FINAL
DUAL PHASE EXTRACTION
AND BIOVENTING
PILOT TEST WORK PLAN
LAUREL STATION
1009 EAST SMITH ROAD
BELLINGHAM, WASHINGTON

For

Kinder Morgan Canada
URS Job No.: 33762778

November 30, 2011

November 30, 2011

Mr. David South
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Pilot Test Work Plan
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1009 East Smith Road
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Dear Mr. South:

Presented herein is the Final Dual Phase Extraction and Bioventing Pilot Testing Work Plan for the above referenced site. This work plan was prepared by URS Corporation on behalf of Kinder Morgan Canada Inc., operator of the Trans Mountain (Puget Sound) LLC pipeline system, in accordance with the First Amended Enforcement Order No. DE 91-N192 effective June 15, 1992. Please contact us if you have any questions or require additional information.

Sincerely,
URS Corporation

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LIST OF ABBREVIATIONS AND ACRONYMS

Kinder Morgan	Kinder Morgan Canada Inc.
bgs	below ground surface
BTEX	benzene, toluene, ethylbenzene, xylenes
BV	bioventing
COCs	contaminants of concern
cfm	cubic feet per minute
DRO	diesel-range organics
DPE	dual phase extraction
FS	Feasibility Study
FID	flame ionization detector
gpm	gallons per minute
GRO	gasoline-range organics
HASP	health and safety plan
HVAC	heating/ventilation/air conditioning
in Hg	inches of mercury
in wc	inches of water column
IDW	investigation derived waste
msl	mean sea level
MCC	Motor Control Center
ORO	oil-range organics
ppm	parts per million
ppmv	parts per million by volume
PPE	personal protective equipment
PID	photoionization detector
PAHs	polycyclic aromatic hydrocarbons
PQLs	practical quantitation limits
PCLs	preliminary cleanup levels
psi	pounds per square inch
PSE	Puget Sound Energy
QAPP	Quality Assurance Project Plan
ROI	radius of influence
RI/FS	Remedial Investigation/Feasibility Study
SAP	Sampling and Analysis Plan
SVE	soil vapor extraction
sf	square feet
scfm	standard cubic feet per minute
TOC	top of casing
TPH	total petroleum hydrocarbons
TVH	total volatile hydrocarbons
UHP	Ultra High Purity
URS	URS Corporation
USEPA	United States Environmental Protection Agency

1.0 INTRODUCTION

This document is the work plan for dual-phase extraction (DPE) and bioventing (BV) pilot testing at the Laurel Station facility located in Whatcom County, Washington (Figure 1). This work plan was prepared by URS Corporation (URS) on behalf of Kinder Morgan Canada Inc. (Kinder Morgan), operator of the Trans Mountain (Puget Sound) LLC pipeline system, in accordance with the First Amended Enforcement Order No. DE 91-N192 effective June 15, 1992.

In June and August 2010 and February 2011, Kinder Morgan and URS performed the data gap investigation outlined in Section 9.0 and Appendix G (Sampling and Analysis Plan [SAP]) of the Final Supplemental Remedial Investigation/Feasibility Study (RI/FS) Work Plan (URS 2010a) and the Work Plan Addendums (URS 2010b and 2011a) for the Laurel Station facility located at 1009 East Smith Road in Bellingham, Washington (site). Based on the results of the data gap investigation activities performed in February 2011, additional soil sample collection, groundwater monitoring well installation and sampling, and DPE and BV pilot tests were proposed in a Work Plan Addendum dated May 23, 2011 (URS 2011b).

The pilot testing is intended to assess the feasibility of using both DPE and/or BV technologies for remediation of petroleum hydrocarbon impacts beneath the site. DPE and BV will be evaluated as either stand-alone remediation technologies or as components of an overall multicomponent long-term remediation approach. The overall scope of work for the pilot testing includes using two four-inch wells (MW-9 and MW-10) near the former oily water sump as test wells to assess DPE and BV remediation technologies. Monitoring wells MW-1, MW-2, MW-5, MW-7, SW-4, and SW-5 will be used as observation wells during the pilot testing. The information from the pilot testing will be included in a site-wide Draft Supplemental RI/FS Report, which will evaluate DPE, BV, and other technologies as potential components of a cleanup action to address petroleum hydrocarbons in soil and groundwater at the site.

This work plan provides site background information including a conceptual site model for the pilot test area; discusses the rationale and objectives of the pilot test; and describes specific activities, methods, and procedures that will be used during data collection efforts associated with the pilot test. Procedures outlined in this work plan govern all aspects of field measurements and testing, sample collection, and documentation efforts that will be used to help ensure that samples collected are representative of conditions in the field, measurements and observations are clearly and concisely documented, and the information obtained is valid and accomplishes the objectives of the pilot test.

1.1 SITE DESCRIPTION AND BACKGROUND

The site is located at 1009 East Smith Road, approximately 4 miles north of the City of Bellingham, in Whatcom County, Washington (Figure 1). The site is zoned as R5 with a

Conditional Use Permit for industrial development and situated in an area of mixed agricultural and residential land use. Green belts and wooded park land are common in the surrounding properties. The site has been previously logged and now consists of access roads, service areas and second growth deciduous and coniferous trees.

The developed site occupies approximately 15 acres and is bounded by an additional 135 acres of Trans Mountain Pipeline (Puget Sound) LLC-owned undeveloped or agriculture land on three sides. Current facility improvements include 20-inch and 16-inch crude oil pipelines, a pump station and associated valve manifolds, an oil drain system, and two 96,000 barrel aboveground break-out tanks. Auxiliary facilities which support the industrial activities include a fire fighting system, electrical building, Tank Motor Control Center (MCC) Building, Puget Sound Energy (PSE) Substation, an emergency generator, transformer, heating/ventilation/air conditioning (HVAC) heat pump, the Trans Mountain administrative office and maintenance facilities. The Laurel Station facility supplies crude oil to refineries in Ferndale and Anacortes, Washington and has been in operation since 1956. A site plan showing current features on an aerial photograph is included as Figure 2.

1.2 ENVIRONMENTAL SETTING

1.2.1 Physiography

The surface topography within the site vicinity slopes to the north-northwest. The region around the site is composed of rolling hills with approximately 100 feet of relief. The two aboveground bulk break-out tanks (Tanks No. 170 and 180) at the rear of the site are located on a low hill at an elevation of approximately 330 feet above mean sea level (msl) (United States Geological Survey, 1994). From this hill the ground surface slopes to the northwest to East Smith Road with an average gradient of about 0.03 feet per foot. The main station facilities are located on an asphalt pad at an elevation of approximately 300 feet msl. A site plan is included as Figure 2.

1.2.2 Geology

The site is located within the Puget Sound lowland physiographic province, most of which is underlain by a thick sequence of unconsolidated Quaternary-age sediments deposited by alpine and continental glacial advances and recessions. These sediments overlie Tertiary-age and older bedrock of sedimentary and igneous origin. Sediments deposited during glacial advance were densely compacted by the glacial ice and looser unconsolidated sediments were deposited as the glacier receded. Excavations, test pits and exploratory borings completed at the Laurel Station facility indicate that the site is covered by a nearly continuous layer of grey or brown silty clays with scattered variable proportion (trace to little) of rounded gravel. This silty clay unit is typically very stiff to hard, exhibits a very low permeability, and has been interpreted to correspond to the Bellingham Drift. This silty clay layer dips toward the north-northwest, following the natural slope of the site, and thickens at the base of the slope near the station. In the area of the former oily water sump (Figure 4), the silty clay layer is not observed in soil borings and is interpreted to have been removed during grading for initial construction of the station. Approximately 10 to 50 feet below ground surface (bgs) beneath the Bellingham Drift, glacial outwash deposits (interpreted to correspond to the Deming Sand) have been observed in soil borings. This unit consists primarily of grey to light brown silty gravels and gravels with sand. This unit ranges from at least 120 to more than 220 feet in thickness and appears to have been deposited as discontinuous lenses with significant heterogeneity in both grain size and permeability. The outwash deposits at the site have been noted as medium dense to dense (Dames & Moore 1992a). Previous deep borings (DW-1 through DW-5) document gravelly sand to sandy gravel between 100 to 180 feet bgs, which is interpreted as an advance outwash deposit. The heterogeneous deposits overlying this are inferred to be a recessional outwash deposit. Both the advance and recessional outwash deposits are interpreted to correspond to the Deming Sand. A north-south geologic cross section of the site is shown on Figure 3.

1.2.3 Hydrogeology

During previous subsurface investigations at the site, groundwater was encountered at depths ranging from approximately 160 to 205 feet bgs (deep aquifer). The deep aquifer appears to occur within the advance outwash, in the lower portions of the Deming Sand deposit. Isolated occurrences of perched shallow groundwater have been encountered during investigations at the site at depths ranging from 5 to 45 feet bgs, in the upper portion of the Deming Sand. The source of perched shallow groundwater at the site is likely infiltration of surface water runoff, based on the seasonality of its occurrence and the strong correlations observed between water levels in shallow wells and precipitation. The Bellingham Drift acts as a confining layer across most of the site, restricting infiltration in most areas. The one exception is the area around the former oily water sump where Bellingham Drift appears to have been removed. Surface soil in this area consists of approximately 3 feet of gravelly sand fill overlying the gravel of the glacial outwash deposits (Deming Sand).

The slope east of the former oily water sump channels surface water runoff to the west and into the area where the drift has been removed. Once surface water has infiltrated the fill, it appears to move laterally through the more permeable layers within the glacial outwash. Some lenses within the upper portion of the outwash exhibit a very low vertical permeability, which impedes the downward movement of water. For this reason, large variations in static groundwater levels are seen in closely spaced shallow wells with similar screen intervals. Overall, shallow groundwater is only encountered in a relatively small area and shallow water bearing zones are not observed deeper than approximately 45 feet bgs (as measured from the elevation of the piping manifold and pump station). Borings have shown that hydraulic connectivity between shallow groundwater and the deep aquifer is unlikely. All shallow borings (all borings except for DW-1 through DW-5) terminated in non-water bearing soils.

Groundwater flow is inferred as westerly in the deep aquifer (Dames & Moore 1992b and URS 2008). Because perched shallow groundwater on the site is the result of surface water infiltration around the pump station and piping manifold, flow is seen both to the east and to the west, recharging from the area where the Bellingham Drift has been removed. Representative groundwater elevation contour maps for the shallow and deep aquifers are presented as Figures 4a through 4e and 5, respectively. Groundwater measurements from monitoring well SW–1 were not used to contour groundwater elevations in the upper portion of the Deming Sand because this well is screened within the Bellingham Drift. Groundwater within SW–1 is interpreted to not be in lateral hydraulic connection with groundwater observed in the other shallow monitoring wells. Groundwater elevation measurements for the monitoring well network are presented in Table 1.

1.3 CONTAMINANTS OF CONCERN

Review of historical data and data obtained during the June 2010 through June 2011 data gap investigation activities were used to develop a list of contaminants of concern (COCs), which include the following:

- Gasoline-range hydrocarbons (GRO) – soil and perched shallow groundwater;
- Diesel-range hydrocarbons (DRO) – soil and perched shallow groundwater;
- Oil-range hydrocarbons (ORO) – soil and perched shallow groundwater; and
- Benzene and ethylbenzene – soil.

1.4 AREAS OF CONCERN

The First Amended Enforcement Order No. DE 91-N192 defines the facility or “site” as three areas of concern (Areas 1 through 3) at the site, as well as “all other properties in the vicinity of the pump station property which have been affected or are potentially affected by spills, leaks, or discharges of petroleum products or other hazardous substances from the pump station”. The “other properties” at the site have been subdivided into seven individual “Study Units” (Study Units 1 through 7). A summary of the areas of concern and the correlation between the individual spills, Study Units, and Order-defined Areas 1 through 3 was provided in the Final Supplemental RI/FS Work Plan (URS 2010a). The areas of concern and Study Units are shown on Figure 2.

1.5 RATIONALE FOR PILOT TEST AREA SELECTION

Based on the results of the data gap investigation activities performed from June 2010 to June 2011, isolated pockets of soil contamination exceeding preliminary cleanup levels (PCLs) exist in Study Units 1, 2, and 3. With the exception of the former oily water sump area located within Study Unit 1 (Figure 6), the areas containing soil contamination exceeding PCLs are limited laterally and vertically (upper 5 to 10 feet of soil) and do not coincide with contaminated groundwater. Based on the limited extent of contamination, these areas will likely be targeted for excavation during a future cleanup action.

The former oily water sump area is located in the southeast portion of Study Unit 1 (Figures 2 and 6). This area was selected for pilot testing of potential remedial technologies based on the following rationale: 1) presence of intermittent contaminated soil to approximately 30 feet bgs;

2) occasional presence of contaminated groundwater (depth-to-groundwater ranges from 5 to 45 feet bgs); and 3) presence of aboveground facility infrastructure that would limit the ability to excavate contaminated soil. The rationale for the selection of technologies to be tested is presented in Section 2.1.

1.6 PHYSICAL-CHEMICAL CONCEPTUAL SITE MODEL FOR FORMER OILY WATER SUMP AREA

This section presents a description of the physical-chemical conceptual model for the former oily water sump area and includes the following:

- The nature of the contamination and the media contaminated;
- The release mechanism and location;
- The movement of the contaminant following release; and
- The current distribution of the contaminants.

This model consists of a summary interpretation of all data currently available for the oily water sump area. The physical-chemical conceptual site model will be revised whenever new data become available.

1.6.1 Subsurface Conditions

During the 1950s, the slope located to the southeast of the current pump station building and piping manifold (Figures 4a through 4e) was cut back during station construction activities (McClary 2011). The Bellingham Drift (the uppermost geologic unit at the site), which consists of silty clay, was removed from this portion of the site during the construction activities, effectively creating an area for overland stormwater flow to infiltrate into the underlying glacial outwash deposits and shallow perched groundwater (Figure 3). Shallow perched groundwater in this portion of the site does not appear to be continuous across the entire site, based on the lack of water observed in wells MW-3, MW-8, and MW-11 through MW-14, which are screened at the same elevation and within similar geologic units as wells MW-1, MW-2, MW-6, and SW-4 which do typically exhibit water. The interpolated areal extent of perched groundwater is shown on Figures 4a through 4e. The perched groundwater elevation appears to fluctuate substantially with precipitation events, with the degree of fluctuation much more pronounced within the area interpreted to be the primary recharge zone for perched groundwater – the vicinity of the former oily water sump. Groundwater elevation fluctuations are depicted graphically on Figure 4f, along with correlations to precipitation records for the Bellingham International Airport.

1.6.2 Soil Impacts

Impacted soil in this portion of the site appears to be the result of accidental leakage from the former oily water sump. The former oily water sump was reportedly constructed in the late 1950s as a 4-foot by 4-foot concrete structure, which extended from the ground surface to approximately 16 feet bgs. The former oily water sump received discharges from a number of former sources including drain lines from the three main pumps, valve and pipe fittings, and oily water from the storage tanks that separated out from the crude oil. The oily water sump was originally designed so that water which accumulated was drained along the drain line to a burn pit west of the office building, while the accumulated oil in an oil/water separator was pumped back into the pipeline. Following removal of the sump in 1991 during station upgrading activities, river rock was used to backfill the excavation. Representative cross sections through the area of the former oily water sump are included as Figures 7 through 9.

The areal extent of soils in the area surrounding the oily water sump exceeding PCLs for total petroleum hydrocarbons (TPH) is approximately 10,000 square feet (sf) (Figure 6). The greatest vertical thickness of soil contamination (up to 20 feet) is present in the locations of SU1-B12, SU1-B21, MW-1, and MW-9 (Figure 6), located approximately 15 feet east of the former oily water sump. The vertical thickness of soil contamination decreases with lateral distance from this location.

The analytical data for the soil samples (Tables 2 and 3) collected during the June 2010 through June 2011 data gap investigation activities indicate that the vertical and lateral extent of petroleum impacts appear to have been delimited (Figure 6).

1.6.3 Shallow Perched Groundwater Impacts

Impacted shallow perched groundwater in the vicinity of the oily water sump appears to be the result of stormwater infiltrating directly into the underlying glacial outwash deposits (where the Bellingham Drift has been removed) and coming into contact with impacted soils. The shallow perched groundwater appears to migrate within preferential pathways (coarser outwash deposits), which were observed in soil cores to be interbedded with lower permeability layers within the upper portion of the outwash deposits. Based on groundwater elevations collected at the site between February and September 2011, a mound of shallow perched groundwater was inferred in the vicinity of MW-2 and MW-6. Groundwater was interpreted to flow southeasterly, southerly and west-northwesterly from this mounded area (Figures 4a through 4e).

The analytical data for the groundwater samples collected from the site monitoring wells near the former oily water sump in February 2011 indicated that TPH concentrations exceeded PCLs in MW-1, MW-2, MW-5, and MW-7 (Tables 4 and 5). Based on these results, the lateral extent of impacted groundwater to the east of the former oily water sump was not defined (Figure 10a). However, the analytical data for the groundwater samples collected from the site monitoring wells near the former oily water sump in June 2011 indicated that impacted groundwater was delimited to the east of the former oily water sump area based on the absence of shallow perched groundwater in wells MW-11 through MW-14 (Figure 10b). In September 2011, only 5 of the 19 site monitoring wells contained measureable shallow perched groundwater levels (SW-1, SW-2, SW-4, MW-6, and MW-7), and the analytical results from these wells were all below PCLs (Tables 4 and 5).

2.0 OBJECTIVES

This section describes the rationale for selection of DPE and BV for pilot testing, overall pilot test objectives, and data collection and analysis objectives.

2.1 RATIONALE FOR TECHNOLOGY SELECTION

As discussed in the conceptual site model (Section 1.6), the soil and perched shallow groundwater in the vicinity of the oily water sump (the pilot test area) are impacted with petroleum hydrocarbons. Soil impacts extend down to approximately 30 feet bgs and are defined laterally to cover an area of approximately 10,000 sf. Perched groundwater elevations in the pilot test area fluctuate significantly (recent depth-to-groundwater measurements ranging from 5 to 45 feet bgs, Table 1) and correlate closely with the amount of surface water infiltration. Large variations in static groundwater levels are seen in closely spaced wells with similar screen intervals, which is interpreted to be caused by heterogeneity in the glacial outwash (see Sections 1.2.3 and 1.6.1).

Because of the relatively large fluctuations in perched groundwater elevation, limited lateral extent of COCs in groundwater, and the discontinuous nature of the water, the remedial technologies considered for this area are focused on soil remediation. Excavation of impacted soil and ex-situ soil treatment technologies are not considered feasible due to the presence of aboveground facility infrastructure in the pilot test area that would likely be undermined by excavation of impacted soil. Therefore, potential in-situ technologies for treatment of petroleum hydrocarbons in soil were considered. DPE, BV, and thermal treatment were selected for further evaluation.

DPE and BV are established technologies for remediation of petroleum-contaminated sites with relatively permeable soils. DPE was selected for further evaluation over soil vapor extraction (SVE) due to the intermittent presence of groundwater at the site and the likelihood of encountering groundwater in the test wells during the wet season. DPE and BV are not considered ideal for heavier-end hydrocarbons (i.e., DRO and ORO); however, they may be considered in combination with other technologies during development of potential remedial alternatives for the FS.

A pilot test is proposed to assess the feasibility of using both DPE and/or BV technologies for remediation of petroleum hydrocarbon impacts beneath the site, as well as to evaluate the operating parameters that would be required for a full-scale system (e.g., applied vacuums, vapor and groundwater extraction rates, air flow rates, etc.). A thermal treatability study was conducted in accordance with the Work Plan Addendum dated May 23, 2011 (URS 2011b) to assess if thermal heating of soils in the former oily water sump area can effectively reduce contaminant concentrations to below PCLs and the treatment temperature required to achieve that reduction. The results of the treatability study and the pilot test will be included in the Draft Supplemental RI/FS Report.

2.2 TECHNOLOGY OVERVIEW

DPE is an in-situ technology that uses a vacuum extraction system to remove various combinations of contaminated groundwater, separate-phase petroleum product, and hydrocarbon vapor from the subsurface. Extracted liquids and vapor are collected and treated for disposal, or are treated and re-injected to the subsurface or discharged to the atmosphere as permitted. DPE systems are typically designed to maximize extraction rates; however, the technology also increases rates of biodegradation of petroleum constituents in the unsaturated zone by increasing the supply of oxygen, in a manner similar to BV. The vacuum applied to the subsurface with DPE systems creates vapor-phase pressure gradients toward the vacuum well. These vapor-phase pressure gradients are also transmitted directly to the subsurface liquids present, and those liquids existing in a continuous phase will flow toward the vacuum well in response to the imposed gradients. The higher the applied vacuum, the larger the hydraulic gradients that can be achieved in both vapor and liquid phases, and thus the greater vapor and liquid recovery rates.

BV is an in-situ remediation technology that uses indigenous microorganisms to biodegrade organic constituents adsorbed to soils in the unsaturated zone. Soils in the capillary fringe and the saturated zone are not affected. The activity of the indigenous bacteria is enhanced by inducing air (or oxygen) flow into the unsaturated zone and, if necessary, by adding nutrients. All aerobically biodegradable constituents can be treated by BV. BV is most often used at sites with mid-weight petroleum products (i.e., DRO and jet fuel), because lighter products (i.e., GRO) tend to volatilize readily and can be removed more rapidly with SVE or DPE. Heavier products (e.g., crude oil) generally take longer to biodegrade than lighter products.

2.3 PILOT TEST OBJECTIVES

The purpose of the pilot test is to assess the feasibility of using DPE and/or BV technologies for remediation of soil (DPE and BV) and intermittent perched groundwater (DPE) impacted with petroleum hydrocarbons beneath the former oily water sump area. To evaluate the suitability of DPE and BV for this site, several questions were considered in the design of the pilot test system and the preparation of this work plan. The objective of the pilot test is to gather the data required to answer these questions.

DPE

- Does the permeability of soil beneath the site accommodate vacuum extraction?
- Will DPE effectively remove the heavy end COCs as well as the light end?
- What are the COC concentrations in extracted vapor and groundwater?
- What is the radius of influence (ROI)?
- What is the extraction rate at various applied vacuums?
- What would be the design parameters for a full-scale system (e.g., applied vacuum, ROI, vapor extraction rate, groundwater extraction rate)?
- What would be the cost of a full-scale system?

- How long would a full-scale system need to operate to achieve the remedial action objectives?

BV

- Will in-situ aeration of soil likely result in an increased rate of hydrocarbon biodegradation in the unsaturated zone?
- Can air be distributed into the full thickness of the unsaturated zone?
- What is the ROI and longevity of the increase in oxygen?
- Are aerobic bacteria present and active in the vadose zone under existing conditions?
- What would be the design parameters for a full-scale system (e.g., applied pressure, air flow rate, ROI, oxygen concentration)?
- What would be the cost of a full-scale system?
- How long would a full-scale system need to operate to achieve the remedial action objectives?

In addition to these questions, the U.S. Environmental Protection Agency (USEPA) document How to Evaluate Alternative Cleanup Technologies for Underground Storage Tank Sites: A Guide for Corrective Action Plan Reviewers (USEPA 2004) identifies a checklist of questions for each technology to help evaluate the completeness of a cleanup action plan that proposes various technologies. The checklists for DPE and BV are included in Appendix A. The pilot test will gather data to answer these checklist questions, as applicable.

2.4 DATA COLLECTION AND ANALYSIS OBJECTIVES

The pilot test will include field data collection, laboratory testing, and analysis of the field and laboratory data. Due to the short duration of the pilot test, a measurable reduction in soil COC concentrations during the test is not expected. Therefore, no soil sampling is proposed as part of the pilot test. However, there are several parameters that can be measured and analyzed to evaluate the suitability of these technologies for full-scale implementation at the site. The field data and laboratory testing data that will be collected are summarized in Table 6 and discussed in Section 3, Scope of Work. Table 6 also details the range of measurements that will be collected in the field, the basis for the selected ranges, and the analyses that will be performed using the field and laboratory data.

These analyses, as well as comparison criteria and evaluation of suitability based on the analyses results, are summarized in Table 7 and discussed in Section 3. The analyses include:

DPE

- Field permeability to air flow (discussed in Section 3.4.4)
- ROI (discussed in Section 3.4.5)
- TPH removal rate (discussed in Sections 3.4.6 and 3.4.7)

BV

- ROI (discussed in Section 3.5.2)
- Permeability test (discussed in Section 3.5.2)
- Air respiration test (discussed in Section 3.5.3)

3.0 SCOPE OF WORK

This section describes the field data collection activities and data analyses that will be performed for the pilot test.

3.1 PRE-CONSTRUCTION SITE/SAFETY MEETING

A pre-construction meeting will be held at the site in advance of starting work to inspect the site, discuss site safety, and coordinate site logistics during future field activities.

A Health and Safety Plan (HASP) for field activities at the site was developed in June 2010 and updated in June 2011. The HASP will be updated prior to pilot test field work to include the pilot test field activities. All URS employees and subcontractors to URS will comply with the HASP requirements as well as facility specific health and safety requirements.

