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CHEVRON ENVIRONMENTAL MANAGEMENT COMPANY

PUBLIC REVIEW DRAFT FINAL FEASIBILITY STUDY REPORT

Former Unocal Edmonds Bulk Fuel Terminal
Edmonds, Washington

June 16, 2017

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ACRONYMS AND ABBREVIATIONS

ABOx	anaerobic bio-oxidation
ABS	acrylonitrile butadiene styrene
amsl	above mean sea level
AO	Agreed Order
APH	air-phase petroleum hydrocarbons
Arcadis	Arcadis U.S., Inc.
AST	aboveground storage tank
bgs	below ground surface
BNSF	BNSF Railway
Chevron	Chevron Environmental Management Company
COC	constituent of concern
Comp. Plan	Edmonds Comprehensive Plan
cPAH	carcinogenic polycyclic aromatic hydrocarbon
Csat	residual saturation concentrations
CSID	Cleanup Site Identification Number
CSL	cleanup screening level
CSM	conceptual site model
CUL	cleanup level
CULs and RELs Report	Cleanup Levels and Remediation Levels Report
cy	cubic yards
DB-1	Detention Basin 1
DB-2	Detention Basin 2
DCA	disproportionate cost analysis
DPE	dual-phase extraction
Draft FS Addendum	Proposed Addendum to the Draft FS Report
Draft FS Report	Draft Feasibility Study Report
Draft Final FS Report	Draft Final Feasibility Study Report
DRO	diesel range organics
EC	Environmental covenant
ECAC	Edmonds Citizens Awareness Committee

ECC	Edmonds City Code
Ecology	Washington State Department of Ecology
Edmonds Crossing EIS	SR 104 Edmonds Crossing, Volume 1 – Preliminary Final Environmental Impact Statement and Preliminary Final Section 4(f) Evaluation
EIMS	Environmental Information Management System
Final CSM	Final Conceptual Site Model
Final Phase II RI Report	Final Phase II Remedial Implementation As-Built Report
Final SICR	Final 2011 Site Investigation Completion Report
fish hatchery	Willow Creek Fish Hatchery
former Unocal property	former Unocal Edmonds Bulk Fuel Terminal, located at 11720 Unoco Road, Edmonds, Washington
FSID	Facility Site Identification Number
GAC	granular activated carbon
gpm	gallons per minute
GRO	gasoline range organics
HI	hazard index
HO	heavy oil range organics
2007 IAWP	Interim Action Report -Work Plan for 2007 Lower Yard Interim Action
IAWP	Interim Action Work Plan
IHS	indicator hazardous substance
IRA	interim remedial action
ISS	in-situ solidification
ITRC	Interstate Technology Regulatory Council
kg	kilogram
LAET	lowest apparent effects threshold
LNAPL	light non-aqueous phase liquid
LRL	laboratory reporting limit
MFA	Maul, Foster, and Alongi
mg/day	milligrams per day
mg/kg	milligrams per kilogram
MNA	monitored natural attenuation
MP-1	Master Plan 1
MP-2	Master Plan Hillside Development, District 2

MTCA	Model Toxics Control Act
NPDES	National Pollutant Discharge Elimination System
NRWQC	National Recommended Water Quality Criteria
NTR	National Toxics Rule
OWS	oil/water separator
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
POC	point of compliance
Point Edwards	Point Edwards condominium complex
PVC	polyvinyl chloride
REL	remediation level
RIWP	Remedial Investigation Work Plan
ROI	radius of influence
SIGMR	2008 Additional Site Investigation and Groundwater Monitoring Report
Site	the areas of the Lower Yard and the Upper Yard where a hazardous substance has been located
SLR	SLR International, Corp.
SMP	Shoreline Master Program
SMS	Sediment Management Standards
SQS	Sediment Quality Standards
SRI	supplemental remedial investigation
SVE	soil vapor extraction
TEE	terrestrial ecological evaluation
total cPAH TEQ	total cPAHs adjusted for toxicity
TPH	total petroleum hydrocarbons
Unocal	Union Oil Company of California
USACE	U.S. Army Corps of Engineers
UST	underground storage tank
VOC	volatile organic compound
VPH	volatile petroleum hydrocarbon
WAC	Washington Administrative Code
WDFW	Washington Department of Fish & Wildlife
WQS	Washington State Water Quality Standards
WSDOT	Washington State Department of Transportation

°F	degrees Fahrenheit
$^{0}/_{00}$	parts per thousand
µg/kg	micrograms per kilogram
µg/L	micrograms per liter
µg/m^3	micrograms per cubic meter

1 INTRODUCTION

On behalf of Chevron Environmental Management Company (Chevron), Arcadis U.S., Inc. (Arcadis) prepared this Draft Final Feasibility Study Report (Draft Final FS Report) for the former Union Oil Company of California (Unocal) Edmonds Bulk Fuel Terminal, located at 11720 Unoco Road, Edmonds, Washington (former Unocal property; Figure 1-1). Agreed Order (AO) No. DE 4460 with Washington State Department of Ecology (Ecology) requires Chevron to conduct a remedial action to remediate soil, groundwater, and sediment; monitor groundwater in the Lower Yard; prepare a feasibility study report; and prepare a draft Cleanup Action Plan. This Draft Final FS Report was prepared as required by AO No. DE4460.

The former Unocal property is formally known as Unocal Edmonds Bulk Fuel Terminal 0178 in Ecology's database. Identifiers are

- Facility Site Identification Number (FSID): 2720
- Cleanup Site Identification Number (CSID): 5180

Ecology's website for the former Unocal property is available at https://fortress.wa.gov/ecy/gsp/Sitepage.aspx?csid=5180 and documents available electronically can be accessed by clicking View Electronic Documents in the sidebar (or clicking on the preceding hyperlink). Documents are also available at the public repository at Edmonds Public Library. The full file can be reviewed at Ecology's Northwest Regional Office in Bellevue (phone 425-649-7000).

Data collected during investigations of the former Unocal property are available in Ecology's Environmental Information Management System (EIMS) database. (See Study IDs UNOCAL01 and UNOCAL 02).

Chevron's website for the former Unocal property is at http://www.unocaledmonds.info/.

1.1 Final Feasibility Study Report Background

As defined in AO No. DE 4460, the former Unocal property consists of three areas: Upper Yard ("Parcel B and Parcel III" in AO), Lower Yard ("Parcel A" in AO), and Willow Creek Fish Hatchery (described as "Lot 1" in AO) (fish hatchery). The Upper Yard and Lower Yard were areas of operation for the former terminal. Although the fish hatchery was included in AO No. DE 4460, it was not used for operations or storage by Unocal and remained undeveloped until 1985 when the fish hatchery was constructed. The recent remediation history at former Unocal property is described below. The former Unocal property layout and areas of the Lower Yard are shown on Figure 1-2.

Remediation of the Upper Yard began in 2001. In 2003, upon the completion of remedial actions, Ecology issued a letter (Ecology 2003) indicating that the Upper Yard Interim Action had met direct contact for soil cleanup criteria as specified in the Interim Action Report, Unocal Edmonds Terminal (Maul, Foster, and Alongi [MFA], 2001a). Unocal sold the Upper Yard to Point Edwards, LLC in October 2003.

The southeast portion of the former Unocal property, near the entrance to the Lower Yard, was leased by Unocal to the Edmonds Chapter of Trout Unlimited in 1984. In 1985, an easement was issued by Unocal for development of the property as a fish hatchery. This property is now owned by the City of Edmonds.

The Lower Yard is currently owned by Unocal. The Lower Yard is a 22-acre vacant property, with no permanent aboveground structures. Unocal and the Washington State Department of Transportation (WSDOT) have entered into a purchase and sale agreement in 2005 that provides for a future transfer of the Lower Yard to the WSDOT. In June 2007, Unocal entered into AO No. DE 4460 with Ecology to conduct interim remedial actions (IRAs) at the Lower Yard. IRAs were conducted at the Lower Yard in two phases in 2007 and 2008. After completion of the IRAs, localized areas of known impacted soil with concentrations exceeding cleanup levels (CULs) remain along the WSDOT stormwater line and near Detention Basin 2 (DB-2). These areas are shown on Figure 1-2.

This Draft Final FS Report discusses the cleanup alternatives of the WSDOT stormwater line and DB-2 impacted soil and associated groundwater impacts.

To address those localized areas of known impacted soil, Chevron submitted a Draft Feasibility Study Report (Draft FS Report; Arcadis 2014a) to Ecology on January 30, 2014. Ecology reviewed the Draft FS Report (Arcadis 2014a) and provided comments on May 21, 2014 (Ecology 2014a). Chevron submitted a Proposed Addendum to the Draft FS Report (Draft FS Addendum; Arcadis 2014b) on August 11, 2014 proposing Remedial Alternative 6 (combination of excavation and dual-phase extraction [DPE] treatment) as a preferred remedy for the remaining impacts at the former Unocal property. Ecology reviewed the Draft FS Addendum (Arcadis 2014b) and provided comments in a letter dated September 23, 2014 (Ecology 2014b). Ecology also asked Chevron to implement Remedial Alternative 6 as a continuation of the interim actions required by AO No. DE 4460 in the letter dated September 23, 2014. Chevron submitted for public comment a public review draft Interim Action Work Plan (IAWP) including Ecology revisions on July 6, 2015 (Arcadis 2015a); a final IAWP was submitted to Ecology on July 19, 2016 (Arcadis 2016).

This Draft Final FS Report incorporates revisions to the Draft FS Report and Draft FS Addendum in response to Ecology's comments, as well as applicable changes relative to public comments and Ecology revision of IAWP (Arcadis 2014a, 2014b, 2016; Ecology 2014a, 2014b). This Draft Final FS Report evaluates the feasibility and effectiveness of cleanup action alternatives for remediation of hazardous substances in the Lower Yard of the former Unocal property. Ecology will review the alternatives presented in this Draft Final FS Report and select a final cleanup remedy based upon the minimum requirements and procedures specified in Washington Administrative Code (WAC) 173-340-360, Selection of Cleanup Actions, in consideration of Ecology's Expectations for Cleanup Action Alternatives specified in WAC 173-340-370, and all other parts of the Model Toxics Control Act (MTCA) Cleanup Regulation, Ch. 173-340 WAC pertinent to cleanup of the former Unocal property.

1.2 Previous Submittals and Historical Data

The specific data and documents referred to in this Draft Final FS Report are listed below in reverse chronological order:

- *Draft FS Addendum (Arcadis 2014b)*. Evaluates Remedial Alternative 6, excavation to address impacts near DB-2 and soil and groundwater treatment using DPE to address impacts near the WSDOT stormwater line.
- *Final Conceptual Site Model (Final CSM; Arcadis 2013a)*. Evaluates remaining impacts, potential fate and transport of the remaining impacts, and potential receptors and exposure pathways.

- *Cleanup Levels and Remediation Levels Report (CULs and RELs Report; Arcadis 2013b)*. Evaluates and confirms the CULs and remediation levels (RELs) for soil, groundwater, and surface water.
- *Final Feasibility Study Work Plan (Arcadis 2012b)*. Summarizes investigation activities implemented in August 2012, which included additional groundwater monitoring well installation, additional groundwater sampling, and sediment sampling.
- *Final 2011 Site Investigation Completion Report (Final SICR; Arcadis 2012a)*. Incorporates a tidal study, pumping tests, and investigation of soil conditions near DB-2.
- *Final Phase II Remedial Implementation As-Built Report (Final Phase II RI Report; Arcadis 2010a)*. Documents the final compliance soil samples collected in 2008 during remedial excavation activities.
- *Phase I Remedial Implementation As-Built Report (Arcadis 2009a)*. Documents the final compliance soil samples collected in 2007/2008 during remedial excavation activities.
- *2008 Additional Site Investigation and Groundwater Monitoring Report (SIGMR; Arcadis 2010b).* Discusses site investigation and groundwater monitoring activities that were conducted near the WSDOT stormwater line and the former asphalt warehouse.

Documents related to remedial actions and investigation conducted under prior AO No. DE 4460 are not included in the list above; however, the references are provided in Section 10.

1.3 Final Feasibility Study Report Organization

The remaining sections of this Draft Final FS Report are summarized below:

- Section 2 – *Background*. Describes the three areas of the former Unocal property (Upper Yard, Lower Yard, and fish hatchery), historical facilities, operations, and releases. Summarizes historical property ownership and regulatory actions including AO No. DE 4460.
- Section 3 – *Nature and Extent of Contamination*. Describes constituents of concern (COCs) and remaining soil and groundwater impacts at the former Unocal property.
- Section 4 – *Conceptual Site Model*. Evaluates fate and transport, potential receptors, and potential exposure pathways.
- Section 5 – *Cleanup Standards*. Describes cleanup standards and development of CULs and RELS for sediment, soil, groundwater, and surface water.
- Section 6 – *Development of Remedial Alternatives*. Identifies and describes the potentially applicable remediation technology types considered for the WSDOT stormwater line and DB-2 impacted soil and associated groundwater impacts.
- Section 7 – *Evaluation of Remedial Alternatives*. Evaluates the proposed remedial alternatives based on applicable regulations, cost analysis, expectations, and implementation.
- Section 8 – *Recommended Remedial Alternative*. Presents the recommended remedial alternative for the WSDOT stormwater line and DB-2 impacted soil and associated groundwater impacts.
- Section 9 – *Conclusion*. Presents the conclusion of this Draft Final FS Report.

- Section 10 – *Schedule*. Discusses the activities that will be conducted following Ecology's approval of this Drat Final FS Report.
- Section 11 – *References*. Lists the references cited throughout this Draft Final FS Report.

2 BACKGROUND

This section describes the three areas of the former Unocal property and summarizes historical activities conducted at the property.

2.1 Former Unocal Property Description

As defined in AO No. DE 4460, the former Unocal property consists of three areas: Upper Yard ("Parcel B and Parcel III"), Lower Yard ("Parcel A"), and the fish hatchery ("Lot 1"). Sections 2.1.1, 2.1.2, and 2.1.3 present background information for the Upper Yard, Lower Yard, and fish hatchery. Table 2-1 presents a chronologic summary of investigation activities at the former Unocal property.

2.1.1 Upper Yard

The approximately 25-acre Upper Yard is located to the south of the Lower Yard. East of the Upper Yard is the fish hatchery and State Route 104. Beyond State Route 104 are residential and commercial areas in Edmonds, Washington. South of the Upper Yard is the residential area of Woodway, Washington. To the west of the Upper Yard are the BNSF Railway (BNSF) right-of way and, west of the right-of-way, the Port of Edmonds Marina, a public park, and Puget Sound. The Upper Yard is shown on Figure 1-2.

The surface elevation of the Upper Yard ranges from approximately 20 to 100 feet above mean sea level (amsl) based on North American Vertical Datum of 1988. The majority of the Upper Yard is approximately 90 to 100 feet amsl. The northern boundary of the Upper Yard is approximately 75 to 80 feet higher than the majority of the Lower Yard. The land declines steeply from the northern boundary of the Upper Yard to the Lower Yard.

Remediation of the Upper Yard began in 2001. In 2003, upon the completion of remedial actions described in Section 2.6.2, Ecology issued a letter (Ecology 2003) confirming that Unocal successfully completed the cleanup actions identified for the Edmonds Upper Yard and as a result of these activities, the Upper Yard is suitable for residential use with regard to the soil direct contact pathway.

Unocal sold the Upper Yard to Point Edwards, LLC in October 2003. Currently, this area is occupied by the Point Edwards condominium complex (Point Edwards). According to the City of Edmonds zoning plan dated April 2015, this area is zoned Master Plan 1 (MP-1), which allows for residential and commercial uses. Point Edwards is fully developed, including underground and overhead utilities, a stormwater system, several high-occupancy residential buildings, administrative buildings, parking areas, landscaping areas, and an outdoor walking path. The slope from the Point Edwards to the Lower Yard is covered by vegetation planted by Point Edwards, LLC, during the construction of Point Edwards.

Point Edwards is served by a stormwater system owned by Point Edwards, LLC that conveys stormwater to a sedimentation/detention pond located in the northern part of the former Upper Yard. This system connects the Point Edwards stormwater retention pond and the tidal basin leading to Puget Sound via a 36-inch-diameter underground drainpipe that runs beneath the Lower Yard and discharges into the tidal basin. The Point Edwards storm drain line is made of corrugated acrylonitrile butadiene styrene (ABS) plastic, is located approximately 3 to 5 feet below ground surface (bgs), and runs parallel to the WSDOT stormwater line that runs across the Lower Yard.

2.1.2 Lower Yard

The approximately 22-acre Lower Yard surrounds the Upper Yard to the north, east, and west, and is currently owned by Unocal. Unocal and WSDOT have entered into a purchase and sale agreement that provides for WSDOT to assume ownership of the Lower Yard after Capital Remediation Work has been completed. The Lower Yard and its subdivisions are shown on Figure 1-2 and Figure 1-3. The Lower Yard is approximately 160 feet from Puget Sound at its closest point.

The surface elevation of the majority of the Lower Yard ranges from approximately 10 to 19 feet amsl and is relatively flat. However, the southeastern-most portion of the Lower Yard, on Unoco Road near the Lower Yard entrance, is approximately 35 feet amsl. Upper Unoco Road continues along the southern property boundary, drops in elevation, and turns into lower Unoco Road at the south-central portion of the Lower Yard. From upper Unoco Road near the Lower Yard entrance, the ground surface drops in elevation to the north from approximately 35 to 16 feet amsl in the south-central portion of the Lower Yard. On the south side of upper Unoco Road is a paved area along the property boundary.

Willow Creek runs along the northern portion of the western boundary and the entire eastern boundary of the Lower Yard. Willow Creek is approximately 10 feet wide and is underlain by silt and sand material. The creek banks on the property boundary are steeply sloped and vegetated with native and non-native vegetation. Willow Creek is tidally influenced. At high tide, water flows from Puget Sound upstream into Edmonds Marsh; at low tide, water drains from Edmonds Marsh into Puget Sound. Water depths in Willow Creek vary from 0 to 4 feet deep, depending on season and tidal cycles (Arcadis 2012a). Additional surface-water information for the Lower Yard is provided in Section 2.4.2.5.

The Lower Yard is currently a vacant property, with no permanent aboveground structures. A temporary storage shed, a concrete pad and a system enclosure are located along lower Unoco Road in the central portion of the Lower Yard. The ground surface is compact dirt, gravel, and natural vegetative cover. The Lower Yard use is described is Section 2.1.5.

Twelve storm drains collect surface-water runoff. The collected water is conveyed via gravity flow to DB-2. Stormwater also collects in Detention Basin 1 (DB-1) from direct precipitation and overland flow. DB-1 and DB-2 form depressions approximately 6 and 4 feet deep, respectively, and are described below:

- DB-1 is located in the east/northeast Lower Yard and west/northwest Lower Yard. DB-1 is bounded to the northwest, northeast, and southeast by a manmade berm. The berm runs along the eastern property boundary, adjacent to Willow Creek. DB-1 acts as a retention pond for overflow from DB-2 during storm events. DB-1 is an unlined pond with one aboveground pump and a piping system to the DB-2 outfall on the bank of Willow Creek. To maintain storage capacity, water levels are monitored in DB1 and water is periodically pumped from DB1 into DB2 and discharged from DB-2.
- DB-2 is located between the west/northwest Lower Yard and central Lower Yard, south of DB-1. DB-2 serves as a stormwater collection area from which Lower Yard stormwater is discharged into Willow Creek. DB-2 has an impermeable liner, two submersible pumps, and a piping system to the DB-2 outfall.

A WSDOT stormwater line crosses beneath the Lower Yard and discharges stormwater collected from State Route 104 to Puget Sound. According to a 1971 drainage plan (Washington State Highway Commission 1971), the WSDOT stormwater line is composed of sections of increasing diameter from 48 inches at the eastern part of the Lower Yard to 72 inches at the western part of the Lower Yard. The WSDOT stormwater line is made of asphalt-coated corrugated metal and crosses the Lower Yard at depths of 9 to 12 feet bgs to the top of the pipe. The WSDOT stormwater line generally runs along the northern edge of lower Unoco Road and trends west across the Lower Yard to the tidal basin leading to Puget Sound. The WSDOT stormwater line was installed between 1972 and 1975 and is a major stormwater drainage structure for State Route 104; WSDOT evaluated the stormwater line in 2011 and found its integrity to be sound, with no visible signs of deterioration.

In addition, a separate stormwater line connects the Point Edwards stormwater retention pond and the tidal basin leading to Puget Sound. For the purposes of this document, to distinguish the Point Edwards stormwater line from the WSDOT stormwater line, it is referred to as a “storm drain line” at the approximate location shown on Figure 1-2. The Point Edwards storm drain line runs parallel to the WSDOT stormwater line where the Point Edwards storm drain line crosses beneath the Lower Yard. The Point Edwards storm drain line is made of corrugated ABS plastic and crosses the Lower Yard at depths of approximately 3 to 5 feet bgs.

The only paved areas of the Lower Yard are Unoco Road and the paved area to the south of upper Unoco Road. The majority of the Lower Yard is covered with 3-inch quarry spall stones, silty sand, and gravel backfill material. Vegetation such as grasses, alder saplings, and native blackberries have begun to reclaim the Lower Yard around its perimeter and throughout most of the southeast Lower Yard. Occasionally, gorse (*Ulex Europeus*) growth is encountered in the Lower Yard. Gorse is a weed that displaces native plants. Gorse removal activities were conducted in the Lower Yard in December 2014 as directed by the Snohomish County Noxious Weed Control Board in a letter dated April 1, 2014.

The berm surrounding DB-1 is covered by native vegetation.

Upon completion of 2008 interim action activities, the banks of Willow Creek were restored pursuant to the Hydraulic Project Approval 112524-1 issued on April 24, 2008 by the Washington Department of Fish & Wildlife (WDFW). Native estuarine wetlands species were planted in the floodplain areas of the creek, comprising areas not in the creek channel but below the high water mark. In addition to the floodplain species, several trees, shrubs, and grasses (meant to stabilize and protect the bank from erosion and invasive species) were planted on the Lower Yard side of the creek, above the high water line. The plantings were installed through cuts made in BioNet, a woven biodegradable straw mat material used as an erosion control measure, at a density and pattern designated by a wetland biologist.

2.1.3 Willow Creek Fish Hatchery

The southeast portion of the former Unocal property, near the entrance to the Lower Yard, is currently the Willow Creek Fish Hatchery and is owned by the City of Edmonds. The fish hatchery, formerly known as the Deer Creek Fish Hatchery, is shown on Figure 1-2.

The fish hatchery currently comprises an approximately 50-foot-long by 20-foot-wide building, an approximately 40-foot-diameter circular fish rearing pond, and a small pump house. The remainder of the developed property is composed of a compact gravel driveway and grass and landscaped areas. Surface-water runoff from the property drains directly into Willow Creek.

Although the fish hatchery property was included in AO No. DE 4460, it was not used for operations or storage by Unocal and remained undeveloped until 1985 when the fish hatchery was constructed. Unocal leased this part of the former Unocal property to the Edmonds Chapter of Trout Unlimited in 1984. In 1985, Unocal issued an easement for development of this part of the property as a fish hatchery. The fish hatchery became the property of the City of Edmonds in 2005.

2.1.4 Site Definition

The Site, as defined by MTCA, means: “any building, structure, installation, equipment, pipe or pipeline (including any pipe into a sewer or publicly owned treatment works), well, pit, pond, lagoon, impoundment, ditch, landfill, storage container, motor vehicle, rolling stock, vessel, or aircraft; or any site or area where a hazardous substance, other than a consumer product in consumer use, has been deposited, stored, disposed of, or placed, or otherwise come to be located.” Historical information was reviewed prior to development of the Remedial Investigation Work Plan (RIWP; EMCON 1995), which indicated that field investigations of the fish hatchery property were not warranted. Therefore, in coordination with Ecology, the fish hatchery property was not further evaluated.

Therefore, at the former Unocal property, the Site (See Figure 1-3) is now comprised of the areas of the Lower Yard and the Upper Yard where a hazardous substance has come to be located. The fish hatchery will no longer be included as part of the Site in future Orders and Decrees as a result of the review of historical information (See Background History Report, EMCON 1994) and a determination that the area was not used for operations or storage by Unocal.

2.1.5 Land Use and Zoning

City of Edmonds land use policies and regulations affecting the Lower Yard are set out in the Edmonds Comprehensive Plan, December, 2016 (Comp. Plan), the Edmonds City Code (ECC) and, for portions of the Lower Yard within the jurisdiction of the State Shorelines Act, the Edmonds Shoreline Master Program (SMP). The Comp. Plan assigns the land use plan designation “Master Planned Development” to the Lower Yard and identifies the Lower Yard as the future location of Edmonds Crossing, a multimodal transportation center. The ECC zones the Lower Yard "Master Plan Hillside Development, District 2” (MP-2) as shown on the Edmonds Zoning Map, April 2015. A multi-modal transportation facility is a permitted use in the MP-2 zone as are mixed residential and commercial uses. Residential use is prohibited on the ground floor of any building constructed on the Lower Yard.

The extreme southeastern part of the Lower Yard near the fish hatchery and the fish hatchery were regulated by the SMP that was in effect until May 10, 2017. The SMP designated these areas “Natural Environment”. On April 26, 2017, Ecology granted final approval of amendments to the SMP. The updated SMP took effect May 10, 2017 (Updated SMP), subject to a 60-day appeal period. The Updated SMP adds the land within 200 feet upland from the ordinary high water mark of tidally influenced portions of the Edmonds Marsh (generally, the west half of the Marsh) to the portions of the Lower Yard subject to the Updated SMP. These added shoreline areas are designated Urban Mixed Use IV. Residential uses are not permitted within areas designated Mixed Use IV.

The Upper Yard is zoned MP-1, which allows for residential and commercial uses. Properties surrounding the Lower Yard consist of various commercial, recreational, and residential sites. The property immediately north-northeast of the former Unocal property (Edmonds Marsh) is designated open space. Farther north, Harbor Square (a commercial development) is zoned commercial general. Land use in the town of Woodway, located immediately south of the Site, is primarily single-family residential. The properties east of the Lower Yard, to the east of State Route 104, are zoned under public use, multifamily, and single-family residential designations. The BNSF right of way, Port of Edmonds Marina, Marina Beach Park, and Puget Sound shoreline to the west-northwest of the Site are zoned commercial waterfront.

2.2 Site History

Unocal operated the terminal from 1923 to 1991. Petroleum products were brought to the terminal on ships, pumped to storage tanks in the Upper Yard, and loaded from the storage tanks into rail cars and trucks for delivery to customers. In addition, an asphalt plant operated at the terminal from 1953 to the late 1970s. From 1991 to 2003, the Lower Yard was only used by Unocal for office purposes. After termination of the terminal activities, Unocal entered into AO No. DE92TC-N328 with Ecology in 1993 and then AO No. DE 4460 in 2007 (superseded AO No. DE92TC-N328). Remedial actions were conducted under those AOs in 2001, 2003, 2007, and 2008.

2.2.1 Lower Yard Creation

Prior to 1923, when the main facility structures of the terminal were constructed, the area of the Lower Yard was tidal marshland. To provide usable working and building surfaces, backfill material was placed over the marsh, presumably beginning in the early 1920s. As seen in aerial photos of the Site (EMCON 1994), in 1947 only the southwest Lower Yard area was developed and contained structures and facilities.[1] The central, eastern, northeastern, and southeastern portions of the Lower Yard were undeveloped marshland at this time. By 1955, backfilled areas, structures, and facilities had expanded to the central area of the Lower Yard. The northeastern and southeastern portions of the Lower Yard were still undeveloped marshland. By 1965, the Lower Yard was filled and developed in all areas except in the southeast, and remained so throughout facility operations.

2.2.2 Historical Facilities and Operations

Historical operations at the Site conducted by Unocal included the storage and distribution of petroleum products, and the production, storage, and distribution of asphalt products. Historical facility operations areas and structures discussed in this section are presented on Figure 2-1.

Facilities at the Site included a loading/unloading dock in Puget Sound, railcar unloading areas, an aboveground tank farm, piping systems, an air-blown asphalt plant, asphalt warehouse, laboratory, truck loading racks, oil/water separators (OWSs), underground storage tanks (USTs), and stormwater and sewer systems (EMCON 1994). A series of aboveground and underground pipelines, valves, and

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[1] Historical aerial photographs are available through Ecology's Unocal Edmonds website under View Electronic Documents. See Group: Technical Reports, 01/26/2012.

manifolds were used at the Site to move product between areas of receipt, storage, blending, packaging, and distribution in the Upper Yard and Lower Yard. The product pipes and valves were made of steel and ranged in diameter from 1.5 to 12 inches. Product was received at the terminal and distributed via barge, ship, tanker, railcar, truck, drums, and cartons.

The southeastern Lower Yard was briefly used as a waste soil stockpile area for material removed from two local Unocal service stations (EMCON 1994).

Detailed operations and historical activities are presented in the Background History Report (EMCON 1994).

2.2.2.1 Former Upper Yard Facilities

Construction of the Upper Yard began in 1923, along with the main terminal structures and loading dock. The Upper Yard consisted of 23 aboveground storage tanks (ASTs), one UST, abovegrade piping, a garage, and a warehouse. Abovegrade piping carried petroleum materials up the hill from the loading dock in the Lower Yard to the ASTs in the Upper Yard. The ASTs ranged in capacity from 9,726 to 3,491,754 gallons. The ASTs in the Upper Yard were primarily used to store and blend products.

The Upper Yard ASTs were contained within soil berms coated with emulsified asphalt. Except for the bermed areas and paved roads, the Upper Yard had a gravel surface. Precipitation infiltrated the gravel, and stormwater was collected in catch basins that drained to an OWS in the Lower Yard (EMCON 1994).

The UST located in the Upper Yard was removed in 1984; its installation date and intended use are unknown.

2.2.2.2 Lower Yard Facilities

The Lower Yard facilities are presented on Figure 2-1 and listed below.

- DB-1 and DB-2
- Former loading dock and pier
- Former railcar unloading areas
- Former air-blown asphalt plant
- Former asphalt warehouse
- Former truck loading racks
- Former OWSs
- Former USTs.

Of those, only DB-1 and DB-2 are still present. Each of the facilities are described in the following sections.

Detention Basins No.1 and No.2

DB-1 is located in the East/Northeast Lower Yard and is approximately 200 by 600 feet in size. DB-1 was constructed in 1952; the original layout was an L-shape with a leg extending south along the northwestern property boundary. DB-1 was constructed by dredging sediment from the northeastern and northwestern site perimeters to create the bermed detention basin, and create a drainage channel (Willow Creek) to carry the flow from small creeks draining surface water from upland areas in the city of Edmonds.

In the late 1960s, DB-1 was modified by partitioning off the southern leg and creating an impoundment area to contain refinery and asphalt sludges and runoff (EMCON 1994). The impoundment area became known as the “slops pond.” In 1974, the slops pond was backfilled and DB-2 was constructed on top of the slops pond. DB-2 is fully lined with polyvinyl chloride (PVC) liner material and contains outfall pumps that discharge to Willow Creek (EMCON 1994).

Former Loading Dock and Pier

Unocal owned and operated an 860-foot long pier extending westward into Puget Sound from the southwest corner of the Lower Yard and terminating in a 275-foot long loading dock (See Figure 1-1). The loading dock received daily deliveries of gasoline, fuel oils, and crude oils from tanker ships in Puget Sound (EMCON 1994), and transferred the deliveries to the Upper Yard ASTs via a piping system. The piping from the dock and pier passed over the BNSF tracks via a trestle at the end of the pier. The dock, pier, and trestle were constructed in 1923. The dock facilities included a system of pipes and valves, including ten 2- to 12-inch-diameter steel pipes. Pipelines from the dock ran aboveground to the shoreline manifold area, in the southwest corner of the Lower Yard. The piping then ran southeast up the hillside to the southwest portion of the Upper Yard, as well as northeast along the toe of the hillside to the north-central portion of the Upper Yard, to the Upper Yard ASTs.

As described in Section 3.6, a sediment investigation was conducted at the former loading dock and pier location. The chemical analytical results showed compliance with Ecology’s Sediment Quality Standards (SQS), presented in the Sediment Management Standards (SMS) at WAC 173-204-320; therefore, the marine sediment is uncontaminated and this area is not considered part of the Site.

Former Railcar Unloading Areas

Two railcar loading/unloading areas were located in the southwest Lower Yard. The southern railcar loading/unloading area was constructed in the early 1930s. The time of construction of the northern railcar unloading area is unknown. Railcar service to the Lower Yard was discontinued in the 1960s and the unloading areas were dismantled in 1974 (EMCON 1994).

The southern loading/unloading area was approximately 40 feet wide by 310 feet long, and was located along the property boundary in the southwest Lower Yard. This loading/unloading area consisted of two railroad spurs parallel to the BNSF tracks, with loading/unloading racks parallel to the railroad spurs. The northern loading/unloading area was located immediately south of the tidal basin leading to Puget Sound, and was approximately 10 feet wide by 70 feet long (EMCON 1994). Railcar tankers were loaded and unloaded in these areas on a regular basis for approximately 30 years.

Former Air-Blown Asphalt Plant

The air-blown asphalt plant was constructed in approximately 1953 and covered a large portion of the west/northwest Lower Yard, adjacent to DB-1 and the former slops pond area. Various grades of air-blown asphalt were produced in this facility, including crack-pouring compound, sub-sealing compound, and canal-lining asphalt. The air-blown asphalt plant was designed to produce up to 100 tons per day and the asphalt products were packaged into 100-pound cartons or steel drums. Materials used to manufacture air-blown asphalt included tank bottom material from the facilities' existing crude distillation column and flux oil shipped to the Site by tanker or rail.

Former Asphalt Warehouse

The steel-framed asphalt warehouse building was constructed in 1953, along with the asphalt plant. The 80- by 280-foot warehouse was located in the central Lower Yard, parallel to the southern edge of DB-1. Operations in the asphalt warehouse consisted of packaging asphalt from the air-blown asphalt plant. Asphalt was pumped from cooling tanks into a 6-inch-diameter pipe that ran in a trench down the centerline of the building. The asphalt was then pumped into containers using a loading arm. These containers were loaded into and distributed via truck and trailer.

Former Truck Loading Racks

Two truck loading racks were located in the Lower Yard. A two-lane gasoline and diesel loading rack was located in the central Lower Yard and a single-lane loading rack was located in the southwest Lower Yard along the toe of the slope leading to the Upper Yard. It is unclear when the loading racks were constructed, but in approximately 1977 they were modified from top-loading racks to bottom-loading racks. This reportedly minimized the potential for accidental releases and product loss during truck loading. Spill containment controls at each rack consisted of a concrete pad, concrete curbs, and strip drains that led to a 10,000-gallon UST separator tank (EMCON 1994).

Former Oil/Water Separators

Two OWSs were located in the Lower Yard, approximately 150 feet south of DB-2. The OWSs were used to remove oil from the site wastewater prior to its discharge into Willow Creek.

The main OWS was built in approximately 1950 and was a concrete vault measuring approximately 45 feet long, 18 feet wide, and 11 feet deep. The main OWS had an open top at ground surface, with baffles and skimmers to remove oil product as wastewater passed through the vault. Product removed from the main OWS was pumped into one of the ASTs in the Lower Yard. Stormwater drains in the Upper Yard and Lower Yard carried stormwater flow to the main OWS since its construction in 1950 until removal of the OWS in 2007. Prior to 1950, wastewater treatment and disposal practices at the Site were not documented.

The secondary OWS was located immediately northwest of the main OWS. The secondary separator was made of steel, consisted of a series of four cells, and contained a full-length float skimmer. This unit was installed in approximately 1974 when DB-2 was constructed and used for additional treatment of wastewater to meet National Pollutant Discharge Elimination System (NPDES) discharge standards (EMCON 1994).

Former Underground Storage Tanks

Eleven USTs operated at the former Unocal property until 1985. UST capacity varied from 200 to 10,000 gallons and the USTs were installed at various times from the pre-1950s to 1985. The USTs were made of welded steel, except for the delivery truck slops tank installed in 1985, which was made of fiberglass.

Ten of the USTs were located throughout the Lower Yard and one was located in the Upper Yard, as summarized below:

- Three were located near the facilities garage and were used to fuel site trucks and equipment.
- One contained diesel fuel and was used to fuel the onsite boiler.
- One contained fuel additive that was mixed during truck loading at the two truck loading racks.
- One was a delivery truck petroleum slops tank, where delivery lines from ingoing and outgoing trucks were drained.
- Two collected truck loading rack overflow, spills, and rainwater from the strip drains at each of the truck loading racks.
- Two served as vapor recovery tanks that collected condensed vapor from the vapor recovery system.

2.2.3 Historical Releases

Facility operations began in the early 1920s with construction of the Unocal pier and main facilities of the Upper Yard and Lower Yard. Although no spills were documented during this time, data collected during the 2007/2008 interim action excavations indicated that soil impacts were present at depths deeper than site groundwater fluctuations (Arcadis 2009a, 2010a, 2010b). Specifically, impacts were found in layers of beach and marsh deposits below the 1929 fill unit, suggesting that releases potentially occurred in either the undeveloped marshland areas of the Lower Yard prior to backfill placement, from the early 1920s to the 1950s, or were transported vertically through the saturated zone by a fluctuating groundwater table through time.

From 1954 to 1990, several documented spills occurred at the terminal, totaling approximately 155,000 gallons. Spilled quantities ranged from a few gallons to 80,000 gallons and involved fuel oils, heavy oils, gasoline, off-specification asphalt, and diesel products. Periodic product releases (approximately 0.2 gallon to 2 gallons) reportedly occurred from valves, flanges, and pumps in the Upper Yard and Lower Yard throughout the terminal history. Records and documentation of these smaller releases are not available. Several remedial actions have been performed to address releases listed above and are summarized in Section 2.6.

2.2.4 Regulatory History and Previous Interim Actions

Unocal operated the terminal from 1923 to 1991. After termination of the terminal activities, Unocal entered into AO No. DE92TC-N328 and then AO No. DE 4460 with Ecology (AO No. DE 4460 superseded AO No. DE92TC-N328). Under these AOs, a number of interim actions were completed and are summarized below.

2.2.4.1 Agreed Order No. DE 92TC-N328

In 1993, Unocal entered into AO No. DE92TC-N328 with Ecology. Under the AO, remedial investigations were conducted during the 1990s. Interim actions were conducted under AO No. DE92TC-N328 in the Upper Yard and Lower Yard during 2001 and 2003.

In 2001, Unocal conducted an interim action in the Lower Yard, removing light non-aqueous phase liquid (LNAPL) and petroleum-impacted soil and groundwater from four areas of the Lower Yard. Results of the 2001 interim action are summarized in the Lower Yard Interim Action As-Built Report (MFA 2002). Additional interim actions conducted in 2003 included soil excavations in the southwest Lower Yard and DB-1. Results of the 2003 interim action are summarized in the 2003 Lower Yard Interim Action As-Built Report (MFA 2004a). The 2001 and 2003 excavations are shown on Figures 1-2 and 2-1, and are discussed in Sections 2.6.2 and 2.6.3.

2.2.4.2 Agreed Order No. DE 4460

In June 2007, Unocal entered into AO No. DE 4460 with Ecology to conduct an IRA at the Lower Yard. AO No. DE 4460, which superseded AO No. DE92TC-N328, required Unocal to conduct an IRA to remediate soil, groundwater, and sediment; and to monitor groundwater in the Lower Yard. The purpose of the IRA was to reduce potential threats to human health and the environment, and to gather information to design additional cleanup actions, if necessary. Specific objectives of the IRA included:

- Remediate the petroleum hydrocarbon-impacted soil in the Lower Yard with petroleum hydrocarbon concentrations greater than the soil RELs or CULs based on direct contact.
- Remove LNAPL from four areas of the Lower Yard.
- Extract groundwater that is in contact with LNAPL.
- Remove soil from the southwest Lower Yard with arsenic concentrations in excess of the soil CUL based on natural background concentrations.
- Remove sediment from Willow Creek at locations near the Site's two stormwater outfalls that failed toxicity tests in 2003.
- Obtain the data necessary to evaluate if the remaining soil concentrations are sources of LNAPL on the groundwater table.
- Obtain the data necessary to evaluate if the remaining soil concentrations will cause an exceedance of the groundwater CULs at the groundwater points of compliance (POCs).
- Obtain the data necessary to evaluate if petroleum hydrocarbon concentrations in groundwater beneath the Lower Yard will naturally attenuate to below the CULs at the groundwater POCs.

The soil RELs were calculated to identify a concentration that is protective of direct contact. Groundwater monitoring was conducted to provide empirical evidence that RELs are protective of groundwater. Soil

CULs and RELs are identified in the Interim Action Report -Work Plan for 2007 Lower Yard Interim Action (2007 IAWP) (SLR International, Corp. [SLR] 2007). The IRAs were conducted in two phases in 2007 and 2008. The 2007 and 2008 excavations are shown on Figure 1-2, and are discussed in Sections 2.6.2 and 2.6.3.

2.3 Regional Environmental Setting

2.3.1 Climate

The Site is located on the eastern shore of Puget Sound, less than 100 miles inland from the Pacific Ocean. Puget Sound lies in a basin between the Olympic Mountains on the west, which form a significant barrier to onshore wind flow from the Pacific, and the Cascade Mountains to the east, which shields the area against westerly flow of colder and drier continental air masses. As a result, the climate of Puget Sound is temperate, with mild to moderate precipitation and temperatures year-round in the Edmonds, Washington area. Occasionally, winter storms will bring heavy rainfall, strong winds, or snowfall. Average temperatures are typically in the 30s and 40s degrees Fahrenheit (°F) during winter, and range from the 50s to 70s °F during spring, summer, and fall. The annual precipitation is approximately 36-inches and consists mostly of rain that falls between October and March.

2.3.2 Regional Geology

The Edmonds, Washington area is located in the Puget Sound Lowland, bound by the North Cascade Mountains and South Cascade Mountains to the east and the Olympic Mountains and Willapa Hills to the west. Continental glaciers advanced into the region several times during the Pleistocene Epoch (between 2 million and 10,000 years ago). This part of the Cordilleran ice sheet is known as the Puget Lobe. The most recent period of glaciation, the Vashon Stade, began approximately 15,000 years ago. As the climate cooled during the Vashon Stade, the continental ice sheet in Canada expanded and the Puget Lobe slowly advanced southward into western Snohomish County and beyond. The ice of this Vashon Glacier blanketed the entire Puget Sound Basin before halting and retreating (Thomas 1997).

As the Vashon Glacier advanced southward, streams and melting ice in front of the glacier deposited sediment throughout the Puget Sound Lowland. As the glacier continued its advance, it overrode these advance outwash deposits and covered them with glacial till. This till, also known as hardpan, consists of reworked older deposits and rocks scoured by the bottom and sides of the advancing glacier. Because of the pressure of thousands of feet of overlying ice, the till is compact and cemented in some areas, with a texture much like concrete. However, local deposits of fine- and coarse-grained sediment resulted in areas where the till was subjected to the influence of subglacial water during deposition. Approximately 13,500 years ago, the climate began to warm and the Vashon Glacier started to retreat. During this retreat, recessional outwash sediment was deposited, filling in discontinuous depressions and channels in front of the glacier. Subsequent to the deposition of glacial sediment, alluvial sediment of Holocene age (10,000 years ago to the present) was deposited. These are predominantly fluvial deposits of sand and gravel in stream and river valleys. During the same time, bog, marsh, and peat deposits were formed in small low-lying and poorly drained areas (Thomas 1997).

The thickness of the entire assemblage of unconsolidated deposits varies considerably over the region, but averages approximately 500 feet thick, with a maximum thickness of more than 1,200 feet. The deposits are thickest in western Snohomish County and are thinner to the east where the Tertiary bedrock is at or near land surface (Thomas 1997).

Beneath the Pleistocene and Holocene deposits are consolidated Tertiary marine sediment and volcanic rocks.

The Site lies within this regional setting, and is underlain by both glacial and nonglacial unconsolidated sediment. The Upper Yard is located on top of a bluff and the Lower Yard is situated at the foot of the bluff, along its northern edge. The Upper Yard bluff consists of three main types of deposits: interglacial deposits (Whidbey Formation), alluvial/lacustrine pre-glacial deposits (Transitional Beds and Advance Outwash), and glacial deposits (till) (Minard 1983). The Lower Yard bounding the bluff is composed of marsh deposits to the northeast and “modified land” that has been dredged and filled to the north and northwest (MFA 2004c).

2.3.3 Regional Hydrogeology

Groundwater flow in the Puget Sound region can generally be divided into large- and small-scale flow systems. Large-scale flow systems exist in unconsolidated, glacially derived units, and in the marine sediment and volcanic rocks underlying them. These systems are recharged by precipitation in upland areas, east of the Puget Sound, where the units are exposed. Large-scale, regional system discharge is into Puget Sound. Small-scale, local flow systems occur in the uppermost deposits of alluvial and lacustrine pre-glacial sediment, glacial sediment, and post-glacial alluvium, as well as in construction-related backfill. Precipitation and deeper flow systems are the chief methods of recharge for these local flow systems. Discharge of local systems is to adjacent surface-water bodies.

The Site lies within this regional setting. Large-scale, Site system discharge is into Puget Sound. Small-scale, local flow systems occur in the uppermost deposits.

2.4 Site Environmental Setting

2.4.1 Site Geology

Five hydrostratigraphic units have been identified in the Lower Yard:

- *2008 fill*. The 2007 and 2008 interim action excavations were backfilled to 6 to 12 inches above the observed groundwater table in the open excavations with poorly graded coarse gravels (⅜ to 1 inch) and little to no fines. Backfill material above the coarse gravel to ground surface was a mixture of very fine to medium sand, trace silt, and fine to medium gravel materials.
- *1929 fill*. This unit consists of silty sands with gravel and sandy silts with gravel. During the 2007 and 2008 interim action excavations, subsurface materials encountered from ground surface to a depth of 8 to 15 feet bgs were mostly fill material placed circa 1929 or later, during creation of the Lower Yard facility.

- *Marsh deposits*. In many areas of the Lower Yard, beneath the 1929 fill unit, a 1- to 15-foot-thick layer is present and is composed of silt and sandy silt with large amounts of organic matter such as peat and wood debris. This layer is encountered at depths ranging from 8 to 14 feet bgs, directly below the 1929 fill unit, and is interpreted to be representative of the former marsh horizon beneath the Lower Yard. This layer is typically demarcated by a 6- to 12-inch-thick layer of decomposing vegetation.
- *Beach deposits*. Below the 1929 fill unit and marsh deposits, a poorly graded sand formation of very fine to medium sand with fine gravel is present, containing organic material such as driftwood and seashells. This layer is interpreted to be representative of the former beach environment in the area prior to creation of the Lower Yard.
- *Whidbey Formation*. This material is a poorly graded sand layer consisting of very fine to medium sand with fine gravel. It is present beneath the overlying deposits to the maximum depth explored by Unocal (41.8 feet bgs). This unit contains interbedded sand with silt and interbedded silt and sandy silt. The interbeds range in thickness from less than 1 inch to several feet and appear to be laterally discontinuous. This unit is interpreted to be alluvium and is likely part of the Whidbey Formation.

The current uppermost stratigraphic unit of the Lower Yard consists primarily of 2008 fill. The 2007 and 2008 interim action excavations were extended to reach beach deposits, marsh deposits, or Whidbey Formation materials. Remaining unexcavated areas are likely 1929 fill material, underlain by the hydrostratigraphic units described above. Cross sections of the Lower Yard are presented on Figures 2-2 through 2-6. Elevations of the 2008 gravel backfill material in the 2007 and 2008 excavation areas are shown on Figures 2-7 and 2-8.

2.4.2 Site Hydrology

2.4.2.1 Water Supply Wells

According to a review of Ecology and Snohomish Health District files, no potable water supply wells exist within ¼ mile of the Site. One abandoned test well is located approximately ⅓ mile northeast of the site boundary and was used for dewatering during construction of the Edmonds wastewater treatment plant. The nearest domestic supply well, installed in 1995, is located approximately ¼ mile south of the site boundary. This well is upgradient from the Site; therefore, groundwater from the Site cannot affect this well.

2.4.2.2 Groundwater Elevations

Groundwater elevations throughout the Lower Yard have remained consistent from October 2008 to October 2016, with average groundwater elevations ranging between 5 and 9 feet amsl. This does not include groundwater elevation data collected in the southeast Lower Yard, which indicate the presence of an area of localized groundwater mounding. During the period of record, average groundwater elevations in the southeast Lower Yard were between 9 and 11 feet amsl. Historical groundwater elevations throughout the Site (excluding the southeast Lower Yard) varied from 2.24 feet amsl at well MW-147 in September 2011 to 11.20 feet amsl at well MW-109 in December 2011. The highest average historical groundwater elevations (8.71 and 8.89 feet amsl) are observed in monitoring wells MW-203 and MW-134X (in the upper Unoco Road portion of the southeast Lower Yard). The lowest average historical groundwater elevations (5.21 and 5.49 feet amsl) are observed in monitoring wells MW-301 and MW-149R in the southwest Lower Yard.

Historical groundwater elevations in the southeast Lower Yard ranged from 6.21 feet in well MW-136 in August 2009 to 15.21 feet amsl in piezometer P-1 in January 2010. The historical average groundwater elevation in the southeast Lower Yard is 9.82 feet amsl.

Groundwater elevation data from June 2015 and October 2016 were contoured and are presented on Figures 2-9 and 2-10. In general, the seasonal variation includes the difference between the highest groundwater elevations observed during January and the lowest groundwater elevations observed between June and September.

2.4.2.3 Groundwater Gradient and Direction

As described in Section 2.7.2, the 2011 investigation activities indicate that tidal variations in water levels in Puget Sound influence groundwater elevations at the site perimeter. Horizontal gradients in the surficial materials of the Lower Yard measured during tidal study activities ranged in magnitude from 0.0053 to 0.0058 foot per foot, with an overall direction to the west-northwest toward Puget Sound (Arcadis 2012a).

Quarterly water-level data from October 2008 to June 2012 were evaluated to assess the long-term hydraulic gradient and overall gradient direction in the Lower Yard. Groundwater elevations during this time period ranged from approximately 2 to 15 feet amsl and generally decreased from south to north-northwest, primarily toward Puget Sound and Edmonds Marsh (east). Depth to water values ranged from approximately 0.6 foot to 27 feet below top of casing. In general, the greatest depth to water values occur near the entrance to the Lower Yard (on upper Unoco Road) and near the central portion of the Site, decreasing with proximity to Puget Sound (to the north) and Edmonds Marsh (southeastern portion of the Lower Yard). Using the quarterly data to calculate a site-wide gradient (Devlin 2003), the analysis indicates that the overall average gradient is 0.002 foot per foot toward the west-northwest.

Groundwater elevations in monitoring wells MW-500 and MW-501, installed in June 2012 in both 2008 fill and in the underlying 1929 fill material, are generally several feet higher (5 to 7 feet) than elevations at surrounding wells. Groundwater gradient in the southeast portion of the Lower Yard is also influenced by the 2007 and 2008 interim action excavations and subsequent 2008 fill. In July 2009, in an effort to understand the higher groundwater elevations, eight piezometers were installed in the southeast Lower Yard near monitoring wells MW-500 and MW-501. The piezometers were installed in pairs, with each piezometer approximately 1 to 2 feet from each other. One piezometer of each pair was installed as a deep well (ranging from 25 to 22 feet bgs) and one piezometer was installed as a shallow well (ranging from 12 to 13 feet bgs). The deep piezometers were constructed with 5 feet of well screen and the shallow piezometers were constructed with 10 feet of well screen. The piezometers and wells MW-500 and 501 screen interval summary is presented in Table 2-2.

Table 2-2. Southeast Lower Yard Well Screen Interval Summary

Well ID	Classification	Well Screen Interval (geologic material)
P-1	Shallow	2008 fill/1929 fill
P-2	Deep	1929 fill
P-3	Shallow	2008 fill
P-4	Deep	1929 fill
P-5	Shallow	2008 fill
P-6	Shallow	2008 fill/1929 fill
P-7	Deep	1929 fill/Whidbey Formation
P-8	Deep	1929 fill/Whidbey Formation
MW-500	Shallow (monitoring well)	2008 fill/1929 fill
MW-501	Shallow (monitoring well)	2008 fill/1929 fill

All shallow piezometers, which are installed in either the 2008 fill or both the 2008 fill and the 1929 fill, have groundwater elevations consistent with those observed in monitoring wells MW-500 and MW-501. The groundwater elevations in the shallow piezometers are also several feet higher than the corresponding deeper piezometers, which are installed in the 1929 fill or both the 1929 fill and the Whidbey Formation.

The 2008 fill material is a higher permeability material than the 1929 fill that underlies and surrounds the 2007 and 2008 interim action excavation areas in the southeast Lower Yard. The 2008 fill appears to have created a distinct zone in which shallow groundwater responds more rapidly to recharge than the surrounding and underlying 1929 fill. Movement of groundwater from the 2007 and 2008 interim action excavation area (both laterally and vertically) is restricted due to the presence of the lower permeability 1929 fill. Additionally, surface-water runoff from the bluff along the Upper Yard may be contributing some recharge to this portion of the Site. As a result, water levels near the 2007 and 2008 interim action excavation area indicate a limited area of groundwater mounding due to the differential permeabilities.

Cross sections of the southeast Lower Yard, with historical groundwater elevation data, are shown on Figures 2-5 and 2-6. Groundwater elevation contours and data from the June 22, 2015 and October 27, 2016 gauging events are presented on Figures 2-9 and 2-10.

2.4.2.4 Hydraulic Conductivity

Results of the hydraulic conductivity testing conducted during the 2011 site investigation, including step drawdown tests, short-duration hydraulic conductivity tests, long-duration hydraulic conductivity tests, and slug tests, indicate that hydraulic conductivity (ranging from 0.06 to 345 feet per day) varies throughout the Lower Yard and corresponds to the heterogeneity of the subsurface materials. The 1929 fill is of lower permeability than the 2008 fill material. Wells completed in the 2008 fill have relatively higher hydraulic conductivity values (ranging from 2.5 to 345 feet per day) than those completed in the 1929 fill (ranging from 0.2 foot to 15 feet per day). Hydraulic conductivity results are presented in Table 2-3, along with the screened interval lithology.

Table 2-3. Revised Summary of Hydraulic Conductivity Results

Tested Well	Minimum Estimated Hydraulic Conductivity (feet/day)	Maximum Estimated Hydraulic Conductivity (feet/day)	Arithmetic Mean Hydraulic Conductivity (feet/day)	Well Screen Interval (geologic material)
LM-2	0.3	0.4	0.3	1929 fill
MW-104	4.7	15	10	1929 fill
MW-129R	0.2	0.5	0.3	1929 fill
MW-149R	2.5	2.5	2.5	2008 fill
MW-500	0.06	0.2	0.1	2008 fill/1929 fill
MW-518	5.8	10	8	2008 fill
MW-8R	186	345	259	2008 fill

Source: Final SICR (Arcadis 2012a).

Note:
The value estimated at LM-2 was from slug testing only because a valid result could not be obtained from the step test data analysis.

2.4.2.5 Surface Water – Groundwater Interaction

The 2011 site investigation included a study to evaluate the potential interaction between Puget Sound, groundwater at the Lower Yard, and surface water in Willow Creek. Results are presented in the Final SICR and its revision (Arcadis 2012a, 2014c) and summarized below.

Tidal Influence on Groundwater

Based on the tidal study, the Lower Yard perimeter wells (located within approximately 62 feet of the site boundary) are tidally influenced. Shallow monitoring wells with observable response to tidal influence indicated a range in amplitude from 0.07 foot to 1.15 feet. Deeper monitoring well MW-122, completed in the Whidbey Formation, indicated a range in amplitude from 0.02 to 0.33 foot. Wells monitored during the tidal study indicate higher tidal efficiency factors (or the ratio of the change in water level in a groundwater well compared to the change in water level in a tidally affected water body) along the northwest boundary wells adjacent to Puget Sound, compared to interior wells and southeast boundary wells adjacent to the marsh. Results indicate that the average tidal efficiency varied between approximately 0.003 (LM-2 and MW-515) and 0.09 (MW-149R). The average tidal efficiency of all wells studied was 0.03. The values are relatively low, likely due to the low permeability and heterogeneity of material at the Site. The relatively low tidal efficiency values observed at monitoring wells indicate that groundwater levels at the Site are not significantly influenced by tidal changes in Puget Sound.

A comparison of groundwater elevations to Puget Sound water elevations measured during the 2011 tidal study indicates that the short-term groundwater gradient direction near the tidal boundaries varies with the tidal stage. At most of the observed perimeter locations during high tide, the Puget Sound water elevation is higher than groundwater elevations in the Lower Yard, indicating an inward flow direction near the boundary. However, at that same time, groundwater gradients between perimeter and interior wells remained almost unchanged, indicating outward flow. Thus, the region experiencing gradient reversal is limited to a narrow band at the site margin near the tidal surface waters. At low tide the opposite is true, and groundwater gradient is toward Puget Sound both within the Site and at the margins. Exceptions to this occur at MW-122, MW-500, and MW-501. At these locations, during the tidal study, elevations were higher than Puget Sound except at the “high” high tide stage, when the groundwater elevations of these wells were lower than Puget Sound; groundwater gradient is therefore reversed and groundwater does not discharge toward Puget Sound during the “high” high tide stage.

Tidal Influence on Surface Water

Data collected during the 2011 tidal study from transducers installed at staff gauges in Willow Creek indicate that Willow Creek is tidally influenced. At locations where Willow Creek was monitored with transducers, the Puget Sound elevation is greater at high tide than surface-water elevations in Willow Creek, and Willow Creek elevations are greater at low tide than those in Puget Sound. Salinity was also measured in Willow Creek during the tidal study. Salinity variations were observed to correlate to the tidal stage at staff gauges with observable tidal influence. During high tide in Puget Sound, the flow is directed toward Willow Creek and salinity concentrations in Willow Creek increase. During low tide in Puget Sound, the flow direction reverses and flow is from Willow Creek toward Puget Sound while salinity concentrations decrease in the creek. During periods of high tide, flow in Willow Creek will be toward Edmonds Marsh, and Edmonds Marsh partially fills with water. During low tide, Edmonds Marsh will partially drain into Puget Sound.

During some tidal cycles in the 2011 tidal study monitoring period, surface-water elevations in Willow Creek were greater than those in Puget Sound during low and low high tides. Staff gauge D-6R (located in DB-1) did not identify any observable tidal influence. Staff gauges with observable tidal responses to tidal influence indicated a range in amplitude from 0.02 foot to 3.73 feet. Fluctuations in surface-water elevations in Willow Creek ranged from 3.06 to 8.76 feet amsl.

Surface Water – Groundwater Interaction

Based on the water-level data and salinity collected during the 2011 tidal study, not only does the flow direction vary with tide, but water from Puget Sound is mixing with water in Willow Creek and (to a lesser extent) with groundwater. This is indicated by the water-level response to tidal fluctuations and the varying salinity concentrations observed at the staff gauge locations. This is also occurring at the tidally influenced monitoring wells; however, the magnitude of responses to tidal fluctuations and salinity concentrations is less at the wells than observed in Willow Creek.

Willow Creek is directly hydraulically connected to Puget Sound through a culvert running under the Port of Edmonds, which also likely contributes to the greater tidal response and higher salinity concentrations. Therefore, based on groundwater elevations, surface-water elevations, and salinity changes, data from the tidal study indicate that groundwater flow is directed to surface water over the long term. However, local, transient flow direction also changes as a result of tidal stage fluctuations in Puget Sound where surface water from Willow Creek is directed to groundwater. This unique hydraulic and hydrogeological setting creates a mixing zone along the western boundary where groundwater, freshwater, and saltwater interact, at times stagnating and ultimately reversing groundwater gradient at the western boundary of the Site.

2.4.3 Surface Water

At its nearest point (the southwest corner of the Lower Yard), the Site is approximately 160 feet from the Puget Sound shoreline. The Site is bounded by Willow Creek, which runs along the northern portion of the western boundary and the entire eastern boundary of the Lower Yard. To the north and northeast of the Lower Yard is Edmonds Marsh, which is a 23-acre freshwater and brackish-water marsh. This tidally influenced marsh is fed by Shellabarger Creek on the southeast side of the marsh and drains a portion of the City of Edmonds and WSDOT stormwater system. Willow Creek connects Edmonds Marsh to Puget Sound and carries surface water into a tidal basin, where the water is conveyed beneath the Port of Edmonds through a culvert to Puget Sound. Willow Creek and Edmonds Marsh are directly connected to Puget Sound and are tidally influenced.

2.4.4 Upland Sediment

Upland sediment on the banks of Willow Creek, the tidal basin, and the berm surrounding DB-1 are partially to fully inundated during high tides. During low tides, these areas are fully exposed. Observations during field activities conducted since 2007 indicated that sediment at the bottom of the main channel of Willow Creek is constantly submerged. The water covering the upland sediment is generally brackish (1 to 30 parts per thousand [$^{0}/_{00}$] salinity) as a result of the mixing of surface water runoff with saltwater from tidal incursion. In June 1995, upland sediment pore water salinities measured between 11 and 21 $^{0}/_{00}$ at depths up to 10 centimeters (MFA 2001b).

In 1995, upland sediment was investigated and sampled for characterization. The results of this investigation are presented in the Draft Remedial Investigation Report (MFA 2001b) and are summarized below.

Upland sediment observed along the northeast boundary of the Site is highly organic, very soft to firm, olive brown to black sandy silt (MFA 2001b). Upland sediment located at an elevation high enough to support perennial vegetation retained a peat-like composition. Sediment located in the bottom of Willow Creek and along the northwest boundary of the Site is generally loose, olive gray to gray, silty sand. Tidal basin sediment is loose, gray to brown, gravelly sand. Reducing sediment indicative of anoxic conditions was observed along the northeast boundary of the Site. Amphipods were observed in the upland sediment (MFA 2001b).

Sediment samples in Willow Creek were collected for indicator hazardous substance (IHS) analysis in 1996, 2003, and 2012, as discussed in Section 3.6.

2.4.5 Wetlands

In 2001, CH2M HILL prepared the SR 104 Edmonds Crossing, Volume 1 – Preliminary Final Environmental Impact Statement and Preliminary Final Section 4(f) Evaluation (Edmonds Crossing EIS;

CH2M HILL 2001) for the U.S. Department of Transportation Federal Highway Administration and the WSDOT in preparation for future construction of the Edmonds Crossing multimodal transportation center on the Lower Yard. The Edmonds Crossing EIS (CH2M HILL 2001) included a wetland delineation of the Lower Yard, and Edmonds Marsh and its surrounding areas. During development of the Edmonds Crossing EIS (CH2M HILL 2001), three wetland areas were identified at or adjacent to the former Unocal property:

- Edmonds Marsh.
- A freshwater marsh on the east side of Highway 104 that was part of Edmonds Marsh before construction of the highway (now known as Edmonds City Park).
- DB-1 area of the Lower Yard.

Two riparian corridors were also identified: one associated with Shellabarger Creek at the north end of Edmonds City Park and the Willow Creek riparian corridor that runs through the fish hatchery.

Edmonds Marsh was classified as a Category II wetland (wetlands that are difficult, though not impossible, to replace, and provide high levels of some functions) by Ecology during the SMP Update implemented by the City of Edmonds (Ecology 2016). The primary functions of the approximately 23-acre Edmonds Marsh are flood storage and desynchronization, sediment trapping, nutrient removal, water quality improvement, wildlife habitat, fish habitat, and passive recreation. Edmonds Marsh is tidally influenced, receiving saltwater during high tides from Willow Creek and freshwater from Shellabarger Creek.

The 3.7-acre freshwater marsh on the east side of Highway 104 is rated as a Category II wetland. Its primary functions are flood storage and desynchronization, sediment trapping, nutrient removal, water quality improvement, and limited biological support. This wetland receives freshwater from Shellabarger Creek and from upland areas to the south and southeast.

The 2.3-acre DB-1 wetland area is located within the Lower Yard. The DB-1 area would likely be classified as a Category III wetland due to its small size, lack of vegetative diversity, disturbed condition, and lack of hydraulic connectivity to Edmonds Marsh. The only source of freshwater to DB-1 is precipitation, surface runoff during heavy precipitation events, and overflow from DB-2.

2.5 Historical Site Investigations

2.5.1 Onsite investigations

Site investigations have been ongoing at the Site since 1986. Historical investigations indicated that in general, the areas of petroleum hydrocarbon-impacted soil coincided with historical operations. Impacts in the Upper Yard were found near AST basins, stormwater drain lines, product piping lines, and facility operations areas. In the Lower Yard, impacts were generally found near the asphalt plant, railcar loading racks, truck loading racks, and fuel storage and distribution areas. Areas of the Lower Yard containing soil impacted with metals (specifically arsenic) were identified in locations where tanks and pipes were sandblasted with arsenic-containing sandblast grit. During 2007 and 2008 interim action excavation activities, it was observed that the southeast Lower Yard was used as a disposal area for petroleum-impacted soil, construction debris, and other waste material, with associated soil impacts. These historical site investigations are summarized in Table 2-1 and in the various reports referenced in Section 1.2. Pertinent data tables from historical site investigations are included in Appendix A.

Historical information reviewed for development of the RIWP (EMCON 1995) indicated that field investigations of the fish hatchery area were not warranted. Indeed, although the fish hatchery property was included in AO No. DE 4460, it was not used for operations or storage by Unocal and remained undeveloped until 1985 when the fish hatchery was constructed.

2.5.2 Offsite investigations

Historical investigations were conducted offsite on Admiral Way (soil borings SB-1 to SB-7 in 2001), along the BNSF tracks (monitoring wells MW-27 to MW-29 in 1991 and MW-105 to MW-107, MW-137 and MW-138 in 1995) and on the Port of Edmonds property (soil borings P-1 to P-9 in 1997 and LAI-DP-6 to LAI-DP-16 in 2004) (GeoEngineers 1993; MFA 2003b; EMCON 1998; Landau Associates, Inc. 1998, 2004).

Offsite investigations conducted by the Port of Edmonds on their property, identified local areas of soil impacted with total petroleum hydrocarbons (TPH) or carcinogenic polycyclic aromatic hydrocarbons (cPAHs), which are believed to be the result of releases at the Port of Edmonds and are not related to the Site nor are expected to cause impacts to the Site. These conclusions are based on the review of chromatograms from soil impacts detected at the Site that did not resemble the petroleum hydrocarbons found in the soil samples collected on the Port of Edmonds property. Furthermore, soil and groundwater samples collected along the BNSF tracks, located between the Site and the observed impacts, did not exceed site REL or CULs. Details of the investigations by Unocal conducted on Admiral Way and along the BNSF tracks are provided below.

As part of the remedial investigation activities conducted by EMCON in 1995, five monitoring wells (MW-105, MW-106, MW-107, MW-137, and MW-138) were installed in the BNSF right of way, between the southwest Lower Yard property boundary and the BNSF tracks. TPH concentrations in the soil samples collected during well installation were generally less than the laboratory reporting limits (LRLs). The maximum TPH concentration in soil was 230 milligrams per kilogram (mg/kg) in MW-105, collected at 1 foot bgs (EMCON 1998). No soil concentrations in these samples were greater than site-specific CULs for the Lower Yard.

Soil samples collected northwest of the Site, in Admiral Way, contained concentrations of TPH less than 500 mg/kg, except samples from two borings (SB-1 and SB-4). Samples from SB-1 and SB-4 contained TPH concentrations of up to 2,694 and 3,203 mg/kg, respectively (MFA 2003b). Based on the localized distribution of impacted soil beneath Admiral Way and the low to non-detect petroleum hydrocarbon concentrations in soil and/or groundwater samples from the borings/wells (MW-28, MW-106, and MW-107) located between the Lower Yard and Admiral Way, impacted soil beneath Admiral Way appears to be unrelated to the Site (MFA 2003b).

In coordination with Ecology, offsite locations on Admiral Way, along the BNSF tracks and on the Port of Edmonds property were not further evaluated.

Data tables and figures from historical offsite investigations are included in Appendix A.

2.6 Previous Cleanup Actions

Cleanup actions have been ongoing at the Site since 1986. In 1993, Unocal entered into AO No. DE-92TC-N328, which was superseded by AO No. DE 4460 in 2007. In accordance with the AOs, Unocal conducted interim action cleanup activities at the Upper Yard and Lower Yard, as described below.

2.6.1 Light Non-Aqueous Phase Liquid Recovery Interim Actions

From 1987 to 1991, GeoEngineers conducted LNAPL recovery operations in the Lower Yard. During this time, approximately 7,500 gallons of LNAPL were recovered from areas adjacent to the tidal basin and DB-1 (EMCON 1994). EMCON (from 1992 to 1998) and MFA (in 1999 and 2000) also conducted LNAPL recovery operations in the Lower Yard. During these periods, approximately 1,970 gallons of LNAPL were recovered from recovery wells in the Lower Yard (EMCON 1999; MFA 2000). Additionally, in 1996 during remedial investigation activities, EMCON recovered approximately 8,600 gallons of LNAPL (EMCON 1998). Recovery operations primarily consisted of skimming, bailing, and pumping the product out of monitoring wells, as well as installing and operating a recovery well system along the northwest border of the Site (MFA 2001a). LNAPL recovery operations are summarized in Table 2-1.

2.6.2 Upper Yard Interim Action

The Upper Yard interim action was conducted between July 2002 and May 2003, in accordance with AO No. DE92TC-N328, and consisted of the excavation of petroleum-impacted soil, metals-impacted surface soil, and asphalt/polyurethane coating material. Approximately 113,034 tons of petroleum-impacted soil, 7,320 tons of metals-impacted soil, and 4,021 tons of asphalt/polyurethane coated material were excavated and removed from the Upper Yard. In October 2003, Ecology confirmed that Unocal had completed cleanup activities in the Upper Yard and that the Upper Yard was suitable for residential use with regard to the soil direct contact pathway. Information regarding the Upper Yard interim action is presented in the Upper Yard Interim Action As-Built Report (MFA 2003a) and summarized below.

MTCA Method B CULs of 200 mg/kg for gasoline range organics (GRO), 460 mg/kg for diesel range organics (DRO), and a combined 2,959 mg/kg for TPH in all ranges (GRO, DRO, and heavy oil range organics [HO]) were used for petroleum-impacted soil in the Upper Yard. A total of 842 confirmation samples were collected along the floors and sidewalls of the excavation areas. Confirmation samples containing concentrations exceeding the Method B CULs triggered additional excavation. At the final extent of each excavation area, no confirmation samples exceeded the Method B CULs for TPH.

A MTCA Method B CUL of 20 mg/kg for arsenic was used in metals-impacted surface soil excavation areas of the Upper Yard. A total of 500 metals confirmation samples were collected, which met the Method B CUL for arsenic. One confirmation sample in the Upper Yard ramp area exceeded the Method B CUL for arsenic, with a concentration of 48.1 mg/kg. Twenty-one additional soil samples were subsequently collected to a maximum depth of 4 feet bgs in the Upper Yard ramp area. Those samples confirmed that arsenic is naturally present in the Upper Yard ramp area; therefore, the concentration exceeding the Method B CUL was associated with naturally occurring arsenic in the native soil. Additionally, in the Appendix B of the June 2007 AO No. DE 4460, a memorandum provided by Integral

Consulting, Inc showed that arsenic concentrations observed onsite were likely caused by geochemical conditions associated with naturally occurring organic carbon sources (SLR 2007).

2.6.3 Lower Yard Interim Actions

2.6.3.1 2001 Excavation

In 2001 Unocal conducted an interim action under AO No. DE92TC-N328 to remove LNAPL and petroleum-saturated soil and groundwater from four areas of -the Lower Yard. These areas were located near the former railcar loading rack (Excavation A), former asphalt plant (Excavation B), and north-central area near the former slops pond (Excavations C and D) (Figure 2-1). The 2001 interim action resulted in the excavation and removal of 10,764 tons of LNAPL-saturated soil and 76,237 gallons of LNAPL and groundwater from these four areas of the Lower Yard. Results of the 2001 interim action are presented in the Lower Yard Interim Action As-Built Report (MFA 2002) and summarized below.

Each excavation (A to D) extended laterally until LNAPL-saturated soil was no longer observed on the excavation sidewalls, or until structural concerns would not allow further excavation. The excavation areas were left open for approximately 1 month to allow LNAPL to enter the excavations and be recovered. Final excavation depths ranged between 6.5 and 10.5 feet bgs.

Soil samples were collected from the sidewalls of each excavation although there was no requirement to meet CULs or minimum concentration criteria because the purpose of the 2001 interim action was to remove LNAPL and visually petroleum-saturated soil. Excavation confirmation soil samples collected during the 2001 interim actions contained TPH concentrations ranging from 724 to 3,203 mg/kg. Excavated material from above the top of the smear zone was stockpiled and sampled for laboratory analysis. Stockpiles with soil concentrations of TPH less than 5,000 mg/kg were used as backfill material above the top of the smear zone.

Excavations B, C, and D and the south part of the Excavation A were over-excavated during the 2007 and 2008 interim action. In the area of Excavation A, soil samples containing concentrations greater than CULs and RELs (EX-A-6 and EX-A-7A containing TPH concentrations of 6,680 and 3,320 mg/kg, respectively) were over-excavated as a part of the 2007/2008 excavation activities.

2.6.3.2 2003 Excavation

Additional interim actions were conducted in 2003 under AO No. DE92TC-N328, including soil excavations in the southwest Lower Yard, DB-1, Metals Area 3 (located adjacent to the southwest Lower Yard excavation area), and the Point Edwards storm drain line area. The interim action excavations conducted in the southwest Lower Yard, DB-1, and Metals Area 3 were implemented to reduce potential threats to human health and the environment, and to provide additional information for the feasibility study and design of the final cleanup action. The Point Edwards storm drain line area excavation was conducted to remove contaminated soil along the alignment of a new storm drain for Point Edwards prior to its installation (Figure 2-1). During the 2003 interim action excavations, 39,130 tons of soil were excavated from DB-1, the southwest Lower Yard, Metals Area 3, and the storm drain line area; and approximately 1,861,520 gallons of groundwater were extracted from the DB-1 and southwest Lower

Yard and treated onsite. Results of the 2003 interim actions are presented in the 2003 Lower Yard Interim Action As-Built Report (MFA 2004a) and summarized below.

Depths of each excavation area were approximately 6 feet bgs in DB-1, 7.5 feet bgs (up to 1.5 feet below the groundwater table) in the southwest Lower Yard, 1 foot bgs in Metals Area 3, and 8.5 feet bgs in the Point Edwards storm drain line area (MFA 2004a).

The lateral extents of the excavations were identified by a REL for TPH (GRO, DRO, and HO) of 3,000 mg/kg and an arsenic CUL of 20 mg/kg. Soil samples were collected along the sidewalls and floors of each excavation area, except those areas that extended below the groundwater table, where floor samples had not previously been collected (the southwest Lower Yard excavation area). Laboratory analysis of soil samples at the extents of the excavations indicated that soil containing concentrations greater than CULs was left in place in two locations in DB-1, five locations in the southwest Lower Yard, and two locations in the Point Edwards storm drain line area. The location containing soil concentrations greater than CULs after the 2003 excavation was addressed during remedial excavations in 2007 and 2008. However, soil sample SWLY-D-3 Wall-3.75, located in the southwest Lower Yard, contained a TPH concentration of 2,923 mg/kg (less than the 2003 site REL for TPH of 3,000 mg/kg, but greater than the current site REL for TPH of 2,775 mg/kg, which was established lower in 2013 (Arcadis 2013b)). Details for the soil sample location SWLY-D-3 Wall-3.75 are provided in Table 2-4.

The Point Edwards storm drain line excavation was conducted to facilitate installation of a new stormwater outfall for Point Edwards, and was not specifically intended as a remedial action. Three sample locations from the Point Edwards storm drain line excavation contained COC concentrations exceeding applicable RELs and CULs:

- TPH: 17,439, 15,388, and 4,913 mg/kg in STRM-6FLOOR-7, STRM-4WALLE(2)-3, and STRM-2WALLE-3, respectively
- Benzene: 54.9 mg/kg in STRM-6FLOOR-7
- Total cPAHs adjusted for toxicity (total cPAHs TEQ): 0.56 mg/kg in STRM-4WALLE(2)-3.

Soil from the STRM-2WALLE-3 location was over-excavated during remedial excavations in 2007 and 2008. Soil sample locations STRM-6FLOOR-7 and STRM-4WALLE(2)-3 are described in Table 2-4.

2.6.3.3 2007 and 2008 Excavation

The 2007 and 2008 interim action excavation activities were conducted in two phases from July 2007 to April 2008 (Phase I), and July to October 2008 (Phase II), in accordance with AO No. DE 4460. Results of the 2007 and 2008 Phase I interim actions are summarized in the Phase I RI Report (Arcadis 2009a). Results of the 2007 and 2008 Phase II interim actions are summarized in the Final Phase II RI Report (Arcadis 2010a). Limits of excavation for all areas of the Phase I and II excavations, as well as quantities of soil removed, are presented on Figure 2-11.

Phase I

Phase I interim actions consisted of removing 108,000 tons of petroleum-impacted soil for offsite disposal and approximately 9,700 gallons of LNAPL from the groundwater surface in open excavations.

During Phase I excavation activities, 438 confirmation soil samples were collected from the floors and sidewalls of the excavation areas for TPH analysis. Soil samples were collected according to a systematic 25-foot grid pattern over the entire excavated areas at the center of each excavated grid cell and from any sidewalls that occur within each excavated grid cell. The site REL for TPH was 2,975 mg/kg and the site total cPAHs TEQ CUL was 0.14 mg/kg. CULs and RELs were met in 430 of 438 confirmation samples. Eight of the confirmation samples contained concentrations of COCs exceeding applicable CULs and RELs. Two areas where samples contained concentrations of COCs exceeding applicable CULs and RELs were over-excavated during Phase II activities. The other six areas were not over-excavated to preserve the integrity of Site structures or due to logistical constraints. Four samples contained COC concentrations exceeding the applicable REL for TPH: EX-A2-Q-14-6 (3,060 mg/kg), EX-B18-VV-1-6SW (4,980 mg/kg), EX-A2-O-15-SSW-6 (7,540 mg/kg) and EX-A2-N-16-SSW-6 (7,550 mg/kg). One sample contained a COC concentration exceeding the applicable CUL for total cPAHs TEQ: EX-B11-U-10-SSW-5 (0.159 mg/kg). One sample, EX-B20-M-17-SSW-6, contained COC concentrations exceeding the applicable CUL for total cPAHs TEQ (0.166 mg/kg) and the REL for TPH (15,700 mg/kg). These six confirmation samples are described in Table 2-4.

As part of Phase I activities, arsenic-impacted soil was excavated and removed from the southwest Lower Yard, beneath the former Unocal railroad trestle. This area contained arsenic-impacted soil associated with sandblasting of the pipelines prior to their removal and was the only remaining metals-impacted area at the Site. This area was excavated to 2.5 feet bgs, where confirmation samples showed concentrations of arsenic less than the arsenic CUL of 20 mg/kg.

At the completion of Phase I excavation activities, the excavation sidewall along the WSDOT stormwater line was demarcated with 20 thousandths of an inch thick plastic sheeting prior to backfilling. This sheeting extends from the ground surface (13.5 feet amsl) to approximately 7.5 feet amsl. Groundwater elevations near the sheeting, as measured at MW-511 and MW-512, have ranged from 5.51 to 9.14 feet amsl during the current groundwater monitoring program.

During Phase I construction activities, approximately 9,700 gallons of LNAPL were recovered and removed from the Site and approximately 2 million gallons of groundwater were extracted, treated onsite, and discharged to Willow Creek under a NPDES permit.

Phase II

In April 2008, 65 confirmation soil borings were completed in the southwest Lower Yard to confirm that soil on the floor of the 2003 excavation met the CULs and RELs. The boring locations were spaced on the same 25-foot grid pattern established for excavation sampling. Sixty-three of the 65 borings did not contain COC concentrations exceeding the CULs and RELs. The two borings with exceedances of the CULs and RELs were completed in a previously unexcavated area of the southwest Lower Yard, in the former location of the pipeline trestle. These two borings (SB-63 and SB-64) were over-excavated during Phase II excavation activities. Subsequent over-excavation confirmation soil samples contained concentrations of site COCs less than applicable site CULs and RELs.

Phase II interim action work was performed between July and October 2008 and consisted of removing 14,825 tons of petroleum-impacted soil for offsite disposal, removing 131 gallons of LNAPL, removing and treating approximately 520,000 gallons of groundwater, and removing 2,000 tons of sediment from Willow Creek.

The excavation areas for Phase II were based on areas of the Lower Yard that could not be excavated during Phase I and areas where impacts were discovered during 2008 investigation activities (see Section 2.7.1). These areas included the northwest perimeter of the site adjacent to Willow Creek where soil samples containing COC concentrations greater than site CULs and RELs were left in place during Phase I activities, the southeast Lower Yard, and impacted soil in the former asphalt warehouse area. Excavation depths ranged from 4 to 15 feet bgs. Limits of excavation extended until LNAPL-saturated soil was removed and TPH concentrations in confirmation soil samples collected at the extent of the excavation were less than the former site REL of 2,975 mg/kg. TPH concentrations in soil samples collected during the 2007 and 2008 interim action excavations ranged from less than LRLs to 17,100 mg/kg.

During Phase II, 71 confirmation soil samples were collected from the floors and sidewalls of the excavation areas. The boring locations were spaced on the same 25-foot grid pattern established for excavation sampling during Phase I. Seventy confirmation soil samples met the site CULs and RELs and one confirmation sample (EX-B1-F-44-4) contained concentrations of total cPAHs TEQ (0.212 mg/kg) exceeding the site CUL (0.14 mg/kg). Soil in the area of this sample was not over-excavated during Phase II due to a calculation error in the field. This sample was collected from the southeast Lower Yard. Approximately 850 tons of concrete and metal debris were excavated from the southeast Lower Yard, including pilings, footings, large concrete blocks, scrap metal, steel I-beams, sheet metal, metal wiring, and lumber debris. In addition, approximately 18 steel drums and drum remnants were encountered in this area, some of which were filled or coated with tar-like substances. Much of this excavation area contained large quantities of tar-like substances intermixed with soil and debris. This material was sent to a permitted solid waste landfill.

Phase II construction activities also included the removal of 2,000 tons of impacted sediment and subsequent restoration of approximately 420 feet of Willow Creek. The sediment removal in Willow Creek was conducted based on 2003 toxicity testing, during which three sampling locations in Willow Creek failed toxicity tests (US-05, US-07 and US-15). Two of these sampling locations (US-05 and US-07), near the Lower Yard's stormwater outfalls #001 and #002, were excavated during the sediment removal portion of the Phase II 2007 and 2008 excavation activities. The third sampling location (US-15) was collected in 2003 as a background sample and suggested there may be contribution causing toxicity in this sample from urban source(s) such as stormwater runoff from highways and roads. This sampling location was later confirmed in compliance during the 2012 investigations (see Section 3-6).

Phase I/Phase II Summary Results

During Phases I and II of the 2007 and 2008 excavation activities, 512 confirmation soil samples were collected from sample locations at the final extent of the excavation areas. Results for the confirmation soil samples are summarized below:

- Concentrations of TPH constituents (GRO, DRO, and HO) were less than LRLs in 261 of the 512 confirmation soil samples.

- Detected TPH concentrations were less than one-half of the former site REL for TPH of 2,975 mg/kg in 227 of the 512 confirmation soil samples, and between one-half of the REL and the REL in 17 of the 512 confirmation soil samples.
- Seven of the 512 confirmation samples contained COC concentrations exceeding applicable CULs and RELs, as described in Table 2-4:
  - o TPH concentrations exceeded the former REL in five samples (EX-A2-Q-14-6 [3,060 mg/kg], EX-B18-VV-1-6SW [4,980 mg/kg], EX-A2-O-15-SSW-6 [7,540 mg/kg], EX-A2-N-16-SSW-6 [7,550 mg/kg], and EX-B20-M-17-SSW-6 [15,700 mg/kg]).
  - o One sample with concentrations of TPH that exceeded the former REL also exceeded the CUL for total cPAHs TEQ (EX-B20-M-17-SSW-6 [0.166 mg/kg]). Two additional samples exceeded the CUL for total cPAHs TEQ (EX-B11-U-10-SSW-5 [0.159 mg/kg] and EX-B1-F-44-4 [0.212 mg/kg]).
- Grid sampling on a 25-foot spacing of the floors and sidewalls confirmed that the lateral and vertical extents of soil impacts were addressed in all but two distinct areas of the Lower Yard (DB-2 and the WSDOT stormwater line area).
- The 2007 and 2008 interim action excavation areas included areas from the 2003 excavations that exceeded the TPH CUL and were not over-excavated in 2003.

2.7 Recent Investigations

2.7.1 2008 Lower Yard Site Investigation

In 2008, 24 soil borings were advanced to collect data and evaluate the nature and extent of limited remaining petroleum impacts in discrete areas of the Lower Yard, including areas to the south and southwest of the WSDOT stormwater line and the former asphalt warehouse area, near monitoring well MW-129R. Results of the 2008 investigation activities are presented in the SIGMR (Arcadis 2010b) and summarized below. Soil sample locations and analytical results from 2008 soil investigation activities are presented on Figure 2-12.

Fourteen soil borings were advanced to the south and southwest of the WSDOT stormwater line, five (SB-65, SB-66, SB-68, SB-69, and SB-80) of which contained soil with concentrations of TPH and/or total cPAHs TEQ exceeding site CULs/RELs (with TPH concentrations ranging from 3,720 to 16,900 mg/kg and total cPAHs TEQ ranging from 0.165 to 0.693 mg/kg). One location (SB-65-6.5) also exceeded the benzene CUL with a benzene concentration of 35.8 mg/kg). The five samples containing concentrations of TPH and/or total cPAHs TEQ exceeding site CULs and RELs are listed in Table 2-4. Three of these boring locations were located between the WSDOT stormwater line and the Point Edwards storm drain line, in the south-central portion of the Lower Yard. One boring was located to the southwest of the Point Edwards storm drain line and one boring was located south of the WSDOT stormwater line where upper and lower Unoco Road meet.

Samples collected from three soil borings in the former asphalt warehouse area, which is located in the east-central portion of the Lower Yard, contained soil with concentrations of TPH and/or total cPAHs TEQ exceeding site CULs and RELs. Soil in the area of the soil borings located near the former asphalt warehouse area was excavated during Phase II excavation activities.

From October 8 to 14, 2008, Arcadis supervised the installation of 29 onsite monitoring wells. One soil sample collected during these activities (MW-129R-7.0) exceeded the site REL for TPH (with a TPH concentration of 3,007 mg/kg). This sample is listed in Table 2-4.

2.7.2 2011 Lower Yard Site Investigation

In 2011, site investigation activities conducted in the Lower Yard included a tidal study, hydraulic conductivity testing, and soil boring advancement in the limited area of impact near DB-2. Details of the 2011 site investigation activities are summarized in the Final SICR (Arcadis 2012a). Soil sample locations and analytical results from the 2011 soil investigation activities are presented on Figure 2-13.

Tidal study data were collected from 17 locations in onsite monitoring wells and staff gauges in Willow Creek to evaluate the potential influence of Puget Sound and Willow Creek on surface water and groundwater gradients at the Site, and groundwater chemistry.

Hydraulic conductivity pumping tests, including step tests, short-duration tests, and one long-term test, were conducted in 10 onsite monitoring wells.

Soil investigation activities included the advancement of 17 soil borings (B-1 to B-17) and installation of nine piezometers (P-9 to P-16) near DB-2, monitoring well MW-510, and Willow Creek. These areas were investigated to assess the recurring but minimal amount of LNAPL present in monitoring well MW-510. LNAPL was not encountered in nine of the 17 borings. Eight of the 17 soil borings presented either residual or free-phase LNAPL at the time of installation. Free-phase LNAPL subsequently appeared in two of the piezometers (P-12 and P-13) in 2011 and in a third piezometer in 2013 (P-15). Soil containing concentrations of COCs exceeding their respective CULs and/or RELs was encountered in 11 of the soil borings (B-4 to B-11, B-13, B-16, and B-17), with TPH concentrations ranging from 4,413 to 220,400 mg/kg and total cPAHs TEQ ranging from 0.1 to 116 mg/kg. The 11 samples containing concentrations of TPH and/or total cPAHs TEQ exceeding site CULs and RELs are listed in Table 2-4.

2.7.3 2012 Lower Yard Investigation

In 2012, site investigation activities conducted in the Lower Yard included the installation of eight monitoring wells and collection of three sediment samples. Results of the 2012 investigation activities are summarized in the Final CSM (Arcadis 2013a).

Eight monitoring wells were installed in the Lower Yard to assess groundwater conditions in areas of known and potential remaining soil impacts.

- Four wells (MW-525, MW-526, MW-531, and MW-532) were installed to the north and south of the WSDOT stormwater line to monitor for the possible presence of LNAPL and dissolved-phase TPH concentrations in groundwater in the unexcavated soil in this area. Specifically, wells MW-525, MW-526, and MW-532 were installed in previously impacted soil that was not removed during previous remedial interim actions.

- Monitoring wells MW-527 and MW-528 were installed in the southeast Lower Yard, near the one confirmation soil sample that contained cPAH concentrations exceeding the CUL.
- Monitoring wells MW-529 and MW-530 were installed on the southeast bank of Willow Creek, directly downgradient of monitoring wells MW-510 and LM-2, respectively. These wells were installed to monitor the potential for contaminant migration in groundwater offsite into Willow Creek.

Soil samples collected during monitoring well installation contained concentrations of benzene, total cPAHs TEQ, and/or TPH exceeding site CULs and RELs in MW-525 and MW-532 only (with respective TPH concentrations of 17,850 and 10,540 mg/kg and total cPAHs TEQ of 0.29 mg/kg in MW-525 only). Monitoring well locations and soil sample analytical data from 2012 site investigation activities are presented on Figure 2-14. The two samples containing concentrations of TPH and/or total cPAHs TEQ exceeding site CULs and RELs are listed in Table 2-4.

In July 2012, three sediment samples were collected from Willow Creek to assess sediment toxicity conditions near the 2003 sediment sampling location US-15. Based on the evaluation of these data, Ecology confirmed that further cleanup of Willow Creek was not needed (Ecology 2003). Sediment sampling locations and analytical results are presented on Figure 2-15.

2.7.4 2013 Soil Vapor Investigation

Soil vapor sampling was conducted in October and November 2013 in selected locations to evaluate worst-case scenario vapor intrusion in discrete areas which have not been excavated or remediated and to support remedial strategy decisions at the Lower Yard. The soil vapor locations tested had one or more chemical concentrations exceeding the soil vapor available screening level. Soil vapor analytical results are presented in Table 2-6. Soil vapor probe locations and analytical results are presented on Figure 2-16.

The sampling locations, soil vapor probes VP-1, VP-2, and VP-3, were selected near areas of maximum TPH detection and/or areas of remaining impacts to represent worst-case scenarios for volatile organic compounds (VOCs) and GRO. These locations represent undisturbed soil in areas where remediation was not conducted. Therefore, the data collected from these locations are not considered indicative of site-wide conditions. Sampling locations VP-1, VP-2, and VP-3 are described below:

- Soil vapor probe VP-1 is located near MW-525 (TPH [17,850 mg/kg], GRO [1,400 mg/kg]) to evaluate potential soil vapor adjacent to the WSDOT stormwater line.
- Soil vapor probe VP-2 is located near B-7 (TPH [111,400 mg/kg], GRO [1,400 mg/kg]) to evaluate potential soil vapor adjacent to DB-2 and groundwater monitoring well MW-510 (LNAPL observed).
- Soil vapor probe VP-3 is located adjacent to monitoring well MW-129R (TPH [3,007 mg/kg], GRO [nondetect]) to evaluate potential soil vapor in the adjacent area.

Soil vapor data were collected at a depth of 5 feet bgs in October; however, data from this sampling event were not considered for the soil vapor quality evaluation due to VOC concentrations detected in quality control samples. Soil vapor samples were collected at a depth of 5 feet bgs in November 2013; these data were used to evaluate soil vapor quality in the remaining impact areas by comparing to available health-based screening criteria (Ecology Method B soil gas screening levels for samples collected at depths of less than 15 feet bgs are presented in Table 2-5and available at http://www.ecy.wa.gov/programs/tcp/policies/VaporIntrusion/vig.html). These screening criteria define levels that Ecology have deemed safe for human exposure under a vapor intrusion scenario for residential use and are not site-specific.

Table 2-5. Soil Vapor Data Screening Levels

COCs	Laboratory Reported Compounds	Method B Shallow Soil Gas Screening Levels (µg/m^3)
Benzene	Benzene	3.2
Naphthalene	Naphthalene	14
Air-phase petroleum hydrocarbons (APH) aliphatic (C5-C8)	Volatile petroleum hydrocarbons (VPH) aliphatic (C5-C6 + >C6-C8)	27,000
APH aliphatic (C9-C12)	VPH aliphatic (>C8-C10 + >C10-C12)	1,400
APH aromatic (C9-C10)	VPH aromatic (>C8-C10)	1,800

Note:

µg/m^3 = micrograms per cubic meter

Concentrations of aliphatic carbon ranges C5-C6 + >C6-C8 were detected greater than available screening criteria in the samples collected from VP-1 (35,000,000 µg/m^3), VP-2 (33,700 µg/m^3), and VP-3 (529,000 µg/m^3). Concentrations of aliphatic carbon ranges >C8-C10 + >C10-C12 were detected greater than available screening criteria in the sample collected from VP-1 (6,600,000 µg/m^3), VP-2 (36,000 µg/m^3), and VP-3 (305,000 µg/m^3). The concentration of aromatic carbon range >C8-C10 was detected greater than available screening criteria in the sample collected from VP-1 (34,000 µg/m^3). Concentrations of benzene were detected greater than available screening criteria in the samples collected from VP-1 (710,000 µg/m^3), VP-2 (340 µg/m^3), and VP-3 (46 µg/m^3). The concentration of aromatic carbon range >C8-C10 was detected greater than available screening criteria in the sample collected from VP-1 (34,000 µg/m^3). Due to sample dilution, the LRLs for the analysis of naphthalene in all samples were greater than the respective available screening criteria.

3 NATURE AND EXTENT OF CONTAMINATION

This section describes the type of contaminants at the Site (nature) and the distribution of these contaminants vertically and horizontally across the Site (extent). The nature and extent of contamination were identified based on data collected during the remedial investigation (MFA 2001c), the supplemental remedial investigation (SRI [MFA 2003b]), 2008 site investigations (Arcadis 2010b), 2011 site investigations (Arcadis 2012a), 2012 site investigations (Arcadis 2013a), and 2013 vapor sampling.

This section describes the nature and extent of contamination, primarily the COCs that were screened for the Lower Yard during development of the 2004 Draft Feasibility Study Report (MFA 2004c). These contaminants are: TPH (combined GRO, DRO, and HO); benzene, arsenic, and cPAHs for soil and TPH (combined GRO, DRO, and HO); and benzene and cPAHs for groundwater and protection of surface water.

3.1 Soil Quality

Soil sampling activities were completed in locations throughout the Lower Yard and in offsite locations (to the west and northwest of the Site). The soil samples were collected as part of several site investigations, including the 2008 additional site investigation (Arcadis 2010b), 2011 site investigation (Arcadis 2012a), remedial investigation (MFA 2001b), SRI (MFA 2003b), 2003 assessment (MFA 2004b), and investigations that were conducted prior to the remedial investigation and are described in the Background History Report (EMCON 1994). Soil samples were also collected as part of the 2001 and 2003 interim actions (MFA 2002, 2004a).

The vertical and lateral distributions of petroleum hydrocarbons, benzene, cPAHs, and arsenic in soil are presented in the 2004 Draft FS Report (MFA 2004c). All COCs except petroleum hydrocarbons were profiled at depths from ground surface to greater than 6 feet bgs. The distribution of petroleum hydrocarbons was profiled in three depth intervals: 0 to 3, 3 to 6, and greater than 6 feet bgs (MFA 2004c).

3.1.1 Petroleum Hydrocarbons

Historically, gasoline, diesel, and heavy oil were stored and used at the terminal. The TPH concentrations observed in soil are a mixture of GRO, DRO, and/or HO in varying proportions; therefore, this section discusses TPH (combined GRO, DRO, and HO concentrations) and not the individual product ranges.

Generally, the areas of TPH-impacted soil at the Site coincided with historical terminal operations conducted in the former asphalt plant, and fuel storage and distribution areas, except the southeastern Lower Yard. The southeastern Lower Yard was used as a waste soil stockpile area for material removed from two local Unocal service stations (EMCON 1994) as well as storage area for other waste and debris.

The 2001 interim actions removed impacted soil from four areas of the Lower Yard: near the former railcar loading rack (Excavation A), near the former asphalt plant (Excavation B), and in the north-central area near the former slops pond (Excavations C and D) (Figure 2-1). Excavation confirmation soil samples collected during the 2001 interim actions contained TPH concentrations ranging from 724 to

3,203 mg/kg. Stockpiles with soil concentrations of TPH less than 5,000 mg/kg were used as backfill material above the top of the smear zone. The 2001 interim actions are detailed in Section 2.6.3.

The 2003 interim actions removed impacted soil from DB-1, the Point Edwards storm drain line, Metals Area 3 (located adjacent to the southwest Lower Yard Excavation Area), and the southwest Lower Yard. Concentrations of TPH ranged from less than LRLs to 17,439 mg/kg in these samples. The 2003 interim actions are detailed in Section 2.6.3.

After the 2001 and 2003 interim action activities, TPH was still present in the shallow soil above the groundwater table throughout most of the Lower Yard (MFA 2004c). Soil containing TPH greater than 5,000 mg/kg at depths from ground surface to greater than 6 feet bgs were also found throughout the majority of the Lower Yard. Areas of remaining impacted soil included the central and south-central Lower Yard (location of the northern truck loading rack area), northwestern property boundary adjacent to Willow Creek (former asphalt plant area), southwest property boundary adjacent to the BNSF right of way (former railcar loading areas and southern truck loading rack), and southeast Lower Yard. Areas with elevated concentrations of TPH in the Lower Yard also included 2001 interim action Excavations B, C, and D, and under the stormwater excavation, adjacent to Excavation A (Figure 2-1). Maximum concentrations of TPH were found at depths from 0 foot to 3 feet bgs in the north-central Lower Yard (31,600 mg/kg), from 3 to 6 feet bgs in the south-central Lower Yard (147,230 mg/kg), and at depths greater than 6 feet bgs in the southeast Lower Yard (18,852 mg/kg). TPH impacts were most laterally extensive at depths from 3 to 6 feet bgs throughout the Lower Yard (SLR 2007).

The 2007 and 2008 excavation activities covered the majority of the Lower Yard, including the western boundary of the southwest Lower Yard, the majority of the central and west-northwestern Lower Yard, and the southeastern Lower Yard. Excavation areas from the 2003 interim actions were re-excavated, except the Point Edwards storm drain line area and DB-1. TPH concentrations in soil samples collected during the 2007 and 2008 interim action excavations ranged from less than LRLs to 17,100 mg/kg. Areas excavated during the 2007 and 2008 interim actions are shown on Figure 2-11.

After the remedial action conducted from 2001 to 2008, the majority of remaining hydrocarbon impacts in soil occur in two localized areas of the Lower Yard (close to the WSDOT and Point Edwards stormwater lines and DB-2) as summarized below:

- Concentrations of TPH remaining in the WSDOT stormwater line range from 3,060 to 16,900 mg/kg, at depths between 4 and 8 feet bgs. This includes soil sample location SB-80 from 2008 along the Point Edwards storm drain line (4,660 mg/kg TPH) at 7.5 feet bgs.
- Soil samples collected in the DB-2 area contain residual LNAPL in some areas and concentrations of TPH ranging from 4,413 to 220,400 mg/kg in some areas. Impacts are found between 4 to 14 feet bgs in the DB-2 area.

Remaining TPH impacts are also present in two sample locations in the southwest Lower Yard (2,923 and 4,980 mg/kg TPH) at 3.75 and 6 feet bgs, respectively; and in monitoring well MW-129R (3,007 mg/kg TPH) at 7 feet bgs. The samples containing TPH concentrations exceeding the site REL are listed in Table 2-4.

Offsite investigations identified local areas of soil impacted with TPH or cPAHs, which are believed to be the result of offsite releases and are not expected to cause impacts to the Site. These conclusions are based on the review of chromatograms from soil impacts detected onsite that did not resemble the petroleum hydrocarbons found in the soil sample collected from the Port of Edmonds property soil explorations. Furthermore, soil and groundwater collected along the BNSF tracks, located between the Site and the observed impacts, did not exceed site REL or CULs. Details of the investigations are provided in Section 2.5.2.

3.1.2 Benzene

Prior to the 2007 and 2008 interim action excavations, benzene in soil was present in localized areas of the Lower Yard. Benzene concentrations exceeding 1 mg/kg were present in localized areas in the southeastern, central, and west-northwestern parts of the Lower Yard. Areas of the Lower Yard where benzene concentrations existed typically also contained elevated TPH concentrations. The maximum detected concentration of benzene in soil in the Lower Yard was 78 mg/kg. Soil sample location STRM-6FLOOR-7, from the Point Edwards storm drain line excavation and containing a benzene concentration of 54.9 mg/kg, was not over-excavated due to the presence of the storm drain line.

During the 2007 and 2008 interim action excavations, benzene concentrations detected in confirmation soil samples ranged from less than LRLs to 14.90 mg/kg, below the site-specific benzene CUL of 18 mg/kg.

During the additional soil investigation activities in 2008, one of the 24 soil samples (SB-65, located south of the WSDOT stormwater line) contained a benzene concentration of 35.8 mg/kg, exceeding the site-specific benzene CUL of 18 mg/kg. SB-65 soil sample location was not over-excavated to avoid damage to the WSDOT stormwater line. SB-65 soil sample presents the highest benzene concentration in soil observed in the Lower Yard during or after the 2007 and 2008 interim action excavations.

In 2012, monitoring wells MW-525, MW-526, and MW-532 were installed along the WSDOT stormwater line in soil that was not disturbed during prior excavation activities. One soil sample collected from the boring for well MW-525 at a depth of 6 feet bgs contained a benzene concentration of 34 mg/kg.

Sample locations MW-525, SB-65, and STRM-6FLOOR-7 are the only soil samples remaining onsite that exceed the site-specific benzene CUL and are listed in Table 2-4.

Benzene in soil was not detected at concentrations greater than LRLs in samples collected during the offsite soil investigation, to the northwest of the Site.

3.1.3 Carcinogenic Polycyclic Aromatic Hydrocarbons

Prior to the 2007 and 2008 interim action excavations, cPAHs were found in subsurface soil in large areas beneath the central and eastern-southeastern parts of the Lower Yard, and in more localized areas beneath the northern and western-southwestern parts of the Lower Yard (MFA 2004c). Areas of cPAHs concentrations typically contained elevated concentrations of TPH.

After the 2007 and 2008 interim actions, 18 soil samples with concentrations of total cPAHs TEQ exceeding the site CUL of 0.14 mg/kg remained onsite. Those samples were collected from depths ranging from 0.5 foot to 10.5 feet bgs at the locations described below and listed in Table 2-4:

- *Near the WSDOT stormwater line.*

  - One soil sample collected during the 2003 Point Edwards storm drain line excavation.
  - Two soil samples collected during the 2007 Phase I excavation activities.
  - Five soil sample locations close to the WSDOT stormwater line during the 2008 site investigation.
  - One soil sample collected from the boring for well MW-525.
- *Southeast Lower Yard.* One soil sample collected during the 2008 Phase II excavation activities.
- *Near DB-2.* Soil samples collected from eight borings in 2011.

3.1.4 Arsenic

Arsenic was identified as the only metal IHS in soil in the Lower Yard. The majority of arsenic-impacted soil in the Lower Yard was removed during the 2003 interim action. Upon completion of the 2003 interim action, arsenic was present only at concentrations greater than 20 mg/kg in the southwestern corner of the southwestern Lower Yard. The maximum arsenic concentration in this area was 1,900 mg/kg.

During the 2007 and 2008 interim action excavations, the arsenic-impacted area of the southwestern Lower Yard was excavated and confirmation samples were collected. Confirmation samples in one sample location exceeded the CUL of 20 mg/kg, with concentrations of 25, 30.7, and 30.9 mg/kg. These samples were over-excavated and one confirmation sample with a concentration of arsenic less than LRL was collected. As discussed in Section 5.5.2, the CUL of 20 mg/kg for arsenic is based on natural background concentrations in the state of Washington [WAC 173-340-740(5)(c)].

Areas where arsenic was identified in soil exceeding CULs in the Lower Yard were removed by prior IRAs.

3.2 Soil Vapor Quality

As discussed in Section 2.7.4, Arcadis conducted a limited soil vapor assessment to represent worst-case scenarios for VOCs in discrete areas, which have not been excavated or remediated. Three vapor probes (VP-1, VP-2, and VP-3) were installed at a depth of 5 feet bgs near areas of maximum TPH detection and/or areas of remaining impacts at the Site.

The soil vapor concentrations at all three locations exceeded available screening levels for one or more chemicals:

- *Near the WSDOT stormwater line.* Soil vapor concentrations analyzed in samples collected from VP-1 exceeded available screening levels for benzene, naphthalene, analyzed vapor-phase hydrocarbon aliphatic carbon ranges, and >C8-C10 vapor-phase hydrocarbon aromatic carbon ranges.
- *Near DB-2*. Soil vapor concentrations analyzed in samples collected from VP-2 exceeded available screening levels for benzene, naphthalene, and analyzed vapor-phase hydrocarbon aliphatic carbon ranges.

- *MW-129 R*. Soil vapor concentrations analyzed in samples collected from VP-3 exceeded available screening levels for benzene, naphthalene, and analyzed vapor-phase hydrocarbon aliphatic carbon ranges.

Based on the limited soil vapor assessment conducted at the Site, the three locations tested indicate that the potential exists for soil vapor to cause exceedances of available screening levels. These screening criteria define levels that Ecology have deemed safe for human exposure under a vapor intrusion scenario for residential use and are not site-specific. These discrete areas have not been excavated or remediated. Additional soil vapor assessment is necessary to define the soil vapor quality at the Site if the land use changes from its current approved use.

3.3 Light Nonaqueous Phase Liquid

LNAPL has been encountered in the Lower Yard since1986 and several LNAPL recovery operations were conducted onsite, recovering 7,500 gallons from 1987 to 1991, 2,500 gallons in 2001, 9,700 gallons in 2007, and 131 gallons in 2008.

Prior to the 2001 interim action, seven main areas of LNAPL were identified beneath the Lower Yard. These areas were the four areas included in the 2001 excavations (Excavations A through D), plus the southwest Lower Yard property boundary and the former asphalt plant area, south of the detention basins, and in the central Lower Yard (MFA 2004c).

Prior to the 2007 and 2008 excavation, SLR conducted a groundwater sampling event at the Lower Yard (SLR 2006) and identified four distinct areas of LNAPL. These areas were in Excavation A (adjacent to the tidal basin), southeast of Excavation B (in the central Lower Yard), Excavation D in the west-northwestern area (south of DB-2), and the central portion of the Lower Yard between DB-1 and lower Unoco Road (SLR 2007).

Since the 2007 and 2008 interim action excavation activities, measurable thickness of 0.01 foot of LNAPL on groundwater has been monitored as requested per the AO No. DE4460 and has been present in the following monitoring wells and piezometers located in the central Lower Yard:

- Monitoring well MW-129R had a measurable thickness of 0.01 foot of LNAPL in February 2009.
- Monitoring well MW-525 had a measurable thickness of 0.01 foot of LNAPL in June 2015.
- Monitoring well MW-510 had measurable thicknesses of LNAPL during nine sampling events from October 2009 to September 2012, with thicknesses ranging from 0.01 to 0.13 foot.
- Piezometer P-12 had measurable thicknesses of LNAPL during 10 sampling events from August 2011 to October 2016, with thicknesses ranging from 0.01 to 0.47 foot. LNAPL was measured at a thickness of 0.47 foot during the last event in October 2016.
- Piezometer P-13 had measurable thicknesses of LNAPL during 19 sampling events from August 2011 to October 2016, with thicknesses ranging from 0.01 foot to 1.96 feet. LNAPL was detected at a thickness of 0.13 foot during the last event in October 2016.
- Piezometer P-15 had measurable thicknesses of LNAPL during six sampling events from August 2011 to September 2014, with thicknesses ranging from 0.06 to 0.14 foot.

- Non-measurable thickness of LNAPL (less than of 0.01 foot) was observed in monitoring wells MW-129R (August 2009 and September 2011), MW-E (October 2016), MW-525 (June and September 2014), MW-510 (occasionally from December 2012 to September 2014) and P-15 (October 2016).

LNAPL has never been observed in the tidal basin or Willow Creek, nor was it detected in the offsite monitoring wells located along the BNSF right of way, adjacent to the southwest Lower Yard.

3.4 Groundwater Quality

Groundwater quality has been assessed at the Site since the late 1980s; only recent groundwater quality is discussed in this section.

The conceptual site model (CSM) presented in the 2007 IAWP (SLR 2007) concluded that groundwater beneath the Site discharges to surface water and sediment in Willow Creek. As a result, the 2007 IAWP (SLR 2007) establishes groundwater CULs based on the protection of surface water. According to AO No. DE 4460, groundwater CULs are required to be met at the perimeter monitoring wells for the interim action, which are located along the downgradient perimeter of the Site where groundwater discharges to surface water. Data collected from the interior monitoring well locations were not used to assess compliance during the interim action; rather, the dissolved concentration data collected at interior monitoring well locations have historically been used to evaluate groundwater concentration trends and overall plume stability.

In accordance with AO No. DE 4460, groundwater monitoring was initiated and has been ongoing since completion of the 2007 and 2008 interim action activities. Groundwater flow paths were established within the interior of the Lower Yard, and each groundwater flow path consisted of seven monitoring wells (one upgradient well, three source area wells, and three downgradient wells). Perimeter wells were established at the point where groundwater discharges to surface water within the monitoring well network, located along the downgradient perimeter of the Site. Seventeen perimeter wells were originally established in the 2007 IAWP (SLR 2007); currently, 23 perimeter wells are present onsite.

The locations of the wells inside the three groundwater flow paths were selected based on the presence of LNAPL on groundwater prior to remedial activities. Prior to the 2007 and 2008 interim action remedial excavations, the groundwater flow paths fit the established model of upgradient, source area, and downgradient wells. However, as a result of the 2007 and 2008 interim action, remedial excavations extended beyond the mapped flow path areas, and the resulting monitoring well arrangement was no longer suitable for use with Ecology's Natural Attenuation Analysis Tool Package A, as originally intended.

Because of the extensive source removal, the flow paths previously defined did not contain monitoring wells that could provide upgradient and downgradient water quality data in relation to specific source areas and were no longer applicable for a spatial evaluation of natural attenuation away from the source, as required for use with Ecology's Natural Attenuation Analysis Tool Package A. This change in the CSM rendered the previous sampling schedule and monitoring program obsolete with respect to the planned data evaluation, and necessitated revisions to the monitoring program that were reviewed and approved by Ecology. However, the current monitoring well network is sufficient to monitor and evaluate the status of the overall dissolved-phase plume. The stability of the site plume is being evaluated on a well-by-well basis, and the monitoring program needed to support this analysis was revised accordingly. Per Ecology's letter dated May 21, 2014 (Ecology 2014a), a conditional POC at the property boundary cannot be used at the Site. Therefore, groundwater compliance must be met throughout the Site.

