476) | U(0.0476) | U(0.0476) | U(0.0476) | U(0.0476) | U(0.0476) | U(0.0476) | -- | U(0.476) | U(0.476) | U(0.476) |
| | 07/15/08 | U(0.476) | U(0.00971) | U(0.00971) | U(0.00971) | U(0.00971) | U(0.00971) | U(0.00971) | U(0.00971) | -- | U(0.0971) | U(0.0971) | U(0.0971) |
| | 10/07/08 | U(0.472) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | -- | U(0.0943) | U(0.0943) | U(0.0943) |
| | 01/22/09 | U(0.472) | U(0.00943) | U(0.00943) | U(0.00943) | U(0.00943) | 0.0108 | U(0.00943) | U(0.00943) | 0.0001 | U(0.0943) | U(0.0943) | U(0.0943) |
| | 04/17/09 | U(0.495) | U(0.00952) | U(0.00952) | U(0.00952) | U(0.00952) | U(0.00952) | U(0.00952) | U(0.00952) | -- | U(0.0952) | U(0.0952) | U(0.0952) |
| | 07/16/09 | **0.97** | U(0.0096) | U(0.019) | 0.014 | U(0.0096) | 0.010 | U(0.0096) | U(0.0096) | 0.002 | U(0.096) | U(0.12) | 0.13 |
| | 11/19/09 | Well Abandoned August 2009 | | | | | | | | | | | |
| MTCA Method A Groundwater Cleanup Level | | 0.5 | MTCA Method A Groundwater cleanup level for the sum of all cPAHs is 0.1 µg/l | | | | | | | 0.1 | MTCA Method A cleanup level for the sum of all Napthalenes is 160 µg/l | | |

Notes:

[1] Chemical analysis performed by Test America of Seattle, Washington.

[2] Washington Department of Ecology Method Northwest Total Petroleum Hydrocarbons as Diesel - Extended (NWTPH-Dx) with acid /silica gel cleanup and calibrated to Bunker-C.

[3] BRPH = Bunker Range Petroleum Hydrocarbons equivalent to Bunker-C fuel oil.

[4] Polycyclic aromatic hydrocarbons (PAHs) were analyzed by Method 8270-SIM.

TEF = Toxicity Equivalency Factor    mg/l = milligrams per liter    µg/l = microgram per liter

U = Analyte was not detected at or greater than the listed reporting limit

MTCA = Model Toxics Control Act

**Bold** = Analyte detected at greater than the listed reporting limit.

TACO:\0\0506141\03\Finals\050614103_RAReport_Appendix H_Tables H1_H2_052810.xlsx

# TABLE H-2

## SUMMARY OF QUARTERLY GROUNDWATER NATURAL ATTENUATION PARAMETERS[1]

THE BNSF OIL PIPELINE SITE
TACOMA, WASHINGTON

| | | Metals | Conventional Chemistry | | Anions | | Field Parameters | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Sample ID | Sample Date | Manganese[2] (mg/l) | Salinity[3] (ppth) | Total Alkalinity[4] (mg/l) | Nitrate-Nitrogen[5] (mg/l) | Sulfate[6] (mg/l) | Dissolved Oxygen (mg/l) | ORP (mv) | Ferrous Iron (mg/l) | Water Level (ft btoc) |
| MW-2 | 05/04/06 | 0.130 | 3.40 | 622 | U(5.00) | 134 | 5.09 | -162 | -- | 5.42 |
| | 08/03/06 | 0.0997 | 2.80 | 674 | U(10.0) | 87.4 | 8.71 | -217 | -- | 5.49 |
| | 10/26/06 | 0.550 | 9.80 | 250 | U(0.200) | 657 | 1.59 | -108 | 3.8 | 4.85 |
| | 01/29/07 | 0.560 | 4.70 | 274 | 0.210 | 310 | 1.27 | -83 | -- | 4.70 |
| | 04/23/07 | 0.470 | -- | 308 | U(0.200) | 351 | 4.20 | 14 | 1.0 | 4.71 |
| | 07/12/07 | 0.207 | 3.4 | 355 | U(0.200) | 186 | 6.26 | -186 | 1.2 | 5.50 |
| | 10/30/07 | 1.44 | 9.2 | 272 | U(0.200) | 650 | 4.30 | -145 | 2.0 | 5.31 |
| | 01/21/08 | 0.446 | 5.8 | 280 | U(0.200) | 386 | 10.27 | -90 | 1.0 | 5.33 |
| | 04/23/08 | 0.276 | 8.2 | 275 | U(0.200) | 771 | 9.67 | -88 | 1.0 | 4.87 |
| | 07/14/08 | 0.352 | 5.3 | 363 | U(0.200) | 333 | 6.74 | -187 | 0.8 | 5.13 |
| | 10/06/08 | 0.934 | 7.4 | 319 | U(0.200) | 497 | -- | -64 | 2.2 | 8.23 |
| | 01/21/09 | 0.337 | 6.3 | 367 | U(0.200) | 342 | 1.93 | -160 | -- | 4.34 |
| | 04/16/09 | 0.630 | 6.3 | 222 | U(0.400) | 466 | 2.49 | -98 | 2.2 | 4.58 |
| | 07/16/09 | 2.3 | 7.4 | 320 | U(0.90) | 510 | 0.00 | -82 | 2.8 | 5.32 |
| | 11/18/09 | 2.4 | 4.5 | 240 | U(0.90) | 290 | 3.53 | -195 | -- | 3.33* |
| MW-3 | 05/04/06 | 0.0536 | 0.200 | 238 | U(0.200) | 0.796 | 0.08 | -111 | -- | 5.30 |
| | 08/03/06 | 0.0905 | 0.300 | 266 | U(0.200) | U(0.400) | 8.81 | -110 | -- | 5.69 |
| | 10/26/06 | 0.0514 | 0.200 | 239 | 0.210 | 1.28 | 1.63 | -91 | 1.8 | 5.25 |
| | 01/29/07 | 0.0702 | 0.300 | 246 | U(0.200) | 0.780 | 0.93 | -135 | 0.0 | 4.79 |
| | 04/23/07 | 0.0537 | -- | 241 | U(0.200) | 0.560 | 3.80 | -66 | 0.2 | 4.78 |
| | 07/12/07 | 0.0566 | 0.30 | 263 | U(0.200) | 0.980 | 0.06 | -168 | 3.6 | 5.38 |
| | 10/30/07 | 0.0575 | 0.30 | 262 | 0.260 | 1.3 | 4.70 | -160 | 0.4 | 5.21 |
| | 01/21/08 | 0.105 | 0.40 | 256 | U(0.200) | 2.98 | 11.90 | -144 | 1.0 | 4.43 |
| | 04/23/08 | 0.0848 | 0.40 | 256 | 0.200 | 7.18 | 10.48 | -158 | 0.6 | 4.99 |
| | 07/14/08 | 0.0710 | 0.40 | 260 | U(0.200) | 2.59 | 8.74 | -96 | 1.0 | 5.28 |
| | 10/06/08 | 0.755 | 4.2 | 2.55 | U(0.200) | 304 | 3.78 | -160 | 2.0 | 5.38 |
| | 01/21/09 | 0.485 | 2.5 | 256 | U(0.200) | 159 | 0.66 | -40 | -- | 4.56 |
| | 04/16/09 | 0.215 | 1.4 | 248 | U(0.200) | 95.2 | -- | -211 | 0.2 | 4.81 |
| | 07/16/09 | 0.15 | 0.70 | 260 | U(0.90) | 32 | 4.35 | -150 | 1.0 | 5.45 |
| | 11/18/09 | 0.16 | 0.60 | 240 | U(0.90) | 12 | 3.63 | -184 | 0.6 | 6.43* |
| MW-4 | 05/04/06 | 4.86 | 5.60 | 621 | U(8.00) | 223 | 0.25 | -120 | 0.1 | 4.58 |
| | 08/03/06 | 3.64 | 6.20 | 709 | U(0.200) | 199 | 7.28 | -147 | -- | 5.75 |
| | 10/26/06 | 3.60 | 6.90 | 708 | U(0.200) | 172 | 6.59 | -164 | 6.3 | 5.70 |
| | 01/29/07 | 1.38 | 1.90 | 457 | U(0.200) | 87.0 | 0.21 | -158 | 4.4 | 5.10 |
| | 04/23/07 | 4.12 | 4.8 | 628 | U(0.200) | 138 | 3.39 | -177 | 2.8 | 5.25 |
| | 07/11/07 | 3.61 | 5.1 | 675 | U(0.200) | 120 | 7.39 | -140 | 3.8 | 7.99 |
| | 10/30/07 | 3.33 | 5.3 | 710 | U(0.200) | 120 | 4.95 | -136 | -- | 5.10 |
| | 01/21/08 | 0.902 | 1.4 | 476 | U(0.200) | 61.2 | 7.79 | -148 | 3.8 | 4.62 |
| | 04/23/08 | 2.56 | 3.3 | 640 | U(0.200) | 73.1 | 12.29 | -133 | 2.6 | 5.35 |
| | 07/15/08 | 2.15 | 4.3 | 700 | U(0.200) | 94.3 | 9.52 | -185 | 5.1 | 6.45 |
| | 10/06/08 | 2.87 | 5.7 | 706 | U(0.200) | 145 | 4.25 | -177 | 4.0 | 5.79 |
| | 01/21/09 | 0.797 | 1.4 | 440 | U(0.200) | 86.9 | 0.41 | -127 | -- | 4.90 |
| | 04/16/09 | 1.92 | 3.1 | 618 | U(0.200) | 74.9 | 0.00 | -123 | 1.8 | 5.04 |
| | 07/16/09 | 2.7 | 3.9 | 690 | U(0.90) | U(120) | 0.00 | -106 | 4.5 | 5.82 |
| | 11/18/09 | 0.9 | 1.9 | 460 | U(0.90) | 71 | 1.09 | -119 | 2.0 | 4.27* |