3.2 EQUIPMENT REQUIRED

The equipment, materials, and supplies needed to perform the pilot test include:

- Mobilization/General Site Equipment
    - Generator to power equipment
    - Decontamination equipment (hot water, pressure washer, containment)
    - Secondary containment materials/supplies (drum/material storage)
- DPE Pilot Test Equipment
    - DPE liquid ring pump (capable of developing a vacuum of 20 inches of mercury [in Hg] and flows of 100 cubic feet per minute [cfm])
    - Wellhead connection and downhole 'stinger' piping for test well
    - Liquid-phase knockout drum
    - Cavity pump capable of removing water from knockout drum during pilot testing
    - Instrumentation for measurement of vapor/liquid extraction rates (e.g., pitot tube)
    - Vapor-phase concentration monitoring port/system
    - Vapor-phase exhaust stack
- BV Pilot Test Equipment
    - BV blower (capable of developing pressures of 10 pounds per square inch [psi] and flows of 20 cfm)
    - Wellhead connection to allow delivery of air/helium and concentration monitoring

    - Helium supply/monitoring system (full-size Ultra High Purity [UHP] gas cylinder, regulator, pressure gauge, rotameter, delivery hose), helium detector (parts per million [ppm] sensitivity)
- General Pilot Test Monitoring Equipment
    - All hose/piping/tubing for connection from equipment to wells
    - All instrumentation and monitoring devices for both test equipment and two 4-inch diameter test wells (e.g., Dwyer Magnehelic and other gauges) and six 2-inch diameter observation wells (e.g., water level [In-Situ Level Troll or similar] and barometric pressure [In-Situ Baro Troll or similar] transducers and dataloggers)
    - Multimeter with oxygen, carbon dioxide, carbon monoxide, and methane detectors
    - Photoionization detector (PID) and flame ionization detector (FID) to measure total volatile hydrocarbons (TVH)

3.3 PILOT TEST WELLS

The scope of work for the pilot testing includes using two four-inch wells (MW-9 and MW-10) near the former oily water sump as test wells to assess DPE and BV remediation technologies. Monitoring wells MW-1, MW-2, MW-5, MW-7, SW-4 and SW-5 will be used as observation wells during the pilot test. Test wells MW-9 and MW-10 are screened from 7 to 27 feet bgs and 10 to 25 feet bgs, respectively, with 0.020-in slotted screens. During groundwater monitoring events in June, July, and September 2011, these wells were either dry or groundwater was measured in the lower 1 foot of the well screen. The observation wells are located in the vicinity of the test wells at distances ranging from approximately 5 feet to 75 feet and are screened at depths ranging from 5 feet bgs to 45 feet bgs (Figure 6).

Prior to the start of the pilot test, groundwater samples will be collected from MW-1 or MW-2 and MW-5 or MW-7 and analyzed for hydrocarbon degrading bacteria and heterotrophic plate count to assess microbial population in the pilot test area. Selection of the sampling location will be based on availability of adequate sample volume in the well.

3.4 DPE PILOT TEST

The DPE pilot test will consist of applying a vacuum to a test well using a portable single-pump high-velocity DPE system that will be mobilized to the site for the pilot test. The test will be performed at three different vacuum steps (e.g., 5, 10, and 20 in Hg). Vacuum will be applied to the test location wellheads using temporary hoses to achieve at least three different flow rates to assess the relationship between applied wellhead vacuum and resulting extraction flow rates. Based on discussions with the Northwest Clean Air Agency, this pilot test is exempt from air permitting requirements. It is anticipated that extracted vapors will be directly vented into the atmosphere through an exhaust stack at least 12 feet above grade. The test procedure is described in detail in Appendix B and summarized below. Data collected and observations made during the performance of the DPE pilot test will be recorded on field forms, which are included in Appendix C.

3.4.1 DPE Pilot Test Procedure

Following field mobilization to the site and completion of site safety meetings, baseline vapor concentration and depth to groundwater measurements will be collected at all pilot test wells. The DPE blower will then be connected to the first test wellhead (MW-9 or MW-10) while observation wellheads are closed with caps fitted with sampling ports. The DPE blower will be started while it is vented to the atmosphere with the flow control valve fully open. Then extraction from the test well will begin at the first vacuum level (e.g., 5 in Hg) by partially closing the flow control valve. Testing at the first vacuum level will proceed for a minimum of two hours while vacuum and groundwater elevations are measured at observation wells, and then the vacuum level at the test well will be increased to an intermediate level (e.g., 10 in Hg). After testing at the intermediate vacuum level for a minimum of two hours while vacuum and groundwater elevations are measured at observation wells, the vacuum level at the test well will be increased to a maximum vacuum level (e.g., 20 in Hg) for a minimum of two hours for the remainder of the first day of testing. The second day of testing will be performed similarly at the second test well.

3.4.2 DPE Pilot Test Data Collection

For each applied wellhead vacuum, the following parameters will be monitored and recorded in the field. Each of these parameters will be recorded continuously (i.e., approximately every 15 minutes) from initiation to shutdown of the test. Parameters will be recorded on field forms, included in Appendix C.

- Applied vacuum (in Hg) at the test well (vapor and liquid).

- Extraction rate for soil vapors (cubic feet per minute [cfm]) and groundwater (gallons per minute [gpm]) at the test well.

- TVH concentrations in the extracted vapors will be measured in the field with both a PID and FID (ppmv).

- Oxygen, carbon dioxide, carbon monoxide, and methane concentrations in extracted vapors at the test well.

- Vapor samples will be collected in Tedlar bags and analyzed for GRO and benzene, toluene, ethylbenzene, and xylenes (BTEX) via EPA Method TO-15. In addition, samples will be collected in sorbent sampling tubes and analyzed for GRO, DRO, and BTEX by modified EPA Method TO-17. Samples will be collected at the beginning (first vacuum level), midpoint (second vacuum level), and twice during the third vacuum level (at the beginning of the final test level and at the end).Because ORO has limited volatility, testing methods are not inclusive of the heavier TPH range. The results from the laboratory analyses will be compared to the field measurements for verification.

- DPE blower operating parameters (e.g., vacuum, temperature, air flows, and energy consumption).

- Transient and steady state vacuum at observation wells (inches of water column [in wc]).

- Transient and steady state groundwater elevation at observation wells (feet below top of casing [TOC]).

Groundwater extracted during the DPE pilot test will be pumped into a storage tank. A separate tank will be provided for each test well. Following completion of the pilot test, the extracted groundwater in each tank will be sampled for laboratory analysis of GRO, DRO, ORO, and BTEX. These data will be used to calculate the amount of hydrocarbons removed in the groundwater during the pilot test.

3.4.3 DPE Data Analysis

Data obtained from the DPE pilot test will be presented in the form of tables and graphs to enable interpretation. Presentation of the data will be as follows:

- Vacuums and flow rates from the test well
- Stabilized vacuum responses in each observation well
- Graph of flow rate versus extracted vacuum (both soil vapor and groundwater)
- Vacuum response in observation wells versus distance from test well
- Groundwater elevation response in observation wells versus distance from test well
- Calculated field permeabilities to air and groundwater flow
- TPH removal rates and total TPHs removed for the test well

Data interpretation procedures are discussed below.

3.4.4 Field Permeability

Field permeability to air flow is a soil property that relates to the rate at which a gas will flow through soil. High permeabilities are characteristic of coarse-grained soil such as gravel and sand, while low permeabilities are characteristic of silts and clay. USEPA guidance suggests that SVE (and/or DPE) may not be appropriate for sites with field permeabilities of less than 0.1 darcy (USEPA 1991). Field permeabilities will be calculated using the following equation (Johnson et al. 1989):

$$k = \frac{Q\ \mu\ \ln(R_w/R_m)^2}{H\ P_w\ \pi\ [1-(P_m/P_w)^2]}$$

Where:

k = Permeability to air flow (cm^2) (1 darcy = 10^{-8} cm^2)
Q = Flow from test well (cm^3/s)

H	=	Screened interval (cm)
μ	=	Viscosity of air (1.8 x 10^{-4} g/cm-s)
P_w	=	Absolute vacuum at test well (1.01 x 10^{6} g/cm-s^2)
P_m	=	Absolute vacuum at observation well (g/cm-s^2)
R_w	=	Radius of test well (cm)
R_m	=	Distance of observation well from test well (cm)

From this equation, the permeability to air flow can be calculated for each vacuum step. The number of permeabilities calculated for each test will be equal to the number of monitoring wells and vacuum steps (in this case, 3). The "site" field permeability will be the average value of all calculated field permeabilities.

3.4.5 Radius of Vacuum Influence

The ROI will be defined as the distance from the test well at which the observed vacuum response is at least 1 percent of the applied vacuum. To estimate the ROI, the vacuum responses at each observation well (i.e., MW-1, MW-2, MW-5, MW-7, SW-4, and SW-5) will be normalized with the applied vacuum and plotted versus distance from the test well. From this plot, the distance will then be estimated at which the response is 1 percent of the applied vacuum. Alternatively, residual vacuum (log scale) and distance (normal scale) will be plotted on a semilog graph, and the ROI graphically determined by intersecting a straight line to the point of 1 percent of the applied wellhead vacuum.

3.4.6 TPH Removal Rate (Vapor)

The amount of TPH removed during the pilot test in the vapor phase will be calculated based on the observed flow rates and the vapor concentrations reported from laboratory analytical tests and field measurements using an FID. Results will be presented in terms of total TPH removed and the removal rates in terms of pounds per hour. The laboratory results will allow speciation of the extracted vapors for GRO, DRO, and BTEX, and therefore enable estimation of removal rates for individual COCs. The formula used to calculate vapor mass extraction rates will be as follows:

$$MER = (7.58 \times 10^{-5})\ Q\ C\ MW$$

Where:

MER	= vapor mass extraction rate (pounds per hour)
Q	= flow rate of extracted soil vapors (scfm)
C	= concentration of TPH (ppmv)
MW	= molecular weight of the TPH (grams per mole)

3.4.7 TPH Removal Rate (Groundwater)

The amount of TPH removed during the pilot test in the liquid phase will be calculated based on the observed flow rates and the TPH concentrations in extracted groundwater reported from laboratory analytical tests. Results will be presented in terms of total TPH removed and the removal rates in terms of pounds per hour. The laboratory results will enable estimation of removal rates for individual contaminants. The formula used to calculate groundwater mass extraction rates will be as follows:

$$LMER = (5x10^{-4})\ Q\ C$$

Where:

LMER = liquid mass extraction rate (pounds per hour)
Q = flow rate of extracted groundwater (gpm)
C = concentration of TPH (milligrams per liter [mg/L])

3.4.8 DPE Evaluation Criteria

Data obtained from the pilot test will be used in the FS to evaluate DPE as a potential cleanup technology for the site. The FS will include evaluation of the following criteria:

- Calculated field permeability: Values should be greater than 0.1 darcy for DPE to be considered effective

- ROI and area of impact: The ROI will be compared to the area of impacts based on prior site characterization work that has been conducted for the site to evaluate the number and spacing of DPE wells that could be required for cleanup using this technology

- Constructability of a full-scale system considering ongoing facility operations and access issues

- Estimated mass removal rates

- Cost of a full-scale system

The DPE pilot test will be conducted for approximately 2 days (i.e., 1 day for each test well) or until the above criteria are adequately assessed.

3.5 BIOVENTING PILOT TEST

Following the DPE pilot test, a BV pilot test is proposed to evaluate whether in situ aeration of soil is likely to result in an increased rate of hydrocarbon biodegradation in the vadose zone. The bioventing pilot test will consist of: (1) baseline soil gas monitoring, (2) oxygen, pressure, and helium influence testing, and (3) in-situ respiration test. The oxygen, pressure, and helium influence testing will be conducted by pressure injecting known quantities of air (less than 20 cfm) and a tracer gas (helium) into a test well and measuring oxygen, carbon dioxide, carbon monoxide, helium, TVH, and methane concentrations and pressures before, during, and after the injections at various observation wells. The test will be performed on each of two 4-inch test wells (MW-9 and MW-10) near the former oily water sump (Figure 6). Monitoring wells MW-1, MW-2, MW-5, MW-7, SW-4, and SW-5, as well as MW-9 or MW-10, when not used as the test well, will be used as observation wells during the pilot test. The in-situ respiration test will be conducted by measuring the rate at which subsurface oxygen concentrations in the test well and observation wells decrease following aeration as an indication that supplied oxygen can be utilized by aerobic microbial populations.

The test procedure is described in detail in Appendix B and summarized below. Data collection and observations made during the performance of the bioventing pilot test will be recorded on field forms, which are included in Appendix C.

3.5.1 Baseline Soil Gas Monitoring

Baseline soil gas monitoring conducted on observation wells prior to air injections will establish baseline concentrations of oxygen, carbon dioxide, carbon monoxide, methane, and TVH prior to the bioventing test. If the oxygen levels are greater than 5 percent in the test wells and observation wells following the previous DPE pilot testing, then the respiration test will be performed soon thereafter (within 4 hours) without additional aeration. However, if oxygen levels remain less than 5 percent, then additional forced aeration of soils will be conducted for a period of up to 8 hours to increase the oxygen levels before conducting the respiration test.

3.5.2 Oxygen, Pressure, and Helium Influence Test

After the initial baseline soil gas conditions are measured, oxygen, pressure, and helium influence testing will be performed to evaluate the influence, if any, of air injection on nearby observation wells and whether vadose-zone soil at the site can be effectively aerated. Measurements of oxygen, carbon dioxide, carbon monoxide, helium, TVH, pressure, and methane will be collected continuously (i.e., approximately every 15 minutes) during each test. The objective of this test is to assess whether oxygen may be sufficiently distributed throughout the petroleum-contaminated soils within the vadose zone to facilitate increased aerobic biodegradation rates.

Soil gas oxygen measurements will be used as the primary measure of the ROI from the air injection and evidence of “good” soil aeration. However, because of the potentially large oxygen deficit and large oxygen demand within the petroleum hydrocarbon affected soils, increased soil gas oxygen concentrations in the observation wells may not be observed during a short-duration bioventing test (i.e., less than a day). To account for this possibility, pressure increases or positive detections of helium in the observation wells will be used as secondary lines of evidence that there is a positive ROI between the air injection well and monitoring well(s). Based on the distribution of the tracer gas over time, an assessment will be made on the practical feasibility of the technology.

The concentrations of TVH in soil gas samples taken from the observation wells will be used to assess whether the forced aeration of soils is spreading the contamination at levels of potential concern. If TVH soil gas concentrations increase more than 20 percent over baseline levels, or more than 500 parts per million by volume (ppmv) (whichever is less), then the amount of injection air will be decreased and soil gas measurements will be retaken. If TVH soil gas concentrations remain above these criteria after three attempts of reducing the air-injection flow rate, then the bioventing pilot test will be immediately terminated.

3.5.3 Respiration Test

The purpose of the respiration test is to evaluate whether aerobic bacteria are present and active in the vadose zone under existing conditions and whether increasing available oxygen in the subsurface will increase the rate of aerobic bacteria activity. The basis for decision making will be the measured utilization of oxygen by aerobic bacteria and the subsequent generation of carbon dioxide as a product of aerobic activity.

Initial biodegradation rates will be estimated based on the results of the in situ respiration tests. These tests will consist of injecting air and helium into a single test well and periodically monitoring levels of oxygen, carbon dioxide, carbon monoxide, TVH, helium, methane, and pressure in soil gas samples from the observation wells and test well (as described above). Measurable increases in oxygen concentrations of soil gas samples in the observation wells will provide a positive indication that the soils were aerated. The rate at which subsurface oxygen concentrations decrease following aeration will provide a positive indication that the supplied oxygen can be utilized by aerobic microbial populations, and the rates at which aerobic bioremediation occurs at the site. Studies have demonstrated that aerobic degradation of hydrocarbons is prevalent when oxygen concentrations in soil pores exceed 5 percent by volume (USACE 2002).

3.6 DECONTAMINATION PROCEDURES

All non-dedicated sampling equipment and downhole equipment will be decontaminated or purged before each sample is collected or equipment is used at a new location. Decontamination will follow procedures described in the Final Supplemental RI/FS Work Plan (URS 2010a). Wastewater resulting from decontamination procedures will be separately contained and characterized for disposal. Drums will be staged as designated by facility personnel.

3.7 ANALYTICAL PROCEDURES

Groundwater samples collected for hydrocarbon degrading bacteria and heterotrophic plate count prior to the pilot test will be submitted to Columbia Analytical Services located in Kelso, Washington. Extracted vapor and extracted groundwater samples will be collected for laboratory analysis during the DPE pilot test. No sampling for laboratory analysis will be performed during the BV pilot test.

Extracted vapor sampled during the DPE pilot test will be submitted to Air Toxics, Ltd located in Folsom, California for analysis of GRO, DRO, and BTEX. Extracted groundwater sampled during the DPE pilot test will be submitted to Analytical Resources, Inc. (ARI) located in Tukwila, Washington. These laboratories are Ecology-accredited and all samples will be submitted under appropriate chain-of-custody procedures. The laboratory will provide the necessary sample containers to collect water and vapor samples for the required testing. Practical quantitation limits (PQLs) and laboratory quality control requirements for groundwater are provided in the Quality Assurance Project Plan (QAPP), which was submitted as Appendix G in the Final Supplemental RI/FS Work Plan (URS 2010a). PQLs and laboratory control limits on QC parameters for the vapor samples will be based on the current information from the respective laboratories. Samples will be shipped to the laboratory for next-day delivery and submitted for a 14-day turnaround time. The laboratory will provide a "validatable" package that will be reviewed by a URS chemist as described in the QAPP.

Vapor samples will be analyzed using the following procedures:

- GRO and BTEX by modified EPA Methods TO-15 and TO-17

DRO by EPA Method TO-17

Groundwater samples will be analyzed using the following procedures:

- GRO by Ecology Method NWTPH-Gx
- BTEX by EPA Method 8021B
- DRO and ORO by Ecology Method NWTPH-Dx

4.0 WASTE HANDLING

Investigation derived waste (IDW) generated during this evaluation will consist of extracted groundwater from DPE pilot testing, wastewater from decontamination (including washout of the vacuum truck and cleanout of the storage tank), personal protective equipment (PPE), and miscellaneous solid wastes. These wastes will be temporarily containerized prior to final disposition at an appropriately permitted facility.

Groundwater recovered during the DPE pilot test will be containerized in drums and/or other storage tanks staged as designated by facility personnel. Decontamination water from washout of the vacuum truck following the DPE pilot test will also be transferred to a storage tank following sampling of the extracted groundwater for laboratory analysis. Purge water collected during groundwater sampling will be transferred to a storage tank using sealed equipment (e.g., hose, buckets). Water will require storage, pending treatment and determination of final disposition by Kinder Morgan.

A minimum of one drum will be kept on site for PPE and one drum will be available for miscellaneous solid wastes. All drums and the storage tank will be properly labeled and staged as designated by facility personnel.

5.0 REPORTING

Following completion of the field activities and review of the laboratory analytical data, URS will evaluate the suitability of DPE and/or BV for full-scale implementation in the former oily water sump area at the site. DPE and BV will be evaluated as either stand-alone remediation technologies or as components of an overall multicomponent long-term remediation approach. The data and analyses from the pilot test will be included in a site-wide Draft Supplemental RI/FS Report that will include evaluation of alternatives to address the petroleum hydrocarbons in soil and groundwater at the site.

6.0 SCHEDULE

The proposed pilot testing activities are tentatively scheduled for the week of December 12, 2011 and are expected to extend for up to 5 days. Kinder Morgan and URS anticipate that a meeting will be necessary with Ecology following completion of the pilot testing activities to discuss the cleanup alternatives that will likely be evaluated as part of the FS. This meeting will likely occur in December 2011/January 2012. The Draft Supplemental RI/FS Report will be submitted to Ecology in February/March 2012.

7.0 REFERENCES

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TABLES

Table 1
Groundwater Elevation Data Summary
Laurel Station
Bellingham, Washington

Well ID	Date Measured	Total Depth (ft-TOC)	TOC Elevation (ft-MSL)	Screen Interval (ft-bgs)	Screen Interval Elevation (ft-MSL)	Depth to Groundwater (ft-TOC)	Groundwater Elevation (ft-MSL)
SW-1	April 15-17, 1992	NM	296.09	5 - 20	291.09 - 276.09	6.06	290.03
	October 31 - November 2, 2000	NM	296.09			5.60	290.49
	September 2004	18.60	296.09			4.92	291.17
	May 10, 2006	18.60	296.09			5.45	290.64
	November 7-8, 2006	NM	296.09			NM	NC
	December 7-8, 2006	NM	296.09			NM	NC
	March 13, 2008	18.60	296.09			4.86	291.23
	August 26, 2010	18.60	296.09			7.70	288.39
	December 1, 2010	18.58	296.09			4.60	291.49
	February 23, 2011	18.56	300.64			4.89	295.75
	April 7, 2011	18.60	300.64			4.18	296.46
	May 11, 2011	18.55	300.64			4.80	295.84
	June 27, 2011	18.45	300.64			5.63	295.01
	July 27, 2011	18.60	300.64			6.10	294.54
	September 7, 2011	18.45	300.64			7.29	293.35
SW-2	April 15-17, 1992	NM	296.69	40 - 50	256.69 - 246.69	38.82	257.87
	October 31 - November 2, 2000	NM	296.69			39.85	256.84
	September 2004	49.34	296.69			39.93	256.76
	May 10, 2006	49.34	296.69			38.58	258.11
	November 7-8, 2006	45.70	296.69			40.50	256.19
	December 7-8, 2006	45.70	296.69			38.60	258.09
	March 13, 2008	48.82	296.69			37.48	259.21
	August 26, 2010	48.90	296.69			38.18	258.51
	December 1, 2010	49.72	296.69			38.12	258.57
	February 23, 2011	49.75	301.37			37.05	264.32
	April 7, 2011	49.80	301.37			37.01	264.36
	May 11, 2011	49.75	301.37			36.60	264.77
	June 27, 2011	49.62	301.37			37.24	264.13
	July 27, 2011	49.75	301.37			37.79	263.58
	September 7, 2011	49.65	301.37			37.85	263.52
SW-3*	April 15-17, 1992	NM	304.79	22 - 32	284.44 - 274.44	33.56	271.23
	October 31 - November 2, 2000	NM	304.79			DRY	NC
	September 2004	35.33	304.79			DRY	NC
	May 10, 2006	35.33	304.79			33.96	270.83
	November 7-8, 2006	34.70	304.79			DRY	NC
	December 7-8, 2006	34.70	304.79			DRY	NC
	March 13, 2008	34.79	304.79			32.75	272.04
	August 26, 2010	34.80	304.79			34.30	270.49
	December 1, 2010	NM	304.79			DRY	NC
	February 23, 2011	34.78	309.48			31.96	277.52
	April 7, 2011	34.80	309.48			31.78	277.70
	May 11, 2011	34.75	309.48			31.49	277.99
	June 27, 2011	34.64	309.48			33.20	276.28
	July 27, 2011	34.80	309.48			33.95	275.53
	September 7, 2011	34.65	309.48			DRY	NC
SW-4	April 15-17, 1992	NM	298.30	18 - 28	280.30 - 270.30	DRY	NC
	September 2004	27.26	298.30			DRY	NC
	May 10, 2006	27.26	298.30			DRY	NC
	November 7-8, 2006	27.40	298.30			15.30	283.00
	December 7-8, 2006	27.20	298.30			17.30	281.00
	March 13, 2008	27.41	298.30			17.95	280.35
	August 26, 2010	27.40	298.30			24.72	273.58
	December 1, 2010	27.39	298.30			19.82	278.48
	February 23, 2011	27.20	303.54			19.41	284.13
	April 7, 2011	27.25	303.54			15.69	287.85
	May 11, 2011	27.15	303.54			18.00	285.54
	June 27, 2011	27.13	303.54			22.45	281.09
	July 27, 2011	27.20	303.54			22.73	280.81
	September 7, 2011	27.10	303.54			25.83	277.71

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Laurel Station
Bellingham, Washington