Until June 2015, groundwater sampling events were conducted quarterly, with perimeter wells sampled during first and third quarter events and all site wells (perimeter and interior wells) sampled during second and fourth quarter events. Due to stable groundwater conditions at the Site and the locations of remaining groundwater impacts limited to areas of future remedial action, Arcadis (2015) proposed to temporarily cease groundwater sampling. This proposed action was approved by Ecology in a letter dated September 1, 2015 (Ecology 2015). With Ecology's concurrence, a reduced monitoring event was conducted in October 2016 to assess if groundwater conditions onsite were stable. The following sections describe the current groundwater conditions in the Lower Yard.

3.4.1 Petroleum Hydrocarbons

3.4.1.1 Total Petroleum Hydrocarbons

A site-wide groundwater sampling event was completed in June 2001, prior to the 2001 interim action. TPH was present in shallow groundwater throughout most of the western, northwestern, and central parts of the Lower Yard, and in localized areas beneath the southwestern, northern, eastern, and southeastern parts of the Lower Yard. In general, the areas of impacted groundwater beneath the Lower Yard coincided with historical facility operations (e.g., former asphalt plant, fuel storage and distribution areas).

Site-wide groundwater sampling events were conducted in February and August 2004 (i.e., after the 2003 interim action). The area of TPH-impacted groundwater in 2004 is similar to the impacted area in June 2001. Based on the results of the 2001 and 2003 interim actions, the TPH concentrations in August 2004 in wells located near Excavation B, the southwest Lower Yard, and DB-1 excavations were typically less than the concentrations in June 2001. Due to the presence of LNAPL in Excavations A and D, elevated TPH concentrations in groundwater remained near Excavations A, C, and D. TPH concentrations in the five offsite wells in the BNSF right of way adjacent to the southwest Lower Yard were less than LRLs (SLR 2004a).

In September 2006, prior to the 2007 and 2008 excavation, SLR conducted a groundwater sampling event at the Lower Yard. Dissolved concentrations of TPH greater than site-specific CULs were detected in six wells outside of the LNAPL areas during the 2006 groundwater sampling event. Dissolved-phase impacts were not found in the southwest or southeast Lower Yard, or north of DB-1 (SLR 2007). TPH concentrations in the five offsite wells in the BNSF right of way adjacent to the southwest Lower Yard were less than LRLs (SLR 2006). Approximate concentration contours of TPH from this time are shown on Figure 3-1.

Compared to groundwater conditions prior to interim action activities in the Lower Yard (2006) (Figure 3-1), there has been a marked decrease in areas of LNAPL and in dissolved-phase TPH across the Site (Figure 3-2 and Figure 3-3). Geochemical parameters monitored across the Site indicate that an environment that is conducive to anaerobic biodegradation of petroleum hydrocarbons is present and that biodegradation is likely ongoing at the Site. June 2015 groundwater sampling analytical results are presented on Figure 3-2. October 2016 groundwater sampling analytical results are presented on Figure 3-3.

As of October 2016, 47 of 52 monitoring wells have consistently been below groundwater CULs for 13 to 30 consecutive quarters. Since September 2013, only five wells (MW-510, MW-518, MW-525, MW-526 and MW-532) contained concentrations of dissolved-phase hydrocarbons exceeding sample-specific CULs. Monitoring wells MW-510 and MW-518 are perimeter wells downgradient of the Lower Yard. However, monitoring well MW-529, located approximately 20 feet further downgradient of MW-510, has not contained dissolved concentrations of TPH greater than LRLs since its installation in June 2012. This supports the conclusion that site groundwater is not creating offsite impacts, nor site groundwater impacting surface water at this location (MW-510). Wells MW-525, MW-526 and MW-532 are interior monitoring wells installed along the WSDOT stormwater line in soil that was not disturbed during prior excavation activities. However, monitoring wells downgradient of MW-525 (MW-104 and MW-20R) and MW-526 (MW-101 and MW-512 through MW-517) have not exceeded the TPH CULs since December 2013, indicating that the noted groundwater impacts at wells MW-525 and MW-526 are localized. These wells are located approximately 47 to 300 feet downgradient of MW-525 and MW-526.

3.4.1.2 Benzene

In June 2001 (before the 2001 interim action), dissolved-phase benzene concentrations were detected in shallow groundwater in localized areas in the western, southwestern, northwestern, central, and eastern parts of the Lower Yard (MFA 2004c). Benzene was not detected in the northern and southeastern parts of the Lower Yard. Outside of the LNAPL areas, benzene concentrations greater than 20 micrograms per liter (µg/L) were present in the western part of the Lower Yard (near the northeastern former truck loading rack) and in the southwestern part of the Lower Yard (MFA 2004c).

Following the 2003 interim action excavation activities, the August 2004 groundwater sampling results indicated that benzene concentrations decreased near Excavations B and C and in the southwest Lower Yard. Due to the continued presence of LNAPL after excavation was completed, elevated benzene concentrations remained in groundwater near Excavations A and D. In August 2004, areas outside of the LNAPL areas contained dissolved benzene concentrations greater than 20 µg/L in four monitoring wells near Excavation A and in a localized area of the southwestern Lower Yard (SLR 2004a).

After completion of the 2007 and 2008 interim action excavation activities, and since the implementation of the current groundwater monitoring program in October 2008, dissolved-phase benzene concentrations have exceeded the recently revised site CUL of 16 µg/L in three monitoring wells. Perimeter monitoring well MW-20R located near the Point Edwards storm drain and interior monitoring well MW-525 located in the central Lower Yard, have contained maximum benzene concentrations of 55 and 6,200 µg/L, respectively. Perimeter monitoring well MW-510 located in the DB-2 area, exceeded the CUL once in June 2009, with a concentration of 18 µg/L, but has not contained benzene greater than reporting limits since August 2009.

3.4.2 Carcinogenic Polycyclic Aromatic Hydrocarbons

Prior to the 2001 interim action excavations, dissolved-phase cPAHs were detected in one groundwater sample collected from one well (MW-8) in the Lower Yard. The sample from well MW-8 contained an estimated cPAH concentration of 0.933 µg/L (MFA 2004c).

Groundwater sampling results from August 2004 showed that dissolved-phase cPAHs were detected in one groundwater sample collected from well MW-13U in the Lower Yard. The sample from well MW-13U, which is located near the former garage, contained a chrysene concentration of 0.0135 µg/L (MFA 2004c).

Since the implementation of the current groundwater monitoring program in October 2008, two samples have exceeded the site-specific total cPAHs TEQ CUL of 0.05 µg/L and six samples presented LRLs exceeding the CUL due to raised detection limits. The two samples exceeding the site-specific total cPAHs TEQ CUL include one sample collected from well MW-510 in December 2012 and one sample collected from well MW-526 in December 2013, with total cPAH TEQ concentrations of 0.078 and 0.090 µg/L, respectively. No other detections in these wells or others wells were observed.

3.5 Surface Water

Surface-water samples (SW-1 through SW-4 and SW-1A through SW-4) were collected from four locations in Willow Creek and the tidal basin in April 1996; September 2001; October 2003; and May, July, and August 2004 (MFA 2004c).

The April 1996 samples were collected during a storm event. The samples from Willow Creek and the tidal basin did not contain GRO, DRO, or HO concentrations greater than LRLs. The samples (SW-3 and SW-4) collected downstream from the Lower Yard stormwater outfalls contained toluene, ethylbenzene, and total xylenes at concentrations up to an estimated 1 µg/L (EMCON 1998). SW-3 also contained pyrene at a concentration of 0.011 µg/L. The upstream (background) surface-water sample (SW-1) collected near the fish hatchery contained detectable concentrations of polycyclic aromatic hydrocarbon (PAH) compounds ranging from 0.017 µg/L for anthracene to 1.1 µg/L for fluoranthene. Arsenic, chromium, copper, lead, and zinc were detected in almost all of the samples, although the detections were estimated values due to the low concentrations (EMCON 1998).

During the 2001 and 2003 sampling events, GRO, DRO, HO, and BTEX constituents were not detected in the surface-water samples collected from Willow Creek or the tidal basin (MFA 2003b). PAHs and metals were not analyzed in the 2001 samples. In 2003, samples SW-1, SW-3, and SW-4 contained detectable concentrations of PAH compounds (including cPAHs) that ranged from 0.030 to 0.066 µg/L (MFA 2004b). Samples SW-3 and SW-4 contained total copper and total lead concentrations ranging from 12 to 19 µg/L; however, the dissolved copper and dissolved lead concentrations ranged up to only 1 µg/L (MFA 2004b).

One additional surface-water sampling event was conducted in 2004 to evaluate the source of the arsenic concentrations detected in 1996 at downstream sample locations SW-3 and SW-4. Using an analysis procedure to reduce interference from the brackish water in the sample, analytical results showed dissolved arsenic concentrations ranging from 1.4 to 2.1 µg/L and that the arsenic concentrations reflected upstream concentrations that flow into the area of the Site (SLR 2004b).

According to the Ecology environment education guide, Protecting Washington's waters from stormwater pollution (http://www.ecy.wa.gov/biblio/0710058.html), "most stormwater runoff carries pollution and more pollution comes from highly urbanized areas". According to Ecology report, Stormwater Quality Programs in the Puget Sound Basin (https://fortress.wa.gov/ecy/publications/publications/wqr93010.pdf), "testing of stormwater has found it to contain high concentrations of heavy metals, fecal coliform bacteria, silt, petroleum products, and nutrients". While no concentration range was mentioned in those Ecology documents, it is likely that the low PAHs, copper and lead concentrations detected in the water of Willow Creek and the tidal basin are either comparable or lower than stormwater runoff associated with urbanized areas.

3.6 Sediment

3.6.1 Willow Creek

In order to assess any potential contamination related to the operation of the former Unocal terminal and specifically the historical releases noted in Section 2.2.3, several sediment investigations as well as remedial actions were conducted at the Site and in Willow Creek, and are summarized below.

In 1996, 15 sediment samples (US-01 through US-15) were collected from Willow Creek and the tidal basin, and two sediment samples were collected from offsite control locations. Of those samples, six sediment samples (US-10 through US-15) were collected from Willow Creek adjacent to Edmonds Marsh and are considered the best indicators of possible contaminant migration from the Site to the Edmonds Marsh. The samples were submitted for conventional analyses (e.g., grain size and total organic carbon) and bioassay testing. The bioassay testing results identified effects on amphipod (*Eohaustarius estuaris*) survival, bivalve (*Mytilus edulis*) larvae survival and development, and juvenile polychaete (*Neanthes arenaceodentata*) development in sediment sample US-15, which was located where stormwater enters Edmonds Marsh from the highway (MFA 2004c).

In 2003, 16 sediment samples were again collected from locations US-1 through US-15 and one additional sample location (US-16), located between locations US-14 and US-15. These samples were analyzed using a suite of chemical analyses and bulk chemistry analyses. Results are summarized below:

- GRO and DRO concentrations were greater than LRLs in 10 samples and HO concentrations were greater than LRLs in 13 samples. The greatest GRO concentration (59.1 mg/kg) was detected near the terminal's stormwater outfall #002 (sample US-07). The highest DRO and HO concentrations (1,470 and 5,480 mg/kg, respectively) were detected in the sample collected downgradient (northwest) of the former asphalt plant (sample US-04).
- PAH compounds (including cPAHs) were detected in six samples.
- VOCs and chlorinated hydrocarbons were not detected in any of the samples (MFA 2004b).
- Polychlorinated biphenyls (PCBs) were detected at a total concentration of 0.484 mg/kg (without normalization to organic carbon content) in sample US-07, collected near stormwater outfall #002 (MFA 2004b).

- Metals (arsenic, copper, zinc, lead, chromium, mercury, and silver) were detected in all 16 samples, with the highest concentration observed in upstream sample location US-16.

Based on the analytical results in the sediment samples, bioassay toxicity testing was conducted on sediment samples from six locations (US-03 to US-05, US-07, US-12, and US-15), two of which were located in Willow Creek adjacent to Edmonds Marsh. The results of the sediment toxicity testing showed that the toxicity at two sample stations located near the Lower Yard outfalls into Willow Creek, adjacent to the OWS and DB-2 (US-05 and US-07), exceeded cleanup screening levels (CSLs). Other than the background sample (US-15), none of the sediment samples collected from Willow Creek adjacent to Edmonds Marsh exceeded CSLs. Results of the bioassay toxicity testing of the background sediment sample (US-15) again suggested there may be contribution causing toxicity in the marsh from urban source(s) such as stormwater runoff from highways and roads.

The 2007 and 2008 interim action included the removal of sediment that failed bioassay tests due to discharges at outfall locations made during facility operations (at sample locations US-05 and US-07).

In July 2012, three sediment samples were collected from Willow Creek to assess sediment toxicity conditions near 2003 sediment sampling location US-15, as described in the Final CSM (Arcadis 2013a). Chemical analytical results for the sediment samples were evaluated to identify if bioassays should be performed on the samples. This determination was made by comparing the results to the SQS (WAC 173-204-320) and CSLs. Based on an evaluation of the data, which showed that all results for the 2012 sediment samples were below the SQS (WAC 173-204-320) and CSL or lowest apparent effects threshold (LAET), Arcadis suggested that bioassay testing was not necessary.

On August 9, 2012, Ecology concurred that bioassay testing was not needed and that no further cleanup of Willow Creek is required unless Willow Creek subsequently becomes contaminated by remaining impacts at the Site (Arcadis 2013a).

Additionally, based on the information provided above, there is no evidence of impacts to Edmonds Marsh from the former operations at the Site. The data collected during two decades of environmental investigation has concluded that hazardous substances from operations of the Site have not come to rest in Edmonds Marsh and further investigation is not recommended. Sediment sample locations are presented on Figure 3-4.

3.6.2 Loading Dock and Pier

In 2000, the City of Edmonds requested technical assistance to CH2M HILL with acquisition of the former loading dock and pier owned by Unocal and described on Section 2.2.2.2. CH2M HILL conducted an environmental assessment and collected sediments at 15 stations in the vicinity of the Unocal pier. Figures showing the sediment sampling locations from the City of Edmonds Sediment Investigation – Final Report (CH2M HILL 2000) are provided in Appendix A. Sediment samples were collected from 15 stations offshore of Marina Beach Park between the shoreline and the outer harbor line and in the Department of Natural Resources lease areas. Sample stations included five near the Willow Creek drain and Edmonds Way drain located south of the Port of Edmonds breakwater and ten near the Unocal pier. The samples were analyzed for metals, SVOCs, PAHS, PCBs, and conventional parameters (ammonia, total solids, sulfides, total organic carbon and particle size). The chemical analytical results indicate that metals, PAHs, SVOCs, and PCBs were below regulatory the SQS (WAC 173-204-320), Most of the results were below the LRLs. As for metals, only chromium (up to 27.2 mg/kg), copper (up to 11.3 mg/kg), lead (up to 10 mg/kg), nickel (up to 35 mg/kg), and zinc (up to 39.5 mg/kg) were detected at concentrations greater than the LRLs. As for PAHs, only benz[a]anthracene (up to 20 micrograms per kilogram [µg/kg]), phenanthrene (up to 24 µg/kg), pyrene (up to 39 µg/kg), chrysene (up to 21 µg/kg), and fluoranthene (up to 55 µg/kg) were detected at concentrations greater than the LRLs. PCBs were not detected at concentrations greater than the LRLs. Several phthalates (dibutyl phthalate, di-N-octyl phthalate and di(2-ethylhexyl) phthalate) as well as other organic compounds (hexachlorobutadiene, hexachlorobenzene, benzoic acid, and phenol) were also detected at concentrations greater than the LRLs. Following review of the data and consultation with Ecology, CH2M HILL recommended that no further investigation or cleanup pursuant to the SMS was required.

4 CONCEPTUAL SITE MODEL

This section synthesizes the data collected during previous investigations and interim actions into a CSM of contaminant occurrence, movement, and potential exposures. The CSM is a tool used to develop CULs and remedial alternatives. The text presented in this section is also provided in the Final CSM (Arcadis 2013a).

4.1 Source Characterization

As discussed in Section 2.2, the Lower Yard was only used by Unocal for office purposes from 1991 to 2003. As discussed in Section 2.6.2, the Upper Yard was redeveloped in 2003. Therefore, there are no continuing sources of hazardous substance releases at the Site. The historical primary sources of contamination in the Lower Yard were the former asphalt plant and the former fuel storage and distribution operations (aboveground tanks and piping, truck loading racks, and railroad loading rack).

Petroleum hydrocarbons (GRO, DRO, and HO) were likely released from the former asphalt plant and fuel storage and distribution activities. Petroleum-impacted materials from offsite sources were also stockpiled and stored in the southeastern Lower Yard. Arsenic impacts were traced to the use of sandblast grit containing arsenic, used during maintenance of aboveground tanks and piping. Off-specification asphalt from the asphalt plant was likely disposed of in DB-1 (EMCON 1994).

4.2 Remaining Impacts

Extensive investigation and remediation have been conducted at the Site, as described in Sections 2.5, 2.6, and 2.7. As the result of interim action excavation activities and confirmation sampling, multiple site investigations, and groundwater monitoring activities, each area of the Lower Yard containing soil, groundwater, or sediment with COC concentrations greater than applicable CULs is fully delineated. Each area containing soil or groundwater impacts is discussed below. Locations of the Lower Yard with remaining impacts are shown on Figure 4-1 for soil and Figures 3-2 and 3-3 for groundwater and LNAPL. Figure 4-2 shows the site soil and groundwater remediation status as of second quarter 2015.

4.2.1 Soil

The soil samples containing COC concentrations exceeding site CULs and RELs are listed in Table 2-4 and shown on Figures 4-1 and 4-2.

4.2.1.1 Washington State Department of Transportation Stormwater Line

The WSDOT stormwater line runs across the Lower Yard, along lower Unoco Road, and out to Puget Sound.

During the 2007 and 2008 interim action excavation activities, impacted soil was encountered adjacent to the WSDOT stormwater line. Five soil samples collected on the excavation sidewalls adjacent to (and directly north of) the WSDOT stormwater line in the south-central portion of the site contained concentrations exceeding site CULs and/or RELs (Arcadis 2009a). These soil samples were collected at depths between 4 and 6 feet bgs, with concentrations of TPH ranging from 3,060 to 15,700 mg/kg. One of these samples also exceeded the CUL for total cPAHs TEQ, with a concentration of 0.166 mg/kg. One additional sample exceeded the CUL for total cPAHs TEQ, with a concentration of 0.159 mg/kg. Soil along the WSDOT stormwater line, including soil with CUL and REL exceedances, was unable to be excavated due to concerns about compromising the integrity of the line. Polyethylene sheeting was left in place to demarcate the excavation limits adjacent to the WSDOT stormwater line. The sheeting extends from ground surface to approximately 6 feet bgs (7.5 feet amsl) and is located along lower Unoco Road as shown on Figure 1-2 (Arcadis 2009a).

In 2008, 14 soil borings were installed along the south and southwest sides of the WSDOT stormwater line. Soil samples from five of these borings adjacent to the WSDOT stormwater line contained COC concentrations that exceeded site RELs and/or CULs. The locations of these borings are to the south and southwest of the WSDOT stormwater line, at the end of upper and lower Unoco Road, and in the area between the WSDOT stormwater line and monitoring well MW-143. Samples were collected between 4 and 8 feet bgs in this area, with TPH concentrations ranging from 3,720 to 16,900 mg/kg and total cPAH TEQ concentrations ranging from 0.165 to 1.01 mg/kg. One of these samples also exceeded the CUL for benzene, with a concentration of 35.8 mg/kg (Arcadis 2010b).

In 2012, four monitoring wells were installed adjacent to the WSDOT stormwater line. Soil samples collected during the installation of two of the monitoring wells exceeded site CULs and/or RELs at depths of 6 and 7 feet bgs, with concentrations of TPH ranging from 10,540 to 17,850 mg/kg. Soil samples collected from these wells at greater depths did not contain concentrations exceeding site CULs and/or RELs. Both of these monitoring wells were installed in an area of known remaining soil impacts that were left in place during 2007 and 2008 excavation activities and verified during 2008 site investigation activities.

Twelve sample locations in two distinct areas adjacent to the WSDOT stormwater line (to the north and south/southwest) contain soil with COC concentrations greater than site CULs and/or RELs. The depths of these remaining impacts occur between 4 and 8 feet bgs. The impacted soil is adjacent to the WSDOT stormwater line and covers an area of approximately 0.31 acre, of the 22 total acres of the Lower Yard.

4.2.1.2 Detention Basin No. 2 Area

In 2011, soil investigation activities were conducted in the unexcavated areas surrounding DB-2, including the installation of 17 soil borings and eight piezometers.

LNAPL was encountered in eight of the soil borings, located south of DB-2, along the northern-most 2007 and 2008 interim action excavation area, surrounding monitoring well MW-510, and in one location north of DB-2 and adjacent to the southwest corner of DB-1. LNAPL was encountered in these borings at depths from 7 to 12 feet bgs (Arcadis 2012a).

Soil samples containing COC concentrations exceeding site CULs and/or RELs were found in 11 of the 17 soil borings in the same areas as the LNAPL previously mentioned, on the berm separating DB-1 and DB-2, and in one location on the bank of Willow Creek at a depth of 0.5 to 1 foot bgs. The depths of these remaining impacts occur between 0.5 foot and 14 feet bgs. TPH concentrations ranged from 4,413 to

220,400 mg/kg and total cPAH TEQ concentrations ranged from 0.145 to 116 mg/kg (with a laboratory flag indicating the internal standard peak areas outside of the quality control limits).

The area surrounding DB-2, where impacted soil was encountered, covers approximately 0.43 acre of the 22 total acres of the Lower Yard. Boring locations from the DB-2 investigation area are shown on Figure 2-13.

4.2.1.3 Monitoring Well MW-129R, Southwest Lower Yard, and Southeast Lower Yard

Isolated soil samples collected from four locations exceeded site CULs and/or RELs for TPH and/or total cPAHs TEQ; these samples are summarized below and shown on Figure 4-1:

- During 2003 interim action activities, one soil sample collected from the southwest Lower Yard (sample SWLY-D-3 Wall-3.75) at a depth of 3.75 feet bgs had a TPH concentration of 2,923 mg/kg. This sample lies at the base of the slope between the Upper Yard and Lower Yard. This is an isolated exceedance surrounded by soil with no impacts observed (Figures 4-1 and 4-2). Based on the available data, this data point is statistically insignificant for further remediation based on the direct contact and soil to groundwater pathways.
- During Phase I of the 2007 and 2008 interim action, one soil sample collected from the southwest Lower Yard (sample EX-B18-VV-1-6SW) at a depth of 6 feet bgs had a TPH concentration of 4,980 mg/kg. This sample location lies on the property boundary with BNSF. This is an isolated exceedance surrounded by soil and groundwater with no impacts observed (Figures 4-1 and 4-2). Based on the available data, this data point is statistically insignificant for further remediation based on the direct contact and soil to groundwater pathways.
- During Phase II of the 2007 and 2008 interim action, one soil sample collected from the southeast Lower Yard (sample EX-B1-F-44-4) at a depth of 4 feet bgs had a total cPAH TEQ concentration of 0.212 mg/kg. This is an isolated exceedance surrounded by soil and groundwater with no impacts observed (Figures 4-1 and 4-2). Based on the available data, this data point is statistically insignificant for further remediation based on the direct contact and soil to groundwater pathways.
- During the installation of monitoring well MW-129R in 2008, one soil sample collected at a depth of 7 feet bgs contained a concentration of TPH of 3,007 mg/kg. This is an isolated exceedance surrounded by soil and groundwater with no impacts observed (Figures 4-1 and 4-2). The soil concentration observed at this location exceeds the site TPH REL by a minimal amount (235 mg/kg) and the groundwater sampled from monitoring well MW-129R has been in compliance for 13 consecutive quarters, indicating that the soil impacts observed at this location are protective of soil leaching pathway. Soil vapor sampling location VP-3 was located near MW-129R. Vapor results exceeded soil gas screening levels for benzene, naphthalene, aliphatics, and aromatics (see Table 2-6).

4.2.1.4 Point Edwards Storm Drain

During the Point Edwards storm drain line excavation in 2003, two samples (STRM-6FLOOR-7 and STRM-4WALLE(2)-3) contained concentrations of COCs greater than applicable RELs and CULs, with

TPH concentrations of 17,439 and 15,388 mg/kg, respectively; a benzene concentration of 54.9 mg/kg for STRM-6FLOOR-7, and a total cPAH TEQ concentration of 0.56 mg/kg for STRM-4WALLE(2)-3. These sample locations were not over-excavated in the 2007 and 2008 excavation due to the presence of the storm drain. These samples were collected at a depth of 7 feet bgs for the floor sample and 3 feet bgs for the wall sample. Sample locations are shown on Figure 4-1. Based on the close proximity to the WSDOT stormwater line, these samples are considered to be included within the WSDOT stormwater line area.

4.2.2 Groundwater

The 2007 IAWP concluded that drinking water is not an appropriate exposure endpoint for groundwater beneath the Lower Yard (SLR 2007, p. 5-12). Groundwater beneath the Lower Yard discharges to the surface water in Willow Creek. As a result, the 2007 IAWP established groundwater CULs based on the protection of surface water. Data collected from the interior and perimeter (property boundary) monitoring well locations are used to assess compliance.

In accordance with AO No. DE 4460, groundwater monitoring was to be conducted after the 2007 and 2008 remedial excavation activities to:

- Determine if the remaining soil concentrations will be a source of LNAPL.
- Evaluate if the remaining soil concentrations will cause an exceedance of groundwater CULs at the POCs.
- Determine if the remaining petroleum hydrocarbon concentrations in groundwater will naturally attenuate to less than the CULs at the POCs.
- Calculate the restoration timeframes to meet the groundwater CULs at the POCs.

In accordance with AO No. DE 4460 and a letter from Arcadis dated December 1, 2009 (Arcadis 2009b) requesting to modify the groundwater sampling program, groundwater sampling events were conducted at 52 compliance monitoring wells including 23 perimeters wells monitored quarterly and 29 interior wells monitored semiannually (Arcadis 2009b). Two perimeter wells (MW-529 and MW-530) and 10 interior monitoring wells (MW-126, MW-13U, MW-134X, MW-203, MW-525 through MW-528, MW-531, and MW-532) have only been sampled since June 2012.

Due to stable groundwater conditions at the Site and the locations of remaining groundwater impacts within areas of future remedial action, Arcadis (2015) proposed to temporarily cease groundwater sampling; the request was approved by Ecology (2015). Arcadis conducted a reduced monitoring event in October 2016 that included sampling 11 perimeter and 24 interior wells; the 17 wells not sampled were considered to comply with the site CULs.

Groundwater samples are collected and analyzed for TPH, benzene, and cPAHs. TPH is calculated by summing the concentrations of GRO, DRO, and HO; if concentrations do not exceed method reporting limits, one-half of the reporting limit is used to calculate TPH. The CUL for TPH in groundwater is calculated based on the relative proportions of GRO, DRO, and HO, and thus differs at each monitoring location and with each monitoring event, as described in Section 5.3.2. The site-specific CULs in groundwater are 16 μg/L for benzene and 0.05 μg/L for total cPAHs TEQ.

Most wells have met groundwater CULs for at least 13 and up to 30 consecutive quarters. Perimeter compliance monitoring wells in the southwest Lower Yard, MW-147, MW-149-R, MW-150, MW-523, and MW-524, have met groundwater CULs for at least 16 and up to 30 consecutive quarters and therefore were not sampled in 2016 in accordance with Ecology's approval. Perimeter compliance monitoring wells in the southeast Lower Yard, MW-108, MW-109, MW-129R, MW-135, MW-136, MW-500, and MW-501 have met groundwater CULs for at least 13 and up to 29 consecutive quarters and therefore were not sampled in 2016 with Ecology's approval. Interior compliance monitoring wells in the southeast Lower Yard, MW-13U, MW-134X, MW-203, MW-527, and MW-528, have met groundwater CULs for seven consecutive semiannual events and therefore were not sampled in 2016 in accordance with Ecology's approval.

4.2.2.1 Groundwater Concentration Trends

The June 2015 sampling event constituted the last and most recent groundwater monitoring event that included all 23 perimeter and 29 interior wells (Arcadis 2015b; Ecology 2015). Because the 2016 results did not include all of these wells, groundwater concentration trends are evaluated until 2015. June 2015 groundwater sampling analytical results are presented on Figure 3-2.

Dissolved concentrations of COCs in groundwater at the perimeter monitoring wells as of June 2015 are summarized below:

- Eight perimeter monitoring wells (MW-8R, MW-101, MW-108, MW-109, MW-523, MW-524, MW-529, and MW-530) have not contained concentrations of TPH greater than sample-specific CULs since monitoring began in October 2008 or their installation in June 2012. Throughout 2015, 50 of the 52 wells were in compliance with the TPH CULs. Monitoring wells MW-525 and MW-526 were the only wells that contained concentrations that exceeded CULs in June 2015, with TPH concentrations of 2,963 and 923 µg/L, respectively. Of the 13 remaining perimeter monitoring wells, 11 have met groundwater CULs for at least 13 consecutive quarters. MW-518 contained a TPH concentration of 974 µg/L in December 2013 and MW-510 contained a TPH concentration of 5,825 µg/L in September 2014; TPH was not detected at a concentration greater than the TPH CUL in MW-510 from September 2014 through June 2015.
- Benzene has not been detected at concentrations greater than the site-specific CUL in samples collected from any perimeter wells since 2009, when concentrations of 55 and 18 µg/L were detected in MW-20R and MW-510.
- cPAHs have not been detected at concentrations greater than the site-specific CUL in samples collected from any perimeter wells since December 2012 when a concentration of 0.078 µg/L was detected in MW-510. cPAH analysis conducted on samples collected from MW-104 and MW-135 exceeded the site-specific CUL because the laboratory detection limit was greater than the CUL for the 2011 and 2009 sampling events, respectively.

Dissolved COC concentrations in groundwater at the 29 interior monitoring wells as of June 2015 are summarized below:

- Fifteen of the 29 interior monitoring wells (MW-126, MW-134X, MW-13U, MW-203, MW-503, MW-505, MW-506, MW-509, MW-511, MW-519, MW-521, MW-527, MW-528, MW-531, and MW-532) have not exceeded the sample-specific TPH CUL since the beginning of the monitoring period in October 2008.

Concentrations of TPH have not exceeded the sample-specific CUL in any interior monitoring wells (except MW-525 and MW-526) for at least seven consecutive semiannual events. Monitoring well MW-525 has contained TPH concentrations exceeding the sample-specific CUL in all sampling events since its installation in June 2012, with a maximum concentration of 28,753 µg/L in December 2014. Monitoring well MW-526 has contained TPH concentrations exceeding the sample-specific CUL for five out of seven sampling events since its installation and initial sampling in June 2012 to June 2015, with a maximum concentration of 1,216 µg/L in June 2013.

- Since the beginning of the monitoring period in October 2008, benzene has been detected in only one interior monitoring well (MW-525), with a maximum concentration of 6,200 µg/L in December 2014.
- cPAHs have been detected at concentrations greater than the site-specific CUL in samples collected in only three interior monitoring wells (MW-502, MW-519, and MW-526) since the beginning of the monitoring period in October 2008. cPAH analysis conducted on samples collected from MW-502 and MW-519 exceeded the site-specific CUL because the laboratory detection limit was greater than the CUL in the samples collected during April and August 2009, respectively. Monitoring well MW-526 has contained cPAH concentrations exceeding the site-specific CUL in one of three sampling events between December 2012 and December 2014.

4.2.2.2 Light Non-Aqueous Phase Liquid

LNAPL has been effectively delineated and is present in the central Lower Yard near DB-2, near the WSDOT line and locally in the eastern portion of the central Lower Yard (see Figure 1-3 and Section 3.3). During the last events of 2015 and 2016 LNAPL was measured at:

- Monitoring well MW-525 at a thickness of 0.01 foot in June 2015. LNAPL has not been observed in MW-525 during the last event in October 2016.
- Piezometer P-12 at a thickness of 0.47 foot during the last event in October 2016.
- Piezometer P-13 at a thickness of 0.13 foot during the last event in October 2016.

Monitoring well MW-E and piezometer P-15 presented a non-measurable thickness (<0.01 foot) of LNAPL during the October 2016 monitoring event.

4.3 Fate and Transport of Contaminants

Petroleum hydrocarbons within the unsaturated vadose zone and smear zone soils can exist in four phases: residual phase (LNAPL is sorbed to soil or trapped within soil pore space), dissolved or aqueous phase (LNAPL is dissolved in water within soil pore space), vapor phase (LNAPL is volatilized into soil pore space), and free phase (recoverable LNAPL). Following a release, the petroleum hydrocarbons are driven by gravity toward the water table and, depending on the quantity released, soil type, and depth to groundwater, may reach the groundwater table. As the hydrocarbons migrate toward the water table, some residual LNAPL is left behind in each of the phases.

When residual phase, dissolved phase, or free phase LNAPL comes into contact with groundwater, dissolution of the hydrocarbons to the groundwater will occur. If a release of petroleum hydrocarbons is large enough, LNAPL will overcome the capillary forces at the capillary fringe within smear zone soil and pool on top of the groundwater.

When rainwater infiltrates subsurface soil in the area of a release, the water will flow downward through the soil and may preferentially follow high conductivity soil lenses horizontally before reaching groundwater.

LNAPL may then dissolve into groundwater, sorbs to saturated soil, or remains above the displaced capillary fringe as LNAPL. LNAPL can then migrate along the groundwater flow path above the capillary fringe, while the dissolved-phase hydrocarbons follow the groundwater flow path. General gradient direction for onsite groundwater are defined as this: groundwater beneath the southeastern, eastern, and northwestern portions of the Lower Yard flows toward Willow Creek; groundwater beneath the southwestern Lower Yard flows toward Puget Sound; and groundwater beneath the central and north-central areas flows toward DB-1. However, as explained in section 2.4.2.5., the perimeter wells are tidally influenced. At most of the observed perimeter locations during high tide, an inward flow direction near the boundary is observed. However, at that same time, groundwater gradients between perimeter and interior wells remained almost unchanged, indicating outward flow. At low tide, groundwater gradient is toward Puget Sound both within the Site and at the margins.

4.4 Potential Receptors

Potential human and ecological receptors are described below.

4.4.1 Human Receptors

The Lower Yard is currently vacant; therefore, current human receptors are limited to environmental professionals and trespassers. Potential future receptors include construction workers exposed during redevelopment activities, as well as potential residents, commercial workers, and the general public if the Site is redeveloped as a multi-modal transportation facility.

4.4.2 Ecological Receptors

The Lower Yard was a former industrial site that has been recently subject to intensive remedial activity, including excavation, backfilling, and grading. Following these activities, limited vegetation was present onsite, but in recent years native and invasive vegetation has grown on the Lower Yard. Because petroleum hydrocarbons are not expected to enter the aquatic food chain, ingestion of fish or other aquatic biota (e.g., crayfish) is not considered a complete exposure pathway.

4.5 Potential Exposures

Potential exposures are possible for human and ecological receptors.

4.5.1 Exposures to Human Receptors

Current and future exposure scenarios for human receptors are described below.

4.5.1.1 Current Exposures

Current human receptors at the Lower Yard are limited to trespassers and onsite environmental consultants, and their occasional escorted visitors. These visitors have included subcontractors, WSDOT representatives, Chevron personnel, and Ecology staff. Current human receptors may be exposed to soil via incidental ingestion, dermal contact, and inhalation of windblown dust. They may be exposed to surface water via direct contact or from eating contaminated seafood. There is no potential exposure to groundwater and exposure to soil vapor is minimal based on the current use of the Site.

The site-specific CULs and RELs established in the 2007 IAWP (SLR 2007) are based on standard Method B CULs for direct contact. The Method B CULs for direct contact are designed to protect children and assume a 16-kilogram (kg) average body weight and ingestion of an average of 200 milligrams per day (mg/day) of soil for six years. Because children are more highly exposed on a body weight basis than adults, the soil CULs and RELs are adequately protective of adult onsite environmental consultants and subcontractors. Inhalation of windblown dust is not explicitly addressed by the Method B CULs; however, the CULs are sufficiently protective of the inhalation pathway because soil exceedances are below ground and surface soil has been covered with clean backfill material. Therefore, windblown dust is considered a limited exposure pathway for the COCs.

Currently, public access to Willow Creek is not allowed and exposure to the public is limited to trespassers. Exposure to the public would be very unlikely due to the restricted access to Willow Creek; even in contact with surface water in Willow Creek, potential exposure is expected to be insignificant because COC concentrations in the creek do not exceed surface water standards. The Method B surface-water CULs established for the Site are designed to protect human receptors from eating contaminated seafood, which is considered a more significant exposure route than incidental contact. cPAHs are not considered for this scenario because they have not been detected at concentrations greater than the site-specific CUL in any perimeter wells since December 2013. Because petroleum hydrocarbons are not expected to enter the aquatic food chain, ingestion of fish or other aquatic biota (e.g., crayfish) is not considered a complete exposure pathway.

Environmental consultants and subcontractors currently working at the Site are further protected from exposures by personal protective equipment and limited exposure duration. Groundwater beneath the Lower Yard is non-potable (Arcadis 2013a; SLR 2007). Therefore, ingestion is not a potential exposure route. Similarly, direct exposure to groundwater represents an incomplete exposure pathway, unless the groundwater directly discharges to surface water. Site groundwater may discharge to the surface water of Willow Creek; however, depending on the net flow in this mixing zone, groundwater seeping into Willow Creek will be quickly mixed with other water in the creek, reducing the concentration in the discharging groundwater and further decreasing the exposure. Also, the tidal nature of Willow Creek and stormwater inputs to the creek will result in significant exchange (i.e., mixing) between discharging groundwater, tidal water, and stormwater.

Exposure to soil vapor by inhalation represents an incomplete exposure pathway due to the dilution in outdoor air.

4.5.1.2 Potential Future Exposures

If the Lower Yard is redeveloped, future human receptors at the Lower Yard could include construction workers, public, commercial workers, and residents. Future human receptors may be exposed to soil via incidental ingestion, dermal contact, and inhalation of windblown dust; to surface water via direct contact or from eating contaminated seafood; and to soil vapor by inhalation in an indoor environment or while excavating or trenching. Exposure to groundwater is an incomplete pathway unless the groundwater directly discharges to surface water. Potential future exposures are discussed below.

If the Lower Yard is redeveloped in the future, construction workers may be exposed to soil via incidental ingestion, dermal contact, and inhalation of dust for short periods while excavating, trenching, or conducting other construction activities near DB-2 and the WSDOT stormwater line. Future commercial workers and residents may be exposed to soil via incidental ingestion, dermal contact, and inhalation of dust while working in buildings onsite. However, as stated above, the site-specific CULs and RELs established in the 2007 IAWP (SLR 2007) are based on standard Method B CULs for direct contact. The Method B CULs for direct contact are designed to protect children and assume a 16 kg average body weight and ingestion of an average of 200 mg/day of soil for six years. Because children are more highly exposed on a body weight basis than adults, the soil CULs and RELs are adequately protective of adult construction workers. Also, if the Site is redeveloped, commercial workers and residents are not expected to be exposed to surface and subsurface soil because the surface will be covered by buildings and pavement. Inhalation of windblown dust is not explicitly addressed by the Method B CULs; however, the CULs are sufficiently protective of that pathway because windblown dust is considered a limited exposure pathway for the COCs.

If human receptors use Willow Creek recreationally in the future, they could come into direct contact with surface water, and they could eat fish or shellfish. As stated above, Method B surface-water CULs are designed to protect people from eating fish or shellfish. Even in contact with surface water in Willow Creek, potential exposure is expected to be insignificant because COC concentrations in the creek do not exceed surface water standards.

Direct exposure to groundwater represents an incomplete exposure pathway, unless the groundwater directly discharges to surface water. Site groundwater may discharge to the surface water of Willow Creek; but depending on the net flow in this mixing zone, groundwater seeping into Willow Creek will quickly mix with other water in the creek, reducing the concentration in the discharging groundwater and further decreasing the exposure. Measured COC concentrations in the creek do not exceed surface water standards. Also, the tidal nature of Willow Creek and stormwater inputs to the creek will result in significant exchange (i.e., mixing) between discharging groundwater, tidal water, and stormwater. Due to the Lower Yard’s proximity to Puget Sound, groundwater at the site contains salinity levels that make it unsuitable for ingestion or for use as a potable water source. Therefore, groundwater ingestion is not a potential exposure route.

If the Lower Yard is redeveloped in the future, future construction workers may be exposed to soil vapor by inhalation while excavating, trenching, or conducting other construction activities near DB-2 and the WSDOT stormwater line. Future commercial workers and residents may be exposed to soil vapor by inhalation in construction above DB-2 and the WSDOT stormwater line. Exposure to soil vapor by inhalation while outdoors represents an incomplete exposure pathway due to the dilution in outdoor air.

An exposure pathways diagram is provided on Figure 4-3. Soil RELs and CULs that have been used to date are believed to be protective for current and future exposure scenarios (Arcadis 2013b).

4.5.2 Exposures to Ecological Receptors

Ecological receptors at the Site and in the surrounding environment can be directly or indirectly exposed to remaining impacts if a complete exposure pathway exists. They may be exposed to soil, groundwater, surface water, and sediment.

Important features that must be considered when evaluating exposure pathway completeness include:

- Chemical concentrations in different media and their respective locations.
- Physical and chemical properties of the COCs.
- Locations of habitats and other environmentally sensitive areas.

As noted above, the remaining impacts at the Site are limited to subsurface soil in two discrete areas, with elevated concentrations present at greater depths. The standard POC for a terrestrial ecological evaluation (TEE) is 15 feet; however, according to WAC 173-340-7490 (4)(a), a conditional POC may be set at the biologically active soil zone. This zone is assumed to extend to a depth of six feet. Due to the shallow level of the groundwater at the Site, this alternative depth is more appropriate for the Site. Because a limited number of soil exceedances exist at the Site at depths shallower than 6 feet bgs, this pathway will be further evaluated.

At the Site, direct exposure to groundwater represents an incomplete exposure pathway, unless the groundwater directly discharges to surface water. Site groundwater may discharge to the surface water of Willow Creek; however, depending on the net flow in this mixing zone, groundwater seeping into Willow Creek will quickly mix with other water in the creek, reducing the concentration in the discharging groundwater and further decreasing the exposure. Though COC concentrations in the creek do not exceed surface water standards, this pathway will be further evaluated via the surface-water pathway.

Aquatic receptors such as fish and water column invertebrates may be directly exposed to surface water via ingestion and direct contact/uptake. Method B surface-water CULs are protective of aquatic receptors living in Willow Creek and direct contact with surface water by upper-trophic-level wildlife through ingestion is not likely to occur given the brackish nature of the stream. Also, the tidal nature of Willow Creek and stormwater inputs to the creek will result in significant exchange (i.e., mixing) between discharging groundwater, tidal water, and stormwater.

As discussed in Section 3.6, sediment analytical results from Willow Creek indicate that sediment in Willow Creek does not contain contaminants in excess of the SQS (WAC 173-204-320), and most perimeter wells directly adjacent to Willow Creek currently comply with surface-water CULs.

Exposure to surface water and soil are considered the only potentially complete pathways for ecological receptors.

An exposure pathways diagram is provided on Figure 4-3. Soil RELs and CULs that have been used to date are believed to be protective for current and future exposure scenarios (Arcadis 2013b).

5 CLEANUP STANDARDS

A cleanup standard consists of the following three elements [WAC 173-340-700(3)]:

- Cleanup Level (CUL), the concentration that must be met to protect human health and the environment.
- Point of Compliance (POC), the location where the CUL must be achieved.
- Other regulatory requirements commonly referred to as applicable or relevant and appropriate requirements that apply to a site because of the type of action or the location of the Site (Appendix B).

The cleanup standards developed for and used during former interim action work are documented in the 2007 IAWP (SLR 2007), which is provided as Exhibit B to AO No. DE 4460. The cleanup standards were re-evaluated in 2013 and are documented in the CULs and RELs Report (Arcadis 2013b). The National Recommended Water Quality Criteria (NRWQC) for marine organisms and humans ingesting organisms were updated in 2015; therefore, CULs developed in the CULs and RELs Report (Arcadis 2013b) were re-evaluated accordingly. The cleanup standards were developed using a MTCA Method B approach and include the use of RELs as part of the interim action soil removal. This section discusses IHSs, and sediment, surface water, groundwater, and soil cleanup standards.

5.1 Indicator Hazardous Substances

IHSs are the chemicals that are expected to account for most of the risks at a site, and cleanup standards must be developed for each IHS in each medium. Cleanup of IHSs is expected to result in cleanup of chemicals that pose the balance of the risks. The IHSs for sediment, surface water, groundwater, and soil were developed in accordance with WAC 173-340-703, as documented in the IAWP – Lower Yard (SLR 2007).

The 2007 IAWP (SLR 2007) identifies four IHSs in the Lower Yard based on the history and previous investigations conducted at the Site. The following IHSs for soil were developed based on direct contact and leaching pathways: TPH (sum of GRO, DRO, and HO); benzene; cPAHs; and arsenic (direct contact only).

Groundwater IHSs were developed to protect surface water and sediment in Willow Creek. Arsenic was eliminated as a groundwater/surface-water IHS because arsenic concentrations in groundwater were determined to be caused by geochemical conditions associated with naturally occurring organic carbon sources in the soil beneath the Lower Yard, and arsenic concentrations in surface-water samples collected in Willow Creek reflect background concentrations (SLR 2007).

5.1.1 Sediment

Willow Creek sediment chemistry data were compared with SQS (WAC 173-204-320) to identify IHSs for sediment. Prior to the 2007 and 2008 interim action, only total PCBs were known to be present at a concentration greater than the SQS. This exceedance was detected at one sample location (US-07), which was located near the terminal’s stormwater outfall #002. Because of the possibility of a sediment to surface-water pathway, several additional chemicals or compound groups were designated as tentative IHSs (TPH, PAHs, and metals) (SLR 2007).

According to the SQS (WAC 173-204-320), sites with sediment that exceed numeric chemical criteria may go through confirmatory biological testing. In 1996 and 2003, biological testing of sediment samples was conducted at the Site to identify areas of sediment toxicity and to help delineate the extent of sediment removal. Sediment samples were collected from 15 locations (US-01 through US-15) in 1996 and 16 locations (US-01 through US-16) in 2003 in all areas of Willow Creek, including locations adjacent to Edmonds Marsh (See Figure 3-4). These samples were submitted for conventional analyses, using a suite of chemical and bulk chemistry analyses, and bioassay toxicity testing.

In 1996, the bioassay testing results identified effects on amphipod (*Eohaustarius estuaris*) survival, bivalve (*Mytilus edulis*) larvae survival and development, and juvenile polychaete (*Neanthes arenaceodentata*) development in sediment sample US-15, which was collected where stormwater enters Edmonds Marsh from the highway (MFA 2004c). In 2003, based on the analytical results in the sediment samples, bioassay toxicity testing was conducted on sediment samples from six locations (US-03 to US-05, US-07, US-12, and US-15), with two locations in Willow Creek adjacent to Edmonds Marsh. Results showed that the toxicity at two sample stations located near the Lower Yard outfalls into Willow Creek adjacent to the OWS and DB-2 (US-05 and US-07) exceeded CSLs. The sediment toxicity at the upstream (background) station adjacent to the southeast Lower Yard (US-15) prevented use of this station as a reference station for two of the three bioassay test species. Other than sample US-15, which was not impacted by inputs from the Site, none of the sediment samples collected from Willow Creek adjacent to Edmonds Marsh exceeded CSLs. Based on 2003 sediment sample data, IHSs were not identified for sediment and sediment CULs were not established for Willow Creek (SLR 2007). The 2007 and 2008 interim action included the removal of sediment that failed bioassay tests due to discharges during historical facility operations at the Lower Yard outfalls (US-05 and US-07).

Three sediment samples (US-100, US-101, and US-102) were collected from Willow Creek on July 30, 2012 to assess sediment toxicity conditions near the 1996 and 2003 sediment sampling location US-15, as described in the Final CSM (Arcadis 2013a). Chemical analytical results for the sediment samples were evaluated to identify if bioassays should be performed on the samples. This determination was made by comparing the results to the SQS (WAC 173-204-320) and CSLs. Based on an evaluation of the data, which showed that all results for the 2012 sediment samples were less than the SQS (WAC 173-204-320) and the CSL or LAET, Arcadis suggested that bioassay testing was not necessary. On August 9, 2012, Ecology concurred that bioassay testing was not needed and that no further cleanup of Willow Creek is required unless Willow Creek becomes contaminated by impacts remaining onsite (Arcadis 2013a).

5.1.2 Surface Water and Groundwater

Groundwater beneath the Site is considered non-potable. AO No. DE 4460, Exhibit B, and Section 5.4.1 discuss this determination. The endpoint for groundwater is protection of Willow Creek (a tidally influenced stream) and Puget Sound.

The endpoint for groundwater CULs is protection of surface water; therefore, a combined list of groundwater and surface-water IHSs was developed (see AO No. DE 4460, Exhibit B, §5.1). TPH, benzene, chrysene, lead, zinc, arsenic, and copper were screened as potential IHSs.

Concentrations of arsenic, copper, lead, and zinc observed in the surface water of Willow Creek were compared to screening levels and background concentrations to identify if the metals should be retained as surface-water IHSs. The samples collected in April 1996 and October 2003 did not contain dissolved copper, lead, and/or zinc concentrations greater than their screening levels. However, the arsenic concentrations in all of the October 2003 samples were greater than the screening level. Therefore, these results support the elimination of copper, lead, and zinc as surface-water IHSs and arsenic was retained for further analysis. Additional evaluation of the sampling results indicated that arsenic concentrations in the samples reflect the upstream concentrations that flow into the Site (background conditions), and that groundwater beneath the Lower Yard is not increasing arsenic concentrations in Willow Creek. On this basis, arsenic was eliminated as an IHS for surface water.

The final surface-water and groundwater IHSs are:

- TPH (sum of GRO, DRO, and HO concentrations)
- Benzene
- Total cPAHs TEQ [sum of benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dibenzo(a,h)anthracene, and indeno(1,2,3-cd)pyrene concentrations that are adjusted using toxicity equivalency factors to represent a total benzo(a)pyrene concentration; the toxicity equivalency factors published in WAC 173-340-900, Table 708-2 are used to make the adjustments].

5.1.3 Soil

The 2007 IAWP (SLR 2007) identifies IHSs for the following four endpoints considered for soil: TEE, direct human contact (incidental ingestion), leaching to groundwater, and residual saturation.

For the TEE and residual saturation concentrations (Csat), GRO, DRO, HO, benzene, cPAHs, and arsenic were considered potential IHSs. Because residual saturation is relevant only to organic chemicals that are in liquid form at ambient soil temperatures, arsenic was eliminated as an IHS for residual saturation. In addition, cPAHs, which exist as needles and platelets at ambient soil temperatures, were also eliminated as IHSs for residual saturation.

The final soil IHSs for the TEE and residual saturation are:

- TPH constituents (GRO, DRO, and HO)
- Benzene
- Total cPAHs TEQ (TEE only)
- Arsenic (TEE only).

For RELs and CULs based on direct human contact and to evaluate the leaching pathway, GRO, DRO, HO, benzene (constituent with a carbon range accounted in the GRO), and cPAHs (constituent with a carbon range accounted in the DRO and HO) were considered in combination to develop one site REL for TPH. A separate soil CUL for benzene and a separate soil CUL for total cPAHs TEQ were also developed to comply with the MTCA Method B risk target for individual carcinogens ($1x10^{-6}$) [WAC 173-340-705(2)(c)(ii)]. Arsenic was evaluated for direct contact, but not for leaching to groundwater because arsenic is not an IHS for groundwater or surface water.

The final soil IHSs for direct contact and the leaching pathway are:

- TPH (sum of GRO, DRO, and HO concentrations)
- Benzene
- Total cPAHs TEQ
- Arsenic (direct contact only).

5.2 Sediment Cleanup Standards

Sediment cleanup was based on bioassay data, as discussed in Section 3.6. Following the 2007 and 2008 interim action, Ecology concurred that cleanup of Willow Creek is complete (Arcadis 2013a), as discussed in Section 3.5.

5.3 Surface-Water Cleanup Standards

5.3.1 Endpoints for Cleanup Levels

Method B surface-water CULs are endpoints for surface water and groundwater at the Lower Yard [WAC 173-340-730(3)(b)], as presented below:

- Washington State Water Quality Standards (WQS; WAC 173-201A) for marine water.
- NRWQC for marine organisms and humans ingesting organisms. The NRWQC for marine organisms and humans ingesting organisms were updated in 2015; therefore, CULs developed in the CULs and RELs Report (Arcadis 2013b) were re-evaluated accordingly.
- National Toxics Rule (NTR) related to human health [40 Code of Federal Regulations 131.36(c)(14)].
- For hazardous substances for which sufficiently protective, health-based criteria or standards have not been established under applicable state and federal standards, MTCA Method B equation values are used for surface water.

Willow Creek is tidally influenced and is not a source of drinking water. The CULs applicable to the Site include the WQS and NRWQC based on use for aquatic organisms and human exposure based on ingestion of aquatic organisms (SLR 2007; Arcadis 2013a), the NTR, and MTCA Method B levels for TPH.

5.3.2 Cleanup Levels

Two pathways are considered in setting groundwater CULs to protect marine surface water:

1. Protection of fish and other aquatic life
2. Protection of human health for consumption of organisms.

MTCA provides that whole effluent toxicity testing may be used to assess CULs protective of fish and aquatic life. CULs for protection of human health are set by considering fish consumption rates. For TPH mixtures, protection of human health is achieved by setting the CUL to those for groundwater whose beneficial use is drinking water [WAC 173-340-730(3)]. The TPH CUL for groundwater used as drinking water was the lowest and was set as the CUL protective of surface water, protecting both marine life and human fish consumption.

The surface-water CULs are presented in Table 5-1 and are based on the WQS (WAC 173-201A-240), NRWQC, and NTR (40 Code of Federal Regulations 131.36) and consider protection of fish and other aquatic life as well as protection of human health for consumption of organisms. The CUL has been adjusted, because it may not be set at levels below the practical quantitation limit or natural background concentration, whichever is higher [WAC 173-340-730(5)(c)].

The CULs for benzene and total cPAHs TEQ (16 to 58 µg/L and 0.00013 µg/L, respectively), are the NRWQC for human health, considering human ingestion of marine organisms. The NRWQC for marine organisms and humans ingesting organisms were updated in 2015; therefore, CULs developed in the CULs and RELs Report (Arcadis 2013b) were re-evaluated accordingly. The NRWQC for human health (organisms only) for benzene is associated with a cancer risk of 2×10^{-6}, and the NRWQC for total cPAHs TEQ is associated with a cancer risk of 6×10^{-7}. Under MTCA, standards are considered sufficiently protective if the cancer risk for those standards is less than 1×10^{-5}. The NRWQC for total cPAHs TEQ is the most stringent CUL; however, the practical quantitation limit for benzo(a)pyrene is 0.05 µg/L. Therefore, an adjustment to the CUL for benzo(a)pyrene (e.g., total cPAHs TEQ) to the practical quantitation limit is required.

The WQS and NRWQC are not established for TPH mixtures. MTCA allows the use of Method A groundwater CULs, whose beneficial use is drinking water (WAC 173-340-900, Table 720-1) to calculate surface-water CULs for TPH mixtures [WAC 173-340-730(3)(b)(iii)(C)]. This protects both marine life and human ingestion of marine organisms.

MTCA Method A CULs for TPH were derived by setting a hazard index (HI) of 1 for all three TPH constituents (DRO, GRO, and HO) and adjusting the compositions of each TPH constituent for each sample, on an individual basis. The CUL ranges from 500 to 800 µg/L, depending on the fraction composition of the sample. The CUL calculation is as follows:

Equation 1: TPH CUL = 1/(%GRO/800+%DRO/500+%HO/500)

Where:

TPH CUL = Overall CUL adjusted for HI = 1

%GRO = Sample-specific percentage of GRO in groundwater, expressed as a decimal

800 = Method A groundwater CUL for GRO (µg/L)

%DRO = Sample-specific percentage of DRO in groundwater, expressed as a decimal

500 = Method A groundwater CUL for DRO and HO (µg/L)

%HO = Sample-specific percentage of HO in groundwater, expressed as a decimal

The surface water CULs are presented in Table 5-1.

Table 5-1. Surface-Water Cleanup Levels

IHS	Surface Water Cleanup Level (µg/L)
TPH	–[1]
Benzene[2]	16
Total cPAHs TEQ[2,3]	0.05

Notes:

[1] Method A (WAC 173-340-900, Table 720-1); TPH calculated on a sample-specific basis. The CUL will fall between 500 and 800 µg/L, depending on the sample's composition.

[2] NRWQC for human-health (organisms only) (United States Environmental Protection Agency 2015). NRWQC. https://www.epa.gov/wqc/national-recommended-water-quality-criteria-human-health-criteria-table Accessed on June 6, 2016.

[3] Total cPAHs TEQ adjusted for practical quantitation limit based on WAC 173-340-730(5)(c).

5.3.3 Surface-Water Points of Compliance

The POCs for surface water CULs are the point or points where hazardous substances are released to surface water [WAC 173-340-730(6)]. At the Site, hazardous substances are released to surface water from groundwater; thus, the POCs for surface water CULs are where groundwater discharges to surface water.

5.4 Groundwater Cleanup Standards

5.4.1 Endpoints for Cleanup Levels

Groundwater beneath the Lower Yard is considered non-potable (Arcadis 2013a; SLR 2007). As such, the endpoint for CULs is based on the groundwater to surface-water pathway. Groundwater beneath the Lower Yard is hydraulically connected to Willow Creek and Puget Sound. MTCA allows groundwater that is hydraulically connected to surface water to be classified as non-potable if the following five criteria can be met [WAC 173-340-720(2)(d)]:

1. Groundwater does not serve as a current source of drinking water.
2. Ecology concurs that it is unlikely that the hazardous substances will be transported from the contaminated groundwater to groundwater that is or could be a source of drinking water.
3. There are known or projected points of entry of the groundwater into the surface water.
4. Surface water is not classified as a suitable domestic water supply source under WAC 173-201A.

5. Groundwater is sufficiently hydraulically connected to the surface water so that it is not practicable to use the groundwater as a drinking water source.

There are no drinking water supply wells located at the Lower Yard or between the Lower Yard and Puget Sound (SLR 2007). As presented in the 2007 IAWP (SLR 2007), it is unlikely that the hazardous substances at the Lower Yard will be transported to an aquifer that could be used for drinking water (SLR 2007). Groundwater monitoring results demonstrate that the general direction of groundwater flow beneath the eastern part of the Lower Yard is toward Willow Creek, which discharges into Puget Sound, and the general direction of groundwater flow beneath the western part of the Lower Yard is toward Willow Creek and Puget Sound (Arcadis 2013a). Tidal response studies and salinity concentrations in groundwater have shown a hydraulic connection between groundwater beneath the Lower Yard and surface water in Willow Creek (directly connected to Puget Sound) (Arcadis 2013a). Therefore, groundwater beneath the Lower Yard is hydraulically connected to Willow Creek and Puget Sound, neither of which is suitable for domestic water supply.

Based upon the above, the groundwater beneath the Lower Yard is non-potable under WAC 173-340-720(2). The endpoint for groundwater is protection of surface water in Willow Creek and Puget Sound.

5.4.2 Cleanup Levels

The endpoint for groundwater is protection of surface water; therefore, the surface-water CULs presented in Section 5.3.2 establish the groundwater CULs for the Lower Yard.

5.4.3 Groundwater Point of Compliance

Current POCs are defined under to AO No. DE 4460 for interim action; the final POC will be set in a Consent Decree with Cleanup Action Plan. Based on Ecology’s letter dated May 21, 2014 (Ecology 2014a), the POC for groundwater is throughout the Lower Yard. Previously the interim POC for groundwater was established at the site perimeter, where groundwater discharges to surface water, represented by 23 groundwater monitoring wells. Previous interim actions, consisting of excavation of impacted soil in various areas of the Site, have demonstrated that groundwater CULs can be met in a reasonable restoration timeframe in all areas, and groundwater monitoring wells throughout the Site should be used for compliance monitoring (Ecology 2014a). The POC for groundwater was monitored by 52 compliance monitoring wells until 2016: 23 monitoring wells located along the downgradient (western, northwestern, northeastern, and eastern) perimeter of the Lower Yard and 29 interior monitoring wells. MW-E was added to this list early 2017 as an interior monitoring well. The Lower Yard compliance monitoring wells are listed in Table 5-2 and shown on Figure 5-1.

Table 5-2. Groundwater Compliance Monitoring Wells

Perimeter Wells	Interior Wells
LM-2	MW-13U
MW-8R	MW-126
MW-20R	MW-134X
MW-101	MW-143
MW-104	MW-203
MW-108	MW-502
MW-109	MW-503
MW-129R	MW-504
MW-135	MW-505
MW-136	MW-506
MW-139R	MW-507
MW-147	MW-508
MW-149R	MW-509
MW-150	MW-511
MW-500	MW-512
MW-501	MW-513
MW-510	MW-514
MW-518	MW-515
MW-522	MW-516
MW-523	MW-517
MW-524	MW-519
MW-529	MW-520
MW-530	MW-521
	MW-525
	MW-526
	MW-527
	MW-528
	MW-531
	MW-532
	MW-E

The POCs for groundwater are the point or points where hazardous substances are released to surface water [WAC 173-340-730(6)]. At the Site, hazardous substances may be released to surface water from groundwater; therefore, the POCs for groundwater are developed to confirm protection of surface water.

Based on Ecology's letter dated May 21, 2014 (Ecology 2014a), the POCs for groundwater are throughout the Lower Yard and are monitored by compliance monitoring wells including perimeter monitoring wells located along the downgradient (western, northwestern, northeastern, and eastern) perimeter of the Lower Yard and interior monitoring wells. The Lower Yard compliance monitoring wells are further discussed in Section 7.2.3.

5.5 Soil Cleanup Standards

Method B soil CULs are endpoints for the Lower Yard [WAC 173-340-740(3)(b)]. Six possible endpoints must be considered for soil:

1. TEE
2. Direct human contact (incidental ingestion)
3. Leaching to groundwater
4. Residual saturation
5. Inhalation of soil vapors
6. Dermal contact with soil

The soil-to-groundwater-to-surface water pathway is being assessed by empirical demonstration; therefore, the direct contact pathway becomes the most stringent pathway. Soil CULs were establish to be protective of groundwater and are therefore protective of surface water in Willow Creek. CULs protective of the direct contact/dermal contact and leaching to groundwater pathways were calculated using the revised Workbook (MTCATPH11.1 [Appendix C]) and are presented in Section 5.5.2. The remaining endpoints are discussed below. The final soil CULs and RELs, and POCs for soil are summarized in Sections 5.5.2 and 5.5.3, respectively.

5.5.1 Terrestrial Ecological Evaluation for Soil

In 2007, SLR conducted a TEE in accordance with MTCA (WAC 173-304-7490 to 173-304-7493) for the Lower Yard (SLR 2007). The 2007 TEE is included as Appendix D.

The TEE calculated ecological indicator concentrations of 5,000 mg/kg for GRO, 6,000 mg/kg for DRO, 12 mg/kg for total cPAHs TEQ [benzo(a)pyrene used as surrogate], and 132 mg/kg for arsenic in unsaturated soil [WAC 173-340-7493(2)(a)(i)]. No table values exist for HO or benzene. These ecological-based concentrations are greater than or equal to the soil CULs based on direct human contact with soil.

According to the 2007 TEE (Appendix D), institutional controls in the form of deed restrictions will be used to document that any soils exceeding the ecological indicator soil concentrations are capped, that the caps are maintained, and that if the covering are disturbed, contaminated soils are handled appropriately [WAC 173-340-7493(2)(a)(ii)]. The combination of remedial actions, planned development, and institutional controls will minimize wildlife exposure to site-related contaminants.

The 2007 TEE (Appendix D) was reviewed to identify if the information used in the evaluation required updating. This review consisted of comparing site-specific data to the TEE evaluation procedures in WAC 173-340-7490 and the TEE exclusion criteria in WAC 173-340-4791. For industrial and commercial properties, WAC 173-340-7490(3)(b) directs that potential exposure to soil contamination be evaluated in terms of terrestrial wildlife protection. An expanded scope of analysis that includes plants and soil biota is required when soil contamination is located on an area of the evaluated property where vegetation must be maintained to comply with local government land use regulations. No current or proposed local land use regulations require that a vegetated area be maintained on the Site and therefore the expanded scope of analysis is not required at this time.

The 2007 TEE was also compared to the exclusion criteria in WAC 173-340-4791(1) and (2) and considered along with information obtained from the following sources:

- Edmonds Crossing EIS (CH2M HILL 2001).
- WDFW Priority Habitat and Species database.
- Washington State Department of Natural Resources' Natural Heritage Information System.

The information obtained from the sources listed above and the rationale used to establish the ecological indicator concentrations in the 2007 TEE (Appendix D) were also re-evaluated. The ecological indicator concentrations of 5,000 mg/kg for GRO, 6,000 mg/kg for DRO, 12 mg/kg for total cPAHs TEQ [benzo(a)pyrene used as surrogate] are still relevant to the Site. However, an arsenic value of 132 mg/kg is used for Arsenic V. The CUL used for Arsenic III is 7 mg/kg. This will default to 20 mg/kg, the background value.

According to the Comp. Plan (see Section 2.1.5) dated December 2016, the master plan provides for the development of Edmonds Crossing, a multimodal transportation center, at the location of the Lower Yard. The Lower Yard qualifies for exclusion from a TEE if the future land use will cover the Lower Yard with physical barriers to prevent plants and wildlife from being exposed to contamination. An environmental covenant (EC) to maintain the conditions for exclusion from TEE as listed in the 2007 TEE would be required. The planned future use shall include a completion date that is acceptable to Ecology [WAC 173-340-7491(1)(b)].

5.5.2 Direct Human Contact Soil Pathway

Soil CULs for direct human contact were developed in accordance with MTCA Method B, WAC 173-340-740(3)(b)(iii), Equations 740-2 and 740-3, and Ecology's MTCASGL10 spreadsheet (for benzene, total cPAHs TEQ [benzo(a)pyrene equivalents], and arsenic) (SLR 2007) and Ecology's MTCATPH11.1 spreadsheet for petroleum mixtures (Appendix C). No changes were made to the default exposure assumptions in any of the equations. The option for inclusion of dermal contact was not considered for benzene, total cPAHs TEQ, or arsenic, as presented in Section 5.5.7. TPH CUL development did include consideration of dermal contact.

Based on the results of these calculations, the Lower Yard TPH CUL is 2,775 mg/kg. This CUL was calculated based on the median of the 14 fractionated samples collected during the 2003 assessment and interim action (SLR 2007). CULs for the direct contact pathway for benzene and total cPAHs TEQ are based on the MTCA Method B direct contact Equation 740-1 [WAC 173-340-740(3)(b)(iii)(B)]. The arsenic CUL is based on its natural background concentration [WAC 173-340-740-(5)(c) and Table 740-1, footnote b]. These CULs are 18 mg/kg for benzene, 0.14 mg/kg for total cPAHs TEQ, and 20 mg/kg for arsenic. The direct soil contact values are presented in Table 5-3.

Table 5-3. Soil Cleanup and Remediation Levels

IHS	Soil Cleanup Level (mg/kg)
TPH[1]	2,775
Benzene[1]	18
Total cPAHs TEQ[1,2]	0.14
Arsenic[3]	20

Notes:

[1] Proposed soil CUL based on soil direct contact pathway and proposed soil REL based on soil leaching pathway (See 5.5.4).
[2]Total cPAHs TEQ adjusted for toxicity based on WAC 173-340-708(8).
[3] Based on natural background concentrations [WAC 173-340-740(5)(c)].

5.5.3 Soil Points of Compliance

Soil IHS concentrations protective of direct contact and TEE for soil in the Lower Yard will be met within the standard soil POC, which is within 15 feet of the ground surface. Soil CULs are protective of the residual saturation pathway throughout the saturated and unsaturated zones.

5.5.4 Soil Leaching Pathway

To evaluate the leaching to groundwater pathway for TPH, the revised Workbook (MTCATPH11.1 [Appendix C]) uses the three- and four-phase partitioning models described in WAC 173-340-747 to calculate a CUL protective of potable groundwater. However, because groundwater beneath the Site is considered nonpotable, a soil CUL protective of surface-water quality is applicable. The revised Workbook (MTCATPH11.1 [Appendix C]) includes a feature that will calculate a soil CUL that is protective of surface-water quality by entering a target TPH groundwater concentration.

Using the results of the 14 fractionated samples discussed in Section 5.5.2 and a target TPH groundwater concentration of 561.3 µg/L (the average surface-water CUL at the Site calculated with Equation 1 shown in Section 5.3.2 for each TPH concentration of groundwater sampled from October 2008 to June 2014), the revised Workbook (MTCATPH11.1 [Appendix C]) calculated a median value of 100 percent LNAPL. This indicates that the TPH soil CUL exceeds the theoretical maximum TPH that would be reached if all available air space in the porous medium is filled with petroleum product. When 100 percent LNAPL is calculated as the leaching pathway CUL, the revised Workbook (MTCATPH11.1 [Appendix C]) states that "soil-to-groundwater is not a critical pathway."

Therefore, to establish compliance with WAC 173-340-740(3)(b)(iii)(A), an empirical demonstration will be used to show that soil concentrations will not cause an exceedance of groundwater CULs. As defined under WAC 173-340-747(9), the following conditions are required for the empirical demonstration:

- The measured groundwater concentration is less than or equal to the applicable groundwater CUL established under WAC 173-340-720.
- The measured soil concentration will not cause an exceedance of the applicable groundwater CUL established under WAC 173-340-720 at any time in the future. Specifically, it must be demonstrated that a sufficient amount of time has elapsed for migration of hazardous substances from soil into groundwater to occur and that the characteristics of the Site (e.g., depth to groundwater and infiltration)

are representative of future site conditions. This demonstration may also include a measurement or calculation of the attenuating capacity of soil between the source of the hazardous substance and the groundwater table using site-specific data.

Compliance monitoring will assess whether the empirical demonstration has been successful.

5.5.5 Soil Residual Saturation

When LNAPL such as petroleum hydrocarbons is released to soil, some of the liquid will dissolve in the soil pore water, some will adsorb to the soil particles, some will vaporize in the soil pore air, and some will be held by capillary force in liquid form LNAPL in the soil pore spaces. The threshold concentration at which LNAPL becomes continuous in the soil pore space is called the Csat. At concentrations less than Csat, LNAPL exists in small, isolated blebs. The concentration at which the isolated LNAPL blebs become connected to form streamers is called residual saturation. At concentrations less than residual saturation, the isolated blebs are relatively immobile. At concentrations greater than residual saturation, the LNAPL streamers can migrate downward under the force of gravity and the LNAPL can reach groundwater if a sufficient volume is present.

The 2007 IAWP (SLR 2007) evaluates soil residual saturation, considering default residual Csat values of 1,000 mg/kg for GRO and 2,000 mg/kg for DRO from MTCA Table 747-5. Data for additional soil types indicate that residual Csat values for silt to fine sand (the predominant soil type in the unsaturated zone) can range as high as 9,643 mg/kg for GRO and 22,857 mg/kg for DRO. Residual Csat values for fine to medium sand (the predominant soil type in the saturated zone) can range as high as 5,625 mg/kg for GRO and 13,333 mg/kg for DRO. The 2007 IAWP (SLR 2007) does not use residual saturation to establish soil RELs and CULs.

An empirical demonstration may be used to show that LNAPL in soil is not impacting groundwater, if the following three criteria can be met [WAC 173-340-747(10)(c)]:

1. LNAPL is not accumulating on or in groundwater.
2. Soil contamination has been present sufficiently long for LNAPL to reach groundwater.
3. Site conditions will not change in the future to promote LNAPL migration.

LNAPL is no longer present at the Site, except in three areas located in the central Lower Yard; near DB-2, near the WSDOT line and locally in the eastern portion of the central Lower Yard (see Section 4.2.2). Because LNAPL is not present where the soil RELs were met, the soil RELs are considered protective of groundwater for the residual saturation pathway. Ongoing groundwater monitoring will continue to assess the presence or absence of LNAPL in the monitoring wells and piezometers. The direct contact TPH concentration is assumed to be less than Csat.

5.5.6 Soil Vapor Pathway

WAC 173-340-740(3)(b)(iii)(C) identifies conditions that determine if an evaluation of the soil to vapor pathway is required. These conditions include:

- For GRO, whenever the TPH concentration is significantly higher than a concentration derived for protection of groundwater for drinking water beneficial use under WAC 173-340-747(6) using the default assumptions.
- For DRO, whenever the TPH concentration is greater than 10,000 mg/kg.
- For other VOCs, including petroleum components, whenever the concentration is significantly higher than a concentration derived for protection of groundwater for drinking water beneficial use under WAC 173-340-747(4).

DRO concentrations in site soil have been detected greater than 10,000 mg/kg. Additionally, GRO and VOCs have been detected in site soil at concentrations greater than the concentrations derived for protection of groundwater for drinking water beneficial use, which (under MTCA) requires further evaluation of the soil to vapor pathway.

WAC 173-340-740(3)(c)(iv)(B) lists the methods available under MTCA to evaluate if soil CULs are protective of the indoor or ambient air. These methods include:

- Measuring site-specific soil vapor concentrations and demonstrating that they do not exceed air CULs established in WAC 173-340-750.
- Measuring ambient air concentrations and/or indoor air vapor concentrations throughout buildings, using methods approved by Ecology, demonstrating that air does not exceed CULs established under WAC 173-340-750.
- Use of modeling methods approved by Ecology to demonstrate that the air cleanup standards established under WAC 173-340-750 will not be exceeded.
- Other methods approved by Ecology demonstrating that the air cleanup standards established under WAC 173-340-750 will not be exceeded.

As discussed in Section 3.2, soil vapor sampling was conducted in 2013 to evaluate worst-case scenario vapor intrusion and to support remedial strategy decisions at the Lower Yard. Based on the results of the 2013 soil vapor sampling, it was identified that the further evaluation of the soil vapor pathway is necessary if the land use changes from its current approved use.

5.5.7 Soil Dermal Contact Pathway

Dermal contact with the IHSs must be evaluated if changes have been made to MTCA Method B direct contact equations, WAC 173-340-740, Tables 740-1 and 740-2 [WAC 173-340-740(3)(c)(iii)]. No changes were made to the equation for calculating CULs for benzene, total cPAHs TEQ, or arsenic (Equation 740-2). The dermal contact pathway is included in the equation for calculation of TPH direct contact CULs, Equation 740-3.

5.6 Summary of Soil and Groundwater Cleanup Levels

Water and soil CULs are summarized in Tables 5-1 and 5-2. The soil CULs of 2,775 mg/kg for TPH, 18 mg/kg for benzene, and 0.14 mg/kg for total cPAHs TEQ are based on direct contact. The soil CUL of 20 mg/kg for arsenic is based on the natural background concentration.

The groundwater CULs are based on protection of surface water, using a weighted average of the Method A groundwater CULs for GRO, DRO, and HO, and considering the composition of TPH in groundwater beneath the Lower Yard using Equation 1. The groundwater CULs (16 μg/L for benzene and 0.05 μg/L for total cPAHs TEQ) are based on the protection of surface water and consider the human consumption of aquatic animals. Arsenic is not an IHS for groundwater.

6 DEVELOPMENT OF REMEDIAL ALTERNATIVES

Interim actions have achieved soil and groundwater remediation levels and cleanup levels over much of the Site. Statistical analyses of soil compliance monitoring samples collected during the interim actions conducted to date are presented in Appendix E. These analyses show that the interim actions have achieved remediation levels and cleanup levels for TPH, benzene, and cPAH in the areas where the interim action have been conducted. There are only four isolated soil samples that exceed a remediation level or a cleanup level, and these are not statistically significant. The four isolated samples are described below.

- Monitoring well MW-129R with a concentration of TPH of 3,007 mg/kg less than twice than the current site REL for TPH of 2,775 mg/kg
- Excavation soil samples EX-B18-VV-1-6SW and SWLY-D-3 Wall-3.75 with TPH concentrations of 4,980 and 2,923 mg/kg, respectively less than twice than the current site REL for TPH of 2,775 mg/kg
- Excavation soil sample EX-B1-F-44-4 with a total cPAH TEQ concentration of 0.212 mg/kg less than twice than the site total cPAHs TEQ CUL of 0.14 mg/kg.

MTCA compliance assessment, WAC-173-340-740(7), requires the 95 percent upper confidence limit on the mean be less than the CUL, with less than 10 percent of the samples exceeding the CUL and no single sample exceeding twice the CUL. These four soil exceedances are isolated and less than twice than the site REL and CUL. More than 1,000 samples were collected on a 25-foot grid pattern thorough the Lower Yard (See Figure 4-2). This systematic sampling design is an unbiased approach that results in COC concentrations representative of average exposure conditions across the entire Lower Yard. Only the four exceedances described above, corresponding to less than 0.5 percent of the samples, are recorded thorough the Lower Yard out of the areas that will be further remediated (DB-2 and the area surrounding the WSDOT line). Per WAC-173-340-740(7), these four soil samples are not statistically significant (See Appendix E) and further remediation activities are not required by MTCA. In addition, the monitoring wells in the immediate vicinity of these locations show no groundwater impacts indicating that these isolated soil exceedances are protective of the soil leaching pathway.

Groundwater monitoring data are presented in progress reports submitted monthly, and groundwater monitoring will continue during the dual-phase extraction system operation.

Potential treatment technologies were developed to define the actions that may be taken, either individually or in combination, to achieve CULs where soil and groundwater contamination still exists on-site exceeding cleanup levels. As described in Section 4.2, the remaining impacts to soil and groundwater to consider for remedial treatment are limited to the following areas (Figures 4-1, 4-2, and 4-3; Table 2-4):

- *WSDOT stormwater line and Point Edwards storm drain*: Twelve sample locations in soil along the WSDOT stormwater line and two sample locations in soil along the Point Edwards storm drain contain soil with COC concentrations greater than site CULs and/or RELs. Most of these sample locations are under the construction easement placed by the WSDOT to restrict the current and/or future activities within 25 feet on each side of the WSDOT stormwater line (Figure 6-1).
- *DB-2 area*: Free-phase and/or residual LNAPL was encountered in the DB-2 area. Additionally, 11 sample locations contain soil with COC concentrations greater than site CULs and/or RELs.

The potentially applicable technologies to address remaining impacts near the WSDOT stormwater line and DB-2 area are discussed below. These technologies are consistent with WAC 173-340-350(8)(b) Screening of Alternatives and were derived from the Federal Remediation Technologies Roundtable's Remediation Technologies Screening Matrix (U.S. Army Corps of Engineers [USACE] 2002; www.frtr.gov) and the project team's professional experience. Per Ecology's request, potential remedial technologies for the Site include:

- Environmental covenant (EC)
- Groundwater MNA
- Excavation
- In-situ solidification (ISS)
- Enhanced anaerobic bio-oxidation (ABOx)
- Surfactant flushing
- Groundwater containment system using groundwater extraction wells
- Groundwater containment system using groundwater extraction trench
- LNAPL barrier trench with reactive core mat
- Funnel and gate system with in-situ remediation
- Funnel and gate system with groundwater extraction
- Soil and groundwater treatment using DPE.

Arcadis performed an initial screening of the technical implementability of each technology type to eliminate less viable technologies before performing a more rigorous screening and evaluation process. Technical implementability refers to the ability of a remedial action or process to meet a cleanup goal or level. The initial screening also eliminates those technologies or process options that are not applicable based on the site COCs and site-specific characteristics. As a result, remedial technologies that cannot be effectively implemented were eliminated from further consideration.

The potential remedial technologies and preliminary screening are described in Table 6-1.

6.1 Description of Possible Remedial Technologies

This section summarizes the remedial technologies presented in Table 6-1 that were developed and evaluated for the Lower Yard.

6.1.1 Remedial Technology 1: Environmental Covenant

An administrative control, such as an EC, may be an effective means of managing exposure to site contaminants. EC alone would not meet the minimum requirements of WAC 173-340-360, but may be used to supplement other technologies.

An EC is a type of restrictive covenant, and per WAC 173-340-440 (9) would (where required):

- Prohibit activities at the Site that may interfere with a cleanup action, operation and maintenance, monitoring, or other measures necessary to assure the integrity of the cleanup action and continued protection of human health and the environment.
- Prohibit activities that may result in the release of a hazardous substance that was contained as part of the cleanup action.
- Require notice to Ecology of the owner's intent to convey any interest in the Site. No conveyance of title, easement, lease, or other interest in the Site would be consummated by the owner without adequate and complete provision for the continued operation, maintenance, and monitoring of the cleanup action, and for continued compliance with this requirement.
- Require the owner to restrict leases to uses and activities consistent with the restrictive covenant and notify all lessees of the restrictions on the use of the Site.
- Require the owner to include in any instrument conveying any interest in any portion of the Site, notice of the restrictive covenant.
- Require notice and approval by Ecology of any proposal to use the Site in a manner that is inconsistent with the restrictive covenant. If Ecology, after public notice and comment approves the proposed change, the restrictive covenant would be amended to reflect the change.
- Grant Ecology and its designated representatives the right to enter the Site at reasonable times to evaluate compliance with the cleanup action plan and other required plans, including the right to take samples, inspect any remedial actions taken at the Site, and inspect records.

This technology does not involve the implementation of active remedial activities to remove, treat, or contain COCs at the Site and is not a stand-alone technology. Minimal long-term maintenance would be required. This remedial technology can be used to supplement the technology selected as a preferred alternative.

6.1.2 Remedial Technology 2: Groundwater Monitored Natural Attenuation

Monitored natural attenuation (MNA) is defined as the reliance on natural attenuation processes (within the context of a carefully controlled and monitored site cleanup approach) to achieve site-specific remediation objectives within a timeframe that is reasonable compared to that offered by other, more active methods. The natural attenuation processes include a variety of physical, chemical, or biological processes that, under favorable conditions, act to reduce the mass, toxicity, mobility, volume, or concentration of COCs in groundwater. These in-situ processes include diffusion, dilution, sorption, biodegradation, volatilization, and chemical biological stabilization, transformation, or destruction of COCs. According to the technical guidance published by the Interstate Technology Regulatory Council (ITRC, 2009) and published rates of LNAPL source zone depletion measured at other sites (Sale and Zimbron, 2013), natural attenuation of LNAPL can take up to 60 years. To be conservative, a period of 60 years will therefore be considered for any natural attenuation of LNAPL source zone depletion for the Site.

The natural attenuation processes are typically occurring at all sites, but to varying degrees of effectiveness depending on the types and concentrations of contaminants present, and the physical, chemical, and biological characteristics of the soil and groundwater. Analytical and biogeochemical data indicate that natural attenuation is occurring at the Site.

This technology does not involve the implementation of active remedial activities to remove, treat, or contain COCs at the Site; natural attenuation processes would reduce chemical concentrations through time. Compliance monitoring would be performed to assess whether the natural attenuation processes are occurring at a sufficient rate to achieve compliance within an acceptable restoration timeframe

This technology is not acceptable as a stand-alone alternative because treatment would not be addressed within a reasonable timeframe. However, this technology is retained for detailed analysis for use in conjunction with other technologies in establishing remedial alternatives.

6.1.3 Remedial Technology 3: Excavation

Excavation is an effective way to meet CULs because contaminants would be physically removed from the Site. This technology has been used extensively at the Site and has been both implementable and effective at removing impacted soil and reducing dissolved-phase petroleum hydrocarbon concentrations in groundwater to below CULs.

Water ingress into the excavation must be evaluated and managed when excavation occurs beneath the groundwater table. If excavating beneath the water table with freestanding water is not feasible due to project conditions (when workers are required to enter the excavation), dewatering would be used. Dewatering is the removal of freestanding water from excavations using submersible "dewatering" pumps, centrifugal ("trash") pumps, or application of vacuum to adjacent well points. Dewatering and shoring would likely be required for excavation at the Site. Excavation can be implemented with minimal exposure of workers to soil and airborne contaminants through the use of personal protective equipment and proper health and safety planning such as the use of dust suppression measures.

This technology could be used to address free-phase and/or residual LNAPL as well as the remaining soil impact in the DB-2 area. Excavation could also be used to physically remove soil surrounding the WSDOT stormwater line; however, most of the soil-impacted locations are under the construction easement placed by the WSDOT to restrict the present /future activities within 25 feet on each side of the WSDOT stormwater line. In addition, the risk of compromising the structural integrity of the line should be evaluated when assessing this remedial technology. This technology is retained for further consideration.

6.1.4 Remedial Technology 4: In-Situ Solidification

ISS provides long-term protection of human health and the environment through physical contaminant sequestering. This technology involves mixing binding agents (typically Portland cement) into the soil. The resulting mixture of soil and binding agent encapsulates the wastes and forms a low-permeability solid. In addition to the encapsulating effect of ISS, the addition of binding agents can improve the engineering strength properties of the soil. Once the treated soil has cured, it acts as a physical barrier between the ground surface and the untreated soil beneath the treated soil. For remediation mixing depths less than 20 feet bgs, conventional backhoes and excavators are the simplest and most common method used to mix the binding agents into the soil.

This technology could be used to address remaining soil impact in DB-2 area or surrounding the WSDOT stormwater line; however, most of the soil-impacted locations in the WSDOT area are under the construction easement placed by the WSDOT to restrict the current or future activities within 25 feet on each side of the WSDOT stormwater line. In addition, the risk of compromising the structural integrity of the line should be evaluated when assessing this remedial technology. This technology is retained for further consideration.

6.1.5 Remedial Technology 5: Enhanced Anaerobic Bio-Oxidation

Engineered ABOx applications entail delivery of soluble electron acceptors other than oxygen to petroleum hydrocarbon release sites to stimulate biodegradation. A review of biogeochemical data from multiple petroleum hydrocarbon release sites demonstrates that groundwater conditions are predominantly anaerobic based on the availability of petroleum hydrocarbon impacts and background electron acceptors (e.g., nitrate, ferric iron, sulfate). In many instances, the abundance of background sulfate and favorable reaction yield (i.e., mass of petroleum hydrocarbons degraded per mass of sulfate used) allows ABOx via sulfate reduction to serve as the dominant terminal electron accepting process and can account for a majority of the natural biodegradation capacity (Wiedemeier et al. 1999).

This technology would include installation of approximately 15 injection wells with approximately 40-foot centers within the unexcavated footprint surrounding DB-2. Magnesium sulfate and sodium nitrate would be injected into the subsurface semiannually for approximately 5 years to enhance ABOx. Groundwater monitoring would be performed to evaluate changes in biogeochemical data and VOC concentrations in groundwater.

ABOx is an approach that is typically reserved for sites where dissolved-phase concentrations remain in groundwater where petroleum hydrocarbon source material has been depleted or remediated. ABOx injections would not address residual LNAPL in vadose zone soil. Additionally, injection rates may be slow based on site-specific groundwater flux calculations.

Remedial Technology 5: Enhanced ABOx was eliminated from further consideration because it does not remove or treat LNAPL and would have to be coupled with excavation to meet terms of the AO.

6.1.6 Remedial Technology 6: Surfactant Flushing

Surfactant injection and subsequent extraction has been successfully used as an alternative soil and groundwater remediation solution at LNAPL-impacted sites in recent years. Surfactant reduces surface tension between LNAPL and groundwater, creating micelles to more readily remove LNAPL with vacuum extraction. Other advantages of surfactant injection include increased biodegradation following LNAPL removal (Paria 2008). Several studies indicate a temporary increase in the solubility of LNAPL and an increased dissolution of molecules in the aqueous phase, which increases the bioavailability to microorganisms.

This technology consists of the addition of surfactants into the subsurface to enhance LNAPL recoverability and its removal. A 4 percent biosurfactant solution would be gravity fed into injection locations selected near DB-2 area. A mobile vacuum event would remove a minimum of three times the injected volume at each injection location and injected wells would be monitored to determine the frequency and extent of recurring measurable LNAPL. Two piezometers would be installed: one downgradient and one crossgradient from the estimated LNAPL boundary to monitor and address potential LNAPL migration during treatment.

Surfactant flushing was eliminated from further consideration because the technology would be difficult to implement. Injection rates would be slow based on site-specific groundwater flux calculations, causing a slow remediation timeframe. Downgradient monitoring would be difficult to implement because Willow Creek is located adjacent and downgradient (<25 feet) from the remaining LNAPL impacts. This technology would not address remaining impacts in soil and would have to be coupled with excavation to meet direct contact CULs and terms of AO No. DE 4460; therefore, this technology was eliminated from further consideration.

6.1.7 Remedial Technology 7: Groundwater Containment System Using Groundwater Extraction Wells

This technology consists of extracting contaminated groundwater through extraction wells and treating extracted groundwater at the surface using a variety of methods (e.g., OWSs, air strippers, filters, and granular activated carbon [GAC]) prior to discharge.

The groundwater extraction wells would be installed at the downgradient site boundary to contain COCs and control plume migration offsite. The system would be designed to allow for expansion. Based on preliminary flux data and groundwater modeling, approximately six wells would be installed downgradient from MW-510. Wells would be advanced to a depth of approximately 15 to 20 feet bgs (maximum historical excavation depth) at a combined average pumping rate of approximately 3 to 5 gallons per minute (gpm).

This technology is effective in controlling offsite migration of COCs and LNAPL to the adjacent surface water body. LNAPL and groundwater would be extracted and treated prior to discharge. This strategy would be coupled with MNA and ECs to meet direct contact CULs and the terms of AO No. DE 4460, and to address remaining petroleum hydrocarbon-related impacts left in place near the WSDOT stormwater line. Remedial Technology 7 is retained for further consideration.

6.1.8 Remedial Technology 8: Groundwater Containment System Using Groundwater Extraction Trench

This remedial technology is similar to Remedial Technology 7. However, for this remedial technology, a series of groundwater extraction sumps within a groundwater extraction trench with high-permeability backfill would be installed. The trench would be excavated along the northeast and northwest boundaries of DB-2 to approximately 15 feet bgs.

This technology would be effective in controlling offsite migration of COCs and LNAPL to the adjacent surface-water body. LNAPL and groundwater would be extracted and treated prior to discharge. MNA and ECs would be required to meet direct contact CULs and the terms of AO No. DE 4460, and to address remaining petroleum-related hydrocarbons in soil left in place near the WSDOT stormwater line. Remedial Technology 8 is retained for further consideration.

6.1.9 Remedial Technology 9: Light Nonaqueous Phase Liquid Barrier Trench with Reactive Core Mat

This technology includes construction of a barrier trench constructed downgradient from DB-2 to stop offsite migration of LNAPL. The LNAPL barrier trench would be constructed with a reactive core mat to essentially lock LNAPL in place and ensure that no offsite migration occurs. When LNAPL comes into contact with the reactive core mat, it eventually becomes an impenetrable barrier. The reactive core mat would allow groundwater to flow through the barrier in areas where LNAPL is not present. However, where LNAPL is present, the barrier would essentially become an impermeable wall. Several LNAPL collection sumps would be installed within the trench to passively remove LNAPL through manual bailing or pumping.

The barrier would prevent horizontal LNAPL discharge to the adjacent surface water; however, because this technology does not include source removal, LNAPL would remain in place through time. Remedial Technology 9 was eliminated from further consideration because it is does not meet compliance requirements and terms of the AO.

6.1.10 Remedial Technology 10: Funnel and Gate System with In-Situ Remediation

This technology consists of low hydraulic conductivity cutoff walls that may be constructed of sheet piling or organoclay mats with gaps that contain in-situ remediation zones where air sparge wells target the plume. The cutoff walls (the funnel) would modify flow patterns so that groundwater would flow primarily toward the higher permeability gates, where a series of sparge wells would treat the groundwater plume through volatilization and aerobic degradation. The remediated groundwater would then flow through the downgradient side of the gate. The funnel and gate system would isolate LNAPL and the dissolved-phase plume in groundwater and effectively funnel the plumes through an in-situ remediation zone.

Site-specific conditions would not allow for an adequately sized in-situ reactive zone within and downgradient from the gate. The highly weathered nature of the LNAPL onsite is not amenable to a volatilization remediation strategy leading to potential offsite migration of the LNAPL. Additionally, this technology is not adaptable to changing conditions and does not treat LNAPL within a reasonable restoration timeframe. Therefore, Remedial Technology 10 was eliminated from further consideration.

6.1.11 Remedial Technology 11: Funnel and Gate System with Groundwater Extraction

This technology would consist of permeable sorptive walls constructed with an organoclay mat. The organoclay in the permeable sorptive walls (the funnel) would adsorb LNAPL until it reaches adsorption capacity. The remediated groundwater would then flow through the downgradient side of the gate where any remaining dissolved-phase hydrocarbons or LNAPL would be extracted and treated ex-situ. The funnel and gate system would isolate LNAPL and dissolved-phase plumes in groundwater and effectively funnel the plumes toward the extraction zone.

Based on pumping test data, this technology would not likely be effective due to the limited groundwater flux across the site boundary caused by dampening tidal effects and recharge from Willow Creek. The funnel and gate with permeable sorptive walls technology was eliminated from further consideration because it would not be effective and would not remove LNAPL observed in soil near DB-2 within reasonable restoration timeframe.

6.1.12 Remedial Technology 12: Soil and Groundwater Treatment using Dual-Phase Extraction

DPE is a remedial technology that relies on mass transfer and subsequent extraction to reduce mass of residual LNAPL within vadose zone and smear zone soils in the subsurface and reduce soil concentration of petroleum. Residual LNAPL is defined as LNAPL that is occluded by the aqueous phase, occurring as immobile ganglia surrounded by aqueous phase in the pore space or as immobile, non-water-entrapped LNAPL that does not drain from the pore spaces (White 2004). Historical soil and groundwater concentrations and historical occurrence of measureable LNAPL observed prior to Lower Yard excavation activities are indicative of residual LNAPL. Mass transfer of residual LNAPL occurs to both the dissolved phase and vapor phase. However, mass transfer is highly preferential to the vapor phase due to the volatile nature of its components. Dissolved phase mass transfer is limited by the component's solubility in water. Successful DPE application relies on the ability to improve mass transfer to the vapor phase through three mechanisms:

1. Lowering the water table to expose the residual LNAPL to surrounding vapor.
2. Drawing vapor through the impacted area.
3. Removing the vapor phase from the subsurface and treating both soil vapor and groundwater ex situ.

DPE systems typically use a network of remediation wells adequately spaced to dewater the target zone through the operation of pneumatic or electric pumps. The groundwater is pumped to a remediation compound housing a groundwater treatment train that may include a settling tanks, bag filters, and GAC vessels prior to discharge. Soil vapor is collected using a regenerative or positive displacement blower sized to induce vacuum from the remediation well on surrounding soil. The vapor stream passes through a condensation knockout tank before treatment by either a catalytic oxidizer or GAC and vented to ambient air.

Implementation of this strategy would involve pilot testing, installation, and operation of a DPE system within the targeted area. A DPE system would be appropriate to remediate remaining soil impacts surrounding the WSDOT stormwater line, and would act as a groundwater intercept system ensuring that offsite migration of dissolved-phase COCs does not occur. This technology would have to be coupled with excavation in the DB-2 area to meet direct contact CULs and the terms of AO No. DE 4460. Remedial Technology 12 is retained for further consideration.

6.2 Summary of Retained Remedial Alternatives

Remedial technologies that passed initial screening were selected as remedial alternatives for further analysis under MTCA requirements. The selected six remedial alternatives include:

- Alternative 1: Excavation and MNA with ECs

- Alternative 2: Groundwater Containment System Using Groundwater Extraction Wells, and MNA with ECs
- Alternative 3: Groundwater Containment System Using Groundwater Extraction Trench, and MNA with ECs
- Alternative 4: Excavation and limited ECs
- Alternative 5: Excavation, ISS and MNA with ECs
- Alternative 6: Excavation, DPE treatment and limited ECs

These remedial alternatives are further described in Section 6.3 and are evaluated in Section 7.

6.3 Description of Retained Remedial Alternatives

The groundwater flow model used to design the six potential remedial alternatives is described in Section 6.3.1; the six potential remedial alternatives are described in Sections 6.3.2 through 6.3.7.

6.3.1 Groundwater Flow Model

Together with current and available construction and scientific accepted practices, a calibrated groundwater flow model for the Site (Appendix F) was used to design the selected six potential remediation scenarios. However, site heterogeneity required that several parameters be estimated during calculations. Therefore, to best manage the uncertainty in predicted quantities, a pilot study will be performed in a portion of the target cleanup zone to collect field data needed to complete the final design of the preferred remedy.

Internal boundary conditions such as extraction wells, high hydraulic conductivity zones, or vertical flow barriers were added to the site groundwater flow model as necessary to simulate each alternative. After the internal boundary conditions were added, the site groundwater flow model was run at steady-state conditions to estimate average flow rates and predict resulting changes in groundwater flow patterns. External boundary conditions were also modified during evaluation of the potential remedial alternatives to predict potential groundwater flow rates and patterns that may occur under high tide conditions and extreme rainfall events. High tides were simulated by raising the assigned constant head elevation by 5 feet. The extreme rainfall event incorporated both a high tide condition and a doubling of assigned recharge rates.

For hydraulic containment alternatives (i.e., Alternatives 2 and 3), the site groundwater flow model was used to estimate the extent of the capture zone resulting from hypothetical groundwater extraction. A “capture zone” is defined as the spatial area that contributes groundwater to the pumping system; in other words, a capture zone is an area of hydraulic containment. The objective of these simulations was to adjust the locations of the simulated extraction wells or interceptor trenches, and to adjust the simulated groundwater extraction rates until the shape of the predicted capture zone fully encompassed the target remediation area.

For the soil excavation area alternatives (i.e., Alternatives 1, 4, and 5), the site groundwater flow model (Appendix F) was used to estimate the construction dewatering rates that would be required during remediation.

For the DPE alternative (i.e., Alternative 6), two DPE pilot tests were performed during first quarter 2015 and the DPE Pilot Test Summary is provided in Appendix G.

6.3.2 Alternative 1: Excavation and Monitored Natural Attenuation with Environmental Covenants

Remedial Alternative 1 involves excavating remaining impacts below the water table near DB-2 from the approximate area shown on Figure 6-2 using conventional soil excavation and construction dewatering equipment. Impacted soil and LNAPL in the area of DB-2 would be excavated, removed from the Site, and transported to an appropriate waste disposal facility. Excavation in the DB-2 area was successfully implemented during previous soil excavations performed onsite; therefore, this alternative is considered practicable.

It is theoretically possible to excavate the remaining impacts near DB-1 and DB-2 using a construction dewatering strategy that would require an average pumping rate of approximately 10 gpm. High tide or short-duration rainfall events may result in the need for excavation dewatering at an average rate of 23 gpm. Extensive shoring and sheet pile installation are not required for this remedial strategy. However, it is anticipated that a Joint Aquatic Resources Permit Application and accompanying Hydraulic Project Approval through the USACE and the WDFW would be required. During excavation of soil near DB-2, Willow Creek would be coffer dammed to prevent unplanned discharges to the creek and Puget Sound. Based on the groundwater model, standard best practices for dewatering using suction pumps or submersible pumps could be used.

A MNA sampling program would be initiated following DB-2 excavation to address soil and groundwater impacts along the WSDOT stormwater line. MNA sampling would include annual sampling of dissolved phase COC data and biogeochemical data along a transect of wells. This program would be implemented until dissolved phase COC concentrations are reduced below CULs.

ECs would be used to protect human health and the environment at the Site and will:

- Cover the entire Site including the area already covered by the construction easement signed in October 1971 by the Washington State's Attorney General's Office and Unocal and shown on Figure 6-1.
- Protect against direct contact with impacted soil or groundwater remaining at the Site by including a soil management plan.
- Protect against vapor pathway by providing guidance for potential future ground construction activities (e.g., installation of vapor barriers) and require a new soil vapor assessment if the land use changed from its current approved use.
- Maintain the Site under an industrial or commercial use compatible with the purchase and sale agreement with the WSDOT.
- Specifically, address subsurface use in the impacted area adjacent to the stormwater line and help guide potential future aboveground construction activities (e.g., installation of vapor barriers, building a structure over the storm drain).
- Maintain the conditions for exclusion from TEE as listed in the 2007 TEE.

- Restrict groundwater use.
- Require long-term maintenance and/or monitoring.

This scenario is based on the following assumptions and limitations:

- The total depth of the construction dewatering system would need to be approximately 15 to 20 feet bgs.
- The intake portion of the construction dewatering system would need to extend to an elevation of approximately 0.25 foot amsl or lower (i.e., drain elevation).
- Faster dewatering rates during the initial phase of excavation may be required.
- The potential exists for pumping-induced saltwater intrusion to further degrade groundwater quality.
- The land use is the current approved use.
- MNA is based on published rates of LNAPL source zone depletion.

6.3.3 Alternative 2: Groundwater Containment System Using Groundwater Extraction Wells, and Monitored Natural Attenuation with Environmental Covenants

Remedial Alternative 2 involves hydraulic containment of remaining impacts near DB-2, as shown on Figure 6-3, using a series of six groundwater extraction wells along the downgradient property boundary northwest of DB-2 to recover and treat groundwater that contains hydrocarbon concentrations greater than the CULs. A conceptual layout of the six groundwater extraction wells and the resulting predicted capture zone are shown on Figure 6-3.

It is theoretically possible to hydraulically contain the remaining impacts near DB-1 and DB-2 using groundwater extraction wells pumping at a long-term average combined rate of approximately 3 to 5 gpm, which would include both high-tide conditions and short-duration rainfall events. The layout of the wells and the pumping footprint minimize well interference and ensure an adequate capture zone. Based on groundwater modeling, extraction wells containing pumps would be installed on approximately 40-foot centers. The theoretical groundwater pumping rate would be verified through additional pilot testing. The 3 to 5 gpm total would require a groundwater treatment system that would include an OWS, air stripper, and series of GAC vessels. These system components would be designed to handle more than 5 gpm and would operate for 24 hours per day. System controls and automatic shutoff alarms would ensure that untreated groundwater will not discharge into Willow Creek. Based on the overall pumping rates and system components, a smaller overall system treatment capacity would be required for Alternative 2 compared to Alternative 3.

Since the containment system does not directly remediate source zone LNAPL, an MNA sampling program would be initiated in conjunction with the system. MNA would address the remaining soil and groundwater impacts across the Site. MNA sampling would include annual sampling of dissolved phase COC data and biogeochemical data along a transect of wells. This program would be implemented until dissolved phase COC concentrations are reduced below CULs.

ECs would be used to protect human health and the environment at the Site and will:

- Cover the entire Site including the area already covered by the construction easement signed in October 1971 by the Washington State's Attorney General's Office and Unocal and shown on Figure 6-1.
- Protect against direct contact with impacted soil or groundwater remaining at the Site by including a soil management plan.
- Protect against vapor pathway by providing guidance for potential future ground construction activities (e.g., installation of vapor barriers) and require a new soil vapor assessment if the land use changed from its current approved use.
- Maintain the Site under an industrial or commercial use compatible with the purchase and sale agreement with the WSDOT.
- Specifically, address subsurface use in the impacted area adjacent to the stormwater line and help guide potential future aboveground construction activities (e.g., installation of vapor barriers, building a structure over the storm drain).
- Maintain the conditions for exclusion from TEE as listed in the 2007 TEE.
- Restrict groundwater use.
- Require long-term maintenance and/or monitoring.

This scenario is based on the following assumptions and limitations:

- Extraction wells would need to be installed to total depths of approximately 15 to 20 feet bgs.
- The intake portion of the extraction wells would need to extend to an elevation of approximately 0.25 foot msl or lower (i.e., drain elevation).
- Extraction wells are 100% efficient.
- The potential exists for pumping-induced saltwater intrusion to further degrade groundwater quality.
- The land use is the current approved use.
- MNA is based on published rates of LNAPL source zone depletion.

6.3.4 Alternative 3: Groundwater Containment System Using Groundwater Extraction Trench, and Monitored Natural Attenuation with Environmental Covenants

Remedial Alternative 3 involves hydraulic containment of remaining impacts near DB-2 as shown on Figure 6-4 using a groundwater interceptor trench. A conceptual layout of the groundwater interceptor trench and the resulting predicted capture zone is also shown on Figure 6-4. Alternative 3 present the same elements that Alternative 2. However, under Alternative 3; in lieu of a series of groundwater extraction wells, a groundwater interceptor trench with high-permeability backfill would be installed.

It is theoretically possible to hydraulically contain the remaining impacts near DB-1 and DB-2 using a groundwater interceptor trench pumping at a long-term average rate of approximately 4 to 7 gpm, which would include both high-tide conditions and short-duration rainfall events. The location and layout of the trench requires a higher overall extraction rate compared to the groundwater extraction system using extraction wells under Alternative 2. The layout of the trench, running along the northeast and northwest boundaries of DB-2, will minimize the likelihood of saltwater intrusion. The theoretical groundwater pumping rate would be verified through additional pilot testing using a smaller section of interceptor trench. The 4 to 7 gpm total would require a groundwater treatment system that would include an OWS, air stripper, and series of GAC vessels. These system components would be designed to handle more than 7 gpm and would operate for 24 hours per day. System controls and automatic shutoff alarms would ensure that untreated groundwater will not discharge into Willow Creek. Based on the greater volume of water to be treated from Alternative 3, system components would need to be sized to handle a larger total volume of water than for Alternative 2.

As with Alternative 2, Alternative 3 also does not directly remediate source zone LNAPL, an MNA sampling program would be initiated in conjunction with the system. MNA would address the remaining soil and groundwater impacts across the site. MNA sampling would include annual sampling of dissolved phase COC data and biogeochemical data along a transect of wells. This program would be implemented until dissolved phase COC concentrations are reduced below CULs.

ECs would be used to protect human health and the environment at the Site and will:

- Cover the entire Site including the area already covered by the construction easement signed in October 1971 by the Washington State's Attorney General's Office and Unocal and shown on Figure 6-1.
- Protect against direct contact with impacted soil or groundwater remaining at the Site by including a soil management plan.
- Protect against vapor pathway by providing guidance for potential future ground construction activities (e.g., installation of vapor barriers) and require a new soil vapor assessment if the land use changed from its current approved use.
- Maintain the Site under an industrial or commercial use compatible with the purchase and sale agreement with the WSDOT.
- Specifically, address subsurface use in the impacted area adjacent to the stormwater line and help guide potential future aboveground construction activities (e.g., installation of vapor barriers, building a structure over the storm drain).
- Maintain the conditions for exclusion from TEE as listed in the 2007 TEE.
- Restrict groundwater use.
- Require long-term maintenance and/or monitoring.

This scenario is based on the following assumptions and limitations:

- The interceptor trench would be installed to a total depth of approximately 15 to 20 feet bgs.
- The intake portion of the interceptor trench would need to extend to an elevation of approximately 0.25 foot msl or lower (i.e., drain elevation).

- The backfill of the interceptor trench would need to have a hydraulic conductivity of 1,000 feet per day.
- The potential exists for pumping-induced saltwater intrusion to further degrade groundwater quality.
- The land use is the current approved use.
- MNA is based on published rates of LNAPL source zone depletion.

6.3.5 Alternative 4: Excavation and Limited Environmental Covenant

Remedial Alternative 4 involves soil excavation in both the DB-2 and WSDOT stormwater line areas, as shown on Figure 6-5. Impacted soil in the area of DB-2 and adjacent to the WSDOT stormwater line would be excavated and disposed of at an appropriate waste disposal facility. Excavation in each of these areas is described below.

Impacted soils would be removed in the targeted areas under this alternative; therefore, it is expected that limited ECs would be implemented:

- Cover the entire Site including the area already covered by the construction easement signed in October 1971 by the Washington State's Attorney General's Office and Unocal and shown on Figure 6-1
- Protect against direct contact with impacted soil remaining at the four isolated locations described in Section 4.2.1.3 by including a soil management plan
- Protect against vapor pathway by providing guidance for potential future ground construction activities (e.g., installation of vapor barriers) and require a new soil vapor assessment if the land use changed from its current approved use
- Maintain the Site an industrial or commercial use compatible with the purchase and sale agreement with the WSDOT
- Maintain the conditions for exclusion from TEE as listed in the 2007 TEE
- Require long-term maintenance and/or monitoring.

6.3.5.1 Soil Excavation Near DB-2

Remedial Alternative 4 involves excavating remaining impacts below the water table near DB-2 from the approximate area. Implementation would be the same as Alternative 1.

6.3.5.2 Soil Excavation Adjacent to the Washington State Department of Transportation Stormwater Line

In addition to the dewatering required for excavation of DB-2, Alternative 4 would involve excavating the remaining impacts below the water table adjacent to the WSDOT stormwater line from the approximate area. To protect against the geotechnical concerns of slope stability of the land area between the Site and Point Edwards, extensive sheet piling would be used, as well as conventional soil excavation equipment, and robust construction dewatering equipment. The amount of dewatering water and the geotechnical stability could also be mitigated by performing the excavation in phases and having only shorter sections open at a time; however, this would impact the overall implementation of the excavation.

It is theoretically possible to excavate the remaining impacts adjacent to the WSDOT stormwater line using sheet pile walls and a construction dewatering strategy that would require an average pumping rate of approximately 60 gpm. High-tide or short-duration rainfall events may result in the need for excavation dewatering at an average rate of 75 gpm. During initial startup, dewatering rates may be as high as 120 to 240 gpm until a steady state is achieved. The excavation dewatering treatment system would require system components to handle a large volume of water (80,000 to 300,000 gallons per day) through a series of flocculation tanks, settling tanks, and filtration prior to discharge to either DB-1 or Willow Creek. Considering typical flocculation and settling tanks hold approximately 21,000 gallons of water, it may take up to 15 tanks to store dewatering water daily. The large volumes of water and the discharge rate of more than 75 gpm would increase the technical difficulty of excavation implementation compared to the other alternatives.

This scenario is based on the following assumptions and limitations:

- The total depth of the construction dewatering system would need to be approximately 30 feet bgs.
- The intake portion of the construction dewatering system would need to extend to an elevation of approximately -15 feet msl or lower (i.e., drain elevation).
- The excavation may encounter fill materials, beach deposits, and marsh deposits, and would terminate at the top of the Whidbey Formation.
- The hydraulic conductivity of the sheet pile walls is 0.003 foot per day.
- Faster dewatering rates during the initial phase of excavation may be required.
- The potential exists for pumping-induced saltwater intrusion to further degrade groundwater quality.
- Sheet piling of the excavation area would be required to effectively dewater the excavation area.
- The land use is the current approved use.

6.3.6 Alternative 5: Excavation, In-Situ Solidification and Monitored Natural Attenuation with Environmental Covenants

Remedial Alternative 5 would involve excavating the remaining impacts below the water table near DB-2 from the approximate area shown on Figure 6-6 using conventional soil excavation and construction dewatering equipment. Impacted soil in DB-2 would be excavated, removed from the Site, and transported to an appropriate waste disposal facility, and impacted soil near the WSDOT stormwater line would be treated using ISS.

Alternative 5 would include the same elements as Alternative 1. However, under Alternative 5, remedial action would be implemented in the WSDOT stormwater line area and would include excavation and ISS. Implementation of excavation in DB-2 area would be the same as Alternative 1. Construction of the ISS would not require extensive dewatering surrounding the WSDOT stormwater line.

With Alternative 5, some soil impacts would be left in place below the ISS treated area, an MNA sampling program would be initiated in conjunction excavation and ISS. MNA sampling would include annual sampling of dissolved phase COC data and biogeochemical data along a transect of wells. This program would be implemented until dissolved phase COC concentrations are reduced below CULs.