| Sample ID | Sample Date | Metals | Conventional Chemistry | | Anions | | Field Parameters | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Manganese[2] (mg/l) | Salinity[3] (ppth) | Total Alkalinity[4] (mg/l) | Nitrate-Nitrogen[5] (mg/l) | Sulfate[6] (mg/l) | Dissolved Oxygen (mg/l) | ORP (mv) | Ferrous Iron (mg/l) | Water Level (ft btoc) |
| MW-5 | 05/04/06 | 3.61 | 13.4 | 290 | U(20.0) | 1,030 | 4.98 | -155 | -- | 7.65 |
| | 08/03/06 | 2.79 | 9.60 | 505 | U(40.0) | 266 | 5.93 | -154 | -- | 6.68 |
| | 10/27/06 | 1.34 | 8.70 | 572 | U(0.200) | -- | 3.85 | -195 | -- | 6.50 |
| | 01/29/07 | 1.52 | 10.6 | 402 | U(0.200) | 635 | 0.39 | -133 | 2.0 | 5.91 |
| | 04/23/07 | 1.50 | 11 | 298 | U(0.200) | 765 | 2.70 | -44 | 3.4 | 5.84 |
| | 07/11/07 | 2.09 | 15 | 287 | U(10.0) | 1,100 | 0.40 | -266 | 4.2 | 6.24 |
| | 10/30/07 | 2.18 | 18 | 275 | U(2.00) | 1,300 | 4.48 | -295 | 3.4 | 5.95 |
| | 01/21/08 | 1.08 | 9.5 | 366 | U(0.400) | 607 | 8.85 | -112 | 1.2 | -- |
| | 04/23/08 | 0.709 | 7.1 | 410 | U(0.200) | 490 | 9.50 | -144 | 1.8 | 6.34 |
| | 07/14/08 | 1.34 | 16 | 269 | U(0.400) | 1,240 | 4.83 | -183 | 3.8 | 6.44 |
| | 10/06/08 | 1.81 | 19 | 270 | U(1.00) | 268 | -- | -201 | 2.2 | 6.24 |
| | 01/21/09 | 0.618 | 8.2 | 391 | U(0.200) | 460 | 0.78 | -83 | -- | 6.02 |
| | 04/16/09 | 0.521 | 8 | 309 | U(0.400) | 637 | -- | -240 | -- | 6.14 |
| | 07/16/09 | 1.2 | 14 | 290 | U(0.90) | 2,200 | 3.07 | -175 | 2.2 | 6.68 |
| | 11/18/09 | 1.2 | 11 | 360 | U(0.90) | 5.2 | 1.29 | -256 | -- | 4.88* |
| MW-7 | 05/05/06 | 2.69 | 0.500 | 555 | U(8.00) | 3.90 | 4.97 | -160 | 5.0 | 7.79 |
| | 08/03/06 | 2.61 | 0.600 | 596 | U(0.200) | 1.48 | 0.01 | -149 | -- | 8.25 |
| | 10/26/06 | 2.06 | 0.600 | 474 | U(0.200) | 1.72 | -- | -161 | -- | 8.31 |
| | 01/30/07 | 2.20 | 0.500 | 480 | U(0.200) | 2.07 | 1.06 | -116 | 4.0 | 7.48 |
| | 04/24/07 | 1.90 | 0.40 | 466 | U(0.200) | 2.59 | 5.10 | -34 | 3.2 | 7.69 |
| | 07/12/07 | 2.89 | 0.50 | 503 | U(0.200) | 2.12 | 6.61 | -148 | 4.1 | 8.00 |
| | 10/31/07 | 2.85 | 0.50 | 517 | U(0.200) | 2.6 | 4.51 | -179 | 4.0 | 7.88 |
| | 01/22/08 | 2.60 | 0.50 | 510 | U(0.200) | 5.75 | 8.80 | -161 | 4.0 | 7.49 |
| | 04/24/08 | 2.50 | 0.50 | 496 | U(0.200) | 0.770 | 11.78 | -123 | 1.6 | 8.04 |
| | 07/15/08 | 2.35 | 0.50 | 550 | U(0.200) | 1.28 | 3.85 | -120 | 5.0 | 8.05 |
| | 10/06/08 | 2.37 | 1.2 | 531 | U(0.200) | 0.910 | 4.56 | -163 | 5.1 | 8.01 |
| | 01/22/09 | 2.45 | 0.50 | 536 | U(0.200) | 0.79 | 0.94 | -126 | -- | 7.39 |
| | 04/17/09 | 0.234 | 0.40 | 512 | U(0.200) | 0.420 | 1.07 | -135 | 4.6 | 7.75 |
| | 07/16/09 | 2.5 | 0.50 | 580 | U(0.90) | U(1.2) | -- | -- | -- | 8.12 |
| | 11/19/09 | Well Abandoned August 2009 | | | | | | | | |
| MW-8 | 05/04/06 | 0.667 | 13.5 | 233 | U(20.0) | 1,030 | 6.75 | -198 | 4.4 | 6.50 |
| | 08/04/09 | 0.772 | 16.0 | 232 | U(1,000) | 1,120 | 0.00 | -140 | -- | 6.98 |
| | 10/27/06 | 0.952 | 24.4 | 206 | U(0.400) | -- | 0.00 | -199 | 2.0 | 6.80 |
| | 01/29/07 | 0.431 | 16.1 | 220 | U(0.200) | 1,110 | 0.48 | -155 | 3.0 | 6.25 |
| | 04/23/07 | 0.562 | 16 | 196 | U(0.200) | 1,240 | 2.80 | -36 | 3.0 | 6.19 |
| | 07/11/07 | 0.523 | 15 | 209 | U(10.0) | 1,130 | 0.49 | -284 | 3.0 | 6.62 |
| | 10/30/07 | 0.722 | 20 | 210 | U(1.00) | 1,500 | 3.74 | -257 | 3.0 | 6.28 |
| | 01/21/08 | 0.504 | 17 | 228 | U(0.400) | 1,250 | 8.87 | -145 | 2.0 | 6.30 |
| | 04/23/08 | 0.290 | 17 | 188 | U(10.0) | 1,420 | 13.26 | -198 | 1.6 | 6.46 |
| | 07/14/08 | 0.454 | 16 | 217 | U(0.400) | 1,280 | 3.06 | -203 | 4.2 | 6.56 |
| | 10/06/08 | 0.464 | 21 | 195 | U(1.00) | 1,480 | 18.75 | -233 | 3.4 | 7.47 |
| | 01/21/09 | 0.352 | 14 | 280 | U(0.200) | 882 | 0.20 | -132 | -- | 6.41 |
| | 04/16/09 | 0.250 | 12 | 247 | U(0.400) | 1,010 | -- | -276 | 2.0 | 6.47 |
| | 07/16/09 | 0.41 | 15 | 250 | U(0.90) | 120 | 0.00 | -231 | 3.6 | 6.85 |
| | 11/18/09 | 0.52 | 20 | 200 | U(0.90) | 1,400 | 2.09 | -314 | 1.1 | 5.34* |
| MW-9 | 05/05/06 | 0.0276 | 0.700 | 360 | U(1.00) | 17.0 | 5.63 | -280 | -- | 7.43 |
| | 08/04/06 | 0.0235 | 0.800 | 323 | U(1,000) | 28.9 | 0.00 | -369 | -- | 8.00 |
| | 10/27/06 | 0.0230 | 1.60 | 297 | U(0.200) | -- | 4.48 | -347 | 0.0 | 7.64 |
| | 01/30/07 | 0.0328 | 0.600 | 429 | 0.280 | 18.0 | 1.05 | -224 | 0.0 | 7.00 |
| | 04/24/07 | 0.0226 | 0.50 | 301 | 0.340 | 19.1 | 3.88 | -217 | 0.6 | 7.11 |
| | 07/11/07 | 0.0276 | 0.40 | 285 | U(0.200) | 6.29 | 6.64 | -228 | 0.8 | 7.58 |
| | 10/31/07 | 0.0298 | 0.60 | 282 | U(0.200) | 13 | 3.57 | -322 | 0.0 | 7.74 |
| | 01/22/08 | 0.0284 | 0.60 | 290 | U(0.200) | 18.3 | 11.05 | -312 | 0.2 | 7.75 |
| | 04/24/08 | 0.0236 | 0.30 | 239 | U(0.200) | 2.32 | 9.53 | -242 | 0.2 | 7.72 |
| | 07/14/08 | 0.0192 | 0.50 | 265 | 0.350 | 10.1 | 8.02 | -226 | 0.1 | 7.37 |
| | 10/07/08 | 0.0280 | 0.50 | 253 | U(0.200) | 5.61 | 4.17 | -310 | 0.2 | 7.84 |