Well ID	Date Measured	Total Depth (ft-TOC)	TOC Elevation (ft-MSL)	Screen Interval (ft-bgs)	Screen Interval Elevation (ft-MSL)	Depth to Groundwater (ft-TOC)	Groundwater Elevation (ft-MSL)
SW-5	April 15-17, 1992	NM	298.86	34 - 39	264.86 - 259.86	20.64	278.22
	September 2004	NM	298.86			20.31	278.55
	May 10, 2006	NM	298.86			20.24	278.62
	November 7-8, 2006	38.60	298.86			DRY	NC
	December 7-8, 2006	38.60	298.86			DRY	NC
	March 13, 2008	38.60	298.86			DRY	NC
	August 26, 2010	NM	298.86			DRY	NC
	December 1, 2010	NM	298.86			DRY	NC
	February 23, 2011	38.90	303.02			DRY	NC
	April 7, 2011	38.60	303.02			DRY	NC
	May 11, 2011	38.60	303.02			DRY	NC
	June 27, 2011	38.50	303.02			DRY	NC
	July 27, 2011	38.60	303.02			DRY	NC
	September 7, 2011	38.50	303.02			DRY	NC
MW-1	February 23, 2011	25.73	303.23	6 - 26	297.23 - 277.23	23.81	279.42
	April 7, 2011	25.75	303.23			18.35	284.88
	May 11, 2011	25.90	303.23			20.69	282.54
	June 27, 2011	25.75	303.23			23.75	279.48
	July 27, 2011	25.90	303.23			25.69	277.54
	September 7, 2011	25.75	303.23			DRY	NC
MW-2	February 23, 2011	29.98	302.49	5 - 31	297.49 - 272.49	9.33	293.16
	April 7, 2011	30.15	302.49			4.29	298.20
	May 11, 2011	30.10	302.49			7.81	294.68
	June 27, 2011	30.00	302.49			12.72	289.77
	July 27, 2011	29.80	302.49			17.71	284.78
	September 7, 2011	30.00	302.49			DRY	NC
MW-3	February 23, 2011	33.53	305.83	24 - 34	281.83 - 271.83	DRY	NC
	April 7, 2011	33.55	305.83			DRY	NC
	May 11, 2011	33.55	305.83			DRY	NC
	June 27, 2011	33.41	305.83			DRY	NC
	July 27, 2011	33.55	305.83			DRY	NC
	September 7, 2011	33.40	305.83			DRY	NC
MW-4	February 23, 2011	30.15	305.67	20 - 30	285.67 - 275.67	24.06	281.61
	April 7, 2011	30.20	305.67			21.78	283.89
	May 11, 2011	30.13	305.67			23.38	282.29
	June 27, 2011	30.02	305.67			29.39	276.28
	July 27, 2011	30.15	305.67			29.74	275.93
	September 7, 2011	30.50	305.67			DRY	NC
MW-5*	February 23, 2011	43.98	319.56	20 - 40	296.72 - 276.72	38.87	280.69
	April 7, 2011	44.00	319.56			39.99	279.57
	May 11, 2011	44.00	319.56			39.89	279.67
	June 27, 2011	43.85	319.56			DRY	NC
	July 27, 2011	43.85	319.56			DRY	NC
	September 7, 2011	43.85	319.56			DRY	NC
MW-6	February 23, 2011	26.55	302.78	11 - 26	291.78 - 276.78	10.58	292.20
	April 7, 2011	26.70	302.78			4.83	297.95
	May 11, 2011	26.70	302.78			8.25	294.53
	June 27, 2011	26.58	302.78			18.30	284.48
	July 27, 2011	26.70	302.78			19.70	283.08
	September 7, 2011	26.60	302.78			25.89	276.89
MW-7*	February 23, 2011	47.97	318.89	30 - 45	286.21 - 271.21	44.99	273.90
	April 7, 2011	48.15	318.89			44.69	274.20
	May 11, 2011	48.13	318.89			44.75	274.14
	June 27, 2011	48.00	318.89			45.40	273.49
	July 27, 2011	48.15	318.89			46.64	272.25
	September 7, 2011	48.00	318.89			47.00	271.89
MW-8	February 23, 2011	37.21	302.24	23 - 38	279.24 - 264.24	DRY	NC
	April 7, 2011	37.20	302.24			DRY	NC
	May 11, 2011	37.20	302.24			DRY	NC
	June 27, 2011	37.06	302.24			DRY	NC
	July 27, 2011	37.25	302.24			DRY	NC
	September 7, 2011	37.10	302.24			DRY	NC

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Bellingham, Washington

Well ID	Date Measured	Total Depth	TOC Elevation	Screen Interval	Screen Interval Elevation	Depth to Groundwater	Groundwater Elevation
		(ft-TOC)	(ft-MSL)	(ft-bgs)	(ft-MSL)	(ft-TOC)	(ft-MSL)
MW-9*	June 27, 2011	30.22	306.51	7 - 27	296.74 - 276.74	DRY	NC
	July 27, 2011	30.40	306.51			30.26	276.25
	September 7, 2011	30.25	306.51			DRY	NC
MW-10	June 27, 2011	25.22	303.02	10 - 25	293.67 - 278.67	DRY	NC
	July 27, 2011	25.40	303.02			25.00	278.02
	September 7, 2011	25.25	303.02			24.90	278.12
MW-11*	June 27, 2011	48.18	321.31	25 - 45	294.06 - 274.06	DRY	NC
	July 27, 2011	48.30	321.31			DRY	NC
	September 7, 2011	48.20	321.31			DRY	NC
MW-12*	June 27, 2011	51.61	323.53	29 - 49	292.02 - 272.02	DRY	NC
	July 27, 2011	51.75	323.53			DRY	NC
	September 7, 2011	51.60	323.53			DRY	NC
MW-13*	June 27, 2011	62.48	323.20	39 - 59	281.51 - 261.51	DRY	NC
	July 27, 2011	62.65	323.20			DRY	NC
	September 7, 2011	62.45	323.20			DRY	NC
MW-14*	June 27, 2011	53.55	319.53	30 - 50	286.96 - 266.96	DRY	NC
	July 27, 2011	53.55	319.53			DRY	NC
	September 7, 2011	53.55	319.53			DRY	NC
DW-1	April 15-17, 1992	NM	322.41	186.5 - 226.5	135.91 - 95.91	197.70	124.71
	November 7-8, 2006	224.80	322.41			197.80	124.61
	December 7-8, 2006	223.20	322.41			198.30	124.11
DW-2	April 15-17, 1992	NM	291.80	153 - 173	138.80 - 118.80	168.86	122.94
	November 7-8, 2006	NM	291.80			168.70	123.10
	December 7-8, 2006	NM	291.80			169.30	122.50
DW-3	April 15-17, 1992	NM	282.41	146.5 - 166.5	135.91 - 115.91	159.35	123.06
	November 7-8, 2006	NM	282.41			160.50	121.91
	December 7-8, 2006	NM	282.41			160.20	122.21
DW-4	April 15-17, 1992	NM	281.42	155.5 - 175.5	125.92 - 105.92	157.16	124.26
	November 7-8, 2006	NM	281.42			157.70	123.72
	December 7-8, 2006	NM	281.42			157.90	123.52
DW-5	April 15-17, 1992	NM	327.73	194 - 214	133.73 - 113.73	195.61	132.12
	November 7-8, 2006	NM	327.73			204.20	123.53
	December 7-8, 2006	NM	327.73			204.20	123.53

Notes:

1. Total depth was measured by sounding the wells prior to sampling and may differ from total depth as installed.
2. Source of top of casing elevations prior to 2011 - Remedial Investigation/Feasibility Study Workplan, Trans Mountain Oil Pipeline, Corp., Laurel Station, Bellingham, WA (Dames & Moore, 1992). Source of top of casing elevations for 2011 - Larry Steele & Associates, 2/17/2011. Vertical elevation datum prior to 2011 was NGVD 29. 2011 vertical elevation datum is NAVD 88 (ft).
3. DW-1 through DW-5 were decommissioned on May 1, 2008.

TOC - top of well casing
ft-TOC - feet below top of well casing
ft-MSL - feet above mean sea level
ft-bgs - feet below ground surface
NC - not calculated
NM - not measured
*Stick-up well monument

Table 2
Summary of Soil Analytical Results for Study Unit 1 - TPH and BTEX
Laurel Station
Bellingham, Washington

Location ID	Sample Date	Depth (ft bgs)	Analyte								
			TPH (mg/kg)				VOCs (ug/kg)				
			TPH - gasoline range	TPH - diesel range	TPH - oil range	Total TPH	benzene	toluene	ethylbenzene	m,p-xylene	o-xylene
Preliminary Cleanup Level			100 / 30 [a]	460	2,000	460	30	7,000	6,000	9,000 [b]	9,000 [b]
MW-1	1/31/2011	20	**1,400 J**	**1,600**	**1,400**	**4,400**	10 U	40 U	40 U	80 U	**1,600**
		25	**13**	**560**	**510**	**1,083**	12 U	12 U	12 U	25 U	12 U
MW-2	2/1/2011	5	6.6 U	**17**	**42**	**59**	17 U	17 U	17 U	33 U	17 U
		10	5.5 U	**16**	**21**	**37**	14 U	14 U	14 U	27 U	14 U
		15	**290**	**200**	**210**	**700**	20 U	20 U	20 U	40 U	**280**
		20	6.6 U	5.2 U	**30**	**30**	16 U	16 U	16 U	33 U	16 U
		25	6.4 U	5.2 U	10 U	0	16 U	16 U	16 U	32 U	16 U
		30	5.8 U	**100**	**120**	**220**	14 U	14 U	14 U	29 U	14 U
		35	5.8 U	5.2 U	10 U	0	14 U	14 U	14 U	29 U	14 U
MW-3	2/2/2011	5	8 U	6.3 U	13 U	0	20 U	20 U	20 U	40 U	20 U
		10	6.2 U	5.7 U	11 U	0	15 U	15 U	15 U	31 U	15 U
		15	7.5 U	5.4 U	11 U	0	19 U	19 U	19 U	38 U	19 U
		20	8.2 U	5.9 U	12 U	0	20 U	20 U	20 U	41 U	20 U
		25	7.5 U	6.1 U	12 U	0	19 U	19 U	19 U	38 U	19 U
		30	5.8 U	5.3 U	11 U	0	14 U	14 U	14 U	29 U	14 U
MW-4	2/2/2011	5	7 U	5.8 U	12 U	0	17 U	17 U	17 U	35 U	17 U
		10	5.6 U	5.7 U	11 U	0	14 U	14 U	14 U	28 U	14 U
		15	5.8 U	5.7 U	11 U	0	15 U	15 U	15 U	29 U	15 U
		20	6.5 U	5.8 U	12 U	0	16 U	16 U	16 U	32 U	16 U
		25	5.1 U	5.2 U	**16**	**16**	13 U	13 U	13 U	25 U	13 U
		30	5.3 U	5.2 U	**11**	**11**	13 U	13 U	13 U	27 U	13 U
MW-5	2/3/2011	20	6.3 U	5.2 U	10 U	0	16 U	16 U	16 U	31 U	16 U
	DUP	20	6.2 U	5.2 U	10 U	0	16 U	16 U	16 U	31 U	16 U
		25	6.4 U	5.1 U	10 U	0	16 U	16 U	16 U	32 U	16 U
		30	6.4 U	5.3 U	11 U	0	16 U	16 U	16 U	32 U	16 U
		35	**140**	**200**	**220**	**560**	13 U	13 U	**100**	26 U	13 U
		40	5.8 U	5.2 U	**16**	**16**	14 U	14 U	14 U	29 U	14 U
MW-6 (SU1-B27)	2/4/2011	5	5.4 U	5.1 U	10 U	0	13 U	13 U	13 U	27 U	13 U
		10	4 U	5.9 U	**16**	**16**	10 U	10 U	10 U	20 U	10 U
		15	5.7 U	5.6 U	**14**	**14**	14 U	14 U	14 U	29 U	14 U
		20	5.9 U	5.3 U	**16**	**16**	15 U	15 U	15 U	29 U	15 U
		25	4.9 U	5.2 U	10 U	0	12 U	12 U	12 U	24 U	12 U
MW-7 (SU1-B28)	2/7/2011	20	6.2 U	**5.7**	**72**	**77.7**	16 U	16 U	16 U	31 U	16 U
		25	5.7 U	5.2 U	10 U	0	14 U	14 U	14 U	28 U	14 U
		30	5.2 U	5.3 U	**27**	**27**	13 U	13 U	13 U	26 U	13 U
	DUP	30	4.8 U	5.4 U	**29**	**29**	12 U	12 U	12 U	24 U	12 U
		35	**440 J**	**330**	**330**	**1,100**	14 U	14 U	**1,400**	**100**	**520**
	2/8/2011	40	**30**	**5.4**	10 U	**35.4**	16 U	**29**	**39**	**46**	**23**
		45	**88**	**34**	**36**	**158**	15 U	15 U	**110**	30 U	**50**
		55	5.7 U	5.4 U	11 U	0	14 U	14 U	14 U	29 U	14 U
		60	5.6 U	5.3 U	10 U	0	14 U	14 U	14 U	28 U	14 U
MW-9	6/9/2011	5	**660**	**530**	**360**	**1,550**	**2,200 J**	**81**	**1,500**	**200**	**380**
		10	**2,700**	**950**	**590**	**4,240**	140 U	**510**	140 U	**610**	**2,500**
		15	**600**	**560**	**380**	**1,540**	29 U	**92**	29 U	**150**	**600**
		20	**1,100**	**1,800**	**1,100**	**4,000**	38 U	**170**	38 U	**240**	**1,200**
	6/10/2011	25	**200**	**310**	**190**	**700**	15 U	15 U	15 U	**56**	**160**

Table 2
Summary of Soil Analytical Results for Study Unit 1 - TPH and BTEX
Laurel Station
Bellingham, Washington

Location ID	Sample Date	Depth (ft bgs)	Analyte								
			TPH (mg/kg)				VOCs (ug/kg)				
			TPH - gasoline range	TPH - diesel range	TPH - oil range	Total TPH	benzene	toluene	ethylbenzene	m,p-xylene	o-xylene
Preliminary Cleanup Level			**100 / 30 [a]**	**460**	**2,000**	**460**	**30**	**7,000**	**6,000**	**9,000 [b]**	**9,000 [b]**
MW-10	6/8/2011	5	4.5 U	5.3 U	11 U	0	11 U	11 U	11 U	22 U	11 U
		10	**1,300**	**2,000**	**1,100**	**4,400**	25 U	**180**	25 U	**230**	**1,100**
	6/9/2011	15	**16**	**5.8**	11 U	**22**	11 U	11 U	11 U	23 U	11 U
		20	**120**	**130**	**83**	**333**	11 U	**19**	11 U	**31**	11 U
		25	4.5 U	5.3 U	11 U	0	11 U	11 U	11 U	22 U	11 U
MW-11	6/7/2011	20	4.8 U	5.2 UJ	10 UJ	0	12 U	12 U	12 U	24 U	12 U
		25	4.8 U	5.4 UJ	11 UJ	0	12 U	12 U	12 U	24 U	12 U
	6/8/2011	30	4.5 U	**8.7 J**	**31 J**	**39.7**	11 U	11 U	11 U	22 U	11 U
		35	5 U	5.2 UJ	10 UJ	0	13 U	13 U	13 U	25 U	13 U
		40	4.6 U	5.3 UJ	10 UJ	0	12 U	12 U	12 U	23 U	12 U
		45	5.3 U	**5.2 J**	**14 J**	**19.2**	13 U	13 U	13 U	26 U	13 U
		49	7.4 U	5.4 UJ	**13 J**	0	18 U	18 U	18 U	37 U	18 U
MW-12	6/6/2011	25	4.6 U	5.1 U	10 U	0	11 U	11 U	11 U	23 U	11 U
		30	4.4 U	5.4 U	11 U	0	11 U	11 U	11 U	22 U	11 U
		35	4.9 U	5 U	10 U	0	12 U	12 U	12 U	24 U	12 U
		39	5.1 U	5 U	10 U	0	13 U	13 U	13 U	26 U	13 U
	6/7/2011	45	4.9 U	5.2 U	10 U	0	12 U	12 U	12 U	24 U	12 U
	DUP	45	**7.3**	5.3 U	11 U	0	14 U	14 U	14 U	28 U	14 U
		50	5 U	5.4 U	11 U	0	12 U	12 U	12 U	25 U	12 U
		54	**7.9**	5.3 U	11 U	0	14 U	14 U	14 U	27 U	14 U
MW-13	6/13/2011	25	5.1 U	5.1 U	10 U	0	13 U	13 U	13 U	25 U	13 U
		30	4.8 U	**5.4**	**13**	**18.4**	12 U	12 U	12 U	24 U	12 U
		35	4.9 U	5.1 U	**19**	0	12 U	12 U	12 U	24 U	12 U
	DUP	35	5 U	**5.9**	**19**	**24.9**	12 U	12 U	12 U	25 U	12 U
		40	4.7 U	5 U	10 U	0	12 U	12 U	12 U	24 U	12 U
		45	4.9 U	5 U	10 U	0	12 U	12 U	12 U	24 U	12 U
	6/14/2011	50	5 U	5 U	10 U	0	12 U	12 U	12 U	25 U	12 U
		55	4.9 U	**11**	**44**	**55**	12 U	12 U	12 U	25 U	12 U
		60	5.1 U	5.3 U	11 U	0	13 U	13 U	13 U	26 U	13 U
MW-14	6/14/2011	20	4.7 U	**10**	**44**	**54**	12 U	12 U	12 U	24 U	12 U
		25	6.1 U	5.2 U	10 U	0	15 U	15 U	15 U	30 U	15 U
	6/15/2011	30	5.7 U	5.1 U	10 U	0	14 U	14 U	14 U	28 U	14 U
		35	6.2 U	5.4 U	11 U	0	16 U	16 U	16 U	31 U	16 U
		40	5.5 U	5 U	10 U	0	14 U	14 U	14 U	27 U	14 U
		45	5.1 U	5 U	10 U	0	13 U	13 U	13 U	25 U	13 U
		50	5 U	5.1 U	10 U	0	12 U	12 U	12 U	25 U	12 U
SU1-B1	6/15/2010	5	8.1 U	6.7 U	**21**	**21**	20 U	20 U	20 U	40 U	20 U
		10	5.6 U	5.6 U	11 U	0	14 U	14 U	14 U	28 U	14 U
		15	5.4 U	5.3 U	11 U	0	14 U	14 U	14 U	27 U	14 U

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Location ID	Sample Date	Depth (ft bgs)	Analyte								
			TPH (mg/kg)				VOCs (ug/kg)				
			TPH - gasoline range	TPH - diesel range	TPH - oil range	Total TPH	benzene	toluene	ethylbenzene	m,p-xylene	o-xylene
Preliminary Cleanup Level			100 / 30 [a]	460	2,000	460	30	7,000	6,000	9,000 [b]	9,000 [b]
SU1-B2	6/15/2010	5	**190**	**95**	**17**	**302**	13 U	13 U	**450**	27 U	13 U
		10	5.4 U	5.7 U	11 U	0	14 U	14 U	14 U	27 U	14 U
		15	5.4 U	5.3 U	11 U	0	14 U	14 U	14 U	27 U	14 U
SU1-B3	6/16/2010	5	9.1 U	7.2 U	14 U	0	23 U	23 U	23 U	45 U	23 U
		10	6 U	5.8 U	12 U	0	15 U	15 U	15 U	30 U	15 U
		15	5.3 U	5.8 U	12 U	0	13 U	13 U	13 U	26 U	13 U
SU1-B4	6/15/2010	5	**85**	7.6 U	15 U	**85**	28 U	28 U	**240**	57 U	28 U
		10	6.1 U	5.9 U	12 U	0	15 U	15 U	15 U	31 U	15 U
		15	6 U	5.6 U	11 U	0	15 U	15 U	15 U	30 U	15 U
SU1-B5	6/16/2010	2	6.6 U	6 U	12 U	0	17 U	17 U	17 U	33 U	17 U
		5	5.6 U	5.7 U	12 U	0	14 U	14 U	14 U	28 U	14 U
SU1-B6	6/16/2010	3	6.1 U	5.9 U	12 U	0	15 U	15 U	15 U	30 U	15 U
		5	**41**	**47**	12 U	**88**	**46**	**32**	**100**	**100**	15 U
		10	5.2 U	5.8 U	12 U	0	13 U	13 U	13 U	26 U	13 U
SU1-B7	6/16/2010	3	6.7 U	5.9 U	12 U	0	17 U	17 U	17 U	34 U	17 U
		5	**40**	6.4 U	13 U	**40**	**1,100**	20 U	**560**	**4,900**	**170**
		10	**9.2**	6 U	12 U	**9.2**	15 U	15 U	15 U	31 U	15 U
		12	6 U	5.8 U	12 U	0	15 U	15 U	15 U	30 U	15 U
SU1-B8	6/16/2010	5	**30**	8.2 U	**20**	**50**	**420**	30 U	**47**	**220**	30 U
		10	6.3 U	5.5 U	11 U	0	16 U	16 U	16 U	31 U	16 U
		12	5.4 U	5.7 U	11 U	0	13 U	13 U	13 U	27 U	13 U
SU1-B9	6/16/2010	3	6 U	**8.8**	**40**	**48.8**	15 U	15 U	15 U	30 U	15 U
		5	**9.4**	6 U	12 U	**9.4**	**680**	14 U	**190**	**1,300**	**88**
		10	6.4 U	5.8 U	12 U	0	16 U	16 U	16 U	32 U	16 U
		12.5	5.8 U	5.8 U	12 U	0	15 U	15 U	15 U	29 U	15 U
	DUP	12.5	5.4 U	5.6 U	11 U	0	14 U	14 U	14 U	27 U	14 U
SU1-B10	6/14/2010	5	12 U	5.7 U	11 U	0	29 U	29 U	29 U	58 U	29 U
		10	11 U	5.7 U	12 U	0	28 U	28 U	28 U	57 U	28 U
		15	10 U	5.5 U	11 U	0	25 U	25 U	25 U	51 U	25 U
SU1-B11	6/14/2010	5	**1,800**	**140**	**130**	**2,070**	*33 U*	**190**	**3,700**	65 U	33 U
		10	5.8 U	5.6 U	11 U	0	15 U	15 U	15 U	29 U	**110**
		15	5.3 U	5.4 U	11 U	0	13 U	13 U	13 U	26 U	13 U
	DUP	15	10 U	5.5 U	11 U	0	26 U	26 U	26 U	52 U	26 U
SU1-B12	6/7/2010	6	**5.8**	**6.4**	**12**	**24**	11 U	**18**	11 U	23 U	**20**
		10	**1,200**	**940**	**1,100**	**3,240**	**18**	**150**	**2,300**	**120**	**1,000**
		15	**8,400**	**3,700**	**3,400**	**15,500**	*180 U*	**1,100**	**16,000**	**680**	**2,800**
		20	**2,200**	**1,200**	**1,100**	**4,500**	30 U	**250**	**4,400**	**170**	**1,800**
		34	**63**	**54**	**63**	**180**	13 U	13 U	**61**	26 U	**34**
		45	**350**	**140**	**140**	**630**	13 U	**41**	**570**	**34**	**240**
SU1-B13	8/18/2010	5	4.9 U	5.3 U	11 U	0	12 U	12 U	12 U	25 U	12 U
		10	**11**	**13**	**18**	**42**	13 U	13 U	13 U	26 U	13 U
	DUP	10	4.2 U	**20 J**	**28**	**48**	10 U	10 U	10 U	21 U	10 U
		15	5.2 U	5 U	10 U	0	13 U	13 U	13 U	26 U	13 U
		20	5.6 U	5.5 U	11 U	0	14 U	14 U	14 U	28 U	14 U
		25	5.2 U	5.3 U	11 U	0	13 U	13 U	13 U	26 U	13 U
		30	5.3 U	5.3 U	11 U	0	13 U	13 U	13 U	26 U	13 U

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Location ID	Sample Date	Depth (ft bgs)	Analyte								
			TPH (mg/kg)				VOCs (ug/kg)				
			TPH - gasoline range	TPH - diesel range	TPH - oil range	Total TPH	benzene	toluene	ethylbenzene	m,p-xylene	o-xylene
Preliminary Cleanup Level			100 / 30 [a]	460	2,000	460	30	7,000	6,000	9,000 [b]	9,000 [b]
SU1-B14	6/8/2010	5	**15**	**45**	**71**	**131**	12 U	12 U	12 U	24 U	12 U
		10	5.6 U	5.1 U	10 U	0	14 U	14 U	14 U	28 U	14 U
		15	**1,500**	**1,200**	**1,200**	**3,900**	26 U	**240 J**	**4,400 J**	**190 J**	26 U
	DUP	15	**1,000**	**920**	**920**	**2,840**	12 U	**110 J**	**1,800 J**	**85 J**	12 U
		20	**920**	**840**	**900**	**2,660**	14 U	**86**	**1,600**	**110**	**430**
		25	**160**	**240**	**260**	**660**	14 U	14 U	**170**	27 U	**74**
		30	5.6 U	5 U	10 U	0	14 U	14 U	14 U	28 U	14 U
		35	**11**	5.2 U	10 U	**11**	13 U	**33**	13 U	**36**	**19**
		40	6.1 U	5.1 U	10 U	0	15 U	**15**	15 U	30 U	15 U
		45	6.6 U	5.1 U	10 U	0	16 U	16 U	16 U	33 U	16 U
SU1-B15	8/18/2010	5	6.1 U	5.4 U	11 U	0	15 U	15 U	15 U	31 U	15 U
		10	5 U	5 U	10 U	0	12 U	12 U	12 U	25 U	12 U
		15	**14**	**570**	**590**	**1,174**	**17**	**19**	13 U	25 U	13 U
		20	5.2 U	5.1 U	10 U	0	13 U	13 U	13 U	26 U	13 U
	8/19/2010	25	6.2 U	5.2 U	10 U	0	16 U	16 U	16 U	31 U	16 U
		30	5.5 U	5.3 U	10 U	0	14 U	14 U	14 U	27 U	14 U
SU1-B16	6/8/2010	5	5.6 U	**93 J**	**59 J**	**152**	14 U	14 U	14 U	28 U	14 U
		15	5.5 U	5.3 U	11 U	0	14 U	14 U	14 U	27 U	14 U
		20	6 U	5.1 U	10 U	0	15 U	15 U	15 U	30 U	15 U
		25	5.4 U	5.3 U	11 U	0	14 U	14 U	14 U	27 U	14 U
		30	5 U	5.2 U	10 U	0	12 U	12 U	12 U	25 U	12 U
		35	5.7 U	5.1 U	10 U	0	14 U	14 U	14 U	28 U	14 U
SU1-B17	6/15/2010	3	6.2 U	5.4 U	11 U	0	16 U	16 U	16 U	31 U	16 U
		5	5.7 U	5.6 U	11 U	0	14 U	14 U	14 U	28 U	14 U
		10	5.5 U	5.6 U	11 U	0	14 U	14 U	14 U	27 U	14 U
SU1-B18	6/16/2010	5	6.3 U	6 U	12 U	0	16 U	16 U	16 U	32 U	16 U
		10	5.5 U	5.6 U	11 U	0	14 U	14 U	14 U	27 U	14 U
SU1-B19	6/14/2010	6	**14**	**7.6**	**23**	**44.6**	14 U	14 U	14 U	28 U	**570**
		8	8.8 U	5.4 U	11 U	0	22 U	22 U	22 U	44 U	**110**
		10	6.4 U	5.6 U	11 U	0	16 U	16 U	16 U	32 U	16 U
SU1-B20	6/7/2010	29	7.3 U	**14**	**19**	**33**	18 U	18 U	18 U	36 U	18 U
		30	5.7 U	5.1 U	10 U	0	14 U	14 U	14 U	28 U	14 U
SU1-B21	8/17/2010	32	5.5 U	**8 J**	**42**	**50**	14 U	14 U	14 U	28 U	14 U
		45	5 U	5 U	10 U	0	12 U	12 U	12 U	25 U	12 U
		50	5.5 U	5.3 U	11 U	0	14 U	14 U	14 U	28 U	14 U
SU1-B22	8/17/2010	5	5.6 U	5 U	10 U	0	14 U	14 U	14 U	28 U	14 U
		10	**190**	**85 J**	**100**	**375**	14 U	**29**	**310**	**33**	**80**
		15	5.7 U	5.3 U	11 U	0	14 U	14 U	14 U	28 U	14 U
		20	5.1 U	5.2 U	10 U	0	13 U	13 U	13 U	26 U	13 U
		25	5.2 U	5 U	10 U	0	13 U	13 U	13 U	26 U	13 U
	8/18/2010	30	6 U	5.2 U	10 U	0	15 U	15 U	15 U	30 U	15 U
		35	5.4 U	5.3 U	11 U	0	14 U	14 U	14 U	27 U	14 U
		40	4.8 U	5.3 U	11 U	0	12 U	12 U	12 U	24 U	12 U
		45	5.6 U	5 U	10 U	0	14 U	14 U	14 U	28 U	14 U