6.3.7 Alternative 6: Excavation, Dual-Phase Extraction Treatment and Limited Environmental Covenant

Remedial Alternative 6 would involve excavating the remaining impacts below the water table near DB-2 from the approximate area shown on Figure 6-7 using conventional soil excavation and construction dewatering equipment. Impacted soil and groundwater in the area of the WSDOT stormwater line would be remediated through implementation of a DPE system.

Impacted soils would be removed or treated in the targeted areas under this alternative; therefore, it is expected that limited ECs would be implemented:

- Cover the entire Site including the area already covered by the construction easement signed in October 1971 by the Washington State's Attorney General's Office and Unocal and shown on Figure 6-1
- Protect against direct contact with impacted soil remaining at the four isolated locations described in Section 4.2.1.3 by including a soil management plan
- Protect against vapor pathway by providing guidance for potential future ground construction activities (e.g., installation of vapor barriers) and require a new soil vapor assessment if the land use changed from its current approved use
- Maintain the Site under an industrial or commercial use compatible with the purchase and sale agreement with the WSDOT
- Maintain the conditions for exclusion from TEE as listed in the 2007 TEE
- Require long-term maintenance and/or monitoring.

6.3.7.1 Soil Excavation Near DB-2

Remedial Alternative 6 would involve excavating remaining impacts below the water table near DB-2 from the approximate area. Implementation would be the same as Alternative 1.

6.3.7.2 Dual-Phase Extraction System Adjacent to the Washington State Department of Transportation Stormwater Line

In addition to the dewatering required for excavation of DB-2, Alternative 6 would involve the use of a DPE system to remediate the remaining impacts below the water table adjacent to the WSDOT stormwater line from the approximate area.

This alternative is based on the following assumptions and limitations:

- DPE technology would lower the water table up to approximately 11 feet bgs (6 feet potentiometric drawdown) in the target treatment zone, thereby capturing and dewatering the residual LNAPL throughout a broad interval in the subsurface (i.e., smear zone).

- DPE technology would introduce atmospheric air into soil pores in the residual LNAPL zone.
- DPE technology would remove residual LNAPL through a combination of soil vapor extraction (SVE) and aerobic biodegradation.

Two DPE pilot tests were performed during first quarter 2015 near the WSDOT stormwater line. The first mobilization was completed from February 17 through 21, 2015. Based on the result of the first mobilization, a second pumping test was conducted from March 30 through April 1 to determine more specifically the appropriate extraction well depth and screen interval, as well as improve overall pumping rate estimates and account for observed subsurface heterogeneity.

Pilot test results indicate that groundwater drawdown to below the impacted soil target is feasible. Pilot test data indicate that wells installed within the 1929 fill can create a drawdown of greater than 2.2 feet at a distance of 30 feet horizontally from the pumping wells after approximately 34 hours of pumping.

Average vapor mass VOC removal rates using photo ionization detector readings and system air flow ranged from 3.1 pounds per day during DPE-3 pilot testing to 13.8 pounds per day during DPE-1 pilot testing, indicating that mass can be removed through DPE implementation.

Based on pilot test data, extraction wells would be installed on a maximum of 50-foot centers targeting a design radius of influence (ROI) of 30 feet. Wells would be spaced closer in areas of highest soil impacts. Remediation wells would be installed to approximately 19 feet bgs, with 15 feet of screen allowing for pump intakes to be adjusted to target shallow soil impacts. The treatment system would be designed to operate at a pumping rate of 3 gpm on all remediation wells, with a target pumping rate of up to 13 gpm on wells with vacuum-enhanced dewatering. Due to the high air flow rates observed (36 to 128 standard cubic feet per minute), vacuum-enhanced dewatering would be applied to a subset of four to six wells. Focusing vacuum-enhanced dewatering on a subset of wells would increase the overall operational efficiency of the proposed remediation system and improve maintenance and optimization downtime.

7 EVALUATION OF REMEDIAL ALTERNATIVES

This section evaluates the proposed remedial alternatives in the context of the requirements of MTCA defined based on WAC 173-340-360, WAC 173-340-370, and WAC 173-340-440. The six potential remedial alternatives are ranked highest (being the worst) to lowest (being the best) and scores are presented in Table 7-1.

Cleanup actions are subject to the threshold requirements set forth in WAC 173-340-360 (2)(a) and other requirements set in WAC 173-340-360 (2)(b):

- (a)(i) Protect human health and the environment and (a)(ii) Comply with cleanup standards (see Section 7.1)
- (a)(iii) Comply with applicable state and federal laws (see Section 7.2)
- (a)(iv) Provide for compliance monitoring (see Section 7.3)
- (b)(i) Use permanent solutions to the maximum extent practicable (see Section 7.4)
- (b)(ii) Provide for a reasonable restoration timeframe (see Section 7.5)
- (b)(iii) Consider public concerns (see Section 7.6)

In addition of requirement WAC 173-340-360 (2) (b)(i), WAC 173-340-440(6) states, "Requirement for primary reliance. In addition to meeting each of the minimum requirements specified in WAC 173-340-360, cleanup actions shall not rely primarily on institutional controls and monitoring where it is technically possible to implement a more permanent cleanup action for all or a portion of the site."

Ecology's expectations for the development of alternatives and the selection of cleanup actions as defined in WAC 173-340-370 are also taking in consideration when evaluating the remedial alternatives (see Section 7.7).

A disproportionate cost analysis (DCA) is also made to evaluate the proposed remedial alternatives (see Section 7.8). As outlined in WAC 173-340-360(3)(e), costs are determined to be disproportionate to benefits if the incremental cost of a more expensive alternative compared to a lower cost alternative exceeds the incremental degree of benefits achieved by the more expensive alternative.

7.1 Protect Human Health and the Environment and Comply with Cleanup Standards

The alternatives are evaluated in order to protect human health and the environment through compliance with either the agreed-upon cleanup standards, or implementation of institutional controls through ECs. All six alternatives would be protective of human health and the environment; however, Alternatives 1, 2, 3, and 5 would leave remaining impacts onsite. ECs coupled with MNA would be used to protect human health and the environment at the Site, however Alternatives 4 and 6 would only have limited ECs if the land use changed from its current approved use.

7.1.1 Alternative 1: Excavation and Monitored Natural Attenuation with Environmental Covenants

In Alternative 1, impacted soil and LNAPL in the area of DB-2 would be excavated, removed from the Site, and transported to an appropriate waste disposal facility. ECs would be used to protect human health and the environment in the WSDOT stormwater line area, and long-term groundwater monitoring would be implemented as part of an MNA program.

The proposed area of excavation is shown on Figure 6-2 and includes soil around and near DB-2. It is anticipated that removal of the impacted soil would meet applicable CULs, and that removal of impacted soil and MNA would eventually remediate COC concentrations in groundwater to less than CULs. Currently MW-529, which is installed downgradient of the proposed excavation area, has demonstrated compliance with its respective groundwater CULs since its installation. Previous excavation work at the Site has demonstrated that removal of impacted soil has resulted in a decrease in dissolved-phase concentrations in the area.

ECs would be used to protect human health and the environment at the Site and will:

- Cover the entire Site including the area already covered by the construction easement signed in October 1971 by the Washington State's Attorney General's Office and Unocal and shown on Figure 6-1.
- Protect against direct contact with impacted soil or groundwater remaining at the Site by including a soil management plan.
- Protect against vapor pathway by providing guidance for potential future ground construction activities (e.g., installation of vapor barriers) and require a new soil vapor assessment if the land use changed from its current approved use.
- Maintain the Site under an industrial or commercial use compatible with the purchase and sale agreement with the WSDOT.
- Specifically, address subsurface use in the impacted area adjacent to the stormwater line and help guide potential future aboveground construction activities (e.g., installation of vapor barriers, building a structure over the storm drain).
- Maintain the conditions for exclusion from TEE as listed in the 2007 TEE.
- Restrict groundwater use.
- Require long-term maintenance and/or monitoring. The long term monitoring program will rely on natural attenuation based on published rates of LNAPL source zone depletion and include up to 60 years of MNA sampling.

The combined elements of Alternative 1 would be protective of human health and the environment; however, impacts would remain onsite.

7.1.2 Alternative 2: Groundwater Containment System Using Groundwater Extraction Wells, and Monitored Natural Attenuation with Environmental Covenants

In Alternative 2, a groundwater containment system using groundwater extraction wells would be installed along the downgradient site boundary northwest of DB-2 to recover and treat groundwater that contains hydrocarbon concentrations greater than the CULs. ECs would be used to protect human health and the environment in the DB-2 area and the WSDOT stormwater line area, and MNA would be used to comply with cleanup standards and address remaining petroleum hydrocarbon concentrations. The layout and capture zone ROI based on groundwater modeling are shown on Figure 6-3.

It is expected than groundwater would comply with the cleanup standard in the DB-2 area; however, soil impacts may remain in place above groundwater level and ECs would be necessary.

The ECs proposed in this alternative would:

- Cover the entire Site including the area already covered by the construction easement signed in October 1971 by the Washington State's Attorney General's Office and Unocal and shown on Figure 6-1.
- Protect against direct contact with impacted soil or groundwater remaining at the Site by including a soil management plan.
- Protect against vapor pathway by providing guidance for potential future ground construction activities (e.g., installation of vapor barriers) and require a new soil vapor assessment if the land use changed from its current approved use.
- Maintain the Site under an industrial or commercial use compatible with the purchase and sale agreement with the WSDOT.
- Specifically, address subsurface use in the impacted area adjacent to the stormwater line and help guide potential future aboveground construction activities (e.g., installation of vapor barriers, building a structure over the storm drain).
- Maintain the conditions for exclusion from TEE as listed in the 2007 TEE.
- Restrict groundwater use.
- Require long-term maintenance and/or monitoring. The long term monitoring program will rely on natural attenuation based on published rates of LNAPL source zone depletion and include up to 60 years of MNA sampling.

The combined elements of Alternative 2 would be protective of human health and the environment; however, impacts would remain onsite.

7.1.3 Alternative 3: Groundwater Containment System Using Groundwater Extraction Trench, and Monitored Natural Attenuation with Environmental Covenants

In Alternative 3, a groundwater containment system using a groundwater extraction trench would be installed downgradient of DB-2 and southwest of DB-1. ECs would be used to protect human health and the environment in the WSDOT stormwater line area, and MNA would be used to comply with cleanup standards and to address remaining petroleum hydrocarbon-related impacts near the WSDOT stormwater line.

Alternative 3 would include the same elements as Alternative 2. However, under Alternative 3, in lieu of a series of groundwater extraction wells a groundwater extraction trench with high-permeability backfill would be installed. The trench would be excavated downgradient from DB-2 to approximately 15 to 20 feet bgs. A series of groundwater collection sumps would be placed within the trench to extract groundwater and contain the groundwater plume onsite. Based on groundwater modeling, the trench would be installed along the northeast and northwest boundaries of DB-2 to provide an adequate capture zone encompassing DB-2. The layout and capture zone ROI based on groundwater modeling are shown on Figure 6-4.

The combined elements of Alternative 3 would be protective of human health and the environment; however, impacts would remain onsite.

7.1.4 Alternative 4: Excavation and Limited Environmental Covenant

In Alternative 4, impacted soil in the area of DB-2 and adjacent to the WSDOT stormwater line would be excavated and disposed of at an appropriate waste disposal facility.

The proposed area of excavation is shown on Figure 6-5 and includes soil around and near DB-2 and the WSDOT stormwater line. The removal of impacted soil is expected to meet applicable CULs. It is expected that the removal of impacted soil and natural attenuation would remediate COC concentrations in groundwater to less than CULs. Previous excavation work at the Site has shown that removal of impacted soil has resulted in a decrease in dissolved-phase hydrocarbon concentrations in the area. Compliance monitoring would be needed to assess if residual groundwater concentrations are less than or reduce to less than the groundwater CUL following excavation.

Impacted soils would be removed in the targeted areas under this alternative; therefore, it is expected that limited ECs would be implemented:

- Cover the entire Site including the area already covered by the construction easement signed in October 1971 by the Washington State's Attorney General's Office and Unocal and shown on Figure 6-1
- Protect against direct contact with impacted soil remaining at the four isolated locations described in Section 4.2.1.3 by including a soil management plan
- Protect against vapor pathway by providing guidance for potential future ground construction activities (e.g., installation of vapor barriers) and require a new soil vapor assessment if the land use changed from its current approved use.

- Maintain the Site under an industrial or commercial use compatible with the purchase and sale agreement with the WSDOT.
- Maintain the conditions for exclusion from TEE as listed in the 2007 TEE.
- Require long-term maintenance and/or monitoring.

Alternative 4 would be protective of human health and the environment and comply with the cleanup standard.

7.1.5 Alternative 5: Excavation and In-Situ Solidification and Monitored Natural Attenuation with Environmental Covenants

In Alternative 5, impacted soil in DB-2 would be excavated, removed from the Site, and transported to an appropriate waste disposal facility; and impacted soil near the WSDOT stormwater line would be treated using ISS.

Alternative 5 would include the same elements as Alternative 1. However, under Alternative 5, remedial action would be implemented in the WSDOT stormwater line area and would include excavation and ISS. The top 1 foot of soil above and adjacent to the stormwater line would be excavated and disposed of at an appropriate waste disposal facility. Soil from 1 foot to 5 feet bgs would be mixed with a binding agent and left in place, which would bulk approximately to the ground surface. The mixture would produce a hardened surface to prevent surface-water infiltration, close the soil leaching to groundwater pathway, and limit the soil vapor pathway in the area of the WSDOT stormwater line. Soil deeper than 5 feet bgs in this area would remain in place. Impacted soil near the WSDOT stormwater line would remain in place under an EC. MNA would be used to comply with cleanup standards and to address remaining petroleum hydrocarbon-related impacts left in place. The long term monitoring program will rely on natural attenuation based on published rates of LNAPL source zone depletion and include up to 60 years of MNA sampling.

The proposed area of excavation and layout of ISS are shown on Figure 6-6.

The combined elements of Alternative 5 would be protective of human health and the environment; however, impacts would remain onsite.

7.1.6 Alternative 6: Excavation, Dual-Phase Extraction Treatment and Limited Environmental Covenant

In Alternative 6, impacted soil and LNAPL in the area of DB-2 would be excavated, removed from the Site, and transported to an appropriate waste disposal facility. Soil and groundwater remediation through implementation of a DPE system in the area of the WSDOT stormwater line would be protective of human health and the environment through compliance with AO No. DE 4460.

The proposed area of excavation and layout of the DPE system are shown on Figure 6-7.

The DPE system installed near the WSDOT stormwater line would dewater soil, exposing residual LNAPL to induced vapor flow. The DPE system would remediate COC concentrations in soil to less than CULs and ensure that offsite migration of dissolved-phase COCs and LNAPL does not occur. Soil vapor extraction within the WSDOT stormwater line area would mitigate the soil vapor pathway.

Impacted soils would be removed in the targeted areas under this alternative; therefore, it is expected that limited ECs would be implemented:

- Cover the entire Site including the area already covered by the construction easement signed in October 1971 by the Washington State's Attorney General's Office and Unocal and shown on Figure 6-1.
- Protect against direct contact with impacted soil remaining at the four isolated locations described in Section 4.2.1.3 by including a soil management plan.
- Protect against vapor pathway by providing guidance for potential future ground construction activities (e.g., installation of vapor barriers) and require a new soil vapor assessment if the land use changed from its current approved use.
- Maintain the Site under an industrial or commercial use compatible with the purchase and sale agreement with the WSDOT.
- Maintain the conditions for exclusion from TEE as listed in the 2007 TEE.
- Require long-term maintenance and/or monitoring.

The combined elements of Alternative 6 would be protective of human health and the environment and comply with the cleanup standard.

7.2 Comply with Applicable State and Federal Laws

As discussed in Section 5, the selected RELs and CULs are consistent with MTCA. Additionally, numerous state and federal laws will apply to each proposed alternative related to environmental protection, health and safety, transportation, and disposal. Each of the proposed alternatives can be implemented in compliance with these laws.

7.3 Provide for Compliance Monitoring

All six alternatives include compliance monitoring as required by WAC 173-340-410 and 173-340-720 through 173-340-760. Compliance monitoring will consist of protection, performance, and confirmation monitoring to determine the short- and long-term safety and effectiveness of the selected alternative, as summarized below:

- Protection monitoring is used to confirm that human health and the environment are adequately protected during construction, operation, and maintenance periods. Under Alternative 6, induced vacuum and extracted vapor concentrations by the DPE system would be monitored periodically to ensure the system adequately captures soil vapor and mitigates the vapor intrusion pathway.
- Performance monitoring confirms that the cleanup action has attained cleanup standards or other performance standards, including those outlined in any permits. For each alternative, performance monitoring will include programs designed to: assess rates of natural attenuation, provide data necessary to assess whether LNAPL migration is continuing in areas with soil TPH concentrations exceeding residual saturation, and confirm that groundwater with exceedances of the CULs in the

area of the WSDOT stormwater line does not leave the Lower Yard. During excavation, performance monitoring will be needed to assess if residual groundwater concentrations are less than or reduced to less than the groundwater CUL following excavation. Under Alternative 6, performance monitoring will also assess mass removal rates in the dissolved and vapor phases.

- Confirmation monitoring verifies the long-term effectiveness of the remedial action.

In addition to meeting compliance monitoring criteria listed above, the preferred alternative will also fulfill the requirements from the second amendment to the purchase and sale agreement with the WSDOT, which includes:

- Following construction, a construction completion document will be prepared and submitted confirming that the system was constructed in accordance with Ecology-approved plans and specifications.
- If Alternative 2, 3, or 6 is implemented, following startup a methodology for calculating and performing confirmation field measurements will be provided and implemented. After 12 months of operation, or upon obtaining asymptotic mass removal rates, whichever comes earlier, the ability of the preferred remedy to achieve remediation objectives within the calculated restoration time frame will be evaluated. The evaluation will also assess whether the system's hydraulic capture zone is calculated and confirmed by field measurements to be at least as large as the targeted zone. A compliance monitoring plan will establish the soil and groundwater sampling requirements that will be needed to confirm the remediation has met the calculated CULs throughout the Site, and will document that the treated groundwater meets permit requirements.

7.4 Use Permanent Solutions to the Maximum Extent Practicable

MTCA states that when selecting an alternative, preference will be given to "permanent solutions to the maximum extent practicable." "Permanent" is defined in WAC 173-340- 200 as a cleanup action in which the cleanup standards of WAC 173-340-700 through 173-340-760 are met without requiring further action at the Site being cleaned up, or at any other site involved with the cleanup action, other than the approved disposal of any residue from the treatment of hazardous substances. Evaluating the "maximum extent practicable" for each alternative requires the application of a DCA as described in Section 7.8. In addition, WAC 173-340-440(6) states, "Requirement for primary reliance. In addition to meeting each of the minimum requirements specified in WAC 173-340-360, cleanup actions shall not rely primarily on institutional controls and monitoring where it is technically possible to implement a more permanent cleanup action for all or a portion of the site."

Alternatives 4 and 6 meet the definition of a permanent solution because impacts to soil and groundwater would be physically and/or biologically removed throughout the Site. Residual LNAPL in soil surrounding the WSDOT stormwater line would be removed through excavation (Alternative 4) or physical extraction, volatilization and biodegradation (Alternative 6), while soil within the DB-2 area will be permanently removed through excavation (both alternatives). Limited ECs would be put in place to protect human health and environment against any residual risks associated with the Site, especially if the land use changed from its current approved use.

Alternatives 1, 2, 3, and 5 do not meet the definition of a permanent solution because impacts to soil and groundwater would remained at the Site. Residual LNAPL in soil surrounding the WSDOT stormwater line would remained in place and would be remediated through natural attenuation processes. ECs would be put in place to protect human health and environment against any residual risks associated with the Site.

7.5 Provide for a Reasonable Restoration Timeframe

WAC 173-340-360(4) contains guidance for evaluating reasonable restoration timeframes. Preference is given for alternatives that can be implemented in a shorter period of time if other factors such as permanence and costs are equal. Relative restoration timeframes are discussed below. A precise analysis to project expected restoration timeframes for the six alternatives would require site-specific bench and/or pilot studies.

Alternative 1 would have a short restoration timeframe (1 to 3 years) in treated area (DB-2) because the removal of impacted soil would remediate COC concentrations in groundwater to less than CULs. Previous excavation work at the Site has shown that removal of impacted soil in the area of DB-2 will result in a rapid decrease of dissolved-phase COC concentrations in the area. Alternative 1 would have a long restoration timeframe (evaluated at up to 60 years based on published rates of LNAPL source zone depletion) in non-treated area (WSDOT stormwater line) because residual LNAPL in soil surrounding the WSDOT stormwater line would remained in place and would be remediated through natural attenuation processes. ECs would be put in place to protect human health and the environment against any residual risks associated with the Site.

Alternative 2 would have long restoration timeframe (15 to 20 years) in treated area because the groundwater pump and treat system may not directly address residual petroleum hydrocarbon-related soil impacts. Alternative 2 would have a long restoration timeframe (evaluated at up to 60 years based on published rates of LNAPL source zone depletion) in non-treated area (WSDOT stormwater line) because residual LNAPL in soil surrounding the WSDOT stormwater line would remained in place and would be remediated through natural attenuation processes. ECs would be put in place to protect human health and environment against any residual risks associated with the Site.

Alternative 3 would also have a long restoration timeframe (15 to 20 years) in treated area because the trench recovery system may not directly address residual petroleum hydrocarbon-related soil impacts. Alternative 3 would have a long restoration timeframe (evaluated at up to 60 years based on published rates of LNAPL source zone depletion) in non-treated area (WSDOT stormwater line) because residual LNAPL in soil surrounding the WSDOT stormwater line would remained in place and would be remediated through natural attenuation processes. ECs would be put in place to protect human health and environment against any residual risks associated with the Site.

Alternative 4 would have a short restoration timeframe (1 to 3 years) because the removal of petroleum hydrocarbon-related impacts to soil coupled with natural attenuation will remediate COC concentrations in groundwater to less than CULs. Previous excavation work at the Site has shown that removal of impacted soil has resulted in a decrease in dissolved-phase COC concentrations in the area. ECs would be put in place to protect human health and environment against any residual risks associated with the Site, especially if the land use changed from its current approved use.

Alternative 5 would have a short restoration timeframe (1 to 3 years) in treated area because the removal of impacted soil and implementation of ISS coupled with MNA would remediate COC concentrations in groundwater to less than CULs. Previous excavation work at the Site has shown that removal of impacted soil has resulted in a decrease in dissolved-phase COC concentrations in the area. Impacted soil and groundwater near the storm drain would remain in place below 5 feet bgs. Alternative 5 would have a long restoration timeframe (evaluated at up to 60 years based on published rates of LNAPL source zone depletion) in non-treated area (WSDOT stormwater line below 5 feet bgs) because residual LNAPL in soil surrounding the WSDOT stormwater line would remained in place and would be remediated through natural attenuation processes. ECs would be put in place to protect human health and the environment against any residual risks associated with the Site.

Alternative 6 would have a short restoration timeframe (5 to 6 years) because the removal or remediation through DPE system of petroleum hydrocarbon-related impacts to soil coupled with natural attenuation would remediate COC concentrations in groundwater to less than CULs. ECs would be put in place to protect human health and environment against any residual risks associated with the Site, especially if the land use changed from its current approved use.

7.6 Consider Community Concerns

Ecology and Chevron have addressed community concerns throughout this project. Ecology and Chevron will consider additional issues or concerns as part of the cleanup action selection process, per WAC 173-340-600. Public comments on the project and this Draft Final FS Report will be solicited from the community during the formal comment period, following Ecology's input. Common community concerns include noise and traffic, short- and long-term risks, and time frame for any proposed cleanup actions.

7.7 Expectations for Cleanup Action Alternatives

WAC 173-340-370 outlines Ecology's expectations for the development of alternatives and the selection of cleanup actions. Each of the expectation criteria is further described below.

7.7.1 Waste/Hazardous Substances Treatment

Ecology expects that treatment technologies will be used for sites that contain liquid wastes, areas impacted with high concentrations of hazardous substances, highly mobile materials, and/or discrete areas of hazardous substances.

For Alternatives 1, 4, 5, and 6, impacted soil and LNAPL in the DB-2 area would be excavated and removed from the Site and transported to an appropriate waste disposal facility. Alternative 4 also includes the excavation and removal of impacted soil near the WSDOT line and therefore would considerably increase the degree of removal. Alternative 6 uses a DPE system to reduce mass of petroleum in vadose zone and smear zone soils in the subsurface near the WSDOT line.

For Alternative 2, only minimal volumes of soil related to system trenching and extraction well installation would be removed from the Site. Groundwater and LNAPL collected from the pump and treat system would be sent to an onsite treatment system, where LNAPL would be recovered, stored, and eventually disposed of at an appropriate waste disposal facility. Treated groundwater would be discharged to DB-2 or Willow Creek under a NPDES permit or to a sanitary sewer under an appropriate discharge permit.

For Alternative 3, impacted soil and LNAPL excavated during trenching activities would be removed from the Site and transported to an appropriate waste disposal facility. The trench would contain five groundwater/LNAPL recovery sumps. Groundwater and LNAPL would be collected from the trench and sent to an onsite system for treatment, where LNAPL would be recovered, stored, and eventually disposed of at an appropriate waste disposal facility. Treated groundwater would be discharged to DB-2 or Willow Creek under a NPDES permit or to a sanitary sewer under the appropriate discharge permit.

Alternatives 4 and 6 best meet this expectation because the remove or treat petroleum-impacted soils in both the DB-2 vicinity and the WSDOT stormwater line area.

7.7.2 Minimization of Long-Term Management at Small Sites

Ecology expects to minimize the need for long-term management of contaminated materials at sites containing small volumes of hazardous substances by destroying, detoxifying, and/or removing these substances to concentrations less than CULs.

This expectation does not apply to the entire site, due to the large size of the Site; however, it does apply to the limited areas of high concentrations remaining onsite.

Alternatives 1, 2, 3, and 5 would leave limited areas of high COC concentrations requiring long-term management such as maintenance of institutional controls (e.g., soil vapor barrier, EC). Alternatives 4 and 6 remove petroleum from both the DB-2 vicinity and the WSDOT stormwater line area.

Alternatives 4 and 6 best meet this expectation.

7.7.3 Use of Engineering Controls at Large Sites

Per WAC 173-340-37(3), Ecology recognizes the need to use engineering controls, such as containment, for sites or portions of sites that contain large volumes of materials with relatively low levels of hazardous substances where treatment is impracticable.

Alternative 1 proposes to remove impacted soil and LNAPL through excavation near DB-2. Any recovered LNAPL would be stored and eventually disposed of at an appropriate waste disposal facility. Groundwater pumped as part of the excavation dewatering strategy would be treated onsite and disposed of under a NPDES permit to DB-2 or Willow Creek. ECs would be put in place to protect human health and the environment against any residual risks associated with the Site. Regular groundwater monitoring events under a MNA program would continue under this alternative to monitor compliance at POC wells. Engineering controls in the DB-2 area would not be necessary following excavation of DB-2 because impacted soil would be removed and site groundwater concentrations would be less than CULs. Based on available groundwater data, it appears that impacts adjacent to the WSDOT stormwater line have not affected downgradient perimeter wells; however, engineering controls may be required to address remaining impacts in the WSDOT stormwater line.

Alternative 2 proposes to use groundwater containment to control the migration of hazardous substances. Groundwater and LNAPL collected from the pump and treat system would be sent to an onsite system for treatment, where LNAPL would be recovered, stored, and eventually disposed of at an appropriate waste disposal facility. Treated groundwater would be discharged under a NPDES permit to DB-2 or Willow Creek. Regular groundwater monitoring under a MNA program would continue under this alternative to monitor compliance at POC wells. ECs would be put in place to protect human health and the environment against any residual risks associated with the Site.

Alternative 3 proposes to use groundwater containment to control the migration of hazardous substances through a groundwater collection trench. Groundwater and LNAPL would be removed from the collection trench through a series of collection sumps and sent to the onsite treatment system. Treated groundwater would be discharged to the appropriately permitted discharge location (DB-2 or Willow Creek). Regular groundwater monitoring under a MNA program would continue under this alternative to monitor compliance at POC wells. ECs would be put in place to protect human health and the environment against any residual risks associated with the Site.

Alternative 4 proposes to remove impacted soil and LNAPL through excavation near DB-2 and the WSDOT stormwater line. Groundwater pumped as part of the excavation dewatering strategy would be treated onsite and disposed of under a NPDES permit to DB-2 or Willow Creek. Following the implementation of this alternative, the need for engineering controls would be minimal. Previous excavation work at the Site has shown that removal of impacted soil has resulted in a decrease in dissolved-phase COC concentrations in the area excavated. Therefore, this alternative should meet groundwater standards at the standard POC. Regular groundwater monitoring events for an estimate of approximately 3 years would continue under this alternative to monitor compliance at POC wells.

Alternative 5 proposes to remove impacted soil and LNAPL through excavation near DB-2 and to implement ISS near the WSDOT stormwater line. Following the implementation of this alternative, engineering controls in DB-2 area would not be necessary because impacted soil would be removed and site groundwater concentrations would be less than CULs. Previous excavation work at the Site has shown that removal of impacted soil has resulted in a decrease of dissolved-phase COC concentrations in the area. ISS would minimize surface-water infiltration in the WSDOT stormwater line area, which would close the soil leaching to groundwater pathway and decrease the possibility of offsite migration. ECs would be put in place to protect human health and the environment against any residual risks associated with the Site. Based on available groundwater data, it appears that impacts adjacent to the WSDOT stormwater line have not affected downgradient perimeter wells; however, engineering controls may be required to address remaining impacts near the WSDOT stormwater line. Regular groundwater monitoring events under a MNA program would continue under this alternative to monitor compliance at POC wells.

Alternative 6 proposes to excavate impacted soil in DB-2 area and to use a DPE system to remediate soil and groundwater near the WSDOT stormwater line. Groundwater collected from the DPE system would be sent to an onsite system for treatment, and any recovered LNAPL will be stored and eventually disposed of at an appropriate waste disposal facility. Groundwater pumped as part of the excavation dewatering strategy and from the DPE system would be treated onsite and disposed of under a NPDES permit to DB-2 or Willow Creek. Regular groundwater monitoring events would continue during system operation to monitor compliance at POC wells for an estimate of approximately 6 years. Soil vapor would be extracted and treated onsite, initially using engineering controls through a catalytic oxidizer. The vapor concentrations would be destroyed by the oxidizer before being discharged to the atmosphere. Engineering controls would not be necessary following completion of DPE system operation and excavation of DB-2 because impacted soil would be removed or treated to soil concentrations below CULs and site groundwater concentrations would be less than CULs.

In its current condition, the Site does not contain large volumes of hazardous substances at low levels. Previous interim actions have remediated most of the Site to soil concentrations protective of direct contact and wildlife (See Figure 4-2). The DB-2 vicinity and WSDOT stormwater line area are two discrete areas with remaining high levels of petroleum. These areas are amenable to removal and/or treatment. ECs will be necessary to maintain the Site in industrial or commercial use or require additional assessment because the current remediation provides for an industrial or commercial use.

7.7.4 Minimize Stormwater Contamination and Offsite Migration

To minimize the potential for migration of hazardous substances, Ecology expects that active measures will be taken to prevent precipitation and subsequent runoff from coming into contact with impacted soil and waste materials. When such measures are impracticable, such as during active cleanup, Ecology expects that site runoff will be contained and treated prior to release from the Site.

For all alternatives, during excavation and construction activities, standard engineering controls and construction techniques will be applied to avoid stormwater contamination and offsite migration. This will be addressed through standard best practices for runoff control.

For Alternatives 1, 4, 5, and 6, following excavation it is expected that removal of impacted soil and LNAPL in the area of DB-2 would reduce the risk of offsite migration due to stormwater infiltration. Regular groundwater monitoring events would continue under all these alternatives.

Impacted soil adjacent to the WSDOT stormwater line would remain in place under Alternatives 1, 2, 3, and 5. Under Alternative 5, it is expected that ISS would minimize surface-water infiltration and decrease the possibility of offsite migration.

Impacted soil and groundwater adjacent to the WSDOT stormwater line would be addressed under Alternatives 4 and 6. It is expected that remedial action of impacted soil in the WSDOT stormwater line would reduce the risk of offsite migration due to stormwater infiltration, as discussed below:

- Alternative 4 would offer the highest potential of short-term risk to discharge contaminated water to surface water. If the WSDOT stormwater line were to float or split during construction, a direct conduit to Puget Sound would be available through the remaining open stormwater line, or as overland flow. The calculated dewatering volumes would require a large storage and treatment system to handle wastewater prior to discharge.
- Alternative 6 proposes to use DPE in the WSDOT stormwater line area as a strategy to prevent migration of hazardous substances. In addition to regular groundwater monitoring events, system operation and maintenance would continue under this alternative during system operation to monitor mass removal and compliance at POC wells. Critical safety devices would be in place on system components to shut down the remediation system and contain any untreated groundwater from release to surface water and the stormwater collection system if DPE system failure occurs.

Alternatives 2 and 3 propose to use groundwater containment to control the migration of hazardous substances. Groundwater and LNAPL collected from the pump and treat system would be sent to an onsite system for treatment. In the system, LNAPL would be recovered, stored, and eventually disposed of at an appropriate waste disposal facility. Treated groundwater would be discharged to DB-2 or Willow Creek. Regular groundwater monitoring events would continue under this alternative to monitor compliance at POC wells.

Alternatives 4 and 6 best minimize the long-term potential for migration of hazardous substances since they remove the most hazardous substances from both the DB-2 vicinity and the WSDOT stormwater line area. Alternative 4 has more potential for hazardous substance migration during active cleanup.

7.7.5 Minimize Direct Contact and Migration by Consolidating Hazardous Substances

If hazardous substances remain onsite at concentrations that exceed CULs, Ecology expects that those hazardous substances will be consolidated to the maximum extent practicable where needed to minimize the potential for direct contact and migration of hazardous substances (Ecology 2007).

Large volumes of impacted soil, product, and groundwater have been removed through prior interim actions. Additional soil, product, and groundwater will be removed as part of all remedial alternatives.

Under Alternatives 1 and 5, remaining impacted soil would be limited to an area adjacent to the WSDOT stormwater line; therefore, consolidation would not be necessary. ECs would be put in place to minimize the potential for direct contact in case future earthwork activities occur in this area.

Under Alternatives 2 and 3, impacted soil would remain in the areas of DB-2 and the WSDOT stormwater line. However, groundwater containment would be used to control offsite migration; therefore, consolidation would not be necessary. Groundwater would be collected and treated onsite. ECs would be put in place to minimize the potential for direct contact in case future earthwork activities occur in these areas.

Under Alternatives 4 and 6, all impacted soil would be removed or treated in situ from the area of DB-2 and the WSDOT stormwater line; therefore, consolidation would not be necessary.

7.7.6 Avoid Surface-Water Contamination through Control of Runoff and Control of Groundwater Discharge or Migration

For facilities located adjacent to a surface-water body, Ecology expects that active measures will be taken to prevent or minimize releases to surface water via surface runoff and groundwater discharges in excess of CULs. Ecology expects that dilution will not be the sole method for demonstrating compliance with cleanup standards in these instances (Appendix C).

All the alternatives protect against surface-water contamination through the control of runoff because IHSs are generally not present at the surface of the Site. Surface-water runoff is further controlled by the stormwater infrastructure and DB-1 and DB-2.

Under Alternatives 1 and 5, releases to surface water through groundwater discharge would not be expected because removal of impacted soil and LNAPL in the area of DB-2, along with MNA, would decrease dissolved-phase COC concentrations and eliminate the soil to groundwater leaching pathway. Based on available groundwater data, it appears that impacts adjacent to the WSDOT stormwater line have not affected downgradient perimeter monitoring wells where groundwater discharges to surface water. However, in case groundwater conditions change in the future, additional measures may be required to avoid stormwater contamination and offsite migration. Regular groundwater monitoring events would continue under this alternative to monitor compliance at POC wells.

Under Alternatives 2 and 3, groundwater containment would be used to control offsite groundwater migration to surface water. Regular groundwater monitoring events would continue under this alternative to monitor compliance at POC wells. Groundwater would be treated with the onsite remediation system prior to discharge to the stormwater system under a NPDES permit, or to the sanitary sewer under appropriate Ecology permits.

Under Alternative 4, releases to surface water through groundwater discharge would not be expected because removal of impacted soil and LNAPL in the area of DB-2 and adjacent to the WSDOT stormwater line, along with natural attenuation, would decrease dissolved-phase COC concentrations and eliminate the soil to groundwater leaching pathway. Regular groundwater monitoring events would continue under this alternative to monitor compliance at POC wells.

Alternative 6 would control groundwater discharge through containment of groundwater only in the area where the threat exists for groundwater with COC concentrations greater than CULs to leave the Lower Yard. Groundwater modeling shows that at the designed pumping rate of 21 gpm from the DPE system, groundwater flow paths would be directed toward the remediation system pumping wells, containing all off-site migration. Regular groundwater monitoring events would continue under this alternative to monitor compliance at POC wells.

Alternatives 4 and 6 best meet this expectation in the long-term because they remove contaminated soil from the Site so it cannot be brought to the surface by construction, and potentially impact surface water at a later date.

7.7.7 Use of Natural Attenuation

Ecology expects that natural attenuation of hazardous substances may be appropriate at sites where:

- Source control has been conducted to the maximum extent practicable.
- Impacts that remain onsite during the restoration timeframe do not pose an unacceptable threat to human health or the environment.
- Site data show that natural biodegradation or chemical degradation is occurring and will continue to occur at a reasonable rate at the Site.
- Appropriate monitoring requirements are conducted to ensure that the natural attenuation process is taking place and that human health and the environment are protected.

Analytical and biogeochemical data indicate that natural attenuation is occurring at the Site and the remediation time frame is estimated at up to 60 years based on technical guidance published by the ITRC (ITRC, 2009) and published rates of NAPL source zone depletion measured at other sites (Sale and Zimbron, 2013).

An MNA approach alone is not an appropriate technology for the Site; however, natural attenuation is a component of all of the alternatives. Regular groundwater monitoring events would continue under each alternative and would be designed to asses if natural attenuation is happening at the Site throughout the remedial action period.

7.8 Disproportionate Cost Analysis

The DCA involves comparing the costs and benefits of alternatives and selecting the alternative with incremental costs that are not disproportionate to the incremental benefits. As outlined in WAC 173-340-360(3)(e), costs are determined to be disproportionate to benefits if the incremental cost of a more expensive alternative compared to a lower cost alternative exceeds the incremental degree of benefits achieved by the more expensive alternative.

The evaluation criteria for the DCA are specified in WAC 173-340-360(3)(f) and include:

- Protectiveness (Section 7.8.1)
- Permanence (Section 7.8.2)
- Cost (Section 7.8.3)
- Long-term effectiveness (Section 7.8.4)
- Management of short-term risks (Section 7.8.5)
- Technical and administrative implement ability (Section 7.8.6)
- Consideration of public concerns (Section 7.8.7).

Table 7-1 summarizes the comparative analysis. Each alternative was given a relative rating between 1 and 5 (1 is highest, 5 is lowest). A DCA preliminary summary is provided in Section 7.8.8. The alternative that ranked highest after this first analysis is further evaluated in Section 7.9 using the rankings assigned by Ecology. Per WAC 173 340 360(3)(e), the best ranked alternative was compared to the most permanent alternative (Alternative 4), which was selected by Ecology as the most permanent remedy of the alternatives presented, and hence the baseline to which the other alternatives are compared in the DCA. (Ecology 2014b).

7.8.1 Protectiveness

MTCA describes protectiveness as the overall protectiveness of human health and the environment, including the degree to which existing risks are reduced, time required to reduce risk at the facility and attain cleanup standards, onsite and offsite risks resulting from implementing the alternative, and improvement of the overall environmental quality.

With proper implementation, all six alternatives are adequately protective of human health and the environment during implementation and after the remedial action has been completed. However, Alternatives 1, 2, 3, and 5 would leave impacts onsite, requiring long-term institutional controls, have much longer restoration time frames, and less certainty about achieving cleanup standards in the WSDOT stormwater line area.

Due to the excavation of soil containing concentrations greater than CULs, Alternatives 1, 4, 5, and 6 are more protective than Alternatives 2 and 3, which leave impacted soil in place in the DB-2 area. Due to the extent of remedial action, Alternatives 4 and 6 are more protective than Alternatives 1,2, 3, and 5. Alternative 5 ranks higher than Alternative 1 because the leaching to groundwater pathway and soil vapor pathway would either be eliminated or reduced. Due to the extent of the groundwater containment through a continuous trench rather than wells at point locations, Alternative 3 is more protective than Alternative 2.

It is expected that Alternatives 4 and 6 will reach groundwater CULs at the compliance wells listed in Table 5-2 through removal of impacted soil and, in the case of Alternative 6, treatment in the WSDOT stormwater line area. Alternatives 1, 2, 3, and 5 are unlikely to achieve groundwater CULs in a reasonable restoration time frame in the WSDOT stormwater line area.

Based on the degree of protectiveness, the following alternatives are ranked from highest to lowest:

- *Highest.* Alternatives 4 and 6 are the most protective alternatives based on the complete remediation of impacted soil and groundwater with COC concentrations greater than CULs. Only limited ECs would be required.
- *Medium.* Alternatives 5 and 1 are less protective than Alternatives 4 and 6 because soil and groundwater with COC concentrations greater than CULs would remain in place in the WSDOT stormwater line area. ECs would be required for any soil or groundwater left in place with COC concentrations greater than CULs.
- *Lowest.* Alternatives 2 and 3 are the least protective because onsite dissolved-phase groundwater COC concentrations, soil COC concentrations, and potentially nonmobile LNAPL may remain in place. ECs would be required for any soil or groundwater left in place with COC concentrations greater than CULs.

7.8.2 Permanence

According to WAC 173-340-360(3)(f)(ii), permanence refers to the degree to which the alternative permanently reduces the toxicity, mobility, or volume of hazardous substances, including the adequacy of the alternative in destroying the hazardous substances, reduction or elimination of hazardous substance releases and sources of releases, degree of irreversibility of waste treatment process, and characteristics and quantity of treatment residuals generated.

Alternatives involving excavation provide the greatest degree of permanence, with the removal of impacted soil and LNAPL from the Site. Due to the extent of remedial action, Alternative 4 and 6 are more protective than Alternatives 1 and 5. Because Alternative 4 removes the greatest quantity of impacted soil, it is expected to have the shortest remediation duration. Alternative 5 ranks equally with Alternative 1 because both alternatives leave impacted soil in place in the WSDOT stormwater line area.

Alternatives 2 and 3 only address potentially mobile LNAPL from groundwater in the DB-2 area. It is expected that groundwater compliance will be met through groundwater treatment and MNA in the DB-2 area; however, impacted soil may remain in place in the vadose zone. Due to the extent of the groundwater containment through a continuous trench rather than wells as well as a larger groundwater capture zone, Alternative 3 has a higher degree of removal than Alternative 2 and therefore is ranked higher than Alternative 2. Both alternatives leave impacted soil in place in the WSDOT stormwater line area.

Based on the degree of permanence, the following alternatives are ranked from highest to lowest:

- *Highest*. Alternatives 4 and 6 are the most permanent alternatives based on the complete removal or treatment of soil with COC concentrations greater than CULs. Only limited ECs would be required.
- *Medium*. Alternatives 5 and 1 are less permanent alternatives because soil and groundwater with COC concentrations greater than CULs would remain in place in the WSDOT stormwater line area. ECs would be required for any soil or groundwater left in place with COC concentrations greater than CULs.
- *Lowest*. Alternatives 3 and 2 are the least permanent because onsite dissolved-phase groundwater COC concentrations, soil COC concentrations, and potentially nonmobile LNAPL would remain in place. Protectiveness would be addressed through ECs.

7.8.3 Cost

Cost refers to the cost of implementing the alternative, including construction, net present value of any long-term costs, and agency oversight costs that are cost recoverable. Long-term costs include operation and maintenance, monitoring, equipment replacement costs, and the cost of maintaining institutional controls.

Order of magnitude costs were developed for all six alternatives. The significant assumptions made to develop the cost estimates for the six alternatives are discussed below. For all alternatives involving disposal of water from excavations, dewatering, or treatment it is assumed that disposal can be accomplished by treatment and discharge to Willow Creek under an NPDES permit. Since Alternatives 1, 2, 3, and 5 would leave impacts in the WSDOT stormwater line area, long-term monitoring of 60 years (based on natural attenuation of NAPL source zone) was accounted in the remediation cost of each of these Alternatives.

Alternative 1 is the least expensive alternative and assumes the excavation of known impacts in the area of DB-2. The area is shown on Figure 6-2. The cost analysis is based on approximately 3,000 to 5,800 cubic yards (cy) of material to be excavated and transported to an appropriate waste disposal facility. Long-term costs include continued groundwater monitoring at the Site coupled with ECs placed on the Site. The cost for Alternative 1 is estimated to range from approximately $2,327,000 to $4,030,000 (Table 7-2).

Alternative 2 is the third least expensive alternative and assumes a groundwater extraction system with six extraction wells installed on 40-foot centers. Wells will be advanced to a depth of approximately 15 to 20 feet bgs (maximum historical excavation depth) at pumping rates of approximately 3 to 5 gpm. Installation costs for the groundwater extraction system include drilling, well construction, soil disposal, conveyance piping, and trenching. System costs include electrical connections, system controls, system building, and groundwater pumping and treatment equipment. Long-term costs include 10 years of utility costs, and operation and maintenance of the treatment system, continued groundwater monitoring at the Site and ECs placed on the Site. The estimated cost for Alternative 2 ranges from approximately $3,978,000 to $5,590,000 (Table 7-3).

Alternative 3 is the fourth least expensive alternative and assumes the installation of an approximately 280-foot groundwater extraction trench. Installation costs for the groundwater extraction trench system include specialized trenching equipment, soil disposal, permeable backfill, and conveyance piping. System costs include electrical connections, system controls, system building, and groundwater pumping and treatment equipment. Long-term costs include 10 years of utility costs, and operation and maintenance of the treatment system, continued groundwater monitoring at the Site and ECs placed on the Site. The estimated cost for Alternative 3 ranges from approximately $4,264,000 to $6,019,000 (Table 7-4).

Alternative 4 is the most expensive alternative based on the excavation of known impacts in the area of DB-2 and near the WSDOT stormwater line. The area is shown on Figure 6-5**.** Costs associated with this alternative include the excavation costs from Alternative 1 in addition to excavation activities near the WSDOT stormwater line. Soil analytical results for the WSDOT stormwater line area indicate that excavations would extend to approximately 8 or 9 feet bgs. To create a reasonable estimate for the FS, and based on previous experiences at the Site, excavations were estimated to extend approximately 10 to 15 feet bgs. It is estimated that approximately 7,990 cy of material will be excavated and transported to an appropriate waste disposal facility. Excavation to that depth near the WSDOT stormwater line will require shoring and dewatering. Long-term costs include continued groundwater monitoring at the Site during 3 years and ECs placed on the Site. The cost for implementing Alternative 4 is estimated to range from approximately $5,473,000 to $8,645,000. Of the total approximate cost for Alternative 4, $3,480,000 to $4,880,000 is associated with the remedial of WSDOT stormwater line, with the bulk of the cost for shoring and dewatering requirements near the WSDOT stormwater line (Table 7-5).

Alternative 5 is the fifth least expensive alternative based on the excavation of known impacts in the area of DB-2 and implementing ISS for impacts near the WSDOT stormwater line. The area is shown on Figure 6-6. To complete ISS activities near the WSDOT stormwater line, it is estimated that approximately 710 cy of material will be excavated, mixed with a binding agent, and used as backfill. It is assumed that costs for excavation of impacted soil near DB-2 will be the same as Alternative 1. Long-term costs include continued groundwater monitoring and implementing ECs at the Site. The total cost of Alternative 5 is estimated to be approximately $4,630,000 to $5,011,500 (Table 7-6).

Alternative 6 is the second least expensive alternative based on the excavation of known impacts in the area of DB-2 and implementing DPE system for impacts near the WSDOT stormwater line. The area is shown on Figure 6-7. Long-term costs include continued groundwater monitoring at the Site for 6 years and ECs placed on the Site. It is assumed that costs for excavation of impacted soil near DB-2 will be the same as Alternative 1. The total cost of Alternative 6 is estimated to be approximately $2,652,000 to $4,342,000 (Table 7-7).

A comparison of cost for Alternatives 1 through 6 is presented in Table 7-8. The lowest cost is highlighted in green, while the highest cost is highlighted in red.

Table 7-8. Cost Comparison of Remedial Alternatives

Remedial Alternative No.	Remedial Alternative	Total Lower Cost ($)	Total Upper Cost ($)
1	Excavation and MNA with ECs	$2,327,000	$4,030,000
2	Groundwater Containment System Using Groundwater Extraction Wells, and MNA with ECs	$3,978,000	$5,590,000

Remedial Alternative No.	Remedial Alternative	Total Lower Cost ($)	Total Upper Cost ($)
3	Groundwater Containment System Using Groundwater Extraction Trench, and MNA with ECs	$4,264,000	$6,019,000
4	Excavation with limited ECs	$5,473,000	$8,645,000
5	Excavation and ISS, and MNA with ECs	$4,630,000	$5,011,500
6	Excavation and DPE Treatment with limited ECs	$2,652,000	$4,342,000

Based on the degree of cost, the following alternatives are ranked from highest (least expensive) to lowest (most expensive):

- *Highest.* Alternatives 1 and 6 are the least expensive alternatives. However, Alternative 6 would also remediate both DB-2 and WSDOT stormwater line areas.
- *Medium.* In order, Alternatives 5, 2, and 3 are more expensive to implement than Alternatives 1 and 6, but less expensive than Alternative 4.
- *Lowest.* Alternative 4 is the most expensive alternative and includes excavation of DB-2 and the WSDOT stormwater line. The cost of this alternative is significantly higher due to the remedial action of impacted soil from both DB-2 and WSDOT stormwater line areas and the extensive dewatering and shoring required for the WSDOT stormwater line.

7.8.4 Long-Term Effectiveness

The following criteria will be considered when evaluating the long-term effectiveness of each alternative:

- Degree of certainty that the alternative will be successful.
- How reliable the alternative will be while the hazardous substances remain onsite and exceed CULs.
- Magnitude of residual risk associated with the alternative.
- Effectiveness of controls that are in place to manage treatment residues or remaining wastes.

MTCA provides guidance for determining long-term effectiveness, as presented below (in descending order:

- Destruction or detoxification.
- Immobilization or solidification.
- Onsite or offsite disposal at an appropriate waste disposal facility.
- Onsite isolation or containment with attendant engineering controls.
- Institutional controls and monitoring.

Alternative 4 offers the highest degree of long-term effectiveness because this alternative removes the largest amount of impacted soil and LNAPL from the Site in the shortest time, thereby providing the greatest reduction in residual risk. It is expected that groundwater impacts will also be eliminated by removal of the source area and by natural attenuation through time. Regular groundwater monitoring events will be used to minimize any additional residual risk.

Alternative 6 offers the second highest degree of long-term effectiveness because this alternative removes the largest amount of impacted soil and LNAPL from the Site. The time period for achieving remediation goals using Alternative 6 (treatment and operation of DPE for 6 years) is relatively higher than Alternative 4 and increases the residual risk with the alternative in place for Alternative 4. It is expected that groundwater impacts will also be eliminated by removal of the source area and by natural attenuation through time. Regular groundwater monitoring events will be used to minimize any additional residual risk.

Alternatives 1 and 5 are also expected to offer a high degree of long-term effectiveness because these alternatives remove impacted soil near DB-2. Alternative 5 ranks higher than Alternative 1 because ISS will provide a surface barrier to prevent surface-water infiltration, which would reduce the migration of impacts from soil to groundwater through leaching, if that were occurring.

Alternative 3 offers the second lowest degree of long-term effectiveness because residual risk at the Site is reduced by removing LNAPL from groundwater. Impacted groundwater in the area will be treated through the reactive core mat while LNAPL will be collected using passive bailers or pumps. Alternative 2 offers the least amount of long-term effectiveness. The groundwater pump and treat system will contain and treat impacted groundwater; however, impacted soil and nonmobile LNAPL may remain onsite and institutional controls will be used to reduce residual risks.

Based on the degree of long-term effectiveness, the following alternatives are ranked from highest to lowest:

- *Highest.* Alternative 4 offers the highest degree of long-term effectiveness based on complete removal of soil with COC concentrations greater than CULs. ECs would be limited for this alternative and groundwater compliance sampling would only be required for a short duration.
- *Medium.* Alternatives 1, 5, and 6 provide a high degree of long-term effectiveness; however, given the MTCA's preference for disposal instead of containment, these alternatives were ranked lower than Alternative 4 because some soil with COC concentrations greater than CULs would remain in place. ECs would be required for any soil left in place with COC concentrations greater than CULs.
- *Lowest.* Alternatives 3 and 2 are the least effective for the long term because onsite dissolved-phase groundwater COC concentrations, soil COC concentrations, and nonmobile LNAPL may remain in place and protectiveness would be addressed through ECs.

7.8.5 Management of Short-Term Risks

Management of short-term risks relates to the risk to human health and the environment associated with the alternative during construction and implementation, and the effectiveness of measures to control the risk.

All alternatives presenting an excavation component requiring transport and offsite disposal involve higher short-term risk than alternatives involving only groundwater disposal (Alternatives 2 and 3). Additionally, excavation to below the groundwater table will pose short-term risk to construction workers and potential releases to surface water through flooding or mismanagement of groundwater. Onsite decontamination procedures must be implemented to reduce short-term risk to site workers and the public.

Alternatives 2 and 3 involve removing the lowest volume of soil and groundwater during remedial system construction and implementation. Only a minimal amount of soil associated with drilling and conveyance piping and trenching will be removed and disposed of offsite under Alternative 2. Under Alternative 3, the largest volume of soil associated with trenching activities will be removed from the Site; therefore, Alternative 3 ranks lower than Alternative 2. During system operation, minimal short-term risk will be associated with groundwater extraction and treatment. Based on the short-term risks, Alternative 2 has the highest rating with the lowest short-term risk.

Alternative 4 has the largest volume of excavated soil, takes place close to the WSDOT stormwater line, and has the highest short-term risk. In addition, significant engineering design will be required to ensure that the shoring and dewatering infrastructure is sufficient for implementation and protection against the geotechnical concern of slope stability. A considerable amount of groundwater will need to be treated and discharged. This activity offers greater short-term risk in terms of direct contact with site contaminants and worker safety through injury from engulfment from heaving sands, and crushing from floating of the stormwater line.

Alternatives 5 and 6 have the second highest short-term risk. In addition to the earthwork associated with excavation of DB-2, Alternative 5 involves excavating and in-situ mixing of the impacted soil surrounding the WSDOT stormwater line, posing a moderate short-term risk and requiring onsite decontamination. In addition to the earthwork associated with excavation of DB-2, drilling, trenching, and installation of the remediation system and operation and maintenance of the remediation system will be required under Alternative 6, posing a moderate short-term risk and requiring additional groundwater treatment.

Based on the management of short-term risks, the following alternatives are ranked from highest (lowest short-term risk) to lowest (highest short-term risk):

- *Highest (lowest short-term risk).* Alternatives 2 and 3 have the lowest volume of soil and groundwater removed during remedial system construction and implementation and offer the highest degree of management of short-term risk.
- *Medium.* Alternatives 1, 5, and 6 include the removal and handling of moderate volumes of soil and groundwater during remedial implementation and offer a medium degree of management of short-term risk.
- *Lowest (highest short-term risk).* Alternative 4 includes removal of the highest volume of soil and groundwater during remedial system construction activities, work near the WSDOT stormwater line, and the highest exposure of workers to direct contact with site contaminants or at risk of being crushed or engulfed. Therefore, Alternative 4 offers the lowest degree of management of short-term risk.

7.8.6 Technical and Administrative Implementability

Technical and administrative implementability relates to the ability of an alternative to be implemented, including whether the alternative is technically possible, availability of necessary offsite facilities, services and materials, administrative and regulatory requirements, scheduling, size, complexity, monitoring requirements, access for construction operations and monitoring, and integration with existing facility operations and other current or potential remedial actions.

All six alternatives require long-term groundwater monitoring; therefore, rating the technical and administrative implementability was based on the amount of work required to install and operate the alternative. ECs are required under each alternative, although Alternatives 4 and 6 required only limited ECs.

Alternative 1 is the most implementable in terms of technical and administrative complexities. Soil removal has occurred at the Site and has been shown to reduce COC concentrations in groundwater to less than CULs. The excavation of DB-2 can be accomplished without extensive dewatering or shoring, and minimal long-term maintenance is only required for the EC.

Alternatives 2 and 3 are respectively the second and third most implementable alternatives in terms of technical and administrative complexities. Pump and treat remediation systems have a history of effective implementation at many remediation sites. The operation and maintenance of the remediation equipment reduces the overall rating of implementability and increases the administrative complexity compared to Alternative 1. Under Alternative 3, installation of the trench coupled with backfill material placement increases the technical implementation of this remedial alternative compared to Alternative 2.

Alternative 4 is the least implementable in terms of technical and administrative complexities. The excavation of DB-2 can be accomplished without extensive dewatering or shoring; however, excavation in the WSDOT stormwater line will require considerable engineering measures to manage risk (see Section 7.8.6).

Alternative 5 is the second least implementable in terms of technical and administrative complexities. Technical complexities involved in ISS of soil above the WSDOT stormwater line are related to specialized mixing equipment and field verification. However, during implementation of this technology, extensive dewatering and shoring will not be required. ISS would provide more permanent protection against direct contact with impacted soil and limit the potential vapor intrusion risk, but will result in a semipermanent barrier above an aging stormwater line. If the WSDOT stormwater line is in need of repair, this stabilized soil will offer a barrier to unearthing the pipe.

Of the three alternatives involving remedial action in the WSDOT stormwater line area, Alternative 6 is the most implementable in terms of technical and administrative complexities. As part of Alternatives 4 and 5, remedial action in the WSDOT stormwater line will be implemented. However, under Alternative 6, the DPE alternative is less intrusive and would require less engineering control than Alternative 4; in addition, the WSDOT stormwater line would still be accessible after completion of the remedial activities. Remediation through DPE is an accepted remedial approach and is widely used to remove petroleum hydrocarbon-related impacts within soil and groundwater. Regularly scheduled maintenance is required to continue operation of the system.

Based on the extent and complexity of earthwork and construction activities, the technical and administrative implementability of each alternative is ranked below from highest to lowest:

- *Highest.* Alternative 1 is the most implementable and offers the highest degree of technical and administrative implementability.

- *Medium.* Operation and maintenance of remediation equipment or implementation of the specialized technology in Alternatives 3, 2, 5, and 6 offer medium degree of technical and administrative implementability.
- *Lowest.* Alternative 4 includes extensive dewatering and shoring and offers lowest degree of technical and administrative implementability.

7.8.7 Public Concerns

See Section 7.6.

7.8.8 Disproportionate Cost Analysis Preliminary Summary

Based on the qualitative and quantitative assessment discussed in Section 7, Alternative 6 offers the best solution for the criteria considered: protectiveness, permanence, long-term effectiveness, management of short-term risks, and technical and administrative implementability. Alternative 6 has an average qualitative score of 2.0, which was the lowest (best) of the six alternatives.

7.9 Final Disproportionate Cost Analysis

The alternative that ranked highest after the first analysis is Alternative 6. Per WAC 173 340 360(3)(e), Alternative 6 was compared to Alternative 4, which Ecology selected as the most permanent remedy of the alternatives presented (Ecology 2014b). Both alternatives include excavation of DB-2 and differ only in the remediation of the area near the WSDOT stormwater line.

The final DCA include two passes:

1. *First pass*. The evaluation criteria were weighted using the qualitative assessment described below and the alternatives were assessed using the rankings presented in the Draft FS Report (Arcadis 2014a) plus consideration of public concerns. The analysis is represented in Table 7-9.
2. *Second pass*. Arcadis used the rankings assigned by Ecology in their DCA and weighted the evaluation criteria. Per WAC 173-340-360(3)(e)(ii)(C), the department has the discretion to favor or disfavor qualitative benefits and use that information in selecting a cleanup action. A scale of 1 to 10 was used; the criteria of most importance in selecting a remedy was assigned a weight of 10. The analysis is represented in Table 7-10.

Per Ecology's comments (Ecology 2014b) this two-pass approach was used to assess robustness, and a weighted sum was calculated by multiplying the ranking of each criterion for each alternative by the weight assigned to the criterion. The lowest sum is the alternative that is permanent to the maximum extent practicable.

The summary of the DCA of the two passes for Alternatives 4 and 6 is provided in Table 7-11.

Table 7-11. Disproportionate Cost Analysis Weighted Sums

DCA Weighted Sums	Remedial Alternative 4	Remedial Alternative 6
Pass 1	114	86
Pass 2	106	97

Additional information developed to further evaluate Alternative 6 is presented below

7.9.1 Protectiveness

This criterion was selected as one of the two most important criteria and was assigned a weight of 10 by Ecology. Both alternatives permanently remove and/or treat the impacted media at the Site.

Alternative 6 offers lower onsite (less construction onsite) and offsite (lower quantity of disposal offsite) risks, but a relatively longer time frame is required to reduce environmental risk at the facility. The DPE portion of the system requires considerable dewatering to expose residual LNAPL in the smear zone. The DPE pilot test study shows that throughout remediation, Alternative 6 will contain groundwater impacts near the WSDOT stormwater line and ensure that groundwater with COC concentrations greater than CULs does not leave the Lower Yard. Data have shown that excavation will also result in the eventual cleanup of groundwater to concentrations less than CULs; however, during that time frame, excavation does not protect against discharge to surface water.

Alternative 4 offers swift achievement of soil CULs and relatively swift achievement of groundwater CULs, but does not protect against potential discharges to surface water while monitoring natural attenuation. Alternative 6 offers a comparative level of protectiveness with the added groundwater containment of remaining impacts near the WSDOT stormwater line, with a slightly longer time frame. Therefore, both alternatives were ranked 1 in protectiveness.

7.9.2 Permanence

This criterion was selected as an important criterion and was assigned a weight of 8 by Ecology. Both alternatives permanently remove and/or treat the impacted media at the Site.

Alternative 4 will permanently remove impacted soil near the WSDOT stormwater line and dispose of the soil at an appropriate waste disposal facility. Alternative 6 will treat impacted media and destroy contaminants prior to discharge to the environment.

Alternative 4 will focus on the area of remaining impacts and remediate all media encountered within that area (soil, residual LNAPL, and groundwater); however, Alternative 6 will achieve the treatment and destruction of contaminants within highly mobile media (soil vapor and groundwater) beyond the depth of excavation offered by Alternative 4.

Excavation has nearly the same time frame for remediation as Alternative 6. However, excavation of contaminated materials adjacent to a stormwater line conveying stormwater to Puget Sound presents a risk of breach in the stormwater line pipe and offers a relatively lower degree of irreversibility of the waste treatment process compared to Alternative 6.

Alternative 4 will generate approximately 12,000 tons of soil to be disposed of from WSDOT stormwater line excavation, whereas Alternative 6 will produce an estimated 20 tons of spent GAC. The GAC will be transported offsite to a handling facility and reactivated. Reactivation destroys sorbed COCs and allows for reuse of the reactivated carbon.

Both Alternatives 4 and 6 offer a high degree of permanence. Alternative 4 will achieve a degree of permanence in the relatively near future by permanently removing contaminants from the Site but not from the environment (landfilling). Alternative 6 will destroy contaminants permanently. Therefore, both alternatives are ranked 1.

7.9.3 Cost

This criterion was selected as an important criterion that balances the overall benefit of a cleanup action and was assigned a weight of 8 by Ecology.

The cost of Alternative 4 is the highest ($5.52 to $8.71 MM) and ranked as 5 in DCA Passes 1 and 2. The cost of Alternative 6 ($2.65 to 4.34 MM) is qualitatively ranked as 1 in DCA Pass 1 and is ranked as 2.4 in DCA Pass 2, which is the direct ratio to the cost of Alternative 4. The cost of Alternative 6 includes the cost to complete the cleanup action, including operation and maintenance of the remediation system for 6 years.

7.9.4 Long-Term Effectiveness

This criterion was selected as one of the two most important criteria that a cleanup action must meet and was assigned a weight of 10 by Ecology.

Alternative 4 offers excavation, a technology that has been effectively used onsite and provides a high degree of certainty that the alternative will be successful. Alternative 6 will remove COCs from the soil and groundwater through DPE. DPE has been successfully employed as a remediation technology at petroleum hydrocarbon-impacted sites. The DPE pilot test study shows that drawdown rates required for DPE will remediate residual LNAPL in soil and dissolved-phase COC concentrations near the WSDOT stormwater line. The time period for achieving remediation goals using Alternative 6 (treatment and operation of DPE for 6 years) is relatively higher than Alternative 4 and increases the residual risk with the alternative in place for Alternative 4. Therefore, Alternative 4 is ranked 1 (shows highest effectiveness for the long term) and Alternative 6 is ranked 2.

7.9.5 Management of Short-Term Risks

This criterion is not a primary criterion for a cleanup action, but helps determine the feasibility of the cleanup action and was assigned a weight of 4 by Ecology.

Alternatives 4 and 6 include earthwork associated with excavation of DB-2 (3,000 to 5,800 cy of impacted soils to be removed and disposed of at an appropriate waste disposal facility). In addition, Alternative 4 involves significant earthwork (approximately 8,000 cy of soil to be excavated) and contaminated materials (soil, groundwater, and residual LNAPL) to be handled and disposed of offsite) during construction. Alternative 6 will include limited earthwork (trenching, drilling, and piping for the system) in addition to the construction work conducted for the DB-2 excavation.

Alternative 4 includes additional technical requirements for excavation and management of risks:

- Hazards associated with stormwater line pipe breach.
- Potential risk of a stormwater line breach and potential discharge to Puget Sound.
- Sheet pile installation.
- Significant engineering design to ensure that the shoring and dewatering infrastructure is sufficient for implementation.

Alternative 6 short-term risks include risks associated with:

- Drilling.
- Trenching and installation of the remediation system.
- Operation and maintenance of the remediation system.

Overall, the management of short-term risk is more effective and easily implemented for Alternative 6 because drilling and trenching at low depth are more conventional and less risky than sheet pile installation and excavation at lower depth. In addition, the risk associated with a stormwater line pipe breach are reduced because Alternative 6 is less intrusive than Alternative 4. Therefore, Alternative 6 was ranked 4 Alternative 4 was ranked 5.

7.9.6 Technical and Administrative Implementability

This criterion is not a primary criterion for a cleanup action but helps determine the feasibility of the cleanup action and was assigned a weight of 4 by Ecology.

Alternatives 4 and 6 include post-remediation groundwater monitoring to evaluate efficient treatment operation, but do not include engineering controls or periodic reviews. Both alternatives require limited ECs.

Alternative 4 offers fewer administrative concerns (excavation is widely accepted as an easily implementable and effective cleanup action by the public and Ecology), but more complicated construction work because the excavation activities are performed below the water table adjacent to the stormwater line conveying stormwater to Puget Sound.

Alternative 6 offers easier technical implementation and higher administrative concerns relative to Alternative 4 because the DPE alternative is implemented over a 6 years period. Remediation through DPE is an accepted remedial approach and is widely used to remove petroleum hydrocarbon-related impacts in soil and groundwater. Pilot test data and modelling show that DPE is a technically feasible alternative and can be implemented using standard equipment that is widely available within the environmental remediation industry. Regularly scheduled maintenance is required to continue operation of the system, increasing the administrative requirements of this alternative compared to Alternative 4.

Overall, the technical and administrative implementability of Alternative 6 was assessed to be equivalent relative to Alternative 4 and was ranked as 3.

7.9.7 Consideration of Public Concerns

Ecology emphasized the importance of public participation and concerns on this Site because the Lower Yard will become the property of the State of Washington and will likely be used as a multi-modal transportation facility. Ecology assigned a weight of 6 to this criterion.

According to WAC 173-340-360(3)(f)(vii), this criterion evaluates whether the community has concerns regarding the alternative and, if so, the extent to which the alternative addresses those concerns. This process includes concerns from individuals, community groups, local governments, tribes, federal and state agencies, or any other organization that may have an interest in or knowledge of the Site. In this case, the community's with interest include the WSDOT (prospective buyer of this property) and the Edmonds Citizens Awareness Committee (ECAC).

Alternatives 4 and 6 meet the expectations of cleanup action by Ecology. Alternative 4 removes contaminated materials and moves them offsite from both areas of remediation (DB-2 and WSDOT stormwater line area). Alternative 6 removes contaminated materials from DB-2 area and treats contaminated media from the WSDOT stormwater line area. Both alternatives will meet the cleanup goals. Both alternatives will not leave impacts onsite at the time of completion (no vapor barriers or ECs in place) and will receive a high degree of public approval. Alternative 6 has additional advantages in the complete removal, excavation, and replacement of the WSDOT stormwater line in relation to public concerns. Construction of the DPE system will require less site traffic and hydrocarbon-impacted material transport from the Site, reducing the number of loads associated with offsite disposal. Construction equipment onsite will be limited to a small excavator for minimal trenching activities, reducing noise and dust. Installation and operation of the DPE system will also keep critical stormwater infrastructure in place while still addressing remediation goals.

Because the WSDOT and the ECAC have expressed concerns regarding ECs and indicated a preference for excavation to address impacts in the WSDOT stormwater line area, we expect that Alternative 4 will be more readily accepted by the WSDOT, the ECAC, and the public, relative to Alternative 6. Therefore Alternative 4 is ranked the highest (1) and Alternative 6 is ranked 2.

7.9.8 Provide for a Reasonable Restoration Time Frame

WAC 173-340-360(4) contains guidance for evaluating reasonable restoration timeframes. Preference is given for alternatives that can be implemented in a shorter period of time if other factors such as permanence and costs are equal. Under the DPE remediation scenario, the LNAPL depletion model shows that TPH concentrations in soil and dissolved TPH concentrations in groundwater in the target treatment zone can be remediated to less than the CUL within approximately 5 and 6 years, respectively. Alternatives 4 and 6 provide for a reasonable restoration time frame.

8 RECOMMENDED REMEDIAL ALTERNATIVE

Alternative 6, Excavation and DPE Treatment, is the recommended remediation action.

The preliminary design is based on standard engineering calculations, modeling, and the DPE pilot test study. Basis of design in terms of well spacing, conveyance piping, and system components are provided below. Each DPE well will be equipped with an electric pump and groundwater discharge conveyance piping. The top of the well casing will be fitted with a connection to vapor extraction conveyance piping from the vacuum blower. Conveyance piping will be placed on grade, and will connect to treatment equipment that will be housed in a newly constructed building located adjacent to the existing equipment shed in the southern area of the Lower Yard. The location of the equipment shed was chosen based on the preliminary layout of the Edmonds Crossing project; however, the equipment shed can be relocated to accommodate the actual layout of the Edmonds Crossing project, or other future development. A preliminary system location in relation to the layout is shown on Figure 6-7. Wells will be constructed of 4-inch Schedule 40 PVC with 0.02-inch wire-wrapped screen from 5 to 35 feet bgs. Below the well screen will be 3 feet of solid casing that will act as a silt collection sump to decrease the occurrence of pump fouling. Well construction details may change based on field observations during the time of drilling.

Extracted vapor and groundwater conveyance piping will connect to the system compound located within the southern portion of Lower Yard as shown on Figure 6-7. The system compound will consist of a system enclosure to house the groundwater and extracted vapor treatment equipment. Extracted vapor will flow through an 14-leg manifold, with each leg consisting of an air flow meter, flow control valve, vacuum gauge, and sampling port. A main header will connect the manifold to an air/water separator prior to the blower. Vapor from the blower will discharge into a catalytic oxidizer for treatment prior to discharge to the atmosphere. Accumulated water from the separator will be transferred using a Moyno progressive cavity or similar pump, to the settling tank that is part of the groundwater treatment equipment. A Grundfos Redi-Flo 4 electric submersible pump will draw down the water table and transfer water to a conical bottom settling tank and holding tank housed within the treatment compound. Each wellhead will be fitted with a flow control valve, and pressure gauge. Each groundwater pumping well will be completed with a well vault fitted with a float to shut off the well if pipe failure or leaks occur at the wellhead. Groundwater conveyance lines will be installed within secondary containment lines.

Groundwater will be pumped through the conveyance lines to a conical bottom tank and holding tank where solids will be allowed to settle. The tanks will be controlled with automatic float switches, pumping water in batches through in-line particulate filters before being treated using liquid GAC beds (two sets of two in series). Treated water will be discharged to Willow Creek or DB-2 under a NPDES permit. Cost estimates for the DPE system are presented in Table 7.7.

Power for the treatment building and equipment will be connected to the existing power service drop located between DB-1 and DB-2 near the north side of the Lower Yard. Electrical conduit will be placed in a trench as shown on Figure 6-7.

9 CONCLUSION

Alternative 6, Excavation and DPE Treatment, is the alternative that is permanent to the maximum extent practicable. The alternative is relatively easy to implement, offers easier short-term risk management procedures, addresses the public's concerns both locally and regionally, removes and/or destroys contaminants permanently, and will cost approximately one-half of the cost of Alternative 4. The increased incremental cost of Alternative 4 over Alternative 6 is disproportionate to the degree of benefits achieved. Therefore, Chevron recommends Alternative 6 as the preferred remedy for the remaining impacts at this Site.

10 SCHEDULE

Following approval of this Draft Final FS Report by Ecology as ready for public review, a Draft Cleanup Action Plan will be prepared and submitted to Ecology for review as required by AO No. DE 4460. The Draft Cleanup Action Plan will present a preferred cleanup action.

Ecology will review the Draft Cleanup Action Plan and use it as the basis for preparing Ecology's Draft Cleanup Action Plan. Ecology's Draft Cleanup Action Plan will be an exhibit to a new draft Consent Decree. The new draft Consent Decree will be issued for public comment and revisions will be made as necessary. Upon entry into Snohomish County Superior Court, the new Consent Decree will take effect and govern further actions at the Site.

This FS Report will be issued for public review concurrently with the draft Cleanup Action Plan and new draft Consent Decree.

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TABLES

Table 2-1
Site Investigations and Remedial Actions Chronology
Chevron Environmental Management Company
FINAL FEASIBILITY STUDY REPORT
Former Unocal Edmonds Bulk Fuel Terminal
Edmonds, Washington

Year	Activity	Details	Contaminated Soils Removed (tons)	LNAPL Removed (gallons)	Focus Site Area	Report	Author
1986	Phase 1 Site Assessment – GeoEngineers (1986)	• Soil, groundwater, and sediment sampling in the Lower Yard. • Light nonaqueous phase liquid (LNAPL) detected in 10 of 27 wells. Thickness ranged from trace to 3.18 feet. Three separate LNAPL plumes were defined. • Depths to groundwater varied from 3 to 8 feet below ground surface (bgs). • Approximately 20,000 gallons (gal) of recoverable product are reported to be in the vicinity of the tidal basin.			Lower Yard	Background History Report Unocal Edmonds Bulk Fuel Terminal	Maul, Foster, and Alongi (MFA)
1987 - 1991	Product Recovery Project – GeoEngineers (1987, 1988, 1989, 1991)	• Two product recovery systems installed, to the southeast of the tidal basin, and northwest of the facility oil/water separators. • Systems consist of recovery sumps and trenches with perforated drains. • Between May 1988 and September 1990, a total of approximately 7,500 gal was recovered from RW-1. • RW-2 was never activated, but it was estimated that 1,000 gallons of recoverable petroleum product were located in the former RW-2 area at the time.		7,500	Lower Yard	Background History Report Unocal Edmonds Bulk Fuel Terminal	MFA
1988	Subsurface Contamination Study, Upland Fuel Tank Area – GeoEngineers (1988)	• Subsurface contamination study to determine conditions within a portion of the Upper Yard. • Consisted of six soil borings, 12 hand auger borings, and installation of groundwater and vapor monitoring wells. • Total petroleum hydrocarbons (TPH) in soil varied from non-detect (ND) to 12,000 milligrams per kilogram (mg/kg), consisting of primarily heavy end hydrocarbons. • Groundwater concentrations were ND for benzene, toluene, ethylbenzene and xylene (BTEX) except for one well with elevated benzene concentrations.			Upper Yard	Background History Report Unocal Edmonds Bulk Fuel Terminal	MFA
1988	Phase 1 Site Assessment, Detention Basin No. 1 – GeoEngineers (1988)	• Phase 1 assessment of Detention Basin No. 1 (DB-1), surface water, soil and tar samples collected for analysis. • TPH concentrations of the lake sediments and tar exceeded 100,000 mg/kg, ethylbenzene ranged from ND to 3.9 mg/kg, and total xylenes varied from 2 to over 1,000 mg/kg. • No volatile or semivolatile organic compounds were detected in water samples analyzed. TPH concentrations ranged from 560 to 930 micrograms per liter (µg/L).			Detention Basin No.1	Background History Report Unocal Edmonds Bulk Fuel Terminal	MFA
1989	Phase 2 Site Assessment, Detention Basin No. 1 – GeoEngineers (1989)	• Investigation to determine the possibility of contamination of groundwater by DB-1. • Installed three new monitoring wells and drilled exploratory borings along the northwest margin of the original limits of DB-1. • TPH in soil ranged from 65 to 360 mg/kg, TPH in groundwater varied from 0.84 to 1.8 milligrams per liter (mg/L). Benzene ranged from ND to 110 µg/L.			Detention Basin No.1	Background History Report Unocal Edmonds Bulk Fuel Terminal	MFA

Table 2-1
Site Investigations and Remedial Actions Chronology
Chevron Environmental Management Company
FINAL FEASIBILITY STUDY REPORT
Former Unocal Edmonds Bulk Fuel Terminal
Edmonds, Washington

Year	Activity	Details	Contaminated Soils Removed (tons)	LNAPL Removed (gallons)	Focus Site Area	Report	Author
1989	Site Contamination Assessment, Waste Soil Stockpile Area – GeoEngineers (1989)	• Purpose of the study was to evaluate the waste soil stockpile area (southeast Lower Yard) for subsurface contamination. • Five hand auger borings and one groundwater monitoring well installed. • Soil in stockpile was from the Unocal Station No. 5353 from 1980, and from Unocal Station No. 6211 from 1987. • TPH in soil varied from 510 to 6,300 mg/kg. TPH immediately below or adjacent to the stockpile ranged from ND to 100 mg/kg. The highest benzene concentration was 110 micrograms per kilogram (µg/kg).			Lower Yard	Background History Report Unocal Edmonds Bulk Fuel Terminal	MFA
1990	Site Contamination Study, Marine Diesel Spill – GeoEngineers (1990)	• On May 5, 1990, approximately 350 gal of marine diesel fuel spilled in the Lower Yard. • Ten soil samples were analyzed for TPH, results ranged from 9 to 14,000 mg/kg. The highest concentrations were found beneath the aboveground pipe racks. Contamination was noted up to 2 to 3 feet bgs, and estimated to be about 100 cubic yards.			Lower Yard	Background History Report Unocal Edmonds Bulk Fuel Terminal	MFA
1990	Site Contamination Assessment, Lower Yard – GeoEngineers (1990)	• Purpose was to determine the extent of soil contamination due to past releases. • Excavated and collecting soil samples from 25 test pits for TPH and BTEX, and evaluated ongoing landfarming activities. • Soil samples collected in 23 of 25 test pits between 6 and 8 feet bgs. • Benzene concentrations ranged from ND to 3 mg/kg, toluene from ND to 17 mg/kg, ethylbenzene from ND to 43 mg/kg, and total xylenes from ND to 310 mg/kg. TPH varied from 12 to 16,000 mg/kg, TPH in the gasoline range (TPH-G) from ND to 2,800 mg/kg, and TPH in the diesel range (TPH-D) from ND to 23,000 mg/kg. • Landfarming efforts reduced TPH levels from 2,600 mg/kg to less than 200 mg/kg.			Lower Yard	Background History Report Unocal Edmonds Bulk Fuel Terminal	MFA
1991	Supplemental Subsurface Contamination Assessment, Upper Yard – GeoEngineers (1991)	• Purpose was to explore subsurface conditions in the eastern portion of the Upper Yard and the BNSF property north of the Lower Yard. • Excavated four test pits, drilled five borings in the eastern portion of the Upper Yard, installed groundwater monitoring wells in each Upper Yard boring, installed 15 hand auger borings throughout the Upper Yard, and installed three borings and groundwater monitoring wells in the BNSF right-of-way. • BTEX components in soil were detected in two of 20 samples. Benzene was not detected in any sample. TPH-G varied from 7 to 2,700 mg/kg, TPH-D ranged from 90 to 19,000 mg/kg, and TPH varied from ND to 30,000 mg/kg. • BTEX components were detected at very low levels in groundwater; TPH-G and TPH-D were ND.			Upper Yard	Background History Report Unocal Edmonds Bulk Fuel Terminal	MFA

Table 2-1
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Year	Activity	Details	Contaminated Soils Removed (tons)	LNAPL Removed (gallons)	Focus Site Area	Report	Author
1991	Harbor Square Phase 1 Site Assessment – Landau Associates (1991) – Offsite investigations	• This assessment was conducted for the Port of Edmonds to assess the nature and extent of potential contamination at a portion of the Port's Harbor Square property. • Identified a report in Ecology files documenting a leaking 2,000 gallon underground storage tank on the BNSF property ~700 feet north of Harbor Square (which was removed in 1990). TPH in soil surrounding the tank ranged from ND to 64,000 mg/kg. • Four soil borings were completed. TPH in soil varied from 2,000 to 4,400 mg/kg, and TPH ranged from ND to 7,900 mg/kg. • The Phase 1 indicated that the source was most likely from the Unocal terminal and the railroad spur on the west side of the Site.			Harbor Square	Background History Report Unocal Edmonds Bulk Fuel Terminal	Maul, Foster, and Alongi
1991	Harbor Square Phase 2 Site Assessment – Landau Associates (1991) – Offsite investigations	• This assessment was conducted for the Port of Edmonds to assess the nature and extent of potential contamination at a portion of the Port's Harbor Square property. • Drilled and sampled five soil borings, and installed five monitoring wells. • TPH in soil ranged from 14 to 110,000 mg/kg, PAHs in soil ranged from 2.9 to 680 mg/kg. • It was reported that up to 4 feet of soil was encountered at one location that was saturated with a viscous tar-like substance. • All groundwater results were ND.			Harbor Square	Background History Report Unocal Edmonds Bulk Fuel Terminal	MFA
1992	Preliminary Remedial Investigation – EMCON (1992)	• Focused on evaluating the aerial extent of LNAPL plumes. Six soil borings were completed, four of which were completed as groundwater monitoring wells. • TPH-G in soil ranged from ND to 2.7 mg/kg, TPH-D in soil ranged from ND to 2,670 mg/kg, and TPH in the heavy oil range (TPH-O) ranged from ND to 2,250 mg/kg. Benzene was not detected in any soil sample. • TPH-G in groundwater ranged from ND to 15 mg/L, TPH-D ranged from ND to 4.96 mg/L, benzene was detected from ND to 0.585 mg/L.			Lower Yard	Background History Report Unocal Edmonds Bulk Fuel Terminal	MFA
1994	UST Decommissioning	• Two Lower Yard and three Upper Yard USTs were decommissioned. • Petroleum hydrocarbon products were detected above MTCA Method A cleanup levels, at two of the tank excavations and in one of the product line trenches.			Upper and Lower Yard	Underground Storage Tank Decommissioning, 1995	EMCON

Table 2-1
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Year	Activity	Details	Contaminated Soils Removed (tons)	LNAPL Removed (gallons)	Focus Site Area	Report	Author
1996	Remedial Investigation (RI) Report	• This RI was performed between October 1994 and August 1996. Field investigation included 31 surface soil samples, 120 shallow soil borings, installation of 39 additional monitoring wells and nine piezometers, 17 basin sediment/soil samples, three test pits, and four trenches. Four quarters of groundwater monitoring were collected, seven monthly rounds of water levels were measured, one round of surface water and storm water samples, and aquifer characterization tests. • LNAPL was found in six Lower Yard plumes. Approximately 8,600 gal of LNAPL were recovered (1996) and it was estimated that 5,200 gal of LNAPL remained. LNAPL consisted of TPH-G, TPH-D, and TPH-O. Field observations indicated that much of the LNAPL may have been heavy end hydrocarbons. LNAPL migration rates were estimated to be less than six feet per year. • Dissolved phase hydrocarbons were primarily found near LNAPL plumes, and in areas with LNAPL trapped in the vadose zone. • Zinc was present at elevated levels in groundwater along the perimeter of the site. • High concentrations of petroleum hydrocarbons in soil were primarily found near LNAPL plumes and in areas with LNAPL trapped in the vadose zone. High concentrations of petroleum hydrocarbons were also found in soil within DB- 1. • Elevated metals concentrations were found in surface soil in areas of sand blast grit and paint chips, but not found in significant concentrations in subsurface soil. • Petroleum-related compounds were detected in onsite stormwater, but at low levels. The highest metal and PAH concentrations were found in surface water upgradient of the Terminal. • Sediment samples passed all criteria for bioassay testing. Limited toxic effects were exhibited in bioassay testing. • Four different vegetation communities were found at the Terminal, but the habitat value was deemed low to moderate.		8,600	Lower Yard	Draft Remedial Investigation Report, 1998	EMCON

Table 2-1
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Year	Activity	Details	Contaminated Soils Removed (tons)	LNAPL Removed (gallons)	Focus Site Area	Report	Author
1992 - 2000	Free Petroleum Product Recovery Operations - EMCON (1994-1998), MFA (1999-2000)	• Four monitoring wells redeveloped, and Welex Environmental, Inc., Hydro-Skimmer units installed in each well for passive recovery of LNAPL. • Two of the Hydro-Skimmer units were removed after it was determined that the product was too viscous to pass through the units' filters. • Between December 1992 and September 1993, monitoring wells containing LNAPL were hand-bailed, and the Hydro-Skimmer units were drained, on a biweekly basis. An estimated 100 gal of petroleum product were recovered by this action. • During 1994, 22 gal of petroleum product were removed from monitoring wells by hand-bailing. • Starting in 1995, product was pumped on a weekly or biweekly basis from monitoring wells and from recovery well RW-1 using a peristaltic pump. • Petroleum product was recovered: 718 gal in 1995; 491 gal in 1996; 223 gal in 1997; 136 gal in 1998; and 111 gal in 1999. • In 2000, more effective product pumping methods were employed at RW-1 and 169 gal of petroleum products were recovered (including 85 gal from RW-1).		1,970	Lower Yard	1998 Interim Product Recovery Operations Report 2000 Interim Product Recovery Operations Report	EMCON MFA
2001	Interim Action	• Consisted of the removal of LNAPL saturated soils from four areas of the Lower Yard. • Excavations were left open for weeks to allow floating LNAPL to be recovered. • 10,763 tons of soil was shipped offsite, 76,237 gallons of product, water, and associated solids were removed from the excavations (including an estimated 2,524 gallons of petroleum product).	10,763	2,524	Lower Yard	Lower Yard Interim Action As-Built Report, 2002	MFA
2001	Interim Action	• Demolition, removal of ASTs, piping and process structures, excavation and removal of 98,000 tons of impacted soil.	98,000		Upper Yard	Interim Action Report, 2003	MFA
2003	Supplemental Remedial Investigation – MFA (2003)	• Offsite contamination at the Port of Edmonds South Marina Property (SMP) was investigated. Borings were completed in South Admiral Way. • The highest concentration of TPH-D was ~2,100 mg/kg, the highest concentration found on the SMP is in excess of 20,000 mg/kg. It was determined that the petroleum impacts on the SMP were not due to migration from the Terminal. Samples from test pits excavated along the southwest Lower Yard contained concentrations of TPH-D at ~13,000 mg/kg but were ~350 feet from the SMP. • The highest concentrations of TPH in soil were found in the far eastern corner of the Lower Yard, in DB-1, and in the central portion of the Lower Yard. • Groundwater conditions were similar to prior years. • Surface water samples from Willows Creek did not contain concentrations of TPH. • It was determined that it was not likely that TPH was migrating offsite from the Terminal.			Lower Yard	Supplemental Remedial Investigation Report, 2003	MFA

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Year	Activity	Details	Contaminated Soils Removed (tons)	LNAPL Removed (gallons)	Focus Site Area	Report	Author
2003	Interim Action	• Excavation of DB1, the Southwestern Lower Yard, Metals Area 3, and the stormdrain line area. • A total of 39,130 tons of soil were removed. • A total of 1,861,520 gal of groundwater were extracted from the excavation and effectively treated on site before being discharged into DB2.	39,130	Not measured. LNAPL mixed with groundwater that was treated on site.	Lower Yard	Lower Yard Interim Action As-Built Report, 2004	MFA
2007	Phase I - Interim Action	• Bulk of soil excavation, 108,000 tons removed and ~9,700 gal of LNAPL recovered.	108,000	9,700	Lower Yard	Phase I As-Built Report, 2007	Arcadis
2008	Additional Site Assessment	• Soil boring installation, soil sample collection along WSDOT line and other areas of concern in the Lower Yard.			Lower Yard, WSDOT line	2008 Additional Site Investigation and Groundwater Monitoring Report, 2010	Arcadis
2008	Phase II - Interim Action	• Sediments removal, remaining soil excavation. 14,825 tons of soil removed, 131 gal of LNAPL and 2,000 tons of sediment from Willow Creek.	16,825	131	Lower Yard	Phase II As-Built Report, 2008	Arcadis
2008	Post-excavation Groundwater Monitoring Program Begins	• Post-excavation groundwater monitoring program begins, POC wells established.			Lower Yard	Reported Annually	Arcadis
2011	Soil Investigation, Tidal Study, Hydraulic Conductivity Testing	• DB-2 soil and LNAPL investigation, piezometer installation, site-wide tidal study, site-wide hydraulic conductivity testing.			Lower Yard, Willow Creek	Final 2011 Site Investigation Completion Report, 2012	Arcadis
2012	Monitoring Well Installation, soil sampling, sediment	• Installed monitoring wells MW-525 to MW-532, collected confirmation sediment samples from Willow Creek.			Lower Yard, Willow Creek	Final Conceptual Site Model, 2012	Arcadis
2015	Well Installation, Dual Phase System Extraction (DPE) pilot test study	• Installed DPE wells (DPE-1, DPE-2, and DPE-3) and three piezometers (PZ-1, PZ-2, and PZ-3/DPE-4) , conducted pilot testing at wells DPE-1, DPE-2 and DPE-3.			Lower Yard	Engineering Design Report. 2016	Arcadis

Table 2-4
Remaining Impacts - Soil Sample Locations
Chevron Environmental Management Company
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Soil Sample Location	Cleanup Action / Investigation	Location	Concentration (mg/kg) exceeded Site			Remarks
			REL for TPH[1] (2,775 mg/kg)	CUL for cPAHs TEQ (0.14mg/kg)	CUL for benzene (18 mg/kg)	
STRM-6FLOOR-7	2003 Point Edwards Storm Drain Line Excavation	Point Edwards Storm Drain Line	17,439	-	54.9	These samples location were not over-excavated. The Point Edwards Storm Drain Line Excavation was conducted to facilitate installation of a new stormwater outfall for Point Edwards, and was not specifically intended as a remedial action. These locations will be remediated through the DPE system.
STRM-4WALLE(2)-3			15,388	0.56	-	
SWLY-D-3 Wall-3.75[2]	2003 Excavation	Southwest Lower Yard	2,923	-	-	This sample location at the base of the steep decline of the Upper Yard was not over-excavated. TPH concentration of this sample was below the REL for TPH appropriate at time of excavation (3,000 mg/kg).
EX-B11-U-10-SSW-5	2007 - Phase I excavation activities	Close to the WSDOT stormwater line	-	0.159	-	These sample locations were not over-excavated to preserve the integrity of the WSDOT stormwater line. These locations will be remediated through the DPE system.
EX-A2-Q-14-6			3,060	-	-	
EX-A2-O-15-SSW-6			7,540	-	-	
EX-A2-N-16-SSW-6			7,550	-	-	
EX-B20-M-17-SSW-6			15,700	0.166	-	
EX-B18-VV-1-6SW[2]		Close to the BNSF Railway	4,980	-	-	Soil in the area of this sample was not over-excavated because of its location on the property boundary between the Lower Yard and the BNSF Railway right-of-way. Soil was removed up to the property boundary, but excavation activities were ceased to maintain the integrity of the BNSF Railway line.
EX-B1-F-44-4[2]	2008 - Phase II excavation activities	Southeast Lower Yard	-	0.212	-	Soil in the area of this sample was not over-excavated.
MW129R-7.0[2]	2008	Northeast Lower Yard	3,007	-	-	Sample collected during the installation of monitoring well MW-129R was not removed.
SB-65-6.5		Close to the WSDOT stormwater line	16,900	1.01	35.8	These sample locations were not over-excavated during the Phase II Excavation activities in 2008 to preserve the integrity of the WSDOT stormwater line. These locations will be remediated through the DPE system.
SB-66-6.0			11,900	0.209	-	
SB-68-4.0			5,470	0.165	-	
SB-69-6.0			3,720	0.236	-	
SB-80-7.5			4,660	0.693	-	
B-4-9.5-10	2011[3]	Near DB-2, monitoring well MW-510, and Willow Creek	4,413	-	-	These locations will be excavated.
B-5-9.5-10			27,021	-	-	
B-6-9-9.5			220,400	3.2	-	
B-7-8-8.5			111,400	2.8	-	
B-8-9.5-10			75,730	0.5	-	
B-9-8.5-9			20,970	0.29	-	
B-10-0.5-1			-	0.2	-	
B-11-10-10.5			37,150	3.4	-	
B-13-7-7.5			15,900	-	-	
B-16-4-4.5			-	0.145**	-	
B-17-(depth varies)			22,201 (4-4.5 ft)	116* (4.5-5 ft)	-	
MW-525-6	2012	Close to the WSDOT stormwater line	17,850	0.29	34	These locations will be remediated through the DPE system.
MW-532-7			10,540	-	-	

NOTES:

[1] In 2003, the Site interim action REL for TPH was 3,000 mg/kg. In 2007/2008, the Site interim action REL for TPH was 2,975 mg/kg.

[2] Four isolated soil samples, corresponding to less than 0.5 percent of the samples, are recorded thorough the Lower Yard out of the two areas that will be further remediated. Those four isolated soil samples are not further considered for remedial treatment since they are considered in compliance with WAC-173-340-740(7) and were removed to the maximum extent practicable at the time of the former interim actions.

[3] Maximum concentrations are displayed per boring location.

* The GC/MS semivolatile internal standard peak areas were outside of the QC limits for both the initial injection and the re-injection. The values here are from the initial injection of the sample.

** This data point was previously reported as .1 in the 2011 Investigation tables. Analytical results report it as 0.145

CUL = Cleanup level
REL = Remediation level
- = concentration below appropriate CULs/RELs
mg/kg = milligrams/killograms
TEQ = Total cPAHs adjusted for toxicity
cPAHs = Carcinogenic polycyclic aromatic hydrocarbons
TPH = Total petroleum hydrocarbons

Table 2-6
2013 Soil Vapor Analytical Results
Chevron Environmental Management Company
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Former Unocal Edmonds Bulk Fuel Terminal
Edmonds, Washington

Sample ID	Sample Depth (ft bgs)	Sample Date	Analytical Method	Dilution Factor	Benzene	Naphthalene	Σ(C5-C6AL) + (>C6-C8AL)	Σ(>C8-C10AL) + (>C10-C12AL)	>C8-C10AR	>C10-C12AR	Oxygen	Methane	Carbon Dioxide	Helium
Analysis Method (units)					TO-15 GC/MS (µg/m³)						ASTM D-1946 (%)			
VP-1	5	10/09/13[2]	TO-17	4	>530,000 SJ	9,700 J	NA	NA	NA	NA	5.0	>5.0	2.62	6.4[3]
		11/21/13	TO-15	108	710,000	ND<11,000	35,000,000	6,600,000	34,000	ND<120,000	2.6	29	11	ND<0.11
VP-2	5	10/09/13[2]	TO-15	1	940	ND<40	23,400	37,000	ND<1,100	ND<1,200	1.8	2.0	8.0	ND<0.11
		10/09/13[2]	TO-17	22.4	310	ND<230	NA	NA	NA	NA	4.8	1.7	1.92	0.19[3]
		11/21/13	TO-15	9.04	340	ND<95	33,700	36,000	1,200	ND<500	1.6	2.6	12	ND<0.11
(DUP)				8.48	300	ND<89	27,800	25,000	1,000	ND<460	4.0	2.3	10	ND<0.11
VP-3	5	10/09/2013[2]	TO-17	1.00	190	8.5	NA	NA	NA	NA	5.4	>5.0	2.1	4.5[3]
		11/21/13	TO-15	21.0	46	ND<220	529,000	305,000	ND<1,700	ND<1,900	1.3	23	11	ND<0.10
Field Blank	NA	10/09/2013[2]	TO-17	1.00	ND<21	ND<1.7	NA	NA	NA	NA	NA	NA	NA	NA
Equipment Blank	NA	10/09/2013[2]	TO-15	2.33	31	ND<6.1	4,530	1,870	210	ND<130	0.79	0.0015	ND<0.023	ND<0.12
Equipment Blank	NA	11/21/13	TO-15	2.10	ND<0.67	ND<5.5	ND<154	ND<270	ND<100	ND<120	2.5	ND<0.00021	ND<0.021	ND<0.10
DOE Method B Soil Gas Screening Levels for Shallow Soil Gas[1]					**3.2**	**14**	**27,000**	**1,400**	**1,800**	**NA**	**NA**	**NA**	**NA**	**NA**

NOTES:
Concentrations are in micrograms per cubic meter (µg/m³).
Highlighted cells indicate detected concentrations above the Ecology Method B Screening Level.
Greyed data was collected during the October 2013 sampling event and was not used for data evaluation.
Fixed gas data for TO-17 samples was collected in the field.
DUP = Duplicate sample
[1]Sub-slab or shallow soil gas screening level just beneath a building or less than 15 feet bgs.
[2]Equipment blank results indicate potential contamination of sampling equipment. Data collected during this sampling event are considered questionable.
[3]Methane causes interference with helium detector and these readings are indicative of methane. To prove the readings were methane interference, the concentration of helium inside the shroud was more than doubled, to 50%; however, a corresponding increase in the helium was not observed.
J = Estimated value due to bias in the Continuous Calibration Value (CCV)
S = Saturated peak; data reported as estimated
<ND = Non-detect, Value listed is laboratory reporting limit.
ft bgs = feet below ground surface
NA = Not applicable.

Table 6-1
Remedial Alternatives Screening
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Potential Remedial Technology	Description	Effectiveness	Implementability	Retained (yes/no)	Comments
1. Environmental Covenant (EC)	An EC is an administrative control which will limit the future uses of the site and therefore limit exposure.	An EC does not involve the implementation of active remedial activities and will not remove or treat contaminated soils or LNAPL (Light Nonaqueous Phase Liquid) in the Detention Basin No. 2 (DB-2) area.	This technology is implementable at the site in supplement with a primary active remedial alternative.	Yes	Does not meet all requirements of Agreed Order (AO) No. DE 4460.
2. Groundwater Monitored Natural Attenuation (MNA)	Natural Attenuation (NA) includes a variety of physical, chemical, or biological processes that, under favorable conditions, act without human intervention to reduce the mass, toxicity, mobility, volume, or concentration of contaminants in groundwater.	NA is occurring in the groundwater beneath the lower yard; however, NA does not meet requirements for restoration within a reasonable timeframe; thus is not effective as a stand-alone technology. When combined with another alternative, compliance monitoring will have to continue to demonstrate that NA is occurring at the predicted rate. Cleanup contingency plans may have to be prepared if expected NA rate is not obtained.	This technology is implementable at the site in supplement with a primary remedial alternative.	Yes	Does not meet all requirements of AO No. DE 4460 .
3. Excavation	Excavation includes the physical removal of impacted soil and LNAPL from the site.	Effective at removing impacted soils and reducing dissolved-phase petroleum hydrocarbons. Extensive excavation has been completed at the site and is an effective way to meet cleanup levels (CULs) because contaminants are physically removed from the site.	This technology will help meet direct contact CULs in soil and groundwater CULs at the point of compliance boundary. Excavation is implementable at the site. Approximately 146,000 tons of material have been removed from the site successfully.	Yes	Preferred alternative outlined in AO No. DE 4460 to remediate observed LNAPL.
4. In-Situ Solidification	In-situ solidification (ISS) involves mixing binding agents (typically Portland cement) into the soil to provide physical sequestration of contaminants and a physical barrier between the ground surface and the soil beneath the treated monolith.	Effective at providing a physical barrier between the ground surface and soils beneath the treated monolith. This barrier can also minimize surface water infiltration which will stop migration of contaminants from soil to groundwater through leaching. Does not directly treat impacted soils or LNAPL.	This technology is implementable at the site in supplement with a primary remedial alternative.	Yes	Technology will need to be coupled with excavation to meet the requirements of AO No. DE 4460.
5. Enhanced Anaerobic Bio-Oxidation (ABOx)	Electron acceptors are injected into the subsurface to promote a reducing environment, which enhances ABOx of contaminants.	The technology is generally less effective on the predominant contaminant at the Lower Yard (fuel hydrocarbons) and may require several injections to see reduction in LNAPL and dissolved phase. ABOx injections will not address residual LNAPL in vadose zone soils.	This technology has low implementability because the volume of contaminated soil at the Lower Yard is likely too low for chemical reduction/oxidation to be implementable on a cost-effective basis.	No	Technology will need to be coupled with excavation to meet the requirements of AO No. DE 4460.
6. Surfactant Flushing	Clean water and surfactant is injected into the subsurface to mobilize contaminants in-situ for subsequent recovery.	Surfactant flushing can be effective in the reduction of organic- and inorganic-contaminant levels within the saturated zone, but may not be effective in addressing LNAPL impacted soil in the vadose zone.	Technology and downgradient monitoring would be difficult to implement as Willow Creek is located adjacent downgradient (<25 feet) of the remaining LNAPL impacts.	No	Does not address remaining impacts in soil and will have to be coupled with excavation to meet direct contact CULs and terms of AO No. DE 4460.
7. Groundwater Containment System using Groundwater Extraction Wells	The groundwater extraction wells would be installed downgradient of DB-2 in order to contain constituent of concern (COC) concentrations and control plume migration off site. Extracted LNAPL and groundwater would be treated prior to discharge.	This technology will act as a barrier to offsite migration of LNAPL and dissolved phase COCs.	This technology is implementable at the site.	Yes	This technology does not address non-mobile LNAPL in soils upgradient of the extraction radius of influence and will have to be coupled with excavation to meet direct contact CULs and terms of AO No. DE 4460.

Table 6-1
Remedial Alternatives Screening
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Edmonds, Washington

Potential Remedial Technology	Description	Effectiveness	Implementability	Retained (yes/no)	Comments
8. Groundwater Containment System using Groundwater Extraction Trench	A Groundwater interceptor trench with high permeability backfill would be installed downgradient of DB-2 in order to contain COC concentrations and control plume migration offsite. There would be a series of collection sumps within the trench to extract groundwater. Extracted LNAPL and groundwater would be treated prior to discharge.	This technology will act as a barrier to offsite migration of LNAPL and dissolved phase COCs.	This technology is potentially implementable at the site.	Yes	This technology does not address non-mobile LNAPL in soils upgradient of the extraction radius of influence and will have to be coupled with excavation to meet direct contact CULs and terms of AO No. DE 4460.
9. LNAPL Barrier Trench with Reactive Core Mat	The LNAPL barrier trench would be constructed with a reactive core mat to essentially lock LNAPL in place and ensure no offsite migration occurs. When LNAPL comes into contact with the reactive organoclay mat, it eventually becomes an impenetrable barrier.	This technology may be effective in preventing migration of contaminants or LNAPL, however is not effective as a long-term solution because it does not treat LNAPL or upgradient groundwater contaminants.	This technology is not potentially implementable at the site.	No	Does not meet all requirements of AO No. DE 4460.
10. Funnel and Gate with in-situ Remediation	Install a funnel and gate system to direct groundwater movement toward the extraction system.	This technology is likely not effective due to the limited net groundwater movement because of dampening tidal effects and recharge from Willow Creek. Additionally, there is limited downgradient area for adequate installation of the in-situ reactive zone consisting of sparge wells. Additionally, this technology is not adaptable to changing conditions and does not treat LNAPL within a reasonable restoration timeframe.	This technology is not implementable at the site.	No	Does not meet requirements of AO No. DE 4460.
11. Funnel and Gate with Groundwater Extraction.	Install a reactive barrier to allow groundwater outside of extraction influence to pass through and remove contaminants.	This technology is likely not effective due to the limited net groundwater movement because of dampening tidal effects and recharge from Willow Creek. Additionally, this technology is not adaptable to changing conditions and does not treat LNAPL within a reasonable restoration timeframe.	This technology is not implementable at the site.	No	Does not meet requirements of AO No. DE 4460.
12. Soil and Groundwater Treatment using Dual Phase Extraction (DPE)	The groundwater extraction wells would be installed downgradient of DB-2 in order to contain constituent of concern (COC) concentrations and control plume migration off site. Extracted LNAPL and groundwater would be treated prior to discharge.	A DPE system will be appropriate to remediate remaining soil impacts surrounding the WSDOT stormwater line, and act as a groundwater intercept system ensuring that offsite migration of dissolved phase COCs does not occur.	This technology is implementable at the site.	Yes	This technology will meet direct contact CULs and terms of AO No. DE 4460 in the WSDOT stormwater line vicinity. Additonnally excavation will be required in the DB-2 area to meet direct contact CULs and terms of AO No. DE 4460.

Notes:
Shading indicates that the process option was eliminated during the initial screening stage.