| Sample ID | Sample Date | Metals | Conventional Chemistry | | Anions | | Field Parameters | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Manganese[2] (mg/l) | Salininty[3] (ppth) | Total Alkalinity[4] (mg/l) | Nitrate-Nitrogen[5] (mg/l) | Sulfate[6] (mg/l) | Dissolved Oxygen (mg/l) | ORP (mv) | Ferrous Iron (mg/l) | Water Level (ft btoc) |
| MW-9 | 01/22/09 | 0.0222 | 0.40 | 270 | U(0.200) | 17.1 | 0.96 | -150 | -- | 7.17 |
| | 04/16/09 | 0.0226 | 0.30 | 252 | 0.430 | 10.2 | 0.00 | -174 | 0.0 | 7.34 |
| | 07/16/09 | 0.029 | 0.30 | 240 | U(0.90) | 2.2 | 3.20 | -285 | 0.4 | 7.71 |
| | 11/18/09 | 0.063 | 2.5 | 270 | U(0.90) | 150 | 0.00 | -234 | 0.0 | 6.08* |
| MW-11 | 05/04/06 | 1.91 | 1.91 | 315 | U(20.0) | 941 | 2.21 | -64 | 0.2 | 6.46 |
| | 08/03/06 | 1.74 | 1.74 | 289 | U(40.0) | 1,100 | 0.00 | -112 | -- | 6.75 |
| | 10/26/06 | 1.98 | 1.98 | 304 | U(0.400) | 1,280 | 4.12 | -279 | 0.8 | 6.64 |
| | 01/29/07 | 1.55 | 1.55 | 388 | U(0.200) | 802 | 0.27 | -211 | 1.6 | 6.10 |
| | 04/23/07 | 1.18 | 1.18 | 292 | U(0.200) | 897 | 3.15 | -245 | 0.8 | 6.00 |
| | 07/11/07 | 1.05 | 1.05 | 265 | U(10.0) | 1,050 | 5.90 | -248 | 0.2 | 7.29 |
| | 10/30/07 | 1.36 | 1.36 | 269 | U(1.00) | 1,300 | 4.21 | -255 | 0.8 | 6.11 |
| | 01/21/08 | 1.22 | 1.22 | 265 | U(0.400) | 1,330 | 6.63 | -182 | 0.8 | 5.92 |
| | 04/23/08 | 0.794 | 0.794 | 313 | U(10.0) | 1,010 | 12.68 | -226 | 1.8 | 6.45 |
| | 07/15/08 | 0.970 | 0.970 | 250 | U(0.400) | 1,220 | 5.63 | -228 | 1.1 | 6.45 |
| | 10/06/08 | 0.938 | 0.938 | 232 | U(1.00) | 1,400 | 3.42 | -276 | 0.8 | 6.32 |
| | 01/21/09 | 0.954 | 0.954 | 332 | U(0.200) | 940 | 0.38 | -214 | -- | 6.21 |
| | 04/16/09 | 0.716 | 0.716 | 313 | U(0.400) | 897 | 0.00 | -116 | 0.0 | 6.30 |
| | 07/16/09 | 0.69 | 0.69 | 280 | U(0.90) | 1,000 | 3.42 | -292 | 0.6 | 6.65 |
| | 11/18/09 | 1.1 | 1.1 | 290 | U(0.90) | 1,200 | 0.00 | -170 | 1.0 | 5.00* |
| MW-14 | 05/05/06 | 0.422 | 0.422 | 525 | U(1.00) | 2.73 | 4.93 | -170 | -- | 5.35 |
| | 08/03/06 | 0.333 | 0.333 | 583 | U(0.400) | 0.791 | 0.01 | -157 | -- | 5.95 |
| | 10/26/06 | 0.293 | 0.293 | 621 | U(0.200) | 1.37 | 4.06 | -276 | -- | 6.02 |
| | 01/30/07 | 0.370 | 0.370 | 493 | U(0.200) | 0.530 | 0.85 | -165 | -- | 5.32 |
| | 04/24/07 | 0.348 | 0.348 | 488 | U(0.200) | 0.850 | 4.65 | -100 | 1.4 | 5.50 |
| | 07/12/07 | 0.402 | 0.402 | 578 | U(0.200) | 0.630 | 0.03 | -227 | 1.2 | 5.68 |
| | 10/31/07 | 0.401 | 0.401 | 605 | U(0.200) | 0.41 | -- | -- | 1.4 | 5.80 |
| | 01/22/08 | 0.424 | 0.424 | 608 | U(0.200) | U(0.400) | -- | -- | -- | 5.80 |
| | 04/24/08 | 0.444 | 0.444 | 658 | U(0.200) | U(0.400) | -- | -- | -- | 5.80 |
| | 07/15/08 | 0.415 | 0.415 | 670 | U(0.200) | 0.480 | -- | -- | -- | 5.69 |
| | 10/07/08 | 0.506 | 0.506 | 650 | U(0.200) | U(0.400) | -- | -- | -- | 6.16 |
| | 01/22/09 | 0.445 | 0.445 | 644 | U(0.200) | U(0.400) | -- | -- | -- | 5.19 |
| | 04/17/09 | 0.405 | 0.405 | 631 | U(0.200) | 0.640 | -- | -- | -- | 5.35 |
| | 07/16/09 | 0.44 | 0.44 | 670 | U(0.90) | U(1.2) | -- | -- | -- | -- |
| | 11/19/09 | Well Abandoned August 2009 | | | | | | | | |

**Notes:**

[1] Chemical analysis performed by TestAmerica of Seattle, Washington.

[2] Mangaese analyzed by EPA Method 200.8

[3] Salinity analyed by EPA Method 2520B

[4] Alkalinity analyzed by EPA Method 310.1

[5] Nitrate as Nitrogen analyzed by EPA Method 300.0

[6] Sulfate anaylzed by EPA Method 300.0

mg/l = milligrams per liter

ppt = parts per thousand

U = Analyte was not detected at or greater than the listed reporting limit

mv = Millivolts

ft btoc = feet below top of casing

* Top of casing elevation change after monument repair work. New elevations were surveyed.

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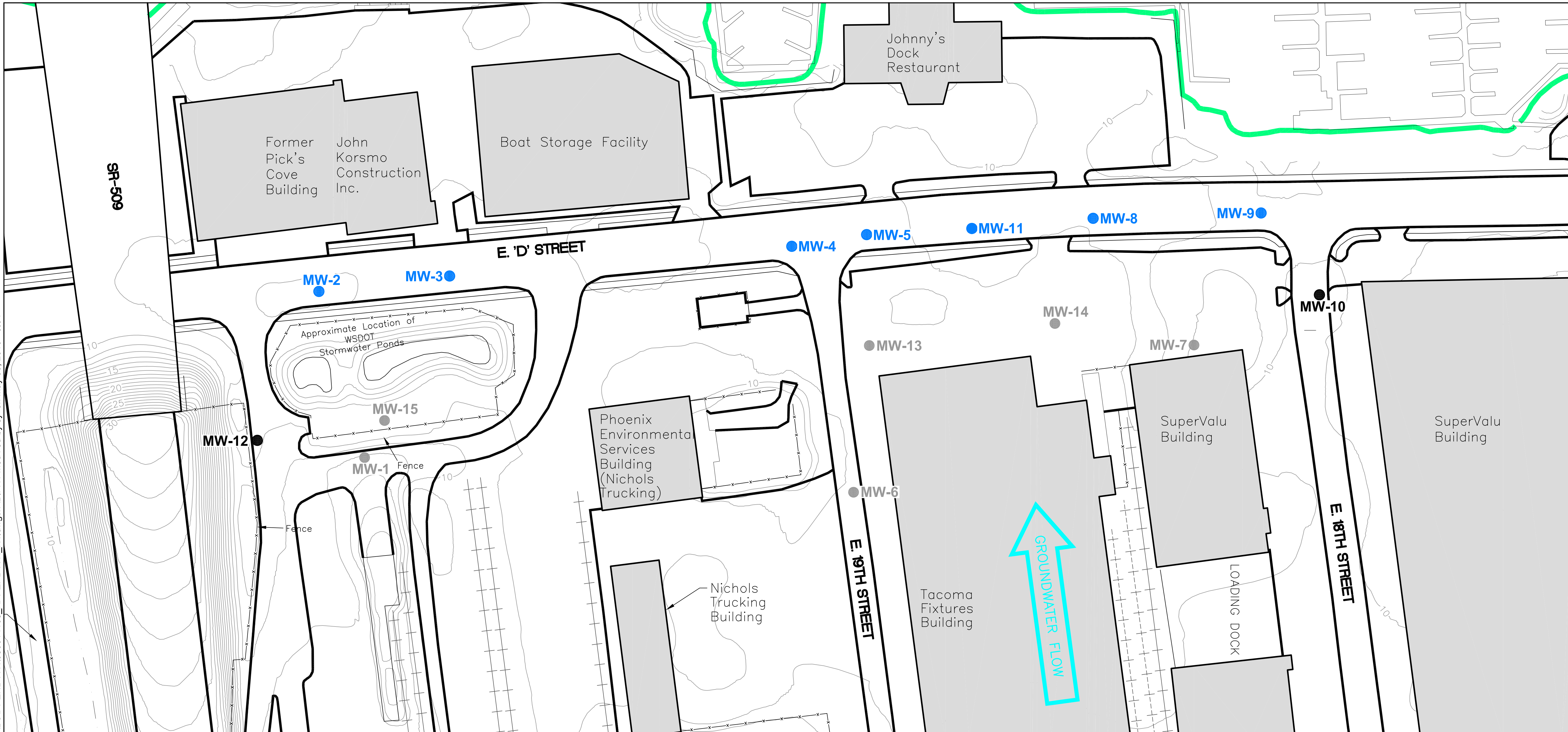


EXPLANATION:

MW-5 ● MONITORING WELL LOCATION AT THE CONDITIONAL POINTS OF COMPLIANCE. WELL TO BE ABANDONED AFTER COMPLETION OF COMPLIANCE MONITORING

MW-12 ● EXISTING MONITORING WELL NOT PART OF COMPLIANCE MONITORING. WELL TO BE ABANDONED AFTER COMPLETION OF COMPLIANCE MONITORING

MW-1 ● ABANDONED MONITORING WELL

THEA FOSS SHORELINE

100 0 100

Feet

Notes:

1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Reference: Drawing created from AutoCAD file, E.D st-oil line-b.DWG", provided by City of Tacoma.

**Monitoring Well Locations**
**Quarterly Groundwater Monitoring Program**

BNSF Oil Pipeline Site (D Street)
Tacoma, Washington

GEOENGINEERS

**Figure H-1**

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PM JCD

OFFICE:TACO

# APPENDIX I
## Soil Freeze Shoring Report

# APPENDIX I
# SOIL FREEZE SHORING REPORT

## INTRODUCTION

This document provides a summary of activities related to frozen soil shoring that was installed as part of the excavation activities associated with remediation of Area C at the BNSF Oil Pipeline Site in Tacoma, Washington. Area C is located east of East D Street, between 18th and 19th Streets in Tacoma, Washington. Site remediation consists of the removal of BRPH-related contaminated soil to the maximum extent practicable within four specified areas (A, B, C and D). The use of temporary frozen soil shoring was considered for excavation activities at Area C because of the extent of the contamination, the known presence of a thick layer of wood debris in the subsurface, previous experience with managing groundwater flow at other excavation areas on D Street, and the proximity of existing buildings and East D Street infrastructure. Figure 1 shows the planned freeze pipe layout. Figures 2A and 2B show the as-built freeze pipe layout.

One of the site remediation requirements was to remove contaminated soil to the maximum extent practicable. To meet this requirement, the Area C excavation was designed with vertical sidewalls, and both frozen soil and sheet pile walls were considered for use as temporary shoring systems. The frozen soil shoring system was ultimately selected based on the following factors:

- Several utilities crossing Area C from East D Street to the existing buildings needed to remain in service during remediation activities. The frozen soil system allowed these utilities to remain in service during excavation.
- For excavations that extend below the groundwater table, the frozen soil system provided an effective barrier against groundwater seepage. This reduced the amount of groundwater seepage into the excavation, thereby reducing the costs related to dewatering, and treatment and disposal of contaminated groundwater from dewatering activities.
- The frozen soil is exposed along the margin of the excavation, allowing sidewall samples to be obtained for chemical analysis.
- The installation of a traditional sheet pile shoring system would likely have created vibration-related issues within surrounding buildings.