Table 2
Summary of Soil Analytical Results for Study Unit 1 - TPH and BTEX
Laurel Station
Bellingham, Washington

Location ID	Sample Date	Depth (ft bgs)	Analyte								
			TPH (mg/kg)				VOCs (ug/kg)				
			TPH - gasoline range	TPH - diesel range	TPH - oil range	Total TPH	benzene	toluene	ethylbenzene	m,p-xylene	o-xylene
Preliminary Cleanup Level			**100 / 30 [a]**	**460**	**2,000**	**460**	**30**	**7,000**	**6,000**	**9,000 [b]**	**9,000 [b]**
SU1-B23	8/19/2010	5	5.5 U	**10**	**81**	**91**	14 U	14 U	14 U	28 U	14 U
		10	4.9 U	5 U	10 U	0	12 U	12 U	12 U	24 U	12 U
		15	5.7 U	5.3 U	10 U	0	14 U	14 U	14 U	29 U	14 U
		20	6.6 U	5.7 U	12 U	0	17 U	17 U	17 U	33 U	17 U
		25	5.3 U	5.2 U	10 U	0	13 U	13 U	13 U	26 U	13 U
SU1-B24	8/19/2010	5	6.2 U	5.3 U	11 U	0	15 U	15 U	15 U	31 U	15 U
	DUP	5	7.4 U	5.3 U	11 U	0	19 U	19 U	19 U	37 U	19 U
		10	5.5 U	5.3 U	11 U	0	14 U	14 U	14 U	28 U	14 U
		15	5.4 U	5.1 U	10 U	0	13 U	13 U	13 U	27 U	13 U
		20	5.6 U	5 U	10 U	0	14 U	14 U	14 U	28 U	14 U
		25	5.9 U	5.1 U	10 U	0	15 U	15 U	15 U	30 U	15 U
SU1-B25	8/19/2010	5	6.5 U	5 U	10 U	0	16 U	16 U	16 U	33 U	16 U
		10	5.4 U	5.3 U	11 U	0	14 U	14 U	14 U	27 U	14 U
		15	5.1 U	5.2 U	10 U	0	13 U	13 U	13 U	26 U	13 U
		20	4.8 U	5.3 U	11 U	0	12 U	12 U	12 U	24 U	12 U
SU1-B26	8/20/2010	5	5.8 U	5 U	10 U	0	14 U	14 U	14 U	29 U	14 U
		10	**320**	**100 J**	**110**	**530**	14 U	**56**	**680**	**41**	**140**
		15	**56**	**130 J**	**140**	**326**	15 U	**38**	**53**	29 U	**35**
		20	**110**	**14 J**	**35**	**159**	11 U	**81**	**100**	22 U	**35**
		23	7.2 U	**6.1 J**	**72**	**78.1**	18 U	18 U	18 U	36 U	18 U
SU1-B29	2/9/2011	20	5.7 U	5.4 U	**14**	**14**	14 U	14 U	14 U	28 U	14 U
		25	5.4 U	5.3 U	11 U	0	14 U	14 U	14 U	27 U	14 U
		30	4.7 U	5.3 U	**11**	**11**	12 U	12 U	12 U	24 U	12 U
	DUP	30	5 U	5.4 U	**15**	**15**	12 U	12 U	12 U	25 U	12 U
		34	5.2 U	5.4 U	**45**	**45**	13 U	13 U	13 U	26 U	13 U
SU1-B30	6/10/2011	3	6.8 U	5.9 U	12 U	0	17 U	17 U	17 U	34 U	17 U
		5	4.9 U	5.6 U	11 U	0	12 U	12 U	12 U	24 U	12 U
		10	6.6 U	5.5 U	11 U	0	16 U	16 U	16 U	33 U	16 U

Notes:

Bolded values indicate the chemical was detected above the laboratory reporting limit

Bolded and highlighted values exceed applicable BTEX MTCA A CUL

Bolded and highlighted Total TPH values exceed the 460 mg/kg DRO TEE CUL. Individual TPH ranges were not compared to CULs.

Italicized values indicate the laboratory reporting limit was above the Preliminary Cleanup Level

TPH - total petroleum hydrocarbons

VOCs - volatile organic compounds

ft bgs - feet below ground surface

mg/kg - milligram per kilogram

ug/kg - microgram per kilogram

J - estimated value

U - undetected

[a] gasoline mixtures without benzene/gasoline mixtures with benzene

[b] Value for m-xylene used in calculation, p-xylene value is NE

Table 3
Summary of Soil Analytical Results for Study Unit 1 - PAHs
Laurel Station
Bellingham, Washington

Location ID	**MW-1**		**MW-9**					**MW-10**	**SU1-B12**			**SU1-B14**			**SU1-B15**	**SU1-B28 (MW-7)**	**Preliminary Cleanup Level**
Sample Date	**1/31/2011**		**6/9/2011**				**6/10/2011**	**6/8/2011**	**6/7/2010**			**6/8/2010**			**8/18/2010**	**2/7/2011**	
Depth (ft bgs)	**20**	**25**	**5**	**10**	**15**	**20**	**25**	**10**	**10**	**15**	**20**	**15**	**15 (DUP)**	**20**	**15**	**35**	
PAHs (ug/kg)																	
1-methylnaphthalene	**6,900**	**2,100**	**3,000**	**1,600**	**1,700**	**4,800**	**1,100**	**3,900**	**700**	**12,000**	**3,300**	**4,400 J**	**2,200 J**	**510 J**	**150**	**370**	**NE**
2-methylnaphthalene	**10,000**	**2,900**	**4,300**	**1,800**	**2,400**	**6,800**	**1,500**	**5,600**	**860**	**17,000**	**4,900**	**6,500 J**	**3,100 J**	**710**	**230**	**460**	**320,000**
acenaphthene	**270**	**49**	**130**	**130**	**110**	**220**	**58**	4.6 U	38 UJ	**270 J**	**95 J**	**97 J**	**110 J**	14 U	9.7 U	**21**	**4,800,000**
acenaphthylene	**100 UJ**	49 U	9.4 U	9.5 U	4.5 U	9.6 U	4.7 U	4.6 U	38 UJ	200 UJ	62 UJ	81 UJ	44 UJ	19 UJ	**26**	4.9 U	**NE**
anthracene	**170**	49 U	**280**	**220**	**150**	**240**	**57**	**140**	15 U	30 U	14 U	15 U	14 U	14 U	**16 J**	**16 J**	**24,000,000**
benzo(a)anthracene	49 U	49 U	**92**	**34**	**20**	**36**	**9.2**	**47**	**28**	**150**	**48**	**53 J**	**18 J**	**22 J**	9.7 U	4.9 UJ	**See Note a**
benzo(a)pyrene	49 U	49 U	**37**	9.5 U	**6.7**	**12**	4.7 U	**63**	**18 J**	**40 J**	14 U	15 U	14 U	14 U	9.7 U	**15 J**	**100**
benzo(b)fluoranthene	NA	NA	NA	NA	NA	NA	NA	NA	15 U	**36**	**15**	15 U	14 U	14 U	NA	NA	**See Note a**
benzo(g,h,i)perylene	49 U	49 U	**38**	**18**	**12**	**11**	4.7 U	**13**	**22**	**49**	**25**	**24**	14 U	**14**	9.7 U	4.9 U	**NE**
benzo(k)fluoranthene	NA	NA	NA	NA	NA	NA	NA	NA	15 U	**36**	**15**	15 U	14 U	14 U	NA	NA	**See Note a**
chrysene	**310**	**93**	**340**	**210**	**110**	**220**	**58**	**230**	**180**	**620**	**230**	**280 J**	**130 J**	**120 J**	**44**	**42 J**	**See Note a**
dibenz(a,h)anthracene	49 U	49 U	9.4 U	9.5 U	4.5 U	9.6 U	4.7 U	4.6 U	15 U	30 U	14 U	15 U	14 U	14 U	9.7 U	4.9 U	**See Note a**
dibenzofuran	**360 J**	**98 J**	**200**	9.5 U	**120**	**300**	**69**	**200**	40 UJ	**300 J**	**120 J**	**130 J**	**89 J**	**17 J**	9.7 U	**37 UJ**	**160,000**
fluoranthene	**170**	49 U	**170**	**53**	**49**	**75**	**19**	**120**	15 U	73 UJ	32 UJ	18 UJ	14 U	14 U	**12 J**	**12**	**3,200,000**
fluorene	**1,200**	**330**	**500**	**480**	**320**	**700**	**180**	**560**	**230**	**1,500**	**540**	**710 J**	**390 J**	**95**	**42**	**140**	**3,200,000**
indeno[1,2,3-cd]pyrene	49 U	49 U	**17**	9.5 U	4.5 U	9.6 U	4.7 U	4.6 U	15 U	30 U	14 U	15 U	14 U	14 U	9.7 U	4.9 U	**See Note a**
naphthalene	**3,200**	**520**	**1,100**	**270**	**540**	**2,200**	**330**	**1,800**	**180**	**4,600**	**1,400**	**1,600**	**970**	**150 J**	**850**	**48 UJ**	**5,000**
phenanthrene	**2,300**	**610**	**1,400**	**1,100**	**780**	**1,600**	**370**	**1,500**	**230**	**2,900**	**1,000**	**1,300 J**	**630 J**	**140**	**62**	**230**	**NE**
pyrene	**150**	49 U	**300**	**130**	**86**	**140**	**48**	**180**	**98 J**	**360 J**	**130 J**	**150 J**	**71 J**	**60 J**	**16**	**11 J**	**2,400,000**
total benzofluoranthene	**88**	49 U	**76**	**29**	**25**	**30**	**5.4**	**38**	NA	NA	NA	NA	NA	NA	**9.7 J**	**13 J**	**See Note a**
TTEC cPAH	**11.9**	**0.93**	**51.3**	**5.5**	**9.8**	**17.8**	**0.58**	**70**	**22.6**	**64.2**	**7.1**	**8.1**	**3.1**	**3.4**	**1.41**	**16.72**	**100**

Notes:

Bolded values indicate the chemical was detected above the laboratory reporting limit

Bolded and highlighted values exceed the selected Preliminary Cleanup Level

PAHs - polycyclic aromatic hydrocarbons

cPAHs - carcinogenic PAHs

ft bgs - feet below ground surface

ug/kg - microgram per kilogram

NA - not analyzed

NE - not established

J - estimated value

U - undetected

[a] Carcinogenic PAH (cPAH) cleanup levels under MTCA are based on the calculated total toxicity of the mixture using the Toxicity Equivalency Methodology in WAC 173-340-708 (8).
The mixture of cPAHs shall be considered a single hazardous substance and compared to the applicable MTCA Method A cleanup level for benzo(a)pyrene.

Table 4
Summary of Shallow Perched Groundwater Analytical Results - TPH and BTEX
Laurel Station
Bellingham, Washington

Location ID	Sample Date	TPH - gasoline range mg/L	TPH - diesel range mg/L	TPH - lube oil mg/L	Total TPH mg/L	benzene ug/L	toluene ug/L	ethylbenzene ug/L	m,p-xylene ug/L	o-xylene ug/L
Preliminary Cleanup Level		**0.8 / 1.0 [a]**	**0.5**	**0.5**	**0.5**	**5**	**1,000**	**700**	**16,000**	**16,000**
MW-1	2/23/2011	**0.98**	**6.6**	**5.9**	**13.5**	0.25 U	0.25 U	**2**	0.5 U	0.25 U
	6/28/2011	**1**	**2.6**	**1.9**	**5.5**	0.25 U	0.25 U	**1.7**	0.5 U	0.25 U
	9/27/2011	NS	NS	NS	NS	NS	NS	NS	NS	NS
MW-2	2/23/2011	**0.51**	**0.56**	**0.58**	**1.7**	0.25 U	0.25 U	0.25 U	0.5 U	0.25 U
	6/27/2011	**0.82**	**5.7 J**	**5.4 J**	**11.9**	0.25 U	0.25 U	**1.2**	0.5 U	0.25 U
	DUP	**0.79**	**3.5 J**	**3.2 J**	**7.5**	0.25 U	0.25 U	**1.2**	0.5 U	0.25 U
	9/27/2011	NS	NS	NS	NS	NS	NS	NS	NS	NS
MW-3	2/23/2011	NS	NS	NS	NS	NS	NS	NS	NS	NS
	6/27/2011	NS	NS	NS	NS	NS	NS	NS	NS	NS
	9/27/2011	NS	NS	NS	NS	NS	NS	NS	NS	NS
MW-4	2/23/2011	**0.63**	**0.14**	0.2 U	**0.77**	**1.6**	0.25 U	0.25 U	0.5 U	0.25 U
	6/28/2011	**0.49**	**3.1**	**3.9**	**7.5**	0.25 U	0.25 U	**0.72**	0.5 U	0.25 U
	9/27/2011	NS	NS	NS	NS	NS	NS	NS	NS	NS
MW-5	2/24/2011	**0.24 J**	**0.6 J**	**1.8 J**	**2.7**	0.25 U	0.25 U	0.25 U	0.5 U	0.25 U
	6/27/2011	NS	NS	NS	NS	NS	NS	NS	NS	NS
	9/27/2011	NS	NS	NS	NS	NS	NS	NS	NS	NS
MW-6	2/24/2011	0.1 UJ	0.1 U	**0.29**	**0.29**	0.25 U	0.25 U	0.25 U	0.5 U	0.25 U
	DUP	0.1 UJ	0.1 U	0.2 U	0	0.25 U	0.25 U	0.25 U	0.5 U	0.25 U
	6/28/2011	0.1 U	**0.47**	**3.8**	**4.3**	0.25 U	0.25 U	0.25 U	0.5 U	0.25 U
	9/27/2011	0.1 U	0.42 U	*0.83 U*	0	0.25 U	0.25 U	0.25 U	0.5 U	0.25 U
MW-7	2/24/2011	**0.74 J**	**1.3**	**1.5**	**3.7**	0.25 U	0.25 U	0.25 U	0.5 U	0.25 U
	6/28/2011	**0.58**	**1.4**	**1.4**	**3.4**	0.25 U	0.25 U	**0.88**	0.5 U	0.25 U
	9/27/2011	0.1 U	0.4 U	*0.8 U*	0	0.25 U	0.25 U	0.25 U	0.5 U	0.25 U
MW-8	2/23/2011	NS	NS	NS	NS	NS	NS	NS	NS	NS
	6/27/2011	NS	NS	NS	NS	NS	NS	NS	NS	NS
	9/27/2011	NS	NS	NS	NS	NS	NS	NS	NS	NS
MW-9	6/27/2011	NS	NS	NS	NS	NS	NS	NS	NS	NS
	9/27/2011	NS	NS	NS	NS	NS	NS	NS	NS	NS
MW-10	6/27/2011	NS	NS	NS	NS	NS	NS	NS	NS	NS
	9/27/2011	NS	NS	NS	NS	NS	NS	NS	NS	NS
MW-11	6/27/2011	NS	NS	NS	NS	NS	NS	NS	NS	NS
	9/27/2011	NS	NS	NS	NS	NS	NS	NS	NS	NS
MW-12	6/27/2011	NS	NS	NS	NS	NS	NS	NS	NS	NS
	9/27/2011	NS	NS	NS	NS	NS	NS	NS	NS	NS
MW-13	6/27/2011	NS	NS	NS	NS	NS	NS	NS	NS	NS
	9/27/2011	NS	NS	NS	NS	NS	NS	NS	NS	NS
MW-14	6/27/2011	NS	NS	NS	NS	NS	NS	NS	NS	NS
	9/27/2011	NS	NS	NS	NS	NS	NS	NS	NS	NS

Table 4
Summary of Shallow Perched Groundwater Analytical Results - TPH and BTEX
Laurel Station
Bellingham, Washington

Location ID	Sample Date	TPH - gasoline range mg/L	TPH - diesel range mg/L	TPH - lube oil mg/L	Total TPH mg/L	benzene ug/L	toluene ug/L	ethylbenzene ug/L	m,p-xylene ug/L	o-xylene ug/L
Preliminary Cleanup Level		**0.8 / 1.0 [a]**	**0.5**	**0.5**	**0.5**	**5**	**1,000**	**700**	**16,000**	**16,000**
SW-1	8/26/2010	0.1 U	0.1 U	0.2 U	0	0.25 U	0.25 U	0.25 U	0.5 U	0.25 U
	12/1/2010	0.1 U	0.1 U	0.2 U	0	0.25 U	0.25 U	0.25 U	0.5 U	0.25 U
	2/24/2011	0.1 UJ	0.1 U	0.2 U	0	0.25 U	0.25 U	0.25 U	0.5 U	0.25 U
	6/28/2011	0.1 U	0.1 U	0.2 U	0	0.25 U	0.25 U	0.25 U	0.5 U	0.25 U
	9/27/2011	0.1 U	**0.14**	0.2 U	**0.14**	0.25 U	0.25 U	0.25 U	0.5 U	0.25 U
SW-2	12/1/2010	0.1 U	0.1 U	0.2 U	0	0.25 U	0.25 U	0.25 U	0.5 U	0.25 U
	DUP	0.1 U	0.1 U	0.2 U	0	0.25 U	0.25 U	0.25 U	0.5 U	0.25 U
	8/26/2010	**0.29**	**0.51**	**3.4**	**4.2**	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U
	DUP	**0.34**	**0.43**	**2.5**	**3.3**	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U
	2/24/2011	0.1 UJ	0.1 U	0.2 U	0	0.25 U	0.25 U	0.25 U	0.5 U	0.25 U
	6/28/2011	0.1 U	0.1 U	0.2 U	0	0.25 U	0.25 U	0.25 U	0.5 U	0.25 U
	9/27/2011	0.1 U	0.1 U	0.2 U	0	0.25 U	0.25 U	0.25 U	0.5 U	0.25 U
SW-3	2/23/2011	0.1 U	0.1 U	0.2 U	0	0.25 U	0.25 U	0.25 U	0.5 U	0.25 U
	6/28/2011	0.1 U	0.1 U	0.21 U	0	0.25 U	0.25 U	0.25 U	0.5 U	0.25 U
	9/27/2011	NS	NS	NS	NS	NS	NS	NS	NS	NS
SW-4	8/26/2010	0.1 U	0.1 U	0.2 U	0	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U
	12/1/2010	0.1 U	0.1 U	0.2 U	0	0.25 U	0.25 U	0.25 U	0.5 U	0.25 U
	2/23/2011	0.1 U	0.1 U	0.2 U	0	0.25 U	0.25 U	0.25 U	0.5 U	0.25 U
	6/27/2011	0.1 U	0.1 U	0.2 U	0	0.25 U	0.25 U	0.25 U	0.5 U	0.25 U
	9/27/2011	0.1 U	0.37 U	*0.74 U*	0	0.25 U	0.25 U	0.25 U	0.5 U	0.25 U

Notes:

Bolded values indicate the chemical was detected above the laboratory reporting limit

Italicized values indicate the reporting limit was higher than the Preliminary CUL.

Bolded and highlighted Total TPH values exceed the 0.5 mg/L DRO and ORO MTCA A CUL. Individual TPH ranges were not compared to CULs.

TPH - total petroleum hydrocarbons

mg/L - milligram per liter

NS - not sampled (well was dry)

ug/L - microgram per liter

J - estimated value

U - undetected

[a] gasoline mixtures without benzene/gasoline mixtures with benzene

Monitoring well SW-5 has been dry since 1992.

Table 5
Summary of Shallow Perched Groundwater Analytical Results - PAHs
Laurel Station
Bellingham, Washington

Location ID	**Preliminary**	**MW-1**			**MW-2**				**MW-3**			**MW-4**		
Sample Date	**Cleanup Level**	**2/23/2011**	**6/28/2011**	**9/27/2011**	**2/23/2011**	**6/27/2011**	**6/27/2011 (D)**	**9/27/2011**	**2/23/2011**	**6/28/2011**	**9/27/2011**	**2/23/2011**	**6/28/2011**	**9/27/2011**
PAHs (ug/L)														
1-methylnaphthalene	**NE**	**75**	**3.3**	NS	**4.2**	**4.8**	**4.7**	NS	NS	NS	NS	**8.8**	NS*	NS
2-methylnaphthalene	**32**	**74**	**1.4**	NS	**2.5**	**2.8**	**2.4**	NS	NS	NS	NS	**7.9**	NS*	NS
acenaphthene	**960**	0.2 UJ	**0.19**	NS	0.05 UJ	**1.4 J**	**0.89 J**	NS	NS	NS	NS	**0.18**	NS*	NS
acenaphthylene	**NE**	**1.6**	0.018 UJ	NS	**0.1**	0.01 U	0.01 U	NS	NS	NS	NS	0.01 U	NS*	NS
anthracene	**4,800**	0.2 U	0.01 U	NS	0.05 U	0.01 U	0.01 U	NS	NS	NS	NS	0.01 U	NS*	NS
benzo(a)anthracene	**See Note a**	0.2 U	**0.03**	NS	0.05 U	**0.063**	**0.014**	NS	NS	NS	NS	0.01 U	NS*	NS
benzo(a)pyrene	**0.1**	**0.41**	**0.02**	NS	**0.082**	**0.066**	**0.013**	NS	NS	NS	NS	**0.012**	NS*	NS
benzo(g,h,i)perylene	**NE**	**0.46**	**0.019**	NS	**0.099**	**0.06**	**0.015**	NS	NS	NS	NS	0.01 U	NS*	NS
chrysene	**See Note a**	**4 J**	**0.29**	NS	**0.63 J**	**0.39 J**	**0.12 J**	NS	NS	NS	NS	**0.034**	NS*	NS
dibenz(a,h)anthracene	**See Note a**	0.2 U	0.01 U	NS	**0.062**	0.01 U	0.01 U	NS	NS	NS	NS	0.01 U	NS*	NS
dibenzofuran	**32**	**3.5**	**0.11**	NS	**0.29**	**0.55**	**0.59**	NS	NS	NS	NS	**0.21**	NS*	NS
fluoranthene	**640**	**1.9**	**0.057**	NS	**0.15**	**0.16 J**	**0.068 J**	NS	NS	NS	NS	**0.017**	NS*	NS
fluorene	**640**	**15**	**0.3**	NS	**0.81**	**1.4**	**1.5**	NS	NS	NS	NS	**0.84**	NS*	NS
indeno[1,2,3-cd]pyrene	**See Note a**	0.2 U	0.01 U	NS	0.05 U	0.01 U	0.01 U	NS	NS	NS	NS	0.01 U	NS*	NS
naphthalene	**160**	**30**	**4.9**	NS	**0.98**	**0.72**	**0.64**	NS	NS	NS	NS	**5.3**	NS*	NS
phenanthrene	**NE**	**15**	**0.14**	NS	**0.39**	**0.86 J**	**0.41 J**	NS	NS	NS	NS	**0.39**	NS*	NS
pyrene	**480**	**2.6**	**0.14**	NS	**0.34**	**0.19 J**	**0.089 J**	NS	NS	NS	NS	**0.035**	NS*	NS
total benzofluoranthenes	**See Note a**	**0.7**	**0.062**	NS	**0.16**	**0.16**	**0.029**	NS	NS	NS	NS	0.01 U	NS*	NS
TTEC cPAH	**0.1**	**0.52**	**0.032**	NS	**0.111**	**0.092**	**0.019**	NS	NS	NS	NS	**0.012**	NS*	NS

Notes:

Bolded values indicate the chemical was detected above the laboratory reporting limit

Bolded and highlighted values exceed the selected Preliminary Cleanup Level

PAHs - polycyclic aromatic hydrocarbons

cPAHs - carcinogenic PAHs

ug/L - micrograms per liter

(D) - duplicate sample

NE - not established

NS - not sampled (well was dry)

NS* - PAH analysis not performed due to insufficient water volume in well

U - undetected

J - estimated value

J+ - estimated value with potential high bias

[a] Carcinogenic PAH (cPAH) cleanup levels under MTCA are based on the calculated total toxicity of the mixture using the Toxicity Equivalency Methodology in WAC 173-340-708 (8).
The mixture of cPAHs shall be considered a single hazardous substance and compared to the applicable MTCA Method A cleanup level for benzo(a)pyrene.