Table 7-1
Remedial Alternatives Evaluation
Chevron Environmental Management Company
FINAL FEASABILITY STUDY REPORT
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Edmonds, Washington

		Remedial Alternative 1	Remedial Alternative 2	Remedial Alternative 3	Remedial Alternative 4	Remedial Alternative 5	Remedial Alternative 6
Disproportionate Cost Analysis Parameter	**Uses Rank in FS Report**	**Excavation of DB-2 and MNA with ECs**	**Groundwater Containment Using Extraction Wells and MNA with ECs**	**Groundwater Containment Using Groundwater Extraction Trench and MNA with ECs**	**Excavation of DB-2 and WSDOT Storm Drain Line and Limited ECs**	**Excavation of DB-2 and In-Situ Solidification near WSDOT Storm Drain Line and MNA with ECs**	**Excavation of DB-2, Dual-Phase Extraction Treatment near WSDOT Storm Drain Line and Limited ECs**
Protectiveness	Overall protectiveness of human health and the environment	3	5	4	1	2	1
Permanence	The degree to which the alternative permanently reduces the toxicity, mobility or volume of hazardous substances	3	5	4	1	2	1
Cost	The cost to implement the alternative	1	2	3	5	4	1
Effectiveness over the long term	The degree of certainty of success, the reliability of the alternative, the magnitude of residual risk, and the effectiveness of controls	3	5	4	1	2	2
Management of short-term risks	The risk to human health and environment associated with construction and implementation of the alternatives	3	1	2	5	4	4
Technical and administrative implementability	Technical feasibility of the alternative and administrative requirements	1	2	3	5	4	3
Consideration of public concerns	Whether the community has concerns regarding the alternative and, if so, the extent to which the alternative addresses those concerns.	4	5	5	1	5	2
	Average	**2.6**	**3.6**	**3.6**	**2.7**	**3.3**	**2.0**

Legend
MNA =Monitored Natural Attenuation
ECs =Environmental Covenants
DB-2 = Detention Basin No. 2
WSDOT = Washington State Department of Transportation

Table 7-2
Cost Estimate for Remedial Alternative 1
Chevron Environmental Management Company
FINAL FEASABILITY STUDY REPORT
Former Unocal Edmonds Bulk Fuel Terminal
Edmonds, Washington

Alternative 1: Excavation and Monitored Natural Attenuation with Environmental Covenants

Task Description	Quantity	Units	Unit Lower Cost ($)	Unit Upper Cost ($)	Total Lower Cost ($)	Total Upper Cost ($)	Assumptions / Descriptions
Pre-Design Costs							
Surveying - Establish Control Points, Base Mapping, As-builts, Etc	1	Lump Sum	$2,000	$3,000	$2,000	$3,000	
Engineering Design		Lump Sum	$10,000	$15,000	$19,000	$28,500	
Remediation Activities							
Mobilization/Demobilization	1	Lump Sum	$50,000	$100,000	$50,000	$100,000	
Excavation Work	3,000-5,800	Cubic Yards	$10	$15	$30,000	$86,730	Lower cost based on anticipated minimum excavation of DB-2 and upper cost based on the assumption that DB2 was built on top of the former Slops pond and complete removal of DB-2 and replacement assumed.
Lab (soil)	50-60	Sample	$572	$572	$28,600	$34,320	
Lab (water)	6	Sample	$950	$950	$5,700	$5,700	
Excavation Water Mangement	1	Lump Sum	$10,000	$15,000	$10,000	$15,000	
Material Handling - Impacted Soils	3,000-5,800	Cubic Yards	$7	$11	$21,000	$63,602	
Material Stockpile Area & Management	1	Lump Sum	$10,000	$15,000	$10,000	$15,000	
Truck Loading Area	1	Lump Sum	$5,000	$7,500	$5,000	$7,500	
Odor/Dust Control System & Material	1	Month	$5,000	$7,500	$5,000	$7,500	
Transportation and Off-Site Disposal							
- Hazardous Soil	0	Tons	$250	$375	$0	$0	
- Non-Hazardous Soil	4,500-8,700	Tons	$60	$90	$270,000	$780,570	
Air Monitoring	1	Lump Sum	$8,000	$12,000	$8,000	$12,000	
Excavation Restoration Activities							
Furnish Backfill	4,500-8,700	Ton	$15	$20	$67,500	$173,460	
Placement & Compaction of Backfill	3,000-5,800	CY	$6	$10	$18,000	$57,820	
Management							
Project Management (8% of Overall Costs)	1	Lump Sum	$43,984	$111,256	$43,984	$111,256	
Construction Oversight and Health & Safety (12% of Construction Costs)	1	Lump Sum	$63,456	$163,104	$63,456	$163,104	
Groundwater Monitored Natural Attenuation							
Groundwater Monitored Natural Attenuation	1	Lump Sum	$1,100,000	$1,375,000	$1,100,000	$1,375,000	Annual Sampling and reporting during 60 years
Environmental Covenant							
Environmental Covenant	1	Lump Sum	$30,000	$50,000	$30,000	$50,000	

Complete Remedial Alternative 1 Subtotal Cost	**$1,790,000**	**$3,100,000**
Contingency (30%)	**$537,000**	**$930,000**
Complete Remedial Alternative 1 Cost	**$2,327,000**	**$4,030,000**

Table 7-3
Cost Estimate for Remedial Alternative 2
Chevron Environmental Management Company
FINAL FEASABILITY STUDY REPORT
Former Unocal Edmonds Bulk Fuel Terminal
Edmonds, Washington

Alternative 2: Groundwater Containment System Using Extraction Wells, and Monitored Natural Attenuation with Environmental Covenants

Task Description	Quantity	Units	Unit Lower Cost ($)	Unit Upper Cost ($)	Total Lower Cost ($)	Total Upper Cost ($)	Assumptions / Descriptions
Pre-Design Costs							
Surveying - Establish Control Points, Base Mapping,	1	Lump Sum	$2,000	$3,000	$2,000	$3,000	Assume Survey for Well Locations
Pilot Testing	1	Lump Sum	$40,000	$60,000	$40,000	$60,000	Pilot Testing with one well and additional Peizometers - includes Pilot Test Designa and Implementation
System Design Costs							
System Design	1	Lump Sum	$25,000	$37,500	$25,000	$37,500	Includes Post Pilot testing system design
Permitting and Fees	1	Lump Sum	$15,000	$22,500	$15,000	$22,500	Includes permitting fees for PSCAA, Construction and NPDES
Remediation Activities							
Mobilization/Demobilization (5% of Construction Costs, Excludes T&D Costs	1	Lump Sum	$21,900	$32,850	$21,900	$32,850	
Soil Disposal	40	Cubic Yards	$10	$15	$400	$600	Assume 40 yds for trenching and Well spoils
Well Installation	6	Wells	$6,000	$9,000	$36,000	$54,000	6 wells based on Groundwater Modeling
Trenching/Piping Installation	1	Lump sum	$115,000	$172,500	$115,000	$172,500	Assumes 300 feet of trenching with indivicual piping for each well. Piping includes Air delivery, water and shutoff
Discharge Piping	1	LS	$10,000	$15,000	$10,000	$15,000	Discharge piping includes connection to stormwater discharge and associated trenching and piping
System Electrical Installation	1	Lump sum	$25,000	$37,500	$25,000	$37,500	Electrical installation includes new power drop to site
Remediation Equipment	1	LS	$250,000	$375,000	$250,000	$375,000	Remediation equipment includes 10 X 20 building, oumps, treatment train, system controls
Operation & Maintenance							
Routine Operation	10	years	$72,000	$108,000	$720,000	$1,080,000	Based on bi-monthly site visits for parameter readings
Maintenance Costs	10	years	$15,000	$22,500	$150,000	$225,000	Based on two carbon changeouts per year along with oil changes, filters and contingency costs.
Utilities	10	years	$24,000	$36,000	$240,000	$360,000	Based on $2000 per month in electrical utilites
Groundwater Monitoring and Sampling	1	Lump Sum	$1,100,000	$1,375,000	$1,100,000	$1,375,000	Annual Sampling and reporting during 60 years
Management							
Project Management (8% of Overall Costs)	1	Lump Sum	$220,024	$308,036	$220,024	$308,036	
Construction Oversight and Health & Safety (12% of Construction Costs)	1	Lump Sum	$54,996	$82,494	$54,996	$82,494	
Environmental Covenant							
Environmental Covenant	1	Lump Sum	$30,000	$50,000	$30,000	$50,000	

Complete System Install Subtotal Cost	**$3,060,000**	**$4,300,000**
Contingency (30%)	**$918,000**	**$1,290,000**
Complete Alternative 2 Cost	**$3,978,000**	**$5,590,000**

Table 7-4
Cost Estimate for Remedial Alternative 3
Chevron Environmental Management Company
FINAL FEASABILITY STUDY REPORT
Former Unocal Edmonds Bulk Fuel Terminal
Edmonds, Washington

Alternative 3: Groundwater Containment System Using Groundwater Extraction Trench, and Monitored Natural Attenuation with Environmental

Task Description	Quantity	Units	Unit Lower Cost ($)	Unit Upper Cost ($)	Total Lower Cost ($)	Total Upper Cost ($)	Assumptions / Descriptions
Pre-Design Costs							
Surveying - Establish Control Points, Base Mapping,	1	Lump Sum	$2,000	$3,000	$2,000	$3,000	Assume Survey for Well Locations
Pilot Testing	1	Lump Sum	$70,000	$105,000	$70,000	$105,000	Pilot Testing with trench section and additional peizometers - includes Pilot Test Design and Implementation
System Design Costs							
System Design	1	Lump Sum	$30,000	$45,000	$30,000	$45,000	Additional costs above well extraction system include trench design
Permitting and Fees	1	Lump Sum	$10,000	$15,000	$10,000	$15,000	
Remediation Activities							
Mobilization/Demobilization (5% of Construction Costs, Excludes T&D Costs)	1	Lump Sum	$29,400	$44,100	$29,400	$44,100	
Soil Disposal	250	Cubic Yards	$10	$15	$2,500	$3,750	250 yds of soil for trench at 280 feet X 4 feet X 20 feet
Trenching Equipment	5	Days	$20,000	$30,000	$100,000	$150,000	Trenching Equipment at $20,000 per day assume 5 days for install
Trenching One Pass	280	LF	$250	$375	$70,000	$105,000	Trenching costs per lineal foot
Trenching/Piping Installation	1	Lump sum	$100,000	$150,000	$100,000	$150,000	Includes additional conveyance piping and trenching
Discharge Piping	1	LS	$10,000	$15,000	$10,000	$15,000	Discharge piping includes connection to stormwater discharge and associated trenching and piping
System Electrical Installation	1	Lump sum	$25,000	$37,500	$25,000	$37,500	
Remediation Equipment	1	LS	$280,000	$420,000	$280,000	$420,000	System will require Larger treatment train to handle 7 GPM
Operation & Maintenance							
Routine Operation	10	years	$72,000	$108,000	$720,000	$1,080,000	Based on bi-monthly site visits for parameter readings
Maintenance Costs	10	years	$15,000	$22,500	$150,000	$225,000	Based on two carbon changeouts per year along with oil changes, filters and contingency costs.
Utilities	10	years	$24,000	$36,000	$240,000	$360,000	Based on $2000 per month in electrical utilites
Groundwater Monitoring and Sampling	1	Lump Sum	$1,100,000	$1,375,000	$1,100,000	$1,375,000	Annual Sampling and reporting during 60 years
Management							
Project Management (8% of Overall Costs)	1	Lump Sum	$235,112	$330,668	$235,112	$330,668	
Construction Oversight and Health & Safety (12% of Construction Costs)	1	Lump Sum	$74,028	$111,042	$74,028	$111,042	
Environmental Covenant							
Environmental Covenant	1	Lump Sum	$30,000	$50,000	$30,000	$50,000	

Complete System Install Subtotal Cost	**$3,280,000**	**$4,630,000**
Contingency (30%)	**$984,000**	**$1,389,000**
Complete Alternative 3 Cost	**$4,264,000**	**$6,019,000**

Table 7-5
Cost Estimate for Remedial Alternative 4
Chevron Environmental Management Company
FINAL FEASABILITY STUDY REPORT
Former Unocal Edmonds Bulk Fuel Terminal
Edmonds, Washington

Alternative 4: Excavation and Limited Environmental Covenants

Task Description	Quantity	Units	Unit Lower Cost ($)	Unit Upper Cost ($)	Total Lower Cost ($)	Total Upper Cost ($)	Assumptions / Descriptions
DB-2 Excavation Costs							
Pre-Design Costs							
Surveying - Establish Control Points, Base Mapping, As-builts, Etc	1	Lump Sum	$2,000	$3,000	$2,000	$3,000	
Engineering Design		Lump Sum	$10,000	$15,000	$19,000	$28,500	
Remediation Activities							
Mobilization/Demobilization	1	Lump Sum	$50,000	$100,000	$50,000	$100,000	
Excavation Work	3,000-5,800	Cubic Yards	$10	$15	$30,000	$86,730	Lower cost based on anticipated minimum excavation of DB-2 and upper cost based on the assumption that DB2 was built on top of the former Slops pond and complete removal of DB-2 and replacement assumed.
Lab (soil)	50-60	Sample	$572	$572	$28,600	$34,320	
Lab (water)	6	Sample	$950	$950	$5,700	$5,700	
Excavation Water Mangement	1	Lump Sum	$10,000	$15,000	$10,000	$15,000	
Material Handling - Impacted Soils	3,000-5,800	Cubic Yards	$7	$11	$21,000	$63,602	
Material Stockpile Area & Management	1	Lump Sum	$10,000	$15,000	$10,000	$15,000	
Truck Loading Area	1	Lump Sum	$5,000	$7,500	$5,000	$7,500	
Odor/Dust Control System & Material	1	Month	$5,000	$7,500	$5,000	$7,500	
Transportation and Off-Site Disposal							
- Hazardous Soil	0	Tons	$250	$375	$0	$0	
- Non-Hazardous Soil	4,500-8,700	Tons	$60	$90	$270,000	$780,570	
Air Monitoring	1	Lump Sum	$8,000	$12,000	$8,000	$12,000	
Excavation Restoration Activities							
Furnish Backfill	4,500-8,700	Ton	$15	$20	$67,500	$173,460	
Placement & Compaction of Backfill	3,000-5,800	CY	$6	$10	$18,000	$57,820	
Management							
Project Management (8% of Overall Costs)	1	Lump Sum	$43,984	$111,256	$43,984	$111,256	
Construction Oversight and Health & Safety (12% of Construction Costs)	1	Lump Sum	$63,456	$163,104	$63,456	$163,104	
				DB-2 Excavation Subtotal Cost	**$660,000**	**$1,670,000**	

Table 7-5
Cost Estimate for Remedial Alternative 4
Chevron Environmental Management Company
FINAL FEASABILITY STUDY REPORT
Former Unocal Edmonds Bulk Fuel Terminal
Edmonds, Washington

Alternative 4: Excavation and Limited Environmental Covenants

Task Description	Quantity	Units	Unit Lower Cost ($)	Unit Upper Cost ($)	Total Lower Cost ($)	Total Upper Cost ($)	Assumptions / Descriptions
WSDOT Stormwater Line Excavation Costs							
Pre-Design Costs							
Surveying - Establish Control Points, Base Mapping, As-builts, Etc	1	Lump Sum	$2,000	$3,000	$2,000	$3,000	
Geotechnical Investigation	1	Lump Sum	$30,000	$45,000	$30,000	$45,000	Assume 3 MR borings to 50 feet bgs and index property testing.
Sheetpile Design	1	Lump Sum	$30,000	$45,000	$30,000	$45,000	Design 2 sheet sections, provide drawings and specs to team
Remediation Activities							
Mobilization/Demobilization	1	Lump Sum	$50,000	$100,000	$50,000	$100,000	
Excavation Work	7990	Cubic Yards	$10	$15	$79,900	$119,850	
15 Foot Excavation Shoring Materials (Drive Extract, Salvage (43 Foot Depth	281	Tons	$1,900	$2,200	$533,828	$618,116	From RSMeans
10 Foot Excavation Shoring Materials (Drive Extract, Salvage (29 Foot Depth	168	Tons	$2,300	$2,800	$386,193	$470,148	From RSMeans + extra for light sheets and higher wieght to labor cost
Water Tight Sealant (sheets sealed to 20 ft bgs)	8600	LF	$3	$5	$25,800	$38,700	
Geotechnical Monitoring	1	Month	$10,000	$20,000	$10,000	$20,000	
Excavation Dewatering -Set up of Water Treatment System	1	Lump Sum	$15,000	$22,500	$15,000	$22,500	Approximate
Excavation Dewatering - Operation of Water Treatment System	1,728,000	Gallons	$0.40	$1	$691,200	$1,036,800	Assumes 60 gpm for 20 continuous days.
Material Handling - Impacted Soils	7990	Cubic Yards	$7	$11	$55,930	$83,895	Material Handling - Relocation and temporary stockpile for subsequent load-out. Double Handling of soils.
Material Stockpile Area & Management	1	Lump Sum	$10,000	$15,000	$10,000	$15,000	
Truck Loading Area	1	Lump Sum	$5,000	$7,500	$5,000	$7,500	
Odor/Dust Control System & Material	1	Month	$5,000	$7,500	$5,000	$7,500	Assumes equipment will be kept on standby for dust/odor control due to existing active facility/tenants
Transportation and Off-Site Disposal							
- Hazardous Soil	0	Tons	$250	$375	$0	$0	
- Non-Hazardous Soil	11985	Tons	$60	$90	$719,100	$1,078,650	
Air Monitoring	1	Lump Sum	$8,000	$12,000	$8,000	$12,000	Assumes air monitoring will be performed as part of work for H&S and active facility/tenants (Provided by Team)
Excavation Restoration Activities							
Pipe Replacement	1	Lump Sum	$20,000	$30,000	$20,000	$30,000	Approximate
Furnish Backfill	11,985	Ton	$15	$20	$179,775	$239,700	
Placement & Compaction of Backfill	7,990	CY	$6	$10	$47,940	$79,900	From RSMeans
Management							
Project Management (8% of Overall Costs)	1	Lump Sum	$232,373	$325,861	$232,373	$325,861	
Construction Oversight and Health & Safety (12% of Construction Costs)	1	Lump Sum	$341,120	$477,631	$341,120	$477,631	
				WSDOT Stormwater Line Excavation Subtotal Cost	**$3,480,000**	**$4,880,000**	
Groundwater Monitoring and Sampling							
Groundwater Monitoring and Sampling	1	Lump Sum	$40,000	$50,000	$40,000	$50,000	Annual Sampling and reporting during 3 years
Environmental Covenant							
Environmental Covenant	1	Lump Sum	$30,000	$50,000	$30,000	$50,000	
				Complete Excavation and MNA Cost	**$4,210,000**	**$6,650,000**	
				Contingency (30%)	**$1,263,000**	**$1,995,000**	
				Complete Alternative 4 Cost	**$5,473,000**	**$8,645,000**	

Table 7-6
Cost Estimate for Remedial Alternative 5
Chevron Environmental Management Company
FINAL FEASABILITY STUDY REPORT
Former Unocal Edmonds Bulk Fuel Terminal
Edmonds, Washington

Alternative 5: Excavation with MNA and In-Situ Solidificationwith Environmental Covenants

Task Description	Quantity	Units	Unit Lower Cost ($)	Unit Upper Cost ($)	Total Lower Cost ($)	Total Upper Cost ($)	Assumptions / Descriptions
DB-2 Excavation Costs							
Pre-Design Costs							
Surveying - Establish Control Points, Base Mapping, As-builts, Etc	1	Lump Sum	$2,000	$3,000	$2,000	$3,000	
Engineering Design		Lump Sum	$10,000	$15,000	$19,000	$28,500	
Remediation Activities							
Mobilization/Demobilization	1	Lump Sum	$50,000	$100,000	$50,000	$100,000	
Excavation Work	3,000-5,800	Cubic Yards	$10	$15	$30,000	$86,730	Lower cost based on anticipated minimum excavation of DB-2 and upper cost based on the assumption that DB2 was built on top of the former Slops pond and complete removal of DB-2 and replacement assumed.
Lab (soil)	50-60	Sample	$572	$572	$28,600	$34,320	
Lab (water)	6	Sample	$950	$950	$5,700	$5,700	
Excavation Water Mangement	1	Lump Sum	$10,000	$15,000	$10,000	$15,000	
Material Handling - Impacted Soils	3,000-5,800	Cubic Yards	$7	$11	$21,000	$63,602	
Material Stockpile Area & Management	1	Lump Sum	$10,000	$15,000	$10,000	$15,000	
Truck Loading Area	1	Lump Sum	$5,000	$7,500	$5,000	$7,500	
Odor/Dust Control System & Material	1	Month	$5,000	$7,500	$5,000	$7,500	
Transportation and Off-Site Disposal							
- Hazardous Soil	0	Tons	$250	$375	$0	$0	
- Non-Hazardous Soil	4,500-8,700	Tons	$60	$90	$270,000	$780,570	
Air Monitoring	1	Lump Sum	$8,000	$12,000	$8,000	$12,000	
Excavation Restoration Activities							
Furnish Backfill	4,500-8,700	Ton	$15	$20	$67,500	$173,460	
Placement & Compaction of Backfill	3,000-5,800	CY	$6	$10	$18,000	$57,820	
Management							
Project Management (8% of Overall Costs)	1	Lump Sum	$43,984	$111,256	$43,984	$111,256	
Construction Oversight and Health & Safety (12% of Construction Costs)	1	Lump Sum	$63,456	$163,104	$63,456	$163,104	
				DB-2 Excavation Subtotal Cost	**$660,000**	**$1,670,000**	

Table 7-6
Cost Estimate for Remedial Alternative 5
Chevron Environmental Management Company
FINAL FEASABILITY STUDY REPORT
Former Unocal Edmonds Bulk Fuel Terminal
Edmonds, Washington

Alternative 5: Excavation with MNA and In-Situ Solidificationwith Environmental Covenants

Task Description	Quantity	Units	Unit Lower Cost ($)	Unit Upper Cost ($)	Total Lower Cost ($)	Total Upper Cost ($)	Assumptions / Descriptions
WSDOT Pipe ISS Costs							
Pre-Design Costs							
Surveying - Establish Control Points, Base Mapping, As-builts, Etc	1	Lump Sum	$2,000	$3,000	$2,000	$3,000	
Geotechnical Investigation	1	Lump Sum	$5,000	$7,500	$5,000	$7,500	
ISS Design	1	Lump Sum	$10,000	$15,000	$10,000	$15,000	
Remediation Activities							
Mobilization/Demobilization	1	Lump Sum	$13,000	$19,500	$13,000	$19,500	5% of labor
Excavation Work	710	Cubic Yards	$10	$15	$7,100	$10,650	Assumed top foot would be removed, then the ISS would bulk into that space, no ISS spoil excavation needed
Material Handling - Impacted Soils	710	Cubic Yards	$7	$11	$4,970	$7,455	
Mobilization/Demobilization & Setup of the ISSS Batch Mixing Plant	1	Lump Sum	$100,000	$150,000	$100,000	$150,000	
In-Situ Soil Mixing - Excavator Mixing (1-5 feet depth interval)	2840	Lump Sum	$50	$75	$142,000	$213,000	
Water Supply	1	Lump Sum	$20,000	$30,000	$20,000	$30,000	
Portland Cement (5%)	213	Tons	$120	$180	$25,560	$38,340	
Performance Monitoring (1 Per 300 Cubic Yards)	10	Each	$1,500	$2,250	$15,000	$22,500	
Odor/Dust Control System & Material	1	Month	$5,000	$7,500	$5,000	$7,500	
Transportation and Off-Site Disposal							
- Hazardous Soil	0	Tons	$250	$375	$0	$0	
- Non-Hazardous Soil	1065	Tons	$60	$90	$63,900	$95,850	
Air Monitoring	1	Lump Sum	$8,000	$12,000	$8,000	$12,000	
Management							
Project Management (8% of Overall Costs)	1	Lump Sum	$33,722	$50,584	$33,722	$50,584	
Construction Oversight and Health & Safety (12% of Construction Costs)	1	Lump Sum	$48,544	$72,815	$48,544	$72,815	
				WSDOT Pipe ISS Subtotal Cost	**$510,000**	**$760,000**	

Task Description	Quantity	Units	Unit Lower Cost ($)	Unit Upper Cost ($)	Total Lower Cost ($)	Total Upper Cost ($)	Assumptions / Descriptions
Groundwater Monitored Natural Attenuation							
Groundwater Monitored Natural Attenuation	1	Lump Sum	$1,100,000	$1,375,000	$1,100,000	$1,375,000	Annual Sampling and reporting during 60 years
Environmental Covenant							
Environmental Covenant	1	Lump Sum	$30,000	$50,000	$30,000	$50,000	
				Excavation, ISS, MNA, and Environmental Covenant Cost	**$2,300,000**	**$3,855,000**	
				Contingency (30%)	**$690,000**	**$1,156,500**	
				Complete Alternative 5 Cost	**$4,630,000**	**$5,011,500**	

Table 7-7
Cost Estimate for Remedial Alternative 6
Chevron Environmental Management Company
FINAL FEASABILITY STUDY REPORT
Former Unocal Edmonds Bulk Fuel Terminal
Edmonds, Washington

Alternative 6: Alternative 6: Excavation and Dual Phase Extraction Treatment

Task Description	Quantity	Units	Unit Lower Cost ($)	Unit Upper Cost ($)	Total Lower Cost ($)	Total Upper Cost ($)	Assumptions / Descriptions
Pre-Design Costs							
Surveying - Establish Control Points, Base Mapping, As-builts, Etc	1	Lump Sum	$2,000	$3,000	$2,000	$3,000	
Engineering Design		Lump Sum	$10,000	$15,000	$19,000	$28,500	
Remediation Activities							
Mobilization/Demobilization	1	Lump Sum	$50,000	$100,000	$50,000	$100,000	
Excavation Work	3,000-5,800	Cubic Yards	$10	$15	$30,000	$86,730	Lower cost based on anticipated minimum excavation of DB-2 and upper cost based on the assumption that DB2 was built on top of the former Slops pond and complete removal of DB-2 and replacement assumed.
Lab (soil)	50-60	Sample	$572	$572	$28,600	$34,320	
Lab (water)	6	Sample	$950	$950	$5,700	$5,700	
Excavation Water Mangement	1	Lump Sum	$10,000	$15,000	$10,000	$15,000	
Material Handling - Impacted Soils	3,000-5,800	Cubic Yards	$7	$11	$21,000	$63,602	
Material Stockpile Area & Management	1	Lump Sum	$10,000	$15,000	$10,000	$15,000	
Truck Loading Area	1	Lump Sum	$5,000	$7,500	$5,000	$7,500	
Odor/Dust Control System & Material	1	Month	$5,000	$7,500	$5,000	$7,500	
Transportation and Off-Site Disposal							
- Hazardous Soil	0	Tons	$250	$375	$0	$0	
- Non-Hazardous Soil	4,500-8,700	Tons	$60	$90	$270,000	$780,570	
Air Monitoring	1	Lump Sum	$8,000	$12,000	$8,000	$12,000	
Excavation Restoration Activities							
Furnish Backfill	4,500-8,700	Ton	$15	$20	$67,500	$173,460	
Placement & Compaction of Backfill	3,000-5,800	CY	$6	$10	$18,000	$57,820	
Management							
Project Management (8% of Overall Costs)	1	Lump Sum	$43,984	$111,256	$43,984	$111,256	
Construction Oversight and Health & Safety (12% of Construction Costs)	1	Lump Sum	$63,456	$163,104	$63,456	$163,104	
				DB-2 Excavation Subtotal Cost	**$660,000**	**$1,670,000**	
DPE on WSDOT SD line							
DPE on WSDOT SD line	1	Lump Sum	$1,263,777	$1,516,532	$1,263,777	$1,516,532	
				DPE on WSDOT SD line Subtotal Cost	**$1,270,000**	**$1,520,000**	
Groundwater Monitoring and Sampling							
Groundwater Monitoring and Sampling	1	Lump Sum	$80,000	$100,000	$80,000	$100,000	Annual Sampling and reporting during 6 years
Environmental Covenant							
Environmental Covenant	1	Lump Sum	$30,000	$50,000	$30,000	$50,000	
				DB-2 Excavation and DPE on WSDOT SD line Cost	**$2,040,000**	**$3,340,000**	
				Contingency (30%)	**$612,000**	**$1,002,000**	
				Complete Alternative 6 Cost	**$2,652,000**	**$4,342,000**	

Table 7-9
Remedial Alternative 6 Versus Remedial Alternative 4 Pass 1 Evaluation
Chevron Environmental Management Company
FINAL FEASABILITY STUDY REPORT
Former Unocal Edmonds Bulk Fuel Terminal
Edmonds, Washington

Disproportionate Cost Analysis: Pass 1 (Ecology Weighting, Chevron Rankings and Public Concerns Criterion Added)

			Remedial Alternative 1	Remedial Alternative 2	Remedial Alternative 3	Remedial Alternative 4	Remedial Alternative 5	Remedial Alternative 6
Disproportionate Cost Analysis Parameter	**Parameter Weight**	**Uses Rank in FS Report***	**Excavation of DB-2 and MNA with ECs**	**Groundwater Containment Using Extraction Wells and MNA with ECs**	**Groundwater Containment Using Groundwater Extraction Trench and MNA with ECs**	**Excavation of DB-2 and WSDOT Storm Drain Line and Limited ECs**	**Excavation of DB-2 and In-Situ Solidification near WSDOT Storm Drain Line and MNA with ECs**	**Excavation of DB-2, Dual-Phase Extraction Treatment near WSDOT Storm Drain Line and Limited ECs**
Protectiveness	10	Overall protectiveness of human health and the environment	3	5	4	1	2	1
Permanence	8	The degree to which the alternative permanently reduces the toxicity, mobility or volume of hazardous substances	3	5	4	1	2	1
Cost	8	The cost to implement the alternative	1	2	3	5	4	1
Effectiveness over the long term	10	The degree of certainty of success, the reliability of the alternative, the magnitude of residual risk, and the effectiveness of controls	3	5	4	1	2	2
Management of short-term risks	4	The risk to human health and environment associated with construction and implementation of the alternatives	3	1	2	5	4	4
Technical and administrative implementability	4	Technical feasibility of the alternative and administrative requirements	1	2	3	5	4	3
Consideration of public concerns	6	Whether the community has concerns regarding the alternative and, if so, the extent to which the alternative addresses those concerns.	4	5	5	1	5	2
		WEIGHTED SUMS:	**132**	**198**	**186**	**114**	**150**	**86**

Legend

[grey shading] Remedial alternative rejected by Ecology
*: Except consideration of public concerns
MNA =Monitored Natural Attenuation
ECs =Environmental Covenants
DB-2 = Detention Basin No. 2
WSDOT = Washington State Department of Transportation

Table 7-10
Remedial Alternative 6 Versus Remedial Alternative 4 Pass 2 Evaluation
Chevron Environmental Management Company
FINAL FEASABILITY STUDY REPORT
Former Unocal Edmonds Bulk Fuel Terminal
Edmonds, Washington

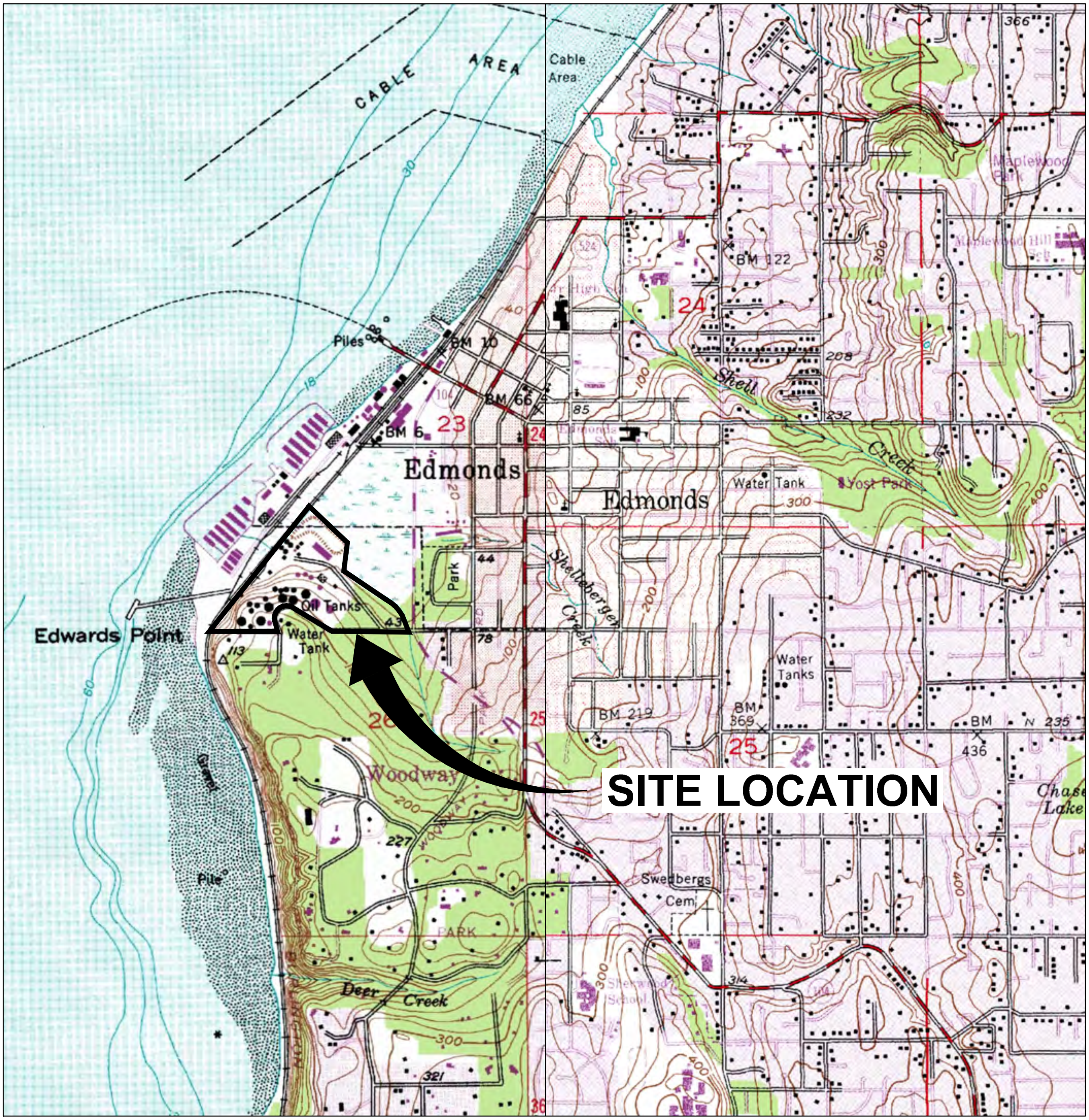
Disproportionate Cost Analysis: Pass 2 (Ecology Weighting and Rankings, and Public Concerns Criterion Added)

			Remedial Alternative 1	Remedial Alternative 2	Remedial Alternative 3	Remedial Alternative 4	Remedial Alternative 5	Remedial Alternative 6
Disproportionate Cost Analysis Parameter	**Parameter Weight**	**Uses Rank in FS Report***	**Excavation of DB-2 and MNA with ECs**	**Groundwater Containment Using Extraction Wells and MNA with ECs**	**Groundwater Containment Using Groundwater Extraction Trench and MNA with ECs**	**Excavation of DB-2 and WSDOT Storm Drain Line and Limited ECs**	**Excavation of DB-2 and In-Situ Solidification near WSDOT Storm Drain Line and MNA with ECs**	**Excavation of DB-2, Dual-Phase Extraction Treatment near WSDOT Storm Drain Line and Limited ECs**
Protectiveness	10	Overall protectiveness of human health and the environment	3	5	5	1	3	1
Permanence	8	The degree to which the alternative permanently reduces the toxicity, mobility or volume of hazardous substances	3	5	5	1	3	1
Cost	8	The cost to implement the alternative	2.1	3.6	3.9	5	4.2	2.4
Effectiveness over the long term	10	The degree of certainty of success, the reliability of the alternative, the magnitude of residual risk, and the effectiveness of controls	3	5	5	1	3	2
Management of short-term risks	4	The risk to human health and environment associated with construction and implementation of the alternatives	3	1	2	5	4	4
Technical and administrative implementability	4	Technical feasibility of the alternative and administrative requirements	3	3	3	3	5	3
Consideration of public concerns	6	Whether the community has concerns regarding the alternative and, if so, the extent to which the alternative addresses those concerns.	3	5	5	1	5	2
		WEIGHTED SUMS:	**143**	**215**	**221**	**106**	**184**	**97**

Legend

[shaded] Remedial alternative rejected by Ecology
*: Except consideration of public concerns
MNA =Monitored Natural Attenuation
ECs =Environmental Covenants
DB-2 = Detention Basin No. 2
WSDOT = Washington State Department of Transportation

FIGURES



REFERENCE: BASE MAP USGS QUADS., 7.5 MIN. SERIES (TOPOGRAPHIC) - EDMONDS EAST, WASH. AND EDMONDS WEST, WASH.

0 2000' 4000'

GRAPHIC SCALE

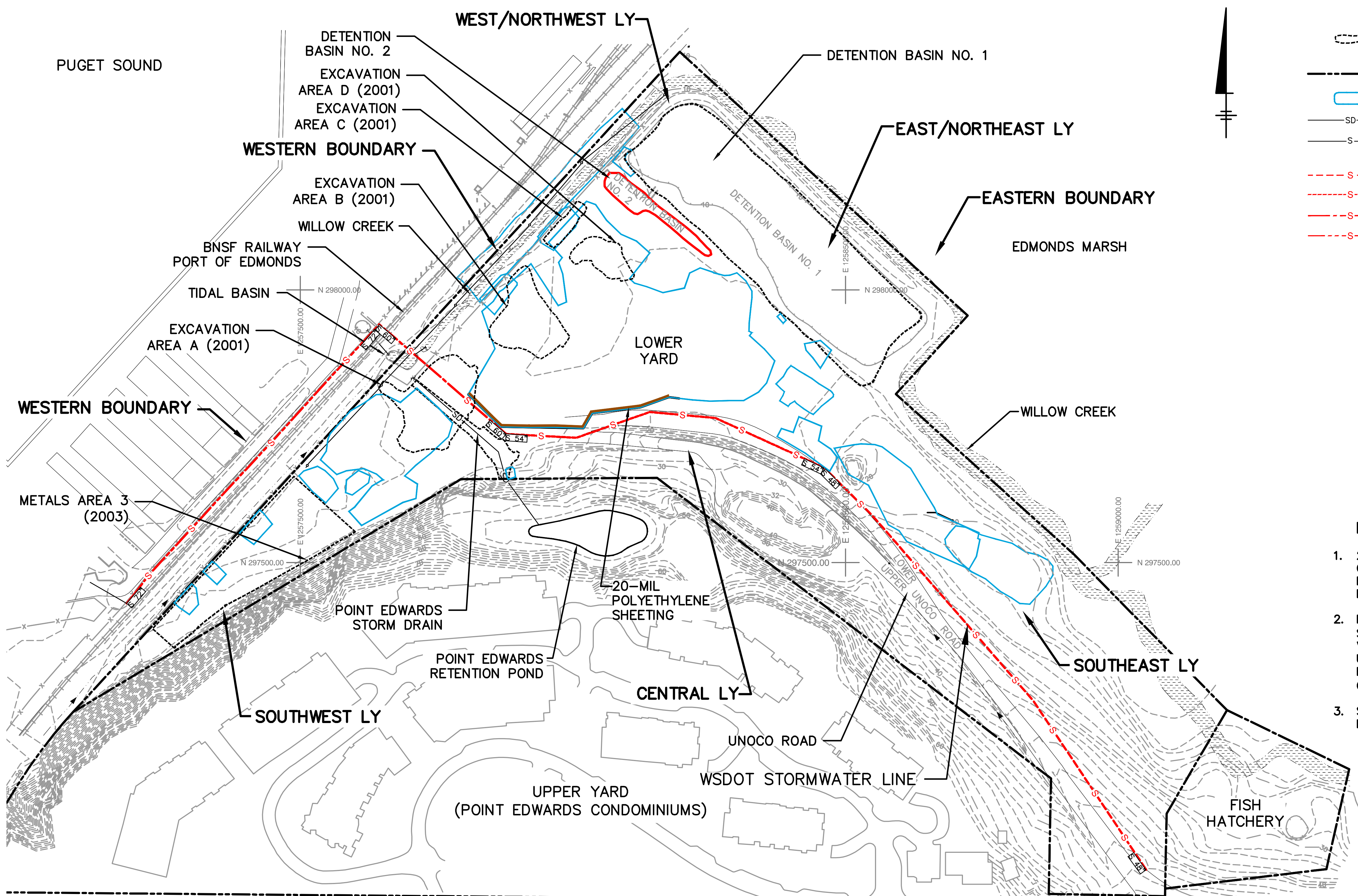
CHEVRON ENVIRONMENTAL MANAGEMENT COMPANY
FORMER UNOCAL BULK FUEL TERMINAL
EDMONDS, WASHINGTON
FINAL FEASIBILITY STUDY REPORT

FORMER UNOCAL BULK FUEL TERMINAL LOCATION MAP

ARCADIS Design & Consultancy for natural and built assets

FIGURE
1-1

PUBLIC REVIEW DRAFT



NOTES:

1. 20-MIL POLYETHYLENE SHEETING INSTALLED UPON COMPLETION OF PHASE I EXCAVATION. SHEETING REACHES TO APPROXIMATELY 7.5 FEET ABOVE MEAN SEA LEVEL.
2. HORIZONTAL DATUM: WASHINGTON STATE COORDINATE SYSTEM NORTH ZONE (NAD 83/98).
   VERTICAL DATUM: N.A.V.D. 88
   UNITS: U.S. SURVEY FEET
   HORIZONTAL AND VERTICAL CONTROL ESTABLISHED BY GPS VIA VERTICAL REFERENCE STATION NETWORK (VRSN).
3. SOUTHEAST PORTION OF WSDOT STORMWATER LINE HAS NOT BEEN SURVEYED.

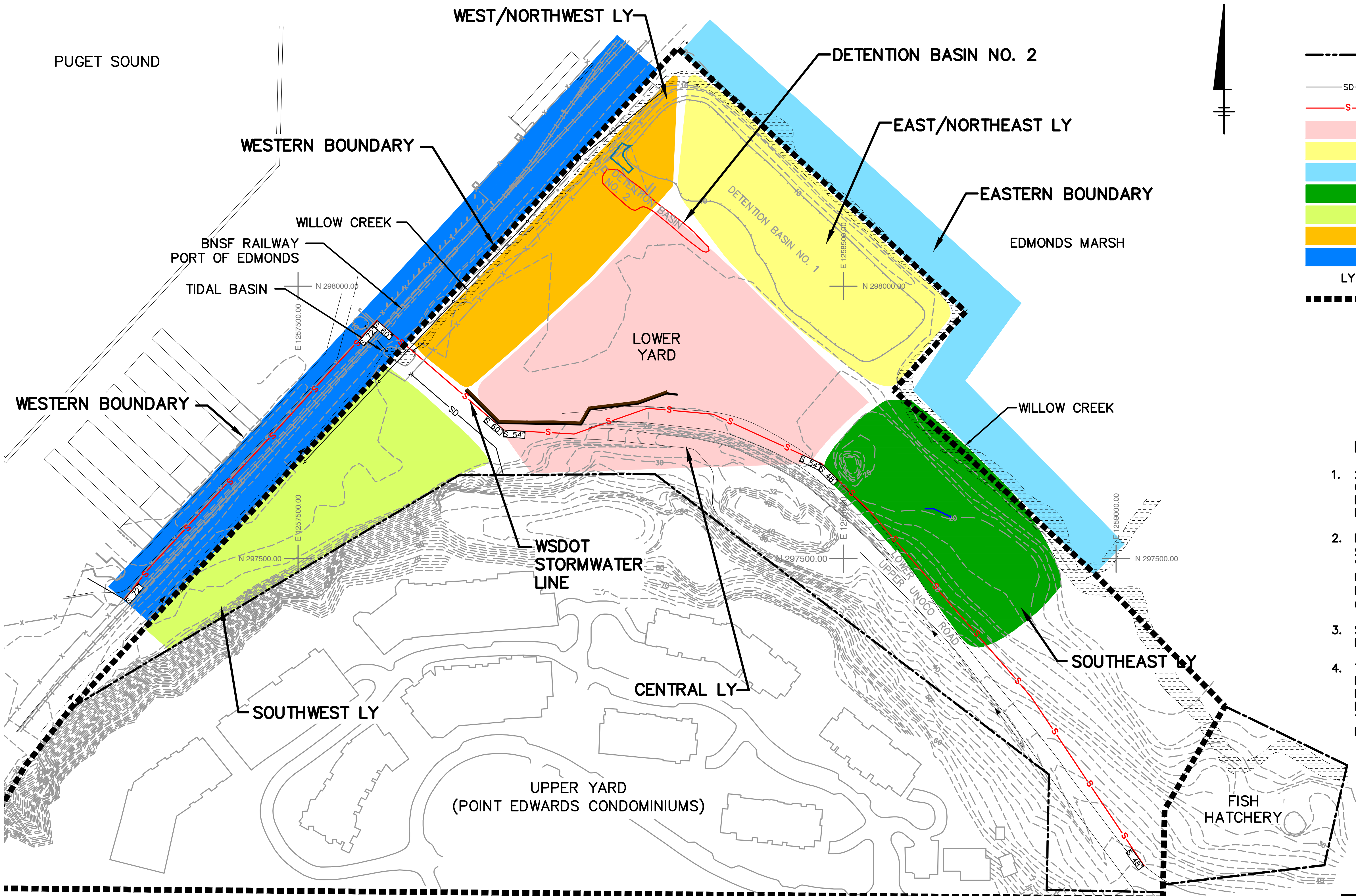
CHEVRON ENVIRONMENTAL MANAGEMENT COMPANY
FORMER UNOCAL BULK FUEL TERMINAL
EDMONDS, WASHINGTON
FINAL FEASIBILITY STUDY REPORT

FORMER UNOCAL BULK FUEL TERMINAL LAYOUT

ARCADIS Design & Consultancy for natural and built assets

FIGURE
1-2

PUBLIC REVIEW DRAFT



LEGEND:

- FORMER UNOCAL BULK FUEL PROPERTY BOUNDARY
- SD — POINT EDWARDS STORM DRAIN LINE
- S — WSDOT STORMWATER LINE
- CENTRAL LY
- EAST/NORTHEAST LY
- EASTERN BOUNDARY
- SOUTHEAST LY
- SOUTHWEST LY
- WEST/NORTHWEST LY
- WESTERN BOUNDARY
- LY — LOWER YARD
- SITE BOUNDARY

NOTES:

1. 20-MIL POLYETHYLENE SHEETING INSTALLED UPON COMPLETION OF PHASE I EXCAVATION. SHEETING REACHES TO APPROXIMATELY 7.5 FEET ABOVE MEAN SEA LEVEL.
2. HORIZONTAL DATUM: WASHINGTON STATE COORDINATE SYSTEM NORTH ZONE (NAD 83/98).
VERTICAL DATUM: N.A.V.D. 88
UNITS: U.S. SURVEY FEET
HORIZONTAL AND VERTICAL CONTROL ESTABLISHED BY GPS VIA VERTICAL REFERENCE STATION NETWORK (VRSN).
3. SOUTHEAST PORTION OF WSDOT STORMWATER LINE HAS NOT BEEN SURVEYED.
4. THE SITE IS NOW COMPRISED OF THE AREAS OF THE LOWER YARD AND THE UPPER YARD WHERE A HAZARDOUS SUBSTANCE HAS COME TO BE LOCATED. THE FISH HATCHERY IS NO LONGER INCLUDED AS PART OF THE SITE AS A RESULT OF THE REVIEW OF HISTORICAL INFORMATION.

0 200' 400'
GRAPHIC SCALE

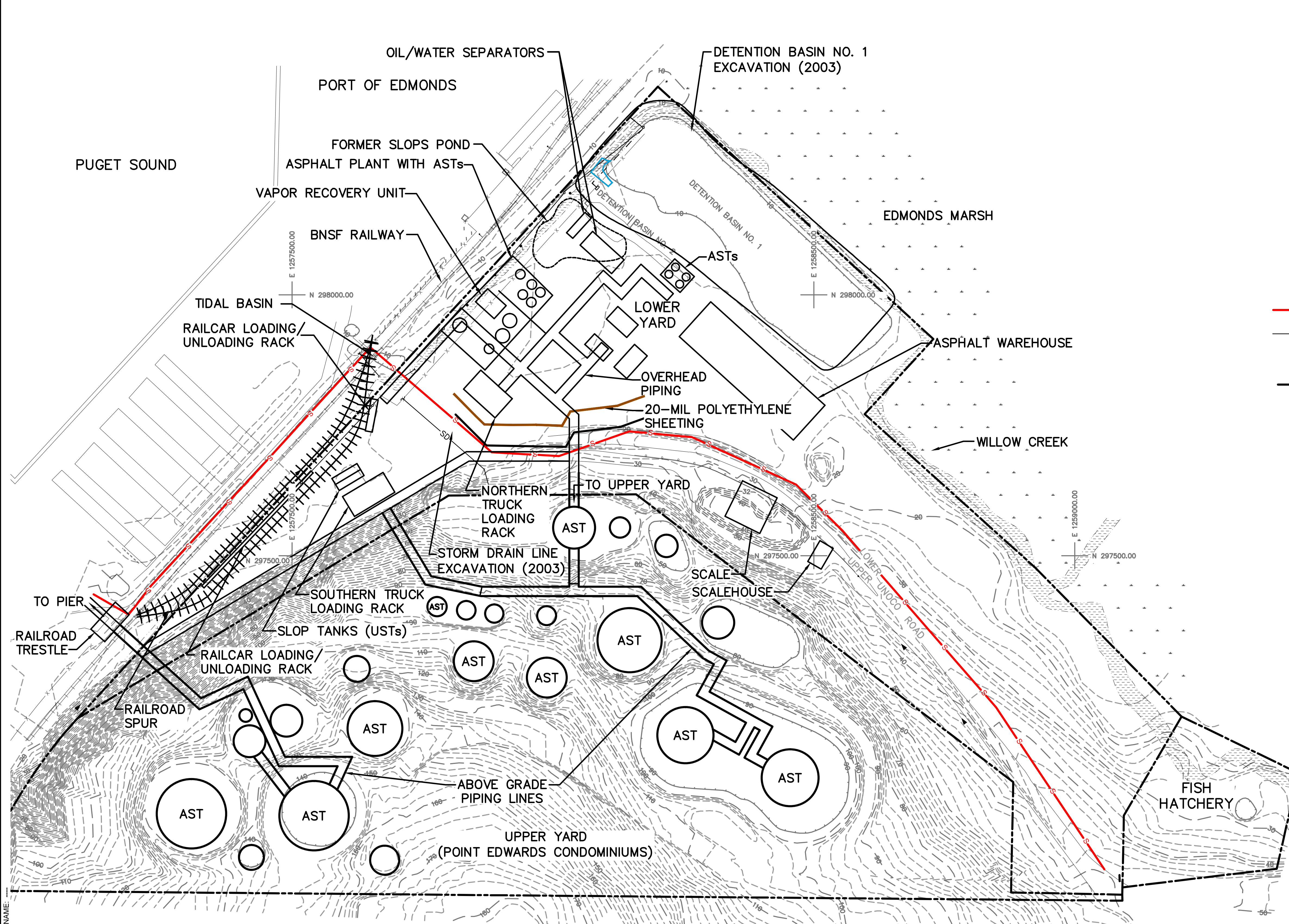
CHEVRON ENVIRONMENTAL MANAGEMENT COMPANY
FORMER UNOCAL BULK FUEL TERMINAL
EDMONDS, WASHINGTON
FINAL FEASIBILITY STUDY REPORT

FORMER UNOCAL BULK FUEL TERMINAL AREA OF THE LOWER YARD

ARCADIS Design & Consultancy for natural and built assets

FIGURE
1-3

PUBLIC REVIEW DRAFT



LEGEND:

- WSDOT STORMWATER LINE
- POINT EDWARDS STORMWATER LINE
- HISTORICAL FEATURE
- PROPERTY BOUNDARY
- AST — ABOVEGROUND STORAGE TANKS (ASTs)
- UST — UNDERGROUND STORAGE TANK

NOTES:

1. 20-MIL POLYETHYLENE SHEETING INSTALLED UPON COMPLETION OF PHASE I EXCAVATION. SHEETING REACHES TO APPROXIMATELY 7.5 FEET ABOVE MEAN SEA LEVEL.
2. HORIZONTAL DATUM: WASHINGTON STATE COORDINATE SYSTEM NORTH ZONE (NAD 83/98). VERTICAL DATUM: N.A.V.D. 88 UNITS: U.S. SURVEY FEET HORIZONTAL AND VERTICAL CONTROL ESTABLISHED BY GPS VIA VERTICAL REFERENCE STATION NETWORK (VRSN).
3. SOUTHEAST PORTION OF WSDOT STORMWATER LINE HAS NOT BEEN SURVEYED.

0 200' 400'
GRAPHIC SCALE

CHEVRON ENVIRONMENTAL MANAGEMENT COMPANY
FORMER UNOCAL BULK FUEL TERMINAL
EDMONDS, WASHINGTON
FINAL FEASIBILITY STUDY REPORT

HISTORICAL FACILITIES LOCATION MAP

ARCADIS Design & Consultancy for natural and built assets

FIGURE
2-1

CITY: MINNEAPOLIS, MN DIV/GROUP: ENV/CAD DB: R. OBERLANDER LD: R. OBERLANDER PIC:(Opt) PM:(Reqd) TM:(Opt) LYR:(Opt)ON=*;OFF=*REF*
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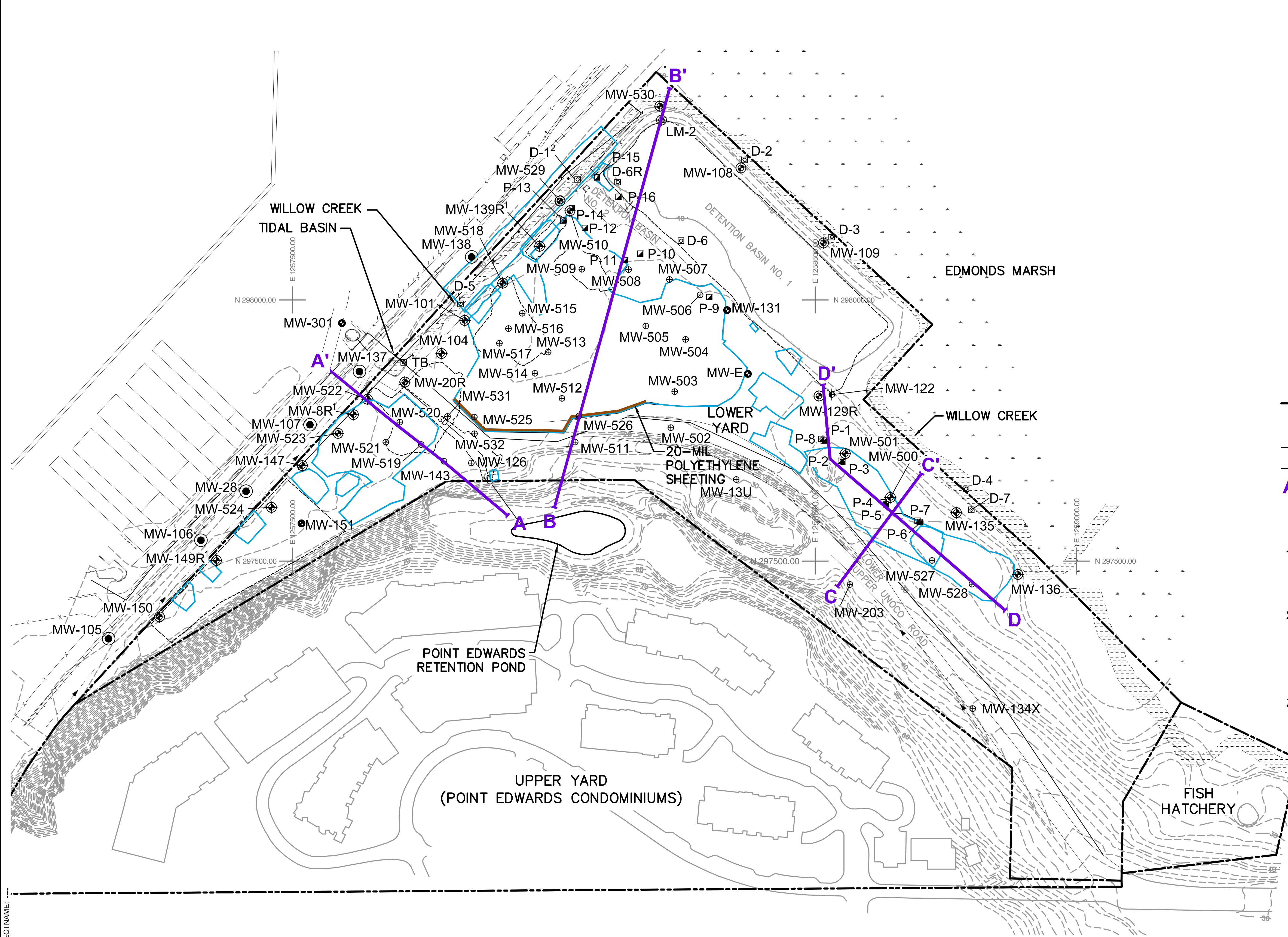


LEGEND:

MW-203 ⊕	INTERIOR MONITORING WELL LOCATION AND DESIGNATION
MW-301	MONITORING WELL
MW-105	BNSF WELLS (DECOMISSIONED)
MW-122	DEEP MONITORING WELL LOCATION AND DESIGNATION
MW-109	PERIMETER MONITORING WELL LOCATION
P-11	PIEZOMETER
D-1	STAFF GAUGE
	2001 AND 2003 SOIL EXCAVATIONS BELOW GROUNDWATER TABLE
	PROPERTY BOUNDARY
	2007/2008 EXCAVATION BOUNDARIES
——S——	WSDOT STORMWATER LINE
——SD——	POINT EDWARDS STORM DRAIN LINE
A——A'	CROSS SECTION LOCATIONS

NOTES:

1. 20-MIL POLYETHYLENE SHEETING INSTALLED UPON COMPLETION OF PHASE I EXCAVATION. SHEETING REACHES TO APPROXIMATELY 7.5 FEET ABOVE MEAN SEA LEVEL.
2. HORIZONTAL DATUM: WASHINGTON STATE COORDINATE SYSTEM NORTH ZONE (NAD 83/98).
   VERTICAL DATUM: N.A.V.D. 88
   UNITS: U.S. SURVEY FEET
   HORIZONTAL AND VERTICAL CONTROL ESTABLISHED BY GPS VIA VERTICAL REFERENCE STATION NETWORK (VRSN).
3. SOUTHEAST PORTION OF WSDOT STORMWATER LINE HAS NOT BEEN SURVEYED.

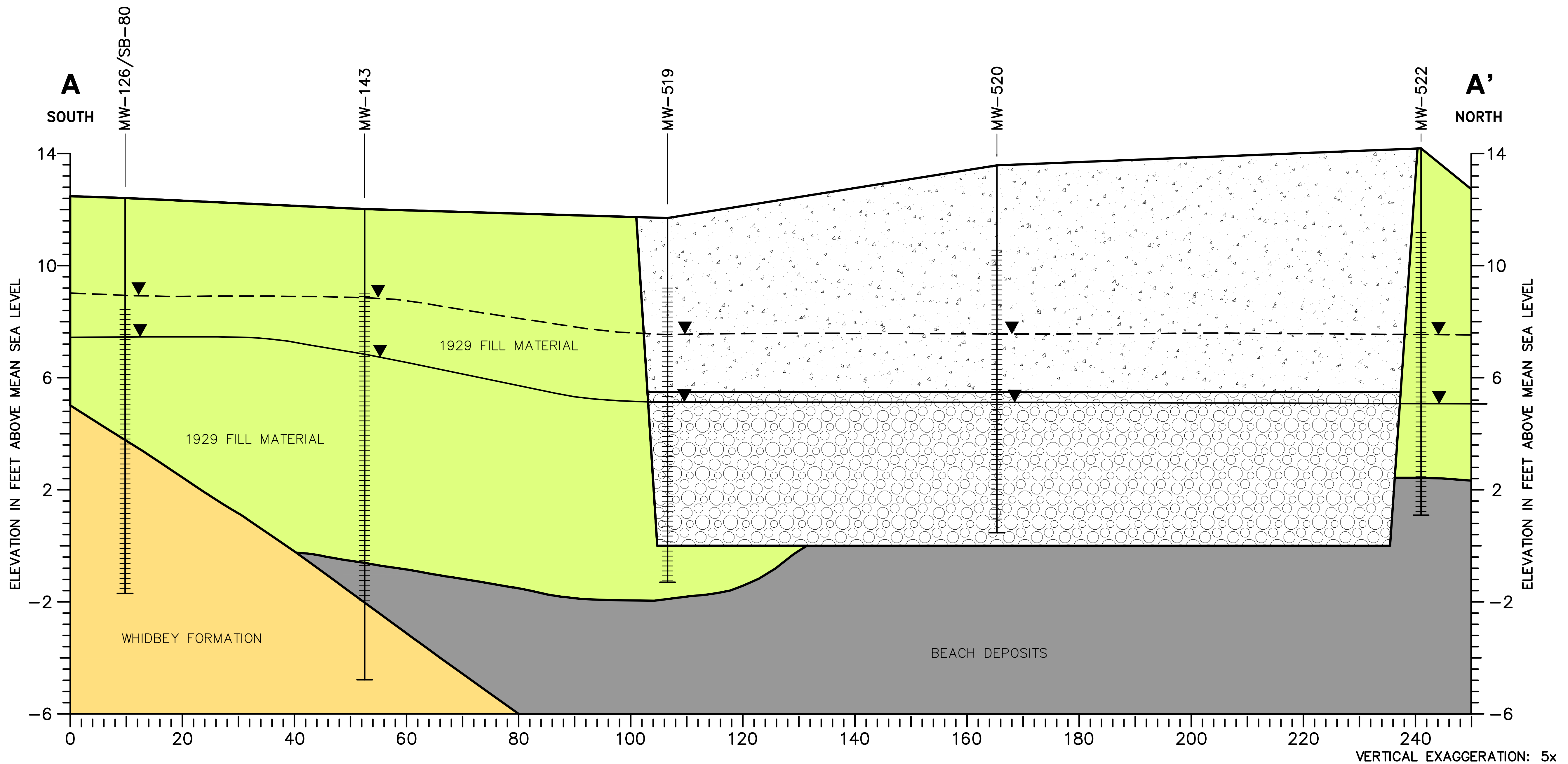
CHEVRON ENVIRONMENTAL MANAGEMENT COMPANY
FORMER UNOCAL BULK FUEL TERMINAL
EDMONDS, WASHINGTON
FINAL FEASIBILITY STUDY REPORT

CROSS SECTION LOCATION MAP

ARCADIS Design & Consultancy for natural and built assets

FIGURE
2-2

PUBLIC REVIEW DRAFT



NOTES:

- HORIZONTAL DATUM: WASHINGTON STATE COORDINATE SYSTEM NORTH ZONE (NAD 83/98).
- VERTICAL DATUM: N.A.V.D. 88
- UNITS: U.S. SURVEY FEET
- HORIZONTAL AND VERTICAL CONTROL ESTABLISHED BY GPS VIA VERTICAL REFERENCE STATION NETWORK (VRSN).

LEGEND:

MW-126

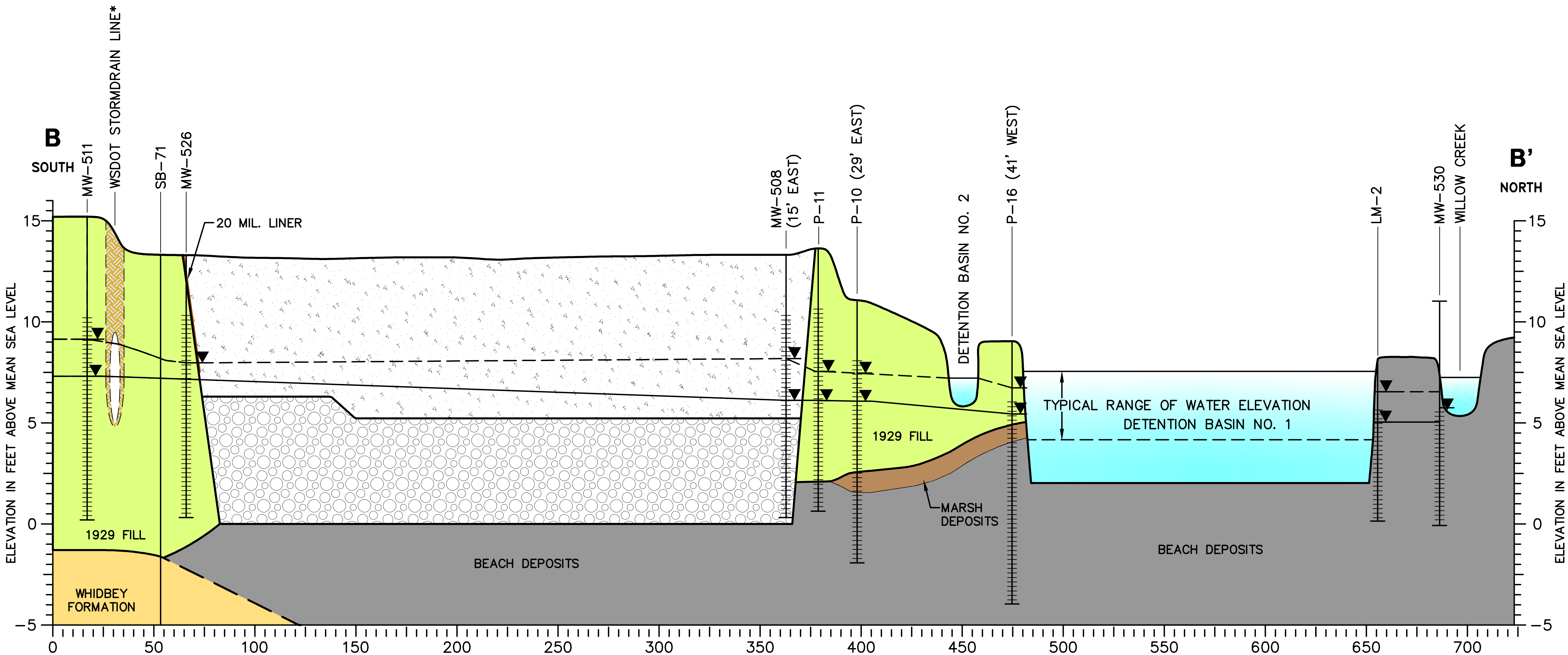
- WELL OR BORING ID
- GROUND SURFACE
- HISTORICAL HIGH WATER LEVEL
- HISTORICAL LOW WATER LEVEL
- LITHOLOGIC CONTACT (DASHED WHERE INFERRED)
- SCREENED INTERVAL
- BOTTOM OF BORING
- 1929 FILL MATERIAL
- BEACH DEPOSITS
- TRANSITIONAL SILT BED
- WHIDBEY FORMATION
- MARSH DEPOSITS
- 2007/2008 FILL (GRAVEL)
- 2007/2008 FILL (SILT, SAND AND GRAVEL)
- (35' SE)=OFFSET DISTANCE FROM CROSS SECTION PROFILE

CHEVRON ENVIRONMENTAL MANAGEMENT COMPANY
FORMER UNOCAL BULK FUEL TERMINAL
EDMONDS, WASHINGTON
FINAL FEASIBILITY STUDY REPORT

LOWER YARD
GEOLOGIC CROSS SECTION A-A'

ARCADIS Design & Consultancy for natural and built assets

FIGURE
2-3



VERTICAL EXAGGERATION: 10x

0 5' 10'

VERTICAL SCALE

0 50' 100'

HORIZONTAL SCALE

NOTES:

1. WSDOT STORMDRAIN LINE LOCATION IS APPROXIMATE AND DRAWN TO A NON EXAGGERATED SCALE FOR CLARITY.
2. HORIZONTAL DATUM: WASHINGTON STATE COORDINATE SYSTEM NORTH ZONE (NAD 83/98).
   VERTICAL DATUM: N.A.V.D. 88
   UNITS: U.S. SURVEY FEET
   HORIZONTAL AND VERTICAL CONTROL ESTABLISHED BY GPS VIA VERTICAL REFERENCE STATION NETWORK (VRSN).

LEGEND:

MW-511 — WELL OR BORING ID

GROUND SURFACE

HISTORICAL HIGH WATER LEVEL

HISTORICAL LOW WATER LEVEL

LITHOLOGIC CONTACT (DASHED WHERE INFERRED)

SCREENED INTERVAL

BOTTOM OF BORING

DISTURBED TRENCH MATERIAL

1929 FILL MATERIAL

BEACH DEPOSITS

WHIDBEY FORMATION

MARSH DEPOSITS

2007/2008 FILL (GRAVEL)

2007/2008 FILL (SILT, SAND AND GRAVEL)

(29' E)=OFFSET DISTANCE FROM CROSS SECTION PROFILE

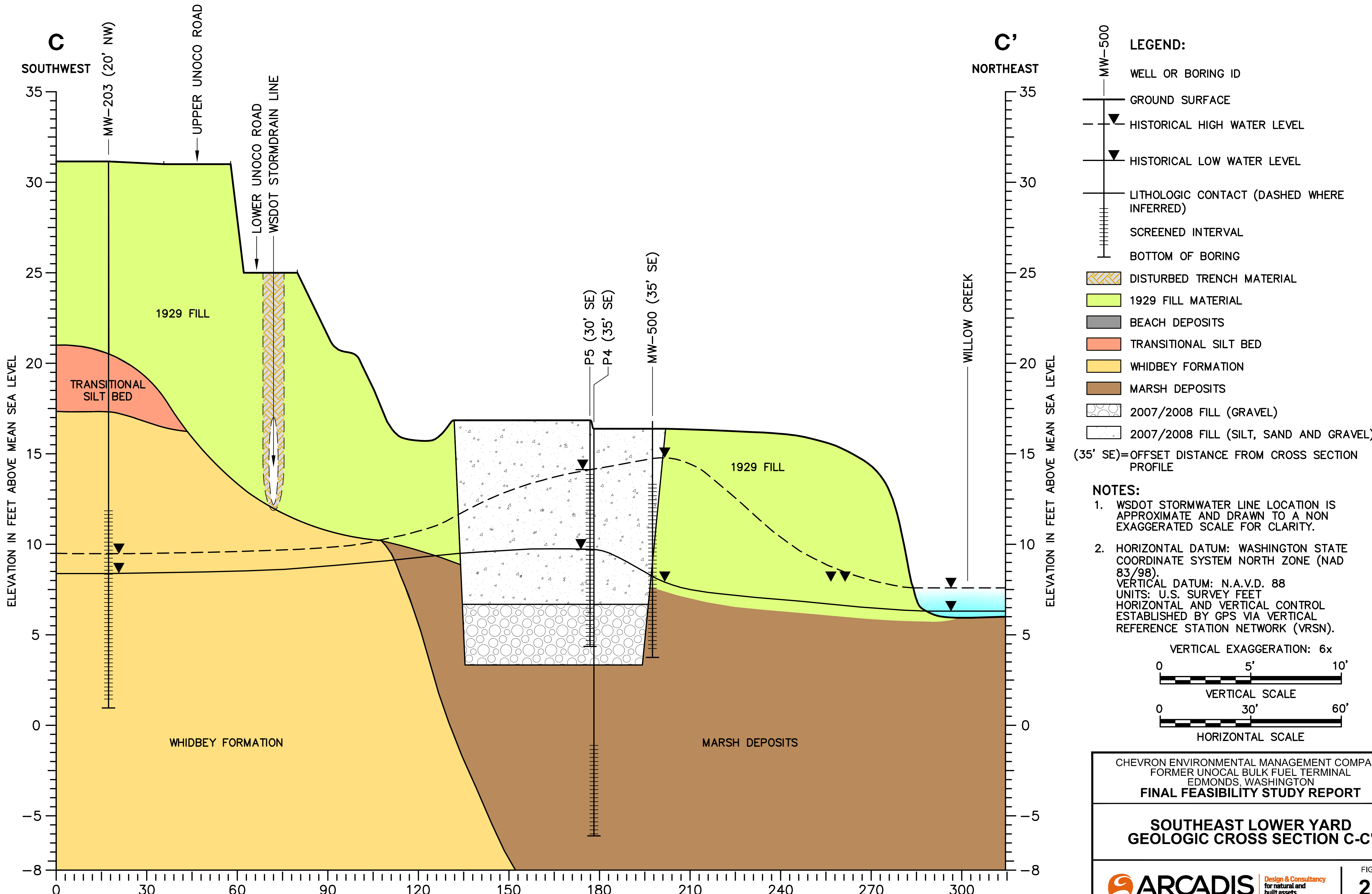
CHEVRON ENVIRONMENTAL MANAGEMENT COMPANY
FORMER UNOCAL BULK FUEL TERMINAL
EDMONDS, WASHINGTON
FINAL FEASIBILITY STUDY REPORT

LOWER YARD
GEOLOGIC CROSS SECTION B-B'

ARCADIS Design & Consultancy for natural and built assets

FIGURE
2-4

PUBLIC REVIEW DRAFT



NOTES:

1. WSDOT STORMWATER LINE LOCATION IS APPROXIMATE AND DRAWN TO A NON EXAGGERATED SCALE FOR CLARITY.
2. HORIZONTAL DATUM: WASHINGTON STATE COORDINATE SYSTEM NORTH ZONE (NAD 83/98).
   VERTICAL DATUM: N.A.V.D. 88
   UNITS: U.S. SURVEY FEET
   HORIZONTAL AND VERTICAL CONTROL ESTABLISHED BY GPS VIA VERTICAL REFERENCE STATION NETWORK (VRSN).

CHEVRON ENVIRONMENTAL MANAGEMENT COMPANY
FORMER UNOCAL BULK FUEL TERMINAL
EDMONDS, WASHINGTON
FINAL FEASIBILITY STUDY REPORT

SOUTHEAST LOWER YARD GEOLOGIC CROSS SECTION C-C'

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FIGURE **2-5**

CITY: MINNEAPOLIS, MN DIV/GROUP: ENV/CAD DB: R. OBERLANDER LD: R. OBERLANDER PIC:(Opt) PM:(Reqd) TM:(Opt) LYR:(Opt)ON=*;OFF=*REF*
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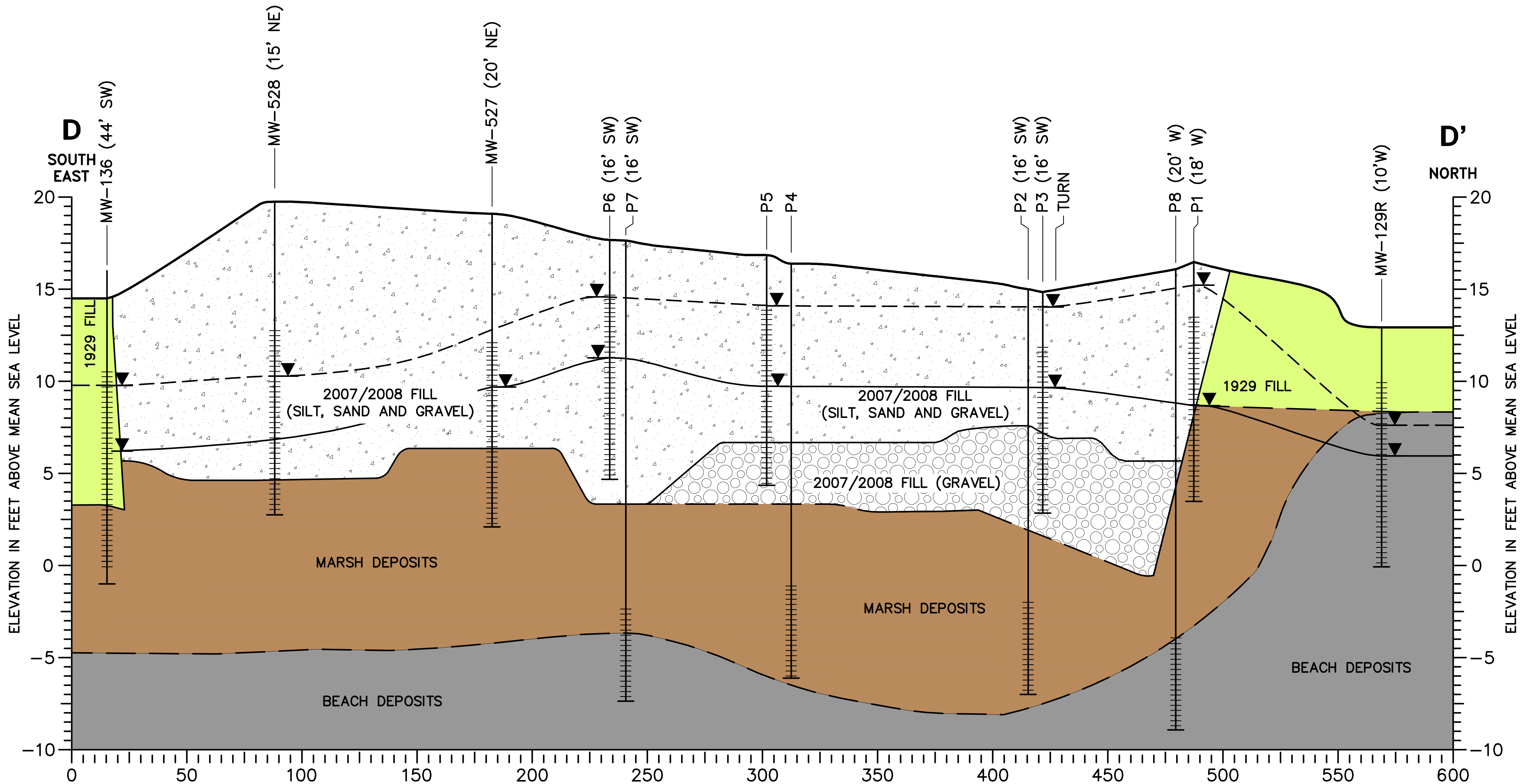
PUBLIC REVIEW DRAFT



LEGEND:

MW–136	WELL OR BORING ID
	GROUND SURFACE
	HISTORICAL HIGH WATER LEVEL
	HISTORICAL LOW WATER LEVEL
	LITHOLOGIC CONTACT (DASHED WHERE INFERRED)
	SCREENED INTERVAL
	BOTTOM OF BORING

- 1929 FILL MATERIAL
- BEACH DEPOSITS
- TRANSITIONAL SILT BED
- WHIDBEY FORMATION
- MARSH DEPOSITS
- 2007/2008 FILL (GRAVEL)
- 2007/2008 FILL (SILT, SAND AND GRAVEL)
- (20' W)= OFFSET DISTANCE FROM CROSS SECTION PROFILE

NOTES:

1. CROSS SECTION DEPICTS SOIL CHARACTERISTICS OF EXCAVATION SIDE WALLS. EXCAVATIONS REACHED TOTAL DEPTHS OF 15 FT. BGS. (<0 FEET AMSI).
2. HORIZONTAL DATUM: WASHINGTON STATE COORDINATE SYSTEM NORTH ZONE (NAD 83/98).
VERTICAL DATUM: N.A.V.D. 88
UNITS: U.S. SURVEY FEET
HORIZONTAL AND VERTICAL CONTROL ESTABLISHED BY GPS VIA VERTICAL REFERENCE STATION NETWORK (VRSN).

VERTICAL EXAGGERATION: 8x

0 6.25' 12.5'

VERTICAL SCALE

0 50' 100'

HORIZONTAL SCALE

CHEVRON ENVIRONMENTAL MANAGEMENT COMPANY
FORMER UNOCAL BULK FUEL TERMINAL
EDMONDS, WASHINGTON
FINAL FEASIBILITY STUDY REPORT

SOUTHEAST LOWER YARD GEOLOGIC CROSS SECTION D-D'

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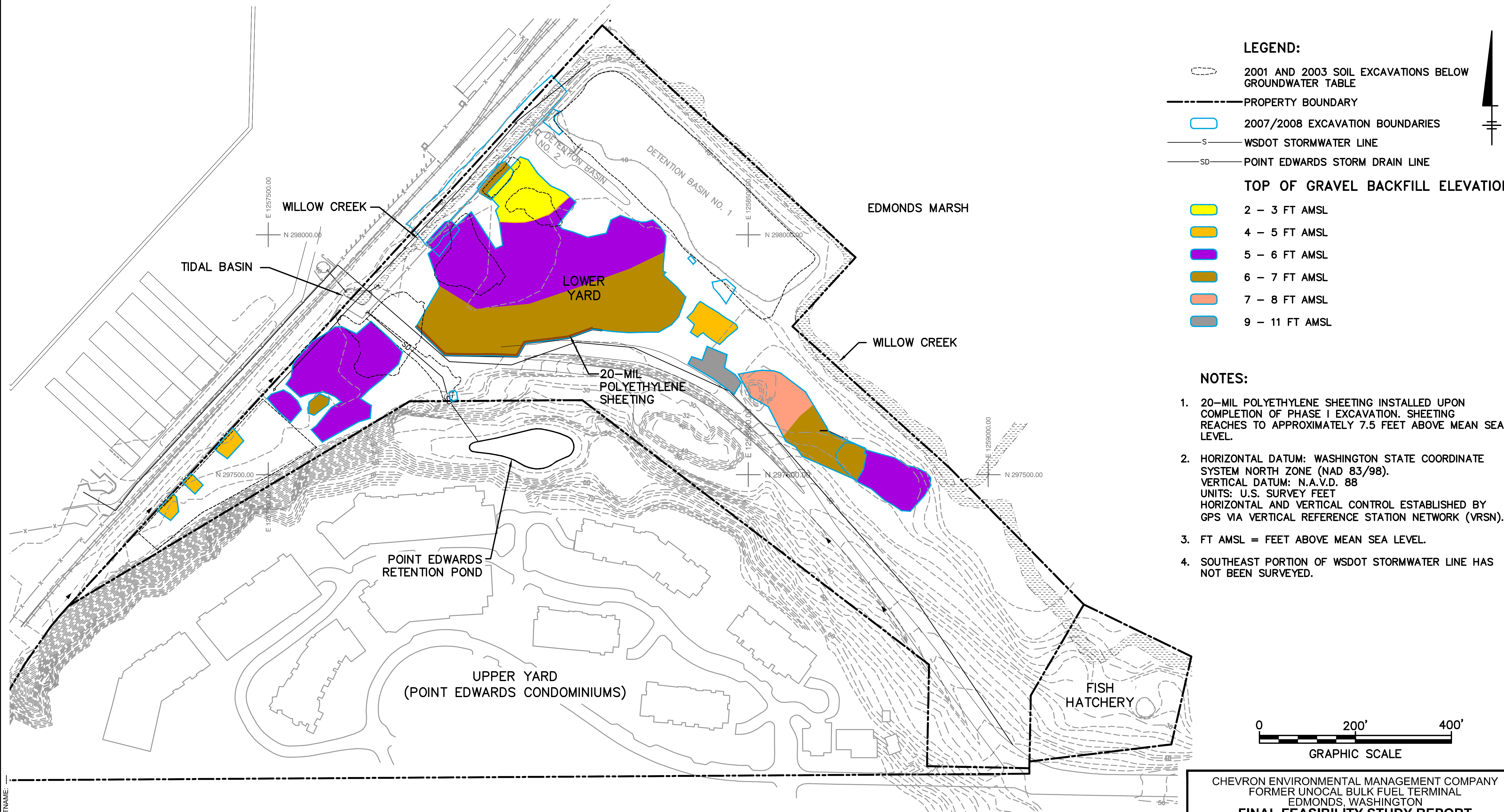
FIGURE **2-6**

PUBLIC REVIEW DRAFT



CHEVRON ENVIRONMENTAL MANAGEMENT COMPANY
FORMER UNOCAL BULK FUEL TERMINAL
EDMONDS, WASHINGTON
FINAL FEASIBILITY STUDY REPORT

TOP OF 2008 GRAVEL BACKFILL ELEVATIONS

ARCADIS Design & Consultancy for natural and built assets

FIGURE
2-7

PUBLIC REVIEW DRAFT

LEGEND:

- 2001 AND 2003 SOIL EXCAVATIONS BELOW GROUNDWATER TABLE
- LOWER YARD PROPERTY BOUNDARY
- 2007/2008 EXCAVATION BOUNDARIES
- WSDOT STORMWATER LINE
- POINT EDWARDS STORM DRAIN LINE

BOTTOM OF GRAVEL BACKFILL ELEVATION:

- 8 – 9 FT AMSL
- 6 – 4 FT AMSL
- 4 – 2 FT AMSL
- 2 – 0 FT AMSL
- 0 TO –2 FT AMSL

NOTES:

1. 20-MIL POLYETHYLENE SHEETING INSTALLED UPON COMPLETION OF PHASE I EXCAVATION. SHEETING REACHES TO APPROXIMATELY 7.5 FEET ABOVE MEAN SEA LEVEL.
2. HORIZONTAL DATUM: WASHINGTON STATE COORDINATE SYSTEM NORTH ZONE (NAD 83/98).
VERTICAL DATUM: N.A.V.D. 88
UNITS: U.S. SURVEY FEET
HORIZONTAL AND VERTICAL CONTROL ESTABLISHED BY GPS VIA VERTICAL REFERENCE STATION NETWORK (VRSN).
3. FT AMSL = FEET ABOVE MEAN SEA LEVEL.
4. SOUTHEAST PORTION OF WSDOT STORMWATER LINE HAS NOT BEEN SURVEYED.

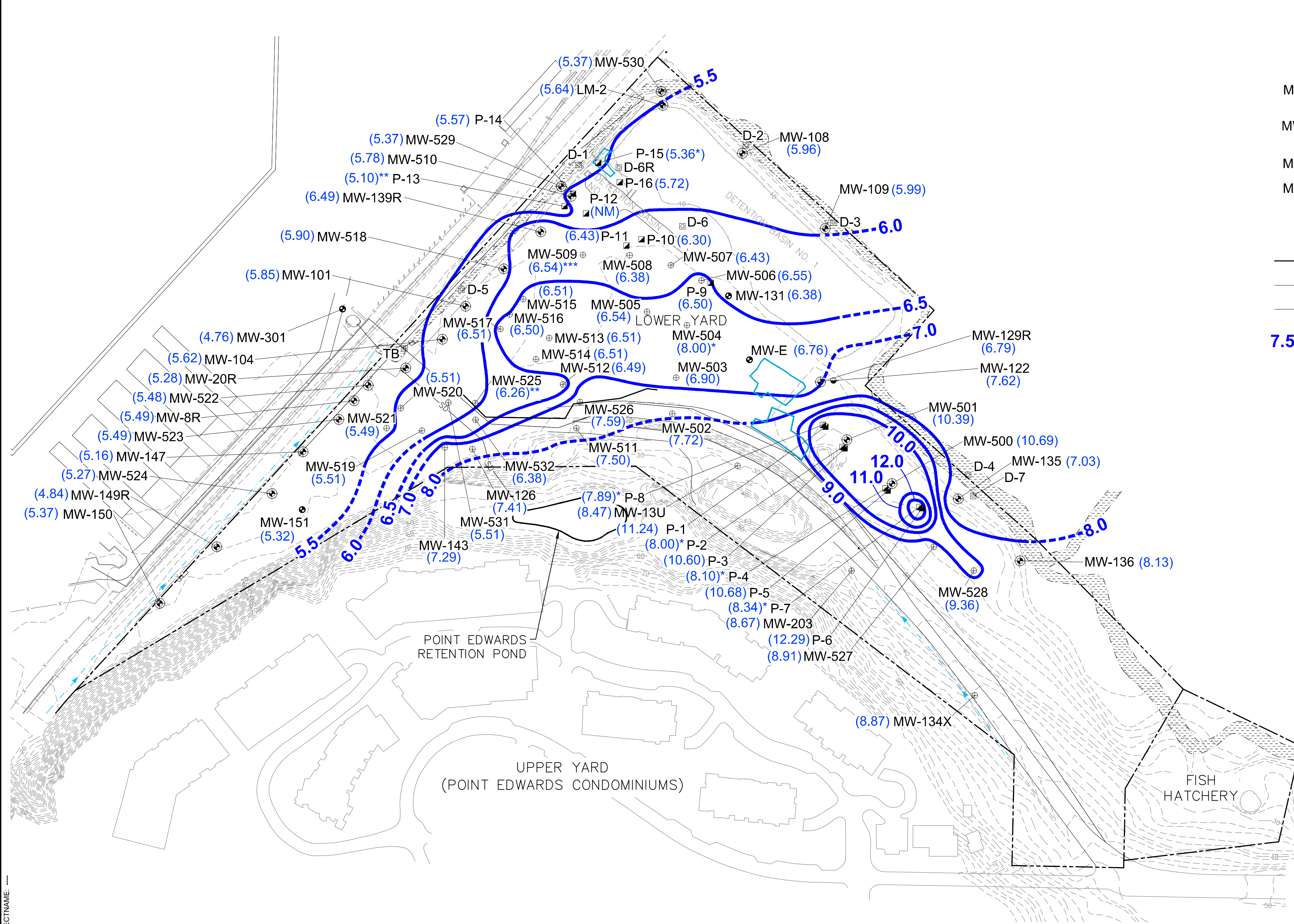
CHEVRON ENVIRONMENTAL MANAGEMENT COMPANY
FORMER UNOCAL BULK FUEL TERMINAL
EDMONDS, WASHINGTON
FINAL FEASIBILITY STUDY REPORT

BOTTOM OF 2008 GRAVEL BACKFILL ELEVATIONS

ARCADIS Design & Consultancy for natural and built assets

FIGURE
2-8

PUBLIC REVIEW DRAFT



LEGEND:

- MW-203 ⊕ INTERIOR MONITORING WELL LOCATION AND DESIGNATION
- MW-122 DEEP MONITORING WELL LOCATION AND DESIGNATION
- MW-301 MONITORING WELL
- MW-109 PERIMETER MONITORING WELL LOCATION
- P-11 PIEZOMETER
- D-1 STAFF GAUGE
- LOWER YARD PROPERTY BOUNDARY
- WSDOT STORM DRAIN LINE
- POINT EDWARDS STORM DRAIN LINE
- 7.5 GROUNDWATER ELEVATION CONTOUR (DASHED WHERE INFERRED)
- (12.29) GROUNDWATER ELEVATION
- (8.10)* GROUNDWATER ELEVATION NOT USED IN CONTOURING
- (5.57)** GROUNDWATER ELEVATION ADJUSTED FOR THE PRESENCE OF LIGHT NON-AQUEOUS PHASE LIQUID (LNAPL)
- (NM) NOT MEASURED
- *** GAUGED ON LATER DATE DUE TO PRESENCE OF BEES AND NOT USED IN CONTOURING

NOTES:

1. 20-MIL POLYETHYLENE SHEETING INSTALLED UPON COMPLETION OF PHASE 1 EXCAVATION. SHEETING REACHES TO APPROXIMATELY 7.5 FEET ABOVE MEAN SEA LEVEL.
2. HORIZONTAL DATUM: WASHINGTON STATE COORDINATE SYSTEM NORTH ZONE (NAD 83/98). VERTICAL DATUM: N.A.V.D. 88 UNITS: U.S. SURVEY FEET HORIZONTAL AND VERTICAL CONTROL ESTABLISHED BY GPS VIA VERTICAL REFERENCE STATION NETWORK (VRSN).
3. SOUTHEAST PORTION OF WSDOT STORM DRAIN LINE HAS NOT BEEN SURVEYED.

0 200' 400'

GRAPHIC SCALE

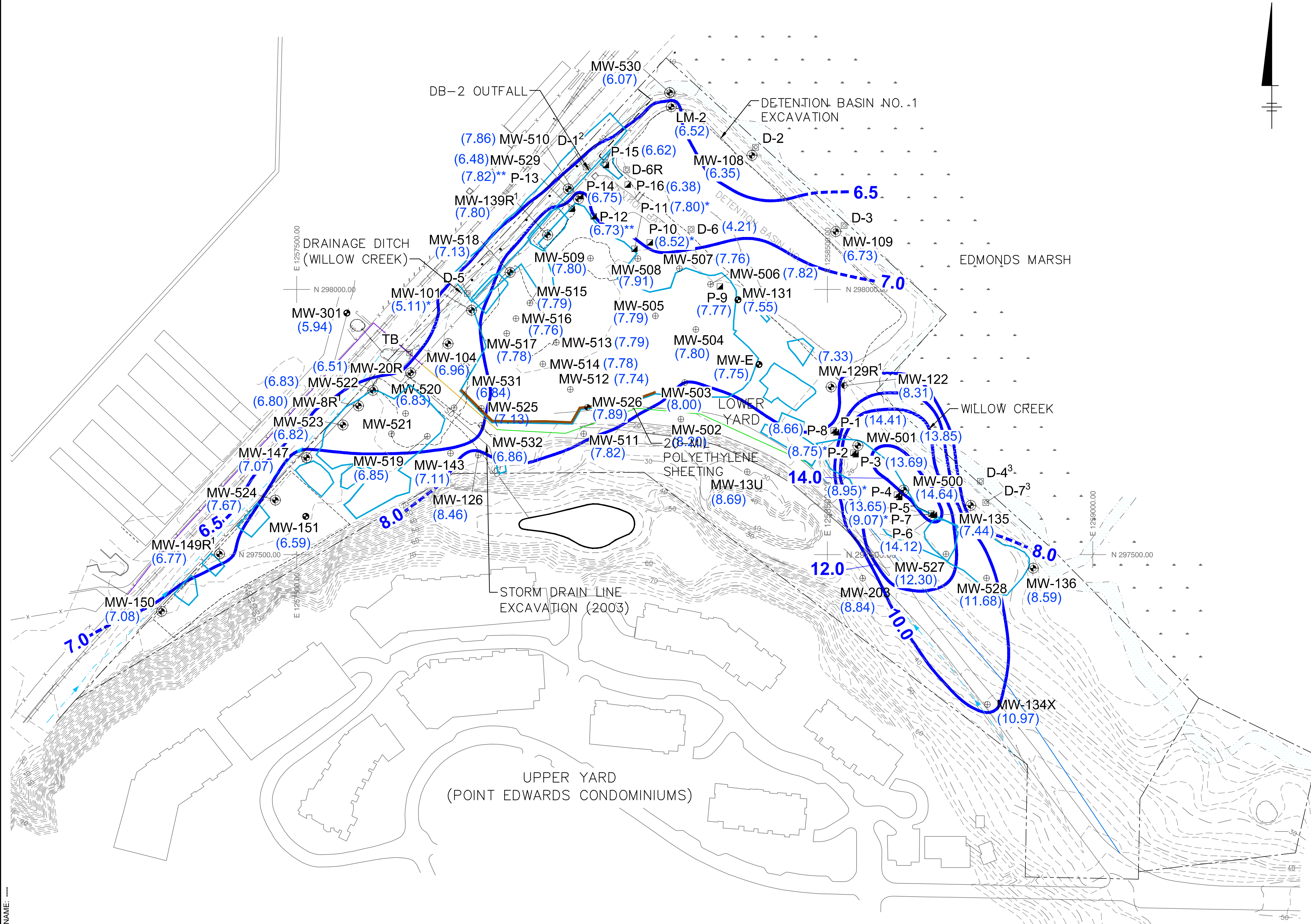
CHEVRON ENVIRONMENTAL MANAGEMENT COMPANY
FORMER UNOCAL BULK FUEL TERMINAL
EDMONDS, WASHINGTON
FINAL FEASIBILITY STUDY REPORT

SECOND QUARTER 2015 GROUNDWATER ELEVATIONS AND CONTOURS - JUNE 22, 2015

ARCADIS Design & Consultancy for natural and built assets

FIGURE
2-9

PUBLIC REVIEW DRAFT



LEGEND:

MW-203 ⊕	INTERIOR MONITORING WELL LOCATION AND DESIGNATION
MW-122	DEEP MONITORING WELL LOCATION AND DESIGNATION
MW-301	MONITORING WELL
MW-109	PERIMETER MONITORING WELL LOCATION
P-11	PIEZOMETER
D-1	STAFF GAUGE
— - — - —	LOWER YARD PROPERTY BOUNDARY
—S—	WSDOT STORM DRAIN LINE
—SD—	POINT EDWARDS STORM DRAIN LINE
7.5 ———	GROUNDWATER ELEVATION CONTOUR (DASHED WHERE INFERRED)
(12.29)	GROUNDWATER ELEVATION
(8.10)*	GROUNDWATER ELEVATION NOT USED IN CONTOURING
(6.73)**	GROUNDWATER ELEVATION ADJUSTED FOR THE PRESENCE OF LIGHT NON-AQUEOUS PHASE LIQUID (LNAPL)
***	GAUGED ON LATER DATE DUE TO PRESENCE OF BEES AND NOT USED IN CONTOURING

NOTES:

1. 20-MIL POLYETHYLENE SHEETING INSTALLED UPON COMPLETION OF PHASE I EXCAVATION. SHEETING REACHES TO APPROXIMATELY 7.5 FEET ABOVE MEAN SEA LEVEL.
2. HORIZONTAL DATUM: WASHINGTON STATE COORDINATE SYSTEM NORTH ZONE (NAD 83/98). VERTICAL DATUM: N.A.V.D. 88 UNITS: U.S. SURVEY FEET HORIZONTAL AND VERTICAL CONTROL ESTABLISHED BY GPS VIA VERTICAL REFERENCE STATION NETWORK (VRSN).
3. SOUTHEAST PORTION OF WSDOT STORM DRAIN LINE HAS NOT BEEN SURVEYED.

CHEVRON ENVIRONMENTAL MANAGEMENT COMPANY
FORMER UNOCAL BULK FUEL TERMINAL
EDMONDS, WASHINGTON
FINAL FEASIBILITY STUDY REPORT

FOURTH QUARTER 2016 GROUNDWATER ELEVATIONS AND CONTOURS OCTOBER 27, 2016

ARCADIS Design & Consultancy for natural and built assets

FIGURE
2-10

CITY: MINNEAPOLIS, MN DIV/GROUP: ENV/CAD DB: R. OBERLANDER LD: R. OBERLANDER PIC:(Opt) PM:(Reqd) TM:(Opt) LYR:(Opt)ON=*;OFF=*REF*
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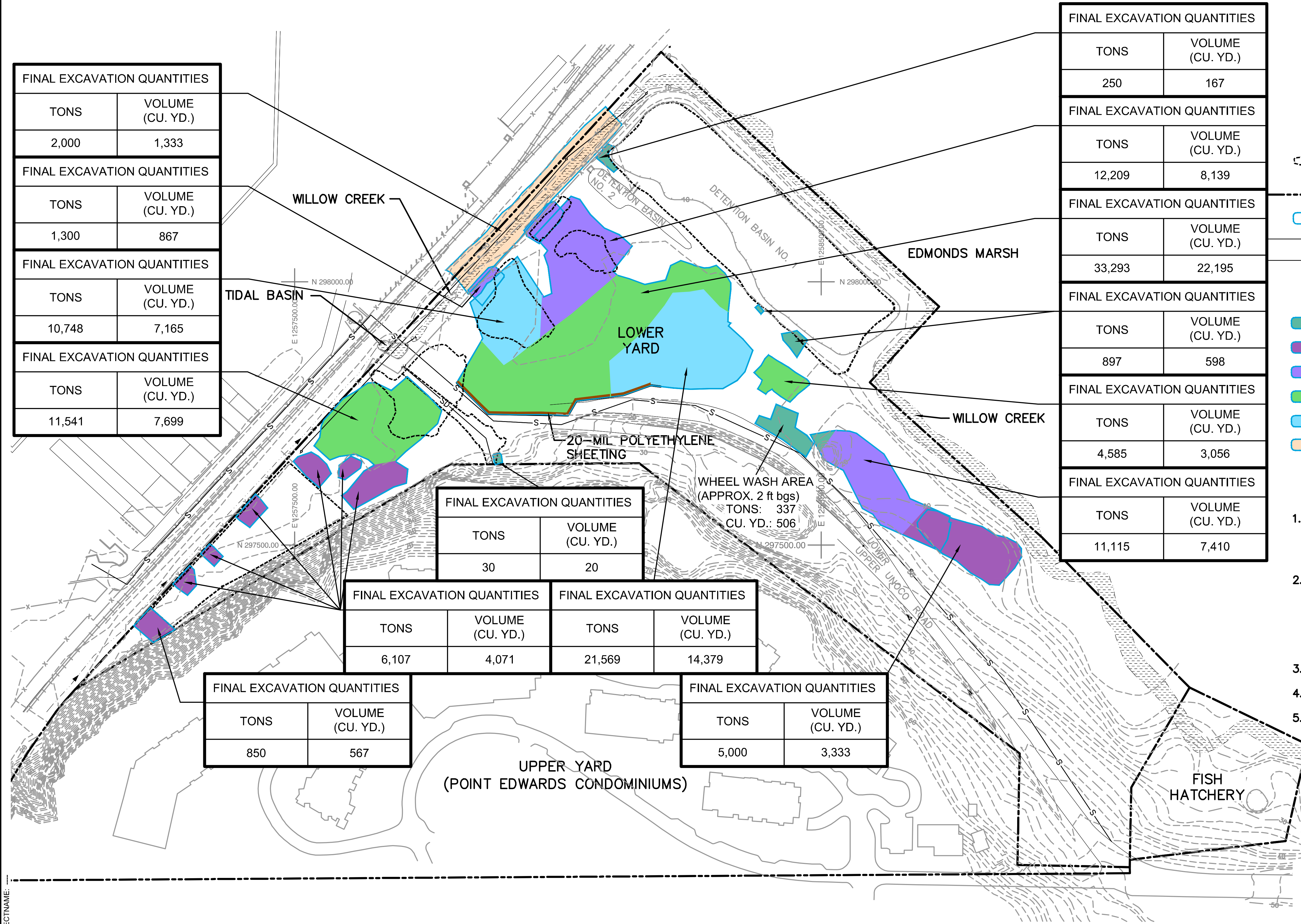
XREFS: 45362X0D 45362X02 45362X03 IMAGES: PROJECTNAME: ----

PUBLIC REVIEW DRAFT



FINAL EXCAVATION QUANTITIES	
TONS	VOLUME (CU. YD.)
2,000	1,333

FINAL EXCAVATION QUANTITIES	
TONS	VOLUME (CU. YD.)
1,300	867

FINAL EXCAVATION QUANTITIES	
TONS	VOLUME (CU. YD.)
10,748	7,165

FINAL EXCAVATION QUANTITIES	
TONS	VOLUME (CU. YD.)
11,541	7,699

FINAL EXCAVATION QUANTITIES	
TONS	VOLUME (CU. YD.)
30	20

FINAL EXCAVATION QUANTITIES	
TONS	VOLUME (CU. YD.)
6,107	4,071

FINAL EXCAVATION QUANTITIES	
TONS	VOLUME (CU. YD.)
21,569	14,379

FINAL EXCAVATION QUANTITIES	
TONS	VOLUME (CU. YD.)
850	567

FINAL EXCAVATION QUANTITIES	
TONS	VOLUME (CU. YD.)
5,000	3,333

FINAL EXCAVATION QUANTITIES	
TONS	VOLUME (CU. YD.)
250	167

FINAL EXCAVATION QUANTITIES	
TONS	VOLUME (CU. YD.)
12,209	8,139

FINAL EXCAVATION QUANTITIES	
TONS	VOLUME (CU. YD.)
33,293	22,195

FINAL EXCAVATION QUANTITIES	
TONS	VOLUME (CU. YD.)
897	598

FINAL EXCAVATION QUANTITIES	
TONS	VOLUME (CU. YD.)
4,585	3,056

FINAL EXCAVATION QUANTITIES	
TONS	VOLUME (CU. YD.)
11,115	7,410

LEGEND:

- 2001 AND 2003 SOIL EXCAVATIONS BELOW GROUNDWATER TABLE
- PROPERTY BOUNDARY
- 2007/2008 EXCAVATION BOUNDARIES
- WSDOT STORMWATER LINE
- POINT EDWARDS STORM DRAIN LINE

BOTTOM OF GRAVEL BACKFILL ELEVATION:

- 8 – 9 FT AMSL
- 6 – 4 FT AMSL
- 4 – 2 FT AMSL
- 2 – 0 FT AMSL
- 0 TO –2 FT AMSL
- WILLOW CREEK SEDIMENT REMOVAL AREA (1 FOOT SCRAPE)

NOTES:

1. 20-MIL POLYETHYLENE SHEETING INSTALLED UPON COMPLETION OF PHASE I EXCAVATION. SHEETING REACHES TO APPROXIMATELY 7.5 FEET ABOVE MEAN SEA LEVEL.
2. HORIZONTAL DATUM: WASHINGTON STATE COORDINATE SYSTEM NORTH ZONE (NAD 83/98).
   VERTICAL DATUM: N.A.V.D. 88
   UNITS: U.S. SURVEY FEET
   HORIZONTAL AND VERTICAL CONTROL ESTABLISHED BY GPS VIA VERTICAL REFERENCE STATION NETWORK (VRSN).
3. CU. YD. = CUBIC YARDS
4. FT AMSL = FEET ABOVE MEAN SEA LEVEL.
5. SOUTHEAST PORTION OF WSDOT STORMWATER LINE HAS NOT BEEN SURVEYED.

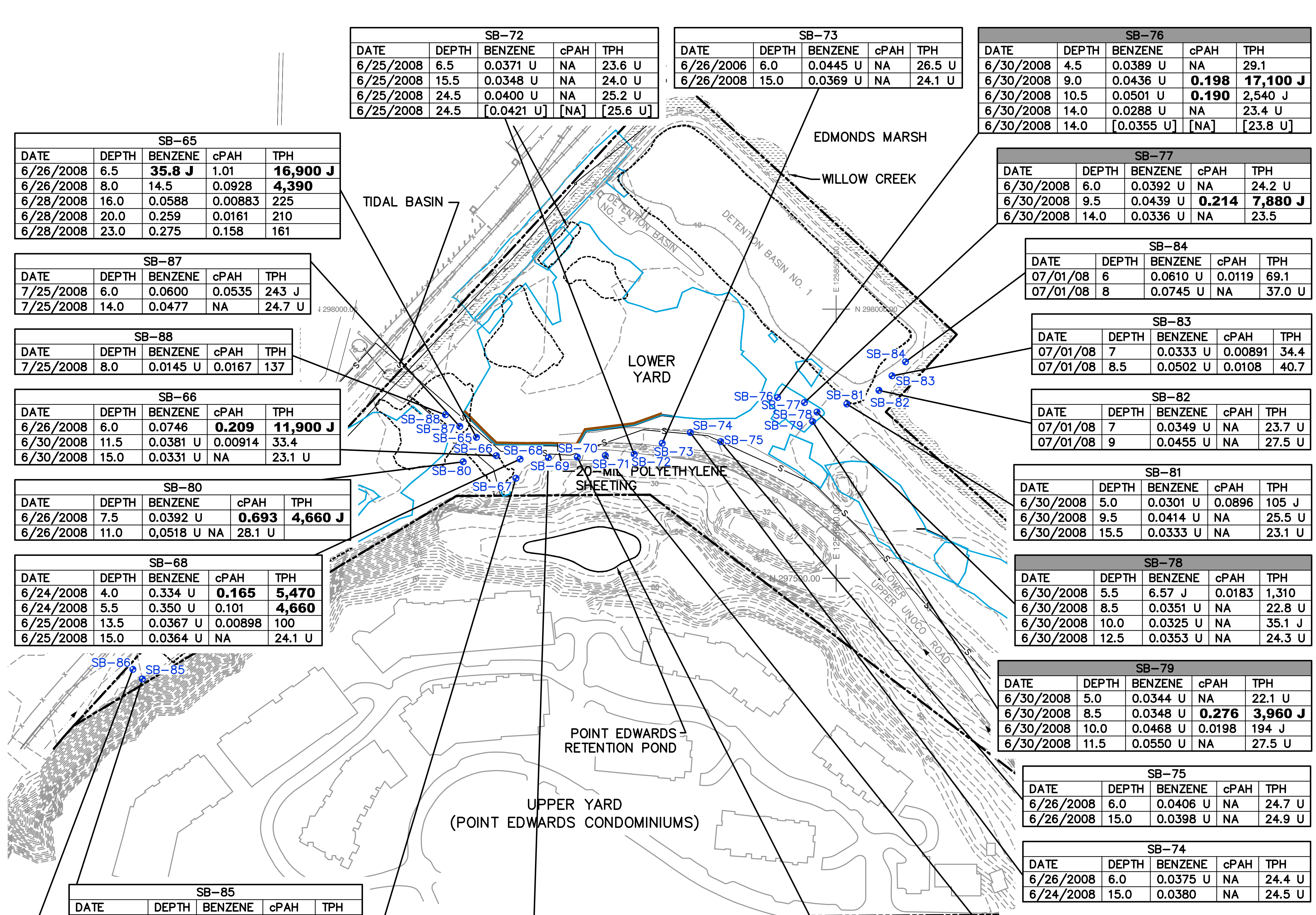
CHEVRON ENVIRONMENTAL MANAGEMENT COMPANY
FORMER UNOCAL BULK FUEL TERMINAL
EDMONDS, WASHINGTON
FINAL FEASIBILITY STUDY REPORT

2007/2008 INTERIM ACTION FINAL EXCAVATION LIMITS AND VOLUMES

ARCADIS Design & Consultancy for natural and built assets

FIGURE 2-11

PUBLIC REVIEW DRAFT



SB-72

DATE	DEPTH	BENZENE	cPAH	TPH
6/25/2008	6.5	0.0371 U	NA	23.6 U
6/25/2008	15.5	0.0348 U	NA	24.0 U
6/25/2008	24.5	0.0400 U	NA	25.2 U
6/25/2008	24.5	[0.0421 U]	[NA]	[25.6 U]

SB-73

DATE	DEPTH	BENZENE	cPAH	TPH
6/26/2006	6.0	0.0445 U	NA	26.5 U
6/26/2008	15.0	0.0369 U	NA	24.1 U

SB-76

DATE	DEPTH	BENZENE	cPAH	TPH
6/30/2008	4.5	0.0389 U	NA	29.1
6/30/2008	9.0	0.0436 U	**0.198**	**17,100 J**
6/30/2008	10.5	0.0501 U	**0.190**	2,540 J
6/30/2008	14.0	0.0288 U	NA	23.4 U
6/30/2008	14.0	[0.0355 U]	[NA]	[23.8 U]

SB-65

DATE	DEPTH	BENZENE	cPAH	TPH
6/26/2008	6.5	**35.8 J**	1.01	**16,900 J**
6/26/2008	8.0	14.5	0.0928	**4,390**
6/28/2008	16.0	0.0588	0.00883	225
6/28/2008	20.0	0.259	0.0161	210
6/28/2008	23.0	0.275	0.158	161

SB-77

DATE	DEPTH	BENZENE	cPAH	TPH
6/30/2008	6.0	0.0392 U	NA	24.2 U
6/30/2008	9.5	0.0439 U	**0.214**	**7,880 J**
6/30/2008	14.0	0.0336 U	NA	23.5

SB-87

DATE	DEPTH	BENZENE	cPAH	TPH
7/25/2008	6.0	0.0600	0.0535	243 J
7/25/2008	14.0	0.0477	NA	24.7 U

SB-84

DATE	DEPTH	BENZENE	cPAH	TPH
07/01/08	6	0.0610 U	0.0119	69.1
07/01/08	8	0.0745 U	NA	37.0 U

SB-88

DATE	DEPTH	BENZENE	cPAH	TPH
7/25/2008	8.0	0.0145 U	0.0167	137

SB-83

DATE	DEPTH	BENZENE	cPAH	TPH
07/01/08	7	0.0333 U	0.00891	34.4
07/01/08	8.5	0.0502 U	0.0108	40.7

SB-66

DATE	DEPTH	BENZENE	cPAH	TPH
6/26/2008	6.0	0.0746	**0.209**	**11,900 J**
6/30/2008	11.5	0.0381 U	0.00914	33.4
6/30/2008	15.0	0.0331 U	NA	23.1 U

SB-82

DATE	DEPTH	BENZENE	cPAH	TPH
07/01/08	7	0.0349 U	NA	23.7 U
07/01/08	9	0.0455 U	NA	27.5 U

SB-80

DATE	DEPTH	BENZENE	cPAH	TPH
6/26/2008	7.5	0.0392 U	**0.693**	**4,660 J**
6/26/2008	11.0	0.0518 U NA	28.1 U	

SB-81

DATE	DEPTH	BENZENE	cPAH	TPH
6/30/2008	5.0	0.0301 U	0.0896	105 J
6/30/2008	9.5	0.0414 U	NA	25.5 U
6/30/2008	15.5	0.0333 U	NA	23.1 U

SB-68

DATE	DEPTH	BENZENE	cPAH	TPH
6/24/2008	4.0	0.334 U	**0.165**	**5,470**
6/24/2008	5.5	0.350 U	0.101	**4,660**
6/25/2008	13.5	0.0367 U	0.00898	100
6/25/2008	15.0	0.0364 U	NA	24.1 U

SB-78

DATE	DEPTH	BENZENE	cPAH	TPH
6/30/2008	5.5	6.57 J	0.0183	1,310
6/30/2008	8.5	0.0351 U	NA	22.8 U
6/30/2008	10.0	0.0325 U	NA	35.1 J
6/30/2008	12.5	0.0353 U	NA	24.3 U

SB-79

DATE	DEPTH	BENZENE	cPAH	TPH
6/30/2008	5.0	0.0344 U	NA	22.1 U
6/30/2008	8.5	0.0348 U	**0.276**	**3,960 J**
6/30/2008	10.0	0.0468 U	0.0198	194 J
6/30/2008	11.5	0.0550 U	NA	27.5 U

SB-75

DATE	DEPTH	BENZENE	cPAH	TPH
6/26/2008	6.0	0.0406 U	NA	24.7 U
6/26/2008	15.0	0.0398 U	NA	24.9 U

SB-74

DATE	DEPTH	BENZENE	cPAH	TPH
6/26/2008	6.0	0.0375 U	NA	24.4 U
6/24/2008	15.0	0.0380	NA	24.5 U

SB-85

DATE	DEPTH	BENZENE	cPAH	TPH
7/02/2008	5.5	0.0357 U	0.0225	92.5
7/02/2008	7.5	0.114 U	NA	214 U

SB-71

DATE	DEPTH	BENZENE	cPAH	TPH
6/25/2008	8.0	0.0368 U	NA	23.6 U
6/25/2008	15.5	0.0363 U	0.00876	50.9
6/25/2008	24.0	0.0366 U	NA	23.7 U

SB-86

DATE	DEPTH	BENZENE	cPAH	TPH
7/02/2008	4.5	0.0324 U	0.0182	112 J
7/02/2008	6.5	0.0513 U	NA	29.1 U

SB-69

DATE	DEPTH	BENZENE	cPAH	TPH
6/26/2008	6.0	0.149 J	**0.236**	**3,720**
6/26/2008	12.0	0.0385 U	NA	24.0 U
6/26/2008	15.0	0.0393 U	NA	24.1 U
6/26/2008	15.0	[0.0384 U]	NA	[32.6]

SB-70

DATE	DEPTH	BENZENE	cPAH	TPH
6/24/2008	6.0	0.0371 U	NA	22.1 U
6/24/2008	7.0	0.0369 U	NA	23.2 U
6/25/2008	12.5	0.0366 U	NA	23.4 U
6/25/2008	20.5	0.0340 U	NA	23.4 U

SB-67

DATE	DEPTH	BENZENE	cPAH	TPH
6/24/2008	5.5	0.0398 U	NA	24.1 U

LEGEND:

- 2001 AND 2003 SOIL EXCAVATIONS BELOW GROUNDWATER TABLE
- PROPERTY BOUNDARY
- 2007/2008 EXCAVATION BOUNDARIES
- S — WSDOT STORMWATER LINE
- SD — POINT EDWARDS STORM DRAIN LINE
- SOIL BORING/HAND AUGER LOCATION
- cPAH — CARCINOGENIC POLYNUCLEAR AROMATIC HYDROCARBONS, ADJUSTED FOR TOXICITY
- TPH — TOTAL PETROLEUM HYDROCARBONS
- [ ] — VALUES SHOWN IN BRACKETS INDICATE DUPLICATE RESULTS
- NA — INDICATES ANALYSIS NOT CONDUCTED
- U — THE COMPOUND WAS ANALYZED FOR BUT NOT DETECTED. THE ASSOCIATED VALUE IS THE COMPOUND QUANTITATION LIMIT
- J — INDICATES AN ESTIMATED VALUE
- ALL DATA REPORTED AS MILLIGRAMS PER KILOGRAMS (mg/kg)
- SAMPLE DEPTHS REPORTED AS FEET BELOW GROUND SURFACE (ft bgs)
- BOLDED DATA INDICATES CONCENTRATIONS GREATER THAN APPLICABLE SITE CULs/RELs
- SAMPLE WAS COLLECTED WITHIN THE 2007/2008 EXCAVATION BOUNDARIES

NOTES:

1. 20-MIL POLYETHYLENE SHEETING INSTALLED UPON COMPLETION OF PHASE I OF THE 2007/2008 EXCAVATION. SHEETING REACHES TO APPROXIMATELY 7.5 FEET ABOVE MEAN SEA LEVEL.
2. HORIZONTAL DATUM: WASHINGTON STATE COORDINATE SYSTEM NORTH ZONE (NAD 83/98). VERTICAL DATUM: N.A.V.D. 88 UNITS: U.S. SURVEY FEET HORIZONTAL AND VERTICAL CONTROL ESTABLISHED BY GPS VIA VERTICAL REFERENCE STATION NETWORK (VRSN).
3. SOUTHEAST PORTION OF WSDOT STORMWATER LINE HAS NOT BEEN SURVEYED.