The frozen soil shoring system was designed by GeoEngineers based on conditions described in our geotechnical report, "*Geotechnical Engineering Services, BNSF Oil Pipeline Site*," dated March 27, 2009. The design of the shoring system is presented in our report, "*Frozen Soil Shoring Design, BNSF Oil Pipeline Site (D Street)*," dated April 10, 2009.

The general contractor for this project was Glacier Environmental Services, Inc. (the contractor). The equipment for the frozen soil system was installed and operated by SoilFreeze, a specialty shoring subcontractor. The freeze pipes were installed by McDowell NW Pile King, under subcontract to SoilFreeze.

## DESIGN AND INSTALLATION

### Initial Design

The frozen soil shoring wall design presented in the April 10, 2009 report consisted of 310 vertical freeze pipes and 40 batter pipes. The batter pipes served to provide additional wall stability and to reduce potential horizontal wall movements after the excavation was completed. The vertical freeze pipes were nominally spaced at 3 feet and the batter pipes were nominally spaced at 21 feet around the perimeter of the excavation. Vertical freeze pipes were designed to be installed 20 feet below ground surface (bgs) and batter pipes inclined at 18 degrees from vertical. The design assumed a maximum excavation depth of 12 feet, with groundwater approximately 6 feet bgs. The planned freeze pipe and wall alignment are shown on Figure 1.

### Installation and Modification

The centerline of the frozen soil wall was surveyed and marked on the ground by July 31, 2009. The freeze pipe locations were marked along the perimeters of the excavation using the design spacing for the vertical pipes of approximately 3 feet, and approximately 21 feet for the batter pipes. Modifications were made to the wall alignment and freeze pipe locations during surveying of the wall centerline to increase the size of the excavation. Where buried utilities crossed the wall alignment, freeze pipe spacing was adjusted and reduced slightly in order to improve the layout around the utilities. Prior to installation, 318 vertical freeze pipes and 40 batter freeze pipe locations were marked on the ground. An additional eight vertical freeze pipes were required because of the modifications to the wall alignment and adjustments to spacing required to clear the existing utilities. As discussed below, additional vertical freeze pipes were also added during installation to provide appropriate pipe spacing to clear subsurface obstructions encountered during installation. Figures 2A and 2B present the approximate locations of the completed freeze pipe installations.

Installation of the freeze pipes began on Monday, August 3, 2009 and was completed on Monday, August 10, 2009. The pipes were installed using a 2,000-pound pneumatic hammer (TB 725) mounted on a Takeuchi 175 excavator body. The pipes were generally installed to the design depth of 20 feet bgs without encountering significant obstructions. One pipe located in the northeast corner of the site did encounter an obstruction, which likely was the old bunker oil pipeline. This freeze pipe was moved 6 inches and redriven without incident.

Other subsurface obstructions did not result in refusal, but did cause a number of the pipes to wander. To accommodate these small obstructions, 65 freeze pipes were installed such that spacing between adjacent pipes exceeded 36 inches. The actual spacing ranged between 36.5 and 42 inches. Based on thermal analyses, spacing between freeze pipes greater than approximately 37 inches would greatly increase the risk of longer freeze down times. Therefore, 13 additional vertical freeze pipes were installed in areas where the spacing between the pipes was greater than 37 inches. These additional pipes are indicated in Figure 1. In the northwest corner of the site, two freeze pipes were placed on either side of the sanitary sewer at a spacing of 40 inches. One additional freeze pipe was also added outside the centerline in order to increase the freezing potential around and below the sanitary sewer. A total of 332 vertical freeze pipes were installed for the project, including additional pipes related to changed excavation geometry, buried utilities and subsurface obstructions.

In addition to the vertical freeze pipes, batter anchor pipes were installed. The batter pipes were installed at an inclination of approximately 18 degrees from vertical, and perpendicular to the centerline of the frozen soil wall. A total of 40 batter pipes were installed, at locations as generally indicated in the original design. The approximate locations of the batter pipes are shown on Figures 2A and 2B.

### Instrumentation

Sixteen temperature monitoring pipes were installed to monitor the freeze down process. The approximate locations of the temperature monitoring pipes are shown on Figures 2A and 2B. The temperature pipes were generally installed vertically. One temperature pipe in the southwest corner of the site (T10c) was slightly battered to avoid an adjacent storm drain line.

## FREEZE DOWN

Freeze down of the project began on August 21, 2009 using three 20-ton chiller units. Based on the thermal analysis performed for the frozen soil wall design, the freeze down time was estimated to be approximately four weeks, resulting in a frozen shoring wall approximately 3 to 6 feet thick.

Temperatures in the soil were monitored on a daily basis. Data from the temperature pipes indicated that the soil was freezing at a slower rate than anticipated. It is our opinion the freeze rate was slowed because of the following issues:

- More wood waste in the soil than anticipated.
- Larger voids in the wood waste and significantly more groundwater in the shoring wall zone than expected.
- Dewatering at Area B to the south that started the second week of the freeze down. The dewatering increased the flow of the groundwater near the frozen soil area, creating a thermal drain on subsurface water, which impeded the formation of the frozen soil wall.

The design/construction team decided that a fourth 20-ton chiller should be added to the freeze system because of the slower than anticipated freeze down rate. This chiller was activated on about September 18, 2009; at approximately the same time that dewatering at Area B was stopped. Data from the temperature pipes indicated that these two actions greatly increased the rate of frozen wall formation.

Dan Mageau from GeoEngineers visited the site on September 25, 2009, at which time the frozen soil system had been operating for approximately five weeks. Six test pits were excavated around the perimeter of the site to observe the condition of the frozen soil wall. The test pits and temperature readings indicated that the northern portion of the site was suitably frozen for excavation to proceed. The test pits indicated that the southern portion of the site was not continuously frozen. The unfrozen areas appeared to be related to areas of wood debris, likely containing large voids filled with groundwater.

GeoEngineers provided a memorandum on September 25, 2009, that indicated that excavation for remediation could begin in the northern half of the site, but excavation in the southern half should be delayed another week or two to allow additional freezing to occur. The contractor had already planned for excavation to proceed from north to south so the additional time required for freeze down did not result in an additional delay.

## EXCAVATION

### General

The contractor began shallow excavation of the site above the groundwater table the week of September 7, 2009 before freeze down was complete. Because this initial excavation did not extend below the groundwater table, it did not affect the freezing process. Excavation below the groundwater table began on September 25, 2009 after GeoEngineers indicated that the frozen soil wall had sufficiently formed to be suitable for excavation. Excavation below the groundwater table began in the northern half of the site, as recommended in our September 25, 2009 memorandum.

Observation of the frozen soil wall during excavation included: 1) monitoring temperature readings, 2) visual inspection, and 3) optical horizontal and vertical surveys of the wall to assess potential wall movement. Because of the short time that the frozen shoring wall would be exposed, insulating blankets normally required to reduce surface thawing were not used for this project. Thin plastic sheeting was used in some areas around the site to protect the frozen soil wall from wind and rain erosion. Some minor sloughing along portions of the frozen soil wall occurred at the approximate locations of the six test pits.

The contractor excavated from north to south and backfilled the excavation as work progressed. The excavated area at the site was generally backfilled to the original surface elevation within days after the excavation and removal of contaminated material was completed.

### Observations

Excavations along the face of the shoring wall exceeded the design depth of 12 feet and extended to depths of approximately 15 feet in several places along the eastern face of the excavation. In these deeper areas, the excavations were typically backfilled within 24 hours to reduce the impact on the adjacent shoring wall. The excavation extended as deep as 19 feet below the center of the excavation. This deeper excavation appears to have been far enough away from the shoring wall to avoid significantly affecting wall stability.

Seepage was not observed through the wall of the excavation. Minor groundwater seepage was observed through the base of the excavation. This groundwater inflow was controlled with a single sump and pump.

Vertical and horizontal wall movements were monitored regularly via optical surveys. Measured lateral and vertical wall movements were typically less than ¼ inch. Wall movements of approximately ¾ inch were measured at two locations: 1) in front of the southern portion of the SuperValu building and 2) in front of the concrete entry steps for the Tacoma Fixtures building. After this initial movement and upon completion of excavation, the area was backfilled and optical surveys did not indicate further wall movements at these two areas. The only impact to adjacent structures appeared to be a minor separation of the stair from the Tacoma Fixtures building. This small opening was later filled with grout.

Throughout the excavation process, SoilFreeze continued to use four chillers at the site. Based on thermal analyses and data from the temperature pipes, the frozen wall gradually became colder and thicker during the course of excavation.