Monitoring well SW-5 has been dry since 1992.

Table 5
Summary of Shallow Perched Groundwater Ana
Laurel Station
Bellingham, Washington

Location ID	**Preliminary**	**MW-5**			**MW-6**				**MW-7**			**MW-8**			**MW-9**	
Sample Date	**Cleanup Level**	**2/24/2011**	**6/28/2011**	**9/27/2011**	**2/24/2011**	**2/24/2011 (D)**	**6/28/2011**	**9/27/2011**	**2/24/2011**	**6/28/2011**	**9/27/2011**	**2/24/2011**	**6/27/2011**	**9/27/2011**	**6/27/2011**	**9/27/2011**
PAHs (ug/L)																
1-methylnaphthalene	**NE**	**1.7**	NS	NS	**0.019**	**0.047**	**0.031**	NS*	**22**	**1.6**	NS*	NS	NS	NS	NS	NS
2-methylnaphthalene	**32**	**1.3**	NS	NS	**0.026**	**0.059**	**0.041**	NS*	**26**	**0.75**	NS*	NS	NS	NS	NS	NS
acenaphthene	**960**	**0.064**	NS	NS	**0.086 J**	**0.082 J**	**0.062**	NS*	**0.39 J**	**0.25**	NS*	NS	NS	NS	NS	NS
acenaphthylene	**NE**	0.01 U	NS	NS	0.01 U	0.01 U	0.01 U	NS*	0.15 UJ	0.033 UJ	NS*	NS	NS	NS	NS	NS
anthracene	**4,800**	0.01 U	NS	NS	**0.52**	**0.42 J**	**0.46**	NS*	0.01 U	0.01 U	NS*	NS	NS	NS	NS	NS
benzo(a)anthracene	**See Note a**	0.01 U	NS	NS	**1.4 J**	**0.72 J**	**1.2**	NS*	0.01 U	0.01 U	NS*	NS	NS	NS	NS	NS
benzo(a)pyrene	**0.1**	0.01 U	NS	NS	**0.71 J**	**0.44 J**	**0.75**	NS*	0.01 U	0.01 U	NS*	NS	NS	NS	NS	NS
benzo(g,h,i)perylene	**NE**	0.01 U	NS	NS	**0.27 J**	**0.15 J**	**0.29**	NS*	0.01 U	0.01 U	NS*	NS	NS	NS	NS	NS
chrysene	**See Note a**	0.01 UJ	NS	NS	**0.96 J**	**0.58 J**	**1.1**	NS*	**0.077 J**	0.01 U	NS*	NS	NS	NS	NS	NS
dibenz(a,h)anthracene	**See Note a**	0.01 U	NS	NS	**0.17 J**	**0.086 J**	**0.085**	NS*	0.01 U	0.01 U	NS*	NS	NS	NS	NS	NS
dibenzofuran	**32**	**0.087**	NS	NS	**0.05**	**0.052**	**0.068**	NS*	**0.66**	**0.096**	NS*	NS	NS	NS	NS	NS
fluoranthene	**640**	0.01 U	NS	NS	**3.2 J**	**1.6 J**	**1.9**	NS*	**0.048**	0.01 U	NS*	NS	NS	NS	NS	NS
fluorene	**640**	**0.3 J**	NS	NS	**0.13 J**	**0.12 J**	**0.11**	NS*	**1.9 J**	**0.28**	NS*	NS	NS	NS	NS	NS
indeno[1,2,3-cd]pyrene	**See Note a**	0.01 U	NS	NS	**0.29 J**	**0.15 J**	**0.24**	NS*	0.01 U	0.01 U	NS*	NS	NS	NS	NS	NS
naphthalene	**160**	**0.22**	NS	NS	**0.044**	**0.055**	**0.048**	NS*	**11**	**0.75**	NS*	NS	NS	NS	NS	NS
phenanthrene	**NE**	**0.17**	NS	NS	**1.3**	**0.95 J**	**1**	NS*	**1.6**	**0.11**	NS*	NS	NS	NS	NS	NS
pyrene	**480**	0.01 U	NS	NS	**2.1 J**	**1 J**	**1.7**	NS*	**0.071**	**0.012**	NS*	NS	NS	NS	NS	NS
total benzofluoranthenes	**See Note a**	0.01 U	NS	NS	**1.2 J**	**0.74 J**	**1.4**	NS*	**0.016**	**0.02 U**	NS*	NS	NS	NS	NS	NS
TTEC cPAH	**0.1**	0	NS	NS	**1.026**	**0.615**	**1.054**	NS*	**0.002**	0	NS*	NS	NS	NS	NS	NS

Notes:

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Bolded and highlighted values exceed the selected Preliminary Cleanup Level

PAHs - polycyclic aromatic hydrocarbons

cPAHs - carcinogenic PAHs

ug/L - micrograms per liter

(D) - duplicate sample

NE - not established

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NS* - PAH analysis not performed due to insufficient water volume in well

U - undetected

J - estimated value

J+ - estimated value with potential high bias

[a] Carcinogenic PAH (cPAH) cleanup levels under MTCA are based on the calculated total toxicity of the mixture using the Toxicity Equivalency Methodology in WAC 173-340-708 (8).
The mixture of cPAHs shall be considered a single hazardous substance and compared to the applicable MTCA Method A cleanup level for benzo(a)pyrene.

Monitoring well SW-5 has been dry since 1992.

Table 5
Summary of Shallow Perched Groundwater Ana
Laurel Station
Bellingham, Washington

Location ID	**Preliminary**	**MW-10**		**MW-11**		**MW-12**		**MW-13**		**MW-14**		**SW-1**				
Sample Date	**Cleanup Level**	**6/27/2011**	**9/27/2011**	**6/27/2011**	**9/27/2011**	**6/27/2011**	**9/27/2011**	**6/27/2011**	**9/27/2011**	**6/27/2011**	**9/27/2011**	**12/1/2010**	**2/24/2011**	**8/26/2010**	**6/28/2011**	**9/27/2011**
PAHs (ug/L)																
1-methylnaphthalene	**NE**	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	**0.019**	**0.03**	**0.29**	0.01 U	**0.013**
2-methylnaphthalene	**32**	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	**0.021 J+**	**0.031**	**0.22**	0.01 U	**0.01**
acenaphthene	**960**	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	0.01 U	0.01 UJ	**0.026**	0.01 U	0.01 U
acenaphthylene	**NE**	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
anthracene	**4,800**	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
benzo(a)anthracene	**See Note a**	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	**0.054**	**0.03**	0.01 U	0.01 U	**0.02**
benzo(a)pyrene	**0.1**	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	**0.082**	**0.045**	0.01 U	**0.014**	**0.03**
benzo(g,h,i)perylene	**NE**	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	**0.041**	**0.014**	0.01 U	0.01 U	**0.019**
chrysene	**See Note a**	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	**0.072**	**0.025 J**	0.01 U	0.01 U	**0.022**
dibenz(a,h)anthracene	**See Note a**	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	**0.022**	**0.011**	0.01 U	0.01 U	**0.01**
dibenzofuran	**32**	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	0.01 U	0.01 U	**0.015**	0.01 U	0.01 U
fluoranthene	**640**	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	**0.05**	**0.025**	0.01 U	0.01 U	**0.019**
fluorene	**640**	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	0.01 U	0.01 UJ	**0.05**	0.01 U	**0.011**
indeno[1,2,3-cd]pyrene	**See Note a**	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	**0.038**	**0.016**	0.01 U	0.01 U	**0.018**
naphthalene	**160**	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	**0.045 J+**	**0.036**	**0.059**	**0.027**	**0.024**
phenanthrene	**NE**	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	**0.025**	**0.014**	**0.013**	0.01 U	**0.015**
pyrene	**480**	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	**0.056**	**0.021**	0.01 U	0.01 U	**0.021**
total benzofluoranthenes	**See Note a**	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	**0.1**	**0.058**	0.01 U	0.02 U	**0.039**
TTEC cPAH	**0.1**	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	**0.104**	**0.057**	0	**0.014**	**0.039**

Notes:

Bolded values indicate the chemical was detected above the laboratory reporting limit

Bolded and highlighted values exceed the selected Preliminary Cleanup Level

PAHs - polycyclic aromatic hydrocarbons

cPAHs - carcinogenic PAHs

ug/L - micrograms per liter

(D) - duplicate sample

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[a] Carcinogenic PAH (cPAH) cleanup levels under MTCA are based on the calculated total toxicity of the mixture using the Toxicity Equivalency Methodology in WAC 173-340-708 (8).
The mixture of cPAHs shall be considered a single hazardous substance and compared to the applicable MTCA Method A cleanup level for benzo(a)pyrene.

Monitoring well SW-5 has been dry since 1992.

Table 5
Summary of Shallow Perched Groundwater Ana
Laurel Station
Bellingham, Washington

Location ID	Preliminary Cleanup Level	SW-2							SW-3			SW-4				
Sample Date		**12/1/2010**	**12/1/2010 (D)**	**2/24/2011**	**8/26/2010**	**8/26/2010 (D)**	**6/28/2011**	**9/27/2011**	**2/23/2011**	**6/28/2011**	**9/27/2011**	**12/1/2010**	**2/23/2011**	**8/26/2010**	**6/27/2011**	**9/27/2011**
PAHs (ug/L)																
1-methylnaphthalene	**NE**	**0.017**	0.01 U	0.01 U	0.01 U	**0.018 J**	0.01 U	0.01 U	**0.022**	0.01 U	NS	0.01 U	**0.072**	**0.016**	0.01 U	NS*
2-methylnaphthalene	**32**	**0.028 J+**	0.01 U	0.01 U	**0.015**	**0.025 J**	0.01 U	0.01 U	**0.025**	0.01 U	NS	0.01 U	**0.074**	**0.028**	0.01 U	NS*
acenaphthene	**960**	0.01 U	0.01 U	0.01 UJ	0.01 U	0.01 UJ	0.01 U	0.01 U	0.01 UJ	0.01 U	NS	0.01 U	0.01 UJ	0.01 U	0.01 U	NS*
acenaphthylene	**NE**	0.01 U	0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 U	0.01 U	0.01 U	0.01 U	NS	0.01 U	0.01 U	0.01 U	0.01 U	NS*
anthracene	**4,800**	0.01 U	0.01 U	0.01 U	0.01 U	**0.022 J**	0.01 U	0.01 U	0.01 U	0.01 U	NS	0.01 U	0.01 U	0.01 U	0.01 U	NS*
benzo(a)anthracene	**See Note a**	0.01 U	0.01 U	0.01 U	0.01 U	**0.03 J**	0.01 U	0.01 U	0.01 U	0.01 U	NS	0.01 U	0.01 U	0.01 U	0.01 U	NS*
benzo(a)pyrene	**0.1**	0.01 U	0.01 U	0.01 U	0.01 U	**0.028 J**	0.01 U	0.01 U	0.01 U	0.01 U	NS	0.01 U	0.01 U	0.01 U	0.01 U	NS*
benzo(g,h,i)perylene	**NE**	0.01 U	0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 U	0.01 U	0.01 U	0.01 U	NS	0.01 U	0.01 U	0.01 U	0.01 U	NS*
chrysene	**See Note a**	0.01 U	0.01 U	0.01 UJ	0.01 U	**0.033 J**	0.01 U	0.01 U	0.01 UJ	0.01 U	NS	**0.011**	0.01 UJ	**0.015**	0.01 U	NS*
dibenz(a,h)anthracene	**See Note a**	0.01 U	0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 U	0.01 U	0.01 U	0.01 U	NS	0.01 U	0.01 U	0.01 U	0.01 U	NS*
dibenzofuran	**32**	0.01 U	0.01 U	0.01 U	0.01 U	**0.011 J**	0.01 U	0.01 U	0.01 U	0.01 U	NS	0.01 U	0.01 U	**0.013**	0.01 U	NS*
fluoranthene	**640**	0.01 U	0.01 U	0.01 U	0.01 U	**0.072 J**	0.01 U	0.01 U	0.01 U	0.01 U	NS	0.01 U	0.01 U	**0.027**	0.01 U	NS*
fluorene	**640**	0.01 U	0.01 U	0.01 UJ	0.01 U	**0.02 J**	0.01 U	0.01 U	0.01 UJ	0.01 U	NS	0.01 U	0.01 UJ	**0.016**	0.01 U	NS*
indeno[1,2,3-cd]pyrene	**See Note a**	0.01 U	0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 U	0.01 U	0.01 U	0.01 U	NS	0.01 U	0.01 U	0.01 U	0.01 U	NS*
naphthalene	**160**	**0.014 J+**	0.01 U	**0.018**	**0.02**	**0.028 J**	**0.02**	**0.038**	**0.046**	**0.02**	NS	0.01 U	**0.06**	**0.028**	**0.013**	NS*
phenanthrene	**NE**	**0.017**	0.01 U	0.01 U	**0.014 J**	**0.12 J**	0.01 U	0.01 U	**0.015**	0.01 U	NS	0.01 U	0.01 U	**0.055**	0.01 U	NS*
pyrene	**480**	0.01 U	0.01 U	0.01 U	0.01 U	**0.077 J**	0.01 U	0.01 U	0.01 U	0.01 U	NS	0.01 U	0.01 U	**0.032**	0.01 U	NS*
total benzofluoranthenes	**See Note a**	0.01 U	0.01 U	0.01 U	0.01 U	**0.042 J**	0.02 U	0.02 U	0.01 U	0.02 U	NS	0.01 U	0.01 U	**0.023**	0.02 U	NS*
TTEC cPAH	**0.1**	0	0	0	0	**0.036**	0	0	0	0	NS	0	0	**0.002**	0	NS*

Notes:
Bolded values indicate the chemical was detected above the laboratory reporting limit
Bolded and highlighted values exceed the selected Preliminary Cleanup Level
PAHs - polycyclic aromatic hydrocarbons
cPAHs - carcinogenic PAHs
ug/L - micrograms per liter
(D) - duplicate sample
NE - not established
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J - estimated value
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[a] Carcinogenic PAH (cPAH) cleanup levels under MTCA are based on the calculated total toxicity of the mixture using the Toxicity Equivalency Methodology in WAC 173-340-708 (8).
The mixture of cPAHs shall be considered a single hazardous substance and compared to the applicable MTCA Method A cleanup level for benzo(a)pyrene.
Monitoring well SW-5 has been dry since 1992.

Table 6
Field and Laboratory Data Objectives for DPE Pilot Test
Laurel Station
Bellingham, Washington

Data/Measurement	Range of Measurements	Relation to Evaluation of Technology (Table 8)
Blower temperature	0 to ? deg F	Operating Parameters / Treatment Costs
Blower vacuum	0 to 20 in Hg (3 steps)	Operating Parameters / Treatment Costs
Vapor extraction flow rate (from well)	0 to 100 cfm	Permeability / Radius of Influence / Extraction Rates / Treatment Costs / Treatment Time
Blower dilution flow rate	0 to 100 cfm	Operating Parameters
Blower vapor exhaust rate	0 to 100 cfm	Operating Parameters / Treatment Costs
Extracted oxygen concentration at blower exhaust	0 to 21 %	Operating Parameters
Extracted carbon dioxide concentration at blower exhaust	0 to ? ppm	Operating Parameters
Extracted carbon monoxide concentration at blower exhaust	0 to ? ppm	Operating Parameters
Extracted methane concentration at blower exhaust	0 to ? %	Operating Parameters
Extracted vapor TVH concentrations (PID and FID)	0 to ? ppm	Extraction Rates / Treatment Costs / Treatment Time
Generator Engine Hours	0 to ? hours	Operating Parameters / Treatment Costs
Applied wellhead vacuum (vapor)	0 to 20 in Hg	Permeability / Radius of Influence / Extraction Rates
Applied stinger vacuum (groundwater)	0 to 20 in Hg	Extraction Rates / Treatment Costs / Treatment Time
Extracted groundwater volume	? gallons	Extraction Rates / Treatment Costs / Treatment Time
Groundwater extraction rate (calculated based on volume and time)	0 to ? gpm	Extraction Rates / Treatment Costs / Treatment Time
Extracted groundwater TPH concentrations (laboratory analyses)	0 to 7 mg/L	Extraction Rates / Treatment Costs / Treatment Time
Oxygen concentration at the test well	0 to 21 %	Operating Parameters
Carbon dioxide concentration at the test well	0 to ? ppm	Operating Parameters
Carbon monoxide concentration at the test well	0 to ? ppm	Operating Parameters
Methane concentration at the test well	0 to ? %	Operating Parameters
TVH concentration at the test well (PID and FID)	0 to ? ppm	Operating Parameters
Extracted vapor TPH concentrations (laboratory analyses)	0 to ? ppm	Extraction Rates / Treatment Costs / Treatment Time
Vacuum measurements at observation wells (transient and steady state)	0 to 100 in wc	Permeability / Radius of Influence / System Design / Treatment Costs / Treatment Time
Groundwater elevations at observation wells (transient and steady state)	5 to 45 ft below TOC	Permeability / Radius of Influence / Extraction Rates / Treatment Costs / Treatment Time

Table 6
Field and Laboratory Data Objectives for DPE Pilot Test
Laurel Station
Bellingham, Washington

Notes:

cfm – cubic feet per minute
deg F – degrees Fahrenheit
FID – flame ionization detector
ft below TOC – feet below top of casing
gpm – gallons per minute
in Hg – inches of mercury
in wc – inches of water column
mg/L – milligrams per liter
PID – photoionization detector
ppm – parts per million
TPH – total petroleum hydrocarbons
TVH – total volatile hydrocarbons

Table 7
Field Data Objectives for BV Pilot Test
Laurel Station
Bellingham, Washington

Data/Measurement	**Range of Measurements**	**Relation to Evaluation of Technology (Table 9)**
Air flow into test well	0 to 20 cfm	Operating Parameters / Treatment Costs / Treatment Time / Permeability
Helium flow into test well	0.01 to 0.1 cfm	Radius of Influence
Blower pressure	0 to 10 psi	Operating Parameters / Treatment Costs
Blower temperature	0 to ? deg F	Operating Parameters / Treatment Costs
Oxygen concentration at test well before, during, after injection	0 to 21 %	Treatment Costs / Treatment Time / Respiration Test
Carbon dioxide concentration at test well before, during, after injection	0 to ? ppm	Treatment Costs / Treatment Time
Helium concentration at test well before, during, after injection	0 to 10 ppm	Treatment Costs / Treatment Time
TVH concentration at test well before, during, after injection (PID and FID)	0 to ? ppm	Treatment Costs / Treatment Time
Methane concentration at test well before, during, after injection	0 to ? %	Treatment Costs / Treatment Time
Pressure at the test well before, during, and after injection	0 to 10 psi	Operating Parameters / Treatment Costs
Oxygen concentration at observation wells before, during, after injection	0 to 21%	Treatment Costs / Treatment Time / Radius of Influence / Permeability
Carbon dioxide concentration at observation wells before, during, after injection	0 to ? ppm	Treatment Costs / Treatment Time
Carbon monoxide concentration at observation wells before, during, after injection	0 to ? ppm	Treatment Costs / Treatment Time
Helium concentration at observation wells before, during, after injection	0 to 10 ppm	Treatment Costs / Treatment Time / Radius of Influence / Permeability
TVH concentration at observation wells before, during, after injection (PID and FID)	0 to ? ppm	Treatment Costs / Treatment Time
Methane concentration at observation wells before, during, after injection	0 to ? %	Treatment Costs / Treatment Time
Pressure at the observation wells before, during, after the injection	0 to 10 in wc	Treatment Costs / Treatment Time / Radius of Influence / Permeability

Notes:
cfm – cubic feet per minute
deg F – degrees Fahrenheit
FID – flame ionization detector
in wc – inches of water column
PID – photoionization detector
ppm – parts per million
psi – pounds per square inch
TVH – total volatile hydrocarbons

Table 8
Technology Evaluation Objectives for DPE Pilot Test
Laurel Station
Bellingham, Washington

Data/Measurement	Criteria for Comparison	Evaluation of Technology Suitability Based on Measurement
Field Permeability (Section 3.4.4)	0.1 darcy (10^{-9} cm^2)	Greater than criterion indicates adequate permeability for application of DPE.
Radius of Influence (Section 3.4.5)	1% of applied vacuum	Extrapolation of collected field data will allow calculation of distance (ROI) at which criterion would be observed. A distance of greater than 5 feet indicates adequate influence for application of DPE.
TPH Extraction Rate – Liquid Phase (Section 3.4.6)	NA	Flows and concentrations related to extracted liquids will be utilized to calculate rates of COC removal from the subsurface.
TPH Extraction Rate – Vapor Phase (Section 3.4.6)	NA	Flows and concentrations related to extracted vapors will be utilized to calculate rates of COC removal from the subsurface.
Operating Parameters	NA	Temperature, pressure, electrical usage, and other operating parameter data collected during the pilot test will allow for extrapolation to full-scale system operating conditions.
Treatment Time	NA	Extraction rate, operating parameter, and other data collected will allow estimation of time required to remove site COCs during full-scale remediation.
Treatment Cost	NA	Extraction rate, operating parameter, and other data collected will allow estimation of full-scale remediation cost.
System Design	NA	Radius of influence, extraction rate, operating parameter, and other data collected will allow design of full-scale remediation system.

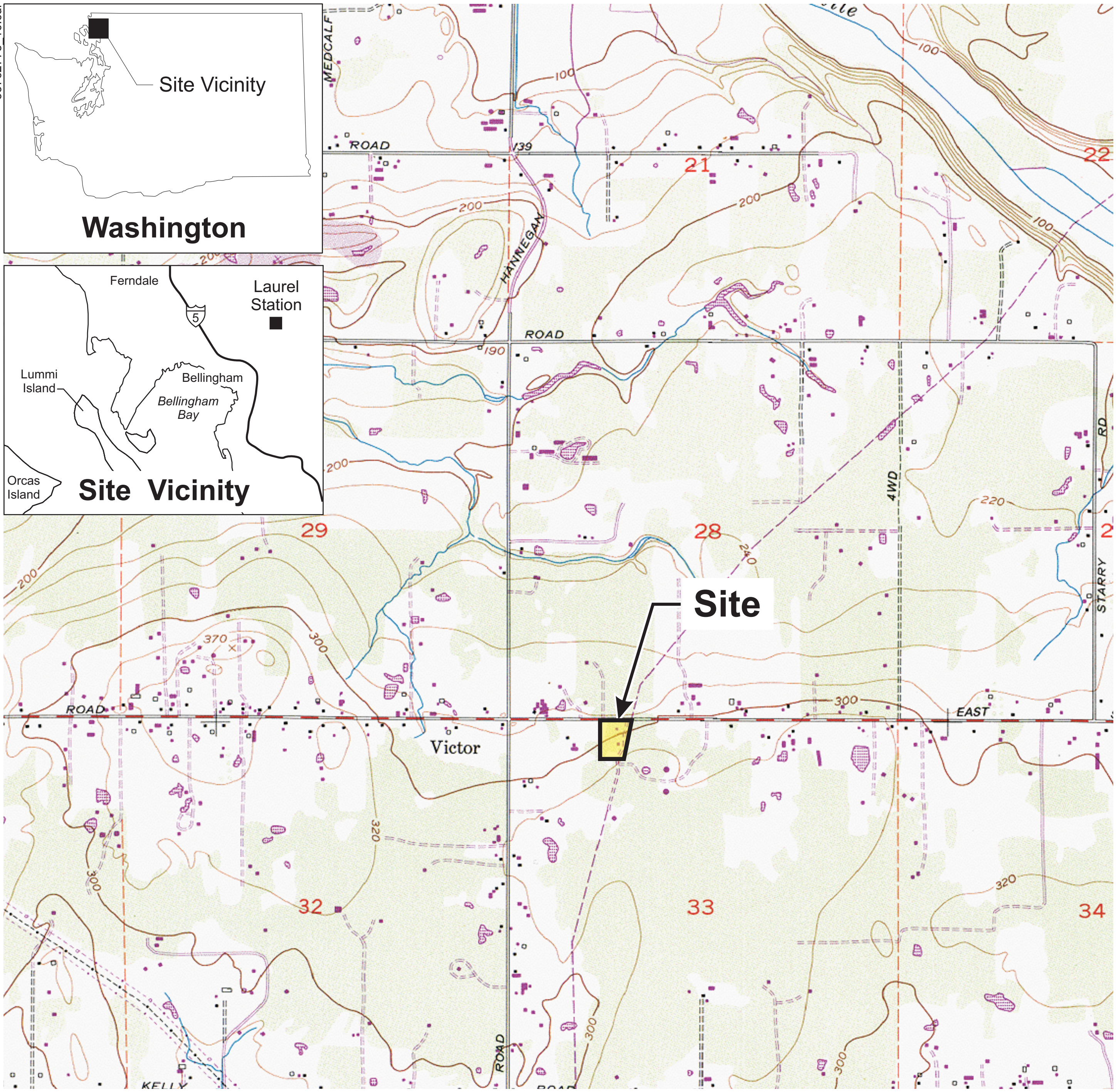
Notes:
cm^2 – square centimeters
COC – chain-of-custody
DPE – dual phase extraction
NA – not applicable
ROI – radius of influence
TPH – total petroleum hydrocarbons

Table 9
Technology Evaluation Objectives for BV Pilot Test
Laurel Station
Bellingham, Washington

Data/Measurement	**Criteria for Comparison**	**Evaluation of Technology Suitability Based on Measurement**
Field Permeability (Section 3.4.4)	0.1 darcy (10^{-9} cm^2)	Greater than criterion indicates adequate permeability for application of BV.
Radius of Influence (Section 3.4.5)	1% of applied pressure and/or helium concentration	Extrapolation of collected field data will allow calculation of distance (ROI) at which criterion would be observed. A distance of greater than 5 feet indicates adequate influence for application of BV.
Respiration Test Initial Oxygen Concentration (Section 3.5.3)	5% above background	Greater than criterion indicates adequate permeability for delivery of air to subsurface and potential application of BV.
Respiration Test Oxygen Concentrations (Section 3.5.3)	Background (existing ambient subsurface concentration)	Higher rates of subsurface oxygen concentrations returning to background levels indicate potentially higher rates of utilization during aerobic bioremediation.
Operating Parameters	NA	Temperature, pressure, electrical usage, and other operating parameter data collected during the pilot test will allow for extrapolation to full-scale system operating conditions.
Treatment Time	NA	Extraction rate, operating parameter, and other data collected will allow estimation of time required to remove site COCs during full-scale remediation.
Treatment Cost	NA	Extraction rate, operating parameter, and other data collected will allow estimation of full-scale remediation cost.
System Design	NA	Radius of influence, extraction rate, operating parameter, and other data collected will allow design of full-scale remediation system.