0 200' 400'
GRAPHIC SCALE

CHEVRON ENVIRONMENTAL MANAGEMENT COMPANY
FORMER UNOCAL BULK FUEL TERMINAL
EDMONDS, WASHINGTON
FINAL FEASIBILITY STUDY REPORT

2008 SITE INVESTIGATION SAMPLE LOCATIONS AND ANALYTICAL RESULTS

ARCADIS Design & Consultancy for natural and built assets

FIGURE
2-12

CITY: MINNEAPOLIS, MN DIV/GROUP: ENV/CAD DB: R. OBERLANDER LD: R. OBERLANDER PIC:(Opt) PM:(Reqd) TM:(Opt) LYR:(Opt)ON=*;OFF=*REF* G:\ENVCAD\Minneapolis-MN\ACT\B0045362\0007\00002\2017 FS\DWG\45362D02-12.dwg LAYOUT: 2-12 SAVED: 12/13/2016 11:39 AM ACADVER: 19.1S (LMS TECH) PAGESETUP: ---- PLOTSTYLETABLE: ---- PLOTTED: 12/13/2016 11:39 AM BY: OBERLANDER, ROSEANNE
XREFS: 45362X02 45362X03 45362X0D IMAGES: PROJECTNAME: ----

PUBLIC REVIEW DRAFT

B-12 8/24/2011		
Sample Depth	Total cPAHs	Total TPH
0.5–1	0.0117	299
1–1.5	0.00072 UU	254
2.5–3	0.079	248
3.5–4	0.00063	33

B-14 8/25/2011		
Sample Depth	Total cPAHs	Total TPH
0.5–1	0.029	155
1.5–2	NA	6 UU
2.5–3	NA	24 UU
3.5–4	0.0009	98

B-15 8/23/2011		
Sample Depth	Total cPAHs	Total TPH
4.5–5	0.0005	22
6.5–7	NA	20
8.5–9	0.0008	63
11–11.5	NA	16 UU

B-13/P-15 8/23/2011		
Sample Depth	Total cPAHs	Total TPH
4.5–5	0.0046	81
6–6.5	0.036	368
7–7.5	0.054 R	**15,900**
9–9.5	NA	9 UU
10–10.5	0.026	2,150
11.5–12	NA	9 UU

B-10 8/25/2011		
Sample Depth	Total cPAHs	Total TPH
0.5–1	**0.2**	758
1.5–2	0.018	86
2.5–3	0.00068 UU	37
3.5–4	0.00072	57

B-16/P-16 8/24/2011		
Sample Depth	Total cPAHs	Total TPH
3.5–4	0.018	386
4–4.5	**0.1**	1,290
4.5–5	0.00123	11
6–6.5	NA	9 UU

B-17 8/24/2011		
Sample Depth	Total cPAHs	Total TPH
3.5–4	0.00109	1,756
4–4.5	0.0008 UU	**22,201**
4.5–5	**116 R**	268
5.5–6	NA	18 UU

B-11/P-14 8/23/2011		
Sample Depth	Total cPAHs	Total TPH
4.5–5	**0.24**	1,011
7.5–8	0.012	**35,240**
8.5–9	0.012	53
9.5–10	**1.6 T**	12
10–10.5	**3.4**	**37,150**
11–11.5	0.01	461
13.5–14	NA	8 UU

B-5/P-10 8/22/2011		
Sample Depth	Total cPAHs	Total TPH
4.5–5	NA	8 UU
9–9.5	0.0138	**27,021**
11.5–12	NA	9 UU
13.5–14	NA	8 UU

B-9/P-13 8/23/2011		
Sample Depth	Total cPAHs	Total TPH
4.5–5	NA	29
8.5–9	**0.29**	**20,970**
9.5–10	0.0024	30
10.5–11	0.025	921
11–11.5	**0.15 T**	**16,250**
12.5–13	0.00065	15

B-3 8/22/2011		
Sample Depth	Total cPAHs	Total TPH
4.5–5	NA	8 UU
7–7.5	0.00076	181
12–12.5	0.00077	96
14–14.5	NA	8

B-1/P-9 8/22/2011		
Sample Depth	Total cPAHs	Total TPH
4.5–5	0.00052	16
9.5–10	0.0082	72
14–14.5	NA	11 UU

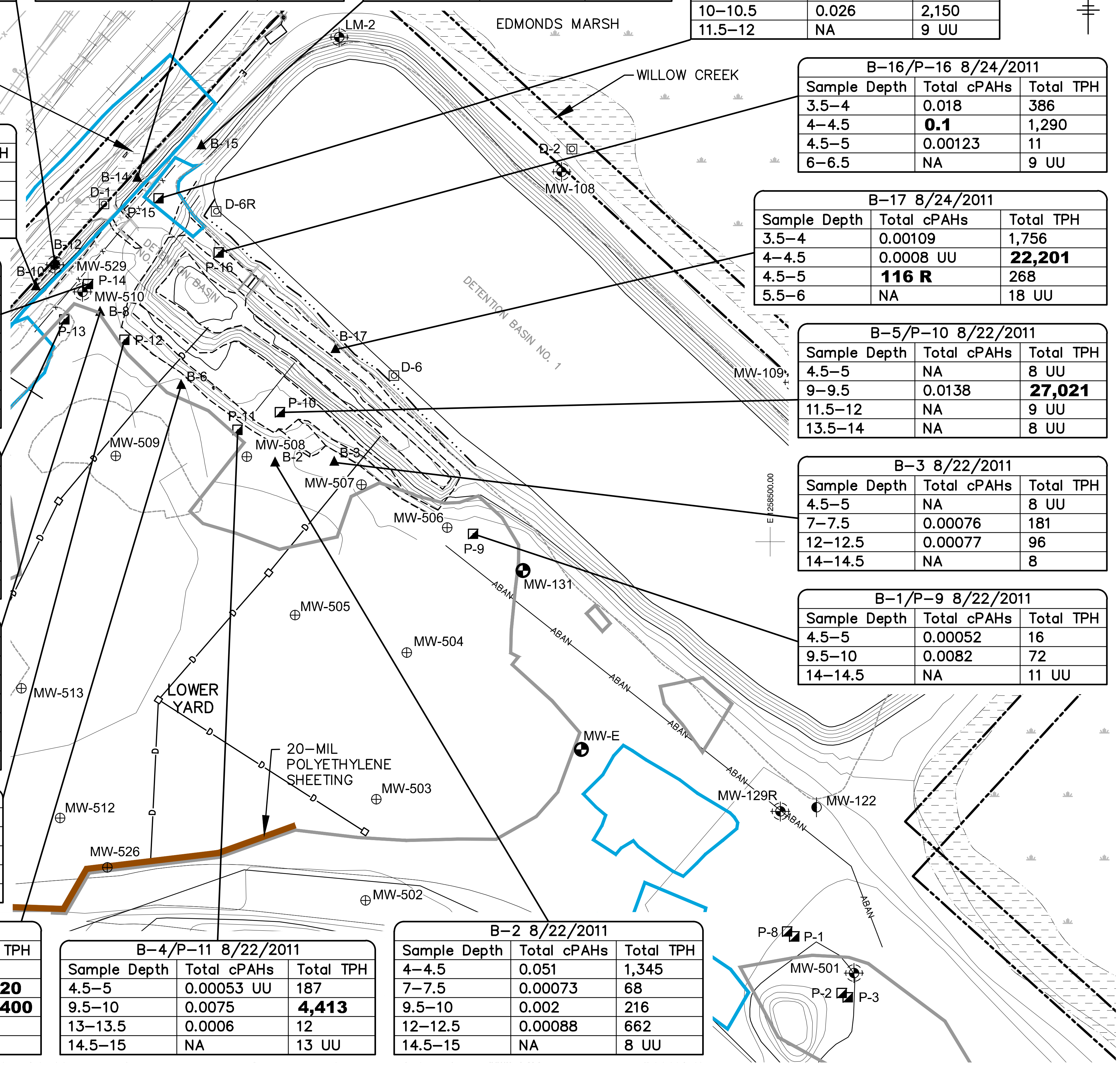
B-8 8/23/2011		
Sample Depth	Total cPAHs	Total TPH
4.5–5	0.114	**16,500**
7.5–8	0.077	**9,360**
9.5–10	**0.5 T**	**75,730**
11–11.5	0.09	**8,200**
13.5–14	**0.1**	55
14.5–15	NA	8 UU

B-7/P-12 8/22/2011		
Sample Depth	Total cPAHs	Total TPH
4.5–5	0.071	700
8–8.5	**2.8 T**	**111,400**
9.5–10	0.037 T	**5,947**
14–14.5	NA	8 UU

B-6 8/22/2011		
Sample Depth	Total cPAHs	Total TPH
4.5–5	0.09	970
7–7.5	**0.36**	**21,620**
9–9.5	**3.2 T**	**220,400**
11–11.5	0.012	317
13–13.5	NA	8 UU

B-4/P-11 8/22/2011		
Sample Depth	Total cPAHs	Total TPH
4.5–5	0.00053 UU	187
9.5–10	0.0075	**4,413**
13–13.5	0.0006	12
14.5–15	NA	13 UU

B-2 8/22/2011		
Sample Depth	Total cPAHs	Total TPH
4–4.5	0.051	1,345
7–7.5	0.00073	68
9.5–10	0.002	216
12–12.5	0.00088	662
14.5–15	NA	8 UU



LEGEND:

- MW-203 ⊕ INTERIOR MONITORING WELL LOCATION AND DESIGNATION
- MW-122 DEEP MONITORING WELL LOCATION AND DESIGNATION
- MW-301 MONITORING WELL
- MW-109 PERIMETER MONITORING WELL LOCATION
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- 2001 AND 2003 SOIL EXCAVATIONS BELOW GROUNDWATER TABLE
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- 2007/2008 EXCAVATION BOUNDARIES
- —S— WSDOT STORMWATER LINE
- —SD— POINT EDWARDS STORM DRAIN LINE

LOCATION ID SAMPLE DATE		
Sample Depth	Total cPAHs	Total TPH
Depth in feet below ground surface	Total carcinogenic polynuclear aromatic hydrocarbons (mg/kg)	Total petroleum hydrocarbons (mg/kg)

THE CONSTITUENTS MAKING UP THE TOTAL ARE ALL NON-DETECTS

UU – REPORTING LIMITS WERE RAISED DUE TO INTERFERENCE FROM THE SAMPLE MATRIX
T – THE GC/MS SEMIVOLATILE INTERNAL STANDARD PEAK AREAS WERE OUTSIDE OF THE QC LIMITS FOR BOTH
R – THE INITIAL INJECTION AND THE RE-INJECTION ANALYSIS NOT CONDUCTED
MILLIGRAMS PER KILOGRAM
NA – BOLD CONCENTRATIONS REPRESENT EXCEEDANCE OF
mg/kg – SITE CLEAN-UP LEVELS

NOTES:

1. 20-MIL POLYETHYLENE SHEETING INSTALLED UPON COMPLETION OF PHASE I EXCAVATION. SHEETING REACHES TO APPROXIMATELY 7.5 FEET ABOVE MEAN SEA LEVEL.
2. HORIZONTAL DATUM: WASHINGTON STATE COORDINATE SYSTEM NORTH ZONE (NAD 83/98). VERTICAL DATUM: N.A.V.D. 88 UNITS: U.S. SURVEY FEET HORIZONTAL AND VERTICAL CONTROL ESTABLISHED BY GPS VIA VERTICAL REFERENCE STATION NETWORK (VRSN).
3. SOUTHEAST PORTION OF WSDOT STORMWATER LINE HAS NOT BEEN SURVEYED.

0 80' 160'

GRAPHIC SCALE

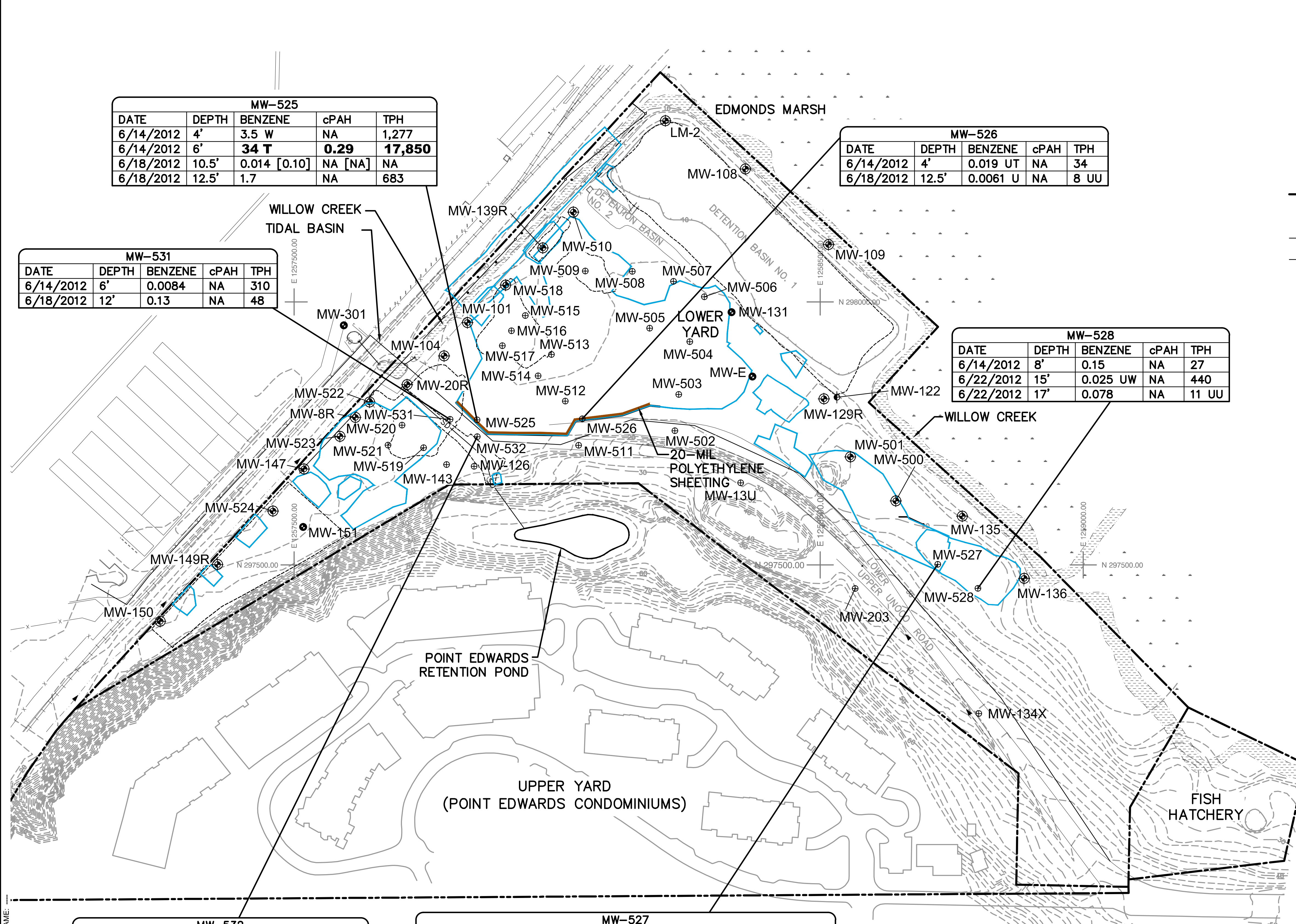
CHEVRON ENVIRONMENTAL MANAGEMENT COMPANY
FORMER UNOCAL BULK FUEL TERMINAL
EDMONDS, WASHINGTON
FINAL FEASIBILITY STUDY REPORT

2011 SITE INVESTIGATION SOIL SAMPLE LOCATIONS AND ANALYTICAL RESULTS

ARCADIS Design & Consultancy for natural and built assets

FIGURE
2-13

CITY: MINNEAPOLIS, MN DIV/GROUP: ENV/CAD DB: R. OBERLANDER LD: R. OBERLANDER PIC:(Opt) PM:(Reqd) TM:(Opt) LYR:(Opt)ON=*;OFF=*REF* G:\ENVCAD\Minneapolis-MN\ACT\B0045362\0007\00002\2017 FS\DWG\45362D02-13.dwg LAYOUT: 2-13 SAVED: 1/30/2017 1:22 PM ACADVER: 19.1S (LMS TECH) PAGESETUP: --- PLOTSTYLETABLE: --- PLOTTED: 1/30/2017 1:22 PM BY: OBERLANDER, ROSEANNE
XREFS: 45362X01 45362X02 45362X03 45362X0D IMAGES: PROJECTNAME: ---



MW-525				
DATE	DEPTH	BENZENE	cPAH	TPH
6/14/2012	4'	3.5 W	NA	1,277
6/14/2012	6'	**34 T**	**0.29**	**17,850**
6/18/2012	10.5'	0.014 [0.10]	NA [NA]	NA
6/18/2012	12.5'	1.7	NA	683

MW-526				
DATE	DEPTH	BENZENE	cPAH	TPH
6/14/2012	4'	0.019 UT	NA	34
6/18/2012	12.5'	0.0061 U	NA	8 UU

MW-531				
DATE	DEPTH	BENZENE	cPAH	TPH
6/14/2012	6'	0.0084	NA	310
6/18/2012	12'	0.13	NA	48

MW-528				
DATE	DEPTH	BENZENE	cPAH	TPH
6/14/2012	8'	0.15	NA	27
6/22/2012	15'	0.025 UW	NA	440
6/22/2012	17'	0.078	NA	11 UU

MW-532				
DATE	DEPTH	BENZENE	cPAH	TPH
6/18/2012	6'	0.084 U	NA	1,499
6/18/2012	7'	0.16 UT	0.04	**10,540**
6/18/2012	10'	0.0079 U	NA	11 UU
6/18/2012	13.5'	0.0066 UU	NA	1,681

MW-527				
DATE	DEPTH	BENZENE	cPAH	TPH
6/14/2012	8'	0.02	NA	352
6/22/2012	9'	0.053 UW	NA	636
6/22/2012	12'	0.11 UW	NA	716
6/22/2012	13.5'	0.11 UW	NA	1,621
6/22/2012	17'	0.068 UW [0.070 UW]	NA [NA]	15 UU [15 UU]

LEGEND:

- MW-203 ⊕ INTERIOR MONITORING WELL LOCATION AND DESIGNATION
- MW-301 MONITORING WELL
- MW-122 DEEP MONITORING WELL LOCATION AND DESIGNATION
- MW-109 PERIMETER MONITORING WELL LOCATION
- 2001 AND 2003 SOIL EXCAVATIONS BELOW GROUNDWATER TABLE
- PROPERTY BOUNDARY
- 2007/2008 EXCAVATION BOUNDARIES
- S WSDOT STORMWATER LINE
- SD POINT EDWARDS STORM DRAIN LINE
- cPAH CARCINOGENIC POLYNUCLEAR AROMATIC HYDROCARBONS, ADJUSTED FOR TOXICITY
- TPH TOTAL PETROLEUM HYDROCARBONS
- [ ] VALUES SHOWN IN BRACKETS INDICATE DUPLICATE RESULTS
- NA INDICATES ANALYSIS NOT CONDUCTED
- U THE COMPOUND WAS ANALYZED FOR BUT NOT DETECTED. THE ASSOCIATED VALUE IS THE COMPOUND QUANTITATION LIMIT
- UU THE CONSTITUENTS MAKING UP THE TOTAL ARE ALL NON-DETECTS
- J INDICATES AN ESTIMATED VALUE
- W REPORTING LIMITS WERE RAISED DUE TO SAMPLE FOAMING
- T REPORTING LIMITS WERE RAISED DUE TO INTERFERENCE FROM THE SAMPLE MATRIX

ALL DATA REPORTED AS MILLIGRAMS PER KILOGRAMS (mg/kg)

SAMPLE DEPTHS REPORTED AS FEET BELOW GROUND SURFACE (ft bgs)

BOLDED DATA INDICATES CONCENTRATIONS GREATER THAN APPLICABLE SITE CULs/RELs

NOTES:

1. 20-MIL POLYETHYLENE SHEETING INSTALLED UPON COMPLETION OF PHASE I EXCAVATION. SHEETING REACHES TO APPROXIMATELY 7.5 FEET ABOVE MEAN SEA LEVEL.
2. HORIZONTAL DATUM: WASHINGTON STATE COORDINATE SYSTEM NORTH ZONE (NAD 83/98). VERTICAL DATUM: N.A.V.D. 88 UNITS: U.S. SURVEY FEET HORIZONTAL AND VERTICAL CONTROL ESTABLISHED BY GPS VIA VERTICAL REFERENCE STATION NETWORK (VRSN).
3. SOUTHEAST PORTION OF WSDOT STORMWATER LINE HAS NOT BEEN SURVEYED.

0 200' 400'
GRAPHIC SCALE

CHEVRON ENVIRONMENTAL MANAGEMENT COMPANY
FORMER UNOCAL BULK FUEL TERMINAL
EDMONDS, WASHINGTON
FINAL FEASIBILITY STUDY REPORT

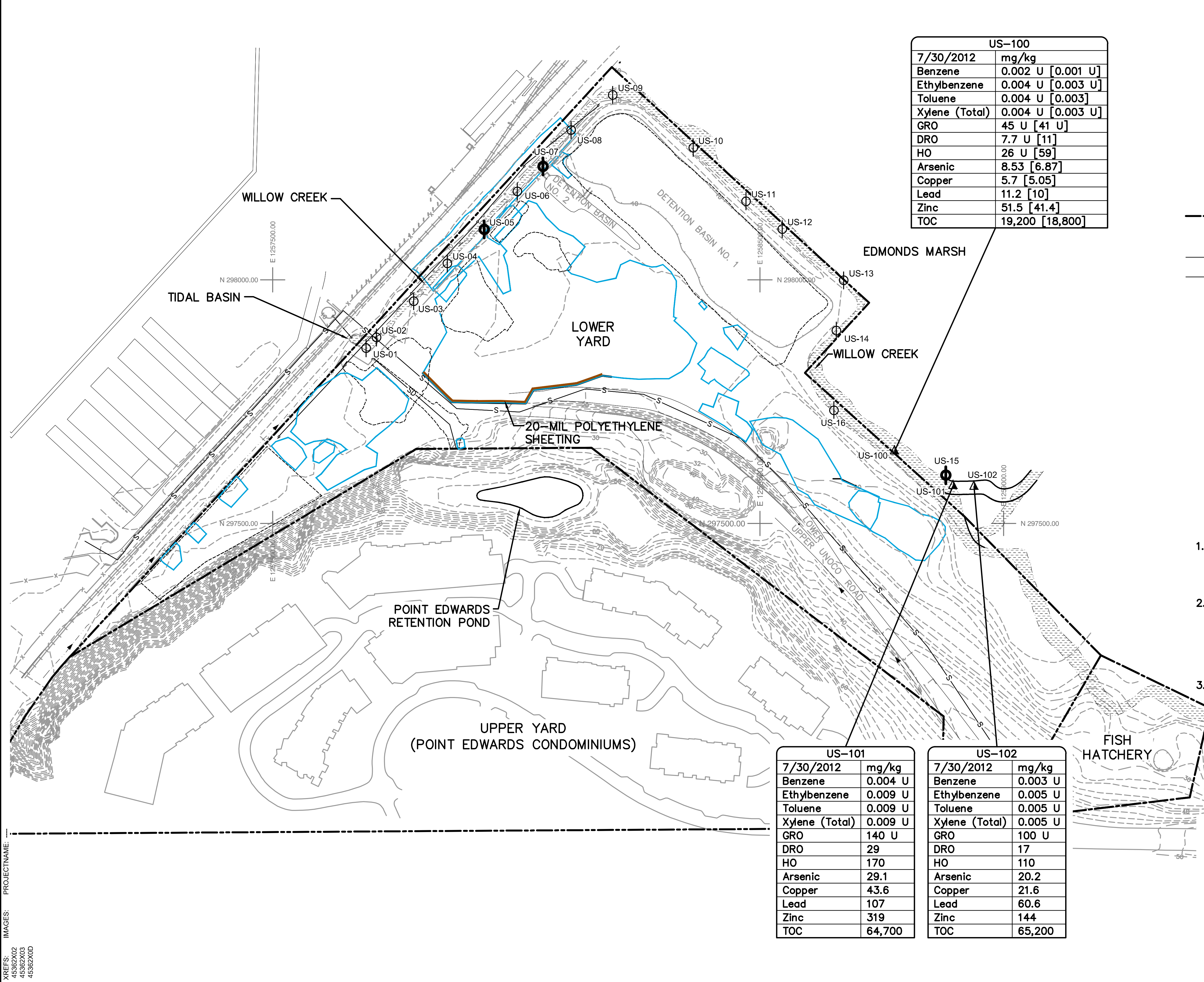
2012 SOIL SAMPLE LOCATIONS AND ANALYTICAL RESULTS

ARCADIS Design & Consultancy for natural and built assets

FIGURE
2-14

CITY: MINNEAPOLIS, MN DIV/GROUP: ENV/CAD DB: R. OBERLANDER LD: R. OBERLANDER PIC:(Opt) PM:(Reqd) TM:(Opt) LYR:(Opt)ON=*;OFF=*REF* G:\ENVCAD\Minneapolis-MN\ACT\B0045362\0007\00002\2017 FS\DWG\45362D02-14.dwg LAYOUT: 2-14 SAVED: 1/31/2017 8:40 AM ACADVER: 19.1S (LMS TECH) PAGESETUP: --- PLOTSTYLETABLE: --- PLOTTED: 1/31/2017 8:40 AM BY: OBERLANDER, ROSEANNE
XREFS: 45362X02 45362X03 45362X0D IMAGES: PROJECTNAME: ---

PUBLIC REVIEW DRAFT



US-100	
7/30/2012	mg/kg
Benzene	0.002 U [0.001 U]
Ethylbenzene	0.004 U [0.003 U]
Toluene	0.004 U [0.003]
Xylene (Total)	0.004 U [0.003 U]
GRO	45 U [41 U]
DRO	7.7 U [11]
HO	26 U [59]
Arsenic	8.53 [6.87]
Copper	5.7 [5.05]
Lead	11.2 [10]
Zinc	51.5 [41.4]
TOC	19,200 [18,800]

US-101	
7/30/2012	mg/kg
Benzene	0.004 U
Ethylbenzene	0.009 U
Toluene	0.009 U
Xylene (Total)	0.009 U
GRO	140 U
DRO	29
HO	170
Arsenic	29.1
Copper	43.6
Lead	107
Zinc	319
TOC	64,700

US-102	
7/30/2012	mg/kg
Benzene	0.003 U
Ethylbenzene	0.005 U
Toluene	0.005 U
Xylene (Total)	0.005 U
GRO	100 U
DRO	17
HO	110
Arsenic	20.2
Copper	21.6
Lead	60.6
Zinc	144
TOC	65,200

LEGEND:

- 2001 AND 2003 SOIL EXCAVATIONS BELOW GROUNDWATER TABLE
- PROPERTY BOUNDARY
- 2007/2008 EXCAVATION BOUNDARIES
- WSDOT STORMWATER LINE
- POINT EDWARDS STORM DRAIN LINE
- SEDIMENT SAMPLE LOCATIONS (2003)
- SEDIMENT SAMPLE LOCATIONS (2012)
- BOLDED SEDIMENT SAMPLE LOCATIONS INDICATE FAILED BIOASSAY TESTING IN 2003.

GRO = Total petroleum hydrocarbons in the gasoline range
DRO = Total petroleum hydrocarbons in the diesel range
HO = Total petroleum hydrocarbons in the heavy oil range
TOC = Total Organic Carbon
U = Indicates the value was below the Method Detection Limit.
[ ] = Duplicate results are shown in brackets

NOTES:

1. 20-MIL POLYETHYLENE SHEETING INSTALLED UPON COMPLETION OF PHASE I EXCAVATION. SHEETING REACHES TO APPROXIMATELY 7.5 FEET ABOVE MEAN SEA LEVEL.
2. HORIZONTAL DATUM: WASHINGTON STATE COORDINATE SYSTEM NORTH ZONE (NAD 83/98).
VERTICAL DATUM: N.A.V.D. 88
UNITS: U.S. SURVEY FEET
HORIZONTAL AND VERTICAL CONTROL ESTABLISHED BY GPS VIA VERTICAL REFERENCE STATION NETWORK (VRSN).
3. SOUTHEAST PORTION OF WSDOT STORMWATER LINE HAS NOT BEEN SURVEYED.

0 200' 400'
GRAPHIC SCALE

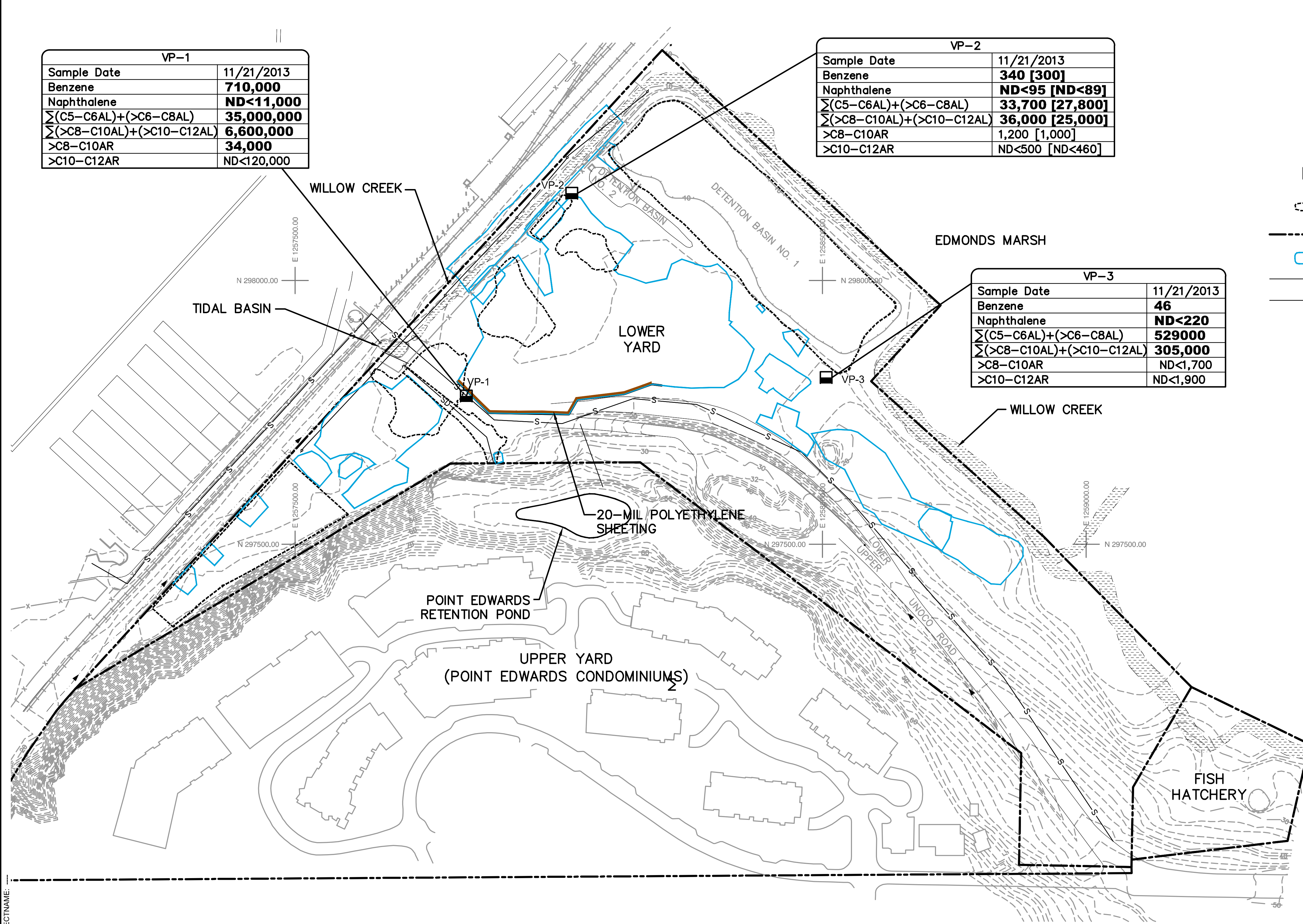
CHEVRON ENVIRONMENTAL MANAGEMENT COMPANY
FORMER UNOCAL BULK FUEL TERMINAL
EDMONDS, WASHINGTON
FINAL FEASIBILITY STUDY REPORT

SEDIMENT SAMPLING LOCATIONS AND 2012 ANALYTICAL RESULTS

ARCADIS Design & Consultancy for natural and built assets

FIGURE
2-15

PUBLIC REVIEW DRAFT



VP-1	
Sample Date	11/21/2013
Benzene	**710,000**
Naphthalene	**ND<11,000**
∑(C5–C6AL)+(>C6–C8AL)	**35,000,000**
∑(>C8–C10AL)+(>C10–C12AL)	**6,600,000**
>C8–C10AR	**34,000**
>C10–C12AR	ND<120,000

VP-2	
Sample Date	11/21/2013
Benzene	**340 [300]**
Naphthalene	**ND<95 [ND<89]**
∑(C5–C6AL)+(>C6–C8AL)	**33,700 [27,800]**
∑(>C8–C10AL)+(>C10–C12AL)	**36,000 [25,000]**
>C8–C10AR	1,200 [1,000]
>C10–C12AR	ND<500 [ND<460]

VP-3	
Sample Date	11/21/2013
Benzene	**46**
Naphthalene	**ND<220**
∑(C5–C6AL)+(>C6–C8AL)	**529000**
∑(>C8–C10AL)+(>C10–C12AL)	**305,000**
>C8–C10AR	ND<1,700
>C10–C12AR	ND<1,900

LEGEND:

- SOIL VAPOR PROBE/SAMPLING LOCATION
- 2001 AND 2003 SOIL EXCAVATIONS BELOW GROUNDWATER TABLE
- PROPERTY BOUNDARY
- 2007/2008 EXCAVATION BOUNDARIES
- S — WSDOT STORMWATER LINE
- SD — POINT EDWARDS STORM DRAIN LINE

AL = vapor phase hydrocarbon aliphatic carbon range
AR = vapor phase hydrocarbon aromatic carbon range
<ND = Non-detect, value listed is laboratory reporting limit.
[ ] = Duplicate results are shown in brackets
bgs = below ground surface

All results are in micrograms per cubic meter (µg/m3).
All samples were collected from soil vapor probes installed at 5 feet bgs.
Bolded cells indicate detected concentrations above the Ecology Method B Screening.
Level for sample locations just beneath a building or less than 15 feet bgs.

NOTES:

1. 20-MIL POLYETHYLENE SHEETING INSTALLED UPON COMPLETION OF PHASE I EXCAVATION. SHEETING REACHES TO APPROXIMATELY 7.5 FEET ABOVE MEAN SEA LEVEL.
2. HORIZONTAL DATUM: WASHINGTON STATE COORDINATE SYSTEM NORTH ZONE (NAD 83/98). VERTICAL DATUM: N.A.V.D. 88 UNITS: U.S. SURVEY FEET HORIZONTAL AND VERTICAL CONTROL ESTABLISHED BY GPS VIA VERTICAL REFERENCE STATION NETWORK (VRSN).
3. SOUTHEAST PORTION OF WSDOT STORMWATER LINE HAS NOT BEEN SURVEYED.

0 200' 400'
GRAPHIC SCALE

CHEVRON ENVIRONMENTAL MANAGEMENT COMPANY
FORMER UNOCAL BULK FUEL TERMINAL
EDMONDS, WASHINGTON
FINAL FEASIBILITY STUDY REPORT

2013 SOIL VAPOR SAMPLE LOCATIONS AND ANALYTICAL RESULTS

ARCADIS Design & Consultancy for natural and built assets

FIGURE **2-16**

CITY: MINNEAPOLIS, MN DIV/GROUP: ENV/CAD DB: R. OBERLANDER LD: R. OBERLANDER PIC:(Opt) PM:(Reqd) TM:(Opt) LYR:(Opt)ON=*;OFF=*REF* G:\ENVCAD\Minneapolis-MN\ACT\B0045362\0007\00002\2017 FS\DWG\45362D02-16.dwg LAYOUT: 2-16 SAVED: 12/13/2016 11:43 AM ACADVER: 19.1S (LMS TECH) PAGESETUP: ---- PLOTSTYLETABLE: ---- PLOTTED: 12/13/2016 11:43 AM BY: OBERLANDER, ROSEANNE
XREFS: 45362X02 45362X03 45362X0D IMAGES: PROJECTNAME: ----

PUBLIC REVIEW DRAFT

LEGEND:

- 2001 AND 2003 SOIL EXCAVATIONS BELOW GROUNDWATER TABLE
- PROPERTY BOUNDARY
- 2007/2008 EXCAVATION BOUNDARIES
- S — WSDOT STORMWATER LINE
- SD — POINT EDWARDS STORM DRAIN LINE
- >500 μg/L
- >700 μg/L
- >900 μg/L
- LIGHT NONAQUEOUS PHASE LIQUID (LNAPL)

NOTES:

1. μg/L = MICROGRAMS PER LITER.
2. TOTAL TPH CONCENTRATIONS BASED ON SEPTEMBER 2006 SAMPLING EVENT RESULTS.
3. 20-MIL POLYETHYLENE SHEETING INSTALLED UPON COMPLETION OF PHASE I EXCAVATION. SHEETING REACHES TO APPROXIMATELY 7.5 FEET ABOVE MEAN SEA LEVEL.
4. HORIZONTAL DATUM: WASHINGTON STATE COORDINATE SYSTEM NORTH ZONE (NAD 83/98). VERTICAL DATUM: N.A.V.D. 88 UNITS: U.S. SURVEY FEET HORIZONTAL AND VERTICAL CONTROL ESTABLISHED BY GPS VIA VERTICAL REFERENCE STATION NETWORK (VRSN).
5. SOUTEAST PORTION OF WSDOT STORMWATER LINE HAS NOT BEEN SURVEYED.

0 200' 400'
GRAPHIC SCALE

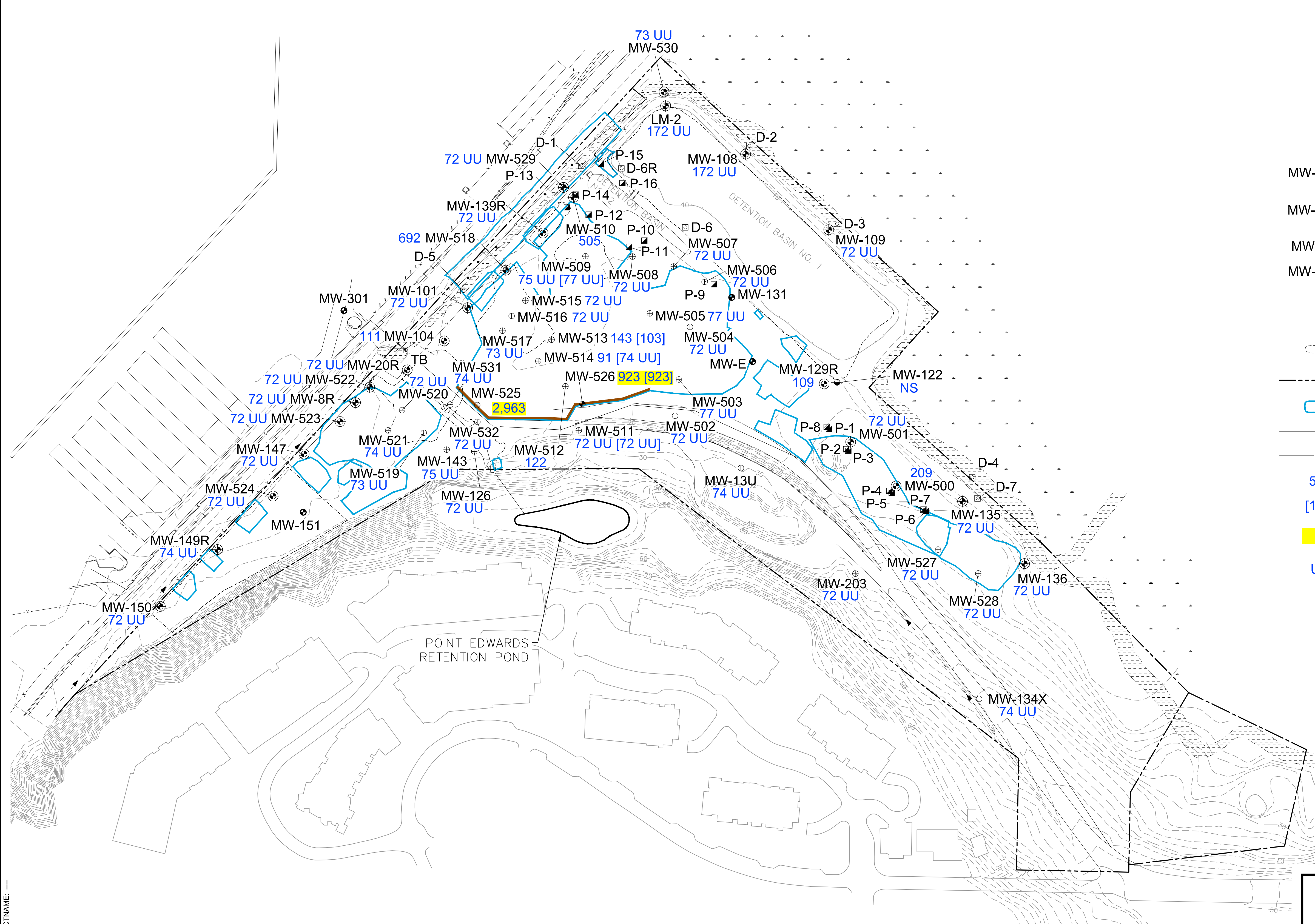
CHEVRON ENVIRONMENTAL MANAGEMENT COMPANY
FORMER UNOCAL BULK FUEL TERMINAL
EDMONDS, WASHINGTON
FINAL FEASIBILITY STUDY REPORT

PRE-REMEDIATION DISSOLVED TOTAL PETROLEUM HYDROCARBON CONCENTRATION AND LNAPL MAP (2006)

ARCADIS Design & Consultancy for natural and built assets

FIGURE
3-1

PUBLIC REVIEW DRAFT



LEGEND:

MW-203	INTERIOR MONITORING WELL LOCATION AND DESIGNATION
MW-122	DEEP MONITORING WELL LOCATION AND DESIGNATION
MW-301	MONITORING WELL
MW-109	PERIMETER MONITORING WELL LOCATION
P-11	PIEZOMETER
D-1	STAFF GAUGE
	2001 AND 2003 SOIL EXCAVATIONS BELOW GROUNDWATER TABLE
	LOWER YARD PROPERTY BOUNDARY
	2007/2008 EXCAVATION BOUNDARIES
S	WSDOT STORM DRAIN LINE
SD	POINT EDWARDS STORM DRAIN LINE
505	TOTAL PETROLEUM HYDROCARBON (TPH)
[103]	DUPLICATE SAMPLE
	HIGHLIGHTED CONCENTRATIONS EXCEED SAMPLE SPECIFIC TPH CLEANUP LEVEL
UU	THE CONSTITUENTS MAKING UP THE TOTAL ARE ALL NON-DETECTS

NOTES:

1. PIEZOMETERS AND WELLS WITHOUT ANALYTICAL RESULTS WERE NOT SAMPLED.
2. LIGHT NONAQUEOUS PHASE LIQUID WAS MEASURED IN MW-525 AND P-13 AT A THICKNESS OF 0.01 AND 1.32 FEET RESPECTIVELY.

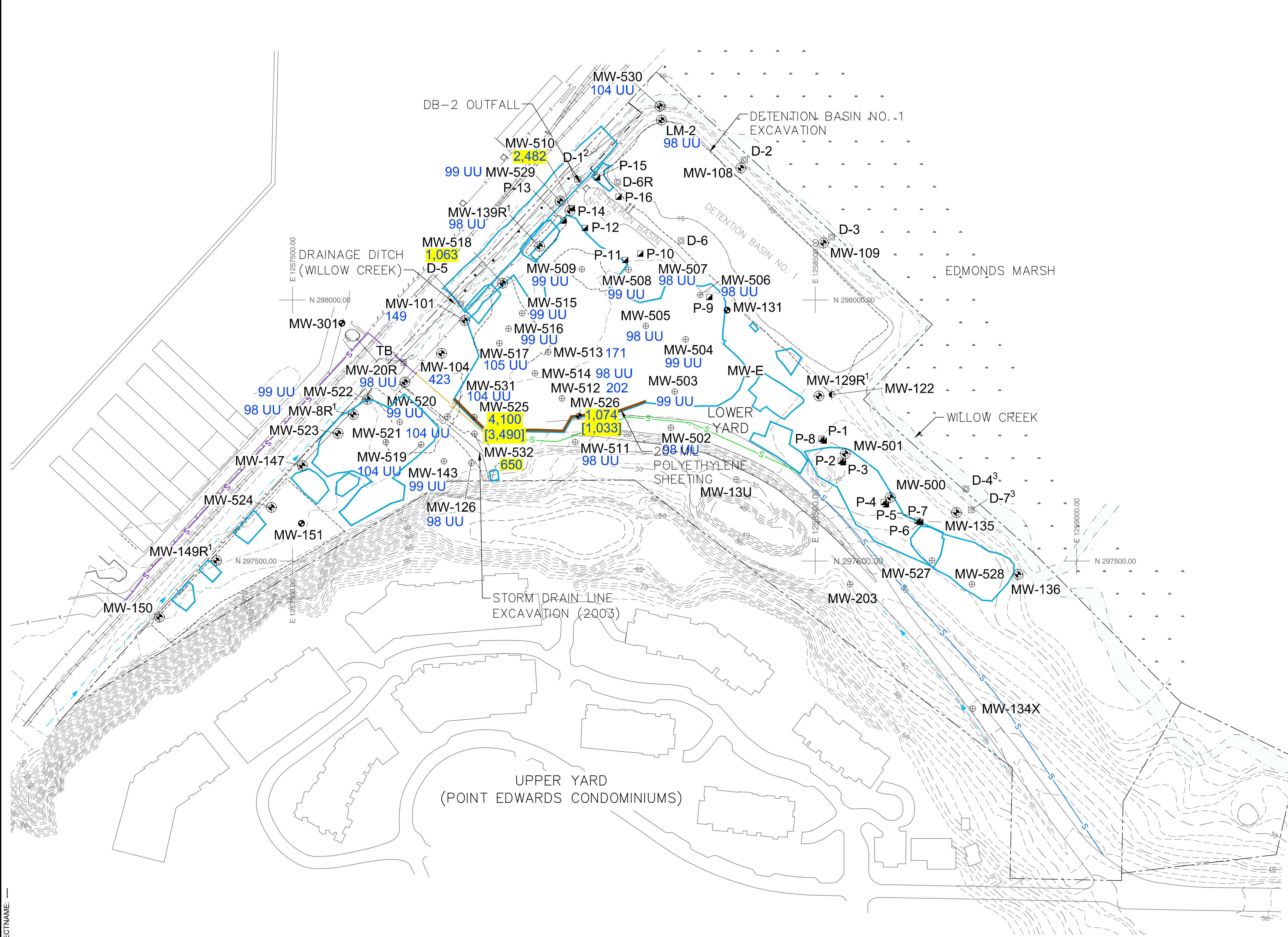
CHEVRON ENVIRONMENTAL MANAGEMENT COMPANY
FORMER UNOCAL BULK FUEL TERMINAL
EDMONDS, WASHINGTON
FINAL FEASIBILITY STUDY REPORT

SECOND QUARTER 2015
TPH CONCENTRATIONS

ARCADIS Design & Consultancy for natural and built assets

FIGURE
3-2

PUBLIC REVIEW DRAFT



LEGEND:

MW-203	INTERIOR MONITORING WELL LOCATION AND DESIGNATION
MW-122	DEEP MONITORING WELL LOCATION AND DESIGNATION
MW-301	MONITORING WELL
MW-109	PERIMETER MONITORING WELL LOCATION
P-11	PIEZOMETER
D-1	STAFF GAUGE
	2001 AND 2003 SOIL EXCAVATIONS BELOW GROUNDWATER TABLE
	LOWER YARD PROPERTY BOUNDARY
	2007/2008 EXCAVATION BOUNDARIES
S	WSDOT STORM DRAIN LINE
SD	POINT EDWARDS STORM DRAIN LINE
505	TOTAL PETROLEUM HYDROCARBON (TPH)
[1,033]	DUPLICATE SAMPLE
	HIGHLIGHTED CONCENTRATIONS EXCEED SAMPLE SPECIFIC TPH CLEANUP LEVEL
UU	THE CONSTITUENTS MAKING UP THE TOTAL ARE ALL NON-DETECTS
	RESULTS PRESENTED IN MICROGRAMS PER LITER (ug/L)

NOTES:

1. PIEZOMETERS AND WELLS WITHOUT ANALYTICAL RESULTS WERE NOT SAMPLED.
2. LIGHT NONAQUEOUS PHASE LIQUID WAS MEASURED IN P-12 AND P-13 AT A THICKNESS OF 0.47 AND 0.13 FEET RESPECTIVELY.

0 200' 400'
GRAPHIC SCALE

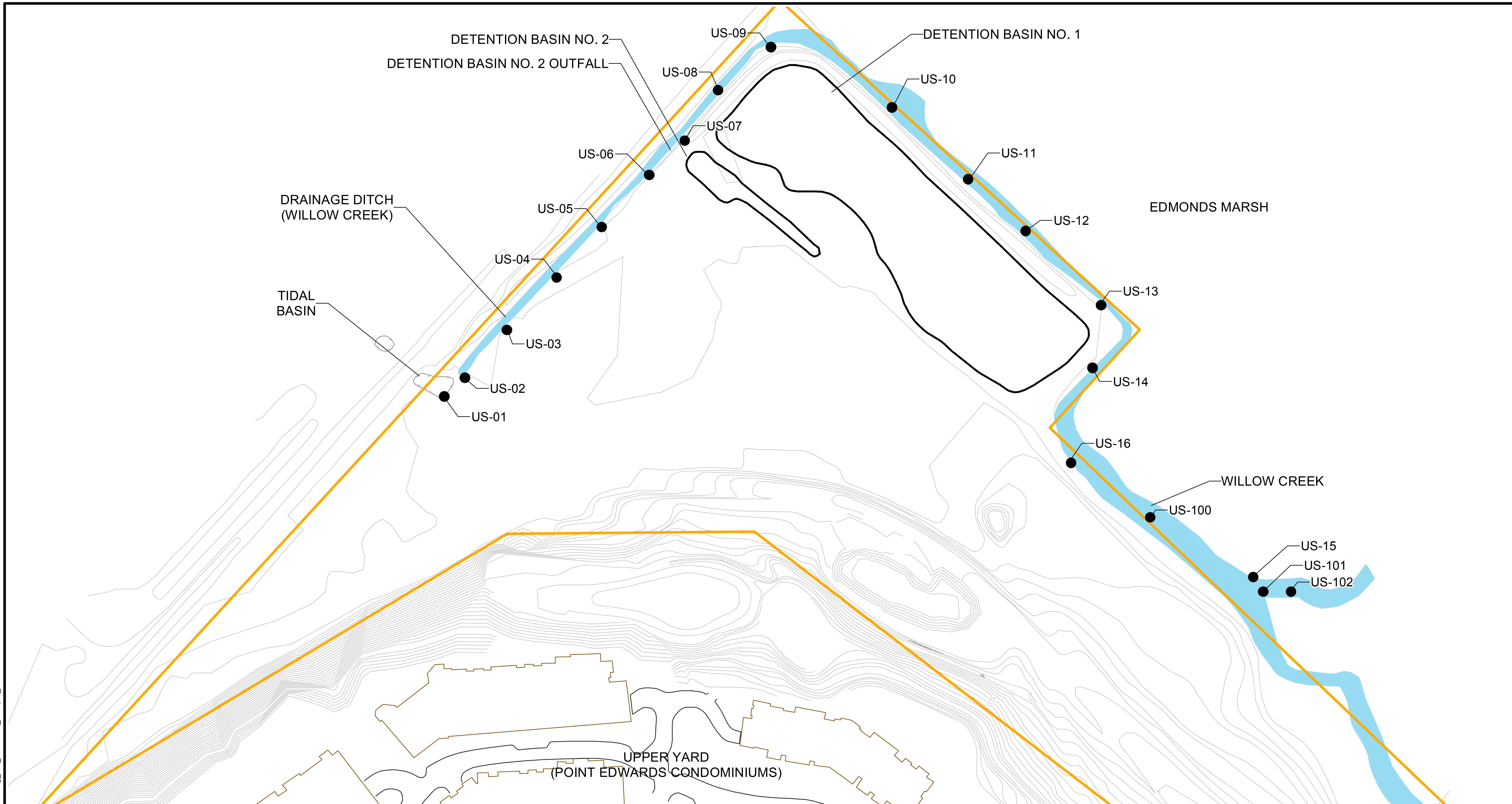
CHEVRON ENVIRONMENTAL MANAGEMENT COMPANY
FORMER UNOCAL BULK FUEL TERMINAL
EDMONDS, WASHINGTON
FINAL FEASIBILITY STUDY REPORT

FOURTH QUARTER 2016
TPH CONCENTRATIONS

ARCADIS Design & Consultancy for natural and built assets

FIGURE
3-3

PUBLIC REVIEW DRAFT



LEGEND

● SEDIMENT SAMPLE LOCATIONS

LOWER YARD PROPERTY BOUNDARY

0 140 280
SCALE IN FEET

CHEVRON ENVIRONMENTAL MANAGEMENT COMPANY
FORMER UNOCAL BULK FUEL TERMINAL
EDMONDS, WASHINGTON
FINAL FEASABILITY STUDY REPORT

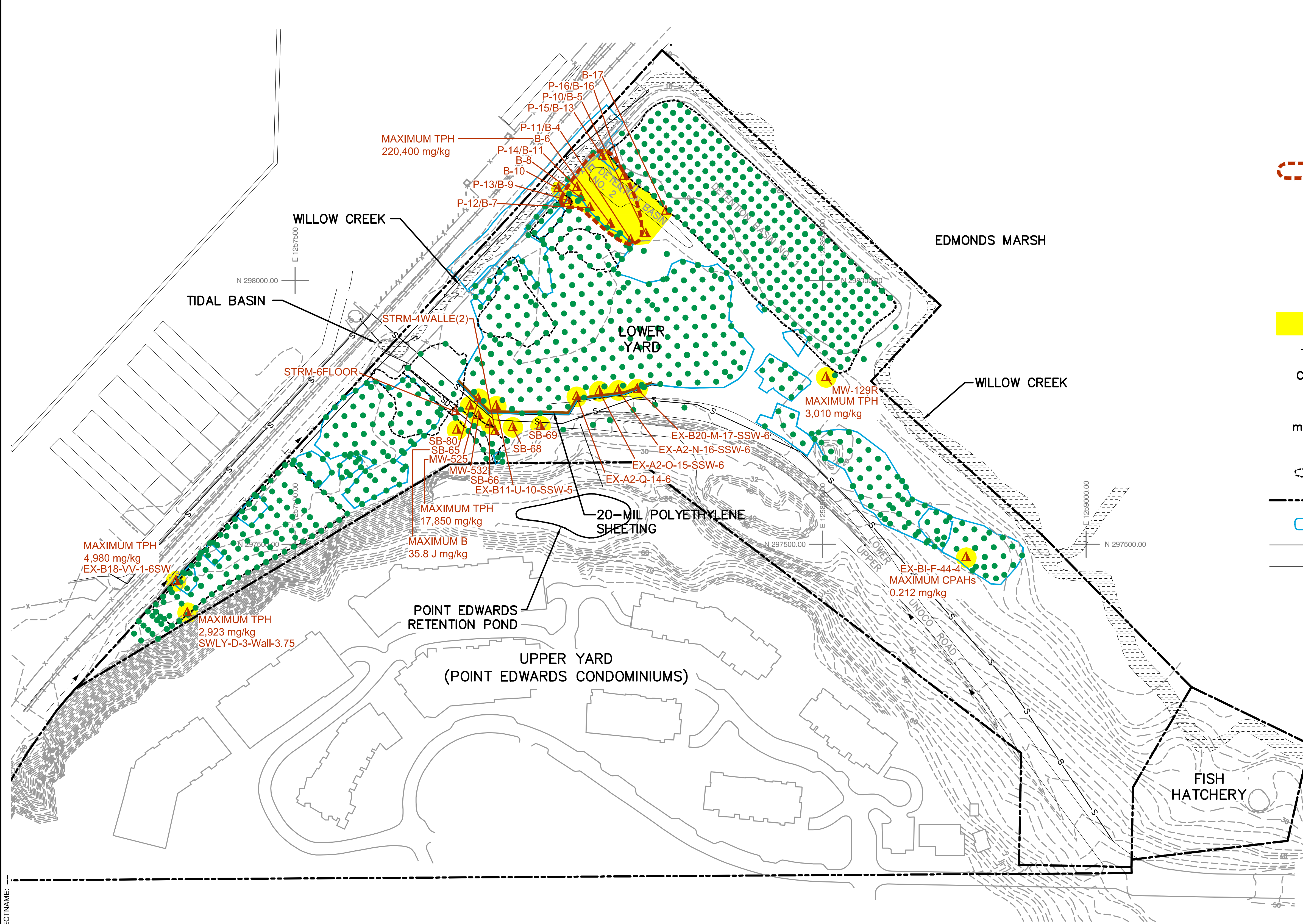
SEDIMENT SAMPLE LOCATIONS

ARCADIS

FIGURE
3-4

CITY:HIGHLANDS RANCH, CO DIV/GROUP:(ENV/GIS) DB: B GRIFFITH
Path: Z:\GISProjects_ENV\Chevron_Edmonds\MXD\Fig_3-4_Sediment_Sample_Locations.mxd Date: 3/7/2017 Time: 10:11:27 AM

PUBLIC REVIEW DRAFT



LEGEND:

- ESTIMATED RECOVERABLE LNAPL BOUNDARY
- SOIL SAMPLE COLLECTION LOCATION WITH CONCENTRATIONS OF TOTAL TPH AND, cPAH AND/OR BENZENE NOT EXCEEDING APPLICABLE SITE CULs AND / OR RELs.
- SOIL SAMPLE COLLECTION LOCATION WITH CONCENTRATIONS OF TOTAL TPH AND/OR CPAHS EXCEEDING APPLICABLE SITE CULs AND/OR RELs.
- AREA WITH REMAINING SOIL IMPACTS EXCEEDING SITE CULs AND/OR RELs
- TPH — TOTAL PETROLEUM HYDROCARBONS
- CPAH — CARCINOGENIC POLYNUCLEAR AROMATIC HYDROCARBONS
- B — BENZENE
- mg/kg — MILLIGRAMS PER KILOGRAM
- J — INDICATES AN ESTIMATED VALUE
- 2001 AND 2003 SOIL EXCAVATIONS BELOW GROUNDWATER TABLE
- PROPERTY BOUNDARY
- 2007/2008 EXCAVATION BOUNDARIES
- S — WSDOT STORMWATER LINE
- SD — POINT EDWARDS STORM DRAIN LINE

NOTES:

1. 20-MIL POLYETHYLENE SHEETING INSTALLED UPON COMPLETION OF PHASE I EXCAVATION. SHEETING REACHES TO APPROXIMATELY 7.5 FEET ABOVE MEAN SEA LEVEL.
2. HORIZONTAL DATUM: WASHINGTON STATE COORDINATE SYSTEM NORTH ZONE (NAD 83/98).
   VERTICAL DATUM: N.A.V.D. 88
   UNITS: U.S. SURVEY FEET
   HORIZONTAL AND VERTICAL CONTROL ESTABLISHED BY GPS VIA VERTICAL REFERENCE STATION NETWORK (VRSN).
3. SOUTHEAST PORTION OF WSDOT STORMWATER LINE HAS NOT BEEN SURVEYED.

0 200' 400'
GRAPHIC SCALE

CHEVRON ENVIRONMENTAL MANAGEMENT COMPANY
FORMER UNOCAL BULK FUEL TERMINAL
EDMONDS, WASHINGTON
FINAL FEASIBILITY STUDY REPORT

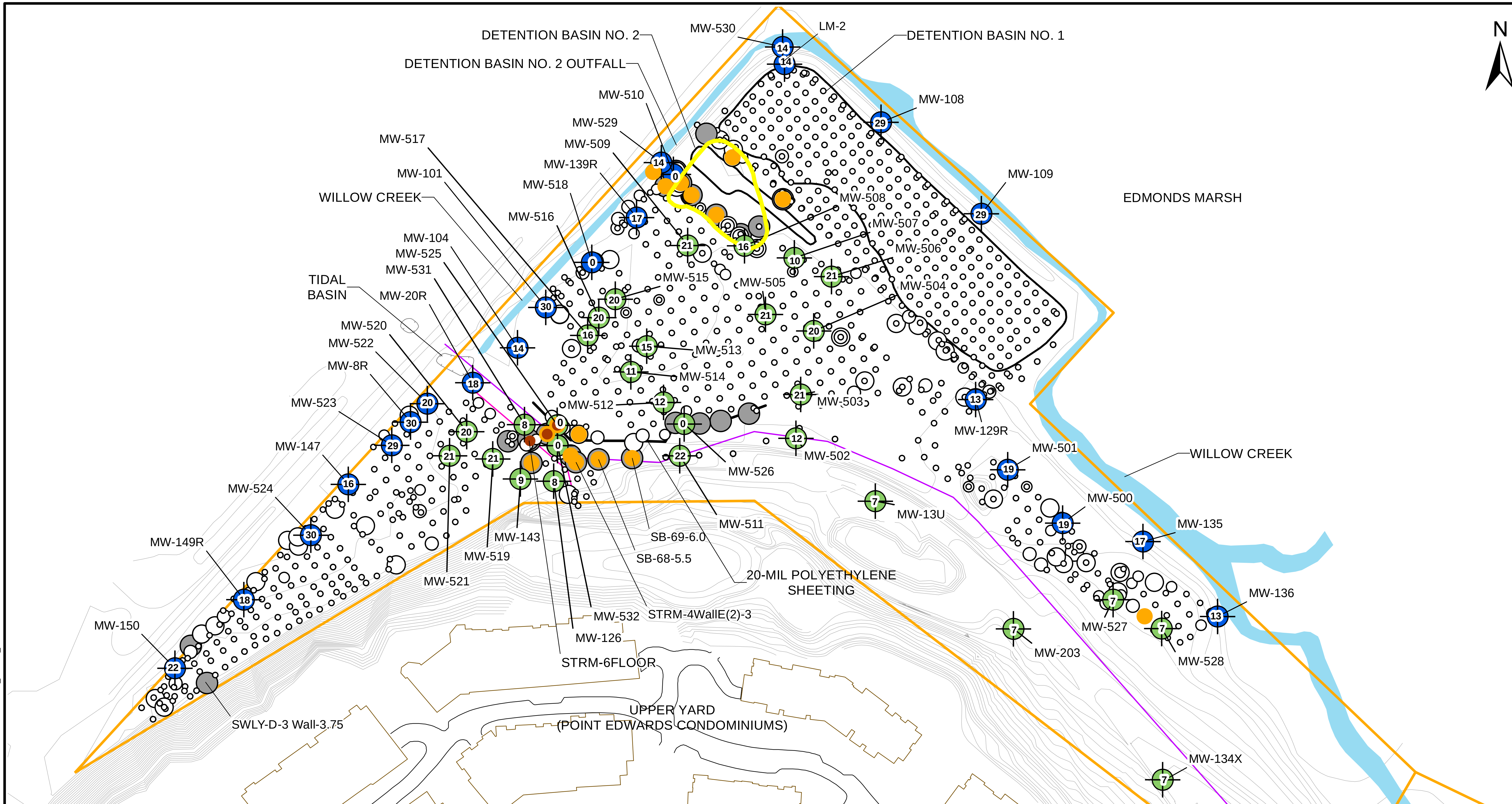
LOWER YARD REMAINING SOIL IMPACTS MAP

ARCADIS Design & Consultancy for natural and built assets

FIGURE
4-1

CITY: MINNEAPOLIS, MN DIV/GROUP: ENV/CAD DB: R. OBERLANDER LD: R. OBERLANDER PIC:(Opt) PM:(Reqd) TM:(Opt) LYR:(Opt)ON=*;OFF=*REF*
G:\ENVCAD\Minneapolis-MN\ACT\B0045362\0007\00002\2017 FS\DWG\45362D04-1.dwg LAYOUT: 4-1 SAVED: 12/13/2016 1:11 PM ACADVER: 19.1S (LMS TECH) PAGESETUP: --- PLOTSTYLETABLE: --- PLOTTED: 12/13/2016 1:12 PM BY: OBERLANDER, ROSEANNE
XREFS: 45362X02 45362X03 45362X0D IMAGES: PROJECTNAME: ----

PUBLIC REVIEW DRAFT



LEGEND

- 25 — PERIMETER WELL AND NUMBER OF CONSECUTIVE SAMPLING ROUNDS SHOWING CONCENTRATIONS OF TPH LESS THAN PROPOSED GW CULS
- 18 — INTERIOR WELL AND NUMBER OF CONSECUTIVE SAMPLING ROUNDS SHOWING CONCENTRATIONS OF TPH LESS THAN PROPOSED GW CULS
- SOIL TPH CONCENTRATION <250 mg/kg
- SOIL TPH CONCENTRATION OF 250 - 500 mg/kg
- SOIL TPH CONCENTRATION OF 500 - 1,000 mg/kg
- SOIL TPH CONCENTRATION OF 1,000 - 2,775 mg/kg
- SOIL TPH CONCENTRATION > 2,775 mg/kg
- SOIL BENZENE CONCENTRATION > CUL (18mg/kg)
- SOIL cPAH CONCENTRATION > CUL (0.14 mg/kg)
- WSDOT STORMWATER LINE
- POINT EDWARDS STORM DRAIN LINE
- LOWER YARD PROPERTY BOUNDARY
- ESTIMATED LNAPL BOUNDARY

0 150 300
SCALE IN FEET

NOTES:
1. 20-MIL POLYETHYLENE SHEETING INSTALLED UPON COMPLETION OF PHASE I EXCAVATION. SHEETING REACHES TO APPROXIMATELY 7.5 FEET ABOVE MEAN SEA LEVEL.
2. SOUTHEAST PORTION OF WSDOT STORMWATER LINE HAS NOT BEEN SURVEYED.

TPH - TOTAL PETROLEUM HYDROCARBONS
MG/KG - MILLIGRAMS PER KILOGRAM
CPAH - CARCINOGENIC POLYNUCLEAR AROMATIC HYDROCARBONS, ADJUSTED FOR TOXICITY
CUL - CLEANUP LEVEL

CHEVRON ENVIRONMENTAL MANAGEMENT COMPANY
FORMER UNOCAL BULK FUEL TERMINAL
EDMONDS, WASHINGTON
FINAL FEASABILITY STUDY REPORT

SITE SOIL AND GROUNDWATER REMEDIATION STATUS - FOURTH QUARTER 2016

ARCADIS

FIGURE
4-2

CITY:HIGHLANDS RANCH, CO DIV/GROUP:(ENV/GIS) DB: B GRIFFITH
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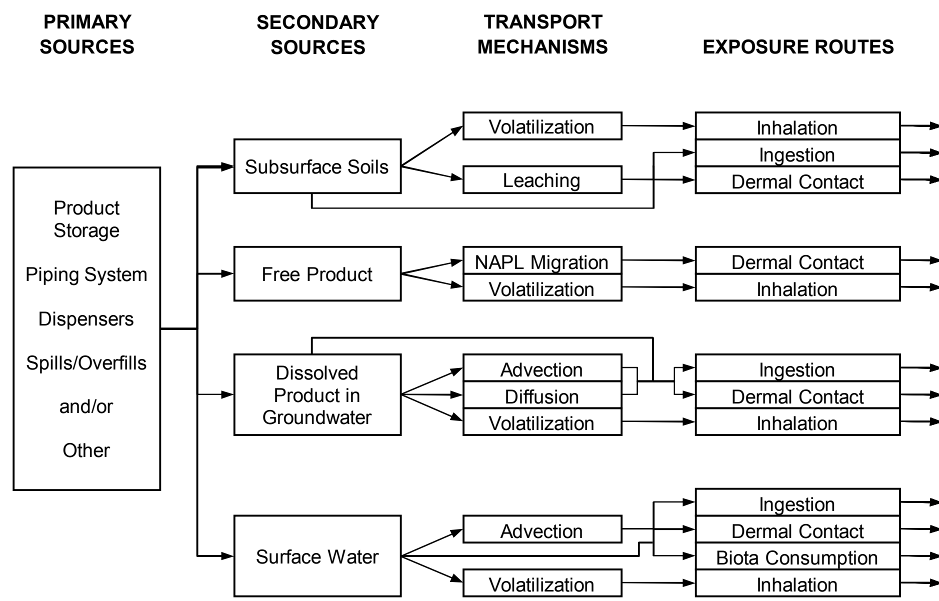
PUBLIC REVIEW DRAFT



Secondary Source	Exposure Route	Residential Future	Commercial Future	Trespassers Current	Trespassers Future	Construction & Excavation Future	Aquatic Biota Current	Aquatic Biota Future	Terrestrial Biota Current	Terrestrial Biota Future
Subsurface Soils	Inhalation	P	P	U	-	P	-	-	P	P
	Ingestion	P	P	U	-	P	-	-	P	P
	Dermal Contact	P	P	U	-	P	-	-	P	P
Free Product	Dermal Contact	-	-	-	-	P	-	-	P	P
	Inhalation	P	P	U	-	P	-	-	P	P
Dissolved Product in Groundwater	Ingestion	-	-	-	-	P	-	-	-	-
	Dermal Contact	-	-	-	-	P	-	-	-	-
	Inhalation	U	P	U	-	P	-	-	-	-
Surface Water	Ingestion	P	P	U	-	P	-	-	P	P
	Dermal Contact	P	P	U	-	P	-	-	P	P
	Biota Consumption	P	P	U	-	P	-	-	P	P
	Inhalation	P	P	U	-	P	-	-	P	P

Notes:
NAPL = nonaqueous phase liquid
P = This route is a potential source of exposure
U = Unlikey source of exposure
\- = There is no exposure by this route

CHEVRON ENVIRONMENTAL MANAGEMENT COMPANY
FORMER UNOCAL EDMONDS TERMINAL, LOWER YARD
EDMONDS, WASHINGTON
FINAL FEASIBILITY STUDY REPORT

CONCEPTUAL SITE MODEL EXPOSURE PATHWAYS

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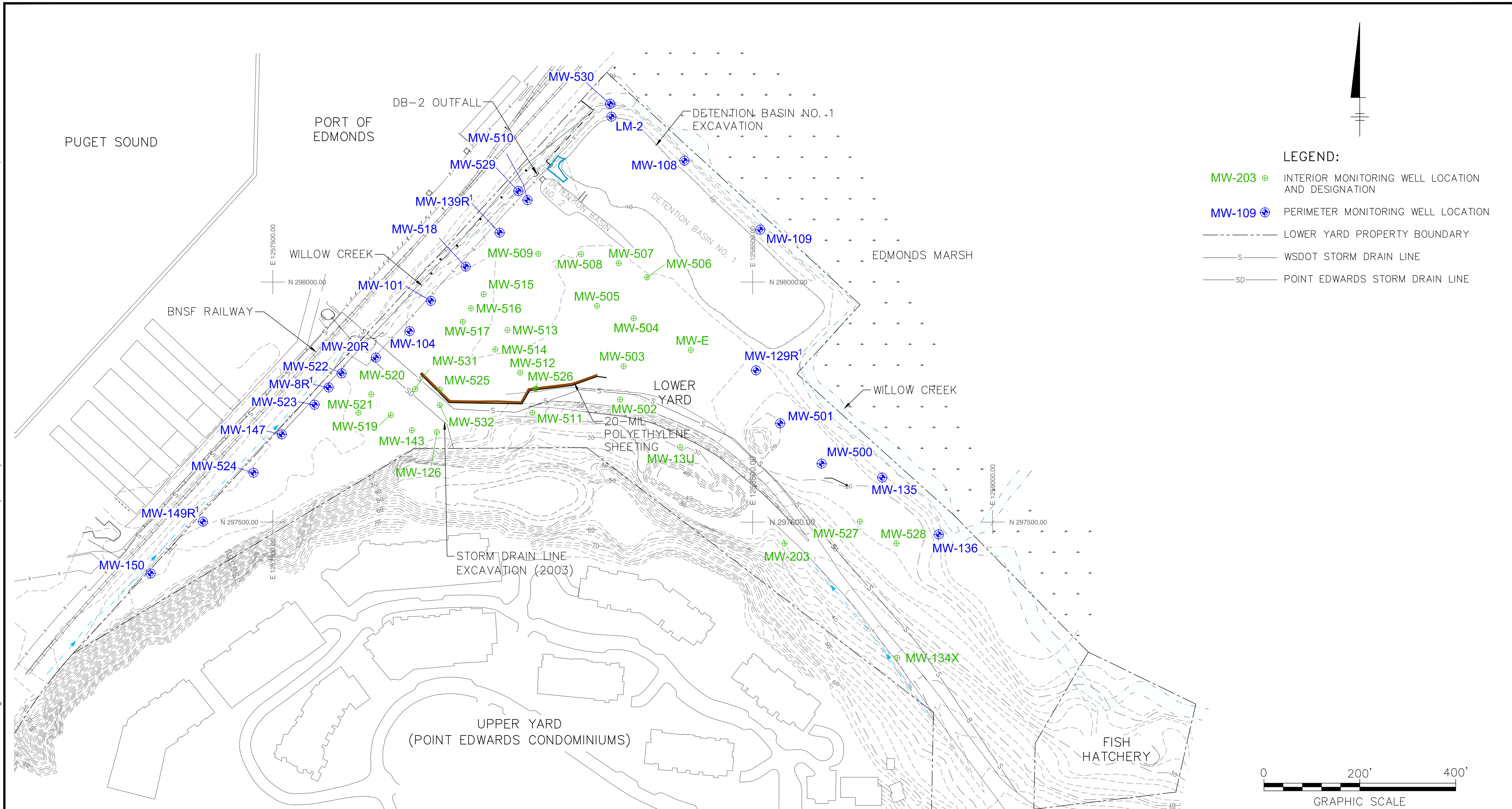
FIGURE 4-3

PUBLIC REVIEW DRAFT



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COMPLIANCE MONITORING WELLS

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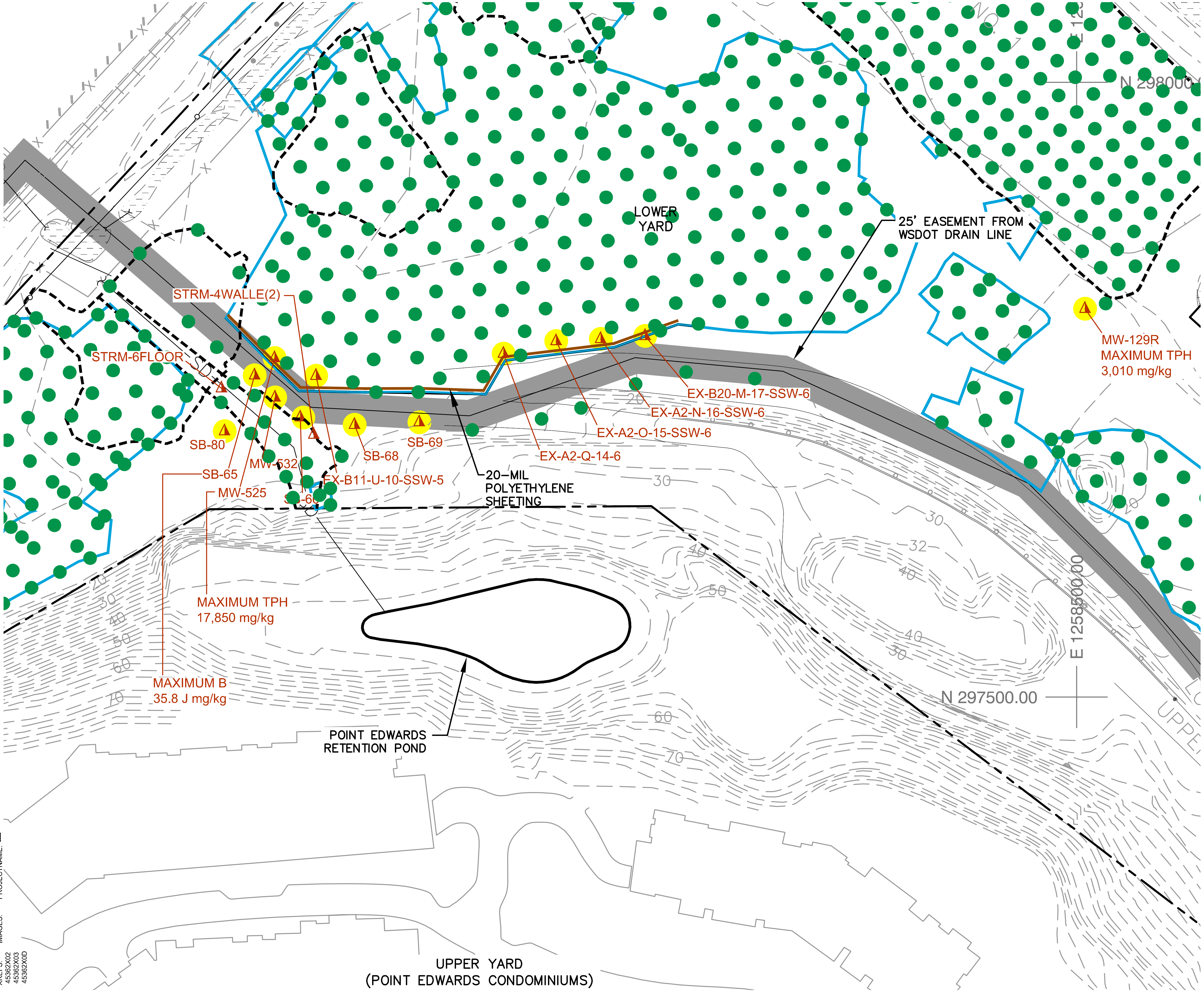
FIGURE
5-1

PUBLIC REVIEW DRAFT



LEGEND:

- ESTIMATED RECOVERABLE LNAPL BOUNDARY
- SOIL SAMPLE COLLECTION LOCATION WITH CONCENTRATIONS OF TOTAL TPH AND, cPAH AND/OR BENZENE NOT EXCEEDING APPLICABLE SITE CULs AND / OR RELs.
- SOIL SAMPLE COLLECTION LOCATION WITH CONCENTRATIONS OF TOTAL TPH AND/OR CPAHS EXCEEDING APPLICABLE SITE CULs AND/OR RELs.
- AREA WITH REMAINING SOIL IMPACTS EXCEEDING SITE CULs AND/OR RELs
- TPH — TOTAL PETROLEUM HYDROCARBONS
- CPAH — CARCINOGENIC POLYNUCLEAR AROMATIC HYDROCARBONS
- B — BENZENE
- mg/kg — MILLIGRAMS PER KILOGRAM
- J — INDICATES AN ESTIMATED VALUE
- 2001 AND 2003 SOIL EXCAVATIONS BELOW GROUNDWATER TABLE
- PROPERTY BOUNDARY
- 2007/2008 EXCAVATION BOUNDARIES
- WSDOT STORMWATER LINE
- POINT EDWARDS STORM DRAIN LINE
- WSDOT CONSTRUCTION EASEMENT

NOTES:

1. 20–MIL POLYETHYLENE SHEETING INSTALLED UPON COMPLETION OF PHASE I EXCAVATION. SHEETING REACHES TO APPROXIMATELY 7.5 FEET ABOVE MEAN SEA LEVEL.
2. HORIZONTAL DATUM: WASHINGTON STATE COORDINATE SYSTEM NORTH ZONE (NAD 83/98).
VERTICAL DATUM: N.A.V.D. 88
UNITS: U.S. SURVEY FEET
HORIZONTAL AND VERTICAL CONTROL ESTABLISHED BY GPS VIA VERTICAL REFERENCE STATION NETWORK (VRSN).
3. SOUTHEAST PORTION OF WSDOT STORMWATER LINE HAS NOT BEEN SURVEYED.

0 80' 160'
GRAPHIC SCALE

CHEVRON ENVIRONMENTAL MANAGEMENT COMPANY
FORMER UNOCAL BULK FUEL TERMINAL
EDMONDS, WASHINGTON
FINAL FEASIBILITY STUDY REPORT

CURRENT WSDOT CONSTRUCTION EASEMENT

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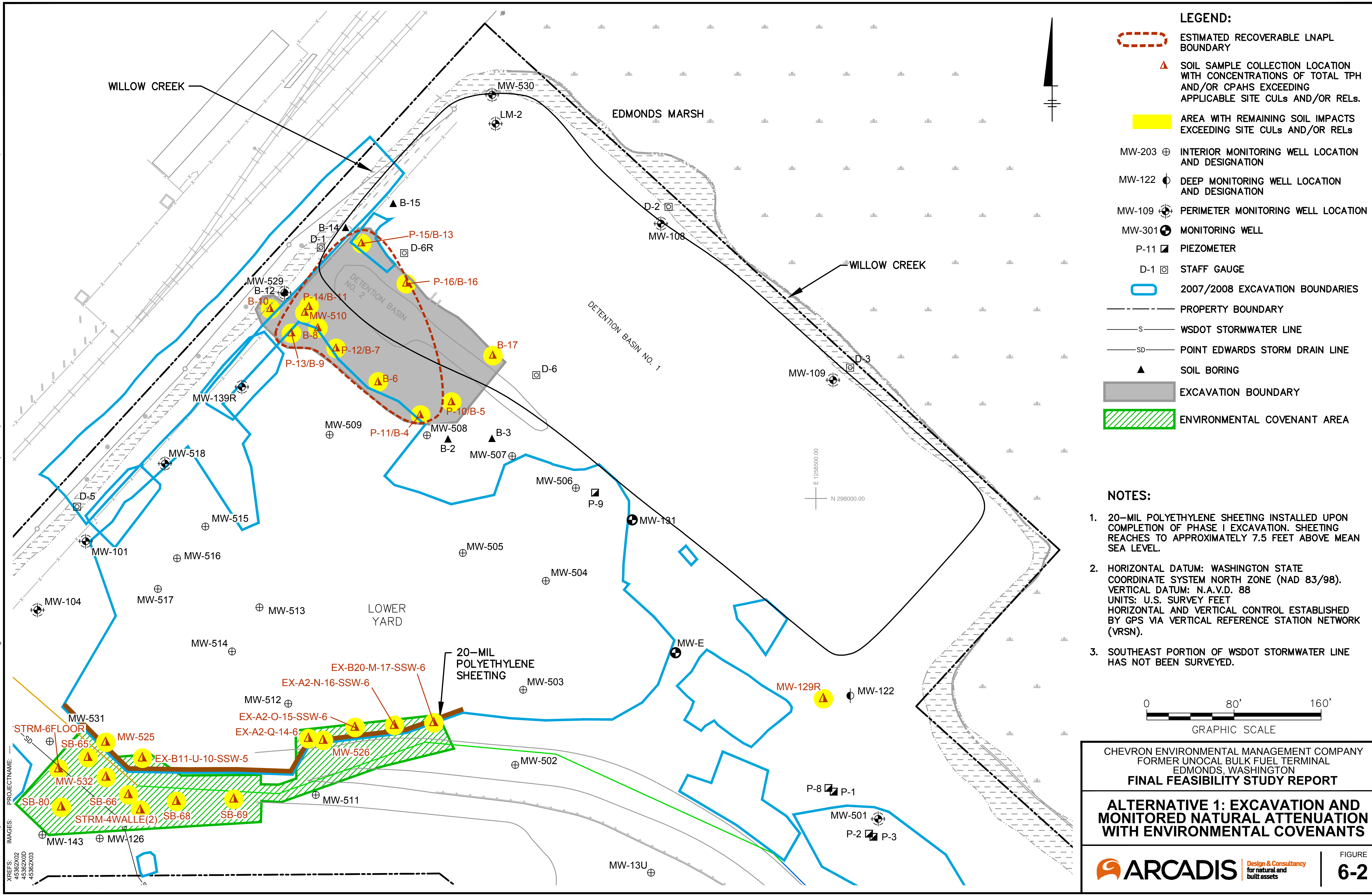
FIGURE
6-1

PUBLIC REVIEW DRAFT



NOTES:

1. 20–MIL POLYETHYLENE SHEETING INSTALLED UPON COMPLETION OF PHASE I EXCAVATION. SHEETING REACHES TO APPROXIMATELY 7.5 FEET ABOVE MEAN SEA LEVEL.
2. HORIZONTAL DATUM: WASHINGTON STATE COORDINATE SYSTEM NORTH ZONE (NAD 83/98). VERTICAL DATUM: N.A.V.D. 88 UNITS: U.S. SURVEY FEET HORIZONTAL AND VERTICAL CONTROL ESTABLISHED BY GPS VIA VERTICAL REFERENCE STATION NETWORK (VRSN).
3. SOUTHEAST PORTION OF WSDOT STORMWATER LINE HAS NOT BEEN SURVEYED.

CHEVRON ENVIRONMENTAL MANAGEMENT COMPANY
FORMER UNOCAL BULK FUEL TERMINAL
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ALTERNATIVE 1: EXCAVATION AND MONITORED NATURAL ATTENUATION WITH ENVIRONMENTAL COVENANTS

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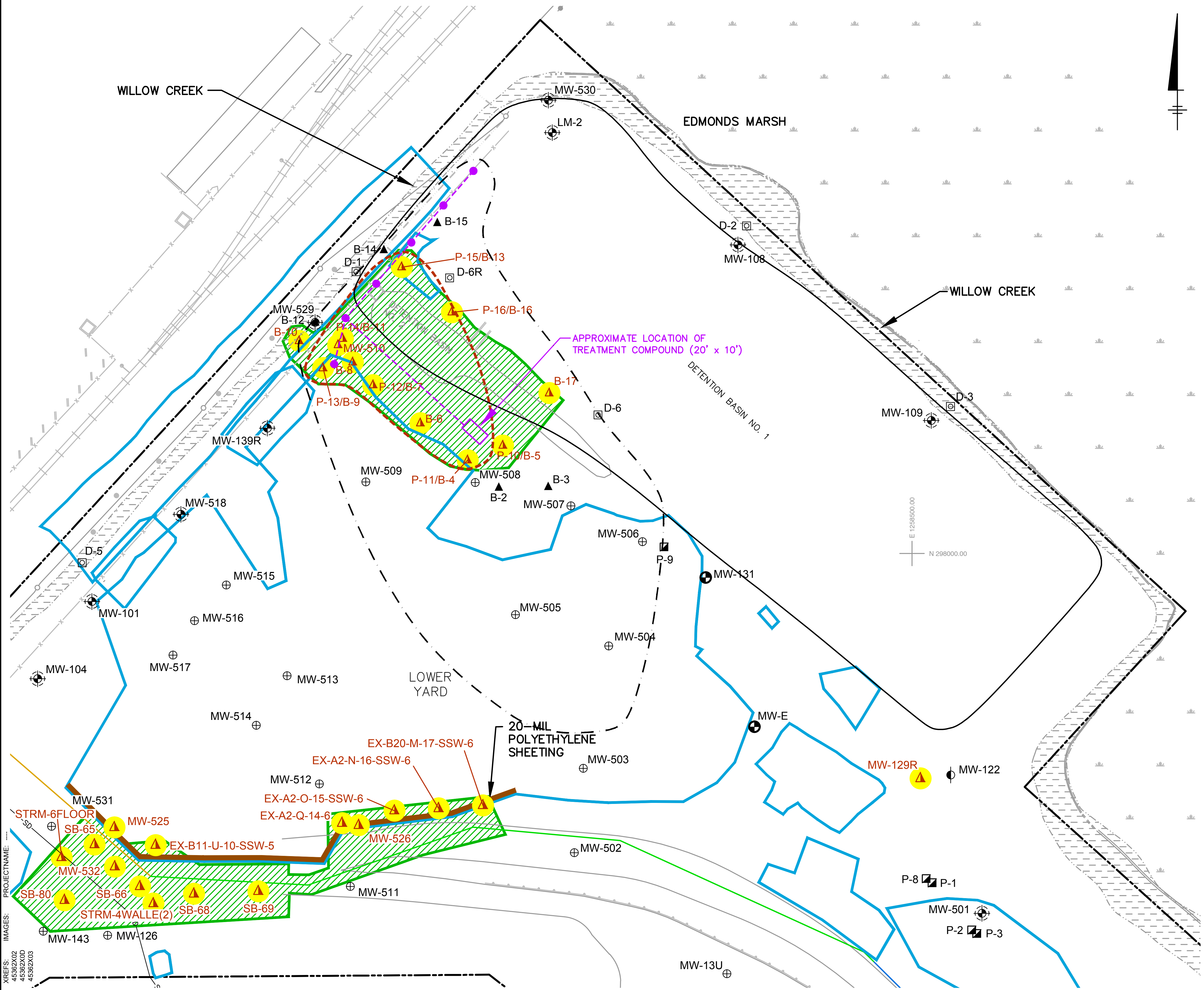
FIGURE
6-2

PUBLIC REVIEW DRAFT



LEGEND:

- ESTIMATED RECOVERABLE LNAPL BOUNDARY
- SOIL SAMPLE COLLECTION LOCATION WITH CONCENTRATIONS OF TOTAL TPH AND/OR CPAHS EXCEEDING APPLICABLE SITE CULs AND/OR RELs.
- AREA WITH REMAINING SOIL IMPACTS EXCEEDING SITE CULs AND/OR RELs
- MW-203 INTERIOR MONITORING WELL LOCATION AND DESIGNATION
- MW-122 DEEP MONITORING WELL LOCATION AND DESIGNATION
- MW-109 PERIMETER MONITORING WELL LOCATION
- MW-301 MONITORING WELL
- P-11 PIEZOMETER
- D-1 STAFF GAUGE
- 2007/2008 EXCAVATION BOUNDARIES
- PROPERTY BOUNDARY
- S WSDOT STORMWATER LINE
- SD POINT EDWARDS STORM DRAIN LINE
- SOIL BORING
- ENVIRONMENTAL COVENANT AREA
- PROPOSED GROUNDWATER EXTRACTION WELL
- PROPOSED GROUNDWATER EXTRACTION SYSTEM HEADER PIPE
- PREDICTED GROUNDWATER CAPTURE ZONE

NOTES:

1. 20-MIL POLYETHYLENE SHEETING INSTALLED UPON COMPLETION OF PHASE I EXCAVATION. SHEETING REACHES TO APPROXIMATELY 7.5 FEET ABOVE MEAN SEA LEVEL.
2. HORIZONTAL DATUM: WASHINGTON STATE COORDINATE SYSTEM NORTH ZONE (NAD 83/98). VERTICAL DATUM: N.A.V.D. 88 UNITS: U.S. SURVEY FEET HORIZONTAL AND VERTICAL CONTROL ESTABLISHED BY GPS VIA VERTICAL REFERENCE STATION NETWORK (VRSN).
3. SOUTHEAST PORTION OF WSDOT STORMWATER LINE HAS NOT BEEN SURVEYED.

0 80' 160'
GRAPHIC SCALE

CHEVRON ENVIRONMENTAL MANAGEMENT COMPANY
FORMER UNOCAL BULK FUEL TERMINAL
EDMONDS, WASHINGTON

FINAL FEASIBILITY STUDY REPORT

ALTERNATIVE 2: GROUNDWATER CONTAINMENT SYSTEM USING GROUNDWATER EXTRACTION WELLS, AND MONITORED NATURAL ATTENUATION WITH ENVIRONMENTAL COVENANTS

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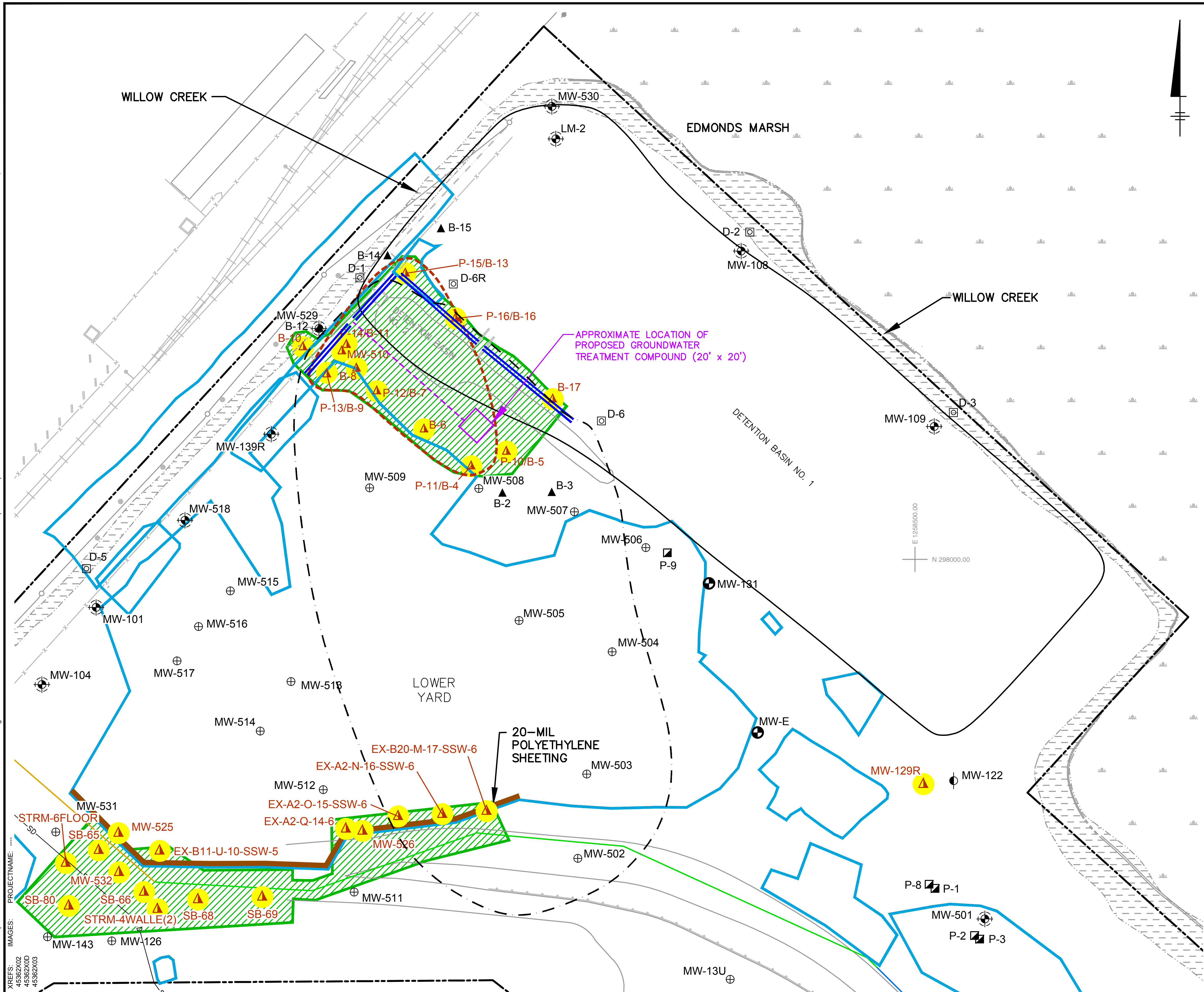
FIGURE
6-3

PUBLIC REVIEW DRAFT



LEGEND:

- ESTIMATED RECOVERABLE LNAPL BOUNDARY
- SOIL SAMPLE COLLECTION LOCATION WITH CONCENTRATIONS OF TOTAL TPH AND/OR CPAHS EXCEEDING APPLICABLE SITE CULs AND/OR RELs.
- AREA WITH REMAINING SOIL IMPACTS EXCEEDING SITE CULs AND/OR RELs
- MW-203 — INTERIOR MONITORING WELL LOCATION AND DESIGNATION
- MW-122 — DEEP MONITORING WELL LOCATION AND DESIGNATION
- MW-109 — PERIMETER MONITORING WELL LOCATION
- MW-301 — MONITORING WELL
- P-11 — PIEZOMETER
- D-1 — STAFF GAUGE
- 2007/2008 EXCAVATION BOUNDARIES
- PROPERTY BOUNDARY
- WSDOT STORMWATER LINE
- POINT EDWARDS STORM DRAIN LINE
- SOIL BORING
- ENVIRONMENTAL COVENANT AREA
- PROPOSED GROUNDWATER EXTRACTION SUMP
- PROPOSED GROUNDWATER EXTRACTION SYSTEM HEADER PIPE
- PROPOSED GROUNDWATER CONTAINMENT TRENCH
- PREDICTED GROUNDWATER CAPTURE ZONE

NOTES:

1. 20-MIL POLYETHYLENE SHEETING INSTALLED UPON COMPLETION OF PHASE I EXCAVATION. SHEETING REACHES TO APPROXIMATELY 7.5 FEET ABOVE MEAN SEA LEVEL.
2. HORIZONTAL DATUM: WASHINGTON STATE COORDINATE SYSTEM NORTH ZONE (NAD 83/98). VERTICAL DATUM: N.A.V.D. 88 UNITS: U.S. SURVEY FEET HORIZONTAL AND VERTICAL CONTROL ESTABLISHED BY GPS VIA VERTICAL REFERENCE STATION NETWORK (VRSN).
3. SOUTHEAST PORTION OF WSDOT STORMWATER LINE HAS NOT BEEN SURVEYED.

0 80' 160'
GRAPHIC SCALE

CHEVRON ENVIRONMENTAL MANAGEMENT COMPANY
FORMER UNOCAL BULK FUEL TERMINAL
EDMONDS, WASHINGTON

FINAL FEASIBILITY STUDY REPORT

ALTERNATIVE 3: GROUNDWATER CONTAINMENT SYSTEM USING GROUNDWATER EXTRACTION TRENCH, AND MONITORED NATURAL ATTENUATION WITH ENVIRONMENTAL COVENANTS

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FIGURE
6-4

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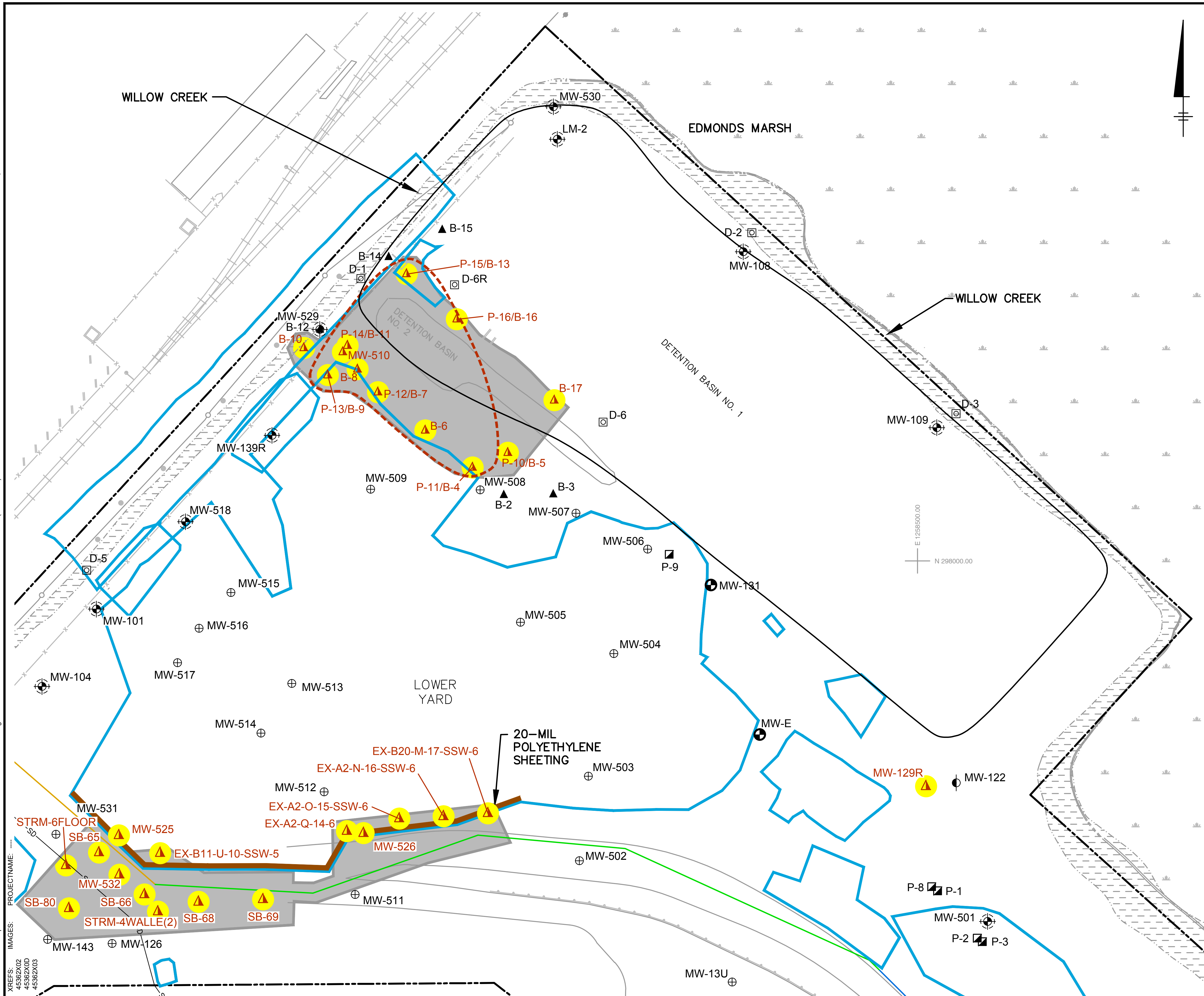


NOTES:

1. 20-MIL POLYETHYLENE SHEETING INSTALLED UPON COMPLETION OF PHASE I EXCAVATION. SHEETING REACHES TO APPROXIMATELY 7.5 FEET ABOVE MEAN SEA LEVEL.
2. HORIZONTAL DATUM: WASHINGTON STATE COORDINATE SYSTEM NORTH ZONE (NAD 83/98). VERTICAL DATUM: N.A.V.D. 88 UNITS: U.S. SURVEY FEET HORIZONTAL AND VERTICAL CONTROL ESTABLISHED BY GPS VIA VERTICAL REFERENCE STATION NETWORK (VRSN).
3. SOUTHEAST PORTION OF WSDOT STORMWATER LINE HAS NOT BEEN SURVEYED.

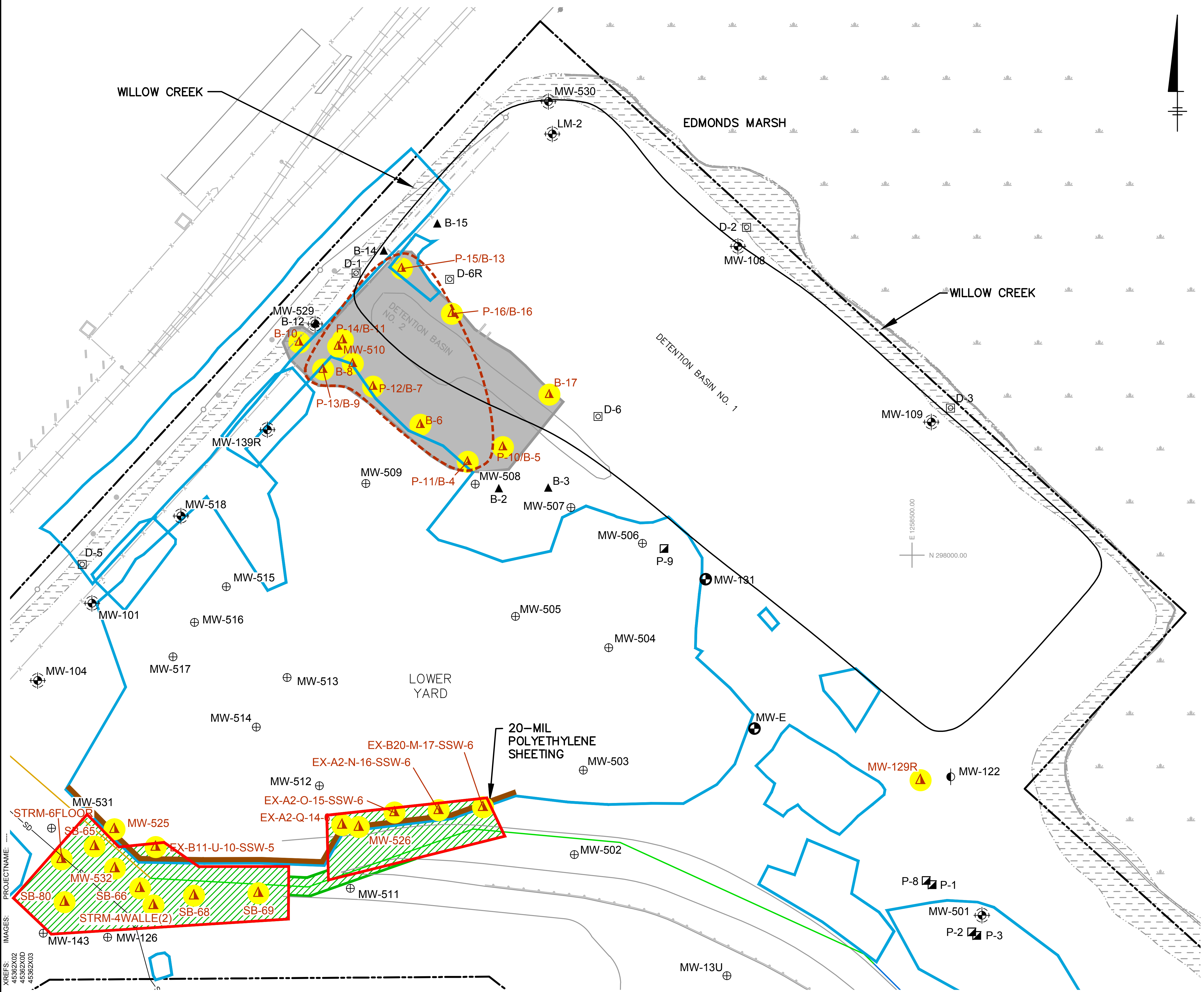
CHEVRON ENVIRONMENTAL MANAGEMENT COMPANY
FORMER UNOCAL BULK FUEL TERMINAL
EDMONDS, WASHINGTON
FINAL FEASIBILITY STUDY REPORT

ALTERNATIVE 4: EXCAVATION (DB-2 AND WSDOT STORMWATER LINE) AND LIMITED ENVIRONMENTAL COVENANT

ARCADIS Design & Consultancy for natural and built assets

FIGURE
6-5

PUBLIC REVIEW DRAFT



LEGEND:

- ESTIMATED RECOVERABLE LNAPL BOUNDARY
- SOIL SAMPLE COLLECTION LOCATION WITH CONCENTRATIONS OF TOTAL TPH AND/OR CPAHS EXCEEDING APPLICABLE SITE CULs AND/OR RELs.
- AREA WITH REMAINING SOIL IMPACTS EXCEEDING SITE CULs AND/OR RELs
- MW-203 INTERIOR MONITORING WELL LOCATION AND DESIGNATION
- MW-122 DEEP MONITORING WELL LOCATION AND DESIGNATION
- MW-109 PERIMETER MONITORING WELL LOCATION
- MW-301 BNSF WELLS
- P-11 PIEZOMETER
- D-1 STAFF GAUGE
- 2007/2008 EXCAVATION BOUNDARIES
- PROPERTY BOUNDARY
- S WSDOT STORMWATER LINE
- SD POINT EDWARDS STORM DRAIN LINE
- SOIL BORING
- EXCAVATION BOUNDARY
- ENVIRONMENTAL COVENANT AREA
- IN-SITU SOLIDIFICATION TREATMENT AREAS

NOTES:

1. 20-MIL POLYETHYLENE SHEETING INSTALLED UPON COMPLETION OF PHASE I EXCAVATION. SHEETING REACHES TO APPROXIMATELY 7.5 FEET ABOVE MEAN SEA LEVEL.
2. HORIZONTAL DATUM: WASHINGTON STATE COORDINATE SYSTEM NORTH ZONE (NAD 83/98).
VERTICAL DATUM: N.A.V.D. 88
UNITS: U.S. SURVEY FEET
HORIZONTAL AND VERTICAL CONTROL ESTABLISHED BY GPS VIA VERTICAL REFERENCE STATION NETWORK (VRSN).
3. SOUTHEAST PORTION OF WSDOT STORMWATER LINE HAS NOT BEEN SURVEYED.