## DEMOBILIZATION

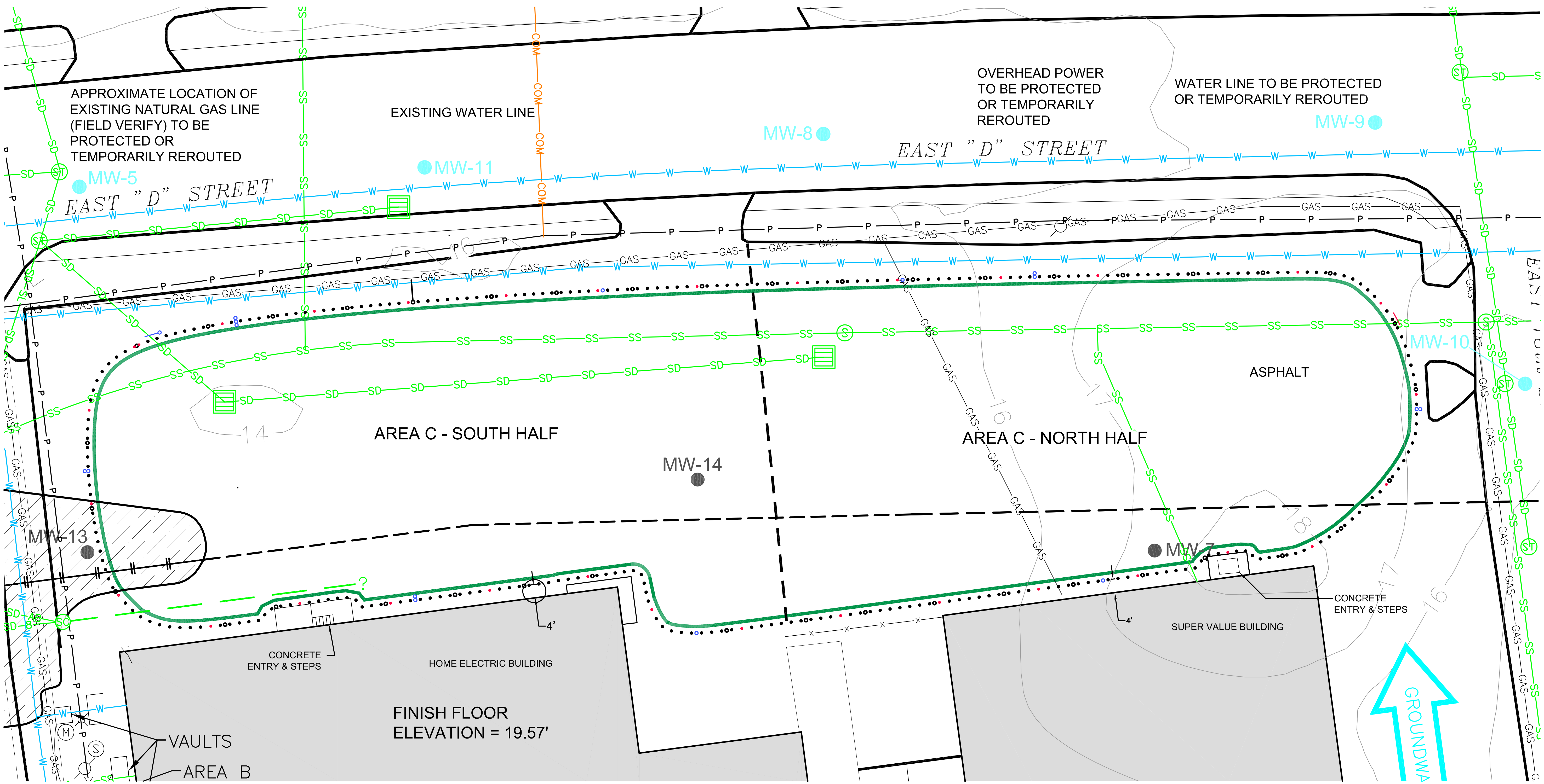
After excavation and backfill activities were substantially complete, the freeze system was turned off and the frozen soil was allowed to thaw. The project schedule and the requirement to remove the freeze pipes required acceleration of the frozen soil wall thawing process. To accomplish this, SoilFreeze circulated hot brine through the freeze pipes, one bank at a time. The ice bond between the freeze pipe and the frozen soil melted within an hour or two. The contractor then pulled the freeze pipes out of the ground using a choker attached to the excavator. The holes were backfilled by using bentonite chips in general accordance with Chapter 173-160, Washington Administrative Code (WAC). Freeze pipe removal occurred during the week of October 19, 2009. SoilFreeze completely demobilized off the site on November 2, 2009.

## CONCLUSIONS

We provide the following conclusions regarding the performance of the shoring wall:

- The location and number of freeze pipes varied from original plan because of changes to the excavation area, buried utilities and out-of-line pipe installation caused by wood obstructions.
- Freeze down took several weeks longer than anticipated, primarily because of increased groundwater flow near the wall caused by dewatering in Area B and because of large, water-filled voids in the wood waste.
- The frozen soil wall was very effective in cutting off groundwater seepage into the excavation, even in areas where significant wood waste was present. The groundwater seepage along the base of the excavation was controlled by small sumps and a pump.
- Lateral wall deflection was typically less than ¼ inch, with only two areas measuring as much as ¾ inch. Wall movements resulted in very little impact to adjacent structures. The level of movement observed was within the range anticipated from finite element analyses completed for the design (April 10, 2009, geotechnical report).

Based on our observations during the excavation at this site, it is our opinion that the frozen shoring wall performed per our design.




## Legend

- Planned Face of Freeze Wall
- Planned Freeze Pipe Location

30 0 30
FEET

## Notes

1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

**Planned Frozen Soil Shoring Overall Site Plan**

BNSF Area C Remedial Site
Tacoma, Washington

GEOENGINEERS

**Figure 1**

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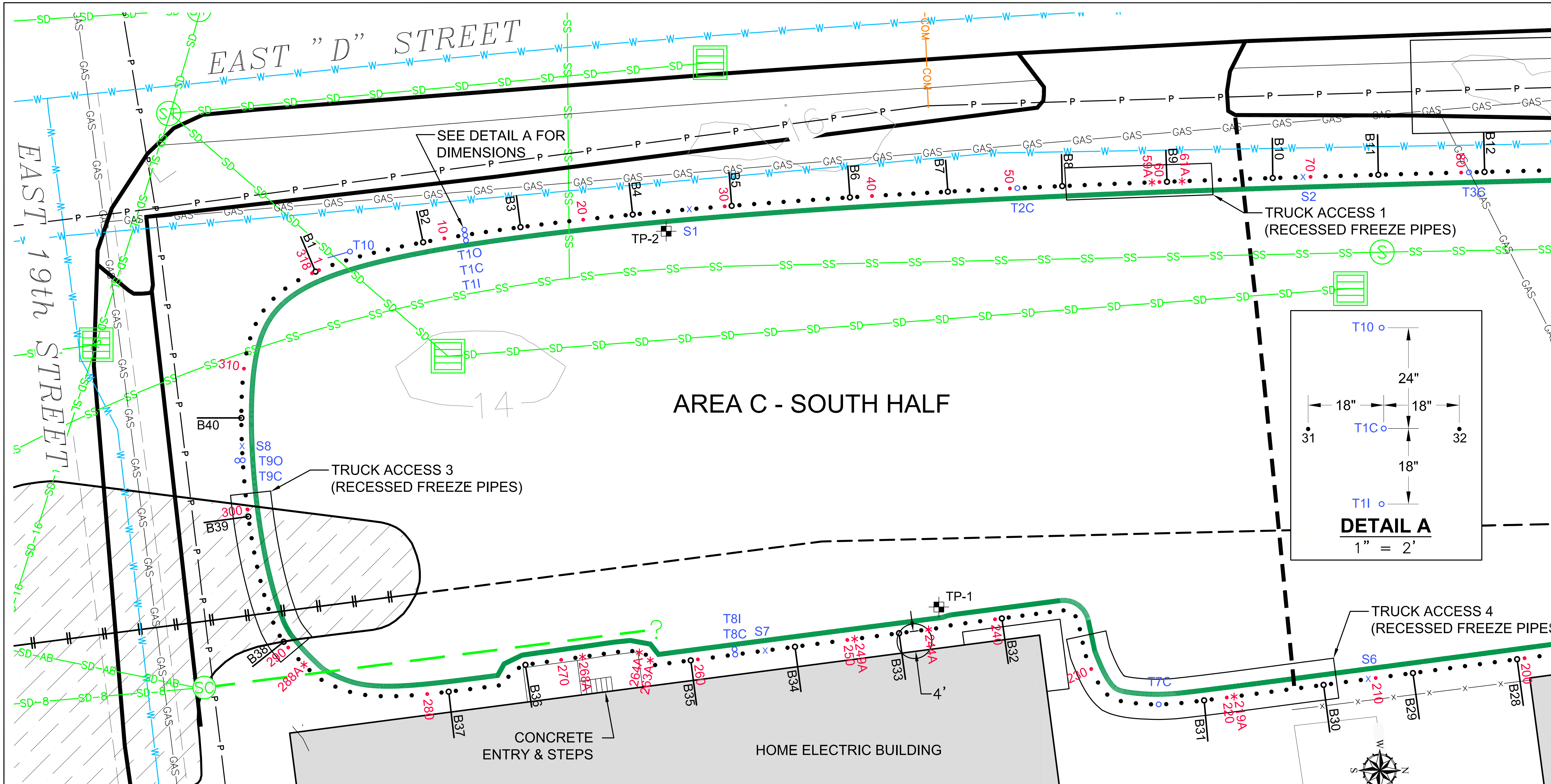


## Technical Notes

1. The contractor shall provide a visible line on the ground indicating the freeze pipe alignment (2' outside the planned face of the shoring wall) prior to the start of the freeze pipe layout.
2. The contractor shall plug all open pipes at the frozen wall face as the excavation proceeds.
3. Freeze pipe locations shown are approximate and may be changed by GeoEngineers during initial layout.
4. The temperature pipe locations shown are approximate. Final locations will be determined by GeoEngineers near the end of freeze pipe installation (typically located in between freeze pipes with largest spaces).
5. Freeze pipes are to be driven within +/- 1inch of locations staked by GeoEngineers.
6. Contractor shall prevent runoff from entering excavation through the use of berms outside the freeze pipe alignment or by other means.

## Legend

| | |
|---|---|
| 269 • | Vertical 3" diameter Freeze Pipes (21 ft long and 3 ft O.C.Typ.) |
| B36 | Batter 3" diameter Freeze Pipes 3V:1H (21 ft long and 21 ft O.C.Typ.) |
| T7C ○ | Temperature Pipe (3" diameter and 21 ft long) |
| S7 + | Survey Stake (#5 Rebar Driver 2 ft into Ground) |
| 264A ✱ | Additional 3" diameter Freeze Pipes |
| ▭ | Recessed area |
| TP-1 | Test Pit by GeoEngineers (9/25/09) |