Notes:
BV - bioventing
cm^2 – square centimeters
COC – chain-of-custody
NA – not applicable
ROI – radius of influence

FIGURES



Map created with TOPO!™ © 1997 Wildflower Productions, www.topo.com, based on USGS topographic map

0 0.5 1.0

Approximate Scale in Miles

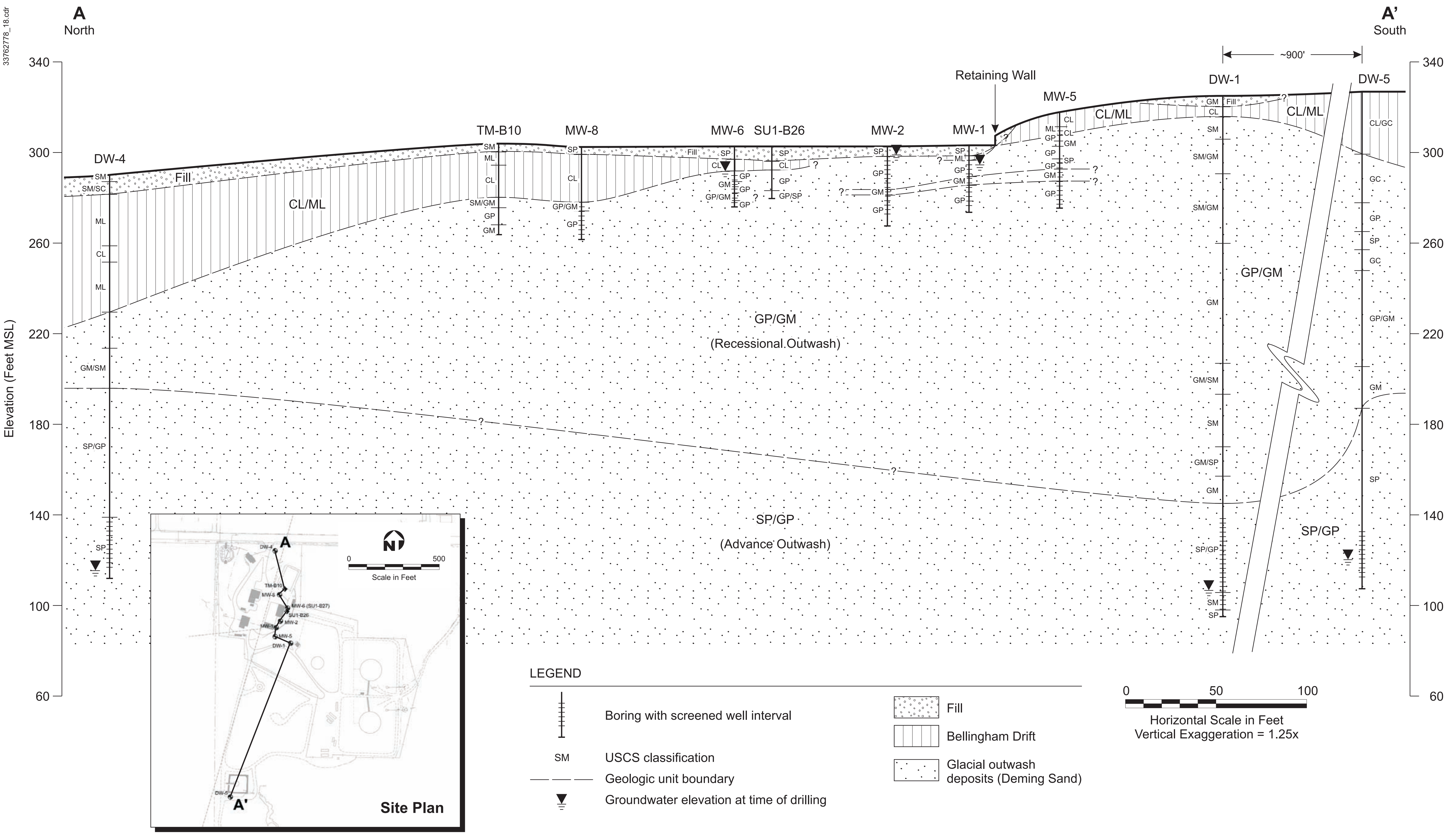
Figure 1

Site Location Map

URS

Laurel Station
Bellingham, Washington

Figure 2
Site Plan - Current Features



LEGEND

Boring with screened well interval

SM USCS classification

Geologic unit boundary

Groundwater elevation at time of drilling

Fill

Bellingham Drift

Glacial outwash deposits (Deming Sand)

Horizontal Scale in Feet
Vertical Exaggeration = 1.25x

33762778_18.cdr

Figure 3

North-South Geologic Cross Section A-A'

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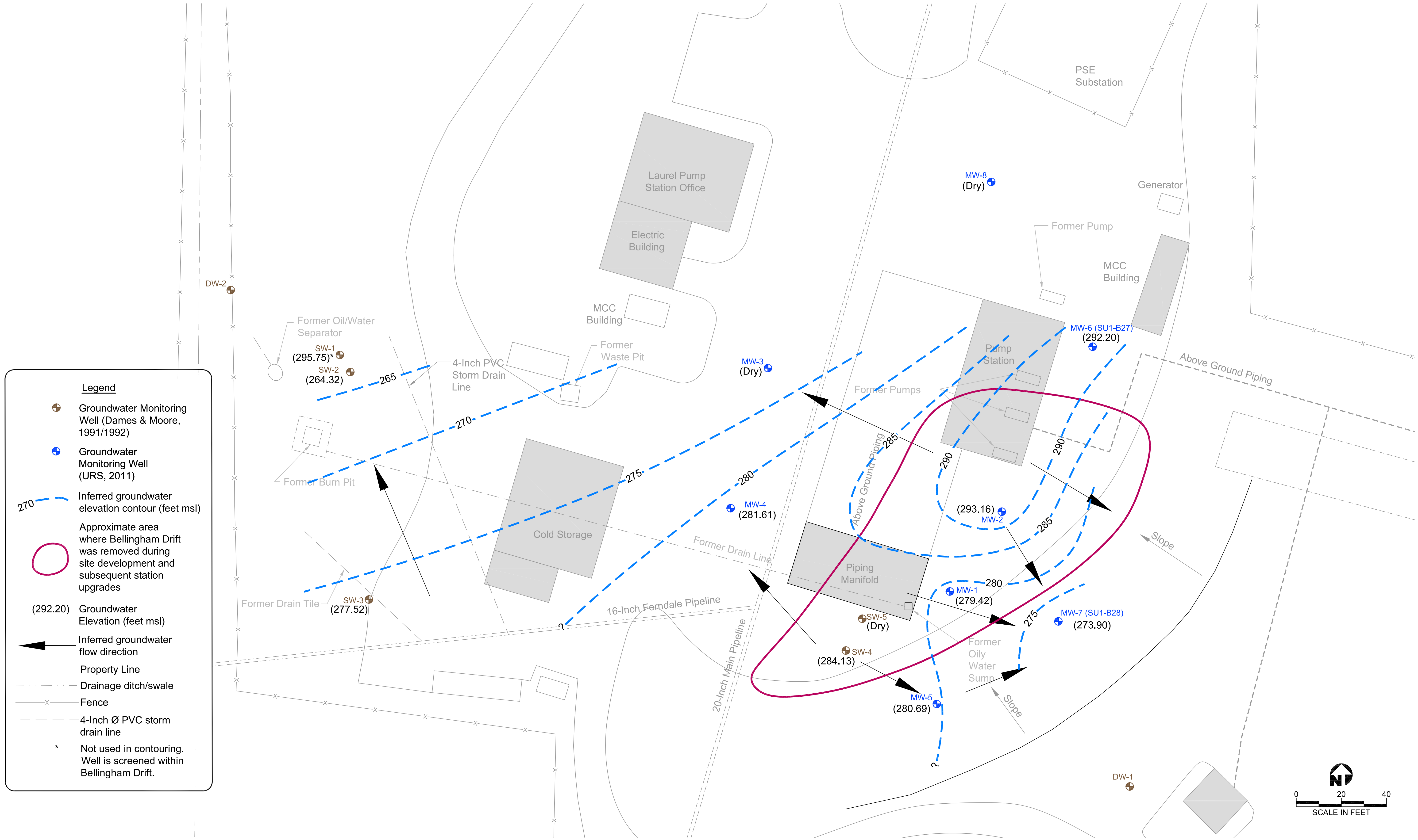

Figure 4a
Groundwater Elevation Contour Map
Shallow Perched Groundwater - February 23, 2011

Q:\geo\Kinder Morgan\Laurel Pump Station\SubTasks\DPE_BV Pilot Test\Figure 4a (Feb 2011 GW Elev Contours).dwg
Mod: 10/21/2011, 09:33 | Plotted: 10/24/2011, 14:26 | john_knobbs

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Bellingham, Washington

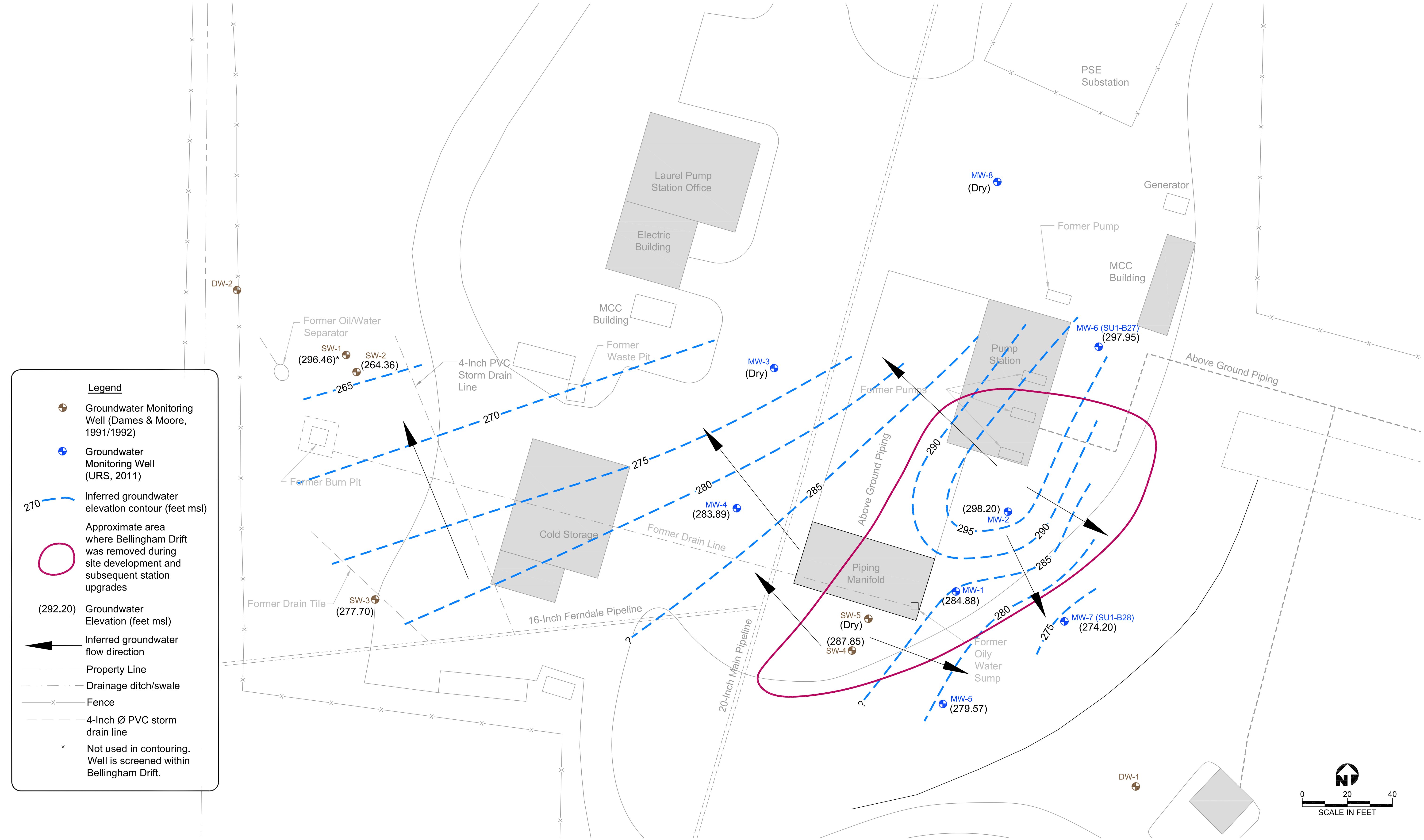

Figure 4b

Groundwater Elevation Contour Map

Shallow Perched Groundwater - April 7, 2011

Q:\geo\Kinder Morgan\Laurel Pump Station\SubTasks\DPE_BV Pilot Test\Figure 4b (April 2011 GW Elev Contours).dwg
Mod: 10/21/2011, 09:36 | Plotted: 10/24/2011, 14:31 | john_knobbs

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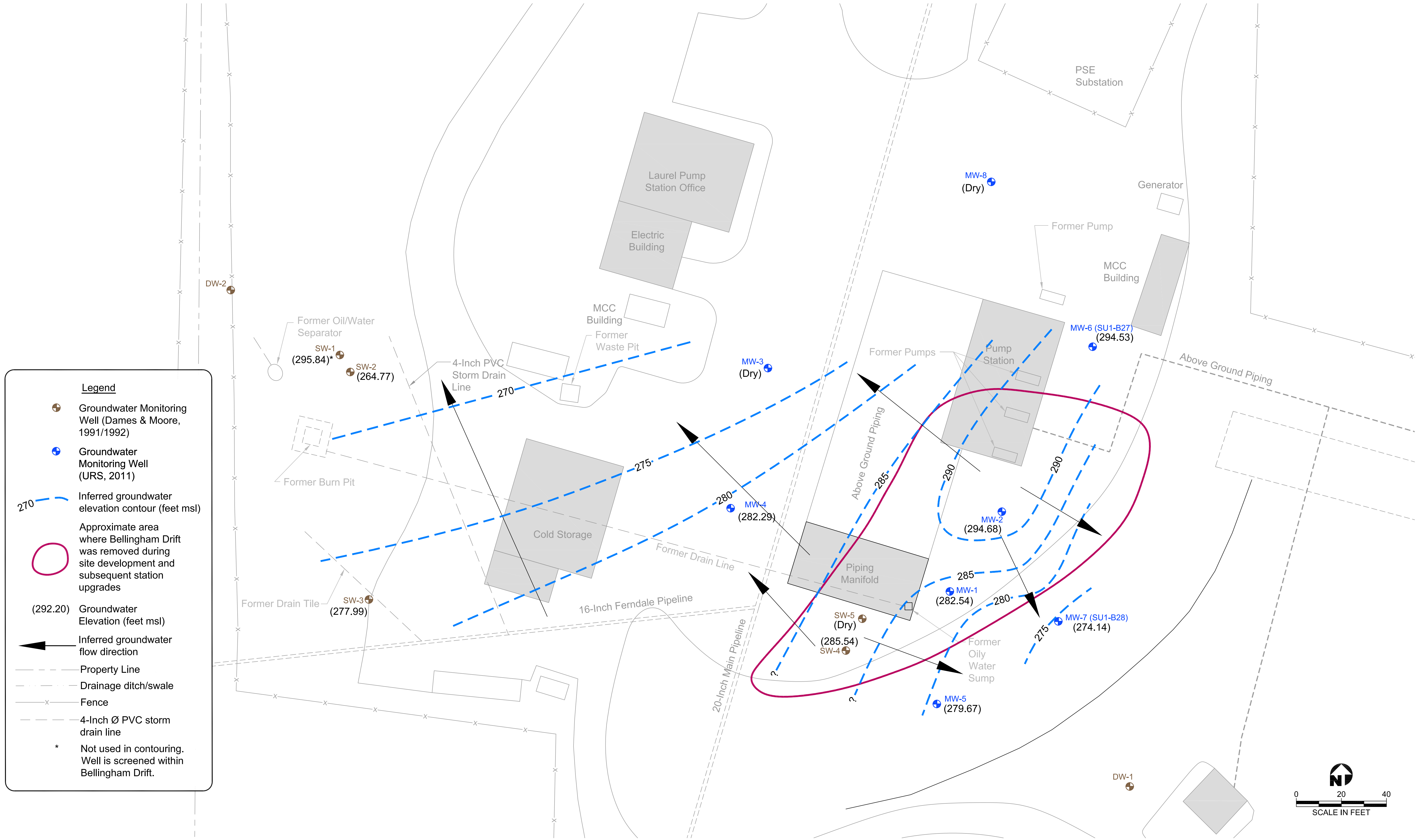

Q:\geo\Kinder Morgan\Laurel Pump Station\SubTasks\DPE_BV Pilot Test\Figure 4c (May 2011 GW Elev Contours).dwg
Mod: 10/21/2011, 09:36 | Plotted: 10/24/2011, 14:32 | john_knobbs

Figure 4c

Groundwater Elevation Contour Map

Shallow Perched Groundwater - May 11, 2011

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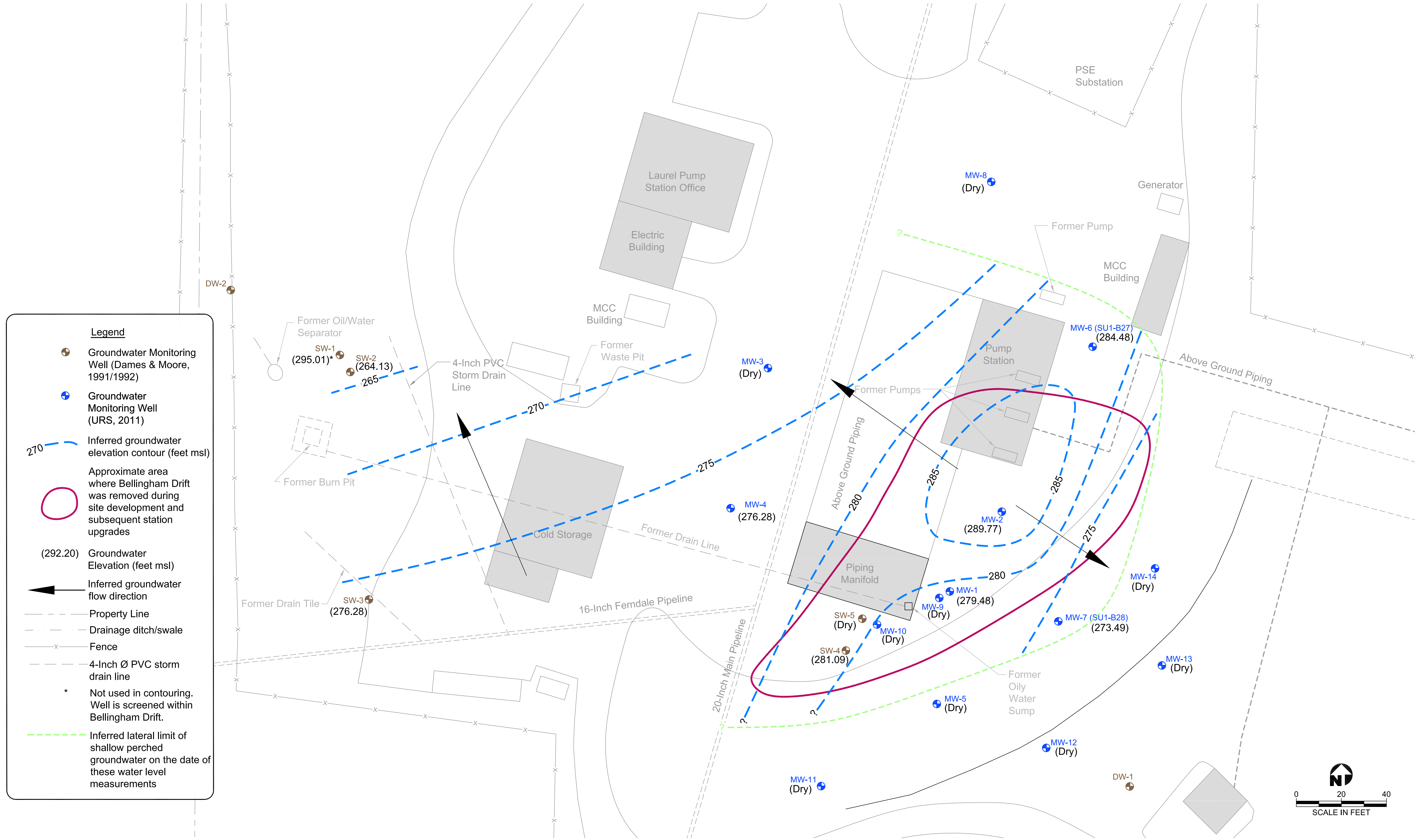

Figure 4d

Groundwater Elevation Contour Map

Shallow Perched Groundwater - June 27, 2011

Q:\geo\Kinder Morgan\Laurel Pump Station\SubTasks\DPE_BV Pilot Test\Figure 4d (June 2011 GW Elev Contours).dwg
Mod: 10/21/2011, 10:16 | Plotted: 10/24/2011, 14:33 | john_knobbs

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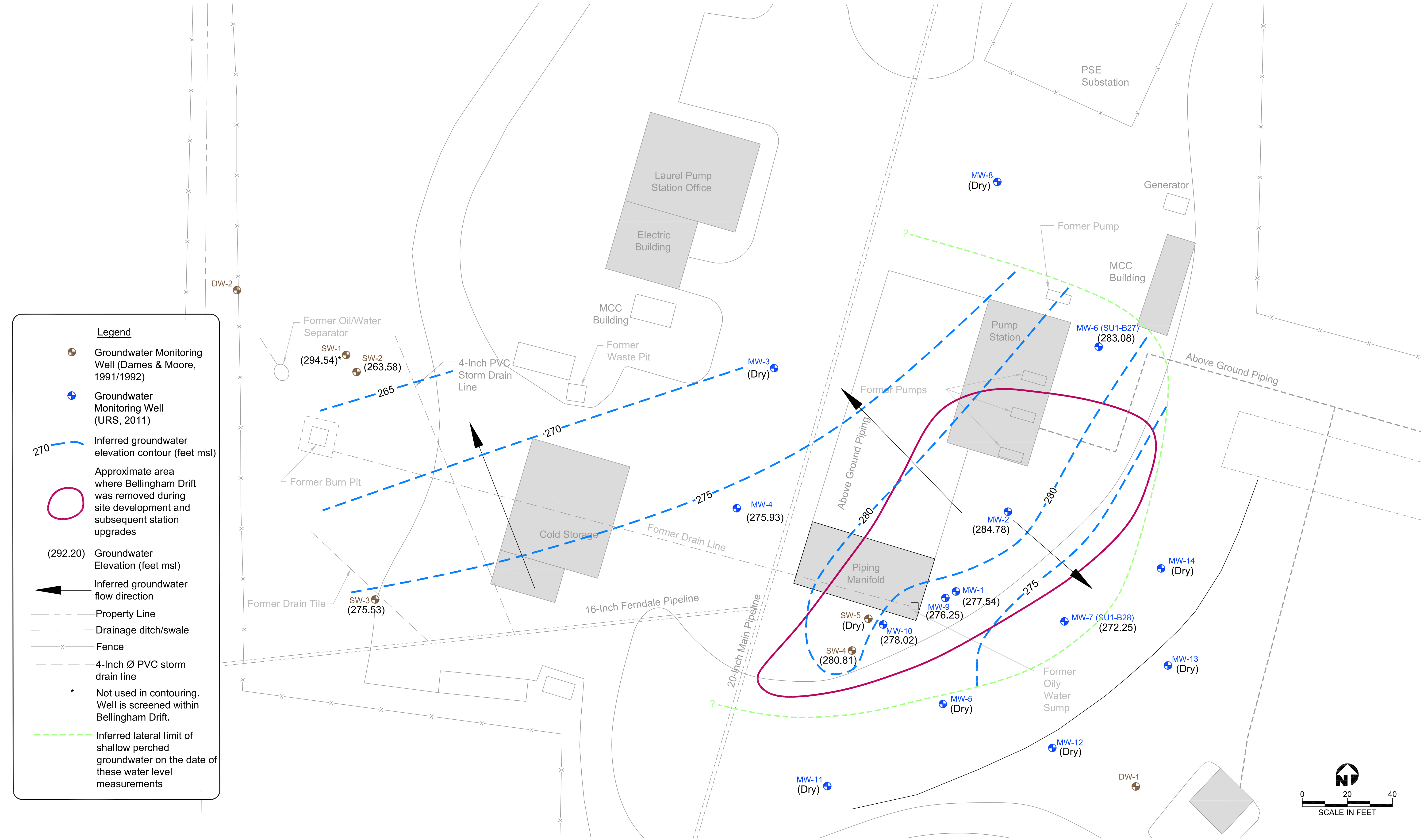