0 80' 160'
GRAPHIC SCALE

CHEVRON ENVIRONMENTAL MANAGEMENT COMPANY
FORMER UNOCAL BULK FUEL TERMINAL
EDMONDS, WASHINGTON
FINAL FEASIBILITY STUDY REPORT

ALTERNATIVE 5: EXCAVATION, IN-SITU SOLIDIFICATION AND MONITORED NATURAL ATTENUATION WITH ENVIRONMENTAL COVENANTS

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FIGURE
6-6

CITY: MINNEAPOLIS, MN DIV/GROUP: ENV/CAD DB: R. OBERLANDER LD: R. OBERLANDER PIC:(Opt) PM:(Reqd) TM:(Opt) LYR:(Opt)ON=*;OFF=*REF*
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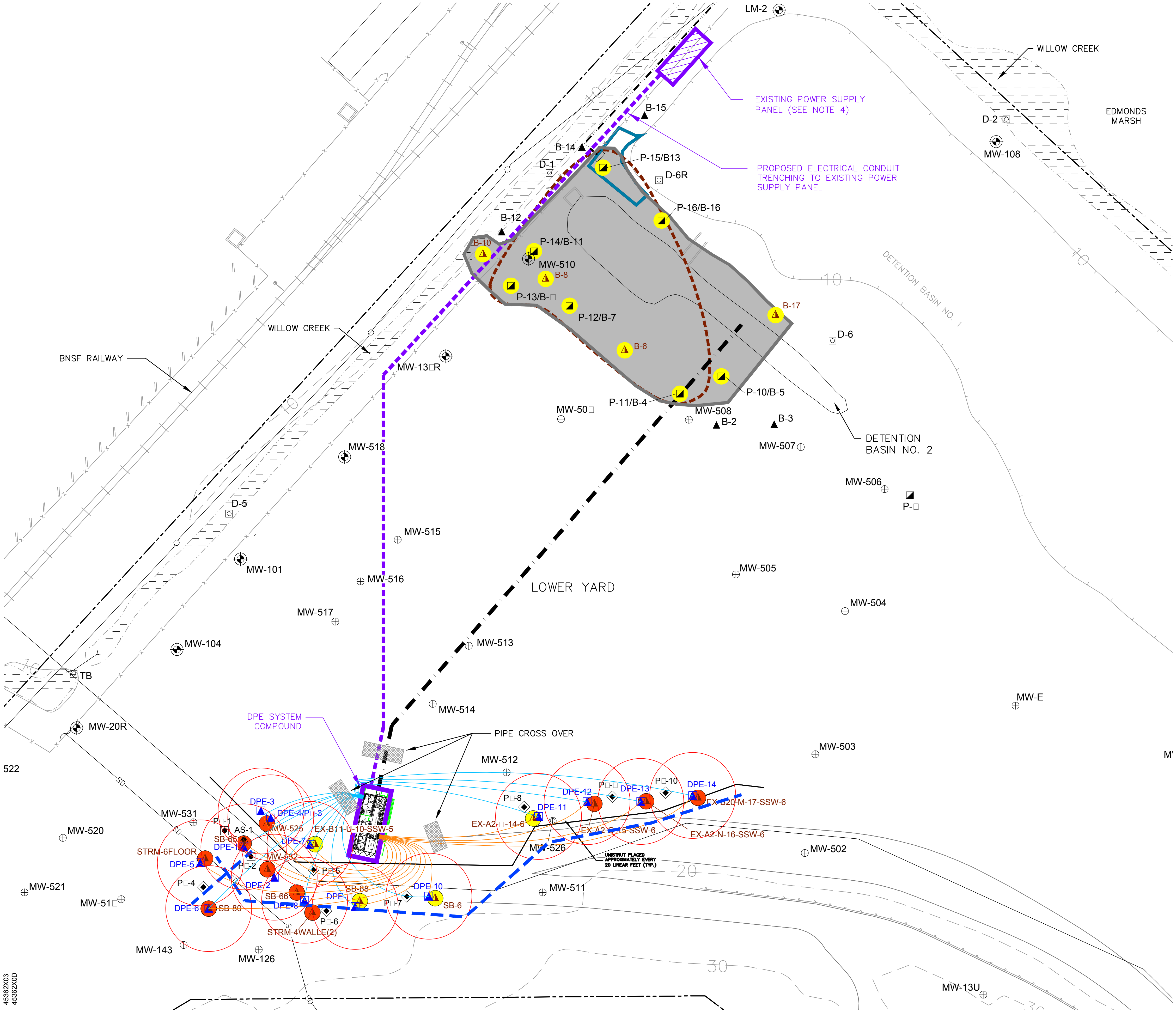

LEGEND:

- ESTIMATED RECOVERABLE LNAPL BOUNDARY
- MW-203 — INTERIOR MONITORING WELL LOCATION AND DESIGNATION
- MW-108 — PERIMETER MONITORING WELL LOCATION
- P-11 — PIEZOMETER
- DPE-14 — DUAL PHASE EXTRACTION (DPE) AND DESIGNATION
- EXCAVATION BOUNDARY
- CUL — CLEANUP LEVEL
- REL — REMEDIATION LEVEL
- PROPERTY BOUNDARY
- WSDOT STORMWATER LINE
- POINT EDWARDS STORM DRAIN LINE
- PROPOSED DPE MONITORING PIEZOMETERS
- EXISTING DPE MONITORING PIEZOMETERS
- SOIL SAMPLE LOCATION WITH ANALYTE CONCENTRATIONS EXCEEDING SITE CULs OR RELs
- SOIL SAMPLE LOCATION WITH ANALYTE CONCENTRATIONS EXCEEDING TWICE THE CUL
- PROPOSED ELECTRICAL CONDUIT TRENCHING
- TREATED GROUNDWATER DISCHARGE LINE
- GROUNDWATER CONVEYING PIPING
- VAPOR CONVEYING PIPING
- ESTIMATED DPE ROI – 30 FOOT RADIUS OF INFLUENCE
- PROPOSED PIPE TRENCHING

NOTES:

1. 20–MIL POLYETHYLENE SHEETING INSTALLED UPON COMPLETION OF PHASE I EXCAVATION. SHEETING REACHES TO APPROXIMATELY 7.5 FEET ABOVE MEAN SEA LEVEL.
2. HORIZONTAL DATUM: WASHINGTON STATE COORDINATE SYSTEM NORTH ZONE (NAD 83/98).
VERTICAL DATUM: N.A.V.D. 88
UNITS: U.S. SURVEY FEET
HORIZONTAL AND VERTICAL CONTROL ESTABLISHED BY GPS VIA VERTICAL REFERENCE STATION NETWORK (VRSN).
3. SOUTHEAST PORTION OF WSDOT STORMWATER LINE HAS NOT BEEN SURVEYED.
4. LOCATION OF EXISTING POWER SUPPLY PANEL HAS NOT BEEN SURVEYED.

0 70' 140'

GRAPHIC SCALE

CHEVRON ENVIRONMENTAL MANAGEMENT COMPANY
FORMER UNOCAL BULK FUEL TERMINAL
EDMONDS, WASHINGTON
FINAL FEASIBILITY STUDY REPORT

ALTERNATIVE 6: EXCAVATION, DUAL PHASE EXTRACTION TREATMENT AND LIMITED ENVIRONMENTAL COVENANT

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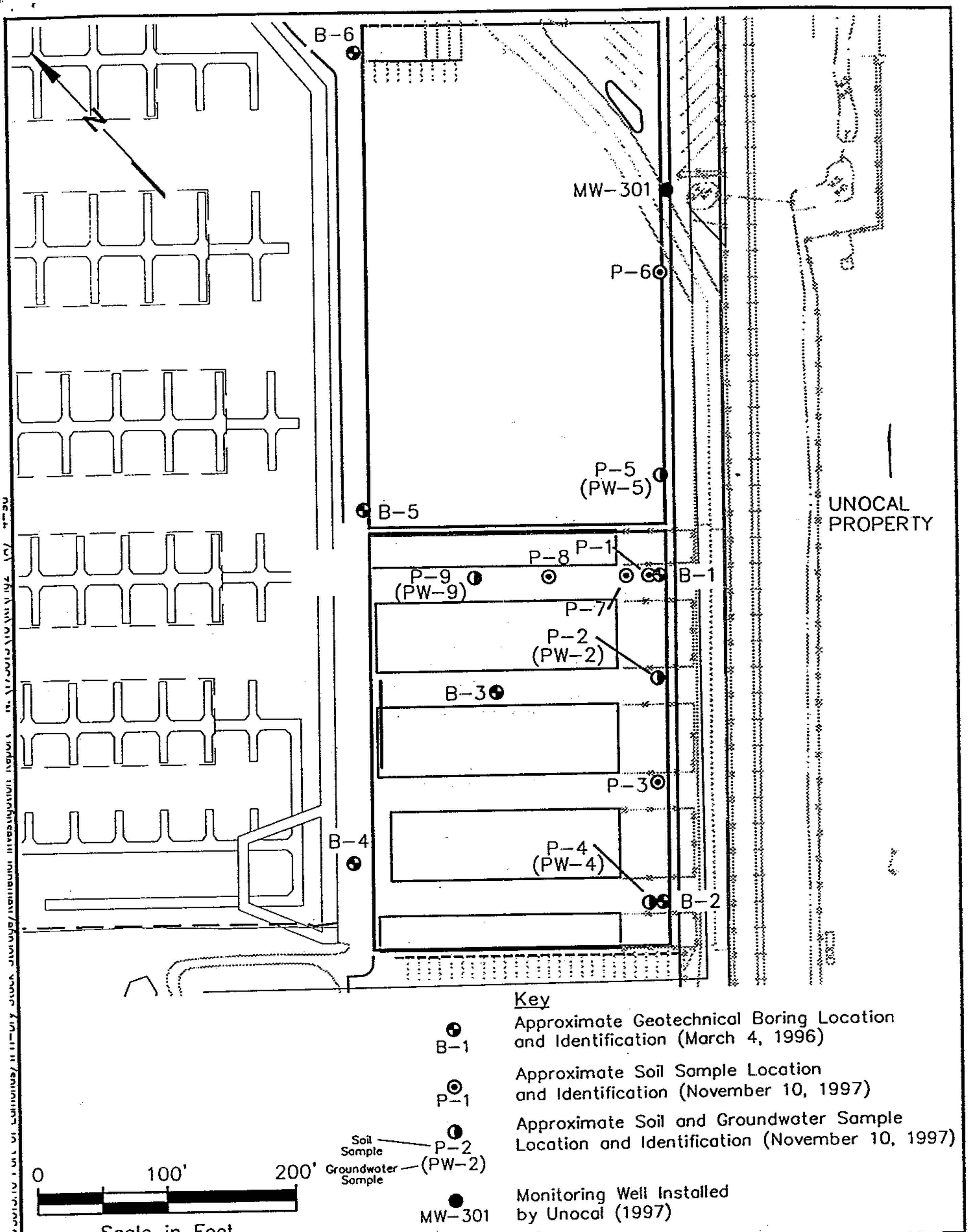
FIGURE
6-7

APPENDIX A

Selected Data from Previous Investigations

Landau Associates, Inc. 1998. Petroleum Hydrocarbon Investigations, South Marina, Port of Edmonds, Washington. April 8, 1998



Exploration Locations

Figure 2

TABLE 1

SOIL ANALYSIS RESULTS
PROPOSED DRY STACK STORAGE FACILITY (mg/kg, ppm)

Sample ID (depth)		Diesel Range		Motor Oil Range	
Method blank		5.0	U	10	U
P-1 S-2	5.9' - 6.3'	1,100		2,200	
P-1 S-3	8.6' - 9'	17,000		20,000	
P-2 S-3	9.7' - 10'	450		740	
P-3 S-3	9.5' - 10'	69		140	
P-4 S-3	9.2' - 9.8'	5.5	U	11	U
P-5 S-3	9.0' - 10.0'	120		250	
P-6 S-3	9.0' - 10.0'	5.4	U	11	U
P-7 S-2	6.0' - 6.75'	5.3	U	11	U
P-7 S-3	8.5' - 9.5'	16,000		16,000	
P-7 S-4	12.0' - 12.75'	9,800		10,000	
P-8 S-3	8.5' - 9.2'	15,000		15,000	
P-8 S-4	12.0' - 12.75'	590		530	
P-9 S-3	9.0' - 10.0'	5.5	U	11	U
P-9 S-4	11.25' - 12.0'	6.6		12	
P-9 S-4	deep	6.2		12	

TABLE 2

GROUNDWATER ANALYSIS RESULTS
PROPOSED DRY STACK STORAGE FACILITY (mg/L, ppm)

Sample ID (depth)		Diesel Range		Motor Oil Range	
Method blank		0.25	U	0.50	U
PW-2	9.0'	13		11	
PW-4	9.0'	0.26		0.50	U
PW-5	8.5'	0.92		1.0	
PW-9	9.25'	0.44		0.50	U

EMCON. 1998. Remedial Investigation Report, Unocal Edmonds Bulk Fuel Terminal. October 19, 1998

Table 2-1

Soil Petroleum Hydrocarbon Data
UNOCAL Edmonds Bulk Fuel Terminal

Location Number	Date Sampled	Depth Sampled (feet)	TPH as Gasoline[a]	TPH as Diesel[a]	TPH-IR[b]	Benzene[c]	Toluene[c]	Ethylbenzene[c]	Total Xylenes[c]
General Lower Yard									
HA-24	04/30/91	1.0	14	160	3,100	—	—	—	—
HA-25[f]	04/30/91	2.0	<10	1,200	11,000	—	—	—	—
HA-101A	12/23/92	2.5	<5J	<25[d]	—	<0.05J	<0.1J	<0.1J	<0.1J
HA-102A	12/23/92	2.0	<5J	<25[d]	—	<0.05J	<0.1J	<0.1J	<0.1J
LM-1	4/17/89	3.0	—	—	260	—	—	—	—
LM-1	4/17/89	8.0	—	—	120	—	—	—	—
LM-2	4/17/89	1.5	—	—	65	—	—	—	—
LM-3	4/17/89	2.0	—	—	360	—	—	—	—
MW-27-1 (BNRR)	05/03/91	2.5	<5	<5	<5	—	—	—	—
MW-27-3 (BNRR)	05/03/91	12.5	<5	<5	—	<0.025	<0.025	<0.025	<0.025
MW-28-2 (BNRR)	05/03/91	7.5	<5	<5	<5	—	—	—	—
MW-28-3 (BNRR)	05/03/91	12.5	<5	<5	—	<0.025	<0.025	<0.025	<0.025
MW-29-2 (BNRR)	05/03/91	7.5	<5	<5	<5	—	—	—	—
MW-29-3 (BNRR)	05/03/91	12.5	<5	<5	—	<0.025	<0.025	<0.025	<0.025
MW-101B	12/22/92	5.5	<5J	<25[d]	—	<0.05J	<0.1J	<0.1J	<0.1J
MW-101C	12/22/92	8.0	43J	<25[d]	—	<0.05J	0.1J	0.3J	0.8J
MW-102B	12/22/92	6.0	<5J	<25[d]	—	<0.05J	<0.1J	<0.1J	<0.1J
MW-102C	12/22/92	8.0	2.7J	2,360*[d]	—	<0.05J	3.7J	5.1J	33.6J
MW-103B	12/22/92	6.0	<5J	2,670J*[d]	—	<0.05J	<0.1J	<0.1J	<0.1J
MW-103C	12/22/92	8.0	<5J	<25[d]	—	<0.05J	<0.1J	<0.1J	<0.1J
MW-104A	12/22/92	5.0	<5J	<25[d]	—	<0.05J	<0.1J	<0.1J	<0.1J
MW-104B	12/22/92	7.5	<5J	<25[d]	—	<0.05J	<0.1J	<0.1J	<0.1J
TP-5	09/90	2.0	<5	180	530	<0.025	<0.025	<0.025	<0.025

Table 5-1
TPH and BTEX in Soil
Admiral Way Borings
UNOCAL Edmonds Terminal

SITE	DATE	DEPTH	TPH - DRO (mg/kg)	TPH - HO (mg/kg)	TPH - GRO (mg/kg)	Benzene (mg/kg)	Ethylbenzene (mg/kg)	Toluene (mg/kg)	Total xylenes (mg/kg)
SB-1	08/23/01	3.5	<10.0	<25.0	<5.00	<0.0300	<0.0500	<0.0500	<0.100
SB-1	08/23/01	6	2190 J	<275	366 J	<0.120 J	0.348 J	<0.200 J	1.05 J
SB-2	08/23/01	6	88.4	84.5	<5.00	<0.0300	<0.0500	<0.0500	<0.100
SB-3	08/24/01	7	15.1	43.8	<5.00	<0.0300	<0.0500	<0.0500	<0.100
SB-4	08/23/01	3.5	<10.0 J	<25.0 J	<5.00 J	<0.0300 J	<0.0500 J	<0.0500 J	<0.100 J
SB-4	08/23/01	6	2010	1190	<5.00	<0.0300	<0.0500	<0.0500	<0.100
SB-5	08/24/01	7	<10.0	<25.0	<5.00	<0.0300	<0.0500	<0.0500	<0.100
SB-6	08/24/01	5	82.3 J	159 J	<5.00 J	<0.0300 J	<0.0500 J	<0.0500 J	<0.100 J
SB-7	08/24/01	5	<10.0	<25.0	<5.00	<0.0300	<0.0500	<0.0500	<0.100

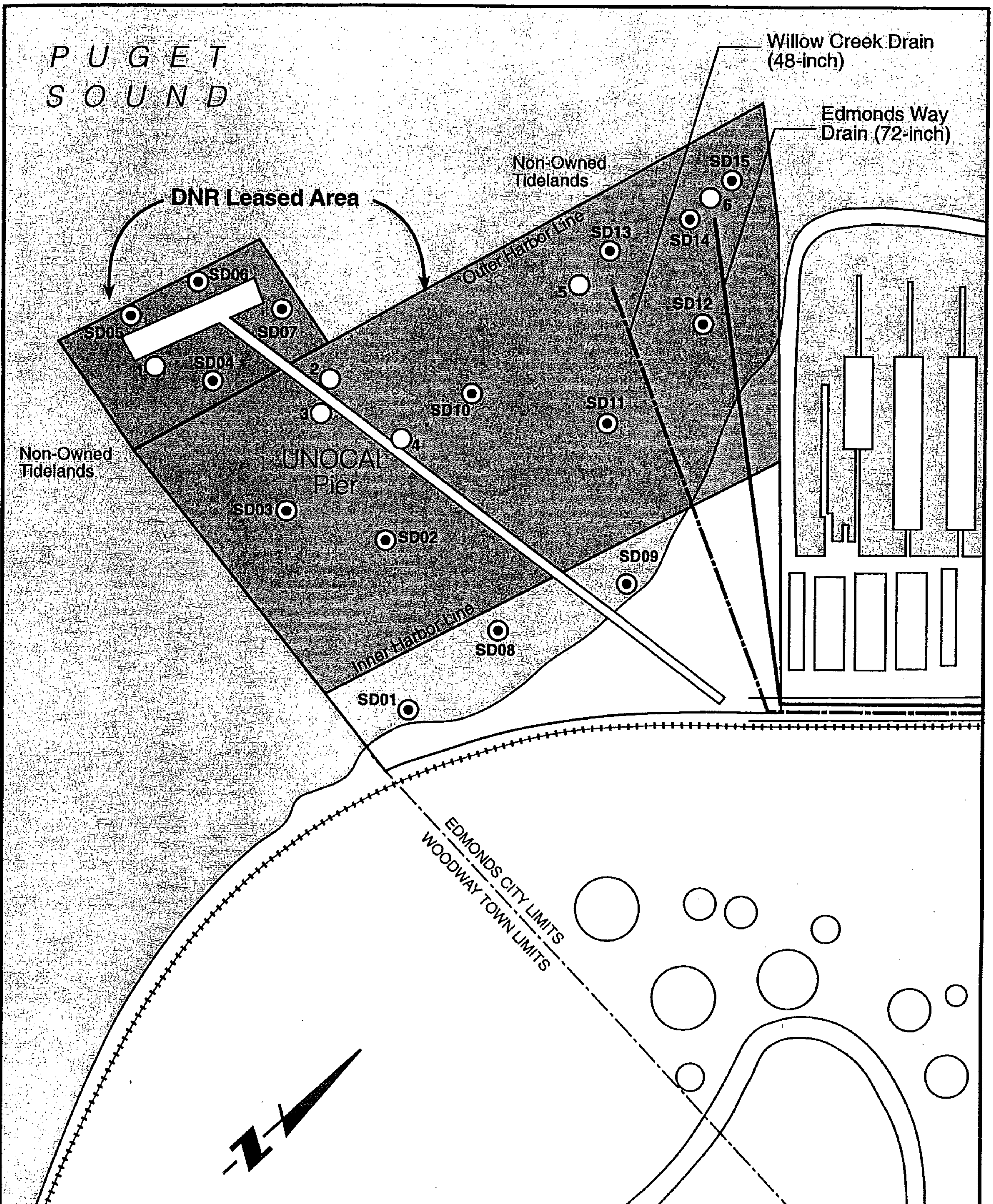
Values represent total concentration unless noted. < = Not detected at indicated reporting limit. --- = Not analyzed. J = Estimated result.

Table 5-2
PAHs in Soil
Admiral Way Borings
UNOCAL Edmonds Terminal

CONSTITUENT	(Units in mg/kg)	SITE DATE DEPTH (ft)	SB-1 8/23/01 3.5	SB-1 8/23/01 6	SB-2 8/23/01 6	SB-3 8/24/01 7	SB-4 8/23/01 3.5	SB-4 8/23/01 6	SB-5 8/24/01 7	SB-6 8/24/01 5	SB-7 8/24/01 5
1-Methylnaphthalene			<0.200	1.68	<0.200	<0.200	<0.100 J	<0.200	<0.100	<0.200	<0.100
2-Methylnaphthalene			<0.200	1.13	<0.200	<0.200	<0.100 J	<0.200	<0.100	<0.200	<0.100
Acenaphthene			<0.0200	0.352	0.0238	<0.0100	<0.0100 J	0.154	<0.0100	<0.0200	<0.0100
Acenaphthylene			<0.0200	<0.0200	<0.0200	<0.0100	<0.0100 J	<0.0200	<0.0100	<0.0200	<0.0100
Anthracene			<0.0200	<0.0200	0.0409	<0.0100	0.011 J	0.373	<0.0100	<0.0200	<0.0100
Benzo(a)anthracene			<0.0200	0.0978	0.0426	<0.0100	0.0378 J	0.721	<0.0100	0.0406	<0.0100
Benzo(a)pyrene			<0.0200	0.0349	0.0358	<0.0100	0.0549 J	0.305	<0.0100	0.0469	<0.0100
Benzo(b)fluoranthene			<0.0200	0.0559	0.0613	<0.0100	0.057 J	0.315	<0.0100	0.0734	<0.0100
Benzo(ghi)perylene			<0.0200	<0.0200	0.0375	<0.0100	0.0364 J	0.194	<0.0100	0.0687	<0.0100
Benzo(k)fluoranthene			<0.0200	<0.0200	<0.0200	<0.0100	0.0124 J	0.048	<0.0100	<0.0200	<0.0100
Chrysene			<0.0200	0.0992	0.0562	<0.0100	0.0343 J	0.803	<0.0100	0.0625	<0.0100
Dibenzo(a,h)anthracene			<0.0200	<0.0200	<0.0200	<0.0100	0.022 J	<0.0200	<0.0100	0.0593	<0.0100
Fluoranthene			<0.0200	0.299	0.177	<0.0100	0.0735 J	1.16	<0.0100	0.0765	<0.0100
Fluorene			<0.0200	0.939	0.0324	<0.0100	<0.0100 J	0.374	<0.0100	<0.0200	<0.0100
Indeno(1,2,3-cd)pyrene			<0.0200	0.0559	0.08	<0.0100	0.059 J	0.166	<0.0100	0.106	<0.0100
Naphthalene			0.0307	0.0796	0.0272	<0.0100	<0.0100 J	<0.0200	<0.0100	<0.0200	<0.0100
Phenanthrene			<0.0200	1.07	0.0851	<0.0100	0.0391 J	1.42	<0.0100	0.0234	<0.0100
Pyrene			<0.0200	0.314	0.155	<0.0100	0.0851 J	1.41	<0.0100	0.0718	<0.0100

Values represent total concentration unless noted.
< = Not detected at indicated reporting limit.
--- = Not analyzed.
J = Estimated result.

CH2MHILL. 2000. Draft work Plan. City of Edmonds Sediment Investigation. June 2000. And associated EIM results



SCALE IN FEET

0 200 400

SCALE IN METERS

0 50 100

Legend

○ Unocal Sample

◉ CH2M HILL Sediment Sample Location

Figure 6

Sediment Sampling Locations and Historical UNOCAL Sampling Locations

154090.G1.06_E052000017SEA • Edmonds Sed. Investigation • New Sediment Sampling2 • 12/21/00 • DK/LW/jg

TABLE 2

Comparison of Edmonds Sediment Data to Applicable Standards or Screening Values

Method	Compound	CAS	Units	Criteria Source[a]	Standard Criteria	SD-01	SD-02	SD-03	SD-04	SD-04D	SD-05	SD-06	SD-07	SD-08	SD-09	SD-10
SW8260	1,3-Dichlorobenzene	541-73-1	ug/kg-dry	Marine AET	>170	1.1 U	0.8 U	0.9 U	0.9 U	0.9 U	0.9 U	1 U	0.9 U	1 U	0.9 U	0.9 U
SW8260	1,4-Dichlorobenzene	106-46-7	ug/kg-dry	Marine AET	110	1.1 U	0.8 U	0.9 U	0.9 U	0.9 U	0.9 U	1 U	0.9 U	1 U	0.9 U	0.9 U
PSDDA	bis(2-Ethylhexyl)phthalate	117-81-7	ug/kg-dry	Marine AET	1300	39	19 U	19 U	19 U	19 U	63	33	20 U	19 U	25	19 U
PSDDA	Butylbenzylphthalate	85-68-7	ug/kg-dry	Marine AET	63	19 U	19 U	19 U	19 U	19 U	20 U	20 U	20 U	19 U	19 U	19 U
PSDDA	Di-n-Butylphthalate	84-74-2	ug/kg-dry	Marine AET	1400	19 U	19 U	19 U	34	19 U	20 U	20 U	20 U	19 U	19 U	19 U
PSDDA	Di-n-Octyl phthalate	117-84-0	ug/kg-dry	Marine AET	>420	19 U	19 U	19 U	19 U	19 U	20 U	20 U	20 U	19 U	19 U	19 U
PSDDA	Dibenzofuran	132-64-9	ug/kg-dry	Marine AET	540	19 U	19 U	19 U	19 U	19 U	20 U	20 U	20 U	19 U	19 U	19 U
PSDDA	Diethylphthalate	84-66-2	ug/kg-dry	Marine AET	>48	19 U	19 U	19 U	19 U	19 U	20 U	20 U	20 U	19 U	19 U	19 U
PSDDA	Dimethylphthalate	131-11-3	ug/kg-dry	Marine AET	71	19 U	19 U	19 U	19 U	19 U	20 U	20 U	20 U	19 U	19 U	19 U
SW8081	Hexachlorobenzene	118-74-1	ug/kg-dry	Marine AET	22	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
SW8081	Hexachlorobutadiene	87-68-3	ug/kg-dry	Marine AET	11	0.2	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
PSDDA	Hexachloroethane	67-72-1	ug/kg-dry	Marine AET	73	19 U	19 U	19 U	19 U	19 U	20 U	20 U		19 U	19 U	19 U
PSDDA	N-Nitrosodiphenylamine	86-30-6	ug/kg-dry	Marine AET	28	19 U	19 U	19 U	19 U	19 U	20 U	20 U	20 U	19 U	19 U	19 U
Semi Volatiles (analytes that do not have organic carbon normalized Marine SQS)																
PSDDA	2,4-Dimethylphenol	105-67-9	ug/kg-dry	Marine SQS	29000	19 U	19 U	19 U	19 U	19 U	20 U	20 U	20 U	19 U	19 U	19 U
PSDDA	2-Methylphenol	95-48-7	ug/kg-dry	Marine SQS	63000	19 U	19 U	19 U	19 U	19 U	20 U	20 U	20 U	19 U	19 U	19 U
PSDDA	4-Methylphenol	106-44-5	ug/kg-dry	Marine SQS	670000	19 U	19 U	19 U	19 U	19 U	20 U	20 U	20 U	19 U	19 U	19 U
PSDDA	Benzoic Acid	65-85-0	ug/kg-dry	Marine SQS	650000	190 U	190 U	190 U	190 U	190 U	120 J	200 U	200 U	190 U	190 U	190 U
PSDDA	Benzyl Alcohol	100-51-6	ug/kg-dry	Marine SQS	57000	19 U	19 U	19 U	19 U	19 U	20 U	20 U	20 U	19 U	19 U	19 U
PSDDA	Pentachlorophenol	87-86-5	ug/kg-dry	Marine SQS	360000	97 U	94 U	93 U	96 U	95 U	98 U	99 U	98 U	97 U	93 U	94 U
PSDDA	Phenol	108-95-2	ug/kg-dry	Marine SQS	420000	19 U	19 U	19 U	19 U	19 U	140	20 U	20 U	19 U	19 U	19 U

All analytes are below sediment criteria and screening levels.

[a] Marine SQS - Marine Sediment Qualifity Standard from Sediment Management Standard (WAC 173-204)
Revised December 1995. Marine AET - Apparent Effects Threshold from PSEP, 1988.
Hexachloroethane AET based on draft 1998 and 1999 AETs since no published values are available.

Q - Data Qualifiers

J = Estimated value.
U = Non-detected at the given detection limit.
Y = Raised reporting limit due to matrix interferences. Analyte may be present at or below the listed concentration.

Acronyms

ug/kg-dry = micrograms per kilogram, dry weight
mg/kg-dry = miligrams per kilogram, dry weight

LPAH - includes Acenaphthene, Acenaphtylene, Anthracene, Fluorene, Naphthalene, and Phenanthrene.
HPAH - includes Fluoranthene, Pyrene, Benz(a)anthracene, Chrysene, Total Benzofluoranthenes,
Benzo(a)pyrene, Indeno(1,2,3,-c,d)pyrene, Dibenzo(a,h)anthracene, and Benzo(g,h,i)perylene
Total PCBs - includes Aroclor 1016, Aroclor 1221, Aroclor 1232, Aroclor 1242, Aroclor 1248, Aroclor 1254, and Aroclor 1260.

TABLE 2

Comparison of Edmonds Sediment Data to Applicable Standards or Screening Values

Method	Compound	CAS	Units	Criteria Source[a]	Standard Criteria	SD-10-D	SD-11	SD-12	SD-13	SD-14	SD-15	SDREF-1	SDREF-2	SDREF-3
General Chemistry														
EPA 350.1M	N-Ammonia		mg-N/kg			0.53	1.9	0.23	2.9	4.1	2.8	2.6	3.6	8.2
EPA 376.2	Sulfide		mg/kg			0.32 U	0.3 U	0.27 U	16	12	7.5	0.3 U	0.32 U	0.32 U
Plumb,1981	Total Organic Carbon		Percent			0.051	0.094	0.06	0.12	0.11	1.3	0.36	0.33	0.34
EPA 160.3	Total Solids		Percent			81	82.2	84.4	75.9	79.4	75.1	79.4	79.4	80.9
PCBs														
Total PCBs				Marine AET	130	5.6 U	2.9 U	5.5 U	5.5 U	5.6 U	5.9 U	5.5 U	5.5 U	5.4 U
SW8081	Aroclor 1016	12674-11-2	ug/kg-dry			2.8 U	2.9 U	2.7 U	2.7 U	2.8 U	2.8 U	2.7 U	2.8 U	2.7 U
SW8081	Aroclor 1221	11104-28-2	ug/kg-dry			5.6 U	5.7 U	5.5 U	5.5 U	5.6 U	5.6 U	5.5 U	5.5 U	5.4 U
SW8081	Aroclor 1232	11141-16-5	ug/kg-dry			2.8 U	2.9 U	2.7 U	2.7 U	2.8 U	2.8 U	2.7 U	2.8 U	2.7 U
SW8081	Aroclor 1242	53469-21-9	ug/kg-dry			2.8 U	2.9 U	2.7 U	2.7 U	2.8 U	2.8 U	2.7 U	2.8 U	2.7 U
SW8081	Aroclor 1248	12672-29-6	ug/kg-dry			2.8 U	2.9 U	2.7 U	2.7 U	2.8 U	2.8 U	2.7 U	2.8 U	2.7 U
SW8081	Aroclor 1254	11097-69-1	ug/kg-dry			2.8 U	2.9 U	2.7 U	2.7 U	2.8 U	2.8 U	2.7 U	2.8 U	2.7 U
SW8081	Aroclor 1260	11096-82-5	ug/kg-dry			2.8 U	2.9 U	2.7 U	2.7 U	2.8 U	2.8 U	2.7 U	2.8 U	2.7 U
Metals														
6010	Antimony	7440-36-0	mg/kg-dry			6 U	6 U	6 U	7 U	6 U	7 U	7 U	7 U	7 U
6010	Arsenic	7440-38-2	mg/kg-dry	Marine SQS	57	6 U	6 U	6 U	7 U	6 U	7 U	7 U	7 U	7 U
6010	Cadmium	7440-43-9	mg/kg-dry	Marine SQS	5.1	0.2 U	0.2 U	0.2 U	0.3 U	0.2 U	0.3 U	0.3 U	0.3 U	0.3 U
6010	Chromium	7440-47-3	mg/kg-dry	Marine SQS	260	25.9	17	13.7	23.8	22.6	27.2	13.3	12.9	14.6
6010	Copper	7440-50-8	mg/kg-dry	Marine SQS	390	5.7	6.4	7.9	9.7	7.5	11.3	3.4	3.1	3.8
6010	Lead	7439-92-1	mg/kg-dry	Marine SQS	450	10	4	3	4	5	5	4	4	5
7471	Mercury	7439-97-6	mg/kg-dry	Marine SQS	0.41	0.05 U	0.05 U	0.05 U	0.07 U	0.06 U	0.06 U	0.06 U	0.05 U	0.07 U
6010	Nickel	7440-02-0	mg/kg-dry			21	18	17	29	28	35	11	9	11
6010	Silver	7440-22-4	mg/kg-dry	Marine SQS	6.1	0.3 U	0.4 U	0.3 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
6010	Zinc	7440-66-6	mg/kg-dry	Marine SQS	410	25.3	24.2	28.8	26.6	32.7	34.8	14.9	13.9	16.5
PAHs														
Low Molecular Weight Polynuclear Aromatic Hydrocarbon				Marine AET	5200	19 U	19 U	19 U	19 U	19 U	42	19 U	19 U	19 U
PSDDA	Acenaphthene	83-32-9	ug/kg-dry	Marine AET	500	19 U	19 U	19 U	19 U	19 U	19 U	19 U	19 U	19 U
PSDDA	Acenaphthylene	208-96-8	ug/kg-dry	Marine AET	>560	19 U	19 U	19 U	19 U	19 U	19 U	19 U	19 U	19 U
PSDDA	Anthracene	120-12-7	ug/kg-dry	Marine AET	960	19 U	19 U	19 U	19 U	19 U	19 U	19 U	19 U	19 U
PSDDA	Fluorene	86-73-7	ug/kg-dry	Marine AET	540	19 U	19 U	19 U	19 U	19 U	19 U	19 U	19 U	19 U
PSDDA	Naphthalene	91-20-3	ug/kg-dry	Marine AET	2100	19 U	19 U	19 U	19 U	19 U	19 U	19 U	19 U	19 U
PSDDA	Phenanthrene	85-01-8	ug/kg-dry	Marine AET	1500	19 U	19 U	19 U	19 U	19 U	19 U	19 U	19 U	19 U
PSDDA	2-Methylnaphthalene	91-57-6	ug/kg-dry	Marine AET	670	19 U	19 U	19 U	19 U	19 U	42	19 U	19 U	19 U
High Molecular Weight Polynuclear Aromatic Hydrocarbon				Marine AET	12000	19 U	19 U	29 J	53	19 U	348	19 U	19 U	19 U
PSDDA	Benzo(a)anthracene	56-55-3	ug/kg-dry	Marine AET	1300	19 U	19 U	19 U	19 U	19 U	33	19 U	19 U	19 U
PSDDA	Benzo(a)pyrene	50-32-8	ug/kg-dry	Marine AET	1600	19 U	19 U	19 U	19 U	19 U	29	19 U	19 U	19 U
PSDDA	Benzo(b)fluoranthene	205-99-2	ug/kg-dry	Marine AET	3200	19 U	19 U	19 U	19 U	19 U	26	19 U	19 U	19 U
PSDDA	Benzo(g,h,i)perylene	191-24-2	ug/kg-dry	Marine AET	670	19 U	19 U	19 U	19 U	19 U	21	19 U	19 U	19 U
PSDDA	Benzo(k)fluoranthene	207-08-9	ug/kg-dry	Marine AET	3200	19 U	19 U	19 U	19 U	19 U	25	19 U	19 U	19 U
PSDDA	Chrysene	218-01-9	ug/kg-dry	Marine AET	1400	19 U	19 U	19 U	19 U	19 U	31	19 U	19 U	19 U
PSDDA	Dibenz(a,h)anthracene	53-70-3	ug/kg-dry	Marine AET	230	19 U	19 U	19 U	19 U	19 U	19 U	19 U	19 U	19 U
PSDDA	Fluoranthene	206-44-0	ug/kg-dry	Marine AET	1700	19 U	19 U	16 J	33	19 U	120	19 U	19 U	19 U
PSDDA	Indeno(1,2,3-cd)pyrene	193-39-5	ug/kg-dry	Marine AET	600	19 U	19 U	19 U	19 U	19 U	19 U	19 U	19 U	19 U
PSDDA	Pyrene	129-00-0	ug/kg-dry	Marine AET	2600	19 U	19 U	13 J	20	19 U	63	19 U	19 U	19 U
Semi Volatiles (analytes that have organic carbon normalized Marine SQS)														
SW8260	1,2,4-Trichlorobenzene	120-82-1	ug/kg-dry	Marine AET	31	4.9 U	3.7 U	4.7 U	4.4 U	4.9 U	4.7 U	5.2 U	5.3 U	5 U
SW8260	1,2-Dichlorobenzene	95-50-1	ug/kg-dry	Marine AET	35	1 U	0.7 U	0.9 U	0.9 U	1 U	0.9 U	1 U	1.1 U	1 U

Maul Foster & Alongi, Inc. 2003b. Draft Supplemental Remedial Investigation Report, Unocal Edmonds Terminal, Edmonds, Washington. April 28, 2003. SIT3.12

LEGEND:

Sample Depth (in feet below ground surface)	TPH (as gasoline or gasoline-range) (mg/kg)	TPH (as diesel or diesel-range) (mg/kg)	TPH (as oil or heavy oil) (mg/kg)
0.0	0	0	0
2.5	0	0	0
5.0	0	0	0
7.5	0	0	0
10	0	0	0

U = NOT DETECTED AT OR ABOVE THE METHOD REPORTING LIMIT.

CONCENTRATIONS IN mg/kg.

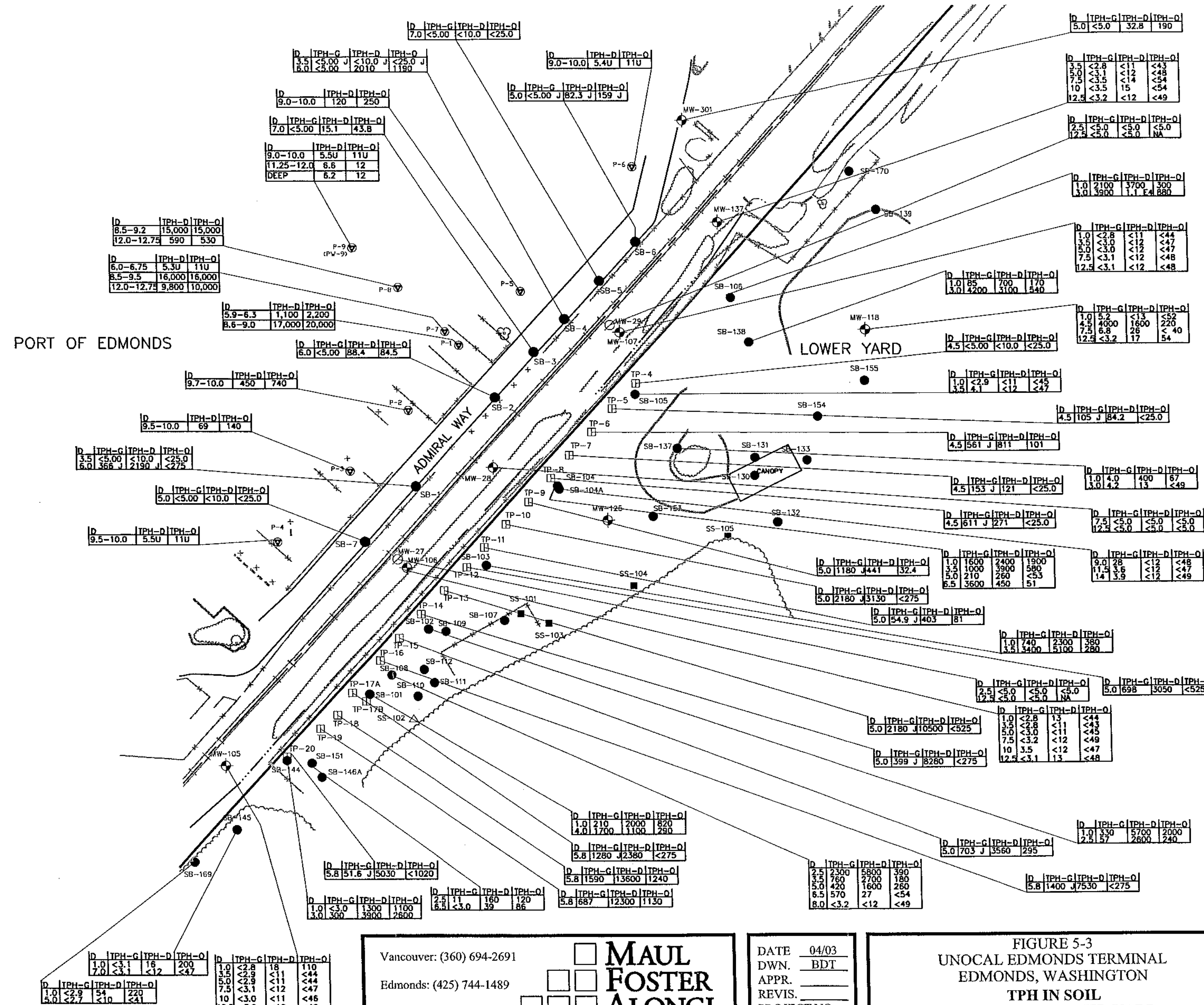
NOTES:
1) P-1 THROUGH P-9 DATA WERE COLLECTED BY LANDAU ASSOCIATES, INC. IN NOVEMBER 1997.

2) MW-27 THROUGH MW-29 DATA WERE COLLECTED BY GEOENGINEERS IN 1991.

3) SB-100 SERIES AND MW-100 SERIES DATA WERE COLLECTED BY EMCON IN 1995.

4) SB-1 THRU SB-7 AND TP-4 THRU TP-20 DATA WERE COLLECTED BY MFA IN 2001.

- Property Boundary
- Test Pit
- Soil Boring
- Monitoring Well/Boring
- Abandoned Monitoring Well/Boring



0 100 200
SCALE IN FEET

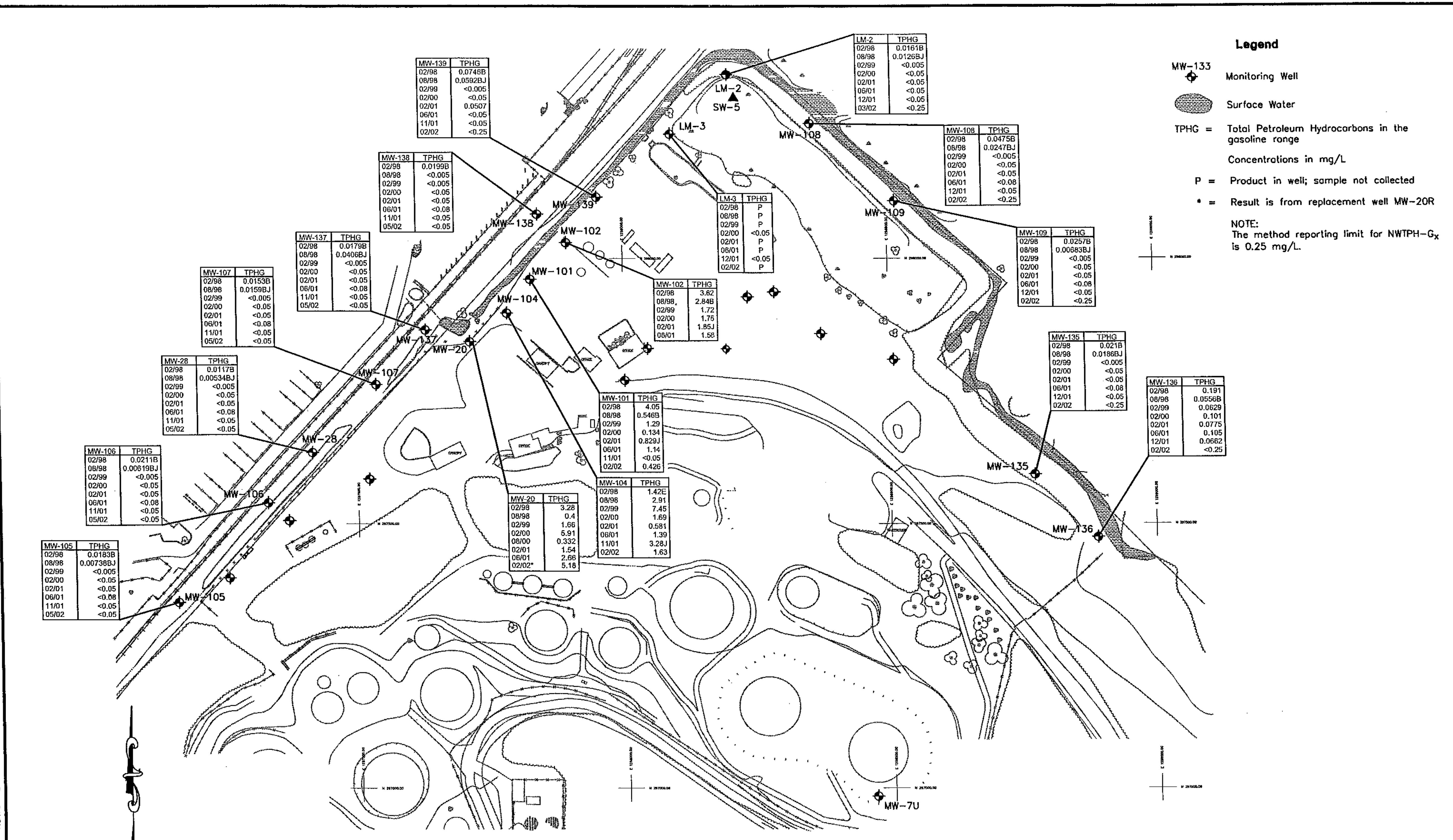
File: \9077\01.05\006-5-3.DWG Last edited: APR 24, 2003 by: btookey Xrefs: wells Black/White

Vancouver: (360) 694-2691
Edmonds: (425) 744-1489
Portland: (971) 544-2139
MAUL FOSTER ALONGI

DATE 04/03
DWN. BDT
APPR.
REVIS.
PROJECT NO.
9077.01.05

FIGURE 5-3
UNOCAL EDMONDS TERMINAL
EDMONDS, WASHINGTON
TPH IN SOIL
SOUTHWEST LOWER YARD, ADMIRAL WAY, PORT OF EDMONDS

LAYOUT: 1



MW-139	TPHG
02/98	0.0746B
08/98	0.0592BJ
02/99	<0.005
02/00	<0.05
02/01	0.0507
06/01	<0.05
11/01	<0.05
02/02	<0.25

MW-138	TPHG
02/98	0.0199B
08/98	<0.005
02/99	<0.005
02/00	<0.05
02/01	<0.05
06/01	<0.08
11/01	<0.05
05/02	<0.05

MW-137	TPHG
02/98	0.0179B
08/98	0.0406BJ
02/99	<0.005
02/00	<0.05
02/01	<0.05
06/01	<0.08
11/01	<0.05
05/02	<0.05

MW-107	TPHG
02/98	0.0153B
08/98	0.0159BJ
02/99	<0.005
02/00	<0.05
02/01	<0.05
06/01	<0.08
11/01	<0.05
05/02	<0.05

MW-28	TPHG
02/98	0.0117B
08/98	0.00534BJ
02/99	<0.005
02/00	<0.05
02/01	<0.05
06/01	<0.08
11/01	<0.05
05/02	<0.05

MW-106	TPHG
02/98	0.0211B
08/98	0.00619BJ
02/99	<0.005
02/00	<0.05
02/01	<0.05
06/01	<0.08
11/01	<0.05
05/02	<0.05

MW-105	TPHG
02/98	0.0183B
08/98	0.00738BJ
02/99	<0.005
02/00	<0.05
02/01	<0.05
06/01	<0.08
11/01	<0.05
05/02	<0.05

LM-2	TPHG
02/98	0.0161B
08/98	0.0126BJ
02/99	<0.005
02/00	<0.05
02/01	<0.05
06/01	<0.05
12/01	<0.05
03/02	<0.25

MW-108	TPHG
02/98	0.0475B
08/98	0.0247BJ
02/99	<0.005
02/00	<0.05
02/01	<0.05
06/01	<0.08
12/01	<0.05
02/02	<0.25

LM-3	TPHG
02/98	P
08/98	P
02/99	P
02/00	<0.05
02/01	P
06/01	P
12/01	<0.05
02/02	P

MW-109	TPHG
02/98	0.0257B
08/98	0.00683BJ
02/99	<0.005
02/00	<0.05
02/01	<0.05
06/01	<0.08
12/01	<0.05
02/02	<0.25

MW-102	TPHG
02/98	3.62
08/98*	2.84B
02/99	1.72
02/00	1.75
02/01	1.85J
06/01	1.58

MW-101	TPHG
02/98	4.05
08/98	0.546B
02/99	1.29
02/00	0.134
02/01	0.829J
06/01	1.14
11/01	<0.05
02/02	0.426

MW-104	TPHG
02/98	1.42E
08/98	2.91
02/99	7.45
02/00	1.69
02/01	0.581
06/01	1.39
11/01	3.28J
02/02	1.63

MW-20	TPHG
02/98	3.28
08/98	0.4
02/99	1.66
02/00	5.91
08/00	0.332
02/01	1.54
06/01	2.66
02/02*	5.18

MW-135	TPHG
02/98	0.021B
08/98	0.0186BJ
02/99	<0.005
02/00	<0.05
02/01	<0.05
06/01	<0.08
12/01	<0.05
02/02	<0.25

MW-136	TPHG
02/98	0.191
08/98	0.0556B
02/99	0.0629
02/00	0.101
02/01	0.0775
06/01	0.105
12/01	0.0662
02/02	<0.25

File: \9077\01.05\006-5-4.DWG Last edited: APR 22, 2003 by: btookey Xrefs: none black/white

Vancouver: (360) 694-2691
Edmonds: (425) 744-1489
Portland: (971) 544-2139

MAUL FOSTER ALONGI

DATE 04/03
DWN. BDT
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REVIS.
PROJECT NO.
9077.01.05

FIGURE 5-4
UNOCAL EDMONDS TERMINAL
EDMONDS, WASHINGTON
TPH-G/GRO IN GROUNDWATER PERIMETER MONITORING WELL NETWORK
1998 - 2002

Integral Consulting, Inc. 2003. Unocal Sediment Bioassay Testing. December 11, 2003

Table 1. Summary of Detected Chemicals with SMS Criteria in Unocal Sediment

Analyte	SQS	CSL	SMS Units	US-01-1003	US-02-1003	US-03-1003	US-04-1003	US-05-1003	US-06-1003	US-07-1003	US-08-1003	US-09-1003	US-10-1003	US-11-1003
SVOCs (mg/kg oc)														
2-Methylnaphthalene	38	64	mg/kg oc	9.26 U	1.66 J	1.16 U	1.41 U	0.37 U	1.32 U	1.47 U	0.18 U	0.06 U	0.08 U	**0.17**
bis(2-Ethylhexyl)phthalate	47	78	mg/kg oc	92.58 U	NA	NA	**7.78**	NA	NA	**21.87**	NA	NA	**1.90**	NA
Butylbenzylphthalate	4.9	64	mg/kg oc	92.58 U	NA	NA	7.04 U	NA	NA	7.33 U	NA	NA	0.41 U	NA
Di-n-butylphthalate	220	1700	mg/kg oc	37.08 U	NA	NA	**9.26**	NA	NA	5.85 U	NA	NA	0.33 U	NA
PAHs (mg/kg oc)														
Acenaphthene	16	57	mg/kg oc	3.71 U	1.42 U	0.46 U	**6.07**	0.15 U	0.53 U	0.59 U	0.07 U	**0.25**	0.03 U	**0.70**
Acenaphthylene	66	66	mg/kg oc	**4.35**	1.42 U	0.46 U	0.56 U	0.15 U	0.53 U	0.59 U	0.07 U	**1.03**	**0.08**	**3.65**
Anthracene	220	1200	mg/kg oc	3.71 U	1.42 U	0.46 U	**9.81**	0.26 J	0.88 J	0.59 U	0.07 U	**1.52**	0.03 U	**3.39**
Fluorene	23	79	mg/kg oc	3.71 U	1.42 U	0.46 U	**9.32**	0.15 U	0.53 U	0.59 U	0.07 U	0.02 U	0.03 U	**0.54**
Naphthalene	99	170	mg/kg oc	9.26 U	1.42 U	0.46 U	0.56 U	0.19 J	0.53 U	0.59 U	0.07 U	0.02 U	**0.03**	**0.32**
Phenanthrene	100	480	mg/kg oc	3.71 U	1.42 U	**1.45**	**34.07**	**0.75**	0.53 U	0.59 U	0.07 U	**0.24**	**0.04**	**4.26**
calculated LPAH [1]	370	780	mg/kg oc	**4.35**	**1.66**	**1.45**	**59.28**	**1.20**	**0.88**	0.58 U	0.18 U	**3.04**	**0.15**	**13.01**
Benzo(a)anthracene	110	270	mg/kg oc	9.26 U	1.42 U	0.46 U	0.56 U	0.15 U	0.53 U	**12.47**	0.07 U	**5.22 D10**	0.03 U	**5.68**
Benzo(a)pyrene	99	210	mg/kg oc	9.26 U	1.42 U	**2.68**	0.56 U	**0.73**	0.53 U	**4.91**	0.07 U	**2.73**	0.03 U	**6.52**
Benzo(g,h,i)perylene	31	78	mg/kg oc	3.71 U	1.42 U	NA	0.56 U	NA	0.53 U	**5.69**	NA	**1.11**	0.03 U	**3.17**
Benzofluoranthenes	230	450	mg/kg oc	7.39 U	1.42 U	**3.54**	1.12 U	**1.36**	1.06 U	**11.27**	0.15 U	**2.85**	0.06 U	**7.65**
Chrysene	110	460	mg/kg oc	**9.47**	1.42 U	**3.08**	**5.43**	**1.36**	0.53 U	**18.40**	0.07 U	**3.86**	0.03 U	**5.74**
Dibenz(a,h)anthracene	12	33	mg/kg oc	9.26 U	1.42 U	0.46 U	0.56 U	0.15 U	0.53 U	0.59 U	0.07 U	**0.29**	0.03 U	**0.68**
Fluoranthene	160	1200	mg/kg oc	**7.27**	1.42 U	**3.84**	**3.94**	**1.57**	**2.87**	**7.20**	0.18 U	**1.15**	**0.10**	**5.52**
Indeno(1,2,3-cd)pyrene	34	88	mg/kg oc	9.26 U	1.42 U	**1.70**	0.56 U	**0.52**	0.53 U	**2.26**	0.07 U	**0.80**	0.03 U	**2.81**
Pyrene	1000	1400	mg/kg oc	**9.11**	1.42 U	**4.60**	**11.23**	**1.98**	**3.69**	**11.53**	0.07 U	**1.93**	0.03 U	**8.00**
calculated HPAH [1]	960	5300	mg/kg oc	**25.86**	1.42 U	**19.45**	**20.60**	**7.52**	**6.57**	**73.73**	0.15 U	**19.93**	**0.10**	**45.76**
SVOCs (ug/kg)														
3-&4-Methylphenol	670	670	ug/kg	309 U	NA	NA	182 U	NA	NA	176 U	NA	NA	52.7 U	NA
Phenol	420	1200	ug/kg	155 U	NA	NA	91.1 U	NA	NA	87.8 U	NA	NA	26.4 U	NA
PCBs (mg/kg oc)														
calculated Total PCBs [1]	12	65	mg/kg oc	2.80 U	NA	NA	0.94 U	NA	NA	**32.27**	NA	NA	0.50 U	NA
Metals (mg/kg)														
Arsenic	57	93	mg/kg	**2.08**	**4.24**	**6.22**	**3.4**	**1.47 J**	**12.2**	**2.99**	**4.81**	**10.8**	**20.7**	**3.79 J**
Chromium	260	270	mg/kg	**15.3**	NA	NA	**21.4**	NA	NA	**15.9**	NA	NA	**35.2**	NA
Copper	390	390	mg/kg	**10.4**	**12.7**	**21.3**	**7.58**	**2.24 J**	**17.8**	**12.1**	**19.8**	**19**	**24.7**	**10.2**
Lead	450	530	mg/kg	**11.7**	**6.25**	**10.4**	**5.91**	1.32 U	**67.4**	**21**	**1.84 J**	**48.7**	**23.8**	**18.3**
Mercury	0.41	0.59	mg/kg	0.0113 U	NA	NA	0.0682 B1	NA	NA	0.0664 B1	NA	NA	0.162 B1	NA
Zinc	410	960	mg/kg	**37.9**	**34**	**48.4**	**31.5**	**11.4**	**80.2**	**78.9**	**35.8**	**86.1**	**42.8**	**43.1**
Conventionals (%)														
TOC	--	--	--	**0.42**	**1.27**	**2.24**	**1.62**	**0.52**	**2.95**	**1.50**	**1.48**	**9.06**	**8.11**	**3.10**

Notes:

Bold font indicates detected concentrations

NA = not analyzed

-- = not applicable

SMS criteria for 4-Methylphenol were applied to data for 3-&4-Methylphenol

[1] It was assumed that non-detects were equal to zero except where all individual compounds were non-detect in which case the highest DL was assumed to be the concentration as per WAC 173-204-320(2)(b)(i)

concentration exceeds SQS

concentration exceeds CSL

US-12-1003	US-13-1003	US-14-1003	US-15-1003	US-16-1003	US-20-1003 (US-06 Dup)	US-21-1003 (US-09 Dup)
0.07 U	0.10 U	0.26	0.08 U	0.07 U	0.10 U	7.58 U
NA	1.38	NA	2.53	NA	NA	NA
NA	0.49 U	NA	1.24	NA	NA	NA
NA	0.40 U	NA	0.54	NA	NA	NA
0.07	0.08	0.04 U	0.06	0.03 U	0.04 U	3.03 U
0.10	0.08	0.08 J	0.03 U	0.07	0.25	3.03 U
0.03 U	0.08	0.20	0.11	0.04 J	1.30	3.03 U
0.03 U	0.04 U	0.21	0.10	0.03 U	0.04 U	3.03 U
0.03 U	0.04 U	0.07 J	0.03 U	0.03 U	0.04 U	3.03 U
0.03 J	0.21	1.08	0.47	0.05	0.53	3.03 U
0.20	0.46	1.90	0.73	0.16	2.08	7.58 U
0.03 U	0.34	0.04 U	0.03 U	0.03 U	1.34	3.03 U
0.03 U	0.37	0.04 U	0.30	0.03 U	0.79	3.03 U
0.03 U	0.04 U	0.04 U	0.03 U	0.03 U	0.04 U	3.03 U
0.06 U	0.67	0.08 U	0.60	0.05 U	0.08 U	6.06 U
0.03 U	0.34	0.59	0.03 U	0.03 U	1.07	49.74
0.03 U	0.04 U	0.04 U	0.03 U	0.03 U	0.04 U	3.03 U
0.10 J	0.73	0.27	0.55	0.12 J	1.25	7.58 U
0.03 U	0.04 U	0.04 U	0.28	0.03 U	0.04 U	3.03 U
0.09	0.68	0.60	0.63	0.15	1.98	105.64
0.20	3.14	1.46	2.36	0.27	6.43	155.38
NA	66.1 U	NA	84.8 J	NA	NA	NA
NA	33 U	NA	41.4 J	NA	NA	NA
NA	0.56 U	NA	0.50 U	NA	NA	NA
7.55	12	4.53	12	36.9	12.2	12.4
NA	49.5	NA	21.6	NA	NA	NA
21	27.3	22.1	17.3	58.7	16.7	20.2
11.1	49.6	7.68	73.4	262	69.1	55.6
NA	0.189 B1	NA	0.128 B1	NA	NA	NA
45	121	40.2	102	378	77.4	99.4
5.41	8.35	2.92	7.38	15.30	3.61	7.80

and (ii)

Table 2. Summary of Unocal Sediment TPH Concentrations - Bulk and Organic Carbon Normalized

	Bulk TPH (mg/kg)				Organic Carbon Normalized TPH (mg/kg oc)			
Station	#2 Diesel (NWTPH-D)	Motor Oil (NWTPH-D)	Gasoline (NWTPH-G)	Total TPH	#2 Diesel (NWTPH-D)	Motor Oil (NWTPH-D)	Gasoline (NWTPH-G)	Total TPH
US-01-1003	378 X1	1820	2.42	2,200	90,431	435,407	579	523,910
US-02-1003	54.7	344	5.25 U	401	4,307	27,087	413 U	31,600
US-03-1003	215 X1	1120	8.52	1,344	9,598	50,000	380	59,979
US-04-1003	1470 X1	5480	9.76	6,960	90,741	338,272	602	429,615
US-05-1003	16.2 U	32.4 U	4.85	29	3098 U	6195 U	927	5,606
US-06-1003	180 X1	353 X1	8.12	541	6,102	11,966	275	18,343
US-07-1003	598 X1	325	59.1	982	39,867	21,667	3,940	65,473
US-08-1003	22.4 U	44.8 U	17.1	51	1514 U	3027 U	1,155	3,426
US-09-1003	191 X1	492 X1	15.8	699	2,108	5,430	174	7,713
US-10-1003	57 U	270 X2	11.9	310	703 U	3,329	147	3,827
US-11-1003	24.9 U	110 X2	8.04 U	126	803 U	3,548	259 U	4,080
US-12-1003	32.3 U	64.6 U	10.7 U	54	597 U	1194 U	198 U	994
US-13-1003	71.8 J	490 X2	10.9	573	860	5,868	131	6,859
US-14-1003	27.9 J	47.7 J	7.83 U	80	955	1,634	268 U	2,723
US-15-1003	47.4 J	362	14.3 U	417	642	4,905	194 U	5,644
US-16-1003	81.4 U	470 X2	24.7 U	523	532 U	3,072	161 U	3,419
US-20-1003 (US-06 Dup)	302 X1	555 X1	5.22	862	8,366	15,374	145	23,884
US-21-1003 (US-09 Dup)	256 X1	627 X1	15.7 U	891	3,282	8,038	201 U	11,421

T

	Conventionals
Station	TOC (%)
US-01-1003	0.418
US-02-1003	1.27
US-03-1003	2.24
US-04-1003	1.62
US-05-1003	0.523
US-06-1003	2.95
US-07-1003	1.5
US-08-1003	1.48
US-09-1003	9.06
US-10-1003	8.11
US-11-1003	3.1
US-12-1003	5.41
US-13-1003	8.35
US-14-1003	2.92
US-15-1003	7.38
US-16-1003	15.3
US-20-1003 (US-06 Dup)	3.61
US-21-1003 (US-09 Dup)	7.8

Table 3. Summary of Available Conventional Parameters for Unocal Sediment (2003)

Station	Solids (%)	Ammonia Nitrogen (mg/kg)	Total Volatile Solids (mg/kg)	TOC (%)
US-01-1003	84.95	19.4	1.8	0.418
US-02-1003	NA	NA	NA	1.27
US-03-1003	NA	NA	NA	2.24
US-04-1003	62.42	88.8	5.33	1.62
US-05-1003	NA	NA	NA	0.523
US-06-1003	NA	NA	NA	2.95
US-07-1003	70.43	94.2	4.65	1.5
US-08-1003	NA	NA	NA	1.48
US-09-1003	NA	NA	NA	9.06
US-10-1003	21.68	661	22.8	8.11
US-11-1003	NA	NA	NA	3.1
US-12-1003	NA	NA	NA	5.41
US-13-1003	18.47	945	16.5	8.35
US-14-1003	NA	NA	NA	2.92
US-15-1003	26.06	564	24.7	7.38
US-16-1003	NA	NA	NA	15.3
US-20-1003 (US-06 Dup)	NA	NA	NA	3.61
US-21-1003 (US-09 Dup)	NA	NA	NA	7.8

NA - Not available.

Table 4. Summary of Sediment Grain Size from Historical Samples

Area	Sample Location	TOC (%)	Gravel(%)	Sand (%)	Fines (%)
~~Site~~ Willow creek	US-01	0.78	45.30	51.30	3.30
Site	US-02	0.97	2.00	76.00	22.00
Site	US-03	3.51	0.00	57.60	42.40
Site	US-04	1.27	11.30	81.90	6.80
Site	US-05	1.78	0.90	69.30	29.70
Site	US-06	2.54	2.20	55.10	42.80
Site	US-07	1.58	7.70	76.20	16.10
Site	US-08	2.74	0.70	18.00	81.30
Site	US-09	8.18	5.20	40.50	54.30
Site	US-10	7.38	3.20	30.00	66.80
Site	US-11	6.35	0.40	37.80	61.80
Site	US-12	6.73	0.70	31.20	68.00
Site	US-13	9.43	1.40	28.90	69.70
Site	US-14	7.04	6.60	9.00	84.40
Site	US-15	0.73	0.00	92.80	7.20
Site	US-20	9.97	1.60	28.50	69.90
Background	NISQ	1.05	0.10	75.60	24.30
Background	CARR	0.55	0.00	43.50	56.40
Summary					
Site minumum		0.73	0.00	9.00	3.30
Site maximum		9.97	45.30	92.80	84.40

Table 5. Summary of Historical (1995) Sediment Bioassay Results

Test Species	Amphipod (*Eohaustarius estuaria* s)	Bivalve (*Mytilus edulis*)	Juvenile Polychaete (*Neanthes arenaceodentata*)	Current (2003) Sediment Chemistry				
Sample Number	**Average Mortality (%)**	**Average Normal Survival (%)**	**Mean Growth Rate (mg/individual/day)**	**Gasoline (mg/kg)**	**#2 Diesel (mg/kg)**	**Motor Oil (mg/kg)**	**Bulk Total TPH (mg/kg)**	**OC Normalized Total TPH (mg/kg oc)**
US-01	6	67	0.609	2.42	378 X1	1820	2,200	523,910
US-02	4	67	0.376	5.25 U	54.7	344	401	31,600
US-03	20 *	55 +	0.369	8.52	215 X1	1120	1,344	59,979
US-04	8	76	0.455	9.76	1470 X1	5480	6,960	429,615
US-05	46 * + CSL	61 +	0.416	4.85	16.2 U	32.4 U	29	5,606
US-06	8	77	0.358	8.12	180 X1	353 X1	541	18,343
US-07	7	70	0.362	59.1	598 X1	325	982	65,473
US-08	6	54 * + SQS	0.402	17.1	22.4 U	44.8 U	51	3,426
US-09	22 *	62 +	0.273 * + SQS	15.8	191 X1	492 X1	699	7,713
US-10	14	70	0.456	11.9	57 U	270 X2	310	3,827
US-11	5	78	0.374	8.04 U	24.9 U	110 X2	126	4,080
US-12	19 *	68	0.444	10.7 U	32.3 U	64.6 U	54	994
US-13	18 *	64	0.298 * + SQS	10.9	71.8 J	490 X2	573	6,859
US-14	10	75	0.339	7.83 U	27.9 J	47.7 J	80	2,723
US-15	4	45 * + CSL	0.412	14.3 U	47.4 J	362	417	5,644
NISQ	4	36 * + CSL	0.437	NA	NA	NA	NA	NA
CARR	3	73	0.402	NA	NA	NA	NA	NA
Control-1	2	62	0.275	NA	NA	NA	NA	NA
Control-2	2	69	0.288	NA	NA	NA	NA	NA
Control-3	NA	92	NA	NA	NA	NA	NA	NA

Notes:

* indicates that the test result is significantly different from the reference result

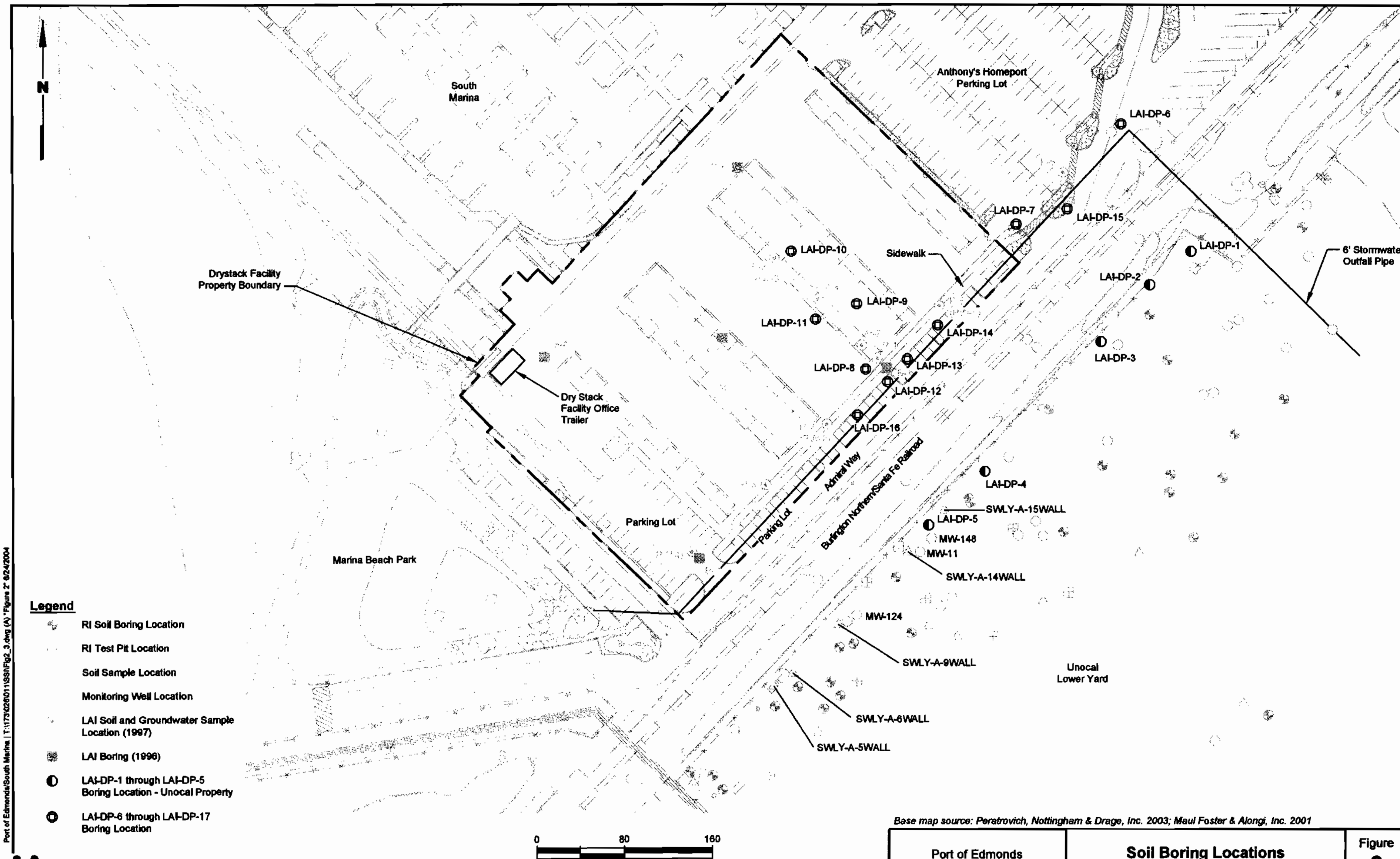
+ indicates that the test result is different from the reference by the magnitude specified in SMS

SQS indicates that the result meets the criteria for a SQS "hit"

CSL indicates that the result meets the criteria for a CSL "hit"

NA = not available

Landau Associates, Inc. 2004. Petroleum Hydrocarbon Investigations, South Marina Dry Stack Storage Facility, Port of Edmonds, Washington. June 24, 2004



Landau Associates

Port of Edmonds
Edmonds, Washington

Soil Boring Locations
South Marina Dry Stack Facility

Figure
2

TABLE 1
SOIL ANALYTICAL RESULTS
SOUTH MARINA DRY STACK STORAGE FACILITY

	MTCA Method A Soil Cleanup Levels for Unrestricted Land Uses	LAI-DP-1 7-8 ft BGS B4E0395-01 5/11/2004	LAI-DP-2 4.5-6 ft BGS B4E0395-02 5/11/2004	LAI-DP-3 3.5-4.5 ft BGS B4E0395-03 5/11/2004	LAI-DP-4 6-8 ft BGS B4E0395-04 5/11/2004	LAI-DP-5 7-8 ft BGS B4E0395-05 5/11/2004	LAI-DP-6 8-10 ft BGS B4E0395-06 5/11/2004	LAI-DP-7 9-11 ft BGS B4E0395-07 5/11/2004	LAI-DP-8 14-16 ft BGS B4E0395-08 5/11/2004	LAI-DP-9 10-12 ft BGS B4E0395-09 5/11/2004
GASOLINE AND BTEX (mg/kg)										
NWTPH-G/EPA 8021B										
Gasoline	30	NA	1580	5.00 U	7680 J (a)	5.00 U	NA	NA	46.8 (b)	225 J (b)
Benzene	0.03	NA	1.54 J	0.0300 U	2.25 J (a)	0.0300 U	NA	NA	0.0300 U	0.120 U
Toluene	7	NA	2.42 J (a)	0.0500 U	8.86	0.0500 U	NA	NA	0.0500 U	0.200 U
Ethylbenzene	6	NA	2.54 J	0.0500 U	33.9	0.0500 U	NA	NA	0.0500 U	0.350 J (a)
Xylenes (total)	9	NA	3.72 J (a)	0.100 U	61.4	0.100 U	NA	NA	0.116 J (a)	1.11 J (a)
NWTPH-Dx (mg/kg)										
Diesel-Range Hydrocarbons	2000	10.0 U	4440	10.0 U	788 (c)	10.0 U	71.9	105	5450	14800
Lube Oil-Range Hydrocarbons	2000	25.0 U	570	25.0 U	1000 U	25.0 U	196	217	5170	14600
cPAHs (mg/kg)										
8270-SIM										
Benzo(a)anthracene		NA	0.0613 J	NA	0.0483	NA	NA	NA	0.152	NA
Benzo(a)pyrene		NA	0.0288 J	NA	0.0257	NA	NA	NA	0.114	NA
Benzo(b)fluoranthene		NA	0.0140 J	NA	0.0294	NA	NA	NA	0.159	NA
Benzo(k)fluoranthene		NA	0.0100 U	NA	0.0226	NA	NA	NA	0.100 U	NA
Chrysene		NA	0.119 J	NA	0.0506	NA	NA	NA	0.561	NA
Dibenz(a,h)anthracene		NA	0.0185 J	NA	0.0128	NA	NA	NA	0.144	NA
Indeno(1,2,3-cd)pyrene		NA	0.0111 J	NA	0.0113	NA	NA	NA	0.100 U	NA
cPAH TEQ (mg/kg)	0.1	NA	0.046	NA	0.042	NA	NA	NA	0.208	NA
DRY WEIGHT (%)		85.0	90.6	85.4	89.8	92.2	86.5	82.7	87.3	93.9

DRAFT

TABLE 1
SOIL ANALYTICAL RESULTS
SOUTH MARINA DRY STACK STORAGE FACILITY

	MTCA Method A Soil Cleanup Levels for Unrestricted Land Uses	LAI-DP-9B 10-12 ft BGS B4E0395-10 5/11/2004	LAI-DP-10 12-16 ft BGS B4E0395-11 5/12/2004	LAI-DP-11 10.5-12 ft BGS B4E0395-12 5/12/2004	LAI-DP-12 10-12 ft BGS B4E0395-13 5/12/2004	LAI-DP-13 9-11 ft BGS B4E0395-14 5/12/2004	LAI-DP-14 9-11 ft BGS B4E0395-15 5/12/2004	LAI-DP-16 9-11 ft BGS B4E0395-16 5/12/2004	LAI-DP-16B 9-11 ft BGS B4E0395-17 5/12/2004
GASOLINE AND BTEX (mg/kg)									
NWTPH-G/EPA 8021B									
Gasoline	30	268 J (b)	NA	NA	94.8 (b)	NA	NA	104 (b)	55.0 (b)
Benzene	0.03	0.120 U	NA	NA	0.0300 U	NA	NA	0.0300 U	0.0435
Toluene	7	0.200 U	NA	NA	0.0500 U	NA	NA	0.0500 U	0.0500 U
Ethylbenzene	6	0.285 J (a)	NA	NA	0.0507 J (a)	NA	NA	0.0500 U	0.0500 U
Xylenes (total)	9	1.03 J (a)	NA	NA	0.290 J (a)	NA	NA	0.339 J (a)	0.239 J (a)
NWTPH-Dx (mg/kg)									
Diesel-Range Hydrocarbons	2000	11100	10.0 U	17900	1680	595	200	955	1000
Lube Oil-Range Hydrocarbons	2000	9840	25.0 U	16100	1850	833	353	1050	1180
cPAHs (mg/kg)									
8270-SIM									
Benzo(a)anthracene		NA	NA	NA	NA	NA	NA	NA	NA
Benzo(a)pyrene		NA	NA	NA	NA	NA	NA	NA	NA
Benzo(b)fluoranthene		NA	NA	NA	NA	NA	NA	NA	NA
Benzo(k)fluoranthene		NA	NA	NA	NA	NA	NA	NA	NA
Chrysene		NA	NA	NA	NA	NA	NA	NA	NA
Dibenz(a,h)anthracene		NA	NA	NA	NA	NA	NA	NA	NA
Indeno(1,2,3-cd)pyrene		NA	NA	NA	NA	NA	NA	NA	NA
cPAH TEQ (mg/kg)	0.1	NA	NA	NA	NA	NA	NA	NA	NA
DRY WEIGHT (%)		92.4	80.7	95.5	87.1	89.3	83.5	92.3	88.7

(a) As reported by the laboratory, the analyte concentration may be artificially elevated due to coeluting compounds or components.
(b) As reported by the laboratory, results reported for the gas range are primarily due to overlap from diesel range hydrocarbons.
(c) As reported by the laboratory, the sample chromatographic pattern does not resemble the fuel standard used for quantitation.
BGS = Below ground surface.
NA = Not analyzed.
U = Indicates the compound was undetected at the reported concentration.
J = Data validation flag indicating the analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.
Box indicates exceedance of soil cleanup level.

DRAFT

APPENDIX C

North Creek Analytical Summary Memorandum: Chromatograph Comparison

Memorandum

To: David Nelson, Landau Associates

CC: Jeannie Garthwaite; Brad Meadows

From: Katharine Nunn

Date: 6/24/2004

Re: Work Order B4E0495 Chromatogram comparison

I compared the diesel analysis chromatograms for B4E0495-02 (DP-2-4.5-6) to the other samples in the work order per your request. The table below shows what I found:

Lab Sample ID	Client Sample ID	Contamination Type
B4E0395-01	DP-1-7-8	No discernable contamination
B4E0395-02	DP-2-4.5-6	Mixture of jet fuel (not the same as jet fuel in 395-04) and diesel
B4E0395-03	DP-3-3.5-4.5	No discernable contamination
B4E0395-04	DP-4-6-8	Appears to be jet fuel – possibly JP-5
B4E0395-05	DP-5-7-8	No discernable contamination
B4E0395-06	DP-6-8-10	Appears to be a mixture of hydrocarbons possibly weathered diesel and motor oil
B4E0395-07	DP-7-9-11	Appears to be a mixture of hydrocarbons possibly weathered diesel and motor oil
B4E0395-08	DP-8-14-16	Appears to be a mixture of hydrocarbons possibly weathered diesel and motor oil
B4E0395-09	DP-9-10-12	Appears to be a mixture of hydrocarbons possibly weathered diesel and motor oil
B4E0395-10	DP-9B-10-12	Appears to be a mixture of hydrocarbons possibly weathered diesel and motor oil
B4E0395-11	DP-10-12-16	Appears to be a mixture of hydrocarbons possibly weathered diesel and motor oil
B4E0395-12	DP-11-10.5-12	Appears to be a mixture of hydrocarbons possibly weathered diesel and motor oil
B4E0395-13	DP-11-10.5-12	Appears to be a mixture of hydrocarbons possibly weathered diesel and motor oil
B4E0395-14	DP-13-9-11	Appears to be a mixture of hydrocarbons possibly weathered diesel and motor oil
B4E0395-15	DP-14-9-11	Appears to be a mixture of hydrocarbons possibly weathered diesel and motor oil
B4E0395-16	DP-16-9-11	Appears to be a mixture of hydrocarbons possibly weathered diesel and motor oil
B4E0395-17	DP-16B-9-11	Appears to be a mixture of hydrocarbons possibly weathered diesel and motor oil

I compared the Gas/BTEX analysis chromatograms for B4E0495-04 (DP-4-6-8) to the other samples in the work order per your request. I don't have as many standards run by purge and trap – so I can't give you as much information as the diesel range. Here's the information I can give:

Lab Sample ID	Client Sample ID	Similarity to B4E0395-04 (DP-4-6-8)
B4E0395-02	DP-2-4.5-6	Appears to contain some of the same components
B4E0395-03	DP-3-3.5-4.5	No discernable contamination
B4E0395-05	DP-5-7-8	No discernable contamination
B4E0395-08	DP-8-14-16	Hydrocarbon pattern is completely different and elutes later
B4E0395-09	DP-9-10-12	Hydrocarbon pattern is completely different and elutes later
B4E0395-10	DP-9B-10-12	Hydrocarbon pattern is completely different and elutes later
B4E0395-13	DP-11-10.5-12	Hydrocarbon pattern is completely different and elutes later
B4E0395-16	DP-16-9-11	Hydrocarbon pattern is completely different and elutes later
B4E0395-17	DP-16B-9-11	Hydrocarbon pattern is completely different and elutes later

I hope this information helps. Please feel free to call me with any questions you have or if you would like me to look at anything else. My direct number is 425-420-9224.

SLR International Corp. 2006. Groundwater Sampling Report – Fall 2006 Sampling Event, Unocal Edmonds Terminal. Edmonds, Washington. November 22, 2006

Table 4
Groundwater Sample Analytical Results - All Events
TPH, Benzene, Total Dissolved cPAH, and Dissolved Arsenic Concentrations
Unocal Edmonds Terminal

Location	Sample ID	Date	Gasoline Range Hydrocarbons[a] (µg/L)	Diesel Range Hydrocarbons[b] (µg/L)	Heavy Oil Range Hydrocarbons[b] (µg/L)	TPH[c] (µg/L)	Benzene[d] (µg/L)	Total Dissolved cPAHs[e,f] (µg/L)	Dissolved Arsenic[g] (µg/L)
Proposed Site Groundwater Cleanup Levels						506/706[h]	51	0.018	34
Proposed Surface Water Compliance Wells									
MW-148	MW148-0804	8/12/2004	4,900	1,350	<500	6,500	1,280	—	4.34
	MW148-0205	2/10/2005	<50	<250	<500	400[i]	0.64	—	<1.0
	MW148-0805	8/25/2005	258	<250	<500	633	24	—	3.30
	MW148-0206	2/9/2006	<50	<236	<472	379[i]	<0.50	0.0086[j]	<1.0
	MW148-0806	8/29/2006	<100	<236	<472	404[i]	<1.0	0.0085[j]	<1.0
MW-149	MW149-0804	8/12/2004	<50	<250	<500	400[i]	<0.50	—	<1.0
	MW149-0205	2/10/2005	<50	<250	<500	400[i]	<0.50	—	<1.0
	MW149-0805	8/25/2005	<50	<250	<500	400[i]	<0.50	—	0.80
	MW149-0206	2/9/2006	<50	<236	<472	379[i]	<0.50	0.0086[j]	<1.0
	MW149-0806	8/29/2006	<100	<236	<472	404[i]	<1.0	0.0085[j]	<1.0
MW-150	MW150-0804	8/12/2004	<50	<250	<500	400[i]	0.76	—	3.24
	MW150-0205	2/10/2005	<50	<250	<500	400[i]	<0.50	—	<1.0
	MW150-0805	8/24/2005	<50	<250	<500	400[i]	<0.50	—	3.30
	MW150-0206	2/9/2006	<50	<236	<472	379[i]	<0.50	0.0086[j]	<1.0
	MW150-0806	8/29/2006	<100	<236	<472	404[i]	<1.0	0.0085[j]	2.44
Off-Site Monitoring Wells									
MW-28	BNRR-MW28-1295	12/4/1995	<100	<240	<710	525[i]	<0.50	—	—
	MW-28-0296	2/21/1996	<100	<240	<710	525[i]	<0.50	—	—
	MW-28-0596	5/14/1996	<100	<250	<750	550[i]	<0.50	—	—
	MW-28-0896	8/14/1996	<100	<240	<710	525[i]	<0.50	—	<0.007
	MW-28-1196	11/5/1996	<100	<240	<710	525[i]	<0.50	—	<0.007
	MW-28-0297	2/25/1997	<50	<250	<750	525[i]	<5.0	—	<0.02
	MW-28-0897	8/12/1997	<50	<250	<500	400[i]	<0.50	—	<0.02 E
	MW-28-0298	2/19/1998	12 B	99.7 B	<92	158	<0.10	—	<0.015
	MW-28-0598	8/26/1998	5.3 BJ	70.5 J	<750	451	<0.10	—	<0.015
	MW-28-0299	2/16/1999	<50	29.1 BJ	<750	429	<0.10	—	<0.10
	MW-28-0200	2/23/2000	<50	<250	<750	525[i]	<0.50	—	0.19
	MW-28-0201	2/7/2001	<50	<250	<750	525[i]	<0.50	—	0.18 U
	MW-28-0601	6/28/2001	<80	<250	<500	415[i]	<0.50	—	0.35 J
	MW-28-1101	11/30/2001	<50	<250	<500	400[i]	<0.50	—	<1.0
	MW-28-0502	5/28/2002	<50	<250	<500	400[i]	<0.50	—	<1.0
	MW-28-0802	8/28/2002	<50	<250	<500	400[i]	<0.50	—	<1.0
	MW-28-0203	2/27/2003	<50	<250	<500	400[i]	<0.50	—	—
	MW-28-0204	2/13/2004	<50	<250	<500	400[i]	<0.50	—	<1.0
	MW28-0804	8/24/2004	<50	<250	<500	400[i]	<0.50	—	<1.0
	MW28-0805	8/24/2005	<50	<250	<500	400[i]	<0.50	—	0.60
	MW28-0206	2/17/2006	<50	<236	<472	379[i]	<0.50	0.0087[j]	<1.0
	MW28-0906	9/28/2006	—	<236	<472	—	—	0.0085[j]	<1.0
	MW28-1006	10/4/2006	<50	—	—	379[i]	<0.50	—	—

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Unocal Edmonds Terminal

Location	Sample ID	Date	Gasoline Range Hydrocarbons[a] (µg/L)	Diesel Range Hydrocarbons[b] (µg/L)	Heavy Oil Range Hydrocarbons[b] (µg/L)	TPH[c] (µg/L)	Benzene[d] (µg/L)	Total Dissolved cPAHs[e,f] (µg/L)	Dissolved Arsenic[g] (µg/L)
Proposed Site Groundwater Cleanup Levels						506/706[h]	51	0.018	34
Off-Site Monitoring Wells									
MW-105	MW-105-1295	12/27/1995	<100	680	<710	1,085	<0.50	—	—
	MW-105-1295-Dup	12/27/1995	<100	690	740	1,480	<0.50	—	—
	MW-105-0296	2/21/1996	<100	510	890	1,450	<0.50	—	—
	MW-105-0596	5/14/1996	<100	1,000	1,100	2,150	<0.50	—	—
	MW-105-0896	8/14/1996	<100	620	<710	1,025	<0.50	—	3.30 J
	MW-105-1196	11/5/1996	<100	940	1,000	1,990	<0.50	—	6.0 J
	MW-105-0297	2/25/1997	5.50 BJ	705	<750	1,086	<5.0	—	9.5
	MW-105-0897	8/12/1997	<50	944	<500	1,219	<0.50	—	5.70 E
	MW-105-0298	2/19/1998	18 B	285 B	323	626	<0.10	—	7.95
	MW-105-0298-Dup	2/19/1998	14 B	459 B	443	916	—	—	8.6
	MW-105-0598	8/26/1998	7.40 BJ	87.6 J	95 J	190	<0.10	—	2.86
	MW-105-0299	2/16/1999	<50	52.9 BJ	<750	453	<0.10	—	11.3
	MW-105-0200	2/23/2000	<50	<250	<750	525[j]	<0.50	—	7.78
	MW-105-0201	2/7/2001	<50	<250	<750	525[j]	<0.50	—	4.68
	MW-105-0601	6/28/2001	<50	<250	<500	400[j]	<0.50	—	4.08
	MW-105-1101	11/30/2001	<50	<250	<500	400[j]	<0.50	—	8.28
	MW-105-0502	5/28/2002	<50	<250	<500	400[j]	<0.50	—	4.16
	MW-105-0802	8/28/2002	<50	<250	<500	400[j]	<0.50	—	4.49
	MW-105-0203	2/27/2003	<50	<250	<500	400[j]	<0.50	—	—
	MW-105-0204	2/13/2004	<50	<250	<500	400[j]	<0.50	—	7.81
	MW105-0804	8/24/2004	<50	<250	<500	400[j]	<0.50	—	5.11
	MW105-0805	8/24/2005	<50	<250	<500	400[j]	<0.50	—	5.30
	MW105-0206	2/17/2006	<50	<236	<472	379[j]	<0.50	0.0087[j]	8.63
	MW105-0906	9/26/2006	—	<236	<472	—	—	0.017[j]	6.04
	MW105-1006	10/4/2006	<50	—	—	379[j]	<0.50	—	—
MW-106	MW-106-1295	12/27/1995	<100	1,600	<1,300	2,300	<0.50	—	—
	MW-106-0296	2/21/1996	<100	530 E	<710	935	<0.50	—	—
	MW-106-0596	5/14/1996	<100	1,700	1,300	3,050	<0.50	—	—
	MW-106-0896	8/14/1996	<100	1,700	1,000	2,750	<0.50	—	<0.07
	MW-106-1196	11/5/1996	<100	1,200	740	1,990	<0.50	—	<0.007
	MW-106-0297	2/25/1997	11 BJ	2,400	1,520	3,931	<5.0	—	<0.20
	MW-106-0897	8/12/1997	<50	2,100	<500	2,375	<0.50	—	<0.02 E
	MW-106-0298	2/19/1998	21 B	1,750	1,080	2,851	<0.10	—	<0.15
	MW-106-0598	8/26/1998	6.20 BJ	137 J	<750	518	<0.10	—	<0.015
	MW-106-0299	2/16/1999	<50	122 BJ	<750	522	0.22 BJ	—	<0.01

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Location	Sample ID	Date	Gasoline Range Hydrocarbons[a] (µg/L)	Diesel Range Hydrocarbons[b] (µg/L)	Heavy Oil Range Hydrocarbons[b] (µg/L)	TPH[c] (µg/L)	Benzene[d] (µg/L)	Total Dissolved cPAHs[e, f] (µg/L)	Dissolved Arsenic[g] (µg/L)
Proposed Site Groundwater Cleanup Levels						506/706[h]	51	0.018	34
Off-Site Monitoring Wells									
MW-106 (Cont.)	MW-106-0200	2/23/2000	<50	<250	<750	525[i]	<0.50	—	0.16
	MW-106-0201	2/7/2001	<50	<250	<750	525[i]	<0.50	—	<0.34
	MW-106-0601	6/28/2001	<80	257	<500	547	<0.50	—	0.48 J
	MW-106-1101	11/30/2001	<50	<250	<500	400[i]	<0.50	—	<1.0
	MW-106-0502	5/28/2002	<50	<250	<500	400[i]	<0.50	—	<1.0
	MW-106-0802	8/28/2002	<50	<250	<500	400[i]	<0.50	—	<1.0
	MW-106-0203	2/27/2003	<50	<250	<500	400[i]	<0.50	—	—
	MW-106-0204	2/13/2004	<50	<250	<500	400[i]	<0.50	—	<1.0
	MW106-0804	8/24/2004	<50	<250	<500	400[i]	<0.50	—	<1.0
	MW106-0805	8/24/2005	<50	<250	<500	400[i]	<0.50	—	0.40
	MW106-0206	2/17/2006	<50	<236	<472	379[i]	<0.50	0.0087[j]	<1.0
	MW106-0906	9/26/2006	—	<236	<472	—	—	0.017[j]	<1.0
	MW106-1006	10/4/2006	<50	—	—	379[i]	<0.50	—	—
MW-107	MW-107-1295	12/27/1995	<100	<240	<710	525[i]	<0.50	—	—
	MW-107-0296	2/21/1996	<100	<240	<710	525[i]	<0.50	—	—
	MW-107-0596	5/14/1996	<100	<250	<740	545[i]	<0.50	—	—
	MW-107-0896	8/14/1996	<100	<240	<720	530[i]	<0.50	—	2.30 J
	MW-107-1196	11/5/1996	<100	<240	<710	525[i]	<0.50	—	<0.007
	MW-107-0297	2/25/1997	34 BJ	252	<750	630	<0.50	—	<0.02
	MW-107-0897	8/12/1997	<50	533	<500	808	<0.50	—	<0.02 E
	MW-107-0298	2/19/1998	15 B	110 B	117	242	<0.10	—	<0.015
	MW-107-0598	8/26/1998	16 BJ	93.1 J	<750	484	<0.10	—	<0.015
	MW-107-0299	2/16/1999	<50	51.6 BJ	<750	452	<0.10	—	<0.01
	MW-107-0200	2/23/2000	<50	<250	<750	525[i]	<0.50	—	<0.0068
	MW-107-0201	2/7/2001	<50	<250	<750	525[i]	<0.50	—	<0.11
	MW-107-0201-Dup	2/7/2001	<50	<250	<750	525[i]	<0.50	—	—
	MW-107-0601	6/28/2001	<80	<250	<500	415[i]	<0.50	—	0.24 J
	MW-107-1101	11/30/2001	<50	<250	<500	400[i]	<0.50	—	<1.0
	MW-107-0502	5/28/2002	<50	<250	<500	400[i]	<0.50	—	<1.0
	MW-107-0802	8/28/2002	<50	<250	<500	400[i]	<0.50	—	2.03
	MW-107-0203	2/27/2003	<50	<250	<500	400[i]	<0.50	—	—
	MW-107-0204	2/13/2004	<50	<250	<500	400[i]	<0.50	—	<1.0
	MW107-0804	8/24/2004	<50	<250	<500	400[i]	<0.50	—	1.34
	MW107-0805	8/24/2005	<50	<250	<500	400[i]	<0.50	—	0.40
	MW107-0206	2/17/2006	<50	<236	<472	379[i]	<0.50	0.0087[j]	<1.0
	MW107-0906	9/26/2006	—	<236	<472	—	—	0.0085[j]	1.78
	MW107-1006	10/4/2006	<50	—	—	379[i]	<0.50	—	—

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TPH, Benzene, Total Dissolved cPAH, and Dissolved Arsenic Concentrations
Unocal Edmonds Terminal

Location	Sample ID	Date	Gasoline Range Hydrocarbons[a] (µg/L)	Diesel Range Hydrocarbons[b] (µg/L)	Heavy Oil Range Hydrocarbons[b] (µg/L)	TPH[c] (µg/L)	Benzene[d] (µg/L)	Total Dissolved cPAHs[e,f] (µg/L)	Dissolved Arsenic[g] (µg/L)
Proposed Site Groundwater Cleanup Levels						506/706[h]	51	0.018	34
Off-Site Monitoring Wells									
MW-137	MW-137-1295	12/27/1995	<100	<240	<730	535[i]	<0.50	—	—
	MW-137-0296	2/21/1996	<100	<240	<710	525[i]	<0.50	—	—
	MW-137-0596	5/14/1996	<100	<240	<730	535[i]	<0.50	—	—
	MW-137-0896	8/14/1996	<100	<240	<710	525[i]	<0.50	—	1.20 J
	MW-137-1196	11/5/1996	<100	<250	<740	545[i]	<0.50	—	<0.007
	MW-137-0297	2/25/1997	<50	<250	<750	525[i]	<5.0	—	<0.02
	MW-137-0897	8/12/1997	<50	<250	<500	650[i]	<0.50	—	2.0 E
	MW-137-0298	2/19/1998	18 B	132 B	139	289	<0.10	—	<0.15
	MW-137-0598	8/26/1998	41 BJ	99.5 J	<750	516	<0.10	—	<0.015
	MW-137-0299	2/17/1999	<50	<250	<750	525[i]	<0.10	—	<0.01
	MW-137-0200	2/23/2000	<50	<250	<750	525[i]	<0.50	—	0.17
	MW-137-0201	2/7/2001	<50	<250	<750	525[i]	<0.50	—	<0.56
	MW-137-0601	6/28/2001	<80	<250	<500	415[i]	<0.50	—	0.29 J
	MW-137-1101	11/30/2001	<50	<250	<500	400[i]	<0.50	—	<1.0
	MW-137-0502	5/28/2002	<50	<250	<500	400[i]	<0.50	—	<1.0
	MW-137-0802	8/28/2002	<50	<250	<500	400[i]	<0.50	—	3.68
	MW-137-0203	2/27/2003	<50	<250	<500	400[i]	<0.50	—	—
	MW-137-0204	2/13/2004	<50	<250	<500	400[i]	<0.50	—	<1.0
	MW137-0804	8/24/2004	<50	<250	<500	400[i]	<0.50	—	7.57
	MW137-0805	8/25/2005	<50	<250	<500	400[i]	<0.50	—	1.40
	MW137-0206	2/17/2006	<50	<238	<476	382[i]	<0.50	0.0087[j]	<1.0
	MW137-0906	9/26/2006	—	<236	<472	—	—	0.0085[j]	20.3 JF
	MW137-1006	10/4/2006	<50	—	—	379[i]	<0.5	—	—
MW-138	MW-138-1295	12/28/1995	<100	<240	<720	530[i]	<0.50	—	—
	MW-138-0296	2/21/1996	<100	<240	<710	525[i]	<0.50	—	—
	MW-138-0596	5/14/1996	<100	<250	<750	550[i]	<0.50	—	—
	MW-138-0896	8/14/1996	<100	<250	<740	545[i]	<0.50	—	<0.007
	MW-138-1196	11/5/1996	<100	<240	<710	525[i]	<0.50	—	<0.07
	MW-138-0897	8/12/1997	<50	<250	<500	400[i]	<0.50	—	<0.02 E
	MW-138-0298	2/19/1998	<20	134 B	233	377	<0.10	—	<0.15
	MW-138-0598	8/26/1998	<50	99.2 J	<750	499	<0.10	—	<0.03
	MW-138-0299	2/17/1999	<50	22.4 BJ	<750	422	<0.10	—	0.69 J
	MW-138-0299-Dup	2/17/1999	<50	<250	<750	525[i]	<0.10	—	0.65 J
	MW-138-0200	2/23/2000	<50	<250	<750	525[i]	<0.50	—	0.43
	MW-138-0201	2/7/2001	<50	<250	<750	525[i]	<0.50	—	<0.83
	MW-138-0601	6/28/2001	<80	<250	<500	415[i]	<0.50	—	1.15
	MW-138-1101	11/30/2001	<50	<250	<500	400[i]	<0.50	—	<1.0
	MW-138-0502	5/28/2002	<50	<250	<500	400[i]	<0.50	—	<1.0

Table 4
Groundwater Sample Analytical Results - All Events
TPH, Benzene, Total Dissolved cPAH, and Dissolved Arsenic Concentrations
Unocal Edmonds Terminal

Location	Sample ID	Date	Gasoline Range Hydrocarbons[a] (µg/L)	Diesel Range Hydrocarbons[b] (µg/L)	Heavy Oil Range Hydrocarbons[b] (µg/L)	TPH[c] (µg/L)	Benzene[d] (µg/L)	Total Dissolved cPAHs[e,f] (µg/L)	Dissolved Arsenic[g] (µg/L)
Proposed Site Groundwater Cleanup Levels						506/706[h]	51	0.018	34
Off-Site Monitoring Wells									
MW-138 (Cont.)	MW-138-0802	8/28/2002	<50	<250	<500	400[i]	<0.50	—	<1.0
	MW-138-0203	2/27/2003	<50	<250	<500	400[i]	<0.50	—	—
	MW-138-0204	2/13/2004	<50	<250	<500	400[i]	<0.50	—	<1.0
	MW138-0804	8/24/2004	<50	<250	<500	400[i]	<0.50	—	2.72
	MW138-0805	8/25/2005	<50	<250	<500	400[i]	<0.50	—	3.20
	MW138-0206	2/17/2006	<50	<238	<476	382[i]	<0.50	0.0087[j]	1.20
	MW138-0906	9/26/2006	—	<236	<472	—	—	0.0085[j]	21.5 JF
	MW138-1006	10/4/2006	<50	—	—	379[i]	<0.50	—	—

Notes:

µg/L = Micrograms per liter.
Bold values exceed the proposed site cleanup levels.
NA = Not available.
— = Not analyzed.
BJ = Estimated result due to contamination in associated method blank.
JD = Estimated result due to sample dilution.
E = Analyte concentration exceeds instrument calibration range.
JS = Estimated result due to sample matrix interference associated with surrogate recoveries.
B = Contamination present in associated method blank.
BCR = Result rejected due to contaminant in the associated method blank.
R = The sample results are rejected due to serious deficiencies in the ability to analyze the sample and meet quality control criteria. The presence or absence of the analyte cannot be verified.
J = The analyte was positively identified; the associated numerical value is estimated.
JF = The analyte was positively identified; the associated numerical value is estimated due to uncertainty about whether the laboratory filtered the sample.
UJ = The analyte was not detected; the results may be biased low due to a low bias in the internal laboratory standard.
UJS = The analyte was not detected; result may be biased low due to sample matrix interference associated with surrogate recoveries.

[a] Gasoline range hydrocarbons (GRO) analyzed by Ecology Methods NWTPH-Gx or WTPH-G.
[b] Diesel and heavy oil range hydrocarbons (DRO and HO) analyzed by Ecology Methods NWTPH-Dx or WTPH-D.
[c] TPH = Total petroleum hydrocarbons (combined concentrations of GRO, DRO and HO). If nondetected, ½ of the method reporting limit (MRL) was used to calculate TPH.
[d] Benzene analyzed by EPA Method 8021B.
[e] Total dissolved carcinogenic polycyclic aromatic hydrocarbons (cPAHs) analyzed by EPA Method 8270C.
[f] Each cPAH compound in a sample was multiplied by that component's toxicity equivalency factor and then the adjusted concentrations were summed to determine the total cPAH concentration. If a cPAH compound was not detected in a sample at a concentration above the MRL, then 1/2 of the MRL for that compound was used.
[g] Dissolved arsenic analyzed by EPA 200 Series Method.
[h] Proposed site cleanup level for TPH is 506 µg/L beneath the eastern part of the lower yard and 706 µg/L beneath the western part of the lower yard.
[i] GRO, DRO, and HO were not detected and the TPH concentration equals the sum of ½ of the MRL of each constituent.
[j] CPAH compounds were not detected in the sample and the total dissolved cPAH concentration equals the sum of 1/2 of the MRL of each compound multiplied by the compound's toxicity equivalence factor.