## General Notes

1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

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Feet

**Freeze Pipe Layout - South Half**
**As-Built Locations**

BNSF Area C Remedial Site
Tacoma, Washington

GEOENGINEERS

**Figure 2A**

Rev. 11/13/09 by AKM/DWM

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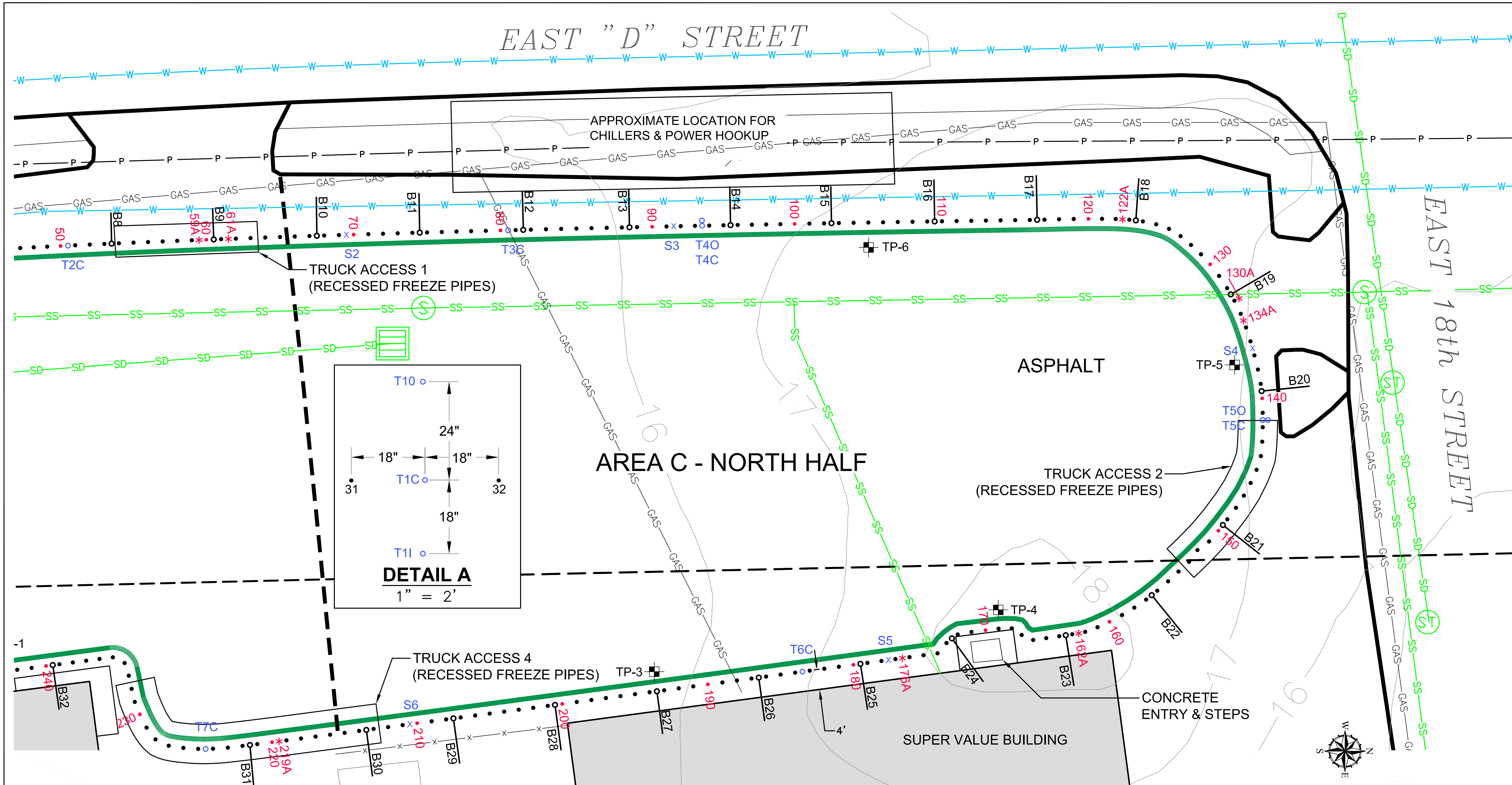


## Technical Notes

1. The contractor shall provide a visible line on the ground indicating the freeze pipe alignment (2' outside the planned face of the shoring wall) prior to the start of the freeze pipe layout.
2. The contractor shall plug all open pipes at the frozen wall face as the excavation proceeds.
3. Freeze pipe locations shown are approximate and may be changed by GeoEngineers during initial layout.
4. The temperature pipe locations shown are approximate. Final locations will be determined by GeoEngineers near the end of freeze pipe installation (typically located in between freeze pipes with largest spaces).
5. Freeze pipes are to be driven within +/- 1inch of locations staked by GeoEngineers.
6. Contractor shall prevent runoff from entering excavation through the use of berms outside the freeze pipe alignment or by other means.

## Legend

| | |
|---|---|
| 269 • | Vertical 3" diameter Freeze Pipes (21 ft long and 3 ft O.C.Typ.) |
| B36 | Batter 3" diameter Freeze Pipes 3V:1H (21 ft long and 21 ft O.C.Typ.) |
| T7C o | Temperature Pipe (3" diameter and 21 ft long) |
| S7 + | Survey Stake (#5 Rebar Driver 2 ft into Ground) |
| 264A* | Additional 3" diameter Freeze Pipes |
| ▭ | Recessed area |
| TP-3 | Test Pit by GeoEngineers (9/25/09) |

## General Notes

1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

0 20 40
Feet

Rev. 11/13/09 by AKM/DWM

**Freeze Pipe Layout - North Half**
**As-Built Locations**

BNSF Area C Remedial Site
Tacoma, Washington

GeoEngineers

**Figure 2B**

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# APPENDIX J
## Site Photographs

## APPENDIX J
## SITE PHOTOGRAPHS (AREA A)

Photo 1A: Pre remediation – east side of excavation area looking southwest.

Photo 2A: Pre remediation – south end of excavation area looking north.

Photo 3A: Pre remediation – northeast corner of excavation area looking west.

Photo 4A: Pre remediation – north side of WSDOT ponds looking south.

Photo 5A: Pre remediation – south side of WSDOT ponds looking north.

Photo 6A: Pre remediation – southeast corner of southern WSDOT pond looking northwest.

Photo 7A: Excavation – overburden removal, south end of excavation area looking north.

Photo 8A: Excavation – overburden removal, southwest corner of excavation area looking northeast.

Photo 9A: Wood waste.

Photo 10A: Excavation dewatering – south half of excavation area looking west. Gray PVC dewatering sumps center and bottom right of picture.

Photo 11A: Excavation dewatering – water treatment system includes blue tanks in upper left and center. South end of excavation area looking southwest.

Photo 12A: Excavation dewatering – south end of excavation area looking northeast.

Photo 13A: Excavation – base under WSDOT ponds, looking south.

Photo 14A: Excavation – south end of excavation area looking north.

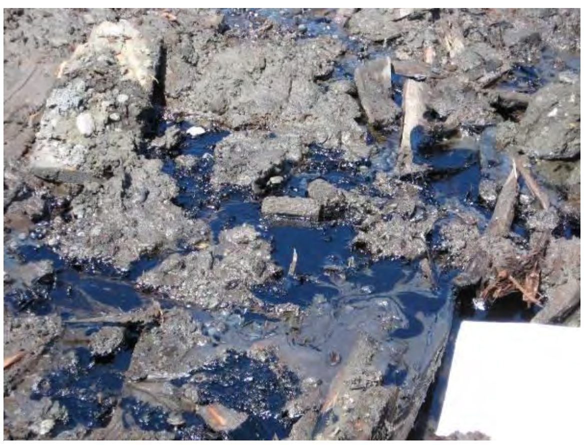

Photo 15A: Bunker-C free product.


Photo 16A: Dewatering/treatment system looking west.

Photo 17A: Guy pole installation for power pole anchor from WSDOT pond area to the east of excavation area.

Photo 18A: Excavation – removing material to eastern limit looking south.

Photo 19A: Pond rebuilding – looking south over north pond.

Photo 20A: Excavation backfilling – placing ballast across excavation base. North end of excavation area looking south.

Photo 21A: Excavation backfilling – placing bank run fill across excavation base. North end of excavation area looking south.

Photo 22A: Excavation backfilling – placing quarry spalls under south end of WSDOT ponds looking west.

Photo 23A: Excavation backfilling – WSDOT pond subgrade reconstruction. North end of excavation area looking south.

Photo 24A: 4-inch pipe in west sidewall of the north WSDOT pond looking north.

Photo 25A: Pond rebuilding – placing pond surcharge material over pond liner. North end of excavation area looking south.

Photo 26A: Pond rebuilding – southeast corner of excavation area looking northwest.

Photo 27A: Site grading – subgrade placed for asphalt access road. Northwest corner of excavation area looking southeast.

Photo 28A: Pond rebuilding – hydroseed placed around ponds for erosion control. North end of excavation area looking south.

Photo 29A: Post remediation – WSDOT pond maintenance road looking north.

Photo 30A: Post remediation – east side of excavation area looking northwest.

Photo 31A: Post remediation – east side of excavation area looking southwest.

## APPENDIX J
## SITE PHOTOGRAPHS (AREA B)

Photo 1B: Pre remediation – southeast corner looking northwest.

Photo 2B: Pre remediation – northeast corner looking west across Safe Dig Area.

Photo 3B: Pre remediation – southeast corner looking north.

Photo 4B: Pre remediation – north side of Phoenix lay down yard looking southwest.

Photo 5B: Pre remediation – north side of Phoenix lay down yard looking southeast.

Photo 6B: Safe Dig Area excavation – looking northwest corner. Water main bypass in foreground.

Photo 7B: Safe Dig Area excavation – west side looking east.

Photo 8B: Safe Dig Area – Tacoma Power boom truck holding power pole during excavation activities.

Photo 9B: Excavation area southwest corner looking northeast. Vactor truck working in Safe Dig Area.

Photo 10B: Safe Dig Area – underground utilities exposed along north side of excavation looking east.

Photo 11B: East 19th Street UST – east end of UST within Safe Dig Area.

Photo 12B: East 19th Street UST – excavating along north side of UST within Safe Dig Area looking west.

Photo 13B: Steel fuel pipes – pipes cut and plugged with cement are protruding from sidewall at the right and left center of photo.

Photo 14B: Excavation area – northwest corner looking southeast.

Photo 15B: BRPH-like free product draining from north sidewall adjacent to south side of East 19th Street UST looking northwest.

Photo 16B: BRPH-like free product draining from sidewall of excavation, adjacent to south side of East 19th Street UST looking northwest.

Photo 17B: BRPH-like free product draining from north sidewall adjacent to south side of East 19th Street UST looking northeast.

Photo 18B: Excavation area – northwest corner looking northwest. Note: observed 2004 Interim Action CDF and BRPH-like free product draining from wood waste at center of photo.


Photo 19B: Excavation area - east end looking west. Dewatering sump left side of photo.

Photo 20B: Excavation area southwest corner looking east along sewer bypass lines.

Photo 21B: Excavation area west end looking east. East 19th Street UST exposed to the left.

Photo 22B: Excavation area – east end looking west. Note: native tidal deposits across base of excavation and wood waste exposed in north sidewall.