Figure 4e
Groundwater Elevation Contour Map
Shallow Perched Groundwater - July 27, 2011

Q:\geo\Kinder Morgan\Laurel Pump Station\SubTasks\DPE_BV Pilot Test\Figure 4e (July 2011 GW Elev Contours).dwg
Mod: 10/21/2011, 11:25 | Plotted: 10/24/2011, 14:34 | john_knobbs

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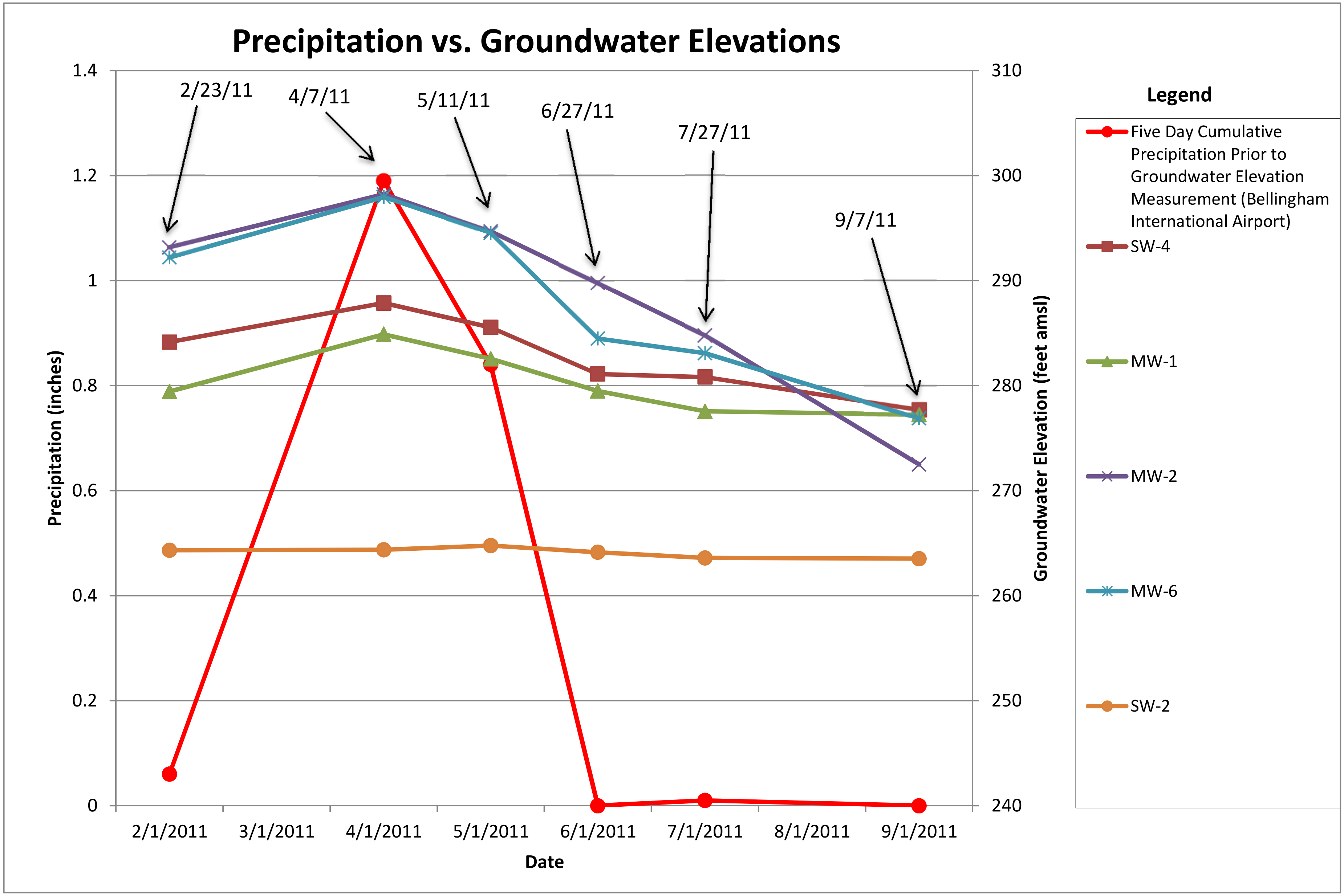
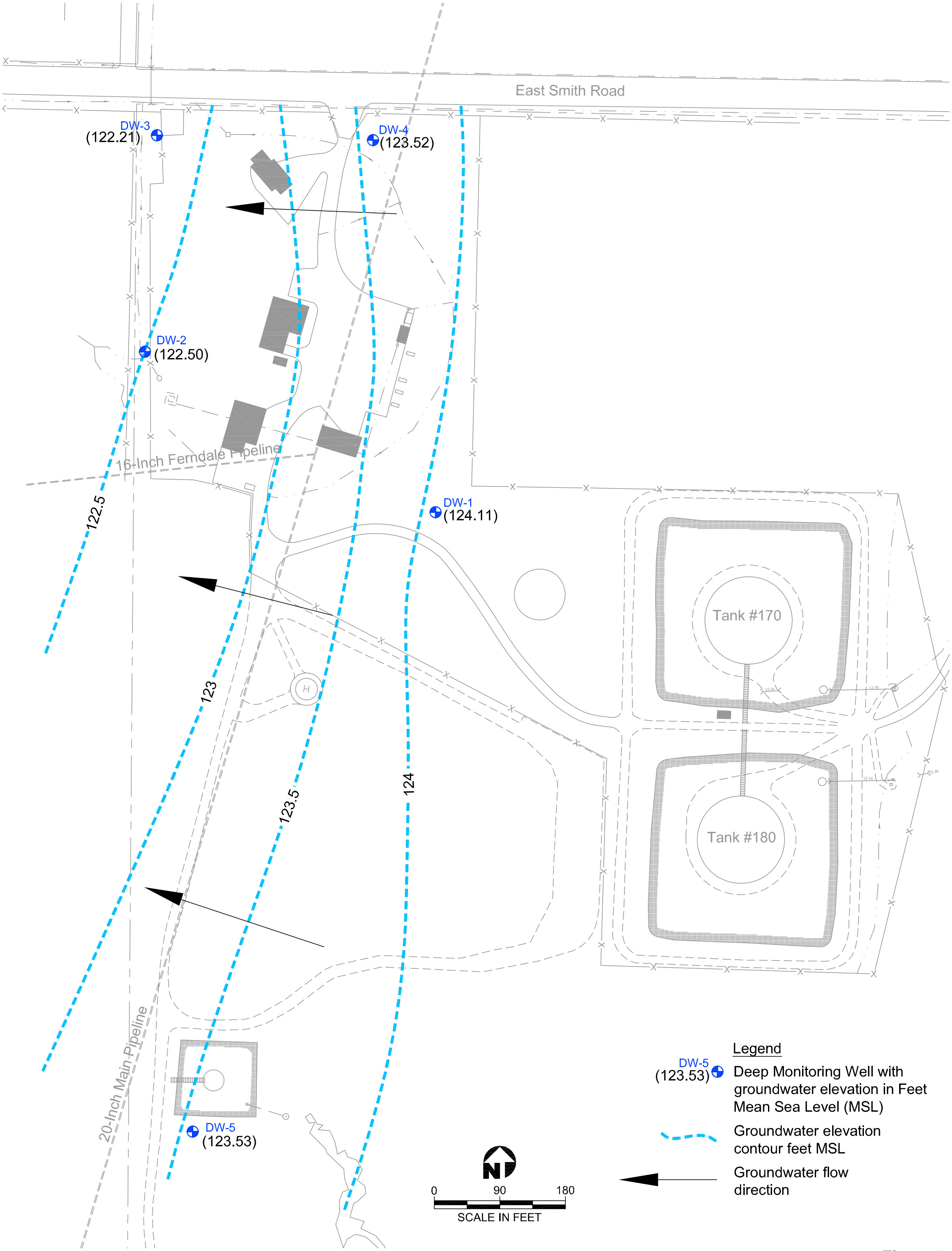
Bellingham, Washington

Figure 4f



I:\Kinder Morgan\Laurel Station\Enforcement Order Support\DPE - BV Pilot Test\Tables\Table 1 Groundwater Elevation Summary



Q:\geo\Kinder Morgan\Laurel Pump Station\SubTasks\RI-FS\Figure 5 (Deep GW Contours).dwg
Mod: 10/25/2011, 14:51 | Plotted: 10/25/2011, 15:36 | john_knobbs

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Figure 5
Groundwater Elevation Contour Map
Deep Aquifer - December 7-8, 2006

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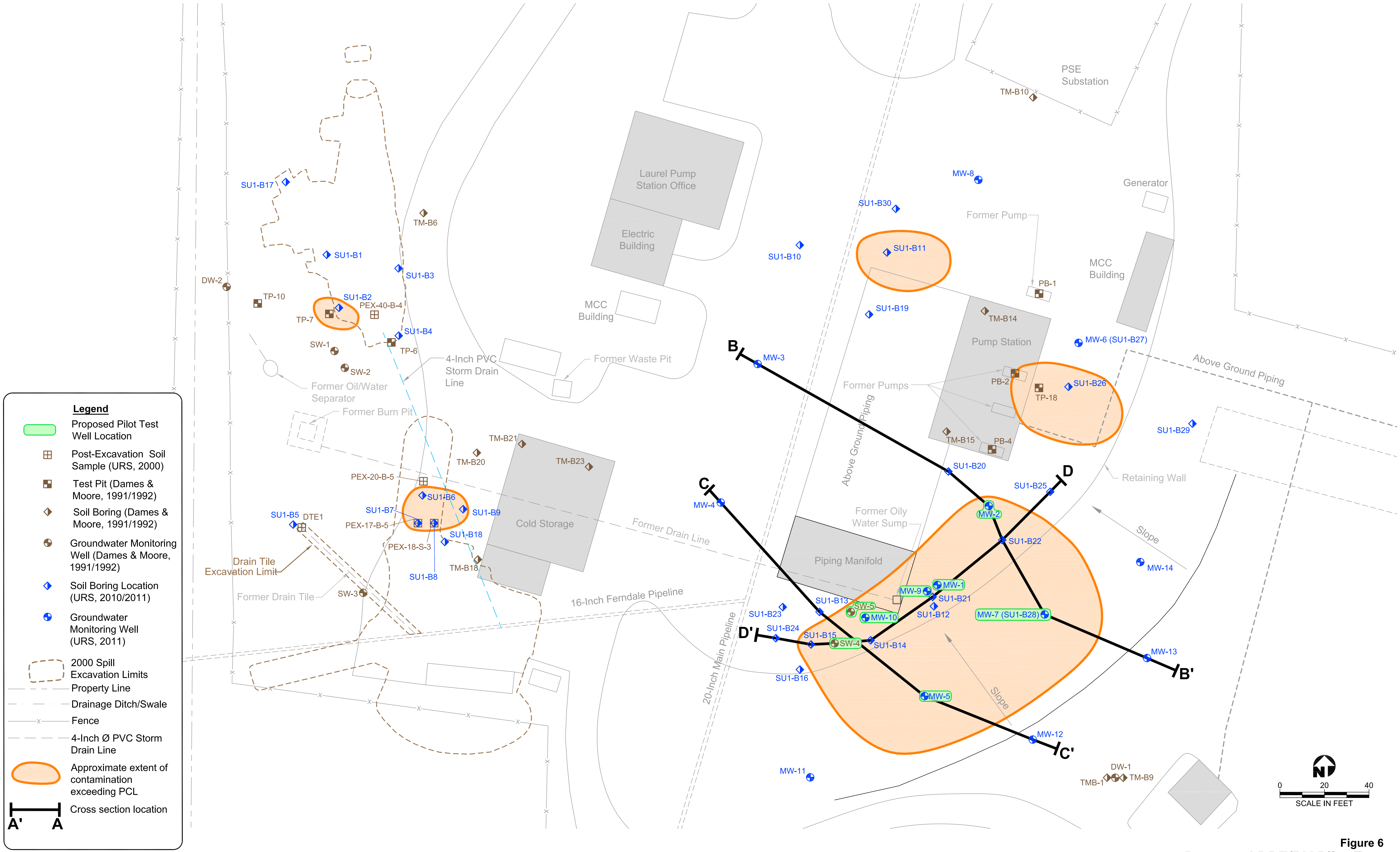

Figure 6
Proposed DPE/BV Pilot Test Well Locations (Study Unit 1)

Q:\geo\Kinder Morgan\Laurel Pump Station\SubTasks\RI-FS\Figure 6 (Unit 1 Proposed Pilot Locs).dwg
Mod: 10/25/2011, 15:31 | Plotted: 10/25/2011, 15:32 | john_knobbs

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Laurel Station
Bellingham, Washington

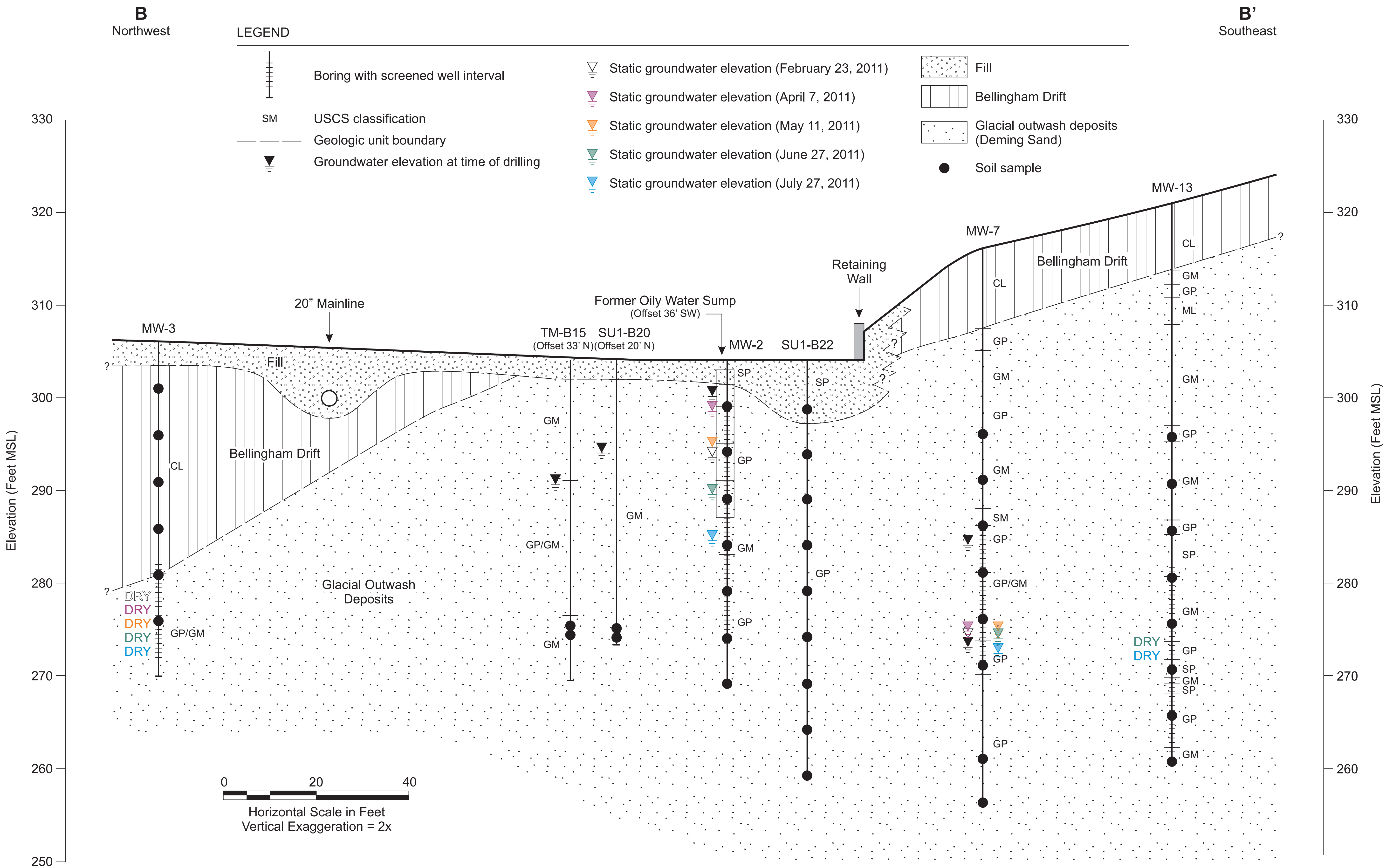

Figure 7

Geologic Cross Section B-B'

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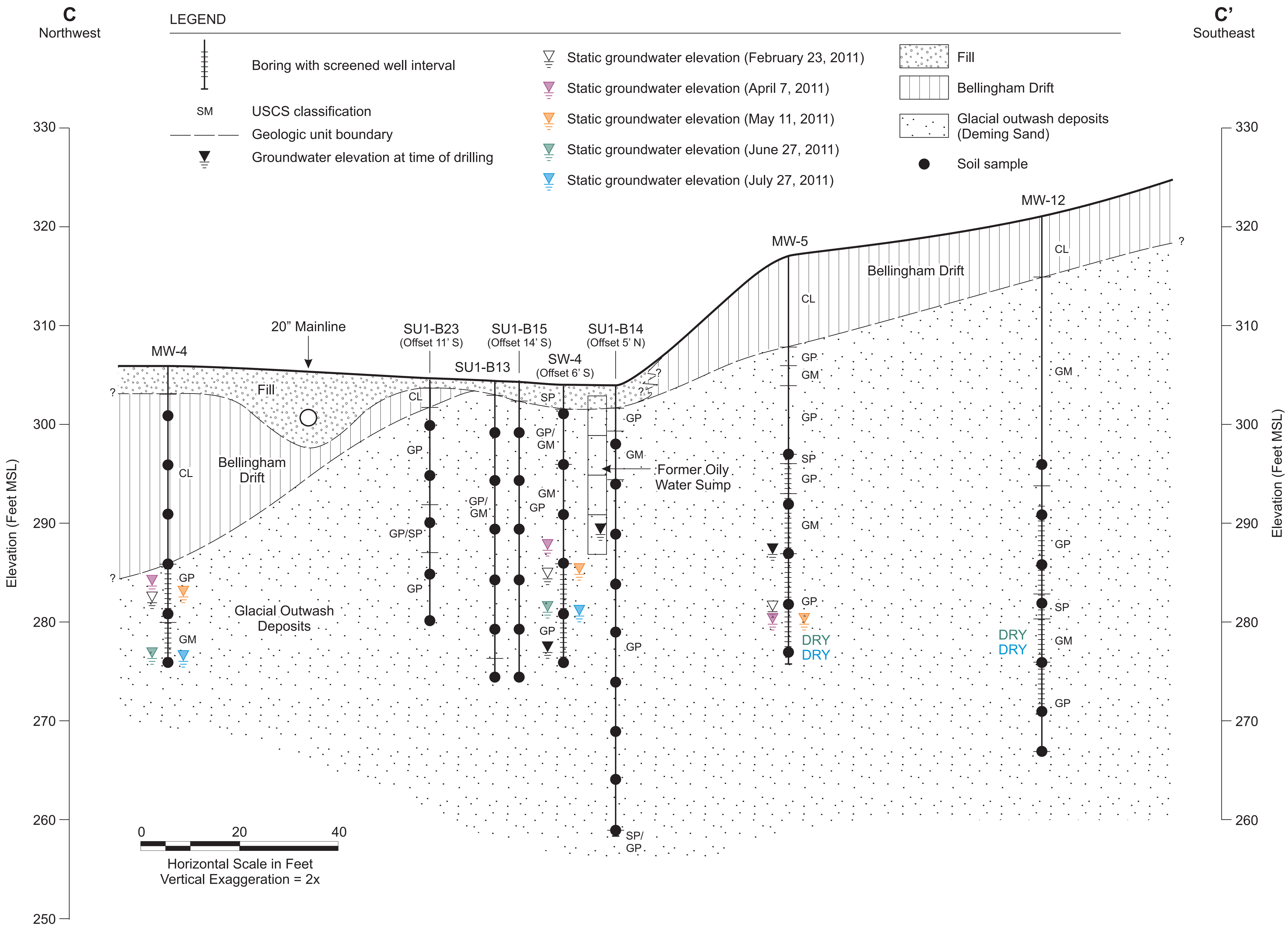

Figure 8
Geologic Cross Section C-C'

URS

Laurel Station
Bellingham, Washington

33762778_16.cdr

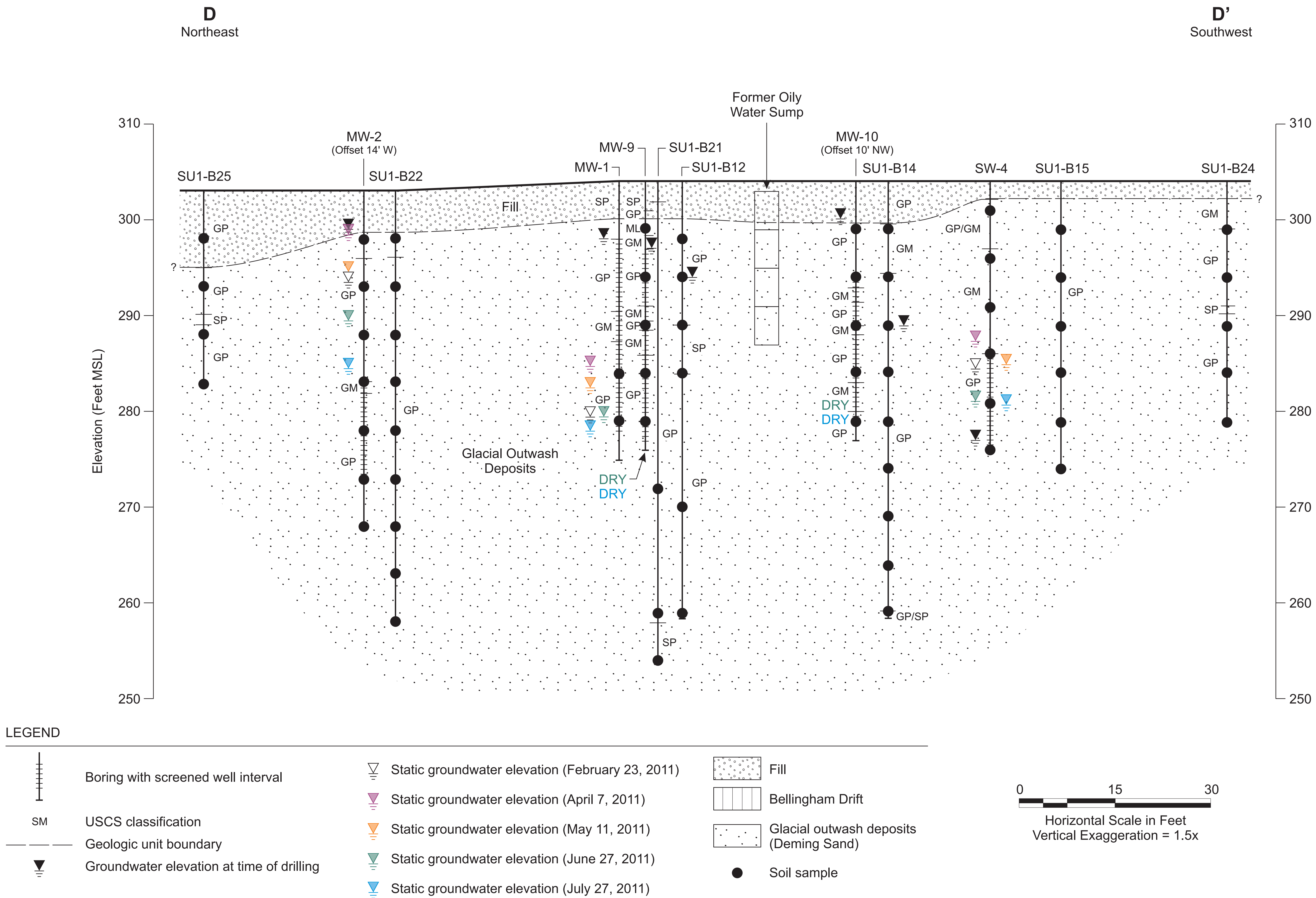

Figure 9
Geologic Cross Section D-D'

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Laurel Station
Bellingham, Washington