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TABLE 4
Excavation Soil Sample Analytical Results
Unocal Edmonds Bulk Fuel Terminal Lower Yard
Phase I Remedial Implementation As-built Report
11720 Unoco Road
Edmonds, Washington

Sample ID	Sample Depth (feet bgs)	Date Sampled	BTEX *(mg/kg)*				Total cPAHs Adjusted for Toxicity *(mg/kg)*	Gasoline *(mg/kg)*	Diesel *(mg/kg)*	Heavy Oil (Lube) *(mg/kg)*	Total TPH *(mg/kg)*
			B	T	E	X					
			REL = 18 mg/kg				*CUL = 0.14 mg/kg*				*REL = 2,975*
B2-TP1-5	5	02/18/08	0.0305 U	0.0508 U	0.0508 U	0.102 U	0.0179	23.6 JZ	2,170 Q9	393 Q9	2,590 J
B2-TP1-10	10	02/18/08	0.0371 U	0.0618 U	0.0618 U	0.124 U	0.0370	9.96 JZ	211 Q9	60.8	282 J
B2-TP1-15	15	02/18/08	0.0325 U	0.0541 U	0.0541 U	0.108 U	0.00893	12.7 JZ	274 Q9	76.9	364 J
B2-TP2-5	5	02/18/08	0.0371 U	0.0619 U	0.0619 U	0.124 U	0.00853	6.19 U	54.6 Q9	103	161
B2-TP2-10	10	02/18/08	0.0319 U	0.0532 U	0.0532 U	0.106 U	0.00846	25.9 JZ	105 Q9	46.2	177 J
B2-TP2-13	13	02/18/08	0.341 U	0.568 U	0.568 U	3.40	0.519	659 JZ	1,680	1,120	3,460 J
EX-A1-C-16-7	7	11/15/07	0.0303 U	0.0504 U	0.0504 U	0.101 U	NA	5.04 U	11.9 U	29.6 U	23.3 UU
EX-A1-C-16-NSW-3	3	11/15/07	0.0301 U	0.0502 U	0.0502 U	0.100 U	0.00892	5.02 U	93.9 Q4	165 Q4	261
EX-A1-C-17-3	3	11/15/07	0.0608	0.0771	0.0499 U	0.0998 U	0.0154	19.5	70.6 Q4	123 Q4	213
EX-A1-D-16-12	12	11/19/07	0.0299 U	0.0498 U	0.0498 U	0.0996 U	NA	4.98 U	12.1 U	30.2 U	23.6 UU
EX-A1-D-17-12	12	11/15/07	0.0294 U	0.0490 U	0.0490 U	0.0981 U	NA	4.90 U	12.6 U	31.5 U	24.5 UU
EX-A1-D-17-ESW-5	5	11/15/07	0.0316 U	0.0526 U	0.0526 U	0.105 U	NA	5.26 U	11.7 U	29.1 U	23.0 UU
EX-A1-D-17-ESW-10	10	11/15/07	0.0272 U	0.0453 U	0.0453 U	0.0907 U	NA	4.53 U	11.7 U	29.4 U	22.8 UU
EX-A1-E-15-15	15	11/08/07	0.0299 U	0.0498 U	0.0498 U	0.0996 U	NA	4.98 U	12.3 U	30.7 U	24.0 UU
EX-A1-E-16-15	15	11/08/07	0.0279 U [0.0311 U]	0.0465 U [0.0518 U]	0.0465 U [0.0518 U]	0.0930 U [0.104 U]	NA [NA]	4.65 U [5.18 U]	11.6 U [12.6 U]	29.0 U [31.5 U]	22.6 UU [24.6 UU]
EX-A1-E-17-12	12	11/14/07	0.0291 U	0.0485 U	0.0485 U	0.0970 U	NA	4.85 U	12.2 U	30.4 U	23.7 UU
EX-A1-E-17-ESW-4	4	11/15/07	0.0637	0.0514 U	0.0514 U	0.103 U	NA	5.14 U	12.2 U	30.6 U	24.0 UU
EX-A1-F-15-15	15	11/08/07	0.0270 U	0.0451 U	0.0451 U	0.0902 U	NA	4.51 U	12.2 U	30.4 U	23.6 UU
EX-A1-F-16-15	15	11/08/07	0.137	0.0454 U	0.0454 U	0.0907 U	NA	4.54 U	12.0 U	30.1 U	23.3 UU
EX-A1-F-17-3	3	10/29/07	0.0267 U	0.0444 U	0.0444 U	0.0889 U	NA	4.44 U	11.2 U	28.0 U	21.8 UU
EX-A1-F-17-12	12	11/14/07	0.0301 U	0.0501 U	0.0501 U	0.100 U	NA	5.01 U	12.3 U	30.8 U	24.1 UU
EX-A1-F-18-4	4	10/29/07	0.0979 [0.0591]	0.0816 [0.0492]	0.351 [0.222]	1.01 [0.670]	0.0432 [0.0441]	201 JZ [139 JZ]	405 Q11 [1,020 Q11]	158 [339]	764 J [1,500 J]
EX-A1-F-18-5	5	11/05/07	0.0273 U [0.0291 U]	0.0455 U [0.0485 U]	0.0455 U [0.0485 U]	0.0911 U [0.0970 U]	NA [NA]	4.55 U [4.85 U]	11.3 U [11.3 U]	28.2 U [28.3 U]	22.0 UU [22.2 UU]
EX-A1-G-15-15	15	11/08/07	0.0289 U	0.0482 U	0.0482 U	0.0964 U	NA	4.82 U	11.7 U	29.3 U	22.9 UU
EX-A1-G-16-15	15	10/31/07	0.0387	0.0494 U	0.0494 U	0.0989 U	NA	4.94 U	11.7 U	29.3 U	23.0 UU
EX-A1-G-17-15	15	10/29/07	0.0291 U	0.0485 U	0.0485 U	0.0970 U	NA	4.85 U	12.0 U	30.1 U	23.5 UU
EX-A1-H-15-15	15	11/08/07	0.0291 U	0.0486 U	0.0486 U	0.0971 U	NA	4.86 U	12.8 U	31.9 U	24.8 UU
EX-A1-H-16-15	15	10/31/07	0.0303 U	0.0505 U	0.0505 U	0.101 U	NA	5.05 U	11.7 U	29.4 U	23.1 UU
EX-A1-H-17-15	15	10/29/07	0.0298 U [0.0282 U]	0.0497 U [0.0470 U]	0.0497 U [0.0470 U]	0.0993 U [0.0939 U]	NA [NA]	4.97 U [4.70 U]	12.8 U [12.7 U]	31.9 U [31.7 U]	24.8 UU [24.6 UU]
EX-A1-I-16-15	15	10/31/07	0.0285 U	0.0474 U	0.0474 U	0.0948 U	NA	4.74 U	12.5 U	31.1 U	24.2 UU
EX-A1-I-17-15	15	10/29/07	0.0317 U	0.0528 U	0.0528 U	0.106 U	NA	5.28 U	12.7 U	31.8 U	24.9 UU
EX-A1-J-16-15	15	10/31/07	0.0306 U	0.0511 U	0.0511 U	0.102 U	NA	5.11 U	12.7 U	31.7 U	24.8 UU
EX-A1-J-17-15	15	10/29/07	0.0316 U	0.0527 U	0.0527 U	0.105 U	NA	5.27 U	13.6 U	34.0 U	26.4 UU
EX-A1-J-19-8	8	10/23/07	0.0312 U	0.0519 U	0.0519 U	0.104 U	NA	5.19 U	12.6 U	31.5 U	24.6 UU
EX-A1-K-17-15	15	10/30/07	0.0308 U	0.0513 U	0.0513 U	0.103 U	NA	5.13 U	12.7 U	31.8 U	24.8 UU
EX-A1-K-18-12	12	10/23/07	0.0278 U	0.0463 U	0.0463 U	0.0926 U	NA	4.63 U	11.7 U	29.3 U	22.8 UU
EX-A1-K-18-SSW-3	3	10/30/07	0.0282 U	0.0470 U	0.0470 U	0.0941 U	NA	4.70 U	10.5 U	26.1 U	20.7 UU
EX-A1-K-18-SSW-8	8	10/30/07	0.0291 U	0.0486 U	0.0486 U	0.0972 U	NA	4.86 U	11.4 U	28.4 U	22.3 UU
EX-A1-K-19-3	3	10/30/07	0.0322 U	0.0536 U	0.0536 U	0.107 U	NA	5.36 U	11.6 U	29.0 U	23.0 UU
EX-A1-L-17-12	12	11/08/07	0.117	0.0465 U	0.0465 U	0.0930 U	NA	4.65 U	11.7 U	29.4 U	22.9 UU
EX-A2-O-9-10	10	01/28/08	0.369 U [0.344 U]	0.615 U [0.573 U]	0.989 [0.819]	1.72 [1.43]	0.0515 [0.0484]	466 JZ [389 JZ]	149 [371]	78.5 [91.5]	694 J [852 J]

TABLE 4
Excavation Soil Sample Analytical Results
Unocal Edmonds Bulk Fuel Terminal Lower Yard
Phase I Remedial Implementation As-built Report
11720 Unoco Road
Edmonds, Washington

Sample ID	Sample Depth (feet bgs)	Date Sampled	BTEX *(mg/kg)*				Total cPAHs Adjusted for Toxicity *(mg/kg)*	Gasoline *(mg/kg)*	Diesel *(mg/kg)*	Heavy Oil (Lube) *(mg/kg)*	Total TPH *(mg/kg)*
			B	T	E	X					
			REL = 18 mg/kg				***CUL = 0.14 mg/kg***				***REL = 2,975***
EX-A2-O-10-10	10	01/28/08	0.0299 U	0.169	0.0864	0.215	0.0239	73.9 JZ	30.6	29.3 U	119 J
EX-A2-O-11-10	10	01/28/08	0.0270 U	0.0450 U	0.0450 U	0.0900 U	NA	4.50 U	11.8 U	29.6 U	23.0 UU
EX-A2-O-12-10	10	01/28/08	0.0305 U	0.0508 U	0.0508 U	0.102 U	NA	5.08 U	13.0 U	32.5 U	25.3 UU
EX-A2-O-13-10	10	01/28/08	0.0351 U	0.0585 U	0.0585 U	0.117 U	NA	5.85 U	12.9 U	32.3 U	25.5 UU
EX-A2-N-16-SSW-6	6	02/20/08	0.0382 U	0.0636 U	0.0654	0.845	0.0868	489 JZ	6,770 D	577 U	7,550 J
EX-A2-O-15-SSW-6	6	02/20/08	1.69	0.645 U	1.07	3.10	0.0308	1,500 JZ	5,750 DQ10	579 U	7,540 J
EX-A2-P-9-15	15	01/30/08	0.0289 U	0.0482 U	0.0482 U	0.0965 U	NA	4.82 U	12.0 U	30.1 U	23.5 UU
EX-A2-P-10-11	11	01/30/08	0.0350 U	0.0583 U	0.0583 U	0.117 U	NA	5.83 U	12.7 U	31.8 U	25.2 UU
EX-A2-P-11-11	11	01/30/08	0.0301 U	0.0501 U	0.0501 U	0.100 U	NA	5.01 U	11.3 U	28.2 U	22.3 UU
EX-A2-P-12-10	10	01/30/08	0.0275 U	0.0458 U	0.0458 U	0.0916 U	0.00921	4.58 U	17.2 JY	43.2	62.7 J
EX-A2-P-13-10	10	01/30/08	0.0318 U	0.0531 U	0.0531 U	0.106 U	NA	5.31 U	12.9 U	32.4 U	25.3 UU
EX-A2-P-14-12	12	02/22/08	0.0364 U	0.0607 U	0.0607 U	0.326	0.00974	67.7 JZ	229	32.2	329 J
EX-A2-Q-9-12	12	02/01/08	0.0333 U	0.0555 U	0.0555 U	0.111 U	NA	5.55 U	11.8 U	29.5 U	23.4 UU
EX-A2-Q-10-12	12	02/01/08	0.0364 U	0.0606 U	0.0606 U	0.121 U	NA	6.06 U	11.9 U	29.8 U	23.9 UU
EX-A2-Q-11-12	12	02/01/08	0.0366 U	0.0610 U	0.0610 U	0.122 U	NA	6.10 U	12.2 U	30.5 U	24.4 UU
EX-A2-Q-12-13	13	02/01/08	0.0324 U	0.0539 U	0.0539 U	0.108 U	NA	5.39 U	12.2 U	30.6 U	24.1 UU
EX-A2-Q-13-12	12	02/22/08	0.0404 U	0.0673 U	0.0673 U	0.135 U	NA	6.73 U	12.8 U	32.1 U	25.8 UU
EX-A2-Q-14-6	6	02/20/08	0.169 J	0.0968 J	0.182 J	1.51 J	0.0241	570 JZ	2,250 J	236 JQ7	3,060 J
EX-A2-R-10-12	12	02/15/08	0.0422 U [0.0375 U]	0.0704 U [0.0626 U]	0.0704 U [0.0626 U]	0.141 U [0.125 U]	NA [NA]	7.04 U [6.26 U]	12.8 U [12.1 U]	31.9 U [30.3 U]	25.9 UU [24.3 UU]
EX-A2-R-11-12	12	02/15/08	0.0484 U	0.0806 U	0.0806 U	0.161 U	NA	8.06 U	13.8 U	34.6 U	28.2 UU
EX-A2-R-12-12	12	02/15/08	0.0380 U	0.0634 U	0.0634 U	0.127 U	NA	6.34 U	12.2 U	30.5 U	24.5 UU
EX-A2-R-13-12	12	02/22/08	0.0433 U	0.0721 U	0.0721 U	0.144 U	NA	7.21 U	13.2 U	33.0 U	26.7 UU
EX-A2-R-14-6	6	02/20/08	0.0380 U	0.0633 U	0.0633 U	0.127 U	0.0157	51.3 JZ	224	65.5	341 J
EX-A2-S-12-12	12	02/22/08	0.0406 U	0.0676 U	0.0676 U	0.135 U	NA	6.76 U	12.8 U	32.0 U	25.8 UU
EX-A2-S-12-SSW-6	6	02/15/08	0.0339 U	0.0565 U	0.0565 U	0.113 U	0.00815	224 JZ	900	37.4 Q7	1,160 J
EX-A2-S-13-6	6	02/15/08	0.0356 U	0.0594 U	0.0594 U	0.406	0.00861	194 JZ	683	54.8 Q7	932 J
EX-A3-AA-5-10	10	09/26/07	0.0290 U	0.0484 U	0.0484 U	0.0968 U	NA	4.84 U	12.3 U	30.7 U	23.9 UU
EX-A3-AA-6-10	10	09/21/07	0.0309 U	0.0515 U	0.0515 U	0.103 U	NA	5.15 U	10.9 U	27.1 U	21.6 UU
EX-A3-AA-7-10	10	09/21/07	0.0333 U	0.0556 U	0.0556 U	0.111 U	NA	5.56 U	12.5 U	31.3 U	24.7 UU
EX-A3-AA-7-ESW-4	4	09/20/07	0.0307 U	0.0511 U	0.0511 U	0.102 U	NA	5.11 U	12.7 U	31.8 U	24.8 UU
EX-A3-BB-6-10	10	09/21/07	0.0296 U [0.0299 U]	0.0493 U [0.0498 U]	0.0493 U [0.0498 U]	0.0986 U [0.0996 U]	NA [NA]	4.93 U [4.98 U]	12.7 U [13.0 U]	31.7 U [32.6 U]	24.7 UU [25.3 UU]
EX-A3-BB-7-10	10	09/21/07	0.0703	0.0527 U	0.0527 U	0.105 U	NA	5.27 U	11.9 U	29.7 U	23.4 UU
EX-A3-BB-7-ESW-4	4	09/21/07	0.158	0.152	0.0856	0.282	0.00997	88.0	18.9	32.6 U	123
EX-A3-CC-6-10	10	10/01/07	2.76	0.0582 U	0.0582 U	0.116 U	NA	7.09 J	12.3 U	30.9 U	28.7 J
EX-A3-CC-7-10	10	10/01/07	1.21 [1.73]	0.0671 U [0.0580 U]	0.0671 U [0.0580 U]	0.134 U [0.116 U]	NA [NA]	6.71 U [5.90]	12.1 U [12.1 U]	30.3 U [30.3 U]	24.6 UU [27.1]
EX-A3-CC-7-ESW-4	4	10/02/07	0.110	0.0512 U	0.245	0.221	0.00876	25.8	85.6 Q4	44.7 Q4	156
EX-A3-DD-6-10	10	10/02/07	0.0878	0.0534 U	0.0534 U	0.107 U	NA	5.34 U	11.9 U	29.6 U	23.4 UU
EX-A3-Y-4-8	8	09/21/07	0.0214 U	0.0357 U	0.0357 U	0.0713 U	NA	3.57 U	10.4 U	25.9 U	19.9 UU
EX-A3-Y-4-NSW-4	4	09/20/07	0.0267 U	0.0446 U	0.0446 U	0.0891 U	0.00868	8.24 JZ	169	140	317 J
EX-A3-Y-4-WSW-4	4	09/20/07	0.0114 U	0.0190 U	0.0190 U	0.0380 U	NA	1.90 U	10.4 U	25.9 U	19.1 UU
EX-A3-Y-5-8	8	09/21/07	0.0275 U	0.0458 U	0.0458 U	0.0916 U	NA	4.58 U	10.3 U	25.9 U	20.4 UU
EX-A3-Y-5-NSW-4	4	09/20/07	0.0498 U	0.0830 U	0.0830 U	0.166 U	0.00880	19.4 JZ	111	122	252 J
EX-A3-Y-6-8	8	09/20/07	3.32 U	5.53 U	5.53 U	11.1 U	0.176	3,000	6,340 J	1,270 J	10,600 J
EX-A3-Y-6-10	10	09/25/07	0.387	0.0500 U	0.0500 U	0.100 U	NA	5.25	12.2 U	30.5 U	26.6
EX-A3-Y-6-NSW-4	4	09/20/07	0.0232 U	0.0386 U	0.0386 U	0.134	0.00793	27.7 JZ	37.4	41.0	106 J
EX-A3-Y-7-8	8	09/20/07	0.194	0.315	0.330	0.403	0.0883	182 JZ	2,240 J	386 J	2,810 J
EX-A3-Y-7-10	10	09/25/07	0.0299 U	0.0498 U	0.0498 U	0.0996 U	NA	4.98 U	11.7 U	29.4 U	23.0 UU
EX-A3-Y-7-ESW-4	4	09/20/07	0.546	0.0518 U	0.0518 U	0.104 U	0.00908	9.13 JZ	103	91.9	204 J
EX-A3-Y-7-NSW-4	4	09/20/07	0.0393 [0.0562 U]	0.0532 [0.0937 U]	0.0735 [0.0937 U]	0.191 [0.187 U]	0.00929 [0.00876]	50.7 JZ [34.1 JZ]	62.9 [133]	60.0 [96.0]	174 J [263 J]
EX-A3-Z-4-10	10	09/21/07	0.0294	0.0485 U	0.0485 U	0.0969 U	NA	5.83	11.4 U	28.4 U	25.7
EX-A3-Z-5-10	10	09/21/07	0.0275 U	0.0459 U	0.0459 U	0.0918 U	NA	4.59 U	11.6 U	29.1 U	22.6 UU
EX-A3-Z-6-10	10	09/21/07	0.191	0.0520 U	0.0520 U	0.104 U	0.00944	5.20 U	18.8	32.0 U	37.4
EX-A3-Z-7-10	10	09/21/07	0.0503	0.0440 U	0.0440 U	0.0879 U	NA	4.40 U	11.1 U	27.8 U	21.7 UU
EX-A3-Z-7-ESW-4	4	09/20/07	0.0207 U	0.0345 U	0.0345 U	0.0690 U	NA	3.45 U	10.6 U	26.4 U	20.2 UU

TABLE 4
Excavation Soil Sample Analytical Results
Unocal Edmonds Bulk Fuel Terminal Lower Yard
Phase I Remedial Implementation As-built Report
11720 Unoco Road
Edmonds, Washington

Sample ID	Sample Depth (feet bgs)	Date Sampled	BTEX *(mg/kg)*				Total cPAHs Adjusted for Toxicity *(mg/kg)*	Gasoline *(mg/kg)*	Diesel *(mg/kg)*	Heavy Oil (Lube) *(mg/kg)*	Total TPH *(mg/kg)*
			B	T	E	X					
			REL = 18 mg/kg				*CUL = 0.14 mg/kg*				*REL = 2,975*
EX-A4-F-6-4	4	09/12/07	0.0296 U [0.0255 U]	0.0494 U [0.0424 U]	0.0494 U [0.0424 U]	0.0988 U [0.0849 U]	0.00967 [0.00854]	4.94 U [4.24 U]	112 Q4 [209 Q4]	66.2 Q4 [109 Q4]	181 [320]
EX-A4-F-7-4	4	09/12/07	0.295	0.0487 U	0.130	0.415	0.00861	85.0 JZ	13.3 Q11	28.5 U	113 J
EX-A4-F-8-4	4	09/12/07	0.126	0.271	0.383	0.555	0.196	149 JZ	1,510 JQ4	710 JQ4	2,370 J
EX-A4-F-8-6	6	10/17/07	0.0740	0.0567 U	0.0567 U	0.129	0.0465	105 JZ	632	246	983 J
EX-A4-F-8-7	7	11/07/07	0.0313 U	0.0522 U	0.0522 U	0.104 U	NA	5.22 U	12.8 U	32.0 U	25.0 UU
EX-A4-F-8-NSW-3.5	3.5	11/13/07	0.0256 U	0.0427 U	0.0427 U	0.0853 U	NA	4.27 U	10.4 U	26.0 U	20.3 UU
EX-A4-F-8-NSW-4	4	11/07/07	0.0288 U	0.0480 U	0.0480 U	0.0960 U	0.0481	30.9 JZ	793 Q4	429	1,250 J
EX-A4-F-9-9	9	10/17/07	0.0646	0.0509 U	0.0619	0.102 U	NA	20.1	11.9 U	29.7 U	40.9
EX-A4-F-9-ESW-4	4	10/17/07	0.0349 U	0.0581 U	0.0581 U	0.116 U	0.0100	5.81 U	17.3 Q12	33.3 U	36.9
EX-A4-F-9-NSW-3.5	3.5	11/07/07	0.0318 U	0.0530 U	0.0530 U	0.106 U	0.0402	5.30 U	330 Q4	356	689
EX-A4-F-9-NSW-4	4	10/17/07	0.248	0.248	0.208	0.105 U	0.0710	219 JZ	731	222	1,170 J
EX-A4-G-6-9	9	10/01/07	0.0307 U	0.0512 U	0.0512 U	0.102 U	NA	5.12 U	12.7 U	31.8 U	24.8 UU
EX-A4-G-7-9	9	09/27/07	0.0295 U	0.0492 U	0.0492 U	0.0983 U	NA	4.92 U	12.7 U	31.7 U	24.7 UU
EX-A4-G-8-9	9	09/27/07	0.0311 U	0.0519 U	0.0519 U	0.104 U	NA	5.19 U	11.7 U	29.2 U	23.0 UU
EX-A4-G-9-9	9	10/17/07	0.0295 U	0.0492 U	0.0492 U	0.0985 U	NA	4.92 U	12.5 U	31.1 U	24.3 UU
EX-A4-G-9-ESW-4	4	10/17/07	0.0290 U [0.0283 U]	0.0483 U [0.0472 U]	0.0483 U [0.0472 U]	0.0965 U [0.0945 U]	0.00853 [0.00868]	9.59 JZ [4.72 U]	41.4 [33.5]	36.0 [32.7]	87.0 J [68.6]
EX-A4-H-6-9	9	09/27/07	0.0269 U [0.0295 U]	0.0448 U [0.0491 U]	0.0448 U [0.0491 U]	0.0897 U [0.0982 U]	NA [NA]	4.48 U [4.91 U]	12.6 U [12.4 U]	31.5 U [31.1 U]	24.3 UU [24.2 UU]
EX-A4-H-7-9	9	09/27/07	0.0318 U	0.0530 U	0.0530 U	0.106 U	NA	5.30 U	12.9 U	32.3 U	25.3 UU
EX-A4-H-8-4	4	09/12/07	0.0286 U	0.0476 U	0.0476 U	0.0952 U	0.0858	19.6 JZ	1,250 JQ4	788 JQ4	2,060 J
EX-A4-H-8-9	9	09/27/07	0.0885	0.0499 U	0.0499 U	0.0997 U	NA	4.99 U	12.3 U	30.8 U	24.0 UU
EX-A4-H-9-9	9	10/17/07	0.323	0.0736 U	0.0736 U	0.147 U	NA	7.36 U	16.8 U	42.0 U	33.1 UU
EX-A4-H-9-ESW-4	4	10/17/07	0.0273 U	0.0455 U	0.0455 U	0.0911 U	0.00861	4.55 U	203	50.3	256
EX-A4-I-6-9	9	09/21/07	0.0565 U	0.0942 U	0.0942 U	0.188 U	NA	9.42 U	19.9 U	49.7 U	39.5 UU
EX-A4-I-7-9	9	10/16/07	0.0372 U	0.0620 U	0.0620 U	0.124 U	NA	6.20 U	12.1 U	30.2 U	24.3 UU
EX-A4-I-8-9	9	10/16/07	0.0396 U	0.0660 U	0.0660 U	0.132 U	NA	6.60 U	12.1 U	30.2 U	24.5 UU
EX-A4-J-6-9	9	09/21/07	0.0288 U	0.0479 U	0.0479 U	0.0959 U	NA	4.79 U	12.1 U	30.4 U	23.6 UU
EX-A4-J-6-SSW-9	9	09/21/07	0.0304 U	0.0507 U	0.0507 U	0.101 U	0.0383	22.1	111 Q4	105 Q4	238
EX-A4-J-7-9	9	09/21/07	0.0299 U	0.0498 U	0.0498 U	0.0996 U	NA	4.98 U	12.2 U	30.4 U	23.8 UU
EX-A4-J-7-SSW-4	4	09/21/07	0.0342 U	0.0569 U	0.0569 U	0.114 U	0.0388	5.69 U	119 Q4	119 Q4	241
EX-A4-J-8-9	9	10/16/07	0.0340 U	0.0566 U	0.0566 U	0.113 U	NA	5.66 U	11.9 U	29.8 U	23.7 UU
EX-A4-K-8-9	9	10/16/07	0.0367 U	0.0612 U	0.0612 U	0.122 U	NA	6.12 U	12.3 U	30.8 U	24.6 UU
EX-B2-E-33(2)-6	6	02/27/08	0.0345 U	0.0575 U	0.0575 U	0.115 U	0.00872	25.1 JZ	203 Q9	126	354 J
EX-B2-E-33-6	6	02/25/08	0.0326 U	0.0543 U	0.0543 U	0.109 U	0.00883	8.75 JZ	129 Q10	86.6 Q10	224 J
EX-B2-E-34-6	6	02/25/08	0.0331 U	0.0552 U	0.0552 U	0.110 U	0.00923	32.2 JZ	101 Q9	54.2	187 J
EX-B2-E-35-(2)-6	6	02/27/08	0.0349 U	0.0582 U	0.0582 U	0.116 U	0.0702	16.5 JZ	1,950 J	1,490 J	3,460 J
EX-B2-E-35(3)-6	6	03/05/08	0.0370 U	0.0617 U	0.0617 U	0.163	0.0993	79.7 JZ	992 Q4	518 Q4	1,590 J
EX-B2-E-35-6	6	02/22/08	0.0336 U	0.0560 U	0.0560 U	0.176	0.117	66.7 JZ	1,270 Q9	687	2,020 J
EX-B2-E-36-6	6	02/27/08	0.0420 U	0.0700 U	0.0700 U	0.140 U	0.0243	20.0 JZ	402 Q9	155	577 J
EX-B2-E-40-4	4	01/23/08	0.0313 U	0.0522 U	0.0522 U	0.104 U	0.00922	5.22 U	48.9 J	48.5 Q4	100 J
EX-B2-E-41(2)-5	5	02/04/08	0.0289 U	0.0482 U	0.0482 U	0.104	0.0879	7.34 JZ	647 Q4	363 Q4	1,020 J
EX-B2-E-41-4	4	01/23/08	0.0262 U [0.0264 U]	0.0436 U [0.0440 U]	0.0436 U [0.0440 U]	0.0872 U [0.0880 U]	0.0528 [0.120]	13.5 JZ [13.3 JZ]	196 Q4 [208 Q4]	152 Q4 [182 Q4]	362 J [403 J]
EX-B2-F-32-12	12	03/03/08	0.108 U	0.180 U	0.180 U	0.360 U	NA	18.0 U	20.6 U	51.4 U	45.0 UU
EX-B2-F-33-12	12	02/28/08	0.0656 U [0.0670 U]	0.109 U [0.112 U]	0.109 U [0.112 U]	0.219 U [0.223 U]	NA [NA]	10.9 U [11.2 U]	16.0 U [15.6 U]	40.1 U [39.1 U]	33.5 UU [33.0 UU]
EX-B2-F-34-11	11	02/28/08	0.0603 U	0.101 U	0.101 U	0.201 U	NA	10.1 U	15.7 U	39.2 U	32.5 UU
EX-B2-F-35-12	12	02/25/08	0.105 U	0.175 U	0.175 U	0.349 U	NA	17.5 U	16.6 U	41.4 U	37.8 UU
EX-B2-F-36-13	13	02/22/08	0.0790 U	0.132 U	0.132 U	0.263 U	0.0205	13.2 U	331 Q9	105	443
EX-B2-F-36-NSW-6	6	02/22/08	0.0409 U	0.0682 U	0.0682 U	0.136 U	0.0305	69.9 JZ	215 Q9	70.9	356 J
EX-B2-F-37-13	13	02/22/08	0.0705 U	0.118 U	0.118 U	0.235 U	NA	11.8 U	16.9 U	42.2 U	35.5 UU
EX-B2-F-37-NSW-6	6	02/22/08	0.0378 U	0.0631 U	0.0631 U	0.126 U	0.00929	8.43	25.3 Q4	30.7 UQ4	64.4
EX-B2-F-38(2)-14	14	02/06/08	0.0570 U	0.0949 U	0.0949 U	0.190 U	NA	9.49 U	15.3 U	38.2 U	31.5 UU
EX-B2-F-38-8	8	01/31/08	0.0357 U	0.0595 U	0.0595 U	0.119 U	0.111	18.9 JZ	1,450	458	1,930 J
EX-B2-F-38-NSW(2)-5	5	02/06/08	0.0350 J	0.123 J	0.397 J	0.637 J	0.0317	214 JZ	329	137	680 J
EX-B2-F-38-NSW(2)-6	6	03/05/08	0.0307 U	0.0512 U	0.0512 U	0.102 U	0.0339	44.9 JZ	374 Q4	187 Q4	606 J
EX-B2-F-38-NSW-4	4	01/31/08	0.0295 U [0.0212 U]	0.0491 U [0.0354 U]	0.0491 U [0.0354 U]	0.0982 U [0.0708 U]	0.00831 [0.0287]	5.97 JZ [13.4 JZ]	25.0 [33.6 J]	28.0 U [28.0 U]	45.0 J [61.0 J]

TABLE 4
Excavation Soil Sample Analytical Results
Unocal Edmonds Bulk Fuel Terminal Lower Yard
Phase I Remedial Implementation As-built Report
11720 Unoco Road
Edmonds, Washington

Sample ID	**Sample Depth (feet bgs)**	**Date Sampled**	**BTEX** *(mg/kg)*				**Total cPAHs Adjusted for Toxicity** *(mg/kg)*	**Gasoline** *(mg/kg)*	**Diesel** *(mg/kg)*	**Heavy Oil (Lube)** *(mg/kg)*	**Total TPH** *(mg/kg)*
			B *REL = 18 mg/kg*	**T**	**E**	**X**	*CUL = 0.14 mg/kg*				*REL = 2,975*
EX-B2-F-38-WSW-5	5	01/31/08	0.0291 U	0.0486 U	0.0486 U	0.0971 U	0.00909	19.2 JZ	105	48.8	173 J
EX-B2-F-39(2)-12	12	02/05/08	0.0580 U	0.0966 U	0.0966 U	0.193 U	NA	9.66 U	15.2 U	38.0 U	31.4 UU
EX-B2-F-39-8	8	01/28/08	0.0290 U [0.0287 U]	0.0483 U [0.0478 U]	0.0483 U [0.0478 U]	0.0966 U [0.0955 U]	0.0894 [0.00886]	5.35 JZ [5.58 JZ]	1,010 J [51.5 J]	250 J [28.8 UJ]	1,270 J [71.5 J]
EX-B2-F-39-NSW-4	4	01/28/08	0.0308 U	0.0514 U	0.0514 U	0.103 U	0.00853	5.14 U	39.6	28.2 U	56.3
EX-B2-F-40-8	8	01/25/08	0.170	0.216	0.210	0.696	0.00914	6.90	67.8 Q11	42.5	117
EX-B2-F-41-8	8	01/23/08	0.0288 U	0.0480 U	0.0480 U	0.0960 U	0.00847	19.0 JZ	111 Q4	64.3 Q4	194 J
EX-B2-F-41-ESW(2)-5	5	02/04/08	3.30	0.840	2.95	17.2	0.0753	127	513 Q4	478 Q4	1,120
EX-B2-F-41-ESW-4	4	01/23/08	0.0747	0.0420 U	0.319	0.0841 U	0.359	4.20 U	14.5 Q4	29.5 Q4	46.1
EX-B2-G-32-6	6	02/26/08	0.139 J	0.0781 J	1.02 J	2.09 J	0.00959	1,090	1,230 J	161 U	2,400 J
EX-B2-G-33(2)-6	6	02/28/08	0.0340 U	0.0567 U	0.0567 U	0.113 U	0.00891	13.1 JZ	32.7 Q9	28.9 U	60.3 J
EX-B2-G-33-6	6	02/25/08	0.371 U	0.618 U	0.961	2.88	0.139	1,510 JZ	4,860 J	1,690 J	8,060 J
EX-B2-G-34-10	10	02/25/08	0.0308 U	0.0513 U	0.0513 U	0.103 U	NA	5.13 U	11.0 U	27.6 U	21.9 UU
EX-B2-G-34-SSW-6	6	02/25/08	0.0429 U	0.0716 U	0.0716 U	0.143 U	0.0323	31.1 JZ	28.9	31.8 U	75.9 J
EX-B2-G-35-10	10	02/22/08	0.119 U	0.198 U	0.198 U	0.397 U	NA	19.8 U	22.4 U	56.1 U	49.2 UU
EX-B2-G-35-SSW-6	6	02/22/08	0.0361 U [0.0404 U]	0.0601 U [0.0674 U]	0.0601 UJ [0.245 J]	0.120 UJ [0.403 J]	0.0167 [0.0474]	6.91 JZ [102 JZ]	19.3 Q9 [42.6 Q9]	30.6 U [35.8]	41.5 J [180 J]
EX-B2-G-36-12	12	02/22/08	0.0423 U	0.0705 U	0.0705 U	0.141 U	0.0240	7.05 U	38.1 Q4	32.5 U	57.9
EX-B2-G-37-13	13	02/22/08	0.0414 U	0.0690 U	0.0690 U	0.138 U	NA	6.90 U	12.8 U	32.0 U	25.9 UU
EX-B2-G-38(2)-13	13	02/06/08	0.0332 U	0.0554 U	0.0554 U	0.111 U	NA	5.54 U	11.8 U	29.6 U	23.5 UU
EX-B2-G-38-8	8	01/28/08	0.0279 U	0.0465 U	0.0577	0.243	0.0702	87.0 JZ	1,020	335	1,440 J
EX-B2-G-38-WSW-5	5	01/31/08	0.0305 U	0.0508 U	0.0545	0.185	0.0516	100 JZ	651	317	1,070 J
EX-B2-G-39(2)-11	11	02/05/08	0.0662 U	0.110 U	0.110 U	0.291	NA	13.5	16.3 U	40.7 U	42.0
EX-B2-G-39-8	8	01/28/08	0.323 U	1.37	1.27	2.35	0.197	568 Q10a	3,450	1,140 Q7	5,160
EX-B2-G-39-SSW-4	4	01/28/08	0.0271 U	0.0452 U	0.0452 U	0.0904 U	0.00861	4.52 U	24.5	30.6	57.4
EX-B2-G-40-8	8	01/25/08	0.0317 U	0.0529 U	0.0529 U	0.106 U	0.00883	5.29 U	59.9 Q11	43.0	106
EX-B2-G-40-SSW-4	4	01/25/08	0.0287 U	0.0479 U	0.0479 U	0.0958 U	0.00906	4.79 U	22.3 Q11	32.6	57.3
EX-B2-G-41-8	8	01/24/08	0.0354 U	0.0939	0.0590 U	0.317	0.00891	61.1 JZ	125 J	110 Q4	296 J
EX-B2-G-41-ESW-4	4	01/24/08	0.0356 U	0.0593 U	0.0593 U	0.119 U	0.0415	5.93 U	438 Q4	361 Q4	802
EX-B2-G-41-SSW-4	4	01/24/08	0.0341 U	0.0568 U	0.0568 U	0.114 U	0.00853	5.68 U	20.1 Q4	57.1 Q4	80.0
EX-B2-H-35-6	6	02/27/08	0.0833 U	0.229	0.139 U	0.278 U	0.0123	18.5	41.4 Q4	40.7 UQ4	101
EX-B2-H-36-6	6	02/22/08	0.0426 U	0.0709 U	0.0790	0.363	0.0225	70.4 JZ	453 Q4	248 Q4	771 J
EX-B2-H-37(2)-6	6	03/05/08	0.0349 U	0.0582 U	0.0582 U	0.159	0.00868	75.0 JZ	312 Q4	513 Q4	900 J
EX-B2-H-37-5	5	02/22/08	0.0398 U	0.0663 U	0.0663 U	0.248	0.167	133 JZ	2,690 J	1,550 J	4,370 J
EX-B2-H-38(2)-10	10	02/06/08	0.0293 U	0.0488 U	0.0488 U	0.0976 U	NA	4.88 U	11.2 U	28.1 U	22.1 UU
EX-B2-H-38-5	5	01/31/08	0.0315 U	0.252 J	0.231 J	0.791 J	0.145	316 JZ	2,940	849	4,110 J
EX-B2-H-38-WSW(2)-5	5	02/06/08	0.0329 U	0.0549 U	0.0549 U	0.110 U	0.0160	6.75 JZ	128 Q4	96.1 Q4	231 J
EX-B2-H-38-WSW-5	5	01/31/08	0.292 URL1	0.487 URL1	0.796	1.25	0.186	406 JZ	2,220	667	3,290 J
EX-B3-E-32-6	6	02/26/08	0.0474 U	0.0790 U	0.0790 U	0.158 U	NA	7.90 U	13.2 U	33.1 U	27.1 UU
EX-B3-F-31-12	12	03/10/08	0.0604 U	0.101 U	0.101 U	0.201 U	NA	10.1 U	15.1 U	37.8 U	31.5 UU
EX-B3-F-31-NSW-6	6	03/10/08	0.0306 U	0.0510 U	0.0510 U	0.102 U	0.00891	5.10 U	13.8 Q4	29.7 U	31.2
EX-B3-G-29-5	5	03/11/08	0.0356 U	0.0594 U	0.0594 U	0.119 U	NA	5.94 U	11.5 U	28.8 U	23.1 UU
EX-B3-G-29-NSW-4	4	03/11/08	0.0313 U	0.0522 U	0.0522 U	0.104 U	0.0300	5.22 U	27.1 JY	161	191 J
EX-B3-G-29-SSW-5	5	03/11/08	0.0377 U [0.0345 U]	0.0629 U [0.0575 U]	0.0629 U [0.0575 U]	0.126 U [0.115 U]	NA [NA]	6.29 U [5.75 U]	12.4 U [11.3 U]	30.9 U [28.4 U]	24.8 UU [22.7 UU]
EX-B3-G-30-12	12	03/11/08	0.0352 U	0.0586 U	0.0586 U	0.117 U	NA	5.86 U	11.9 U	29.9 U	23.8 UU
EX-B3-G-30-NSW-6	6	03/11/08	0.108	0.0711 U	0.0711 U	0.142 U	0.0184	12.8 JZ	169 Q4	120 Q4	302 J
EX-B3-G-30-SSW-6	6	03/10/08	0.0322 U	0.0536 U	0.0536 U	0.107 U	NA	5.36 U	11.5 U	28.7 U	22.8 UU
EX-B3-G-31-12	12	03/10/08	0.0368 U	0.0613 U	0.0613 U	0.123 U	NA	6.13 U	12.5 U	31.3 U	25.0 UU
EX-B3-G-31-SSW-6	6	03/10/08	0.0427 U	0.0711 U	0.0711 U	0.224	NA	27.4	12.3 U	30.8 U	49.0
EX-B4-B-23-6	6	02/25/08	0.0297 U [0.0321 U]	0.263 J [0.0679 J]	0.0494 U [0.0535 U]	0.0988 U [0.107 U]	0.0145 [NA]	4.94 U [5.35 U]	15.5 JY [11.2 U]	27.8 U [28.0 U]	31.9 J [22.3 UU]
EX-B4-B-24-6	6	02/25/08	0.0366 U	0.0610 U	0.0610 U	0.122 U	NA	6.10 U	12.1 U	30.3 U	24.3 UU
EX-B5-B-20(2)-4	4	02/28/08	0.0354 U	0.0590 U	0.0590 U	0.118 U	NA	5.90 U	12.1 U	30.3 U	24.2 UU
EX-B5-B-20-4	4	02/22/08	0.0363 U	0.0605 U	0.0605 U	0.121 U	0.111	6.05 U	592 Q4	473 Q4	1,070
EX-B6-C-15-3	3	11/19/07	0.0335 U	0.0559 U	0.0559 U	0.112 U	NA	5.59 U	12.6 U	31.5 U	24.8 UU
EX-B6-D-13-3	3	11/19/07	0.0269 U	0.0448 U	0.0448 U	0.0895 U	0.00846	12.1	61.6	27.7 U	87.6
EX-B6-D-14-10	10	11/19/07	0.0321 U	0.0535 U	0.0535 U	0.107 U	NA	6.31	12.2 U	30.5 U	27.7

TABLE 4
Excavation Soil Sample Analytical Results
Unocal Edmonds Bulk Fuel Terminal Lower Yard
Phase I Remedial Implementation As-built Report
11720 Unoco Road
Edmonds, Washington

Sample ID	Sample Depth (feet bgs)	Date Sampled	BTEX *(mg/kg)*				Total cPAHs Adjusted for Toxicity *(mg/kg)*	Gasoline *(mg/kg)*	Diesel *(mg/kg)*	Heavy Oil (Lube) *(mg/kg)*	Total TPH *(mg/kg)*
			B	T	E	X					
			REL = 18 mg/kg				***CUL = 0.14 mg/kg***				***REL = 2,975***
EX-B6-D-14-NSW-3	3	11/19/07	0.0369 U	0.0616 U	0.0616 U	0.123 U	NA	6.16 U	15.0 U	37.4 U	29.3 UU
EX-B6-D-15-12	12	11/19/07	0.0332 U [0.0323 U]	0.0554 U [0.0538 U]	0.0554 U [0.0538 U]	0.111 U [0.108 U]	NA [NA]	5.54 U [5.79]	13.2 U [12.6 U]	33.0 U [31.6 U]	25.9 UU [27.9]
EX-B6-E-13-4	4	11/19/07	0.0261 U [0.0270 U]	0.0435 U [0.0449 U]	0.0435 U [0.0449 U]	0.0870 U [0.0899 U]	0.00853 [0.00853]	4.35 U [4.49 U]	146 J [33.6 J]	113 [28.4 U]	261 J [50.0 J]
EX-B6-E-14-10	10	11/19/07	0.0312 U	0.0520 U	0.0520 U	0.104 U	NA	5.20 U	12.1 U	30.2 U	23.8 UU
EX-B6-F-14-10	10	11/19/07	0.0302 U	0.0504 U	0.0504 U	0.101 U	NA	5.04 U	12.6 U	31.5 U	24.6 UU
EX-B6-F-14-WSW-3	3	11/19/07	0.0275 U	0.0459 U	0.0459 U	0.0918 U	0.00846	4.59 U	42.4 Q11	28.0 U	58.7
EX-B8-F-4-4	4	10/01/07	0.0278 U	0.0464 U	0.0464 U	0.0928 U	0.0222	53.6 JZ	1,070 Q4	496 Q4	1,620 J
EX-B8-F-4-9	9	10/22/07	0.224	0.0784	0.0625 U	0.125 U	0.0468	6.25 U	801 Q4	347 Q4	1,150
EX-B8-F-4-NSW-4	4	10/22/07	0.0326 U	0.0543 U	0.0543 U	0.109 U	0.0422	80.7	834 Q4	332 Q4	1,250
EX-B8-F-4-NSW-6	6	10/09/07	0.0318 U [0.0324 U]	0.0531 U [0.0540 U]	0.0531 U [0.0540 U]	0.106 U [0.108 U]	0.0424 [0.0854]	23.5 JZ [52.2 JZ]	1,310 Q4 [2,440 J]	496 Q4 [1,030 J]	1,830 J [3,520 J]
EX-B8-F-4NSW-6	6	10/15/07	0.0428 U	0.0713 U	0.0713 U	0.143 U	0.112	53.2 JZ	3,850 Q4	1,760 Q4	5,660 J
EX-B8-F-4-WSW-4	4	10/01/07	0.0400 U	0.0666 U	0.0666 U	0.133 U	NA	6.66 U	10.9 U	27.3 U	22.4 UU
EX-B8-F-5-4	4	10/01/07	0.0374 U	0.0623 U	0.0623 U	0.125 U	0.0885	94.8 JZ	462 J	424 J	981 J
EX-B8-F-5-NSW-6	6	10/09/07	0.0292 U	0.0487 U	0.0487 U	0.0975 U	0.00909	16.3 JZ	422 Q4	187 Q4	625 J
EX-B8-G-4-9	9	10/01/07	0.0308 U	0.0514 U	0.0514 U	0.103 U	0.00921	5.14 U	18.2	30.5 U	36.0
EX-B8-G-4-WSW-4	4	10/01/07	0.0271 U	0.0452 U	0.0452 U	0.0904 U	0.0808	5.76 JZ	133 J	245 J	384 J
EX-B8-G-5-9	9	10/01/07	0.0319 U	0.0532 U	0.0532 U	0.106 U	NA	5.32 U	13.3 U	33.2 U	25.9 UU
EX-B8-H-4-9	9	10/01/07	0.0324 U	0.0540 U	0.0540 U	0.108 U	NA	5.40 U	11.9 U	29.8 U	23.6 UU
EX-B8-H-4-WSW-4	4	10/01/07	0.0279 U	0.0465 U	0.0465 U	0.0931 U	0.0768	86.7 JZ	2,080 Q4	1,100 Q4	3,270 J
EX-B8-H-5-9	9	10/01/07	0.0353 U	0.0588 U	0.0588 U	0.118 U	NA	5.88 U	12.2 U	30.4 U	24.2 UU
EX-B8-I-4-9	9	10/01/07	0.0817	0.0498 U	0.0498 U	0.0996 U	NA	4.98 U	12.2 U	30.4 U	23.8 UU
EX-B8-I-4-WSW-4	4	10/01/07	0.0323 U [0.0334 U]	0.0539 U [0.0557 U]	0.0539 U [0.0557 U]	0.108 U [0.111 U]	0.0991 [0.0524]	25.4 JZ [34.7 JZ]	3,130 Q4 [1,990 Q4]	1,480 Q4 [1,010 Q4]	4,640 J [3,030 J]
EX-B8-I-5-9	9	10/01/07	0.0292 U	0.0486 U	0.0486 U	0.0972 U	NA	4.86 U	12.1 U	30.2 U	23.6 UU
EX-B8-J-4-4	4	10/01/07	0.0217 U	0.0362 U	0.0362 U	0.0723 U	0.165	80.5 JZ	1,530 Q4	798 Q4	2,410 J
EX-B8-J-4-5	5	10/23/07	0.0251 U	0.0419 U	0.0419 U	0.0838 U	0.0170	4.19 U	146 Q4	167 Q4	315
EX-B8-J-4-SSW-2.5	2.5	10/23/07	0.0331 U	0.0552 U	0.0552 U	0.110 U	NA	5.52 U	10.9 U	27.3 U	21.9 UU
EX-B8-J-5-4	4	10/01/07	0.0272 U	0.0453 U	0.0453 U	0.0907 U	0.00831	4.53 U	35.9 JY	43.8	82.0 J
EX-B8-J-5-9	9	10/01/07	0.0366 U	0.0610 U	0.0610 U	0.122 U	NA	6.10 U	11.3 U	28.4 U	22.9 UU
EX-B9-M-4-11	11	02/20/08	0.0315 U	0.0524 U	0.0524 U	0.105 U	NA	5.24 U	11.6 U	29.1 U	23.0 UU
EX-B9-M-4-NSW-6	6	02/19/08	0.329 U	0.548 U	0.548 U	1.71	0.00907	755 JZ	439 Q4	211 Q4	1,410 J
EX-B9-M-4-WSW-6	6	02/19/08	0.336 U	0.561 U	0.561 U	1.84	0.0173	816 JZ	537 JX	141 U	1,420 J
EX-B9-M-5-11	11	02/19/08	0.0411 U	0.0685 U	0.0685 U	0.137 U	NA	6.85 U	13.0 U	32.5 U	26.2 UU
EX-B9-M-5-NSW-6	6	02/19/08	0.0285 U	0.0475 U	0.0750 J	0.375 J	0.00823	98.5 JZ	40.9 Q4	27.1 UQ4	167 J
EX-B9-M-6-11	11	02/19/08	0.0364 U [0.0453 U]	0.0606 U [0.0755 U]	0.0606 U [0.0755 U]	0.121 U [0.151 U]	NA [NA]	6.06 U [7.55 U]	12.5 U [13.4 U]	31.4 U [33.4 U]	25.0 UU [27.2 UU]
EX-B9-M-6-NSW-6	6	02/19/08	0.0383 U	0.0638 U	0.291	0.426	NA	16.2	13.0 U	32.6 U	39.0
EX-B9-N-4-11	11	02/20/08	0.0349 U	0.0582 U	0.0582 U	0.116 U	NA	5.82 U	12.1 U	30.3 U	24.1 UU
EX-B9-N-4-WSW-6	6	02/20/08	0.0338 U	0.250 J	0.172 J	0.871 J	0.00891	276 JZ	139 Q4	128 Q4	543 J
EX-B9-N-5-12	12	02/13/08	0.0343 U	0.0572 U	0.0572 U	0.114 U	NA	5.72 U	11.8 U	29.6 U	23.6 UU
EX-B9-O-4-12	12	02/20/08	0.0373 U [0.0373 U]	0.0622 U [0.0621 U]	0.0622 U [0.0621 U]	0.128 [0.209]	NA [NA]	20.2 [15.9]	12.3 U [12.5 U]	30.7 U [31.2 U]	41.7 [37.8]
EX-B9-O-4-WSW-6	6	02/20/08	0.0322 U	0.0536 U	0.0536 U	0.107 U	0.00800	50.7 JZ	24.4	26.5 U	88.4 J
EX-B9-O-5-12	12	02/13/08	0.0365 U [0.0354 U]	0.0609 U [0.0591 U]	0.0609 U [0.0591 U]	0.122 U [0.118 U]	NA [NA]	6.09 U [5.91 U]	11.8 U [11.9 U]	29.6 U [29.7 U]	23.7 UU [23.8 UU]
EX-B9-P-4-12	12	02/20/08	0.0396 U	0.0660 U	0.0660 U	0.132 U	NA	8.18	12.6 U	31.5 U	30.2
EX-B9-P-4-SSW(2)-6	6	02/25/08	0.332 U	0.553 U	0.553 U	3.82	0.0194	967 JZ	470 JX	138 U	1,510 J
EX-B9-P-4-SSW-6	6	02/20/08	0.295 U	0.491 U	0.595	3.53	0.0316	898 JZ	1,430 Q4	248 Q4	2,580 J
EX-B9-P-4-WSW-6	6	02/20/08	0.0333 U	0.0556 U	0.0556 U	0.111 U	NA	5.56 U	11.8 U	29.5 U	23.4 UU
EX-B9-P-5-12	12	02/13/08	0.0315 U	0.0525 U	0.0525 U	0.105 U	NA	5.25 U	11.6 U	29.0 U	22.9 UU
EX-B9-Q-5-6	6	02/13/08	0.0175 U	0.0291 U	0.0291 U	0.0582 U	0.0145	2.91 U	56.5 Q4	35.4 Q4	93.4
EX-B10-N-6-10	10	02/08/08	0.0361 U	0.0601 U	0.0601 U	0.120 U	NA	6.01 U	12.4 U	31.1 U	24.8 UU
EX-B10-O-6-10	10	02/08/08	0.0352 U	0.0586 U	0.0586 U	0.117 U	NA	5.86 U	12.3 U	30.8 U	24.5 UU
EX-B10-O-7-12	12	01/16/08	0.0302 U [0.0330 U]	0.0503 U [0.0550 U]	0.0503 U [0.0550 U]	0.101 U [0.110 U]	NA [NA]	5.03 U [5.50 U]	12.2 U [13.3 U]	30.5 U [33.3 U]	23.9 UU [26.1 UU]
EX-B10-O-8-12	12	01/16/08	0.0316 U	0.0527 U	0.0527 U	0.105 U	NA	5.27 U	12.7 U	31.8 U	24.9 UU
EX-B10-P-6-10	10	02/08/08	0.0400 U	0.0666 U	0.0666 U	0.176	NA	8.23	12.6 U	31.6 U	30.3
EX-B10-P-7-15	15	01/30/08	0.0328 U	0.0546 U	0.0546 U	0.109 U	NA	9.68	13.2 U	32.9 U	32.7
EX-B10-P-8-15	15	01/30/08	0.0322 U	0.0536 U	0.0536 U	0.107 U	NA	5.36 U	12.2 U	30.5 U	24.0 UU

TABLE 4
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Unocal Edmonds Bulk Fuel Terminal Lower Yard
Phase I Remedial Implementation As-built Report
11720 Unoco Road
Edmonds, Washington

Sample ID	Sample Depth (feet bgs)	Date Sampled	BTEX (mg/kg)				Total cPAHs Adjusted for Toxicity (mg/kg)	Gasoline (mg/kg)	Diesel (mg/kg)	Heavy Oil (Lube) (mg/kg)	Total TPH (mg/kg)
			B	T	E	X					
			REL = 18 mg/kg				CUL = 0.14 mg/kg				REL = 2,975
EX-B10-Q-6-11	11	02/08/08	0.0343 U	0.0572 U	0.0572 U	0.114 U	NA	5.73	12.8 U	32.1 U	28.2
EX-B10-Q-7-15	15	01/30/08	0.0309 U	0.0516 U	0.0516 U	0.103 U	NA	5.16 U	12.5 U	31.3 U	24.5 UU
EX-B11-Q-8-14	14	01/30/08	0.0306 U [0.0317]	0.0510 U [0.0496 U]	0.0510 U [0.0496 U]	0.102 U [0.0991 U]	0.00891 [NA]	5.80 [4.96 U]	20.1 JY [11.8 U]	29.7 U [29.5 U]	40.8 J [23.1 UU]
EX-B11-R-6-5	5	02/08/08	0.0346 U [0.0340 U]	0.0577 U [0.0566 U]	0.0577 U [0.0566 U]	0.115 U [0.113 U]	0.0224 [0.0258]	56.8 JZ [168 JZ]	1,510 [1,310]	296 [265]	1,860 J [1,740 J]
EX-B11-R-7-12	12	01/22/08	0.0331	0.0688	0.0509 U	0.145	NA	5.09 U	12.0 U	30.0 U	23.5 UU
EX-B11-R-7-WSW-5	5	01/18/08	0.0297 U	0.0495 U	0.0495 U	0.0989 U	0.107	80.4 JZ	7,130	1,360 Q7	8,570 J
EX-B11-R-8-12	12	01/30/08	0.0303	0.0993	0.109	0.565	NA	13.9	11.8 U	29.6 U	34.6
EX-B11-R-9-12	12	02/12/08	0.0612	0.0555 U	0.0555 U	0.111 U	NA	5.55 U	11.7 U	29.3 U	23.3 UU
EX-B11-S-7-12	12	01/22/08	0.0402	0.122	0.0601	0.333	NA	6.08	12.1 U	30.2 U	27.2
EX-B11-S-7-WSW-5	5	01/18/08	0.0290 U	0.0483 U	0.0483 U	0.0966 U	NA	4.83 U	10.9 U	27.2 U	21.5 UU
EX-B11-S-8-12	12	01/30/08	0.0287 U	0.0478 U	0.0478 U	0.0955 U	NA	8.58	12.1 U	30.2 U	29.7
EX-B11-S-9-12	12	02/12/08	0.0413	0.0628 U	0.150	0.457	0.00929	38.7 JZ	67.6	31.1 U	122 J
EX-B11-S-10-2	2	02/15/08	0.0408 U	0.0680 U	0.0680 U	0.136 U	NA	6.80 U	12.7 U	31.8 U	25.7 UU
EX-B11-S-11-12	12	02/14/08	0.0398 U	0.0663 U	0.0663 U	0.133 U	NA	6.63 U	12.3 U	30.7 U	24.8 UU
EX-B11-T-7-12	12	01/22/08	0.0310	0.0851	0.103	0.532	0.00891	48.4 JZ	52.3	29.6 U	116 J
EX-B11-T-7-WSW-5	5	01/18/08	0.0290 U	0.0484 U	0.0484 U	0.0967 U	NA	9.95 JZ	10.9 U	27.2 U	29.0 J
EX-B11-T-8-12	12	01/30/08	0.231	0.561	0.150	0.778	NA	6.50	11.9 U	29.9 U	27.4
EX-B11-T-9-12	12	02/12/08	0.193	0.0636 U	0.0647	0.127 U	NA	6.36 U	12.5 U	31.4 U	25.1 UU
EX-B11-T-10-10	10	02/14/08	0.0342 U	0.0570 U	0.0570 U	0.114 U	NA	5.70 U	12.3 U	30.6 U	24.3 UU
EX-B11-T-11-12	12	02/14/08	0.0306 U	0.0510 U	0.0510 U	0.102 U	NA	5.10 U	11.7 U	29.2 U	23.0 UU
EX-B11-T-11-ESW-6	6	02/15/08	0.0382 U	0.0637 U	0.0637 U	0.127 U	NA	6.37 U	12.5 U	31.4 U	25.1 UU
EX-B11-U-7-5	5	01/18/08	0.0290 U	0.0484 U	0.0484 U	0.0967 U	NA	4.84 U	11.0 U	27.5 U	21.7 UU
EX-B11-U-8-14	14	01/30/08	2.59	3.57	1.59	7.94	NA	48.6	11.9 U	29.7 U	69.4
EX-B11-U-9-12	12	01/31/08	0.461	0.824	0.460	1.71	NA	15.8	12.1 U	30.3 U	37.0
EX-B11-U-10-10	10	02/14/08	1.20	0.0890 U	0.0890 U	0.178 U	NA	8.90 U	14.0 U	34.9 U	28.9 UU
EX-B11-U-10-SSW-5	5	02/12/08	14.9	0.606 U	1.48	1.21 U	0.159	214	957 Q4	639 Q4	1,810
EX-B11-U-11-5	5	02/12/08	0.0429 U	0.0716 U	0.0716 U	0.143 U	0.0260	8.80 JZ	423 Q4	131 Q4	563 J
EX-B11-V-8-5	5	01/31/08	0.127	0.219	0.196	0.218	0.0172	175 JZ	616	28.0 U	805 J
EX-B11-V-9-5	5	01/31/08	0.142 J	0.302 J	1.17 J	2.36 J	0.00872	405 JZ	265	84.4	754 J
EX-B13-AA-2-10	10	09/26/07	0.0346	0.0564 U	0.0564 U	0.113 U	NA	12.8	12.5 U	31.1 U	34.6
EX-B13-AA-2-NSW-4	4	09/19/07	0.0306 U	0.0511 U	0.0511 U	0.102 U	0.0126	5.11 U	35.2	101	139
EX-B13-AA-2-WSW-4	4	09/19/07	0.0303 U	0.0505 U	0.0505 UJ	0.101 U	NA	5.05 U	11.0 U	27.5 U	21.8 UU
EX-B13-AA-3-10	10	09/26/07	0.0322 U	0.0537 U	0.0537 U	0.107 U	NA	5.37 U	12.9 U	32.2 U	25.2 UU
EX-B13-AA-3-NSW-4	4	09/19/07	0.0265 U	0.0441 U	0.0441 U	0.0883 U	NA	4.41 U	10.5 U	26.2 U	20.6 UU
EX-B13-AA-4-10	10	09/26/07	0.0313 U	0.0522 U	0.0522 U	0.104 U	NA	5.22 U	11.7 U	29.2 U	23.1 UU
EX-B13-BB-2-10	10	09/25/07	0.0336 U	0.0560 U	0.0560 U	0.112 U	NA	5.60 U	11.8 U	29.5 U	23.5 UU
EX-B13-BB-2-WSW-4	4	09/19/07	0.476	0.959	0.993	1.12	0.0335	774 JZ	1,030 J	105 J	1,910 J
EX-B13-BB-3-10	10	09/25/07	0.0281 U [0.0319 U]	0.0468 U [0.0532 U]	0.0468 U [0.0532 U]	0.0935 U [0.106 U]	NA [NA]	4.98 U [5.32 U]	10.7 U [11.5 U]	26.7 U [28.8 U]	21.2 UU [22.8 UU]
EX-B13-BB-4-10	10	09/25/07	0.0283 U	0.0472 U	0.0472 U	0.0945 U	NA	4.72 U	12.7 U	31.8 U	24.6 UU
EX-B13-BB-5-10	10	09/27/07	0.0295 U	0.0491 U	0.0491 U	0.0983 U	NA	4.91 U	11.4 U	28.5 U	22.4 UU
EX-B13-CC-1-4	4	10/10/07	0.0432 U	0.104	0.0720 U	0.144 U	NA	20.2	18.4 U	45.9 U	52.4
EX-B13-CC-1-10	10	10/08/07	0.952	3.90	2.99	2.51	0.0881	1,630	3,810 J	656 J	6,100 J
EX-B13-CC-2-4	4	09/25/07	8.83	4.68 U	4.68 U	9.37 U	0.0499	3,020	2,520	582	6,120
EX-B13-CC-2-10	10	10/08/07	0.0278 U	0.0463 U	0.0463 U	0.0926 U	NA	4.63 U	11.3 U	28.1 U	22.0 UU
EX-B13-CC-3-10	10	09/27/07	0.0285 U	0.0475 U	0.0475 U	0.0951 U	NA	4.75 U	12.1 U	30.2 U	23.5 UU
EX-B13-CC-4-10	10	09/27/07	0.0279 U	0.0465 U	0.0465 U	0.0931 U	NA	4.65 U	12.0 U	30.1 U	23.4 UU
EX-B13-CC-5-10	10	09/27/07	0.0299 U	0.0498 U	0.0498 U	0.0997 U	NA	4.98 U	12.5 U	31.2 U	24.3 UU
EX-B13-DD-1-4	4	10/08/07	0.0408 U	0.0679 U	0.0679 U	0.136 U	NA	6.79 U	14.7 U	36.7 U	29.1 UU
EX-B13-DD-2-10	10	10/08/07	0.0291 U	0.0484 U	0.0484 U	0.0968 U	NA	4.84 U	11.8 U	29.5 U	23.1 UU
EX-B13-DD-3-10	10	10/02/07	0.0279 U	0.0465 U	0.0465 U	0.0929 U	NA	4.65 U	11.1 U	27.8 U	21.8 UU
EX-B13-DD-4-10	10	10/02/07	0.173	0.0461 U	0.0461 U	0.0921 U	NA	4.61	11.7 U	29.1 U	25.0
EX-B13-DD-5-10	10	10/02/07	0.0637	0.0451 U	0.0451 U	0.0901 U	NA	4.51 U	11.6 U	28.9 U	22.5 UU
EX-B13-EE-1-4	4	10/08/07	0.0283 U	0.0472 U	0.0472 U	0.0944 U	NA	4.72 U	12.2 U	30.4 U	23.7 UU
EX-B13-EE-2-10	10	10/08/07	0.0272 U	0.0453 U	0.0453 U	0.0905 U	NA	4.53 U	11.6 U	28.9 U	22.5 UU

TABLE 4
Excavation Soil Sample Analytical Results
Unocal Edmonds Bulk Fuel Terminal Lower Yard
Phase I Remedial Implementation As-built Report
11720 Unoco Road
Edmonds, Washington

Sample ID	Sample Depth (feet bgs)	Date Sampled	BTEX (mg/kg)				Total cPAHs Adjusted for Toxicity (mg/kg)	Gasoline (mg/kg)	Diesel (mg/kg)	Heavy Oil (Lube) (mg/kg)	Total TPH (mg/kg)
			B	T	E	X					
			REL = 18 mg/kg				*CUL = 0.14 mg/kg*				*REL = 2,975*
EX-B13-EE-3-10	10	10/05/07	0.0298 U	0.0496 U	0.0496 U	0.0992 U	NA	4.96 U	11.5 U	28.8 U	22.6 UU
EX-B13-EE-3-SSW-4	4	10/05/07	0.0509	0.0502 U	0.0502 U	0.100 U	NA	6.85	12.2 U	30.6 U	28.3
EX-B13-EE-4-10	10	10/05/07	0.0296 U [0.0292 U]	0.0494 U [0.0487 U]	0.0494 U [0.0487 U]	0.0987 U [0.0974 U]	NA [NA]	4.94 U [4.87 U]	11.7 U [11.1 U]	29.3 U [27.8 U]	23.0 UU [21.9 UU]
EX-B13-EE-4-SSW-4	4	10/05/07	0.0314 U	0.0523 U	0.0523 U	0.105 U	NA	5.23 U	12.6 U	31.5 U	24.7 UU
EX-B13-FF-2-4	4	10/09/07	0.0302 U	0.0504 U	0.0504 U	0.101 U	NA	5.04 U	12.8 U	32.0 U	24.9 UU
EX-B13-FF-3-10	10	10/09/07	0.0447	0.0538 U	0.0538 U	0.108 U	NA	8.17	11.7 U	29.4 U	28.7
EX-B13-FF-3-ESW-4	4	10/09/07	0.0289 U	0.0481 U	0.0481 U	0.0963 U	NA	4.81 U	12.7 U	31.8 U	24.7 UU
EX-B13-GG-3-4	4	10/09/07	0.136	0.0462 U	0.0462 U	0.0925 U	NA	4.62 U	12.9 U	32.2 U	24.9 UU
EX-B14-DD-7-2.5	2.5	08/23/07	1.85	0.0664 U	0.0844	0.133 U	0.0121	70.6	151	82.0	304
EX-B14-DD-7-WSW-2.5	2.5	09/10/07	14.6	2.94	7.66	8.28	0.0111	2,940 J	3,640 J	213	6,790 J
EX-B14-DD-8-5	5	08/23/07	0.0500 [0.0302 U]	0.0519 U [0.0504 U]	0.0519 U [0.0504 U]	0.104 U [0.101 U]	0.226 [0.222]	40.3 JZ [23.3 JZ]	990 Q4 [425 Q4]	861 Q4 [396 Q4]	1,890 J [844 J]
EX-B14-DD-8-6	6	09/04/07	0.0999 [0.0912]	0.0496 U [0.0507 U]	0.0549 [0.0507 U]	0.0993 U [0.101 U]	0.00945 [0.00929]	13.9 [11.9]	70.8 JQ4 [28.3 JQ4]	75.1 JQ4 [30.9 UQ4]	160 J [71.1 J]
EX-B14-DD-NSW-2.5	2.5	08/23/07	0.0885 J [1.32 J]	0.0509 U [0.0687 U]	0.0509 U [0.0768]	0.102 U [0.137 U]	0.0112 [0.0244]	25.0 [72.9 JZ]	157 Q4 [188]	83.6 Q4 [88.7]	266 [350 J]
EX-B14-EE-5-4	4	09/10/07	0.404	0.0701 U	0.662	0.800	NA	445 JZ	12.1 U	30.3 U	466 J
EX-B14-EE-6-8	8	09/10/07	0.239	0.0541 U	0.0541 U	0.108 U	NA	5.41 U	11.7 U	29.2 U	23.2 UU
EX-B14-EE-7-8	8	08/23/07	0.0581 U	0.0968 U	0.0968 U	0.194 U	NA	9.68 U	17.9 U	44.7 U	36.1 UU
EX-B14-EE-8-4	4	08/23/07	0.255	0.0490 U	0.0490 U	0.0980 U	NA	4.90 U	12.7 U	31.7 U	24.7 UU
EX-B14-EE-WSW-4	4	08/23/07	2.30	0.539 U	4.91	7.39	0.224	1,040 JZ	3,290 J	598 UJ	4,630 J
EX-B14-FF-6-4	4	09/07/07	0.213	0.0536 U	0.0536 U	0.107 U	NA	5.57	12.6 U	31.4 U	27.6
EX-B14-FF-7-8	8	08/23/07	0.0763 U	0.127 U	0.127 U	0.254 U	NA	12.7 U	20.1 U	50.3 U	41.6 UU
EX-B14-FF-8-4SW	4	08/22/07	0.0505 U	0.0841 U	0.0841 U	0.168 U	0.0119	8.41 U	523	144	671
EX-B14-FF-WSW-4	4	08/23/07	0.100	0.0489 U	0.0489 U	0.0977 U	0.0107	16.3	64.2	34.6	115
EX-B14-GG-7-8	8	08/23/07	0.0266 U	0.0444 U	0.0444 U	0.0888 U	NA	4.44 U	12.1 U	30.4 U	23.5 UU
EX-B14-GG-WSW-4	4	08/23/07	0.0275 U	0.0458 U	0.0458 U	0.0915 U	0.0218	8.72	428 Q4	138 Q4	575
EX-B14-HH-6-4	4	08/23/07	0.0302 U [0.0285 U]	0.0504 U [0.0475 U]	0.0504 U [0.0475 U]	0.101 U [0.0949 U]	0.0107 [0.0107]	5.04 U [4.75 U]	40.1 Q4 [44.6 Q4]	80.6 Q4 [90.5 Q4]	123 [137]
EX-B14-HH-6F	6	08/23/07	0.0260 U	0.0433 U	0.0433 U	0.0866 U	0.0110	4.33 U	38.3 Q12	29.4 U	55.2
EX-B14-HH-7-4SW	4	08/23/07	0.0277 U	0.0461 U	0.0461 U	0.0923 U	0.0117	9.66 JZ	29.1 JY	29.5 U	53.5 J
EX-B15-HH-2-4	4	08/28/07	0.0901	0.0563 U	0.0563 U	0.184	NA	5.63 U	13.2 U	33.0 U	25.9 UU
EX-B15-HH-3-ESW-4	4	08/28/07	0.0319 U	0.0532 U	0.0532 U	0.106 U	NA	5.32 U	11.9 U	29.8 U	23.5 UU
EX-B15-HH-3-NSW-4	4	08/28/07	0.356	0.0539 U	0.0539 U	0.108 U	NA	5.39 U	13.0 U	32.4 U	25.4 UU
EX-B15-II-2-8	8	08/28/07	0.0571	0.0789 U	0.0789 U	0.158 U	NA	12.6	15.4 U	38.4 U	39.5
EX-B15-II-2-WSW-4	4	08/28/07	1.10	0.0517 U	0.143	0.133	NA	29.2	12.9 U	32.4 U	51.9
EX-B15-II-3-8	8	08/28/07	0.0264 U	0.0440 U	0.0440 U	0.0880 U	NA	4.40 U	11.6 U	29.1 U	22.6 UU
EX-B15-II-4-ESW-4	4	08/28/07	0.0316 U	0.0527 U	0.0527 U	0.169	0.0115	209 JZ	676	153	1,040 J
EX-B16-MM-1-6SW	6	08/20/07	0.305 U	0.508 U	0.807	1.02 U	0.00911	293 JZ	656	78.3 Q7	1,030 J
EX-B17-RR-1-6SW	6	08/20/07	0.0488 U	0.0814 U	0.0814 U	0.163 U	0.0113	8.14 U	51.2 JY	72.5 J	128 J
EX-B17-SS-1-6SW	6	08/20/07	0.0270 U	0.0450 U	0.0450 U	0.0900 U	NA	4.50 U	12.0 U	30.1 U	23.3 UU
EX-B18-UU-1-6SW	6	08/17/07	0.290 U [0.288 U]	0.484 U [0.480 U]	0.691 [0.554]	2.55 [1.94]	0.0435 [0.0103]	693 JZ [611 JZ]	1,140 J [376 J]	146 U [58.5 U]	1,910 J [1,020 J]
EX-B18-VV-1-6SW	6	08/17/07	1.56 U	2.60 U	2.60 U	5.82	0.0457	2,150 JZ	2,670 J	312 U	4,980 J
EX-B20-O-14-12	12	01/18/08	0.0303 U	0.0505 U	0.0505 U	0.101 U	NA	5.05 U	12.1 U	30.1 U	23.6 UU
EX-B20-O-15-12	12	01/18/08	0.0299 U	0.0499 U	0.0499 U	0.0998 U	NA	4.99 U	12.4 U	31.1 U	24.2 UU
EX-B20-F-19-6	6	10/18/07	0.0538	0.0521 U	0.0763	0.320	NA	23.0	12.4 U	31.1 U	44.8
EX-B20-F-19-NSW-3	3	10/26/07	0.0271 U	0.0451 U	0.0451 U	0.0902 U	NA	4.51 U	11.1 U	27.8 U	21.7 UU
EX-B20-F-20-10	10	10/30/07	0.0290 U	0.0484 U	0.0484 U	0.0968 U	0.0230	4.84 U	53.4	31.1 U	71.4
EX-B20-F-20-NSW-4	4	10/30/07	0.0286 U [0.0292 U]	0.0476 U [0.0486 U]	0.0476 U [0.0486 U]	0.0952 U [0.0972 U]	NA [NA]	4.76 U [4.86 U]	11.1 U [11.3 U]	27.8 U [28.3 U]	21.8 UU [22.2 UU]
EX-B20-F-21-4	4	10/17/07	0.0316 U	0.0526 U	0.0526 U	0.105 U	NA	5.26 U	12.0 U	30.0 U	23.6 UU
EX-B20-G-13-12	12	11/26/07	0.0268 U	0.0447 U	0.0447 U	0.0895 U	0.00823	4.47 U	100 J	27.3 U	116 J
EX-B20-G-14-12	12	11/20/07	0.0292 U	0.0486 U	0.0486 U	0.0973 U	NA	4.86 U	12.1 U	30.3 U	23.6 UU
EX-B20-G-14-WSW-4	4	11/20/07	0.0299 U	0.0498 U	0.0498 U	0.0995 U	0.00815	4.98 U	48.5 Q11	32.9	83.9
EX-B20-G-18-15	15	10/18/07	0.0276 U	0.0460 U	0.0460 U	0.0919 U	NA	5.04 U	12.1 U	30.3 U	23.7 UU
EX-B20-G-19-15	15	10/18/07	0.0377 U	0.0628 U	0.0628 U	0.126 U	NA	6.28 U	12.0 U	30.1 U	24.2 UU
EX-B20-G-20-15	15	10/18/07	0.0365	0.0488 U	0.179	0.0976 U	NA	4.88 U	11.8 U	29.4 U	23.0 UU
EX-B20-G-21-10	10	10/17/07	0.271 U	0.792	0.451 U	0.903 U	0.00944	123 JZ	1,020	59.0	1,200 J
EX-B20-G-21-ESW-5	5	10/26/07	0.0273 U	0.0455 U	0.0455 U	0.0910 U	0.00891	4.55 U	36.0 C8	29.3 U	52.9

TABLE 4
Excavation Soil Sample Analytical Results
Unocal Edmonds Bulk Fuel Terminal Lower Yard
Phase I Remedial Implementation As-built Report
11720 Unoco Road
Edmonds, Washington

Sample ID	Sample Depth (feet bgs)	Date Sampled	BTEX *(mg/kg)*				Total cPAHs Adjusted for Toxicity *(mg/kg)*	Gasoline *(mg/kg)*	Diesel *(mg/kg)*	Heavy Oil (Lube) *(mg/kg)*	Total TPH *(mg/kg)*
			B	T	E	X					
			REL = 18 mg/kg				***CUL = 0.14 mg/kg***				***REL = 2,975***
EX-B20-H-10-4	4	11/30/07	0.0291 U	0.0484 U	0.0484 U	0.0968 U	0.00858	4.84 U	148 Q4	195 Q4	345
EX-B20-H-11-4	4	11/29/07	0.0298 U	0.0497 U	0.0497 U	0.0994 U	NA	4.97 U	11.0 U	27.5 U	21.7 UU
EX-B20-H-12-6	6	11/29/07	0.0284 U [0.0291 U]	0.0473 U [0.0485 U]	0.0473 U [0.0485 U]	0.0946 U [0.0970 U]	0.00823 [0.00831]	4.73 U [4.85 U]	28.9 Q11 [35.8 Q11]	27.4 U [27.6 U]	45.0 [52.0]
EX-B20-H-12-NSW-2	2	11/29/07	0.0262 U	0.0437 U	0.0437 U	0.0873 U	NA	4.37 U	11.3 U	28.3 U	22.0 UU
EX-B20-H-13-12	12	11/26/07	0.0330 U	0.0550 U	0.0550 U	0.110 U	NA	5.50 U	12.3 U	30.7 U	24.3 UU
EX-B20-H-14-12	12	11/20/07	0.0319 U	0.0531 U	0.0531 U	0.106 U	0.00959	5.31 U	70.9 Q11	31.6 U	89.4
EX-B20-H-14-WSW-4	4	11/20/07	0.0277 U [0.0306 U]	0.0461 U [0.0510 U]	0.0461 U [0.0510 U]	0.0922 U [0.102 U]	0.00876 [0.00846]	4.61 U [5.10 U]	27.1 Q11 [20.4 Q11]	28.5 U [27.6 U]	43.7 [36.8]
EX-B20-H-18-15	15	10/18/07	0.0299 U [0.0301 U]	0.0498 U [0.0502 U]	0.0498 U [0.0502 U]	0.0997 U [0.100 U]	NA [NA]	4.98 U [5.02 U]	12.0 U [12.2 U]	30.0 U [30.5 U]	23.5 UU [23.9 UU]
EX-B20-H-19-15	15	10/18/07	0.0276 U	0.0460 U	0.0689	0.0920 U	NA	4.60 U	12.1 U	30.2 U	23.5 UU
EX-B20-H-20-15	15	10/18/07	0.107	0.0671 U	0.474	0.378	NA	10.5	13.8 U	34.5 U	34.7
EX-B20-H-21-10	10	10/18/07	0.0683 U	0.114 U	0.114 U	0.228 U	0.0153	11.4 U	506	72.1	584
EX-B20-H-21-ESW-5	5	10/26/07	0.0271 U	0.0452 U	0.0452 U	0.0903 U	0.00891	7.14 JZ	58.7 J	29.1 U	80.4 J
EX-B20-I-9-9	9	10/17/07	0.0440 U	0.0733 U	0.0733 U	0.147 U	NA	7.33 U	15.6 U	39.1 U	31.0 UU
EX-B20-I-10-10	10	11/29/07	0.0308 U	0.0514 U	0.0514 U	0.103 U	NA	5.14 U	12.7 U	31.8 U	24.8 UU
EX-B20-I-11-10	10	11/29/07	0.0329 U	0.0549 U	0.0549 U	0.110 U	NA	7.89	12.2 U	30.6 U	29.3
EX-B20-I-11-NSW-6	6	11/29/07	0.0299 U	0.0499 U	0.0499 U	0.0997 U	0.00815	5.84 JZ	63.6 Q11	26.9 U	82.9 J
EX-B20-I-12-10	10	11/29/07	0.0296 U	0.0493 U	0.0493 U	0.0985 U	NA	5.87	12.4 U	31.0 U	27.6
EX-B20-I-13-12	12	11/26/07	0.0291 U	0.0485 U	0.0485 U	0.0971 U	NA	4.85 U	11.8 U	29.4 U	23.0 UU
EX-B20-I-14-12	12	11/20/07	0.0314 U	0.0524 U	0.0524 U	0.105 U	NA	5.24 U	13.0 U	32.5 U	25.4 UU
EX-B20-I-15-15	15	11/05/07	0.0315 U	0.0525 U	0.0525 U	0.105 U	NA	5.25 U	13.6 U	34.0 U	26.4 UU
EX-B20-I-18-15	15	10/19/07	0.0392	0.0498 U	0.156	0.0997 U	NA	4.98 U	12.6 U	31.6 U	24.6 UU
EX-B20-I-19-15	15	10/18/07	0.0361 U [0.0326 U]	0.0601 U [0.0543 U]	0.0601 U [0.0543 U]	0.120 U [0.109 U]	NA [NA]	6.01 U [5.43 U]	13.3 U [13.1 U]	33.2 U [32.9 U]	26.3 UU [25.7 UU]
EX-B20-I-20-8	8	10/18/07	0.0303 U	0.0505 U	0.0505 U	0.101 U	NA	5.05 U	12.7 U	31.7 U	24.7 UU
EX-B20-I-21-4	4	10/30/07	0.0254 U	0.0423 U	0.0423 U	0.0846 U	0.0231	4.83 JZ	37.8	49.7	92.3 J
EX-B20-J-9-9	9	10/17/07	0.0310 U	0.0517 U	0.0517 U	0.103 U	0.00906	37.0 JZ	12.9	29.8 U	64.8 J
EX-B20-J-10-10	10	11/29/07	0.0340 U	0.0945	0.0567 U	0.123	NA	18.1	12.7 U	31.8 U	40.4
EX-B20-J-11-11	11	12/13/07	0.0301 U	0.0502 U	0.0502 U	0.100 U	NA	5.02 U	12.6 U	31.6 U	24.6 UU
EX-B20-J-12-10	10	11/28/07	0.0329	0.0539 U	0.0539 U	0.108 U	NA	5.39 U	12.3 U	30.8 U	24.2 UU
EX-B20-J-13-12	12	11/26/07	0.0304 U	0.0507 U	0.0507 U	0.101 U	NA	5.07 U	12.2 U	30.4 U	23.8 UU
EX-B20-J-14-12	12	11/20/07	0.0302 U	0.0503 U	0.0503 U	0.101 U	0.00891	5.03 U	29.6 Q11	29.3 U	46.8
EX-B20-J-15-15	15	11/05/07	0.0346 U	0.0577 U	0.0577 U	0.115 U	NA	5.77 U	13.2 U	32.9 U	25.9 UU
EX-B20-J-18-15	15	10/19/07	0.0293 U	0.0489 U	0.0489 U	0.0978 U	NA	4.89 U	12.2 U	30.5 U	23.8 UU
EX-B20-J-20-4	4	10/30/07	0.0355 U	0.0592 U	0.0592 U	0.118 U	NA	5.92 U	13.9 UC	34.8 U	34.3
EX-B20-K-7-5	5	01/10/08	0.0349 U	0.0918	0.0928	0.416	0.00936	65.1 JZ	16.1 JY	41.1	122 J
EX-B20-K-9-9	9	10/16/07	0.0385 U	0.0642 U	0.0642 U	0.128 U	NA	8.19	12.3 U	30.9 U	29.8
EX-B20-K-10-10	10	11/30/07	0.0315 U	0.0525 U	0.0525 U	0.105 U	NA	5.25 U	12.9 U	32.3 U	25.2 UU
EX-B20-K-11-10	10	11/29/07	0.0290 U	0.0483 U	0.0483 U	0.0967 U	NA	4.83 U	12.4 U	31.0 U	24.1 UU
EX-B20-K-12-12	12	11/29/07	0.0310 U	0.0517 U	0.0517 U	0.103 U	NA	5.17 U	12.8 U	32.1 U	25.0 UU
EX-B20-K-13-12	12	11/26/07	0.0305 U	0.0508 U	0.0508 U	0.102 U	NA	5.08 U	13.1 U	32.8 U	25.5 UU
EX-B20-K-14-12	12	11/20/07	0.0283 U	0.0471 U	0.0471 U	0.0943 U	NA	4.71 U	12.3 U	30.8 U	23.9 UU
EX-B20-K-15-15	15	11/05/07	0.0282 U	0.0470 U	0.0470 U	0.0940 U	NA	4.70 U	12.2 U	30.5 U	23.7 UU
EX-B20-K-16-15	15	10/31/07	0.0279 U	0.0466 U	0.0466 U	0.0932 U	NA	4.66 U	12.4 U	31.0 U	24.0 UU
EX-B20-L-7-5	5	02/08/08	0.0256 U	0.0427 U	0.128	0.217	0.00956	41.3 JZ	84.8	64.8	191 J
EX-B20-L-8-10	10	12/11/07	0.0337 U	0.0561 U	0.0561 U	0.112 U	NA	6.07	13.7 U	34.1 U	30.0

TABLE 4
Excavation Soil Sample Analytical Results
Unocal Edmonds Bulk Fuel Terminal Lower Yard
Phase I Remedial Implementation As-built Report
11720 Unoco Road
Edmonds, Washington

Sample ID	Sample Depth (feet bgs)	Date Sampled	BTEX *(mg/kg)*				Total cPAHs Adjusted for Toxicity *(mg/kg)*	Gasoline *(mg/kg)*	Diesel *(mg/kg)*	Heavy Oil (Lube) *(mg/kg)*	Total TPH *(mg/kg)*
			B	T	E	X					
			REL = 18 mg/kg				***CUL = 0.14 mg/kg***				***REL = 2,975***
EX-B20-L-8-WSW5	5	01/07/08	0.0410 [0.0430]	0.123 [0.142]	0.0586 U [0.0651]	0.131 [0.110 U]	0.0104 [0.00973]	26.8 JZ [36.4 JZ]	107 Q4 [154 Q4]	81.4 JQ4 [202 JQ4]	215 J [392 J]
EX-B20-L-9-10	10	12/11/07	0.0320 U	0.0534 U	0.0534 U	0.107 U	NA	5.34 U	12.8 U	31.9 U	25.0 UU
EX-B20-L-10-10	10	11/30/07	0.0310 U	0.0516 U	0.0516 U	0.103 U	NA	5.16 U	12.6 U	31.4 U	24.6 UU
EX-B20-L-11-10	10	12/07/07	0.0322 U	0.0537 U	0.0537 U	0.107 U	NA	5.37 U	13.1 U	32.7 U	25.6 UU
EX-B20-L-12-12	12	11/29/07	0.0321 U	0.0536 U	0.0536 U	0.107 U	NA	5.36 U	12.1 U	30.3 U	23.9 UU
EX-B20-L-13-12	12	11/26/07	0.0295 U	0.0492 U	0.0492 U	0.0983 U	NA	4.92 U	12.8 U	32.0 U	24.9 UU
EX-B20-L-14-12	12	11/20/07	0.0292 U	0.0486 U	0.0486 U	0.0972 U	NA	4.86 U	12.2 U	30.5 U	23.8 UU
EX-B20-L-15-15	15	11/05/07	0.0282 U	0.0471 U	0.0471 U	0.0941 U	NA	4.71 U	12.3 U	30.8 U	23.9 UU
EX-B20-L-16-15	15	10/31/07	0.0297 U	0.0496 U	0.0496 U	0.0992 U	NA	4.96 U	12.7 U	31.7 U	24.7 UU
EX-B20-M-6-5	5	02/08/08	0.778 J	0.278 U	13.8 J	40.1 J	0.103	4,630 JZ	5,250 JQ10	7,070 J	17,000 J
EX-B20-M-7-10	10	02/08/08	0.0376 U	0.0627 U	0.0627 U	0.125 U	NA	6.27 U	12.0 U	29.9 U	24.1 UU
EX-B20-M-8-12	12	01/16/08	0.0297 U	0.0495 U	0.0495 U	0.0990 U	NA	9.22	11.9 U	29.8 U	30.1
EX-B20-M-9-12	12	01/16/08	0.0319 U	0.0532 U	0.0532 U	0.106 U	NA	9.88	12.3 U	30.8 U	31.4
EX-B20-M-10-12	12	12/07/07	0.0363	0.0534 U	0.0534 U	0.107 U	NA	8.72	12.5 U	31.2 U	30.6
EX-B20-M-11-12	12	12/07/07	0.0314 U	0.0523 U	0.0523 U	0.105 U	NA	5.23 U	12.7 U	31.7 U	24.8 UU
EX-B20-M-12-12	12	12/07/07	0.0299 U [0.0310 U]	0.0498 U [0.0517 U]	0.0498 U [0.0517 U]	0.0997 U [0.103 U]	NA [NA]	4.98 U [5.17 U]	11.5 U [11.0 U]	28.9 U [27.4 U]	22.7 UU [21.8 UU]
EX-B20-M-13-14	14	12/07/07	0.0332 U	0.0554 U	0.0554 U	0.111 U	NA	5.54 U	13.8 U	34.5 U	26.9 UU
EX-B20-M-14-11	11	12/07/07	0.0306 U	0.0510 U	0.0510 U	0.102 U	NA	5.10 U	11.9 U	29.7 U	23.4 UU
EX-B20-M-15-11	11	12/07/07	0.0316 U	0.0527 U	0.0527 U	0.105 U	NA	5.27 U	11.5 U	28.8 U	22.8 UU
EX-B20-M-16-15	15	11/09/07	0.0302 U	0.0504 U	0.0504 U	0.101 U	NA	5.04 U	11.9 U	29.8 U	23.4 UU
EX-B20-M-16-SSW-12	12	11/09/07	0.0298 U	0.0497 U	0.0497 U	0.0995 U	NA	4.97 U	10.8 U	26.9 U	21.3 UU
EX-B20-M-17-10	10	11/09/07	0.0297 U	0.0495 U	0.0495 U	0.0989 U	NA	4.95 U	12.0 U	30.0 U	23.5 UU
EX-B20-M-17-ESW-5	5	11/09/07	0.0303 U	0.0505 U	0.0505 U	0.101 U	NA	5.05 U	12.4 U	30.9 U	24.2 UU
EX-B20-M-17-SSW-4	4	11/09/07	1.09	0.504 U	0.504 U	1.04	0.412	1,090 JZ	13,000	271 UQ7	14,400 J
EX-B20-M-17-SSW-6	6	01/28/08	0.577	0.529 U	0.529 U	1.21	0.166	1,380 Q10a	13,600 J	1,380 UJ	15,700 J
EX-B20-N-7-8	8	01/16/08	0.0324 U	0.0540 U	0.0540 U	0.108 U	NA	8.29	11.9 U	29.7 U	29.1
EX-B20-N-7-WSW-4	4	01/16/08	0.0293 U	0.0489 U	0.0489 U	0.0978 U	0.0152	33.5 JZ	148 Q4	125 Q4	307 J
EX-B20-N-8-12	12	01/16/08	0.0318 U	0.0530 U	0.0530 U	0.106 U	NA	5.30 U	12.8 U	31.9 U	25.0 UU
EX-B20-N-9-12	12	01/16/08	0.0313 U	0.0521 U	0.0521 U	0.104 U	NA	5.21 U	12.6 U	31.6 U	24.7 UU
EX-B20-N-10-12	12	01/08/08	0.0292 U	0.0487 U	0.0487 U	0.0974 U	NA	4.87 U	11.7 U	29.2 U	22.9 UU
EX-B20-N-11-12	12	01/08/08	0.0292 U	0.0487 U	0.0487 U	0.0975 U	NA	5.56	12.1 U	30.2 U	26.7
EX-B20-N-12-12	12	01/08/08	0.0282 U	0.0470 U	0.0470 U	0.0941 U	NA	4.70 U	11.9 U	29.9 U	23.3 UU
EX-B20-N-13-12	12	01/08/08	0.0310 U	0.0517 U	0.0517 U	0.103 U	NA	5.17 U	12.4 U	31.0 U	24.3 UU
EX-B20-N-14-12	12	12/11/07	0.0308 U	0.0513 U	0.0513 U	0.103 U	NA	5.13 U	12.3 U	30.7 U	24.1 UU
EX-B20-N-15-12	12	12/11/07	0.0338 U	0.0563 U	0.0563 U	0.113 U	NA	5.63 U	13.1 U	32.7 U	25.7 UU
EX-B20-N-16-4	4	11/09/07	2.02	1.74	2.41	2.52	0.409	2,120 JZ	14,700	312 Q7	17,100 J
EX-B20-N-16-12	12	11/13/07	0.0322 U	0.0537 U	0.0537 U	0.107 U	NA	5.37 U	11.6 U	29.1 U	23.0 UU
EX-B21-ESW-2	2	10/11/07	0.0354 U	0.0591 U	0.0591 U	0.118 U	NA	5.91 U	11.0 U	27.5 U	22.2 UU
EX-B21-FLOOR-4	4	10/11/07	0.0303 U	0.0506 U	0.0506 U	0.101 U	NA	5.06 U	11.8 U	29.5 U	23.2 UU
EX-B21-NSW-2	2	10/11/07	0.0300 U	0.0500 U	0.0500 U	0.100 U	0.00883	5.00 U	12.4 JY	44.6	59.5 J
EX-SDTI-5-NSW-4	4	08/22/07	0.0320 U	0.0533 U	0.0533 U	0.107 U	NA	5.33 U	12.8 U	31.9 U	25.0 UU
EX-SDTI-5-SSW-4	4	08/22/07	0.0344 U	0.0574 U	0.0574 U	0.115 U	NA	5.74 U	13.0 U	32.4 U	25.6 UU
EX-SDTI-ESW-4	4	08/22/07	0.0400 U	0.0667 U	0.0667 U	0.133 U	0.0107	6.67 U	30.1 Q11	35.6 U	51.2
EX-SDTI-FF-S-8	8	08/22/07	0.0333 U	0.0556 U	0.0556 U	0.111 U	0.00951	5.56 U	32.3 Q11	64.7	99.8
EX-SDTI-GG-ESW-4	4	08/22/07	0.0304 U	0.0507 U	0.0507 U	0.101 U	NA	5.07 U	12.3 U	30.6 U	24.0 UU
EX-SDTI-GG-S-8	8	08/22/07	0.0286 U	0.0477 U	0.0477 U	0.0953 U	0.00936	4.77 U	12.1 U	42.4	50.8
EX-SDTI-GG-WSW-4	4	08/22/07	0.0322 U	0.0537 U	0.0537 U	0.107 U	0.00929	5.37 U	36.8 Q11	31.5 U	55.2
EX-SDTI-WSW-4	4	08/22/07	0.0757	0.0580 U	0.0580 U	0.116 U	NA	9.40	12.2 U	30.6 U	30.8
EX-WW-G-27-2SW	2	08/07/07	0.0287 U	0.0479 U	0.0479 U	0.0958 U	0.00924	4.79 U	14.9 JY	49.7	67.0 J
EX-WW-G-27-4	4	08/07/07	0.0299 U	0.0498 U	0.0498 U	0.0997 U	NA	4.98 U	10.9 U	27.3 U	21.6 UU
EX-WW-H-27-2.5	2.5	08/07/07	0.0384 U	0.0639 U	0.0639 U	0.128 U	0.0321	6.39 U	16.4 JY	60.0	79.6 J
EX-WW-H-28-2	2	08/07/07	0.0294 U	0.0491 U	0.0491 U	0.0981 U	0.00891	6.07	21.4 JY	68.1	95.6 J
EX-WW-H-29-1	1	08/07/07	0.0335 U	0.0559 U	0.0559 U	0.112 U	0.00808	4.59 U	20.0 JY	78.9	101 J
EX-WW-I-26-1	1	08/07/07	0.0254 U	0.0424 U	0.0424 U	0.0848 U	0.00934	4.24 U	12.3 JY	44.3	58.7 J

TABLE 4
Excavation Soil Sample Analytical Results
Unocal Edmonds Bulk Fuel Terminal Lower Yard
Phase I Remedial Implementation As-built Report
11720 Unoco Road
Edmonds, Washington

Sample ID	Sample Depth (feet bgs)	Date Sampled	BTEX *(mg/kg)*				Total cPAHs Adjusted for Toxicity *(mg/kg)*	Gasoline *(mg/kg)*	Diesel *(mg/kg)*	Heavy Oil (Lube) *(mg/kg)*	Total TPH *(mg/kg)*
			B	T	E	X					
			REL = 18 mg/kg				***CUL = 0.14 mg/kg***				***REL = 2,975***
P-B15-NE-SW	4	08/16/07	0.598	0.692	2.35	2.87	NA	874 J	763 JX	637	2,270 J
P-B15-NW-SW	4	08/16/07	8.73	5.36 U	63.5	18.5	NA	6,610	1,910 JX	580 UJ	8,810 J

Notes:
BTEX analyzed by EPA Method 8021B.
cPAHs analyzed by EPA Method 8270 SIM.
Gasoline analyzed by method NWTPH-G.
Diesel and Heavy Oil (Lube) analyzed by method NWTPH-D Extended.
Total TPH calculated by summing the concentrations of gasoline, diesel and heavy oil. If one or more TPH constituents were reported as Non-Detect, half of the reporting limit value was added to the total.
cPAHs adjusted for toxicity according to WAC 173-340-708(8) and *Air Toxics Hot Spots Program Risk Assesment Guidelines, Part II Technical Support Document for Describing Available Cancer Potency Factors* . Office of Environmental Health Hazard Assessment, California EPA, May 2005. If one or more adjusted cPAH constituents were reported as Non-Detect, half of the reporting limt was used in calculations.
Highlighted cells indicate concentration exceeds REL or CUL.
[ ] = Bracketed data indicate duplicate sample.

feet bgs = Feet below ground surface
BTEX = Benzene, toluene, ethylbenzene, and total xylenes
mg/kg = Milligrams per kilogram
cPAHs = Carcinogenic polyaromatic hydrocarbons
TPH = Total petroleum hydrocarbons
REL = Remediation level
CUL = Cleanup level
NA = Not analyzed
EPA = Environmental Protection Agency

Lab Qualifiers	Definition
C	Calibration Verification recovery was above the method control limit for this analyte. Analyte not detected, data not impacted.
C8	Calibration Verification recovery was above the method control limit for this analyte. A high bias may be indicated.
D	Compound quantitated using a secondary dilution.
J	Indicates an estimated value.
JX	Results in the diesel organic range are primarily due to overlap from a gasoline range product.
JY	Results in the diesel organics range are primarily due to overlap from a heavy oil range product.
JZ	Detected hydrocarbons in the gasoline range appear to be due to overlap of diesel range hydrocarbons.
Q10	Hydrocarbon pattern most closely resembles a blend of gasoline and diesel range hydrocarbons.
Q10a	Hydrocarbon pattern most closely resembles a blend of gasoline and diesel range hydrocarbons.
Q11	Detected hydrocarbons in the diesel range do not have a distinct diesel pattern and may be due to heavily weathered diesel.
Q12	Detected hydrocarbons in the diesel range do not have a distinct diesel pattern and may be due to heavily weathered diesel or possibly biogenic interference.
Q4	The hydrocarbons present are a complex mixture of diesel range and heavy oil range organics.
Q7	The heavy oil range organics present are due to hydrocarbons eluting primarily in the diesel range.
Q9	Hydrocarbon pattern most closely resembles transformer oil.
U	The compound was analyzed for but not detected. The associated value is the compound quantitation limit.
RL1	Reporting limit raised due to sample matrix effects.
UJ	The compound was analyzed for but not detected. The associated value is the estimated compound quantitation limit.
UU	The constituents making up the total are all non-detects.

TABLE 5
Soil Sample Arsenic Results
Unocal Edmonds Bulk Fuel Terminal Lower Yard
Phase I Remedial Implementation As-built Report
11720 Unoco Road
Edmonds, Washington

Sample ID	**Date Sampled**	**Sample Depth** (feet bgs)	**Arsenic** *(mg/kg)*
			CUL = 20 mg/kg
EX-B19-YY-3-1	3/5/2008	1	5.08
EX-B19-YY-2-1	3/5/2008	1	9.84
EX-B19-YY-1-1	3/5/2008	1	5.45
EX-B19-ZZ-1-1	3/5/2008	1	**25.0 [30.9]**
EX-B19-ZZ-2-1	3/5/2008	1	8.56
EX-B19-ZZ-3-1	3/5/2008	1	5.54
EX-B19-ZZ-1-2	3/7/2008	2	**30.7**
EX-B19-ZZ-1-2.5	3/12/2008	2.5	<5.54

Notes:
feet bgs = Feet below ground surface
mg/kg = Milligrams per kilogram.
CUL = Cleanup level
[ ] Indicate Duplicate samplDuplicate samples immediately preceed the parent sample.
Highlighted cells indicate concentration exceeds REL or CUL.

Lab Qualifiers	Definition
<	The compound was analyzed for but not detected. The associated value is the compound quantitation limit.

TABLE 8
Confirmation Boring Analytical Results
Unocal Edmonds Bulk Fuel Terminal Lower Yard
Phase I Remedial Implementation As-built Report
11720 Unoco Road
Edmonds, Washington

Sample ID	Date Sampled	Sample Depth *(feet bgs)*	BTEX *(mg/kg)*				Total cPAHs Adjusted for Toxicity *(mg/kg)*	Gasoline *(mg/kg)*	Diesel *(mg/kg)*	Heavy Oil (Lube) *(mg/kg)*	Total TPH *(mg/kg)*
			B	T	E	X					
			REL = 18 mg/kg				***CUL = 0.14 mg/kg***				***REL = 2,975***
SB-1-11.5	04/03/08	11.5	0.0304 U	0.0507 U	0.0507 U	0.101 U	NA	5.07 U	11.4 U	28.6 U	22.5 UU
SB-2-11	04/03/08	11	0.0609 U	0.102 U	0.102 U	0.203 U	NA	10.2 U	15.6 U	38.9 U	32.4 UU
SB-3-10.5	04/03/08	10.5	0.0335 U	0.0559 U	0.0559 U	0.112 U	NA	5.59 U	12.0 U	30.0 U	23.8 UU
SB-3-12	04/03/08	12	0.0372 U	0.0620 U	0.0620 U	0.124 U	NA	6.20 U	11.9 U	29.7 U	23.9 UU
SB-4-10.5	04/04/08	10.5	0.0307 U	0.0511 U	0.0511 U	0.102 U	NA	5.11 U	11.3 U	28.1 U	22.3 UU
SB-5-11.5	04/04/08	11.5	0.0394	0.0513 U	0.0513 U	0.103 U	NA	5.13 U	10.9 U	27.4 U	21.7 UU
SB-6-11.0	04/04/08	11	0.0356 U	0.0594 U	0.0594 U	0.119 U	NA	5.94 U	11.8 U	29.5 U	23.6 UU
SB-7-11.5	04/04/08	11.5	0.0334 U	0.0556 U	0.0556 U	0.111 U	NA	5.56 U	11.5 U	28.8 U	22.9 UU
SB-8-11.0	04/04/08	11	0.0501	0.0505 U	0.0505 U	0.101 U	NA	5.05 U	11.4 U	28.5 U	22.5 UU
SB-9-11.0	04/04/08	11	0.0401	0.0543 U	0.0543 U	0.109 U	NA	5.43 U	11.5 U	28.7 U	22.8 UU
SB-10-11.0	04/04/08	11	0.0341 U [0.0350 U]	0.0569 U [0.0584 U]	0.0569 U [0.0584 U]	0.114 U [0.117 U]	NA [NA]	5.69 U [5.84 U]	11.8 U [11.6 U]	29.6 U [28.9 U]	23.5 UU [23.2 UU]
SB-11-11.0	04/04/08	11	0.0556 U	0.0927 U	0.0927 U	0.185 U	NA	9.27 U	14.2 U	35.5 U	29.5 UU
SB-12-11.5	04/04/08	11.5	0.0348 U	0.0580 U	0.0580 U	0.116 U	NA	5.80 U	12.1 U	30.2 U	24.1 UU
SB-13-11	04/11/08	11	0.0465 U	0.0776 U	0.0776 U	0.155 U	NA	7.76 U	13.1 U	32.8 U	26.8 UU
SB-14-11	04/11/08	11	0.0385 U	0.0642 U	0.0642 U	0.128 U	NA	6.42 U	12.4 U	31.1 U	25.0 UU
SB-15-10.5	04/14/08	10.5	0.0354 U [0.0366 U]	0.0590 U [0.0611 U]	0.0590 U [0.0611 U]	0.118 U [0.122 U]	NA [NA]	5.90 U [6.11 U]	11.9 U [11.9 U]	29.7 U [29.7 U]	23.8 UU [23.9 UU]
SB-16-9.5	04/14/08	9.5	0.0312 U	0.0519 U	0.0519 U	0.104 U	NA	5.19 U	11.1 U	27.6 U	21.9 UU
SB-17-11.5	04/14/08	11.5	0.0321 U	0.0535 U	0.0535 U	0.107 U	NA	5.35 U	11.8 U	29.4 U	23.3 UU
SB-18-11	04/11/08	11	0.711	5.53	4.20	3.24	0.00842	1,070 JZ	299	45.0	1,410 J
SB-19-12	04/11/08	12	0.0292 U	0.0486 U	0.0486 U	0.0972 U	NA	4.86 U	11.5 U	28.6 U	22.5 UU
SB-20-9.5	04/14/08	9.5	0.0323 U	0.0538 U	0.0538 U	0.108 U	NA	5.38 U	11.8 U	29.5 U	23.3 UU
SB-21-10.5	04/14/08	10.5	0.0348 U	0.0581 U	0.0581 U	0.116 U	NA	5.81 U	12.3 U	30.6 U	24.4 UU
SB-22-10	04/11/08	10	0.0371 U [0.0371 U]	0.0618 U [0.0619 U]	0.0618 U [0.0619 U]	0.124 U [0.124 U]	NA [NA]	6.18 U [6.19 U]	12.8 U [12.3 U]	32.1 U [30.6 U]	25.5 UU [24.5 UU]
SB-23-11	04/11/08	11	0.0357 U	0.0595 U	0.0595 U	0.119 U	NA	5.95 U	12.2 U	30.5 U	24.3 UU
SB-24-10	04/11/08	10	0.0398 U	0.0663 U	0.0663 U	0.133 U	NA	6.63 U	12.9 U	32.3 U	25.9 UU
SB-25-11	04/11/08	11	0.0359 U	0.0598 U	0.0598 U	0.120 U	NA	5.98 U	12.0 U	30.0 U	24.0 UU
SB-26-10.5	04/14/08	10.5	0.0339 U	0.0565 U	0.0565 U	0.113 U	NA	5.65 U	11.6 U	29.1 U	23.2 UU
SB-27-10	04/14/08	10	0.200	0.0537 U	0.0537 U	0.107 U	0.00896	13.8 JZ	279	29.2 U	307 J
SB-28-9	04/11/08	9	0.0313 U	0.0522 U	0.0522 U	0.104 U	0.00838 UU	6.59	11.9	27.7 U	32.3
SB-29-9	04/08/08	9	0.0708	0.0566 U	0.0566 U	0.113 U	NA	10.7	11.4 U	28.4 U	30.6
SB-30-9.5	04/10/08	9.5	0.0343 U	0.0572 U	0.0572 U	0.114 U	NA	5.72 U	11.6 U	29.1 U	23.2 UU
SB-31-9.5	04/10/08	9.5	0.0420 U	0.0699 U	0.0699 U	0.140 U	NA	6.99 U	12.9 U	32.4 U	26.1 UU
SB-32-9.5	04/10/08	9.5	0.0541 U [0.0538 U]	0.0902 U [0.0897 U]	0.0902 U [0.0897 U]	0.180 U [0.179 U]	NA [NA]	9.02 U [8.97 U]	14.4 U [14.4 U]	36.0 U [36.0 U]	29.7 UU [29.7 UU]
SB-33-11	04/10/08	11	0.0471 U	0.0786 U	0.0786 U	0.157 U	NA	7.86 U	13.2 U	32.9 U	27.0 UU
SB-34-11	04/10/08	11	0.0344 U	0.0574 U	0.0574 U	0.115 U	NA	5.74 U	11.8 U	29.5 U	23.5 UU
SB-35-9	04/10/08	9	0.0442 U	0.0736 U	0.0736 U	0.147 U	NA	7.36 U	12.7 U	31.7 U	25.9 UU
SB-36-12	04/10/08	12	0.0252 U	0.0420 U	0.0420 U	0.0839 U	NA	4.20 U	10.9 U	27.2 U	21.2 UU

TABLE 8
Confirmation Boring Analytical Results
Unocal Edmonds Bulk Fuel Terminal Lower Yard
Phase I Remedial Implementation As-built Report
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Sample ID	Date Sampled	Sample Depth *(feet bgs)*	BTEX *(mg/kg)*				Total cPAHs Adjusted for Toxicity *(mg/kg)*	Gasoline *(mg/kg)*	Diesel *(mg/kg)*	Heavy Oil (Lube) *(mg/kg)*	Total TPH *(mg/kg)*
			B	T	E	X					
			REL = 18 mg/kg				***CUL = 0.14 mg/kg***				***REL = 2,975***
SB-37-9	04/08/08	9	0.224 [0.225]	0.0566 U [0.0647 U]	0.0566 U [0.0647 U]	0.113 U [0.129 U]	NA [NA]	5.66 U [6.47 U]	12.0 U [12.8 U]	29.9 U [31.9 U]	23.8 UU [25.6 UU]
SB-38-8.5	04/08/08	8.5	0.0749	0.0634 U	0.0634 U	0.127 U	NA	6.34 U	12.0 U	29.9 U	24.1 UU
SB-38-10	04/08/08	10	0.108	0.0585 U	0.0585 U	0.117 U	0.00929 UU	5.85 U	12.3 U	30.8 U	24.5 UU
SB-39-14	04/10/08	14	0.0285 U	0.0475 U	0.0475 U	0.0951 U	NA	4.75 U	11.3 U	28.4 U	22.2 UU
SB-40-11	04/10/08	11	0.0365 U	0.0609 U	0.0609 U	0.122 U	NA	6.09 U	12.1 U	30.1 U	24.1 UU
SB-41-10	04/10/08	10	0.0346 U	0.0576 U	0.0576 U	0.115 U	NA	5.76 U	11.8 U	29.6 U	23.6 UU
SB-42-10	04/09/08	10	0.0464 U [0.0821]	0.0774 U [0.0822 U]	0.166 [0.152]	0.327 [0.231]	NA [NA]	7.74 U [8.22 U]	14.1 U [14.8 U]	35.2 U [37.1 U]	28.5 UU [30.1 UU]
SB-43-11.5	04/09/08	11.5	0.0420 U	0.0699 U	0.0699 U	0.140 U	NA	6.99 U	13.3 U	33.3 U	26.8 UU
SB-44-11	04/09/08	11	0.205	0.0548 U	0.0548 U	0.110 U	NA	5.48 U	11.8 U	29.4 U	23.3 UU
SB-45-10	04/08/08	10	0.206	0.0591 U	0.0591 U	0.118 U	NA	5.91 U	11.4 U	28.4 U	22.9 UU
SB-46-6	04/08/08	6	0.0323 U	0.0538 U	0.0538 U	0.108 U	NA	5.38 U	11.5 U	28.8 U	22.8 UU
SB-46-10.5	04/08/08	10.5	0.0311 U	0.0518 U	0.0518 U	0.104 U	NA	5.18 U	11.4 U	28.5 U	22.5 UU
SB-47-10	04/09/08	10	0.0437 U	0.0729 U	0.0729 U	0.146 U	NA	7.29 U	12.9 U	32.2 U	26.2 UU
SB-48-11.5	04/09/08	11.5	0.0459 U	0.0765 U	0.0765 U	0.153 U	NA	7.65 U	13.6 U	34.1 U	27.7 UU
SB-49-10.5	04/09/08	10.5	0.0333 U	0.0555 U	0.0555 U	0.111 U	NA	5.55 U	11.8 U	29.4 U	23.4 UU
SB-50-10.5	04/09/08	10.5	0.0350 U	0.0583 U	0.0583 U	0.117 U	NA	5.83 U	12.1 U	30.2 U	24.1 UU
SB-51-9.5	04/08/08	9.5	0.0350 U	0.0583 U	0.0583 U	0.117 U	NA	5.83 U	12.1 U	30.3 U	24.1 UU
SB-52-9.5	04/08/08	9.5	0.0317 U	0.0528 U	0.0528 U	0.106 U	NA	5.28 U	11.4 U	28.5 U	22.6 UU
SB-53-10.5	04/09/08	10.5	0.0309 U	0.0515 U	0.0515 U	0.103 U	NA	14.8	10.8 U	27.1 U	33.8
SB-54-10.5	04/09/08	10.5	0.0373 U	0.0622 U	0.0622 U	0.124 U	NA	6.22 U	12.1 U	30.3 U	24.3 UU
SB-55-11.5	04/07/08	11.5	0.0606 U	0.101 U	0.101 U	0.202 U	NA	10.1 U	15.7 U	39.2 U	32.5 UU
SB-56-14.5	04/08/08	14.5	0.0337 U	0.0561 U	0.0561 U	0.112 U	NA	5.61 U	11.7 U	29.3 U	23.3 UU
SB-57-10.5	04/07/08	10.5	0.0307 U	0.0511 U	0.0511 U	0.102 U	NA	5.11 U	11.3 U	28.2 U	22.3 UU
SB-58-11.0	04/07/08	11	0.0359 U	0.0598 U	0.0598 U	0.120 U	NA	5.98 U	11.6 U	29.1 U	23.3 UU
SB-59-5.5	04/08/08	5.5	0.0311 U	0.0518 U	0.0518 U	0.104 U	NA	5.18 U	11.4 U	28.5 U	22.5 UU
SB-60-10.5	04/07/08	10.5	0.0825 [0.0864]	0.0741 U [0.0637 U]	0.0741 U [0.0637 U]	0.148 U [0.127 U]	NA [NA]	7.41 U [6.37 U]	12.3 U [21.7]	30.8 U [29.0 U]	25.3 UU [39.4]
SB-61-10.5	04/07/08	10.5	0.0511 U	0.0852 U	0.0852 U	0.170 U	NA	8.52 U	15.1 U	37.8 U	30.7 UU
SB-62-10.5	04/07/08	10.5	0.0607 U	0.101 U	0.101 U	0.202 U	NA	10.1 U	15.8 U	39.5 U	32.7 UU
SB-63-5.5	04/07/08	5.5	0.327 U	0.577	1.11	6.56	0.107	2,190 JZ	2,970 J	193 J	5,350 J
SB-63-6.0	04/07/08	6	0.157 J	0.194 J	2.16 J	8.43 J	NA	978 JZ	20.2 U	50.4 U	1,010 J
SB-64-2.5	04/07/08	2.5	0.656	2.75	1.72	7.15	0.108	1,540 JZ	5,810 J	362 J	7,710 J
SB-64-5.5	04/07/08	5.5	0.139 J	2.42 J	0.782 J	3.20 J	0.0452 UU	534 JZ	444	32.2	1,010 J
SB-64-7.0	04/07/08	7	0.325	0.157 U	0.157 U	0.730	NA	63.1	19.9 U	49.7 U	97.9

TABLE 8
Confirmation Boring Analytical Results
Unocal Edmonds Bulk Fuel Terminal Lower Yard
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Notes:
BTEX analyzed by EPA Method 8021B.
cPAHs analyzed by EPA Method 8270 SIM.
Gasoline analyzed by method NWTPH-G.
Diesel and Heavy Oil (Lube) analyzed by method NWTPH-D Extended.
Total TPH calculated by summing the concentrations of gasoline, diesel and heavy oil. If one or more TPH constituents were reported as Non-Detect, half of the reporting limit value was added to the total.
cPAHs adjusted for toxicity according to WAC 173-340-708(8) and *Air Toxics Hot Spots Program Risk Assessment Guidelines, Part II Technical Support Document for Describing Available Cancer Potency Factors* .
Highlighted cells indicate concentration exceeds REL or CUL.
[ ] = Bracketed data indicate duplicate sample.

feet bgs = Feet below ground surface
BTEX = Benzene, toluene, ethylbenzene, and total xylenes
mg/kg = Milligrams per kilogram
cPAHs = Carcinogenic polyaromatic hydrocarbons
TPH = Total petroleum hydrocarbons
REL = Remediation level
CUL = Cleanup level
NA = Not analyzed
EPA = Environmental Protection Agency

Lab Qualifiers	Definition
J	Indicates an estimated value.
JZ	Detected hydrocarbons in the gasoline range appear to be due to overlap of diesel range hydrocarbons.
U	The compound was analyzed for but not detected. The associated value is the compound quantitation limit.
UJ	The compound was analyzed for but not detected. The associated value is the estimated compound quantitation limit.
UU	The constituents making up the total are all non-detects.