Photo 23B: Excavation area – west end looking north. Orange sewer bypass pump for Tacoma Fixtures in upper right of photo. Note: storm line protruding from west sidewall.

Photo 24B: East 19th Street UST – marine chemist testing void space for explosive vapors.

Photo 25B: East 19th Street UST – cutting UST with torch while marine chemist monitors tank atmosphere.

Photo 26B: East 19th Street UST – cutting of UST has been completed, opening UST to access CDF.

Photo 27B: East 19th Street UST – removing CDF from UST.

Photo 28B: East 19th Street UST – Note: observed fist-sized holes corroded through side of UST.

Photo 29B: East 19th Street UST – removing CDF from UST.

Photo 30B: East 19th Street UST – Note: observed failed weld seen inside UST.

Photo 31B: East 19th Street UST – removed UST placed in excavation looking southeast.

Photo 32B: East 19th Street UST – UST removed with bank run backfill in north sidewall from Safe Dig Area. Note: natural gas main and telecom line crossing tank pit supported with temporary guy lines.

Photo 33B: East 19th Street UST – Note: observed fist-sized holes corroded through side of UST.

Photo 34B: Excavation area – east end looking south. Sewer and storm bypass pumps in upper left of photo.

Photo 35B: Excavation area – south sidewall adjacent to the north side of Phoenix lay down yard. Trench represents East 19th Street sanitary sewer alignment.

Photo 36B: West sidewall with 12-inch sanitary sewer line exposed. Pea gravel in sewer trench saturated with BRPH-like free product.

Photo 37B: Phoenix area excavation – west end of excavation looking east.

Photo 38B: Nichols area excavation – beginning in southeast of Area B looking northeast.

Photo 39B: Nichols area excavation – northwest corner of excavation looking southeast.

Photo 40B: Nichols area excavation – west end of excavation looking east with groundwater level after ½ day.

Photo 41B: Phoenix/Nichols area excavation – looking south along west side of Phoenix lay down yard.

Photo 42B: Excavation area southwest of Area B looking west.

Photo 43B: Excavation area southwest of Area B along sanitary sewer alignment.

Photo 44B: Northwest corner of excavation area west of Phoenix lay down yard, looking southeast. Note: base of excavation is 6 feet below water surface.

Photo 45B: Utility reconstruction – new sanitary sewer manhole at southeast corner of Area B with bypass system looking east.

Photo 46B: Utility reconstruction – new sanitary sewer manhole at southeast corner of Area B with bypass system.

Photo 47B: Utility reconstruction – East 19th Street storm sewer alignment.

Photo 48B: Utility reconstruction– East 19th Street storm sewer west connection.


Photo 49B: Utility reconstruction – sanitary sewer main alignment looking east.

Photo 50B: Utility reconstruction – Tacoma Fixtures sanitary sewer lateral crossing East 19th Street.

Photo 51B: Utility reconstruction – storm sewer lateral crossing Nichols excavation area.

Photo 52B: Utility reconstruction – East 19th Street water main looking east.

Photo 53B: Utility reconstruction – water service for Tacoma Fixtures.

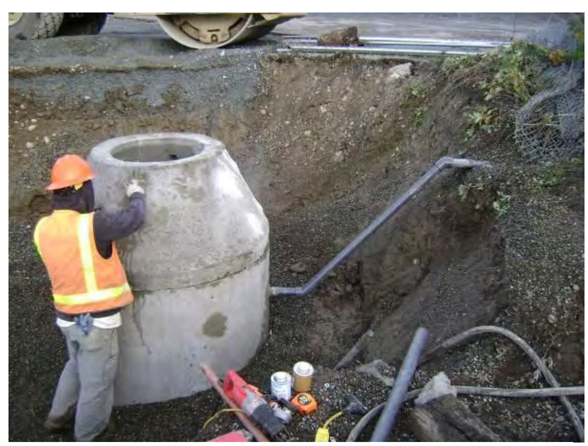

Photo 54B: Utility reconstruction – constructing the Phoenix Environmental sanitary sewer discharge lateral manhole.


Photo 55B: Utility reconstruction – fire service line for Tacoma Fixtures with welded penetration through Area B HDPE liner looking north.

Photo 56B: Excavation backfilling – north side of East 19th Street UST within Safe Dig Area looking east.

Photo 58B: Excavation backfilling – placing quarry spalls across base of excavation looking west.

Photo 57B: Excavation backfilling – west end of Safe Dig Area looking northeast.

Photo 59B: HDPE liner – north sidewall looking east.

Photo 60B: HDPE liner – darker high TOC material placed against liner looking east.

Photo 61B: Excavation backfilling – sanitary sewer subgrade reconstruction along south side of Area B looking east.


Photo 62B: Excavation backfilling – placing next lift of bank run backfill, southwest corner of excavation looking northeast.

Photo 63B: Excavation backfilling – southwest corner of Phoenix excavation area looking northeast. 2-inch ballast in place.

Photo 64B: Excavation backfilling – northwest corner of Phoenix excavation looking southeast.

Photo 65B: Excavation backfilling – west end of Nichols excavation looking east.

Photo 66B: Excavation backfilling – east end of Nichols excavation looking west.

Photo 67B: Excavation backfilling – excavation area west of Phoenix lay down yard looking northeast.

Photo 68B: Excavation backfilling – excavation area west of Phoenix lay down yard looking northeast.

Photo 69B: Site grading – west end of excavation looking east.

Photo 70B: Site grading – excavation area west of Phoenix lay down yard looking south.

Photo 71B: Excavation backfilling – final lifts of bank run backfill for Phoenix excavation. West end of excavation looking east.

Photo 72B: Site grading – Phoenix lay down yard reconstruction looking southeast.

Photo 73B: Site grading – gravel subgrade for East 19th Street looking east.

Photo 74B: Site grading– Phoenix lay down yard reconstruction looking southwest.

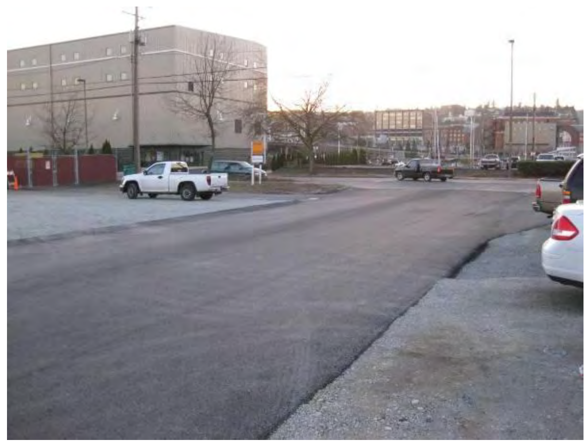

Photo 75B: Post remediation – East 19th Street new asphalt pavement looking southwest.

Photo 76B: Post remediation – East 19th Street new asphalt pavement looking west.

Photo 77B: Post remediation – East 19th Street new asphalt pavement looking northeast.

## APPENDIX J
## SITE PHOTOGRAPHS (AREA C)

Photo 1C: Pre remediation – northwest corner of excavation area looking southeast.

Photo 2C: Pre remediation – freeze wall alignment layout at northwest corner of Tacoma Fixtures building looking northeast.

Photo 3C: Pre remediation – south end of excavation area looking north.

Photo 4C: Pre remediation – D Street entrance of excavation area looking east.

Photo 5C: Pre remediation – Tacoma Fixtures building southwest corner of excavation area looking northeast.

Photo 6C: Freeze wall installation – rotohammer attached to miniexcavator used to drive freeze pipes.

Photo 7C: Soil freeze wall – east sidewall adjacent to the SuperValu west entrance.

Photo 8C: Freeze wall chillers – north end of west side of excavation area. Freeze wall manifolding wrapped with foam insulation.

Photo 9C: Soil freeze wall – freeze pipe manifolding with ice buildup.

Photo 10C: Soil freeze wall – northwest corner of Tacoma Fixtures looking south.

Photo 11C: Soil freeze wall – looking southwest, displaying east sidewall curvature.

Photo 12C: Soil freeze wall – ice buildup on freeze pipe head.

Photo 13C: Excavation area south end looking north.

Photo 14C: BNSF Oil Pipeline – rust colored alignment crossing center of photo. Looking east toward SuperValu building.

Photo 15C: Segments of BNSF Oil Pipeline lying in excavation. Natural gas service crossing excavation from left to right. East side of excavation area looking north.

Photo 16C: Excavation – north end looking southeast toward SuperValu building, soil fill removed down to top of groundwater table.

Photo 17C: Excavation – freeze wall along west side of SuperValu building. Wood waste exposed in base of excavation.

Photo 18C: Excavation – wood waste from north half of excavation area looking southwest.

Photo 19C: BRPH free product – top of the northern extent of wood waste at the groundwater table.

Photo 20C: East sidewall – northern extent of wood waste exposed in sidewall with BRPH free product. Bank run backfill to left of wood waste from previous excavation under SuperValu building footprint.

Photo 21C: Excavation –north half of excavation area looking southwest.

Photo 22C: Excavation – north half of excavation area looking northwest.

Photo 23C: Excavation – deepest portion of area approximately 19 feet below grade surface at center of photo. North end of excavation area looking northeast.

Photo 24C: Soil freeze wall – east sidewall in front of Tacoma Fixtures building. Wood waste overlain by soil fill.

Photo 25C: Excavation – southwest quarter of excavation area looking south.

Photo 26C: Excavation – southeast quarter of excavation area looking southeast.

Photo 27C: Excavation – northwest corner of southwest quarter of excavation area looking southeast.


Photo 28C: Excavation – southeast quarter in front of Tacoma Fixtures building looking northeast.

Photo 29C: BRPH free product – east sidewall below west entrance of Tacoma Fixtures bus building with shovel for scale.


Photo 30C: Utility reconstruction – sanitary sewer alignment looking south.


Photo 31C: Utility reconstruction – natural gas service trench to northwest corner of SuperValu building.

Photo 32C: Utility reconstruction – sanitary sewer manhole placement south end of excavation area looking southeast.


Photo 33C: Utility reconstruction – new natural gas meter for SuperValu building.

Photo 34C: Utility reconstruction – sanitary sewer lateral connection for SuperValu building looking northeast.

Photo 35C: Utility reconstruction – north end of the sanitary sewer alignment looking south.