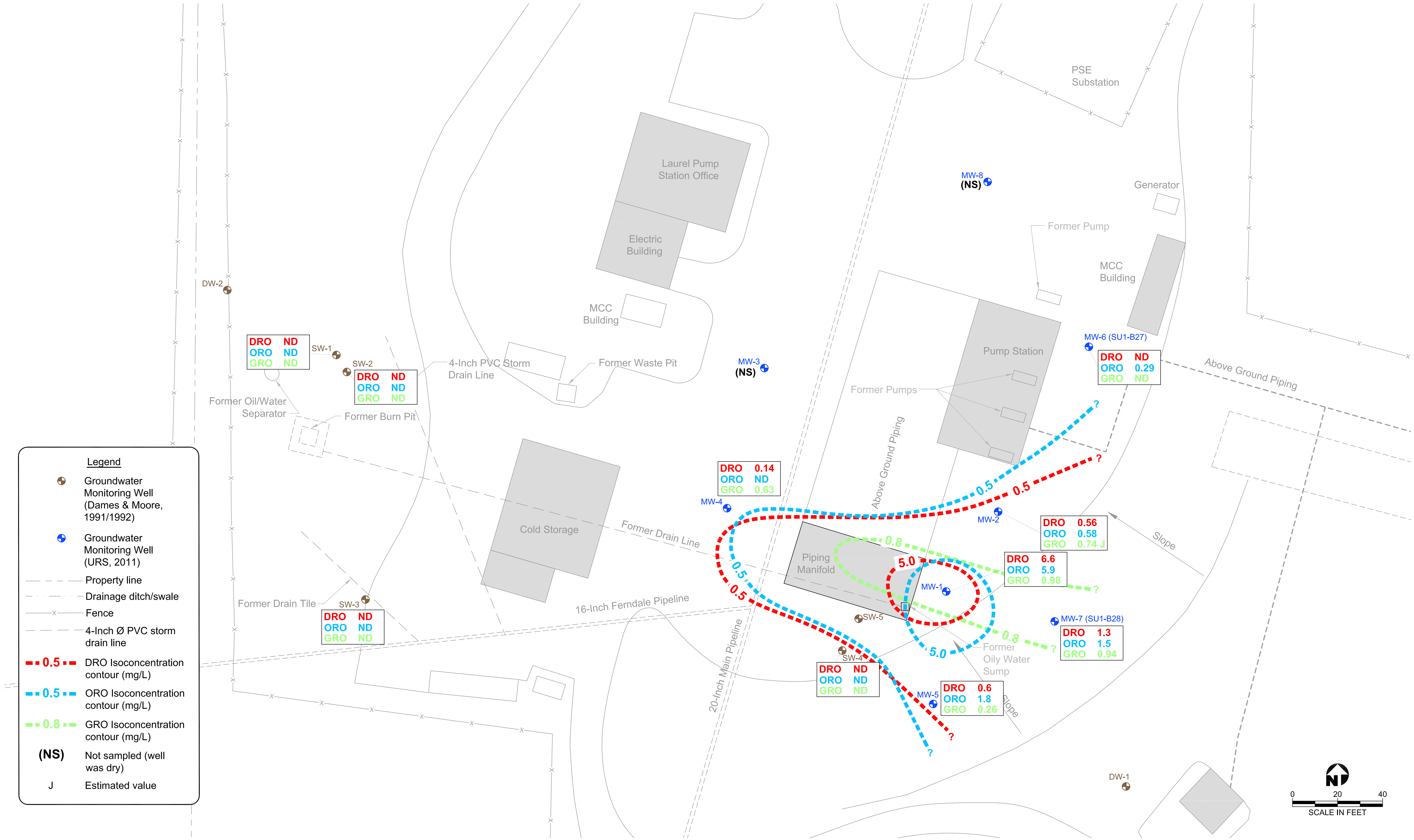

Figure 10a
Isoconcentration Contour Map - Shallow Perched Groundwater
February 23 and 24, 2011 - (Study Unit 1)

Q:\geo\Kinder Morgan\Laurel Pump Station\SubTasks\DPE_BV Pilot Test\Figure 10a (Unit 1 Iso Contours).dwg
Mod: 10/25/2011, 14:51 | Plotted: 10/25/2011, 15:34 | john_knobbs

URS

Laurel Station
Bellingham, Washington

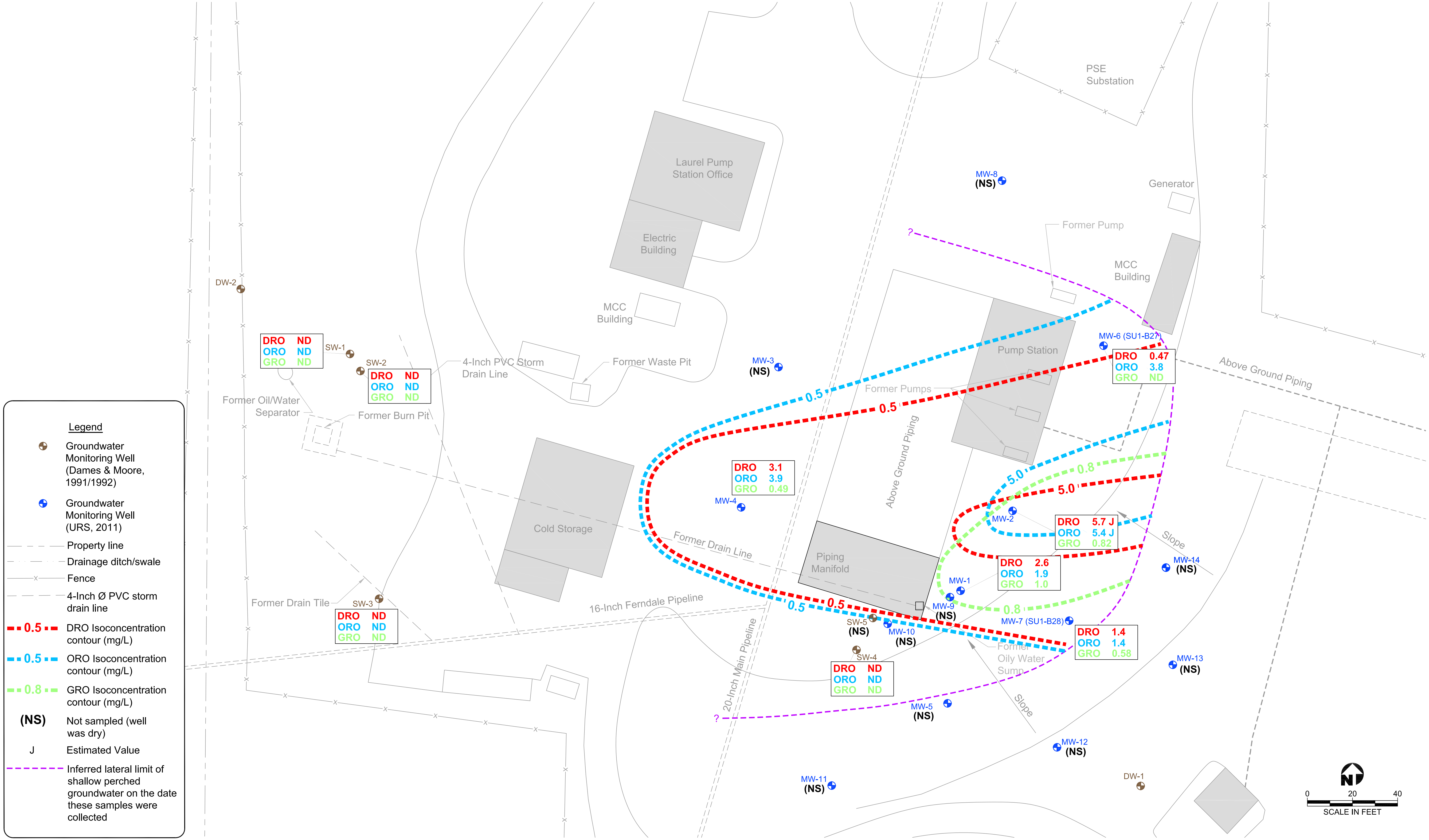

Figure 10b
Isoconcentration Contour Map - Shallow Perched Groundwater
June 27 and 28, 2011 - (Study Unit 1)

Q:\geo\Kinder Morgan\Laurel Pump Station\SubTasks\DPE_BV Pilot Test\Figure 10b (Unit 1 Iso Contours).dwg
Mod: 10/24/2011, 14:22 | Plotted: 10/24/2011, 14:23 | john_knobbs

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Bellingham, Washington

APPENDIX A

USEPA Technology Checklists

Checklist: Can Dual-Phase Extraction Be Used At This Site?

This checklist can help you evaluate the completeness of the CAP and to identify areas that require closer scrutiny. As you go through the CAP, answer the following questions. If the answer to several questions is no, you should request additional information to determine if DPE will accomplish cleanup goals at the site:

1. Site Characteristics

Yes	No	
❑	❑	Are the soil and aquifer media intrinsic permeabilities greater than 10^{-12} cm^2?
❑	❑	Is the soil free of impermeable layers or other conditions that would disrupt air flow?
❑	❑	Is the soil moisture in the unsaturated zone less than or equal to 85 percent of saturation?
❑	❑	Is depth to groundwater at least three feet?

2. Constituent Characteristics

Yes	No	
❑	❑	Are constituent vapor pressures greater than 0.5 mm Hg, boiling points less than 300°C, and Henry's law constants greater than 100 atm?
❑	❑	Are the chemical sorptive capacities of the constituents present sufficiently low?

3. Evaluation Of The DPE System Design

Yes	No	
❑	❑	Does the radius of influence (ROI) for the proposed extraction wells fall within the range of 5 to 100 feet?
❑	❑	Has the ROI been calculated for each soil type at the site?

❑ ❑ For more complex sites with multiple treatment depth intervals and/or the need for multiple extraction wells, was subsurface airflow modeling conducted to determine well placement?

❑ ❑ Is wellhead vacuum determined from field pilot studies and between 3 and 100 inches of water?

❑ ❑ Is vapor extraction flow rate between 2 and 50 cfm per well?

❑ ❑ Are groundwater extraction rates sufficient to capture groundwater with constituent concentrations above cleanup goals?

❑ ❑ Will initial constituent vapor concentrations be monitored?

❑ ❑ Are required final constituent concentrations specified?

❑ ❑ Is a specified cleanup time required?

❑ ❑ Is soil volume to be treated estimated?

❑ ❑ Is the pore volume exchange rate calculated?

❑ ❑ Are discharge limits specified?

❑ ❑ Were site construction limitations considered?

❑ ❑ Is the well density appropriate, given the total area to be cleaned up and the radius of influence of each well?

❑ ❑ Is manifold piping design addressed and do extraction pipes slope toward the wells?

❑ ❑ Is vapor pretreatment specified?

❑ ❑ Is vapor treatment included, if warranted based on treatability study?

❑ ❑ Is the blower selected appropriate for the desired vacuum conditions?

❑	❑	Are appropriate instrumentation and controls specified, including means to monitor pressure (or vacuum), air/vapor flow rate, groundwater extraction rates, carbon dioxide and/or oxygen concentrations in extracted air, contaminant concentrations in extracted air, and temperature.

4. Optional DPE Components

Yes	No	
❑	❑	Are land surface seals proposed?
❑	❑	Are air injection or passive inlet wells proposed and are they appropriate to the site?

5. Operation And Monitoring Plans

Yes	No	
❑	❑	Does the CAP propose daily monitoring for at least 1 week of flow measurements, constituent concentrations, vacuum readings, and carbon dioxide and oxygen concentrations?
❑	❑	Does the CAP propose weekly to biweekly ongoing monitoring of these same parameters?

Checklist: Can Bioventing Be Used At This Site?

This checklist can help you evaluate the completeness of the CAP and to identify areas that require closer scrutiny. As you go through the CAP, answer the following questions. If the answer to several questions is no, you should request additional information to determine if bioventing will accomplish cleanup goals at the site.

1. Site Characteristics

Yes No

❑ ❑ Is the soil intrinsic permeability greater than 10^{-10} cm^2?

❑ ❑ Is the soil free of impermeable layers or other conditions that would disrupt air flow?

❑ ❑ Is the total heterotrophic bacteria count > 1,000 CFU/gram dry soil?

❑ ❑ Is soil pH between 6 and 8?

❑ ❑ Is the moisture content of soil in contaminated area between 40% to 85% of saturation?

❑ ❑ Is soil temperature between 10°C and 45°C during the proposed treatment season?

❑ ❑ Is the carbon:nitrogen:phosphorus ratio between 100:10:5 and 100:1:0.5?

❑ ❑ Is the depth to groundwater > 3 feet?[1]

2. Constituent Characteristics

Yes No

❑ ❑ Are constituents all sufficiently biodegradable?

❑ ❑ Is the concentration of Total Petroleum Hydrocarbon ≤ 25,000 ppm and heavy metals ≤ 2,500 ppm?

❑ ❑ If there are constituents with vapor pressures greater than 0.5 mm Hg, boiling ranges above 300°C, or Henry's law constants greater than 100 atm/mole fraction, has the CAP addressed the potential environmental impact of the volatilized constituents?

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[1] This parameter alone may not negate the use of bioventing. However, provisions for the construction of horizontal wells or trenches or for lowering the water table should be incorporated into the CAP.

3. Evaluation Of The Bioventing System Design

Yes No

- ❑ ❑ Will the induced air flow rates achieve cleanup in the time allotted for remediation in the CAP?
- ❑ ❑ Does the radius of influence (ROI) for the proposed extraction or injection wells fall in the range of 5 to 100 feet?
- ❑ ❑ Has the ROI been calculated for each soil type at the site?
- ❑ ❑ Is the type of well proposed (horizontal or vertical) appropriate for the site conditions present?
- ❑ ❑ Is the proposed well density appropriate, given the total area to be cleaned up and the radius of influence of each well?
- ❑ ❑ Do the proposed well screen intervals match soil conditions at the site?
- ❑ ❑ Are air injection wells proposed?
- ❑ ❑ Is the proposed air injection well design appropriate for this site?
- ❑ ❑ Is the selected blower appropriate for the desired vacuum conditions?

4. Optional Bioventing Components

Yes No

- ❑ ❑ If nutrient delivery systems will be needed, are designs for those systems provided?
- ❑ ❑ Are surface seals proposed?
- ❑ ❑ Are the proposed sealing materials appropriate for this site?
- ❑ ❑ Will groundwater depression be necessary?
- ❑ ❑ If groundwater depression is necessary, are the pumping wells correctly spaced?
- ❑ ❑ Is a vapor treatment system required?
- ❑ ❑ If a vapor treatment system is required, is the proposed system appropriate for the contaminant concentration at the site?

5. Operation And Monitoring Plans

Yes No

- ❑ ❑ Is monitoring of offgas vapors for VOC and carbon dioxide concentration proposed?
- ❑ ❑ Is subsurface soil sampling proposed for tracking constituent reduction and biodegradation conditions?
- ❑ ❑ Are manifold valving adjustments proposed for the start-up phase?
- ❑ ❑ Is nutrient addition (if necessary) proposed to be controlled on a periodic rather than continuous basis?

APPENDIX B

Standard Operating Procedures

STANDARD OPERATING PROCEDURE FOR DUAL-PHASE EXTRACTION PILOT TEST

1.0 PROCEDURES FOR VAPOR / LIQUID EXTRACTION

The following procedures and measurements will be used during the dual phase-extraction portion of the pilot test:

- Ensure that all field instrumentation is calibrated in accordance with the manufacturer's instructions. Field instrumentation includes:
    - Multigas meter for oxygen, carbon dioxide, carbon monoxide, methane (as % LEL) measurements
    - PID for TVH measurements
    - FID for TVH measurements
- Place DPE stinger in test well for groundwater and vapor extraction. The stinger will extend to near the bottom of the test well. Seal test wellhead so it is air-tight.
- Connect Dwyer Magnehelic (or similar) vacuum gauges onto the hose barb fittings at the top of the observation wells using Tygon tubing.
- Before extracting air from the test well, open the flow control valve (FCV) so that air can initially be pulled from atmosphere without loading a vacuum on the test system. Turn on the blower system and check to ensure that air is flowing freely through the FCV.
- While keeping an eye on the vacuum and flow rate instrumentation, slowly close the FCV until the vacuum is applied at the appropriate target for the current test step. Check the vacuum gauges both at the equipment and at the test wellhead.
- Using a set of Dwyer Magnehelic (or similar) gauges, the vacuum at the top of the wellheads will be periodically monitored and recorded.

2.0 PROCEDURES FOR MEASURING SOIL VAPOR CONDITIONS

This section describes the procedures for collecting baseline and subsequent soil vapor measurements using calibrated field instrumentation.

2.1 SAMPLE EQUIPMENT PURGING AND INSTRUMENT CONNECTION AT THE TEST WELL

Prior to collecting a soil vapor sample, the sampling equipment (e.g., tubing, valves, and instrumentation) will be purged of atmospheric air using the following procedures:

- Check that the purge pump is operating correctly without being connected to any tubing. Calibrate the instrumentation (multigas meter, PID, FID) in accordance with manufacturer's instructions.

- Connect Tygon tubing to the hose barb at the top of the test well and to the vacuum (inlet) end of the purge pump. Open the air-tight valve between the well cap and the hose barb on the top of the test well.

- Connect Tygon tubing to a "sampling tee" placed several feet downstream of the pressure side of the purge pump.

- With an eye on the vacuum gauge and tubing, turn on the sampling pump. After approximately 10 seconds, record the vacuum reading and note if the tubing is collapsed or if water is being drawn into the tubing.

- With the purge pump still running, connect a Tedlar bag or instrument (i.e., multigas meter, PID, and FID) to the sampling tee. Note that the instrument is connected in a manner to sample from a portion of the vapor stream and not to sample the entire vapor stream. (The meters have built-in air pumps to draw the vapor through the instrument. Directing all of the purge pump flow through the detector may damage it.)

2.2 SOIL VAPOR MONITORING AND SAMPLE COLLECTION AT THE TEST WELL

Soil vapor samples for monitoring with a field instrument or for laboratory analysis of GRO, BTEX, and DRO will be collected as described below. Purging between samples and method blanks will be used to control and monitor "bleeding" of contaminants into the sampling stream, which would compromise results.

Soil gas samples for field monitoring will be collected using one or more of 4 methods:

- Upstream of sampling pump in 1-liter Tedlar bags using an air-tight chamber
- Downstream of sampling pump in 1-liter Tedlar bags
- Downstream of sampling pump with direct connection of the instrument using a sampling tee
- Downstream of DPE blower (i.e., exhaust stack) using a sampling tee and sorbent tubes

Once a Tedlar bag is filled with the soil vapor sample, the dedicated pump on the instrument will be used to draw a sample into the instrument for analysis. A multigas meter will be used for oxygen, carbon dioxide, carbon monoxide, and methane (as % LEL) measurements. A PID and/or FID will be used for TVH measurements.

If there is insufficient oxygen in the undiluted soil vapor sample to facilitate direct measurement of TVH concentrations using an FID (i.e., “flame-outs”), then the FID will be equipped with a dilution tip to facilitate measurements of TVH concentrations. The field notes will indicate whether or not a dilution tip was used for a particular measurement with the FID.

Soil vapor samples to be submitted to the laboratory for GRO and BTEX analysis will be collected in 1-liter Tedlar bags using an air-tight chamber placed upstream of the sampling pump. Soil vapor samples will also be collected on sorbent media downstream of the DPE blower for GRO, BTEX, and DRO analysis. All vapor samples will be immediately stored in dry, cool, dark containers (e.g., coolers without ice) and shipped to laboratories for analysis using standard chain-of-custody (COC) procedures.

STANDARD OPERATING PROCEDURE FOR BIOVENTING PILOT TEST

1.0 PROCEDURES FOR AIR INJECTION

The following procedures and measurements will be used during the air-injection phase of the pilot test:

- Ensure that all field instrumentation is calibrated in accordance with the manufacturer's instructions. Field instrumentation includes:
    - Multigas meter for oxygen, carbon dioxide, carbon monoxide, methane (as % LEL) measurements
    - PID for TVH measurements
    - FID for TVH measurements
    - Helium detector for helium measurements
- Connect Tygon tubing onto the hose barb fittings at the top of the observation wells.
- Before injecting air into the test well, open the flow control valve (FCV) so that the initial surge of air can be safely diverted away from the test well. Turn on the blower system and check to ensure that air is flowing freely out of the FCV.
- While keeping an eye on the pressure and flow rate instrumentation, slowly close the FCV until all of the air is injected into the well (or injection flow rate is 20 CFM, whichever is less). Check the pressure gauge at the test wellhead to verify that it doesn't exceed the manufacturer's maximum rated pressure (e.g., 10 psi).
- Using a set of Dwyer Magnehelic (or similar) gauges, the pressure at the top of the wellheads will be periodically monitored and recorded.

2.0 PROCEDURES FOR MEASURING SOIL VAPOR CONDITIONS

This section describes the procedures for collecting baseline and subsequent soil vapor samples for analysis using calibrated field instrumentation.

2.1 PURGING OF SAMPLE EQUIPMENT

Prior to collecting a soil vapor sample for monitoring, the sampling equipment (e.g., tubing, valves, and instrumentation) will be purged of atmospheric air using the following procedures at observations wells:

- Confirm that the purge pump will operate without being connected to any tubing. Calibrate the instrumentation (multigas meter, PID, FID, helium monitor) in accordance with manufacturer's instructions.

- Connect the Tygon tubing at the hose barb at the top of the observation well to the vacuum end of the purge pump. Open the air-tight valve between the well cap and the hose barb on the top of the observation well.

- Connect Tygon tubing to a "sampling tee" placed several feet downstream of the pressure side of the purge pump.

- With an eye on the vacuum gauge and tubing, turn on the sampling pump. After approximately 10 seconds, record the vacuum reading and note if the tubing is collapsed or if water is being drawn into the tubing.

Sampling equipment will be purged of atmospheric air at the test well prior to monitoring using procedures similar to those above, with the exception that a purge pump will not be required due to the pressurization of the test well. Tygon tubing will be used to connect directly between a hose barb and valve at the test well and a downstream sampling tee to which a Tedlar bag or instrument will be connected. Note that the instrument is connected in a manner to sample from a portion of the vapor stream and not to sample the entire vapor stream. (The meters have built-in air pumps to draw the vapor through the instrument. Directing all of the purge pump flow through the meter may damage it.).

2.2 SOIL VAPOR MONITORING

Following purging of sampling equipment with soil vapor with conditions representative of subsurface conditions at a particular location, the following monitoring and sampling procedures will be employed:

- With the purge pump still running, connect a Tedlar bag or instrument to the sampling tee.

- The dedicated pump on the instrument will be used to draw a sample into the instrument for analysis. The TVH instrument (FID and/or PID) will be calibrated to hexane in accordance with manufacturer's instructions. The multigas and helium instruments will be calibrated to a combination gas and helium standard, respectively, in accordance with manufacturer's recommendations for those instruments.

- If there is insufficient oxygen in the undiluted soil vapor sample to facilitate direct measurement of TVH concentrations using an FID (i.e., “flame-outs”), then the FID will be equipped with a dilution tip to facilitate measurements of TVH concentrations. The field notes will indicate whether or not a dilution tip was used for a particular measurement with the FID.

APPENDIX C

Field Forms

DUAL PHASE EXTRACTION PILOT TEST FIELD FORM
KINDER MORGAN - LAUREL STATION

Test Start: ____________________ **Page:** ________ **of** ________
Date: ____________________ **Field Personnel:** ______________________________

	Time												
	Barometric Pressure (in wc)												
DPE Blower	Blower Vacuum (in Hg)												
	Temp. (°F)												
	Generator Engine Hours (hours)												
	Flow from Well (in wc diff press)												
	Flow from Well (lfm)												
	Flow from Well (cfm)												
	Dilution Flow (cfm)												
	Exhaust Flow (cfm)												
	Vapor CO Conc (ppm)												
	Vapor CO2 Conc (ppm)												
	Vapor LEL (CH4) Conc (%)												
	Vapor O2 Conc (%)												
	Vapor TVH - FID (ppm)												
	Vapor TVH - PID (ppm)												
	Extracted GW Volume (gallons)												
Test Well	MW-9/10 Stinger Vacuum (in Hg)												
	MW-9/10 Casing Vacuum (in Hg)												
	MW-9/10 Vapor CO Conc (ppm)												
	MW-9/10 Vapor CO2 Conc (ppm)												
	MW-9/10 Vapor LEL (CH4) Conc (%)												
	MW-9/10 Vapor O2 Conc (%)												
	MW-9/10 Vapor TVH PID Conc (ppm)												
	MW-9/10 Vapor TVH FID Conc (ppm)												

Monitoring Points	**Point**	**Distance (ft - dir)**													
	MW-1		Vac (in wc)												
			DTW (ft below TOC)												
	MW-2		Vac (in wc)												
			DTW (ft below TOC)												
	MW-5		Vac (in wc)												
			DTW (ft below TOC)												
	MW-7		Vac (in wc)												
			DTW (ft below TOC)												
	SW-4		Vac (in wc)												
			DTW (ft below TOC)												
	SW-5		Vac (in wc)												
			DTW (ft below TOC)												
	MW-9/10		Vac (in wc)												
			DTW (ft below TOC)												

Comments:

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BIOVENTING PILOT TEST FIELD FORM
KINDER MORGAN – LAUREL STATION

FIELD PERSONNEL: DATE:
TEST START:
TEST TYPE (Circle One): BASELINE SOIL GAS / IN-SITU RESPIRATION / OXYGEN-PRESSURE INFLUENCE

Monitoring Point	Time	Flow Air (in wc)	Flow Air (cfm)	Flow He (cfm)	Press (psi)	Temp (°F)	Gen Eng Hrs	O2 (%)	CO2 (ppm)	CH4 (LEL) (%)	TVH PID (ppm)	TVH FID (ppm)	He Conc (ppm)
BV Blower													
MW-9 / 10 (circle one)													

Monitoring Point	Time	Press (in wc)	CO (ppm)	CO2 (ppm)	LEL (CH4) (%)	O2 (%)	He (ppm)	TVH PID (ppm)	TVH FID (ppm)
MW-1									
MW-2									
MW-5									
MW-7									
SW-4									
SW-5									
MW-9									
MW-10									