Photo 36C: Utility reconstruction – storm sewer lateral catch basin for south end of SuperValu parking lot looking northeast.

Photo 37C: Utility reconstruction – storm sewer lateral alignment looking south.

Photo 38C: Excavation backfilling – placing quarry spalls at the north end of excavation area.

Photo 39C: BNSF Oil Pipeline – grouted at north end of excavation area.

Photo 40C: BNSF Oil Pipeline with holes and corrosion at north end of excavation area.

Photo 41C: Excavation backfilling- north half at north end of excavation area looking north.

Photo 42C: Excavation backfilling – spreading quarry spalls across bottom of north half of excavation area looking north.

Photo 43C: Excavation backfilling – north half of excavation area looking north.

Photo 44C: Excavation backfilling – southwest quarter of excavation area looking north.

Photo 45C: Excavation backfilling – compaction testing within of excavation area.

Photo 46C: HDPE liner – north end of liner looking south.

Photo 47C: Excavation backfill – high TOC fill next to HDPE liner looking south.

Photo 48C: HDPE liner – southeast corner of excavation area with additional HDPE liner placement.

Photo 49C: High TOC fill – southeast quarter of excavation area looking southeast.

Photo 50C: Excavation backfilling – south half of excavation area looking south.

Photo 51C: Excavation backfilling – southeast quarter of excavation area looking north.

Photo 52C: Site grading – south end of excavation area looking north.

Photo 53C: Site grading – south half of excavation area looking south.

Photo 54C: Post remediation – new asphalt parking lot for SuperValu, north end of excavation area looking southeast.

Photo 55C: Post Remediation – new asphalt parking lot for Tacoma Fixtures, south end of excavation area looking north.

## APPENDIX J
## SITE PHOTOGRAPHS (AREA D)

Photo 1D: Pre remediation – southeast corner of excavation area looking northwest.

Photo 2D: Pre remediation – north end of excavation area looking southwest.

Photo 3D: Excavation – south end of excavation area looking north.

Photo 4D: BNSF Oil Pipeline to the right and storm sewer line to the left looking northwest.

Photo 5D: Excavation – trench along oil pipeline alignment looking southwest.

Photo 6D: Excavation – all BRPH-impacted material removed, north end of excavation area looking southwest.

Photo 7D: Backfilling – bank run fill placed in lifts south of excavation area end looking north.

Photo 8D: Backfilling – north end of excavation area looking southwest.

Photo 9D: Grading – gravel base for new asphalt. North end of excavation area looking southwest.

Photo 10D: Asphalt pavement complete, south end of excavation area looking north.

Photo 11D: Post remediation – parking stalls repainted north end of excavation area looking southwest.

# APPENDIX K
**Environmental Covenants and Related Figures (Included on Attached CD)**

# APPENDIX L
## Responses to Ecology's Comments, Draft Remedial Action Report

# APPENDIX L
# RESPONSE TO ECOLOGY'S COMMENTS, DRAFT REMEDIAL ACTION REPORT

Ecology Comment 1. Section 2.1.5 and Appendix F. Based on communications of September 8, 2008 we apparently expected to return to the south end of the WSDOT pond after it had been rebuilt and the dewatering equipment removed to attempt to get some additional contamination removal that was earlier precluded by the presence of the dewatering equipment. What happened to that plan?

Response: The material located under the dewatering equipment was removed on September 18 and 19, 2008 as described in Section 2.1.1 (page 6, last paragraph). Section 2.1.1 was modified to include reference to the removal of additional contamination from beneath and adjacent to the dewatering equipment at Area A.

While Ecology referenced Section 2.1.5 in this comment, we believe the revisions to Section 2.1.1 fully addresses the comment. No revisions have been made to Section 2.1.5, which describes activities related to Area A backfill activities including restoring the WSDOT stormwater ponds and does not include a description of the additional contamination removal.

Ecology Comment 2. Section 2.4.4. I wasn't on site when Area D got rehabbed; did a vibratory drum roller get used to compact backfill? Seemed like a small area to get one of those in there. No problem, just curious.

Response: Yes. Glacier mobilized the smooth-drum vibratory roller from Area A to compact the backfill placed at Area D in accordance with the project specifications. The deepest central section of the Area D excavation was compacted by the smooth-drum vibratory roller after an excavator widened the edges of the deeper central section.

Ecology Comment 3. Appendix H. It would be helpful if you could include one map in this section that shows all the monitoring wells. It would be easier to get a picture of what the overall site hydrogeology looks like as one reads the text of the appendix.

Response: Comment noted. A new figure, Figure H-1, has been added to Appendix H that depicts the location, use and fate of various project monitoring wells for this project.

Ecology Comment 4. Section 2.0. Discussion is presented relating to the use and fate of the various wells (bottom of page H-1/top of page H-2). What about MW-12? And was there an MW-10? I don't see one on any of the previous maps or in this report.

Response: The uses of monitoring wells MW-10 and MW-12 are described in Section 2.0 of Appendix H. This section of Appendix H has been modified to include a discussion of the fate of monitoring wells MW-10, MW-12 and the "D Street wells".

As described above, Figure H-1 has been added to Appendix H that depicts the location, use and fate of all project monitoring wells, including MW-10 and MW-12.

**Ecology Comment 5. Appendix H.** The discussion seems to infer that monitored natural attenuation (MNA) has been difficult to determine, based on the mixed messages derived from the analytical parameters. If this is the case, I would suggest stating that fact more definitely. Is it possible that significant changes in the groundwater regime, resulting from the modification of the saturated substrate at the site, could result in different results in the MNA indicator parameters in the future? Some discussion of this possibility (if it is a possibility) would be helpful.

**Response**: Comment noted. Appendix H, Section 5.2, has been modified to indicate that it has been difficult to establish consistent trends in certain MNA parameters. Sections 4.4.1 and 4.4.3 of Appendix H have also been modified to clarify observed MNA parameters.

Historical and recent MNA parameters collected during compliance monitoring sampling show variations, and there are a number of potential sources for these variations, including seasonal effects on groundwater chemistry, instrument discrepancies and the complex nature of degradation and geochemistry in the wood debris that hosts the contamination at depth. Removal of the source mass will also likely disturb the equilibrium of natural attenuation processes.

**Ecology Comment 6. Appendix H.** I don't see any discussion regarding continued monitoring of the CPOC monitoring wells. There will have to be a provision for that, and a proposed schedule should be included in the report. Depending upon your thoughts regarding the last item, MNA, provision for some additional MNA testing could be added to monitoring the basic COCs, to see if reductions in COCs are accompanied by positive MNA indicators. I note the fact that the CPOC wells have not had exceedances of the COCs in the past, but I am concerned that post-RA bounce back could occur, as is not uncommon. Some sampling should be done at least for a period that would assure us that bounce back is not going to occur.

**Response**: Comment noted. Compliance monitoring is described in Section 4.0 of the Remedial Action Report and will be implemented as described in Appendix F of the 2009 EDR, "Compliance Monitoring Plan, Remedial Excavation, BNSF Oil Pipeline Site, Tacoma, Washington." This compliance monitoring plan includes a description of MNA sampling and analysis to be performed as part of the compliance monitoring.

A new section, Section 5.3, has been added to Appendix H to provide a brief description and schedule for continued compliance monitoring for COCs and MNA parameters at the CPOC. The schedule calls for annual monitoring for five years, unless otherwise determined by Ecology.

**Ecology Comment 7. Appendix K.** I like the fact that you are including those figures…they are really helpful to someone wanting to understand the covenants. The title should just read Environmental Covenant, rather than Restrictive Environmental Covenant. For the legal descriptions, it will be o.k. to use the abbreviated version at the beginning of the covenants, but the attachment should consist of the full legal description. At the top, for the "After Recording Return to:" should be myself: Marv Coleman, Site Manager/Inspector, Department of Ecology, Southwest Regional Office, Toxics Cleanup Program, P.O. Box 47775, Olympia, WA 98504-7775. The reason for this is that the original has to come back to Ecology with the original proof of filing stamp on it. We will then distribute copies to all the necessary parties. Which brings up a question…should copies of all the covenants go to all the PLPs, or just the ones affected by any particular covenant? From our standpoint, and legally, we can do it either way.

**Response**: Comment noted. The covenants have been revised to be titled, "Environmental Covenant" and to direct that they be returned to Ecology after recording. The covenants have also been revised to reflect that the relevant property owner will provide a complete legal description for inclusion in Attachment A prior to recording. Pursuant to Section XX of the Consent Decree, Defendants 1815 D Street LLC, the City of Tacoma and BNSF will execute and record their respective covenants within 30 days of Ecology's approval of the Final Remedial Action Report. BNSF will coordinate with John D. Nichols for execution of the covenant against the Nichols property and will also record that covenant within 10 days of obtaining the owner's signature, pursuant to Section XX of the Consent Decree.

We believe it is unnecessary to provide copies of all covenants to all PLPs. Rather, each PLP affected by a covenant should be provided a copy of the covenant relative to their property.

**Ecology Comment 8. Appendix K.** There is a requirement that Ecology must "…consult with and seek comment from a city or county with land use planning authority for real property subject to the environmental covenant." RCW 70.105(D)(1)(F). Although the citation says Ecology must consult, we have been allowing the maker of the covenants to consult on some of the VCP sites that have gotten covenants. I haven't been able to find any formal sites that have done this, either way, and the Tacoma Planning Dept. has not seen these either. I currently have an inquiry in with Charlie Solverson, who is the head of the planning department to see who in their department we should inform; he was not sure himself and is checking on that. In any case, we think "consultation" would basically just consist of sending a copy of the covenant(s) to the correct person in the planning department while the covenant is still in the draft stage. Unless you have had some experience to the contrary, I plan on doing that as soon as Charlie gets back to me with a point of contact. If you would like I can send you a copy of the UECA Briefing Paper that Ecology has been using to be in compliance with the regulatory requirements that resulted from the Uniform Environmental Covenants Act, SB5421.

**Response**: Comment noted. We concur with Ecology's approach to "consultation" with the City of Tacoma Planning Department. Please forward a copy of the UECA Briefing Paper to GeoEngineers for our information and project files.

Please contact us if we can be of further assistance.

Sincerely,

Tony C. Mathis, PE, LG, LHG
Associate, Environmental Engineer

Nick E. Rohrbach
Environmental Scientist

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