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TABLE 3
Excavation Soil Sample Analytical Results
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Sample ID	Sample Depth (feet bgs)	Date Sampled	BTEX *(mg/kg)*				Total cPAHs Adjusted for Toxicity *(mg/kg)*	Diesel Range Organics *(mg/kg)*	Gasoline Range Organics *(mg/kg)*	Heavy Oil (Lube) *(mg/kg)*	Total TPH (mg/kg)
			B	T	E	X					
Site Soil Remediation Level (REL)/Cleanup Level (CUL) (mg/kg)			18	--	--	--	0.14	--	--	--	2,975
EX-AW-E-23-5	5	09/11/08	0.0404 U	0.0674 U	0.0674 U	0.135 U	0.278	596	109	410	1,120
EX-AW-E-23-5(2)	5	09/17/08	0.0363 U	0.0605 U	0.0605 U	0.121 U	NA	11.9 U	6.05 U	29.7 U	23.8 UU
EX-AW-E-24-10	10	09/11/08	0.0354 U	0.0590 U	0.0590 U	0.118 U	0.00891	28.1	5.90 U	29.0 U	45.6
EX-AW-E-24-NSW-5	5	09/11/08	0.0363 U	0.0605 U	0.0605 U	0.121 U	0.00892	357	30.0 JZ	134	521 J
EX-AW-E-25-10	10	09/11/08	0.0405 U	0.0675 U	0.0675 U	0.135 U	0.00982	102	6.75 U	32.8 U	122
EX-AW-E-25-ESW-5	5	09/11/08	0.0327 U [0.0339 U]	0.228 J [0.470 J]	0.0545 U [0.0564 U]	0.109 U [0.320 J]	0.00846 [0.00838]	18.4 [24.6]	75.2 JZ [171 JZ]	28.2 U [27.5 U]	108 J [209 J]
EX-AW-E-25-NSW-5	5	09/11/08	0.0373 U	0.0621 U	0.0621 U	0.124 U	0.00898	16.1	6.21 U	29.7 U	34.1
EX-AW-F-23-5	5	09/11/08	0.0359 U	0.0598 U	0.0598 U	0.120 U	0.00950	2,840	5.98 U	692	3,530
EX-AW-F-23-5(2)	5	09/12/08	0.0339 U	0.0565 U	0.0565 U	0.113 U	NA	11.6 U	5.65 U	29.1 U	23.2 UU
EX-AW-F-24-5	5	09/11/08	0.0345 U	0.0575 U	0.0575 U	0.115 U	NA	10.9 U	12.0	27.3 U	31.1
EX-AW-F-25-5	5	09/11/08	0.0277 U	0.0461 U	0.0461 U	0.0923 U	0.0181	58.1	6.68 JZ	71.8	137 J
EX-AW-F-25-ESW-5	5	09/11/08	0.0372 U	0.0620 U	0.0620 U	0.124 U	0.00846	62.6	6.20 U	27.9 U	79.7
EX-B1-C-46-4	4	08/08/08	0.355	1.06	0.294 U	3.20	0.228	2,920	260 JZ	911	4,090 J
EX-B1-C-46-4(2)	4	09/02/08	0.0302 U	0.0503 U	0.0503 U	0.101 U	0.0142	46.8 JY	5.03 U	92.7	142 J
EX-B1-C-47-4	4	08/08/08	0.0309 U	0.0679	0.0515 U	0.166	0.0414 UU	236	51.8 JZ	123	411 J
EX-B1-D-43-4	4	08/19/08	4.39	32.3	22.5	117	NA	11.6 U	2,000 J	29.0 U	2,020 J
EX-B1-D-44-12	12	08/18/08	0.121 U	0.202 U	0.202 U	0.404 U	0.0369 UU	25.6	20.2 U	60.3 U	65.9
EX-B1-D-44-NSW-4	4	08/18/08	1.23	2.68	0.470 U	9.81	0.554	9,620 J	678 JZ	3,350 J	13,600 J
EX-B1-D-44-NSW-4(2)	4	09/02/08	0.0508	0.107	0.0452 U	0.0903 U	0.0188	101	32.6	153	287
EX-B1-D-45-12	12	08/14/08	0.224 [0.0598 U]	0.956 J [0.0996 UJ]	1.41 J [0.0996 UJ]	4.87 J [0.199 UJ]	NA [NA]	14.6 U [15.4 U]	76.1 JZ [9.96 UJ]	36.4 U [38.5 U]	102 J [31.9 UU]
EX-B1-D-45-NSW-4	4	09/02/08	0.0316 U	0.0526 U	0.0526 U	0.105 U	0.0152	28.8 JY	5.26 U	69.0	100 J
EX-B1-D-46-12	12	08/11/08	0.113 U	0.189 U	0.189 U	0.378 U	0.0431	69.6 JY	18.9 U	158	237 J
EX-B1-D-47-4	4	08/08/08	0.0349 U	0.0582 U	0.0582 U	0.116 U	0.123	135	36.6 JZ	105	277 J
EX-B1-E-41-8	8	08/27/08	0.0325 U	0.0542 U	0.0542 U	0.108 U	0.0205	173	9.58	153	336
EX-B1-E-41-NSW-4	4	08/27/08	0.0314 U	0.0524 U	0.0524 U	0.105 U	NA	10.6 U	7.74	26.6 U	26.3
EX-B1-E-42-8	8	08/27/08	0.0327 U	0.0544 U	0.0544 U	0.109 U	0.0172	130	13.0	122	265
EX-B1-E-42-NSW-4	4	08/27/08	0.156	0.283	2.54	5.88	0.0714	76.8	223	83.1	383
EX-B1-E-43-12	12	08/21/08	0.259 U	0.431 U	0.431 U	0.863 U	NA	40.8 U	43.1 U	102 U	93.0 UU

TABLE 3
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Sample ID	Sample Depth (feet bgs)	Date Sampled	BTEX *(mg/kg)* B	T	E	X	Total cPAHs Adjusted for Toxicity *(mg/kg)*	Diesel Range Organics *(mg/kg)*	Gasoline Range Organics *(mg/kg)*	Heavy Oil (Lube) *(mg/kg)*	Total TPH (mg/kg)
Site Soil Remediation Level (REL)/Cleanup Level (CUL) (mg/kg)			**18**	--	--	--	**0.14**	--	--	--	**2,975**
EX-B1-E-44-12	12	08/19/08	0.143 U	0.239 U	0.239 U	0.477 U	NA	28.0 U	23.9 U	69.9 U	60.9 UU
EX-B1-E-45-12	12	08/14/08	0.106 U	0.177 U	0.177 U	0.354 U	NA	19.8 U	17.7 U	49.6 U	43.6 UU
EX-B1-E-46-12	12	08/13/08	0.133 U	0.221 U	0.221 U	0.442 U	NA	23.0 U	22.1 U	57.6 U	51.4 UU
EX-B1-E-47-4	4	08/08/08	0.0336 U	0.147	0.0561 U	0.116	0.0172	21.1	5.61 U	26.9 U	37.4
EX-B1-E-47-SSW-4	4	08/08/08	0.351 U	0.586 U	0.743	4.44	0.756	11,400 J	493 JZ	3,820 J	15,700 J
EX-B1-E-47-SSW-4(2)	4	09/02/08	0.0280 U	0.0466 U	0.0466 U	0.0932 U	NA	10.8 U	4.66 U	27.0 U	21.2 UU
EX-B1-F-42-8	8	08/27/08	0.0332 U	0.0553 U	0.0553 U	0.111 U	0.0165	144	12.4	114	270
EX-B1-F-42-SSW-4	4	08/27/08	0.0327 U [0.0306 U]	0.0546 U [0.0511 U]	0.0546 U [0.0511 U]	0.109 U [0.102 U]	NA [NA]	10.7 U [10.6 U]	5.46 U [5.11 U]	26.8 U [26.6 U]	21.5 UU [21.2 UU]
EX-B1-F-43-4	4	08/21/08	0.0288 U	0.0481 U	0.0481 U	0.0961 U	0.0184	231	35.6 JZ	275	542 J
EX-B1-F-44-4	4	08/18/08	0.0298 U	0.0497 U	0.0497 U	0.0994 U	0.212	58.3	4.97 U	60.2	121
EX-B1-F-45-10	10	08/15/08	0.0671 U	0.112 U	0.112 U	0.224 U	NA	16.8 U	11.2 U	41.9 U	35.0 UU
EX-B1-F-45-SSW-4	4	08/18/08	0.0296 U	0.0493 U	0.0493 U	0.0986 U	0.0719	95.5	21.4 JZ	115	232 J
EX-B1-F-46-4	4	08/08/08	4.81	9.05	4.52	48.6	1.14	8,430 J	1,650 JZ	2,500 J	12,600 J
EX-B1-F-47-4(2)	4	09/02/08	0.0291 U	0.0486 U	0.0486 U	0.0971 U	NA	10.9 U	4.86 U	27.2 U	21.5 UU
EX-B7-B3-4	4	08/01/08	0.0377 U	0.0628 U	0.0628 U	0.126 U	0.0411	1,990	6.28 U	2,060	4,050
EX-B7-B4-4	4	08/01/08	0.366 U [0.0548 U]	0.610 U [0.0913 U]	0.610 U [0.0913 U]	1.22 U [0.183 U]	0.0488 [0.0517]	1,120 [960]	61.0 U [9.13 U]	629 [544]	1,780 [1,510]
EX-B7-B-4-5	5	09/10/08	0.0383 U	0.0638 U	0.0638 U	0.128 U	0.00944 UU	64.2	20.9	30.7 U	100
EX-B8-H-3-10	10	09/10/08	0.0385 U	0.0642 U	0.0642 U	0.128 U	NA	12.2 U	6.42 U	30.5 U	24.6 UU
EX-B8-H-3-NSW-5	5	09/10/08	0.0322 U	0.0537 U	0.0537 U	0.107 U	0.0266	10.9 U	5.37 U	31.2	39.3
EX-B8-H-3-WSW-5	5	09/10/08	0.0427 U	0.0712 U	0.0712 U	0.142 U	0.0439	58.0 JY	7.12 U	342	404 J
EX-B8-I-3-10	10	09/10/08	0.0412 U	0.0686 U	0.0686 U	0.137 U	NA	12.4 U	6.86 U	31.0 U	25.1 UU
EX-B8-I-3-WSW-5	5	09/10/08	0.0833 U	0.139 U	0.139 U	0.278 U	0.0728	2,740	15.0	2,590	5,350
EX-B8-I-3-WSW-5(2)	5	09/11/08	0.0525 U	0.0875 U	0.0875 U	0.175 U	0.0589	352	8.75 U	354	710
EX-B8-J-3-10	10	09/10/08	0.0369 U	0.0616 U	0.0616 U	0.123 U	NA	11.8 U	6.16 U	29.5 U	23.7 UU
EX-B8-J-3-SSW-5	5	09/10/08	0.0302 U [0.0338 U]	0.0504 U [0.0564 U]	0.0504 U [0.0564 U]	0.101 U [0.113 U]	0.00793 UU [0.00793 UU]	51.5 [335 JY]	9.14 [5.64 U]	41.1 [315]	102 [653 J]
EX-B8-J-3-WSW-5	5	09/10/08	0.0302 U	0.0503 U	0.0503 U	0.101 U	0.00800 UU	270 JY	5.03 U	278	551 J
EX-B9-N-3-5	5	09/09/08	0.0331 U	0.0551 U	0.0551 U	0.110 U	NA	10.8 U	5.51 U	26.9 U	21.6 UU
EX-B9-O-3-10	10	09/09/08	0.0353 U	0.0588 U	0.0588 U	0.118 U	NA	11.7 U	9.57	29.3 U	30.1
EX-B9-O-3-WSW-5	5	09/09/08	0.0322 U	0.0537 U	0.0537 U	0.107 U	NA	10.5 U	5.37 U	26.2 U	21.0 UU
EX-B9-P-3-10	10	09/09/08	0.0360 U	0.0600 U	0.0600 U	0.120 U	NA	12.0 U	11.4	29.9 U	32.4
EX-B9-P-3-SSW-5	5	09/09/08	0.0320 U	0.0533 U	0.0533 U	0.107 U	NA	10.6 U	5.33 U	26.4 U	21.2 UU

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Sample ID	Sample Depth (feet bgs)	Date Sampled	BTEX *(mg/kg)*				Total cPAHs Adjusted for Toxicity *(mg/kg)*	Diesel Range Organics *(mg/kg)*	Gasoline Range Organics *(mg/kg)*	Heavy Oil (Lube) *(mg/kg)*	Total TPH (mg/kg)
			B	T	E	X					
Site Soil Remediation Level (REL)/Cleanup Level (CUL) (mg/kg)			**18**	--	--	--	**0.14**	--	--	--	**2,975**
EX-B9-P-3-WSW-5	5	09/09/08	0.0327 U	0.0545 U	0.0545 U	0.109 U	NA	10.3 U	5.45 U	25.9 U	20.8 UU
ISP-E-17-2	2	09/17/08	0.0310 U	0.0516 U	0.0516 U	0.103 U	NA	10.4 U	5.16 U	26.1 U	20.8 UU
ISP-E-18-2	2	09/17/08	0.0312 U	0.0519 U	0.0519 U	0.104 U	0.0248	15.2	5.19 U	27.9 U	31.7
ISP-E-19-2	2	09/22/08	0.0337 U	0.0562 U	0.0562 U	0.112 U	0.00868 UU	51.3 J	5.62 U	42.8	96.9 J
ISP-E-20-2	2	09/22/08	0.0333 U	0.0555 U	0.0555 U	0.111 U	0.0212	105	7.17 JZ	67.4	180 J
ISP-E-21-2	2	09/22/08	0.0318 U	0.0530 U	0.0530 U	0.113	0.00850	16.7	25.0 JZ	27.7 U	55.6 J
ISP-F-17-2	2	09/17/08	0.0319 U	0.0532 U	0.0532 U	0.106 U	NA	10.4 U	5.32 U	26.0 U	20.9 UU
ISP-F-18-2	2	09/17/08	0.0267 U	0.0445 U	0.0445 U	0.0890 U	0.0170	29.0	4.45 U	32.9	64.1
ISP-F-19-2	2	09/22/08	0.0329 U	0.0549 U	0.0549 U	0.110 U	0.0523	14.3	5.49 U	27.5 U	30.8
ISP-F-20-2	2	09/22/08	0.0351 U	0.0585 U	0.0585 U	0.117 U	0.0498	11.6	5.85 U	27.1 U	28.1
ISP-F-21-2	2	09/22/08	0.0344 U	0.0574 U	0.0574 U	0.115 U	NA	11.0 U	5.74 U	27.4 U	22.1 UU
ISP-G-17-2	2	09/17/08	0.0314 U	0.0524 U	0.0524 U	0.105 U	NA	10.4 U	5.24 U	26.1 U	20.9 UU
ISP-G-18-2	2	09/17/08	0.0314 U	0.0523 U	0.0523 U	0.105 U	NA	10.6 U	5.23 U	26.4 U	21.1 UU
ISP-G-19-2	2	09/22/08	0.0305 U [0.0301 U]	0.0508 U [0.0502 U]	0.0508 U [0.0502 U]	0.102 U [0.100 U]	0.306 [0.0187]	38.9 [47.5]	5.08 U [5.02 U]	27.5 U [27.5 U]	55.2 [63.8]
ISP-G-19-2(2)	2	09/25/08	0.0344 U	0.0573 U	0.0573 U	0.115 U	0.0161	75.5	5.73 U	57.1	135
ISP-G-20-2	2	09/22/08	0.0328 U	0.0546 U	0.0546 U	0.109 U	0.00823 UU	11.4	5.46 U	27.1 U	27.7
ISP-G-21-2	2	09/22/08	0.0322 U	0.0536 U	0.0536 U	0.107 U	0.0335	74.1	9.03 JZ	35.0	118 J
EX-RRT-ZZ-2-4	4	08/01/08	0.0552 U	0.0920 U	0.0920 U	0.184 U	NA	15.2 U	20.3	38.0 U	46.9
EX-RRT-ZZ-2-ESW-3	3	08/01/08	0.0800 U	0.133 U	0.133 U	0.560 J	NA	18.2 U	46.4 J	45.4 U	78.2 J
RRT-YY-2-6	6	08/04/08	0.105 U	0.376 J	0.174 U	1.61 J	NA	20.8 U	39.9 J	52.0 U	76.3 J
RRT-YY-2-WSW-3	3	08/04/08	0.0397 U [0.0357 U]	0.0661 U [0.0595 U]	0.0661 U [0.0595 U]	0.132 U [0.119 U]	0.00808 UU [0.00808 UU]	27.1 JY [26.8 JY]	6.61 U [5.95 U]	32.9 [31.6]	63.3 J [61.4 J]
RRT-ZZ-2-NSW-3	3	08/04/08	0.0349 U	0.0581 U	0.0581 U	0.116 U	0.00853 UU	30.2 J	5.81 U	60.4	93.5 J
RRT-ZZ-3-NSW-3	3	08/04/08	0.0382 U	0.0637 U	0.0637 U	0.127 U	NA	11.8 U	6.37 U	29.4 U	23.8 UU

TABLE 3
Excavation Soil Sample Analytical Results
Unocal Edmonds Bulk Fuel Terminal Lower Yard
Phase II Remedial Implementation As-built Report
11720 Unoco Road
Edmonds, Washington

Notes:
BTEX analyzed by EPA Method 8021B.
cPAHs analyzed by EPA Method 8270 SIM.
Gasoline analyzed by method NWTPH-G.
Diesel and Heavy Oil (Lube) analyzed by method NWTPH-D Extended.
Total TPH calculated by summing the concentrations of gasoline, diesel and heavy oil. If one or more TPH constituents were reported as Non-Detect, half of the reporting limit value was added to the total.
cPAHs adjusted for toxicity according to WAC 173-340-708(8) and *Air Toxics Hot Spots Program Risk Assessment Guidelines, Part II Technical Support Document for Describing Available Cancer Potency Factors.* Office of Environmental Health Hazard Assessment, California EPA, May 2005. If one or more adjusted cPAH constituents were reported as Non-Detect, half of the reporting limt was used in calculations.
Highlighted cells indicate concentration exceeds REL or CUL.
NA = Indicates analysis not conducted.
[ ] = Bracketed data indicate duplicate sample.

BTEX = Benzene, toluene, ethylbenzene, and total xylenes
EPA = Environmental Protection Agency
mg/kg = Milligrams per kilogram
cPAHs = Carcinogenic polynuclear aromatic hydrocarbons
REL = Remediation level
CUL = Cleanup level
TPH = Total petroleum hydrocarbons
bgs = below ground surface

Lab Qualifiers	Definition
J	Indicates an estimated value.
JY	Results in the diesel organics range are primarily due to overlap from a heavy oil range product.
JZ	Detected hydrocarbons in the gasoline range appear to be due to overlap of diesel range hydrocarbons.
Q4	The hydrocarbons present are a complex mixture of diesel range and heavy oil range organics.
U	The compound was analyzed for but not detected. The associated value is the compound quantitation limit.
UJ	The compound was analyzed for but not detected. The associated value is the estimated compound quantitation limit.
UU	The constituents making up the total are all non-detects.

TABLE 6
Monitoring Well Installation Soil Sample Analytical Results
Unocal Edmonds Bulk Fuel Terminal Lower Yard
Phase II Remedial Implementation As-built Report
11720 Unoco Road
Edmonds, Washington

Sample ID	Sample Depth (feet bgs)	Date Sampled	BTEX *(mg/kg)*				Total cPAHs Adjusted for Toxicity *(mg/kg)*	Diesel Range Organics *(mg/kg)*	Gasoline Range Organics *(mg/kg)*	Heavy Oil (Lube) *(mg/kg)*	Total TPH (mg/kg)
			B	T	E	X					
Site Soil Remediation Level (REL)/Cleanup Level (CUL) (mg/kg)			18	--	--	--	0.14	--	--	--	2,975
MW-129R-4.5	4.5	10/14/08	0.0303 U	0.0506 U	0.0506 U	0.101 U	0.0439	823	24.4 JZ	178	1,030 J
MW-129R-7.0	7	10/14/08	0.0446 U	0.0743 U	0.0743 U	0.149 U	0.0479 UU	2,690	7.43 U	313	3,010
MW-502-6.0	6	10/14/08	0.0337 U	0.0562 U	0.0562 U	0.112 U	NA	11.6 U	5.62 U	29.0 U	23.1 UU
MW-511-8.5	8.5	10/14/08	0.0378 U [0.0361 U]	0.0630 U [0.0601 U]	0.0630 U [0.0601 U]	0.126 U [0.120 U]	NA [NA]	11.7 U [11.5 U]	6.30 U [6.01 U]	29.2 U [28.8 U]	23.6 UU [23.2 UU]
MW-510-6.5	6.5	10/08/08	0.0462 U	0.0770 U	0.0770 U	0.154 U	0.0200 UU	80.5	7.70 U	33.0 U	101
MW-510-12.5	12.5	10/08/08	0.0345 U	0.0574 U	0.0574 U	0.115 U	NA	11.9 U	5.74 U	29.6 U	23.6 UU

Notes:
BTEX analyzed by EPA Method 8021B.
cPAHs analyzed by EPA Method 8270 SIM.
Gasoline analyzed by method NWTPH-G.
Diesel and Heavy Oil (Lube) analyzed by method NWTPH-D Extended.
Total TPH calculated by summing the concentrations of gasoline, diesel and heavy oil. If one or more TPH constituents were reported as Non-Detect, half of the reporting limit value was added to the total.
cPAHs adjusted for toxicity according to WAC 173-340-708(8) and *Air Toxics Hot Spots Program Risk Assessment Guidelines, Part II Technical Support Document for Describing Available Cancer Potency Factors* . Office of Environmental Health Hazard Assessment, California EPA, May 2005. If one or more adjusted cPAH constituents were reported as Non-Detect, half of the reporting limt was used in calculations.
Highlighted cells indicate concentration exceeds REL or CUL.
NA = Indicates analysis not conducted.
[ ] = Bracketed data indicate duplicate sample.

BTEX = Benzene, toluene, ethylbenzene, and total xylenes
EPA = Environmental Protection Agency
mg/kg = Milligrams per kilogram
cPAHs = Carcinogenic polynuclear aromatic hydrocarbons
REL = Remediation level
CUL = Cleanup level
TPH = Total petroleum hydrocarbons

Lab Qualifiers	Definition
J	Indicates an estimated value.
JZ	Detected hydrocarbons in the gasoline range appear to be due to overlap of diesel range hydrocarbons.
U	The compound was analyzed for but not detected. The associated value is the compound quantitation limit.
UU	The constituents making up the total are all non-detects.

2008 Additional Site Investigation and Groundwater Monitoring Report

Table 1

Additional Site Investigation
Soil Analytical Data
Former Unocal Terminal
11720 Unoco Road
Edmonds, Washington

Sample ID	Sample Depth (feet bgs)	Date Sampled	BTEX[1] (EPA Method 8021B) *(mg/kg)*				Total Adjusted cPAHs[2] (EPA Method 8270 SIM) *(mg/kg)*	NWTPH-G *(mg/kg)*	NWTPH-D Extended *(mg/kg)*		Total TPH[3] *(mg/kg)*
			B	T	E	X		Gasoline	Diesel	Heavy Oil (Lube)	
Site Soil Remediation Level (REL)/Cleanup Level (CUL) (mg/kg)			18	--	--	--	0.14	--	--	--	2,975
SB-65-6.5	6.5	06/26/08	35.8 J	47.2 J	3.79 J	4.35 J	1.01	3,820	9,450 J	3,660 J	16,900 J
SB-65-8.0	8	06/26/08	14.5	78.0	2.96 U	48.9	0.0928	2,290	1,910	186	4,390
SB-65-16.0	16	06/26/08	0.0588	0.241	0.0575 U	0.782	0.00883 UU	13.1	176	35.6	225
SB-65-20	20	06/26/08	0.259	1.13	0.0432 U	3.79	0.0161	59.2	136	28.6 U	210
SB-65-23	23	06/26/08	0.275	1.43	0.0677	4.66	0.0158	61.3	85.1	28.8 U	161
SB-66-6.0	6	06/26/08	0.0746	0.281	0.0598 U	2.92	0.209	467 JZ	9,790 J	1,640 J	11,900 J
SB-66-11.5	11.5	06/30/08	0.0381 U	0.0635 U	0.0635 U	0.127 U	0.00914 UU	6.35 U	15.0	30.4 U	33.4
SB-66-15	15	06/30/08	0.0331 U	0.0552 U	0.0552 U	0.110 U	NA	5.52 U	11.6 U	29.1 U	23.1 UU
SB-67-5.5	5.5	06/24/08	0.0398 U	0.0663 U	0.0663 U	0.133 U	NA	6.63 U	11.9 U	29.7 U	24.1 UU
SB-68-4.0	4	06/24/08	0.334 U	29.7	0.653	88.7	0.165	4,090	1,240	141	5,470
SB-68-5.5	5.5	06/24/08	0.350 U	32.9 J	0.583 U	166	0.101	3,960	633	143 U	4,660
SB-68-13.5	13.5	06/25/08	0.0367 U	0.403	0.0612 U	2.65	0.00898 UU	73.7	11.9	29.7 U	100
SB-68-15.0	15	06/25/08	0.0364 U	0.0606 U	0.0606 U	0.121 U	NA	6.06 U	12.0 U	30.1 U	24.1 UU
SB-69-6.0	6	06/26/08	0.149 J	4.34 J	1.07 J	48.3	0.236 UU	1,770	1,870	157 U	3,720
SB-69-12.0	12	06/26/08	0.0385 U	0.0642 U	0.0642 U	0.128 U	NA	6.42 U	11.9 U	29.7 U	24.0 UU
SB-69-15.0	15	06/26/08	0.0393 U [0.0384 U]	0.0654 U [0.0639 U]	0.0654 U [0.0639 U]	0.131 U [0.128 U]	NA	6.54 U [6.39 U]	11.9 U [14.4]	29.7 U [30.1 U]	24.1 UU [32.6]
SB-70-6.0	6	06/24/08	0.0371 U	0.0618 U	0.0618 U	0.124 U	NA	6.18 U	10.9 U	27.2 U	22.1 UU
SB-70-7.0	7	06/25/08	0.0369 U	0.0616 U	0.0616 U	0.123 U	NA	6.16 U	11.5 U	28.8 U	23.2 UU
SB-70-12.5	12.5	06/25/08	0.0366 U	0.0611 U	0.0611 U	0.122 U	NA	6.11 U	11.6 U	29.1 U	23.4 UU
SB-70-20.5	20.5	06/25/08	0.0340 U	0.0567 U	0.0567 U	0.113 U	NA	5.67 U	11.8 U	29.4 U	23.4 UU
SB-71-8.0	8	06/25/08	0.0368 U	0.0614 U	0.0614 U	0.123 U	NA	6.14 U	11.7 U	29.3 U	23.6 UU
SB-71-15.5	15.5	06/25/08	0.0363 U	0.0605 U	0.0605 U	0.121 U	0.00876 UU	6.05 U	11.6 U	42.1	50.9
SB-71-24.0	24	06/25/08	0.0366 U	0.0610 U	0.0610 U	0.122 U	NA	6.10 U	11.8 U	29.4 U	23.7 UU
SB-72-6.5	6.5	06/25/08	0.0371 U	0.0619 U	0.0619 U	0.124 U	NA	6.19 U	11.7 U	29.3 U	23.6 UU
SB-72-15.5	15.5	06/25/08	0.0348 U	0.0581 U	0.0581 U	0.116 U	NA	5.81 U	12.1 U	30.1 U	24.0 UU
SB-72-24.5	24.5	06/25/08	0.0400 U [0.0421 U]	0.0667 U [0.0701 U]	0.0667 U [0.0701 U]	0.133 U [0.140 U]	NA	6.67 U [7.01 U]	12.5 U [12.6 U]	31.2 U [31.5 U]	25.2 UU [25.6 UU]
SB-73-6.0	6	06/26/08	0.0445 U	0.0741 U	0.0741 U	0.148 U	NA	7.41 U	13.0 U	32.6 U	26.5 UU
SB-73-15.0	15	06/26/08	0.0369 U	0.0615 U	0.0615 U	0.123 U	NA	6.15 U	12.0 U	30.1 U	24.1 UU
SB-74-6.0	6	06/26/08	0.0375 U	0.0625 U	0.0625 U	0.125 U	NA	6.25 U	12.2 U	30.4 U	24.4 UU
SB-74-15	15	06/26/08	0.0380 U	0.0634 U	0.0634 U	0.127 U	NA	6.34 U	12.2 U	30.4 U	24.5 UU
SB-75-6.0	6	06/26/08	0.0406 U	0.0677 U	0.0677 U	0.135 U	NA	6.77 U	12.2 U	30.5 U	24.7 UU
SB-75-15.0	15	06/26/08	0.0398 U	0.0663 U	0.0663 U	0.133 U	NA	6.63 U	12.3 U	30.8 U	24.9 UU

Table 1

Additional Site Investigation
Soil Analytical Data
Former Unocal Terminal
11720 Unoco Road
Edmonds, Washington

Sample ID	Sample Depth (feet bgs)	Date Sampled	BTEX[1] (EPA Method 8021B) *(mg/kg)*				Total Adjusted cPAHs[2] (EPA Method 8270 SIM) *(mg/kg)*	NWTPH-G *(mg/kg)*	NWTPH-D Extended *(mg/kg)*		Total TPH[3] *(mg/kg)*
			B	T	E	X		Gasoline	Diesel	Heavy Oil (Lube)	
Site Soil Remediation Level (REL)/Cleanup Level (CUL) (mg/kg)			18	--	--	--	0.14	--	--	--	2,975
SB-76-4.5	4.5	06/30/08	0.0389 U	0.0648 U	0.316	0.130 U	NA	9.14	11.4 U	28.5 U	29.1
SB-76-9	9	06/30/08	0.0436 U	0.0727 U	0.0727 U	0.145 U	0.198	7.66 JZ	14,500 J	2,550 J	17,100 J
SB-76-10.5	10.5	06/30/08	0.0501 U	0.0835 U	0.0835 U	0.167 U	0.190	40.1 JZ	2,090 J	409 J	2,540 J
SB-76-14	14	06/30/08	0.0288 U [0.0355 U]	0.0480 U [0.0591 U]	0.0480 U [0.0591 U]	0.0959 U [0.118 U]	NA	4.80 U [5.91 U]	12.0 U [11.9 U]	30.0 U [29.8 U]	23.4 UU [23.8 UU]
SB-77-6	6	06/30/08	0.0392 U	0.0653 U	0.0653 U	0.131 U	NA	6.53 U	12.0 U	29.9 U	24.2 UU
SB-77-9.5	9.5	06/30/08	0.0439 U	0.0731 U	0.0731 U	0.146 U	0.214	7.31 U	7,120 J	757 J	7,880 J
SB-77-14	14	06/30/08	0.0336 U	0.0561 U	0.0561 U	0.112 U	NA	5.61 U	11.8 U	29.5 U	23.5 UU
SB-78-5.5	5.5	06/30/08	6.57 J	9.74 J	42.4 J	49.6 J	0.0183	693	257	356	1,310
SB-78-8.5	8.5	06/30/08	0.0351 U	0.0585 U	0.0585 U	0.117 U	NA	5.85 U	11.4 U	28.4 U	22.8 UU
SB-78-10	10	06/30/08	0.0325 U	0.0542 U	0.0542 U	0.108 U	NA	15.1 JZ	11.4 U	28.6 U	35.1 J
SB-78-12.5	12.5	06/30/08	0.0353 U	0.0589 U	0.0589 U	0.118 U	NA	5.89 U	12.2 U	30.6 U	24.3 UU
SB-79-5	5	06/30/08	0.0344 U	0.0573 U	0.0573 U	0.115 U	NA	5.73 U	11.0 U	27.5 U	22.1 UU
SB-79-8.5	8.5	06/30/08	0.0348 U	0.0581 U	0.0581 U	0.116 U	0.276	32.5 JZ	2,960 J	964 J	3,960 J
SB-79-10	10	06/30/08	0.0468 U	0.0779 U	0.0779 U	0.156 U	0.0198	19.7 JZ	137	37.0	194 J
SB-79-11.5	11.5	06/30/08	0.0550 U	0.0916 U	0.0916 U	0.183 U	NA	9.16 U	13.1 U	32.7 U	27.5 UU
SB-80-7.5	7.5	06/26/08	0.0392 U	0.0654 U	0.0654 U	0.131 U	0.693	24.5 JZ	1,870	2,770	4,660 J
SB-80-11.0	11	06/26/08	0.0518 U	0.0864 U	0.0864 U	0.173 U	NA	8.64 U	13.6 U	34.0 U	28.1 UU
SB-81-5	5	06/30/08	0.0301 U	0.0501 U	0.0501 U	0.100 U	0.0896	21.1 JZ	34.4	49.4	105 J
SB-81-9.5	9.5	06/30/08	0.0414 U	0.0691 U	0.0691 U	0.138 U	NA	6.91 U	12.6 U	31.4 U	25.5 UU
SB-81-15.5	15.5	06/30/08	0.0333 U	0.0556 U	0.0556 U	0.111 U	NA	5.56 U	11.6 U	29.0 U	23.1 UU
SB-82-7	7	07/01/08	0.0349 U	0.0581 U	0.0581 U	0.116 U	NA	5.81 U	11.9 U	29.7 U	23.7 UU
SB-82-9	9	07/01/08	0.0455 U	0.0758 U	0.0758 U	0.152 U	NA	7.58 U	13.6 U	33.9 U	27.5 UU
SB-83-7	7	07/01/08	0.0333 U	0.0555 U	0.0555 U	0.111 U	0.00891	5.55 U	16.8	29.6 U	34.4
SB-83-8.5	8.5	07/01/08	0.0502 U	0.0837 U	0.0837 U	0.167 U	0.0108	8.37 U	18.7	35.6 U	40.7
SB-84-6	6	07/01/08	0.0610 U	0.102 U	0.102 U	0.203 U	0.0119	10.2 U	20.7	43.3	69.1
SB-84-8	8	07/01/08	0.0745 U	0.124 U	0.124 U	0.248 U	NA	12.4 U	17.6 U	44.0 U	37.0 UU
SB-85-5.5	5.5	07/02/08	0.0357 U	0.0596 U	0.0596 U	0.119 U	0.0225	5.96 U	75.4	28.2 U	92.5
SB-85-7.5	7.5	07/02/08	0.114 U	0.218 J	0.189 U	1.09 J	NA	177 J	21.2 U	52.9 U	214 J
SB-86-4.5	4.5	07/02/08	0.0324 U	0.0540 U	0.0540 U	0.108 U	0.0182	5.40 U	31.1 JY	77.9	112 J
SB-86-6.5	6.5	07/02/08	0.0513 U	0.0856 U	0.0856 U	0.171 U	NA	8.56 U	14.2 U	35.4 U	29.1 UU
SB-87-6.0	6	07/25/08	0.0600	0.0825	0.0464 U	0.153	0.0535	74.2 JZ	79.8	88.6	243 J
SB-87-14.0	14	07/25/08	0.0477	0.0686 U	0.0686 U	0.137 U	NA	6.86 U	12.2 U	30.4 U	24.7 UU
SB-88-8.0	8	07/25/08	0.0145 U	0.0242 U	0.0242 U	0.0484 U	0.0167	2.59	35.9	98.5	137

Table 1

Additional Site Investigation
Soil Analytical Data
Former Unocal Terminal
11720 Unoco Road
Edmonds, Washington

Sample ID	Sample Depth (feet bgs)	Date Sampled	BTEX[1] (EPA Method 8021B) *(mg/kg)*				Total Adjusted cPAHs[2] (EPA Method 8270 SIM) *(mg/kg)*	NWTPH-G *(mg/kg)*	NWTPH-D Extended *(mg/kg)*		Total TPH[3] *(mg/kg)*
			B	T	E	X		Gasoline	Diesel	Heavy Oil (Lube)	
Site Soil Remediation Level (REL)/Cleanup Level (CUL) (mg/kg)			18	--	--	--	0.14	--	--	--	2,975

Notes
Shaded data indicates concentrations greater than the applicable site Remedial Action Levels.
(mg/kg)= milligram per kilogram (parts per million)
bgs= below ground surface
[1] B= Benzene, T= Toluene, E= Ethylebenzene, X= Total Xylenes
[2] Carcinogenic Polynuclear Aromatic Hydrocarbons (cPAHs). cPAHs adjusted for toxicity according to WAC 173-340-708(8) and Air Toxics Hot Spots Program Risk Assessment Guidelines, Part II Technical Support Document for Describing Available Cancer Potency Factors. Office of Environmental Health Hazard Assessment, California EPA. May 2005. If one or more adjusted cPAH constituents were reported as Non-Detect, half of the reporting limt was used in calculations.
[3]Total TPH calculated by summing the concentrations of gasoline, diesel and heavy oil. If any TPH constituents were reported as Non-Detect, half of the reporting limit value was used.
NA = Indicates analysis not conducted.
[ ] = Bracketed data indicate duplicate sample.

Lab Qualifiers Definition

J	Indicates an estimated value.
JY	Results in the diesel organics range are primarily due to overlap from a heavy oil range
JZ	Detected hydrocarbons in the gasoline range appear to be due to overlap of diesel range hydrocarbons
U	The compound was analyzed for but not detected. The associated value is the compound quantitation limit
UU	The constituents making up the total are all non-detects.

2011 Final Site Investigation
Completion Report

TABLE 1
Tidal Study Results Summary
Former Unocal Terminal
11720 Unoco Road
Edmonds, Washington

Well ID	GWE (feet)		Depth (feet)		Salinity (PSU)			Amplitude (feet)	
	Max	Min	Max	Min	Max	Min	Avg	Max	Min
LM-2	6.68	6.50	5.34	5.16	12.32	8.94	11.07	--	--
MW-8R	6.42	5.77	4.60	3.95	0.22	0.18	0.19	0.31	0.02
MW-104	5.42	4.53	8.34	7.45	0.14	0.11	0.12	0.53	0.03
MW-122	-1.06	-1.39	8.40	8.07	0.39	0.38	0.38	0.33	0.02
MW-129R	7.28	6.76	6.99	6.47	0.69	0.63	0.67	0.37	0.03
MW-149R	6.10	4.59	5.92	4.41	0.34	0.23	0.29	1.15	0.07
MW-500	13.35	12.63	8.46	7.74	0.44	0.30	0.37	--	--
MW-501	12.98	12.60	9.74	9.36	0.17	0.15	0.17	--	--
MW-502	8.92	8.66	8.02	7.76	0.17	0.14	0.17	--	--
MW-515	7.47	7.21	7.57	7.31	0.21	0.18	0.19	--	--
MW-518	6.98	6.19	4.88	4.09	0.32	0.27	0.30	0.56	0.02
Staff Gauge ID	**GWE (feet)**		**Depth (feet)**		**Salinity (PSU)**			**Amplitude (feet)**	
	Max	**Min**	**Max**	**Min**	**Max**	**Min**	**Avg**	**Max**	**Min**
D-1	8.20	5.95	2.53	0.28	27.76	0.22	10.72	1.96	0.02
D-2	8.13	5.63	2.11	-0.39	27.56	0.10	10.68	1.84	0.04
D-3	8.11	5.59	2.37	-0.15	27.96	0.00	9.73	2.12	0.02
D-5	8.76	4.81	2.65	-1.30	27.76	0.00	11.55	3.73	0.19
D-6	6.84	5.54	2.43	2.43	1.80	1.47	1.68	--	--
TB	5.56	3.06	3.36	0.86	30.08	0.31	12.91	2.22	0.04

Notes:
GWE = Groundwater Elevations in feet above mean sea level
PSU = Practical Salinity Units

TABLE 2
Well Construction Details Summary
Unocal Edmonds Bulk Fuel Terminal Lower Yard
11720 Unoco Road
Edmonds, Washington

Well ID	Date Installed	Top of Casing (feet amsl) [a]	Well Diameter (inches)	Well Material	Pipe Schedule	Slotted Screen Size (inches)	Borehole Diameter (inches)	Top of Screen (feet bgs)	Bottom of Screen (feet bgs)	Well Depth (feet bgs)	Borehole Depth (feet bgs)	Top of Filter Pack (feet bgs)	Bottom of Filter Pack (feet bgs)	Depth to Bottom - 2008 (feet btoc) [b]
LM-2	4/18/1989	8.14	2	PVC	40	0.02	--	2.5	8	8	9.1	2	9	7.8
MW-8R	10/9/2008	13.82	2	PVC	40	0.01	8	3	13	13	13	2	13	13
MW-104	12/22/1992	14.08	2	PVC	40	0.02	10	5	15	15	16.5	7	15	18.2
MW-122	9/27/1995	15.54	2	PVC	40	0.01	--	30	40	40	41.5	27.66	41.5	42.65
MW-129R	10/14/2008	12.92	2	PVC	40	0.01	8	3	13	13	13.5	2	13.5	12.9
MW-149R	10/8/2008	12.18	2	PVC	40	0.01	8	3	13	13	13.5	2	13	13
MW-500	10/14/2008	16.64	2	PVC	40	0.01	8	3	13	13	13	2	13	12.75
MW-501	10/14/2008	15.24	2	PVC	40	0.01	8	3	13	13	13	2	13	13
MW-502	10/14/2008	13.00	2	PVC	40	0.01	8	3	13	13	13	2	13	13.1
MW-515	10/10/2008	11.60	2	PVC	40	0.01	8	3	13	13	13	2	13	12.7
MW-518	10/8/2008	14.60	2	PVC	40	0.01	8	3.5	13.5	13.5	13.5	2	13.5	13.5
MW-521	10/9/2008	12.18	2	PVC	40	0.01	8	3	13	13	13	2	13	12.7
MW-522	10/9/2008	13.82	2	PVC	40	0.01	8	3	13	13	13	2	13	12.7
MW-523	10/8/2008	13.53	2	PVC	40	0.01	8	3	13	13	13	2	13	12.7

Notes:
(a) Vertical Datum: N.A.V.D. 88
(b) Depth to bottom was gauged on October 20, 2008, following well development activities.
amsl = above mean sea level
-- = Data not available
bgs = below ground surface
btoc = below top of casing

TABLE 3
Hydraulic Conductivity Step Test Data Summary
Unocal Edmonds Bulk Fuel Terminal Lower Yard
11720 Unoco Road
Edmonds, Washington

Well ID	Date	Pump Used	Initial DTW (feet)	Flow Rate (GPM)	Maximum Drawdown (feet)	Notes
MW-104	5/11/2011	2" Submersible Pump	7.90	0.50	0.45	Test terminated due to pump failure.
				1.0	1.37	
				1.5	2.80	
MW-129R	5/12/2011	2" Submersible Pump	5.35	0.50	5.84	Well pumped dry at 0.5 GPM.
				0.25	5.65	
MW-149R	5/11/2011	2" Submersible Pump	6.63	0.50	1.07	
				1.0	1.98	
				1.5	2.96	
MW-500	5/10/2011	Peristaltic Pump	3.81	0.10	1.30	Test terminated after 109 minutes. Stabilized drawdown not achieved.
				0.19	5.55	
	5/12/2011	2" Submersible Pump	3.80	0.25	3.30	Test terminated due to well pumping dry at 0.5 GPM flow rate.
				0.50	7.61	
MW-518	5/11/2011	2" Submersible Pump	8.01	0.25	0.36	Test terminated after 60 minutes.
				1.0	1.39	
				1.5	1.90	
MW-8R	5/12/2011	2" Submersible Pump	8.03	0.25	0.11	Test terminated due to pump tubing failure.
				0.50	0.12	
				1.5	1.26	
	5/18/2011	2" Submersible Pump	7.50	2.0	0.17	
				4.0	0.46	
				5.0	0.59	
LM-2	5/11/2011	2" Submersible Pump	1.48	0.25	4.59	Well pumped dry.
	5/13/2011	Peristaltic Pump	1.47	0.10	1.80	
				0.15	2.18	
				0.18	3.43	

Notes:
DTW: Depth to water
btoc: below top of casing
GPM: Gallons per minute

TABLE 4
Short Duration Hydraulic Conductivity Test Data Summary
Unocal Edmonds Bulk Fuel Terminal Lower Yard
11720 Unoco Road
Edmonds, Washington

Well ID	Date	Pump Used	Initial DTW (feet)	Flow Rate (GPM)	Maximum Drawdown (feet)	Notes
MW-104	5/16/2011	2" Submersible Pump	7.73	3.0	5.18	Test terminated after 88 minutes.
MW-129R	5/17/2011	2" Submersible Pump	5.10	0.30	4.39	Test terminated after 60 minutes.
MW-149R	5/16/2011	2" Submersible Pump	6.45	2.0	4.24	Test terminated after 60 minutes.
MW-500	5/13/2011	2" Submersible Pump	3.79	0.30	7.32	Well pumped dry.
	5/13/2011	2" Submersible Pump	3.79	0.25	7.75	Well pumped dry.
LM-2	5/17/2011	2" Submersible Pump	1.20	0.30	5.40	Well pumped dry.
	5/17/2011	2" Submersible Pump	1.20	0.20	5.44	Well pumped dry.
MW-518	5/17/2011	2" Submersible Pump	8.71	2.5	3.28	Test terminated after 90 minutes.
MW-8R	5/16/2011	2" Submersible Pump	7.70	5	0.62	Test terminated after 60 minutes.

Notes:
DTW: Depth to water
btoc: below top of casing
GPM: Gallons per minute

TABLE 5
Long Term Hydraulic Conductivity Test Data Summary
Unocal Edmonds Bulk Fuel Terminal Lower Yard
11720 Unoco Road
Edmonds, Washington

Well ID	Date	Pump Used	Initial DTW (feet)	Flow Rate (GPM)	Maximum Drawdown (feet)	Notes
MW-8R	5/19/11 - 5/20/11	2" Submersible Pump	7.65	5.0	0.88	Test conducted for 24hrs, with no stoppages. Flow rate was confirmed every hour.
MW-521	5/19/11 - 5/20/11	NA	6.01	NA	no measurable drawdown	observation well
MW-522	5/19/11 - 5/20/11	NA	7.69	NA	no measurable drawdown	observation well
MW-523	5/19/11 - 5/20/11	NA	7.38	NA	no measurable drawdown	observation well

Notes:
DTW: Depth to water
btoc: below top of casing
GPM: Gallons per minute
NA: Not Applicable

TABLE 7
Detention Basin No.2 Investigation Soil Sample Analytical Results
Unocal Edmonds Bulk Fuel Terminal Lower Yard
11720 Unoco Road
Edmonds, Washington

Sample ID	Sample Depth (feet bgs)	Date Sampled	BTEX (mg/kg)				Total cPAHs Adjusted for Toxicity (mg/kg)	Diesel Range Organics (mg/kg)	Gasoline Range Organics (mg/kg)	Heavy Oil (Lube) (mg/kg)	Total TPH (mg/kg)
			B	T	E	X					
Site Soil Remediation Level (REL)/Cleanup Level (CUL) (mg/kg)			18	--	--	--	0.14	--	--	--	2975
B1-4.5-5	4.5-5	08/22/11	0.0022 U	NA	NA	NA	0.00052	3.1 U X	1.1 U	14 X	16
B1-9.5-10	9.5-10	08/22/11	0.23 W	NA	NA	NA	0.0082	5.3	25 W	42	72
B1-14-14.5	14-14.5	08/22/11	0.17	NA	NA	NA	N/A	4.8 U	2.1 U	16 U	11 UU
B2-4-4.5	4-4.5	08/22/11	0.018 UW	NA	NA	NA	0.051	620	9.2 U W	720	1,345
B2-7-7.5	7-7.5	08/22/11	0.0020 U	NA	NA	NA	0.00073	30	1 U	37	68
B2-9.5-10	9.5-10	08/22/11	0.0019 U	NA	NA	NA	0.002	100	16	100	216
B2-12-12.5	12-12.5	08/22/11	0.0020 U	NA	NA	NA	0.00088	130	2	530	662
B2-14.5-15	14.5-15	08/22/11	0.0024 U	NA	NA	NA	N/A	3.4 U	1.2 U	11 U	8 UU
B3-4.5-5	4.5-5	08/22/11	0.0022 U	NA	NA	NA	N/A	3.2 U	1.1 U	11 U	8 UU
B3-7-7.5	7-7.5	08/22/11	0.0021 U	NA	NA	NA	0.00076	110 X	1.1 U	70 X	181
B3-12-12.5	12-12.5	08/22/11	0.0020 U	NA	NA	NA	0.00077	43 X	6.8	46 X	96
B3-14-14.5	14-14.5	08/22/11	0.0040	NA	NA	NA	N/A	3.3 U	1.3	11 U	8
B4-4.5-5	4.5-5	08/22/11	0.0020 U	NA	NA	NA	0.00053 UU	160	1 U	53 U	187
B4-9.5-10	9.5-10	08/22/11	0.024 W	NA	NA	NA	0.0075	2,900	13 W	1,500	**4,413**
B4-13-13.5	13-13.5	08/22/11	0.010	NA	NA	NA	0.0006	4.2	1.8	12 U	12
B4-14.5-15	14.5-15	08/22/11	0.021 U W	NA	NA	NA	N/A	3.6 U	11 U W	12 U	13 UU
B5-4.5-5	4.5-5	08/22/11	0.0022 U	NA	NA	NA	N/A	3.5 U	1.1 U	12 U	8 UU
B5-9-9.5	9-9.5	08/22/11	0.083 U W	NA	NA	NA	0.0138	16,000	42 U W	11,000	**27,021**
B5-11.5-12	11.5-12	08/22/11	0.0023 U	NA	NA	NA	N/A	3.8 U	1.2 U	13 U	9 UU
B5-13.5-14	13.5-14	08/22/11	0.0024 U	NA	NA	NA	N/A	3.7 U	1.2 U	12 U	8 UU
B6-4.5-5	4.5-5	08/22/11	0.021 U W	NA	NA	NA	0.09	470	190 W	310	970
B6-7-7.5	7-7.5	08/22/11	0.55 U	NA	NA	NA	**0.36**	16,000 Y	720	4,900 Y	**21,620**
B6-9-9.5	9-9.5	08/22/11	0.97	NA	NA	NA	**3.2 T**	170,000 Y	2,400	48,000 Y	**220,400**
B6-11-11.5	11-11.5	08/22/11	0.023 U W	NA	NA	NA	0.012	230 Z	30 W	57 Z	317
B6-13-13.5	13-13.5	08/22/11	0.0028 U	NA	NA	NA	N/A	3.5 U	1.4 U	12 U	8 UU

TABLE 7
Detention Basin No.2 Investigation Soil Sample Analytical Results
Unocal Edmonds Bulk Fuel Terminal Lower Yard
11720 Unoco Road
Edmonds, Washington

Sample ID	Sample Depth (feet bgs)	Date Sampled	BTEX (mg/kg)				Total cPAHs Adjusted for Toxicity (mg/kg)	Diesel Range Organics (mg/kg)	Gasoline Range Organics (mg/kg)	Heavy Oil (Lube) (mg/kg)	Total TPH (mg/kg)
			B	T	E	X					
Site Soil Remediation Level (REL)/Cleanup Level (CUL) (mg/kg)			18	--	--	--	0.14	--	--	--	2975
B7-4.5-5	4.5-5	08/22/11	0.083 U W	NA	NA	NA	0.071	260	230 W	210	700
B7-8-8.5	8-8.5	08/22/11	1.5 U W	NA	NA	NA	**2.8 T**	72,000	1,400 W	38,000	**111,400**
B7-9.5-10	9.5-10	08/22/11	0.030 U W	NA	NA	NA	0.037 T	4,200	47 W	1700	**5947**
B7-14-14.5	14-14.5	08/22/11	0.0021 U	NA	NA	NA	N/A	3.6 U	1 U	12 U	8 UU
B8-4.5-5	4.5-5	08/23/11	0.24 U T	NA	NA	NA	0.114	11,000	1,000	4,500	**16,500**
B8-7.5-8	7.5-8	08/23/11	0.0029	NA	NA	NA	0.077	6,800	260	2,300	**9,360**
B8-9.5-10	9.5-10	08/23/11	3.2	NA	NA	NA	**0.5 T**	50,000	730	25,000	**75,730**
B8-11-11.5	11-11.5	08/23/11	0.51 W	NA	NA	NA	0.09	4,900	300 W	3,000	**8,200**
B8-13.5-14	13.5-14	08/23/11	0.0073	NA	NA	NA	**0.1**	40	1.2 U	14	55
B8-14.5-15	14.5-15	08/23/11	0.0056	NA	NA	NA	N/A	3.5 U	1.2 U	12 U	8 UU
B9-4.5-5	4.5-5	08/23/11	0.0022 U	NA	NA	NA	N/A	3.2 U	1.1 U	27	29
B9-8.5-9	8.5-9	08/23/11	0.023 U W	NA	NA	NA	**0.29**	14,000	270 W	6,700	**20,970**
B9-9.5-10	9.5-10	08/23/11	0.0025 U	NA	NA	NA	0.0024	23	1.2 U	12 U	30
B9-10.5-11	10.5-11	08/23/11	0.0030 U	NA	NA	NA	0.025	640	1.5 U	280	921
B9-11-11.5	11-11.5	08/23/11	1.1 W	NA	NA	NA	**0.15 T**	11,000	950 W	4,300	**16,250**
B9-12.5-13	12.5-13	08/23/11	0.0026 U V	NA	NA	NA	0.00065	8.3	1.3 U	13 U	15
B10-0.5-1	0.5-1	08/25/11	0.030 U W	NA	NA	NA	**0.2**	360	15 U W	390	758
B10-1.5-2	1.5-2	08/25/11	0.046 U W	NA	NA	NA	0.018	12	23 U W	62	86
B10-2.5-3	2.5-3	08/25/11	0.030 U W	NA	NA	NA	0.00068 UU	4.1 U	15 U W	27	37
B10-3.5-4	3.5-4	08/25/11	0.0037 U V	NA	NA	NA	0.00072	15	1.8 U V	41	57
B11-4.5-5	4.5-5	08/23/11	0.0027 U	NA	NA	NA	**0.24**	360	1.3 U U	650	1,011
B11-7.5-8	7.5-8	08/23/11	0.25 U W	NA	NA	NA	0.012	24,000 S	240 W	11,000	**35,240**
B11-8.5-9	8.5-9	08/23/11	0.15 U W	NA	NA	NA	0.012	7.5	75 U W	15 U	53
B11-9.5-10	9.5-10	08/23/11	0.0034	NA	NA	NA	**1.6 T**	5.3	1.3 U	12 U	12
B11-10-10.5	10-10.5	08/23/11	0.1 U W	NA	NA	NA	**3.4**	25,000	150 W	12,000	**37,150**
B11-11-11.5	11-11.5	08/23/11	0.0042 U V	NA	NA	NA	0.01	310	2.1 U	150	461
B11-13.5-14	13.5-14	08/23/11	0.002 U	NA	NA	NA	N/A	3.5 U	1 U	12 U	8 UU

TABLE 7
Detention Basin No.2 Investigation Soil Sample Analytical Results
Unocal Edmonds Bulk Fuel Terminal Lower Yard
11720 Unoco Road
Edmonds, Washington

Sample ID	Sample Depth (feet bgs)	Date Sampled	BTEX (mg/kg)				Total cPAHs Adjusted for Toxicity (mg/kg)	Diesel Range Organics (mg/kg)	Gasoline Range Organics (mg/kg)	Heavy Oil (Lube) (mg/kg)	Total TPH (mg/kg)
			B	T	E	X					
Site Soil Remediation Level (REL)/Cleanup Level (CUL) (mg/kg)			18	--	--	--	0.14	--	--	--	2975
B12-0.5-1	0.5-1	08/24/11	0.033 U W	NA	NA	NA	0.0117	140	17 U W	150	299
B12-1-1.5	1-1.5	08/24/11	0.038 U W	NA	NA	NA	0.00072 UU	120	34 W	100	254
B12-2.5-3	2.5-3	08/24/11	0.051 U W	NA	NA	NA	0.079	160	25 U W	75	248
B12-3.5-4	3.5-4	08/24/11	0.0028 U	NA	NA	NA	0.00063	4.1	1.4 U	28	33
B13-4.5-5	4.5-5	08/23/11	0.025 U W	NA	NA	NA	0.0046	11	12 U W	64	81
B13-6-6.5	6-6.5	08/23/11	0.031 U W	NA	NA	NA	0.036	110	15 U W	250	368
B13-7-7.5	7-7.5	08/23/11	0.16 U W	NA	NA	NA	0.054 R	12,000	200 W	7,400 U	**15,900**
B13-9-9.5	9-9.5	08/23/11	0.018	NA	NA	NA	N/A	3.7 U	1.3 U	12 U	9 UU
B13-10-10.5	10-10.5	08/23/11	0.071 U W	NA	NA	NA	0.026	1,300	110 W	740	2,150
B13-11.5-12	11.5-12	08/23/11	0.0056	NA	NA	NA	N/A	4 U	1.4 U	13 U	9 UU
B14-0.5-1	0.5-1	08/25/11	0.11 U W	NA	NA	NA	0.029	16	57 U W	110	155
B14-1.5-2	1.5-2	08/25/11	0.023 U W	NA	NA	NA	N/A	NA	11 U W	NA	6 UU
B14-2.5-3	2.5-3	08/25/11	0.051 U W	NA	NA	NA	N/A	5 U	25 U W	17 U	24 UU
B14-3.5-4	3.5-4	08/25/11	0.058 U W	NA	NA	NA	0.0009	7.4	29 U W	76	98
B15-4.5-5	4.5-5	08/23/11	0.0025 U	NA	NA	NA	0.0005	4.5	1.3 U	17	22
B15-6.5-7	6.5-7	08/23/11	0.0026 U V	NA	NA	NA	N/A	3.6 U	1.3 U	18	20
B15-8.5-9	8.5-9	08/23/11	0.0048 U V	NA	NA	NA	0.0008	7.8	2.4 U	54	63
B15-11-11.5	11-11.5	08/23/11	0.029 U W	NA	NA	NA	N/A	4 U	15 U W	13 U	16 UU
B16-3.5-4	3.5-4	08/24/11	0.023 U W	NA	NA	NA	0.018	100	11 U W	280	386
B16-4-4.5	4-4.5	08/24/11	0.27 U W	NA	NA	NA	**0.1**	280	140 U W	940	1,290
B16-4.5-5	4.5-5	08/24/11	0.0024 U	NA	NA	NA	0.00123	4	1.2 U	12 U	11
B16-6-6.5	6-6.5	08/24/11	0.0031 U	NA	NA	NA	N/A	3.9 U	1.5 U	13 U	9 UU
B17-3.5-4	3.5-4	08/24/11	0.025 U W	NA	NA	NA	0.00109	550	12 U W	1,200	1,756
B17-4-4.5	4-4.5	08/24/11	0.0066	NA	NA	NA	0.0008 UU	14,000	2.3 U	8,200	**22,201**
B17-4.5-5	4.5-5	08/24/11	0.34 U W	NA	NA	NA	**116 R**	55	170	43	268
B17-5.5-6	5.5-6	08/24/11	0.033 U W	NA	NA	NA	N/A	4.3 U	17 U W	14 U	18 UU

TABLE 7
Detention Basin No.2 Investigation Soil Sample Analytical Results
Unocal Edmonds Bulk Fuel Terminal Lower Yard
11720 Unoco Road
Edmonds, Washington

Sample ID	Sample Depth (feet bgs)	Date Sampled	BTEX (mg/kg)				Total cPAHs Adjusted for Toxicity (mg/kg)	Diesel Range Organics (mg/kg)	Gasoline Range Organics (mg/kg)	Heavy Oil (Lube) (mg/kg)	Total TPH (mg/kg)
			B	T	E	X					
Site Soil Remediation Level (REL)/Cleanup Level (CUL) (mg/kg)			18	--	--	--	0.14	--	--	--	2975

Notes:
BTEX analyzed by EPA Method 8021B.
cPAHs analyzed by EPA Method 8270 SIM.
Gasoline analyzed by method NWTPH-G.
Diesel and Heavy Oil (Lube) analyzed by method NWTPH-D Extended.
Total TPH calculated by summing the concentrations of gasoline, diesel and heavy oil. If one or more TPH constituents were reported as Non-Detect, half of the reporting limit value was added to the total.

cPAHs adjusted for toxicity according to WAC 173-340-708(8) and *Air Toxics Hot Spots Program Risk Assessment Guidelines, Part II Technical Support Document for Describing Available Cancer Potency Factors* .
Office of Environmental Health Hazard Assessment, California EPA, May 2005. If one or more adjusted cPAH constituents were reported as Non-Detect, half of the reporting limt was used in calculations.
Highlighted cells indicate concentration exceeds REL or CUL.
NA = Indicates analysis not conducted.
[ ] = Bracketed data indicate duplicate sample.

BTEX = Benzene, toluene, ethylbenzene, and total xylenes
EPA = Environmental Protection Agency
mg/kg = Milligrams per kilogram
cPAHs = Carcinogenic polynuclear aromatic hydrocarbons
REL = Remediation level
CUL = Cleanup level
TPH = Total petroleum hydrocarbons

Lab Qualifiers	Definition
J	Indicates an estimated value.
JZ	Detected hydrocarbons in the gasoline range appear to be due to overlap of diesel range hydrocarbons.
R	The GC/MS semivolatile internal standard peak areas were outside of the QC limits for both the initial injection and the re-injection. The values here are from the initial injection of the sample
S	Due to the nature of the sample extrac matrix, the extract could only be concentrated to a final volume of 10ml instead of the usual volume of 5ml. The reporting limits were raised accordingly
T	Reporting limits were raised due to interference from the sample matrix
U	The compound was analyzed for but not detected. The associated value is the compound quantitation limit.
UU	The constituents making up the total are all non-detects.
V	The recovery for the sample surrogate is outside the QC acceptance limits as noted on the QC Summary. A reanalysis was not performed to confirm a matrix effect
W	Reporting limits were raised due to sample foaming
X	The LCS recovery is outside the QC limits. Results from the re-extraction are within the limits. The hold time had expired prior to the re-extraction; therefore, all results are reported from the original extraction. Similar results were obtained in both extracts.
Y	Due to dilution of the sample extract, capric acid recovery could not be determined.
Z	The caprice acid reverse surrogate recovery is 0%

TABLE 8

LNAPL Baildown Test Log

Unocal Edmonds Bulk Fuel Terminal Lower Yard
11720 Unoco Road
Edmonds, Washington

Site Name	Edmonds Terminal	**Test Well ID**	MW-510
Date and Time In	8/24/11 7:30 AM	**Date and Time Out**	8/24/11 3:00 PM
Personnel	Scott Zorn/Seamas McGuire	**Weather**	Sun

Well Construction Details

Top of Casing Elevation (ft amsl)	12.53	**Screen Slot Size (in)**	0.01
Total Well Depth (ft)	13	**Filter Pack Type**	#2/12 silica
Depth to Top of Screen (ft)	3	**Depth to Bottom of Screen (ft)**	13
Well Casing Diameter (in)	2	**Borehole Diameter (in)**	8

Initial Test Conditions

Static Depth to LNAPL (ft)	7.06	**Test Date**	8/24/2011
Static Depth to Water (ft)	7.07	**Start Time**	7:45 AM
LNAPL Thickness (ft)	0.01	**Initial LNAPL Volume in Well (gal)**	0.0016

LNAPL Removal Information

LNAPL Removal Method/Equipment	Bailer	**Time LNAPL Removal Begins**	7:53 AM
Volume of LNAPL Removed (gal)	0.0016	**Time LNAPL Removal is Completed**	7:53 AM
Volume of Groundwater Removed (gal)	0.0044		

Baildown Test Data

Elapsed Time (min)	Time	Depth to LNAPL (ft)	Depth to Water (ft)	Ground Water Elevation (ft)	Tide Elevation (Ft above Mean Lower Low Water)	Observations
2	7:55 AM	7.1	7.1	5.43	0.4264	LNAPL appears to have a darker color and lower viscocity
3	7:56 AM	7.11	7.11	5.42	0.4264	
5	7:58 AM	7.1	7.1	5.43	0.4592	Much darker in color
7	8:00 AM	7.09	7.09	5.44	0.4592	
9	8:02 AM	7.09	7.09	5.44	0.492	
11	8:04 AM	7.09	7.09	5.44	0.492	
13	8:06 AM	7.1	7.1	5.43	0.5248	
15	8:08 AM	7.1	7.1	5.43	0.5248	
22	8:15 AM	7.1	7.1	5.43	0.5904	
25	8:28 AM	7.1	7.11	5.42	0.7544	
30	8:33 AM	--	7.12	5.41	0.8528	
35	8:38 AM	--	7.12	5.41	0.9184	LNAPL on probe - DTP not measured
45	8:48 AM	7.13	7.13	5.4	1.0824	
55	8:58 AM	7.13	7.13	5.4	1.2464	
65	9:08 AM	7.15	7.15	5.38	1.4432	LNAPL on probe - DTP not measured
75	9:18 AM	--	7.15	5.38	1.6728	
85	9:28 AM	--	7.16	5.37	1.9024	Very small amount of LNAPL on probe
95	9:38 AM	--	7.18	5.35	2.1648	No LNAPL on probe
105	9:48 AM	--	7.16	5.37	2.3944	Very small amount on probe
115	9:58 AM	--	7.17	5.36	2.6568	very small amount of LNAPL
125	10:08 AM	--	7.17	5.36	2.9848	Very small amount of LNAPL
135	10:18 AM	--	7.17	5.36	3.2472	Very small amount of LNAPL
145	10:28 AM	--	7.17	5.36	3.5424	Very small amount of LNAPL
155	10:38 AM	--	7.17	5.36	3.8704	Very small amount of LNAPL
165	10:48 AM	--	7.17	5.36	4.1656	Very small amount of LNAPL
175	10:58 AM	7.17	7.17	5.36	4.4936	LNAPL on probe - sheen
185	11:08 AM	--	7.16	5.37	4.7888	Small LNAPL on probe
300	1:03 PM	--	7.05	5.48	8.0688	very small amount on tip
389	2:22 PM	--	6.86	5.67	9.348	very small amount on tip
423	3:14 PM	--	6.79	5.74	9.7088	very small amount on tip

2012 Final Conceptual Site Model

TABLE 7
Sediment Sample Analytical Results - June 2012
Unocal Edmonds Bulk Fuel Terminal Lower Yard
11720 Unoco Road
Edmonds, Washington

				Sample ID	US-100		DUP-1		US-101		US-102	
				Sample Date	7/30/2012		7/30/2012		7/30/2012		7/30/2012	
Chemical	**Units**	**SQS[1]**	**CSL[1]**	**LAET[2]**								
Volatile Organic Compounds												
Benzene	mg/kg	NA	NA	NA	0.002	U	0.001	U	0.004	U	0.003	U
Ethylbenzene	mg/kg	NA	NA	NE	0.004	U	0.003	U	0.009	U	0.005	U
Toluene	mg/kg	NA	NA	NA	0.004	U	0.003	U	0.009	U	0.005	U
Xylene (Total)	mg/kg	NA	NA	NE	0.004	U	0.003	U	0.009	U	0.005	U
Petroleum Hydrocarbons												
GRO	mg/kg	NA	NA	NA	45	U	41	U	140	U	100	U
DRO	mg/kg	NA	NA	NA	7.7	U	11		29		17	
HO	mg/kg	NA	NA	NA	26	U	59		170		110	
Metals												
Arsenic	mg/kg	57	93	130	8.53		6.87		29.1		20.2	
Copper	mg/kg	390	390	390	5.7		5.05		43.6		21.6	
Lead	mg/kg	450	530	430	11.2		10		107		60.6	
Zinc	mg/kg	410	960	460	51.5		41.4		319		144	
Conventionals												
TOC	mg/kg	NA	NA	NA	19200		18800		64700		65200	
TOC	%	NA	NA	NA	2		2		6		7	
Moisture	%	NA	NA	NA	60.8		60.2		83.6		77.5	
Ammonia-Nitrogen	mg/kg	NA	NA	NA	148		163		863		402	
PAHs[3]												
Acenaphthene	mg/kg	16	57	0.13	0.27	U	0.27	U	0.012	U	0.0089	U
Acenaphthylene	mg/kg	66	66	0.07	0.57		0.34		0.014		0.013	
Anthracene	mg/kg	220	1200	0.28	0.45		0.39		0.034		0.023	
Benzo(a)anthracene	mg/kg	110	270	0.96	0.63		0.64		0.16		0.061	
Benzo(a)pyrene	mg/kg	99	210	1.10	0.68		0.69		0.22		0.084	
Benzo(b)fluoranthene	mg/kg	NA	NA	NA	1.15		1.22		0.42		0.15	
Benzo(g,h,i)perylene	mg/kg	31	78	0.67	0.89		0.69		0.19		0.067	
Benzo(k)fluoranthene	mg/kg	NA	NA	NA	0.36		0.44		0.14		0.06	
Chrysene	mg/kg	110	460	0.95	0.94		1.01		0.28		0.11	
Dibenz(a,h)anthracene	mg/kg	12	33	0.23	0.27	U	0.27	U	0.042		0.015	
Fluoranthene	mg/kg	160	1200	1.30	2.40		2.29		0.46		0.21	
Fluorene	mg/kg	23	79	0.12	0.45		0.53		0.059		0.028	
Indeno(1,2,3-cd)pyrene	mg/kg	34	88	0.60	0.68		0.53		0.17		0.057	
Naphthalene	mg/kg	99	170	0.23	2.92		1.38		0.052		0.059	
Phenanthrene	mg/kg	100	480	0.66	2.29		1.91		0.18		0.11	
Pyrene	mg/kg	1000	1400	2.40	2.34		2.18		0.44		0.19	
Total LPAH[4]	mg/kg	370	780	1200	6.68		4.55		0.34		0.23	
Total HPAH[5]	mg/kg	960	5300	7900	10.05		9.69		2.52		1.00	

Notes:
PAH = Polycyclic aromatic hydrocarbons
LPAH = low molecular weight PAH
HPAH = high molecular weight PAH
SQS = Sediment Quality Standards
CSL = Cleanup Screening Levels
NA = Not applicable
NE= Not evaluated because these analytes do not have SQS or CSL.
U = Indicates the value was below the Method Detection Limit.

1. SQS and CSL from Chapter 173-204 WAC Sediment Management Standards. PAH results for US-100 and DUP-1 are organic carbon normalized.
2. LAET from Puget Sound Dredged Disposal Analysis. 1996. Progress Re-evaluation Puget Sound Apparent Effects Thresholds (AETs). LAET value is the lowest concentration of the echinoderm, microtox, and oyster AETs from Table 9.
3. Samples US-100 and DUP-1 required normalization as TOC fell in the range of 0.2 to 4%. PAH values were normalized by dividing the original concentration by the TOC percentage expressed as a decimal.
4. Total LPAH is the sum of naphthalene, acenaphthylene, acenaphthene, fluorene, phenanthrene, and anthracene. Non-detect values are treated as zero in the summation.
5. Total HPAH is the sum of fluoranthene, pyrene, benz(a)anthracene, chrysene, total benzofluoranthenes, benzo(a)pyrene, indeno(1,2,3,-c,d)pyrene, dibenzo(a,h)anthracene, and benzo(g,h,i)perylene. Non-detect values are treated as zero in the
6. US-100 and DUP-1 were compared to SQS and CSL screening criteria and US-101 and US-102 were compared to LAET based on TOC concentrations and Ecology guidance (Washington Department of Ecology. 1992 and 1993. Organic Carbon Normalization of Sediment Data)
7. All results are reported on a dry weight basis except as indicated in footnote 3.

APPENDIX B

Applicable or Relevant and Appropriate Requirements

SUMMARY OF POTENTIALLY APPLICABLE REQUIREMENTS

According to WAC 173-340-360(2), all cleanup actions under the Model Toxics Control Act (MTCA) must comply with applicable state and federal laws. Such laws are defined under the MTCA as including Applicable or Relevant and Appropriate Requirements (ARARs). ARARs for the Lower Yard are discussed below:

Summary of Generally Applicable or Relevant and Appropriate Regulations

Clean Water Act (CWA)

Provisions set forth in the Federal Water Pollution Control Act (FWPCA), commonly referred to as the CWA, require the development of regulations to protect the nation's waters. Requirements of the CWA have been delegated to the State of Washington which has corresponding rules and regulations, encompassing all of those stated in the CWA. Therefore, potential discharges to surface water will be managed under the State program.

Resource Conservation and Recovery Act (RCRA)

Investigation –derived waste (IDW), soil, water or other substances removed from the site during the implementation of remedial activities will be handled per RCRA regulations and implemented according to WAC 173-303.

The Endangered Species Act

The only threatened or endangered species identified in the vicinity of the Terminal is the bald eagle. Bald eagles are frequently observed in flight over the Lower Yard, and they may perch in trees of the Upper Yard. Implementation of the remedial action in conformance with MTCA will result in the protection of wildlife, including any threatened and endangered species.

Migratory Bird Treaty Act

A great blue heron colony is found in the southeast Lower Yard. In 2007, testing was conducted to evaluate the level of disturbance in the areas adjacent to the great blue heron nests. The testing determined that the heron would not disturbed by site remediation activities conducted greater than 150 feet away from the nests. Site remedial activities will not be conducted less than 150 feet from the colony. Additionally, implementation of the remedial action in conformance with MTCA, will provide that wildlife, including migratory birds, will be protected.

The Safe Drinking Water Act

The groundwater CULs for the Lower Yard were established based on protection of surface water, since a determination was made that the groundwater beneath the Lower Yard is non-potable.

Natural Resource Damages

Remedial design and implementation will establish means and methods to ensure that the remedial action minimizes risks that could potentially damage natural resources, such as surface-water resources, groundwater resources, air resources, geologic resources, and biological resources. Damages to natural resource caused by remedial action implementation will be avoided, and are not expected to occur.

U.S. Department of Transportation Hazardous Materials Regulations

The U.S. Department of Transportation has published regulations, including communications and emergency response requirements, shipping, and packaging requirements (49 CFR 107, 171)), that govern the transportation of hazardous materials to or from the site. Hazardous waste generated at the site will be appropriately characterized to determine package, transportation and transportation requirements prior to implementing remedial action.

National Ambient Air Quality Standards Attainment Area
Air emissions generated by the remedial implementation at the site are subject to applicable air-quality standards in order to control or prevent the emission of air contaminants. The applicable pollutants at the site would be particulate matter (dust) and carbon monoxide. Degradation of ambient air quality caused by remedial action implementation at the site will be avoided, and is not expected to occur.

Occupational Safety and Health Administration (OSHA)
Site activities will be conducted in a manner compliant with OSHA standards and regulations (29 CFR 1910).

Model Toxics Control Act
All elements of the remedial design and site activities will occur in accordance with MTCA statutes and regulations.

National Pollutant Discharge Elimination System Stormwater Permit Program
A NPDES permit modification will be needed for discharge of treated water to Willow Creek. Effluent limitations, sampling parameters and discharge quality standards will be defined in this permit, which will affect the treatment technologies used in the treatment system. Consequently, design and operation of the system will conform to applicable regulations.

Air Quality Standards
During remedial implementation, engineering controls will be necessary to control particulate emissions. Air testing may be required to show that emissions meet the substantive requirements of applicable air quality permits and rules, as administered by the Puget Sound Clean Air Agency.

Noise Regulations
Site activities will be conducted at appropriate noise levels, according to the City of Edmonds Municipal Code. Noise production during remedial activities may limit operating hours of project work.

State Environmental Policy Act
The State Environmental Policy Act (SEPA) provides the framework for agencies to consider the environmental consequences of a proposed land use action. SEPA requires the preparation of an environmental checklist and review of the potential environmental impacts and mitigation measures used to protect the environment. A SEPA checklist will be prepared with the permitting of the remedial action to be conducted at the site.

Spill Prevention, Preparedness, and Response
A spill prevention, control, and countermeasures plan will be developed for the storage and handling of these materials. This will include potential groundwater treatment system facilities and heavy equipment used onsite, as well as any stored materials.

Minimum Standards for Construction and Maintenance of Wells, Regulation and Licensing of Well Contractors and Operators
Resource protection wells will be decommissioned, constructed and maintained according to the appropriate regulations

Washington Industrial Safety and Health Act
Site activities will be conducted in a manner compliant with Washington Industrial Safety and Health Act (WISHA) standards and regulations.

City of Edmonds Permits
The City of Edmonds requires permits for grading, excavation, and fill activities. All required permits needed from the City of Edmonds will be obtained during the design phase of the remedial action and will apply to all of the remedial activities.

APPENDIX C

MTCATPH11.1 Worksheet and Calculation Summary

MTCATPH 11.1 Calculation Worksheet

		SB-183-2.5	SB-183-5.5	SB-184-2.5	SB-184-4.0	SB-185-4.0	SB-185-5.5	DB1-A-26wall1-4	DB1-A-1wall-2.5	DB1-A-21wall-2.5	DB1-A-25wall-3.5	SWLY-A-5wall-3.75	SWLY-A-14wall-3.75	SWLY-C-21wall-3.75	SWLY-D-3wall-3.75
Fraction/Constituent (mg/kg)															
Aliphatic	EC>5-6	4.95	2.45	44.85	22.84	37.3	31.3	2.25	2.25	2.4	9.89	4.75	9.75	45.49	68.7
	EC>6-8	5	2.5	350	83.8	178	199	2.5	2.5	2.5	10	5	10	312	826
	EC>8-10	5	24.9	530	166	137	94.9	2.5	2.5	19.5	41.7	277	66.5	287	19.6
	EC>10-12	80.7	111	649	342	287	249	2.5	2.5	81.8	80	908	173	353	16.3
	EC>12-16	641	558	1020	581	717	840	12.3	291	481	269	2500	431	732	39.1
	EC>16-21	1770	785	1270	717	858	1080	23.7	1030	973	438	1720	310	528	32.6
	EC>21-34	1400	443	500	245	306	395	51	1060	575	564	817	98.4	742	12.8
Aromatic	EC>8-10	16.49	10.38	617.5	241.38	338.9	333.1	2.43	2.43	2.43	54.34	26.36	21.46	299.51	280.1
	EC>10-12	102.79	85.4	1571.22	714.39	641.3	899.97	2.43	2.2	2.16	228.77	214.58	63.86	416.87	2.79
	EC>12-16	340	309	1420	624	325	978	19	22.5	92.5	483	1080	65.9	308	303
	EC>16-21	930.02	539.64	518.63	332.69	326.61	477.59	18.27	450.4	547.41	355.49	1679.85	158.38	326.32	28.84
	EC>21-34	698.95	452.95	345.95	212.95	215.95	294.95	82.25	642.8	337.9	565.9	886.99	67.45	573.8	7.55
	Benzene	0.015	0.015	0.554	0.15	1.15	1.15	0.015	0.015	0.015	0.046	0.032	0.06	2.42	4.47
	Toluene	0.025	0.025	4.09	1.16	2.42	3.33	0.025	0.025	0.025	0.095	0.11	0.1	1.43	6.25
	Ethylbenzene	0.171	0.086	4.19	1.49	27.1	43.9	0.025	0.025	0.025	0.572	0.298	0.523	6.39	17.9
	Xylenes	0.444	0.336	15.3	6.13	72	25	0.05	0.05	0.05	1.99	0.438	1.32	25.1	35
	Naphthalene	0.597	0.4	7	4.5	22	6.4	0.025	0.1	0.025	0.18	1	1.4	2.7	0.94
	1-methylnaphthalene	3.84	2	4.1	3	11	7.3	0.025	0.1	0.22	0.49	15	2.1	6.3	1.3
	2-methylnaphthalene	3.77	1.6	7.7	5.1	21	15	0.025	0.1	0.096	0.57	20	2.4	11	1.7
	n-Hexane	0.05	0.05	5.15	2.16	12.7	18.7	0.25	0.25	0.0965	0.113	0.25	0.25	4.51	17.9
	MTBE	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	EDB	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	EDC	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Benzo(a)anthrancene	0.234	0.0949	0.0976	0.0845	0.109	0.116	0.0776	0.1	0.152	0.131	0.0307	0.102	0.1	0.005
	Benzo(b)fluoranthene	0.0779	0.025	0.025	0.025	0.0617	0.0713	0.0893	0.1	0.108	0.12	0.005	0.115	0.1	0.005
	Benzo(k)fluoranthene	0	0	0	0	0	0	0.025	0.1	0.0721	0.0733	0.0166	0.124	0.1	0.005
	Benzo(a)pyrene	0.163	0.025	0.025	0.025	0.0545	0.0601	0.501	0.1	0.025	0.025	0.0108	0.0767	0.1	0.0264
	Chrysene	0.501	0.211	0.222	0.173	0.167	0.165	0.136	0.205	0.232	0.162	0.088	0.2	0.285	0.0154
	Dibenzo(a,h)anthracene	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.1	0.0721	0.0733	0.005	0.025	0.1	0.005
	Indeno(1,2,3-cd)pyrene	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.1	0.025	0.025	0.005	0.025	0.1	0.005
		6004.8379	3329.1379	8885.6536	4307.0975	4537.8722	5994.0524	222.4489	3512.55	3118.8387	3104.7556	10156.8191	1484.5207	4984.725	1722.9068

	SB-183-2.5	SB-183-5.5	SB-184-2.5	SB-184-4.0	SB-185-4.0	SB-185-5.5	DB1-A-26wall1-4	DB1-A-1wall-2.5	DB1-A-21wall-2.5	DB1-A-25wall-3.5	SWLY-A-5wall-3.75	SWLY-A-14wall-3.75	SWLY-C-21wall-3.75	SWLY-D-3wall-3.75
Method B Direct Contact CUL	3,049	2,996	2,673	2,617	2,789	2,761	44	2,395	3,608	3,009	2,495	1,306	2,967	6,148
Method B PoSW CUL	100% NAPL	100% NAPL	246	466	113	187	100% NAPL	100% NAPL	100% NAPL	100% NAPL	100% NAPL	100% NAPL	504	42
100% NAPL =	76,000	77,000					84,000	76,000	75,000	79,000	75,000	71,000		

Median Method B Direct Contact CUL	**2,775**	
Median Method B PoSW using MTCATPH 100% NAPL values		**73,000**

Notes

"100% NAPL" = Occasionally, for the evaluation of the soil-to-groundwater exposure pathway, TPH soil CUL exceeds the theoretical maximum TPH that would be reached if all of the air space in the porous medium is filled with petroleum product. It means the risk is acceptable even at this high soil TPH concentration. In this case, the soil-to-groundwater is not a critical pathway and "100% NAPL" will appear in the protective soil TPH concentration box.

APPENDIX D

2007 TEE

TERRESTRIAL ECOLOGICAL EVALUATION

INTRODUCTION

This appendix presents the terrestrial ecological evaluation (TEE) for the lower yard of the Unocal Edmonds Bulk Fuel Terminal (Terminal), as required by WAC 173-340-7490. It is formatted consistent with the documentation forms provided by the Department of Ecology (Ecology) on its interactive website.

Site background and history are summarized in Section 2 of this report. Soils on site are mainly contaminated with petroleum, primarily in the diesel and oil range, from fuel storage and transfer activities. Union Oil Company (Union Oil) has performed interim actions to remove free product and soils in the areas of highest soil contamination. The completed interim actions, the planned interim action, and the nature of the future development of the lower yard minimize potential exposures to terrestrial receptors by reducing contaminant levels and controlling exposure pathways. Substantial amounts of contaminated soils have been removed, significantly reducing both the spatial extent of contamination and the concentrations of remaining contaminants.

Soils containing significant TPH concentrations remain in areas of the lower yard. Union Oil intends to complete remediation of the lower yard prior to redevelopment as a multi-modal transportation facility. After development, a large portion of the site will be covered with buildings and pavement. In covered areas, terrestrial receptors will be unable to contact soil contaminants.

RI/FS activities included sediment sampling for chemical analyses and bioassays in Willow Creek, adjacent to the lower yard. The RI also included whole effluent toxicity (WET) testing of groundwater beneath the lower yard. These data are discussed in Section 5 of this report. This appendix focuses on ecological issues related to the terrestrial environment only.

Environmental studies of the Edmonds Marsh, which is located on the opposite side of Willow Creek from the lower yard, were conducted in conjunction with the Final Environmental Impact Statement (EIS) conducted for the SR104 Edmonds Crossing Project (CH_2M Hill, 2004). Information from these studies was used in this TEE.

PRIMARY EXCLUSIONS

An answer of "Yes" to any one question in this section excludes the site from further TEE [WAC 173-340-7491(1)].

1a) Will soil contamination be located at least 6 feet beneath the ground surface and less than 15 feet [WAC 173-340-7491(1)(a)]?

No. Detectable concentrations of TPH will likely be present within 6 feet of ground surface following remediation.

1b) Will soil contamination be located at least 15 feet beneath the ground surface [WAC 173-340-7491(1)(a)]?

No. As noted above, detectable concentrations of TPH will likely be present within 15 feet of ground surface following remediation.

1c) Will soil contamination be located below the conditional point of compliance [WAC 173-340-7491(1)(a)]?

No. Union Oil does not plan to propose a conditional point of compliance.

2) Will soil contamination be covered by buildings, paved roads, pavement, or other physical barriers that will prevent plants or wildlife from being exposed [WAC 173-340-7491(1)(b)]?

No. After redevelopment as a multi-modal transportation terminal, there may be some uncapped areas that contain detectable concentrations of the IHSs.

3a) Is there less than 1.5 acres of contiguous undeveloped land on the site, or within 500 feet of any area of the site affected by hazardous substances (other than those substances listed in WAC 173-340-7491(1)(c)(ii)) [WAC 173-340-7491(1)(c)(i)]?

No. There are more than 1.5 acres of contiguous undeveloped land in a wooded area adjacent to the southwest portion of the lower yard.

3b) Is there less than 0.25 acres of contiguous undeveloped land on or within 500 feet of any area of the site affected by hazardous substances listed in WAC 173-340-7491(1)(c)(ii) [WAC 173-340-7491(1)(c)(ii)]?

Not applicable. The site is not contaminated with any of the listed substances.

4) Are concentrations of hazardous substances in the soil less than or equal to natural background concentrations of those substances at the point of compliance [WAC 173-340-7491(1)(d)]?

No. Ecology does not recognize natural background concentrations of petroleum hydrocarbons.

EXCLUSIONS CONCLUSION: The lower yard does not qualify for exclusion from the TEE.

SIMPLIFIED OR SITE-SPECIFIC EVALUATION

An answer of "Yes" to any one question below means the lower yard is required to undergo a site-specific TEE [WAC 173-340-7491(2)]. Otherwise, a simplified evaluation is allowed.

1) Is the site located on or directly adjacent to an area where management or land use plans will maintain or restore native or semi-native vegetation [WAC 173-340-7491(2)(a)(i)]?

Yes. Edmonds Marsh is directly adjacent to the eastern portion of the lower yard. According to the Final EIS for the Edmonds Crossing project [CH_2M Hill, 2004 (p. 3-41)], Edmonds Marsh has been rated by the City of Edmonds as a Category 1 (high quality) wetland based on its uniqueness, large size, and habitat for a state monitor species (great blue heron). It is designated by the city as a Wildlife Sanctuary on the City of Edmonds Environmentally Sensitive Areas map and as a Priority Habitat in the WDFW Priority Habitat and Species database. Category I wetlands are considered the most valuable, and their disturbance is rarely permitted.

2a) Is the site used by a threatened or endangered species [WAC 173-340-7491(2)(a)(ii)]? For animals, "used" means that individuals of a species have been observed to live, feed or breed at the site. For plants, "used" means that a plant species grows at the site or has been found growing at the site.

No. A Wildlife Habitat Study was performed in 1996 as part of the remedial investigation of the Terminal (Adolfson, 1996). Specific to threatened and endangered species, the study findings were as follows:

> Bald eagles are reported as nesting approximately one mile south of the Terminal. Bald eagle nests are not known to exist on the Terminal property or within one mile of the property boundary. During field surveys in 1995, bald eagles were observed perched in large deciduous trees located along the bluff to the south of the Terminal's pier.

No other threatened or endangered animal species were identified. Although bald eagles have been removed from the endangered list, they are still listed as threatened (www.wa.gov/wdfw/wlm/diversty/soc/threaten.htm). Observations by former site personnel indicate that bald eagle do not live at the Terminal, nor have bald eagles been seen perching in trees at the Terminal. As bald eagles are primarily fish eaters, the lower yard does not provide suitable foraging habitat. Bald eagles are seen in flight above the Terminal, but this behavior does not meet the definition of "use" (live, feed, or breed).

The Washington Department of Fish and Wildlife (WDFW) was contacted in the spring of 2002 for additional information. The Priority Habitats and Species Database and Wildlife Heritage Database show the Terminal to be in an area where priority habitats and species are unknown, or the area was not mapped. The area to the south of the Terminal is identified as a bald eagle use area (breeding occurrence).

2b) Is the site used by a wildlife species classified by the Washington State Department of Fish and Wildlife as a "priority species" or "species of concern" under Title 77 RCW [WAC 173-340-7491(2)(a)(ii)]?

No. The WDFW database (www.wa.gov/wdfw/wlm/diversty/soc/threaten.htm) was searched for mammalian, avian, reptilian, and amphibian species listed as expected to occur at the Terminal per the Wildlife Habitat Study. None of the species identified in the Wildlife Habitat Study is listed in the WDFW database as a "priority species" or "species of concern."

2c) Is the site used by a plant species classified by the Washington State Department of Natural Resources Natural Heritage Program as "endangered," "threatened," or "sensitive" under Title 79 RCW [WAC 173-340-7491(2)(a)(ii)]?

No. A review of the Washington State Department of Natural Resources' Natural Heritage Information System (www.wa.gov/htdocs/fr/nhp/refdesk/fsrefix.htm) was performed as part of the 1996 Wildlife Habitat Study. There are no records of significant natural features, rare plants, high quality native wetlands, or high quality native plant communities within the vicinity of the project area.

Additional studies have been performed for purposes of the Edmonds Crossing EIS. No endangered, threatened, or sensitive species were identified in studies performed in 2000 and 2001 (personal communication between Cathy Conolly of Adolfson Associates and Linda Dawson of Maul Foster & Alongi, Inc. on November 30, 2001).

3) Is the area of contamination located on a property that contains at least 10 acres of native vegetation within 500 feet of the area of contamination [WAC 173-340-7491(2)(a)(iii)]?

No. The lower yard (23 acres in area) was an active industrial site that has recently been subject to intensive remedial activity including excavation, backfilling, and grading, and it contains limited vegetation. A small area (approximately 2 acres) located in the southeast corner of the lower yard contains native vegetation. The lower yard will be redeveloped as a multi-modal transportation facility, so it will be primarily covered by buildings and pavement. At present, the lower yard offers limited, disturbed terrestrial habitat. The sparse vegetative cover, low species diversity, and amount of human disturbance in this area limit wildlife use of this habitat [Adolfson Associates, Inc., 1996 (p. 9)].

4) Has the department determined that the site may present a risk to significant wildlife populations [WAC 173-340-7491(2)(a)(iv)]?

No. Ecology has not determined that the lower yard may present a significant risk to wildlife populations.

SIMPLIFIED OR SITE-SPECIFIC EVALUATION CONCLUSION: A site-specific TEE is required because of the site's location next to Edmonds Marsh.

SIMPLIFIED EVALUATION

A simplified TEE is not allowed because a site-specific evaluation is required.

SITE-SPECIFIC EVALUATION

A site-specific TEE consists of two elements: problem formulation and the actual evaluation. After reviewing the problem formulation, Ecology may determine that additional evaluation is not necessary [WAC 173-340-7493(1)(d)].

Problem Formulation

Problem formulation involves identifying the following components of the site-specific TEE:

- Chemicals of ecological concern
- Exposure pathways
- Terrestrial ecological receptors of concern
- Toxicological assessment

The indicator hazardous substances (IHSs) chosen for the TEE are the following (see Section 5.1.3 of this report):

- GRO
- DRO
- HO
- Benzene
- CPAHs
- Arsenic

Following remediation, if the maximum or the upper 95 percent confidence limit concentrations of the IHSs do not exceed the ecological indicator concentrations in MTCA Table 749-3, they may be eliminated from further consideration [WAC 173-340-7493(2)(a)(i)]. Since the site will be used for commercial purposes, only the values in the wildlife column of the table are applicable [WAC 173-340-7493(2)(a)(i)]. The ecological indicator concentrations are 5,000 mg/kg for GRO, 6,000 mg/kg for DRO, 12 mg/kg for cPAHs (benzo(a)pyrene is used as a surrogate), and 132 mg/kg for arsenic in unsaturated soil. There are no table values for HO and benzene.

The petroleum indicator concentrations note that soil concentrations may not exceed residual saturation values. However, the TPH cleanup level (CUL) for the site (2,975 mg/kg; based on direct contact) exceeds the default residual saturation concentration. This higher CUL can be applied because an empirical demonstration (free product does not occur on the groundwater) will be used to show that post-remediation soil concentrations do not exceed residual saturation. The residual saturation requirements will be met at the conclusion of the remediation.

Institutional controls, in the form of deed restrictions, will be used to ensure that any soils exceeding the ecological indicator soil concentrations are capped, that the caps are maintained, and that if the coverings are disturbed, contaminated soils are handled appropriately [WAC 173-340-7493(2)(a)(ii)]. This will ensure there are no complete exposure pathways to soil concentrations of IHSs exceeding the ecological indicator soil concentrations. If there are no complete exposure pathways, no further evaluation is necessary [WAC 173-340-7493(2)(a)(ii)].

The combination of remedial actions, planned development, and institutional controls will minimize wildlife exposure to site-related contaminants. Evaluation of the first two components of problem formulation finds that additional evaluation is not necessary. Capping the soil with IHS concentrations exceeding those listed in MTCA Table 749-3 (wildlife column only) will allow the site-specific TEE to be ended.

APPENDIX E

Statistical Analysis – Lower Yard Soil Samples

MEMO

To:

Scott Zorn

Copies:

1

Arcadis U.S., Inc.
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Knoxville, TN, 37934
USA

From:

Jeanine Smith

Ophelie Encelle

Date:

June 12, 2017

Arcadis Project No.:

B0045362.0009

Subject:

Statistical Analysis – Lower Yard Soil Samples

Former Unocal Edmonds Bulk Fuel Terminal Edmonds, Washington

This memo presents the 95 percent (%) upper confidence limits on the mean (95% UCL) for constituents of concern (COCs) in soil, for the Lower Yard at the Former Unocal Edmonds Bulk Fuel Terminal Edmonds, Washington.

Approach

Per Washington Administrative Code (WAC) 173-340-740(7), because the cleanup levels (CULs) and remediation level (REL) for the COCs are based on chronic and carcinogenic effects, compliance with the CULs and REL were evaluated by comparison with the 95% UCL for the COCs, or the maximum detected concentration if the recommended 95% UCL was greater than the maximum detected concentration. The 95% UCLs were calculated using the United States Environmental Protection Agency's (USEPA's) ProUCL software (version 5.1.002; USEPA 2016) for datasets with at least eight samples and five detections. Although there are greater than 50% non-detects, the datasets for the Lower Yard are robust, with a very large number of samples that have been collected (575 for carcinogenic polycyclic aromatic hydrocarbons [cPAHs] and 988 samples for benzene and total petroleum hydrocarbons [TPH]) and a large number of detected values (between 100 and 348 samples). Because of the robust nature of the datasets, the non-detects were replaced with a value of one-half of the reporting limit and treated as detections. In addition, as a conservative alternative method, the 95% UCLs were also calculated using only the detected concentrations.

The COCs and their relative CUL and REL are provided in Table 1 below.

Table 1. Soil Cleanup Levels and Remediation Level for the Site Constituents of Concern

COC	Soil CULs and REL
TPH, sum of: • gasoline range organics (GRO), • diesel range organics (DRO), • and heavy oil range organics (HO)	2,775 milligrams per kilogram (mg/kg)
Benzene	18 mg/kg
Total cPAHs adjusted for toxicity (TEQ), sum of: • benzo(a)anthracene, • benzo(a)pyrene, • benzo(b)fluoranthene, • benzo(k)fluoranthene, • chrysene, • dibenzo(a,h)anthracene, and • indeno(1,2,3-cd)pyrene Concentrations are adjusted using toxic equivalency factors to represent a total benzo(a)pyrene concentration (WAC 173-340-900).	0.14 mg/kg

Criteria for soil compliance are as follow:

- The 95% UCL for TPH are below the soil REL.
- The 95% UCL for total cPAHs TEQ and benzene are below the soil CULs.
- Less than 10 percent of the samples contain COC concentrations that exceed the REL or CULs.
- Any single sample contains a COC concentration that is lower than twice the REL or CULs.

Soil Datasets

Soil datasets are presented in Table 2.

Soil datasets include samples from:

- 2003 excavations soil samples from the interim actions conducted under Agreed Order (AO) No. DE92TC-N328 that were not over excavated in later interim actions conducted in 2007 and 2008 (Maul, Foster, and Alongi 2004).
- 2007 excavation soil samples from interim action conducted during Phase I, in accordance with AO No. DE 4460 that were not over excavated in later interim actions conducted during Phase II (Arcadis 2009).
- 2008 soil samples from the 2008 soil investigation activities that were not over excavated in later interim actions conducted during Phase II (Arcadis 2010b).
- 2008 excavation soil samples from interim action conducted during Phase II, in accordance with AO No. DE 4460 (Arcadis 2010a).
- 2011 soil samples from the 2011 soil investigation activities (Arcadis 2012).
- 2012 soil samples from the 2012 soil investigation activities (Arcadis 2013).

Soil samples located in the areas of future remedial actions in the central and west/northwest Lower Yard near the Detention Basin 2 (DB-2) and the Washington State Department of Transportation (WSDOT) stormwater line areas were removed from the datasets. The samples not considered in the datasets are listed in Table 3 and their locations are presented on Figure 1. This resulted in a dataset consisting of 988 soil samples with benzene and TPH data, and a dataset of 575 soil samples with cPAHs data. (Only samples with detectable DRO and/or HO concentrations were also analyzed for cPAHs).

Soil samples that were disposed of during excavation activities and samples that were over excavated, and therefore not onsite anymore, have also been removed from the dataset.

Data Processing

Laboratory results. Analytical results were obtained from a Washington State certified laboratory using USEPA Method 8021B for benzene, USEPA Method 8270 SIM for cPAHs, Washington State Department of Ecology (Ecology) method NWTPH-Gx for GRO, and Ecology method NWTPH-Dx for DRO and HO.

Field duplicate samples. Laboratory results from field duplicate samples were combined into one result to represent each field duplicate pair as follows:

- If both results were non-detects, the lowest reporting limit was used,
- If both results were detects, the highest detected value was used, and
- If there was a detect and a non-detect, the detected value was used.

Non-detect results. Because greater than 50% of the results were non-detects for the COCs, the non-detect results were treated as detections at one-half of the reporting limit. For individual non-detect cPAHs, one-half of the reporting limit was used in the calculation of the cPAH TEQ value. For individual non-detect TPH fractions, one-half of the reporting limit was used to calculate the TPH.

Statistical Methods for Calculating 95 Percent Upper Confidence Limits on the Mean

USEPA's ProUCL version 5.1.002 (USEPA 2016) was used to calculate 95% UCLs for the COCs. Because the datasets are large with many detects, but more than 50% non-detects, 95% UCLs were calculated treating non-detects as detections at one-half of the reporting limit. As a conservative alternative approach, the 95% UCLs were also calculated using only detected concentrations. UCLs calculated following this alternative approach provides a conservative high-biased result, as it disregards the many sample results that were non-detected.

The distributions for all six datasets (three COCs using either one-half of the reporting limit or only detected results) were non-parametric. Because the datasets were not lognormal, the recommended 95% UCLs from ProUCL were used for comparison to the REL and CULs. The ProUCL output file is provided in Attachment 1.

Results and Compliance

A data summary for each of the datasets evaluated and the calculated 95% UCLs are presented in Table 4. As shown in Table 4, remaining concentrations of COCs in soil are compliant with the CULs and REL based on the following:

Benzene. None of the dataset of 988 soil samples exceeded the CUL or two times the CUL. The maximum detected concentration of benzene in the remaining samples (6.57 mg/kg) and the calculated 95% UCLs (0.104 mg/kg and 0.824 mg/kg [conservative high-biased result]) did not exceed the CUL of 18 mg/kg.

cPAH TEQ. One out of the dataset of 575 soil samples, or 0.2%, exceeded the CUL of 0.14 mg/kg, and the maximum detected concentration (0.19 mg/kg) did not exceed two times the CUL. The 95% UCLs (0.0181 mg/kg and 0.0321 mg/kg [conservative high-biased result]) did not exceed the CUL.

TPH. Three out of the dataset of 988 soil samples, or 0.3%, exceeded the REL of 2,775 mg/kg, and the maximum detected concentration (4,980 mg/kg) did not exceed two times the REL. The 95% UCLs (188 mg/kg and 478 mg/kg [conservative high-biased result]) did not exceed the REL.

Conclusions and Recommendations

The statistical analyses show that the Lower Yard datasets for benzene, TPH, and cPAH TEQ fall well within the established limits of compliance outlined above, using either method for calculating 95% UCLs. Additional statistical analyses will be conducted upon the completion of the planned remedial activities and receipt of laboratory analytical reports for confirmation samples. Due to the large nature of the datasets and the conclusions of the statistical analyses completed in this memo, Arcadis proposes that for future statistical analyses, non-detects be replaced with one-half of the reporting limit and be treated as detects.

References

Arcadis. 2009. Phase I Remedial Implementation As-Built Report, Unocal Edmonds Bulk Fuel Terminal Lower Yard. July 31.

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Arcadis. 2010b. 2008 Additional Site Investigation and Groundwater Monitoring Report, Former Unocal Edmonds Bulk Fuel Terminal (Lower Yard). January 18.

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Maul, Foster, and Alongi. 2004. 2003 Lower Yard Interim Action As-Built Report, Unocal Edmonds Terminal, Edmonds WA. February 26. SIT5.5

USEPA. 2016. A Statistical Software for Environmental Applications for Data Sets With and Without Non Detect Observations. National Exposure Research Lab, EPA, Las Vegas Nevada, May. Available online at: http://www.epa.gov/osp/hstl/tsc/softwaredocs.htm.

Enclosures

Tables

Table 1 (imbedded): Soil Cleanup Levels and Remediation Level for the Site Constituents of Concern

Table 2: Samples Used to Calculate 95 Percent Upper Confidence Limits on the Mean

Table 3: Samples Located in the Areas of Future Remedial Actions

Table 4: Data Summary and 95 Percent Upper Confidence Levels on the Mean

Figure

Figure 1: Samples Located in the Areas of Future Remedial Actions

Attachment

Attachment 1. ProUCL Output

Table 2: Samples Used to Calculate 95 Percent Upper Confidence Limits on the Means

Sample Identification (ID)	Sample Depth (feet bgs)	Sample Date	TPH (mg/kg)[1]	Benzene (mg/kg)[2]	Total cPAHs TEQ (mg/kg)[3]
B1-14-14.5	14-14.5	8/22/2011	11.45 U	0.17	NA
B12-0.5-1	0.5-1	8/24/2011	298.5	0.033 U W	0.01167
B12-1-1.5	1-1.5	8/24/2011	254	0.038 U W	0.0007224 U
B12-2.5-3	2.5-3	8/24/2011	247.5	0.051 U W	0.07917
B12-3.5-4	3.5-4	8/24/2011	32.8	0.0028 U	0.0006283
B1-4.5-5	4.5-5	8/22/2011	16.1	0.0022 U	0.0005213
B14-0.5-1	0.5-1	8/25/2011	154.5	0.11 U W	0.02947
B14-1.5-2	1.5-2	8/25/2011	5.5 U	0.023 U W	NA
B14-2.5-3	2.5-3	8/25/2011	23.5 U	0.051 U W	NA
B14-3.5-4	3.5-4	8/25/2011	97.9	0.058 U W	0.0009003
B15-11-11.5	11-11.5	8/23/2011	16 U	0.029 U W	NA
B15-4.5-5	4.5-5	8/23/2011	22.15	0.0025 U	0.0005311
B15-6.5-7	6.5-7	8/23/2011	20.45	0.0026 U V	NA
B15-8.5-9	8.5-9	8/23/2011	63	0.0048 U V	0.0008315
B1-9.5-10	9.5-10	8/22/2011	72.3	0.23 W	0.008175
B2-12-12.5	12-12.5	8/22/2011	662	0.0020 U	0.000881
B2-14.5-15	14.5-15	8/22/2011	7.8 U	0.0024 U	NA
B2-4-4.5	4-4.5	8/22/2011	1344.6	0.018 UW	0.05368
B2-7-7.5	7-7.5	8/22/2011	67.5	0.0020 U	0.000727
B2-9.5-10	9.5-10	8/22/2011	216	0.0019 U	0.002005
B3-12-12.5	12-12.5	8/22/2011	95.8	0.0020 U	0.0005765
B3-14-14.5	14-14.5	8/22/2011	8.45	0.0040	NA
B3-4.5-5	4.5-5	8/22/2011	7.65 U	0.0022 U	NA
B3-7-7.5	7-7.5	8/22/2011	180.55	0.0021 U	0.0007175
DB1-A-10-4	4	10/8/2003	20 U	0.03 U	0.00755 U
DB1-A-10wall-2	2	10/8/2003	20 U	0.03 U	0.00755 U
DB1-A-11-4	4	10/8/2003	20 U	0.03 U	0.00755 U
DB1-A-11wall-2	2	10/8/2003	20 U	0.03 U	0.00755 U
DB1-A-12-4	4	10/8/2003	20 U	0.03 U	0.00755 U
DB1-A-12wall-2	2	10/8/2003	20 U	0.03 U	0.00755 U
DB1-A-13-4	4	10/8/2003	20 U	0.03 U	0.00755 U
DB1-A-13wall-2	2	10/8/2003	20 U	0.03 U	0.00755 U
DB1-A-14-3	3	10/9/2003	20 U	0.03 U	0.00755 U
DB1-A-1-5	5	9/16/2003	26.7	0.03 U	0.00755 U
DB1-A-15-3	3	10/9/2003	20 U	0.03 U	0.00755 U
DB1-A-16-3	3	10/9/2003	30.4	0.03 U	0.00755 U
DB1-A-17-5	5	10/9/2003	20 U	0.03 U	0.00755 U
DB1-A-17Wall-2	2	10/9/2003	20 U	0.03 U	0.00755 U
DB1-A-18-5	5	10/9/2003	20 U	0.03 U	0.00755 U
DB1-A-18Wall-2	2	10/9/2003	167.7	0.26	0.00755 U
DB1-A-19-5	5	10/9/2003	20 U	0.03 U	0.00755 U
DB1-A-19Wall-2.5	2.5	10/9/2003	30.49	0.03 U	0.00755 U
DB1-A-20-5	5	10/10/2003	20 U	0.03 U	0.00755 U
DB1-A-20wall-2	2	10/10/2003	28.9	0.03 U	0.00755 U
DB1-A-21-5	5	10/10/2003	20 U	0.03 U	0.01001
DB1-A-22-8	8	9/8/2003	20 U	0.03 U	0.00755 U
DB1-A-22wall-4	4	9/8/2003	625.5 D	0.03 U	0.0911 U

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FORMER UNOCAL BULK FUEL TERMINAL
EDMONDS, WASHINGTON
FINAL FEASABILITY STUDY REPORT - APPENDIX E

Table 2: Samples Used to Calculate 95 Percent Upper Confidence Limits on the Means

Sample Identification (ID)	Sample Depth (feet bgs)	Sample Date	TPH (mg/kg)[1]	Benzene (mg/kg)[2]	Total cPAHs TEQ (mg/kg)[3]
DB1-A-23-6	6	10/10/2003	20 U	0.03 U	0.00755 U
DB1-A-23wall-3	3	10/10/2003	1303.5 D	0.03 U	0.03775 U
DB1-A-24-6	6	10/10/2003	20 U	0.03 U	0.00755 U
DB1-A-24wall-3	3	10/10/2003	20 U	0.03 U	0.00755 U
DB1-A-25-7	7	10/10/2003	20 U	0.03 U	0.00755 U
DB1-A-25wall-3	3	10/10/2003	2644 D	0.05	0.06873
DB1-A-2-6	6	9/12/2003	20 U	0.03 U	0.00755 U
DB1-A-26-11	1	9/5/2003	20 U	0.03 U	0.00755 U
DB1-A-27-10	10	9/3/2003	20 U	0.03 U	0.00755 U
DB1-A-27wall1-3	3	9/3/2003	20 U	0.03 U	0.00755 U
DB1-A-27wall2-7	7	9/3/2003	20 U	0.03 U	0.00755 U
DB1-A-28-7	7	9/3/2003	20 U	0.03 U	0.00755 U
DB1-A-28wall-3	3	9/3/2003	386.3	0.03 U	0.00755 U
DB1-A-29-9	9	9/2/2003	20 U	0.03 U	0.00755 U
DB1-A-29wall1-2	2	9/2/2003	25.4 U	0.03 U	0.00755 U
DB1-A-29wall2-5	5	9/2/2003	20 U	0.03 U	0.00755 U
DB1-A-2wall-3	3	9/12/2003	64.07	0.04	0.00755 U
DB1-A-30-7	7	9/3/2003	20 U	0.03 U	0.00755 U
DB1-A-30wall-3	3	9/3/2003	122.7	0.03 U	0.02413
DB1-A-31-10	0	9/3/2003	20 U	0.03 U	0.00755 U
DB1-A-31wall1-3	3	9/3/2003	506.5 D	0.03 U	0.02186
DB1-A-31wall2-7	7	9/3/2003	20 U	0.03 U	0.00755 U
DB1-A-3-4	4	9/19/2003	20 U	0.03 U	0.00755 U
DB1-A-3wall2-2.5	2.5	9/23/2003	1202.6 D	0.03 U	0.05025
DB1-A-4-4	4	9/19/2003	20 U	0.03 U	0.00755 U
DB1-A-4wall-2.5	2.5	9/22/2003	435.46 D	0.03 U	0.05075
DB1-A-5-5	5	9/22/2003	20 U	0.03 U	0.00755 U
DB1-A-5wall-2	2	10/6/2003	32.6	0.03 U	0.00755 U
DB1-A-6-5	5	9/24/2003	20 U	0.03 U	0.00755 U
DB1-A-6wall-2.5	2.5	9/24/2003	875.5 D	0.03 U	0.00755 U
DB1-A-7-5	5	9/24/2003	38.7	0.03 U	0.00755 U
DB1-A-7wall-2.5	2.5	9/24/2003	75.4	0.03 U	0.00755 U
DB1-A-8-5	5	10/6/2003	41.8	0.03 U	0.00755 U
DB1-A-8wall-2.5	2.5	10/6/2003	20 U	0.03 U	0.00755 U
DB1-A-9-5	5	10/6/2003	20 U	0.03 U	0.00755 U
DB1-A-9wall-2.5	2.5	10/6/2003	20 U	0.03 U	0.00755 U
DB1-B-10-4	4	9/26/2003	20 U	0.03 U	0.00755 U
DB1-B-11-4	4	9/29/2003	20 U	0.03 U	0.00755 U
DB1-B-1-2	2	9/12/2003	89	0.03 U	0.00755 U
DB1-B-12-4	4	10/3/2003	20 U	0.03 U	0.00755 U
DB1-B-13-4	4	10/6/2003	20 U	0.03 U	0.00755 U
DB1-B-14-3	3	10/6/2003	20 U	0.03 U	0.00755 U
DB1-B-15-3	3	10/6/2003	20 U	0.03 U	0.00755 U
DB1-B-16-3.5	3.5	10/8/2003	20 U	0.03 U	0.00755 U
DB1-B-17-4.5	4.5	10/9/2003	20 U	0.03 U	0.00755 U
DB1-B-18-3	3	9/15/2003	25.8	0.03 U	0.00755 U
DB1-B-19-3	3	9/15/2003	20 U	0.03 U	0.00755 U

Table 2: Samples Used to Calculate 95 Percent Upper Confidence Limits on the Means

Sample Identification (ID)	Sample Depth (feet bgs)	Sample Date	TPH (mg/kg)[1]	Benzene (mg/kg)[2]	Total cPAHs TEQ (mg/kg)[3]
DB1-B-20-4	4	9/8/2003	20 U	0.03 U	0.00755 U
DB1-B-21-4	4	9/8/2003	20 U	0.03 U	0.00755 U
DB1-B-22-4	4	9/8/2003	20 U	0.03 U	0.00755 U
DB1-B-2-3	3	9/12/2003	20 U	0.03 U	0.00755 U
DB1-B-23-0.5	0.5	8/29/2003	106.5	0.37	0.00755 U
DB1-B-24-1	1	8/29/2003	20 U	0.03 U	0.00755 U
DB1-B-25-1.5	1.5	9/5/2003	43.3	0.03 U	0.00755 U
DB1-B-26-1	1	8/28/2003	20 U	0.03 U	0.00755 U
DB1-B-27-1	1	8/27/2003	72.4	0.03 U	0.00755 U
DB1-B-28-1	1	8/27/2003	20 U	0.03 U	0.00755 U
DB1-B-29-1.5	1.5	8/25/2003	20 U	0.03 U	0.00755 U
DB1-B-30-4	4	8/25/2003	20 U	0.03 U	0.00755 U
DB1-B-31-6	6	9/4/2003	20 U	0.03 U	0.00755 U
DB1-B-31wall-3	3	9/4/2003	20 U	0.03 U	0.00755 U
DB1-B-3-3.5	3.5	9/19/2003	20 U	0.03 U	0.00755 U
DB1-B-4-4	4	9/19/2003	20 U	0.03 U	0.00755 U
DB1-B-5-4	4	9/22/2003	20 U	0.03 U	0.02743
DB1-B-6-4	4	9/24/2003	20 U	0.03 U	0.00755 U
DB1-B-7-4	4	9/24/2003	20 U	0.03 U	0.00755 U
DB1-B-8-4	4	9/25/2003	20 U	0.03 U	0.00755 U
DB1-B-9-4	4	9/25/2003	20 U	0.03 U	0.00755 U
DB1-C-10-4	4	9/26/2003	20 U	0.03 U	0.00755 U
DB1-C-11-4	4	9/29/2003	20 U	0.03 U	0.00755 U
DB1-C-1-2	2	9/12/2003	20 U	0.03 U	0.00755 U
DB1-C-12-3	3	10/3/2003	20 U	0.03 U	0.00755 U
DB1-C-13-3	3	10/3/2003	20 U	0.03 U	0.00755 U
DB1-C-14-3	3	10/3/2003	20 U	0.03 U	0.00755 U
DB1-C-15-3	3	10/3/2003	20 U	0.03 U	0.00755 U
DB1-C-16-2	2	9/16/2003	20 U	0.03 U	0.00755 U
DB1-C-17-5	5	9/16/2003	20 U	0.03 U	0.00755 U
DB1-C-17wall-2	2	9/16/2003	20 U	0.03 U	0.00755 U
DB1-C-18-2.5	2.5	9/17/2003	20 U	0.03 U	0.00755 U
DB1-C-19-1.5	1.5	9/15/2003	20 U	0.03 U	0.00755 U
DB1-C-20-4	4	9/8/2003	20 U	0.03 U	0.00755 U
DB1-C-21-5	5	9/12/2003	20 U	0.03 U	0.00755 U
DB1-C-22-4	4	9/12/2003	20 U	0.03 U	0.00755 U
DB1-C-23-1.5	1.5	9/5/2003	20 U	0.03 U	0.00755 U
DB1-C-2-4	4	9/12/2003	20 U	0.03 U	0.00755 U
DB1-C-24-1	1	8/29/2003	20 U	0.03 U	0.00755 U
DB1-C-25-1	1	8/28/2003	27.8	0.03 U	0.00766
DB1-C-26-1	1	8/28/2003	20 U	0.03 U	0.00755 U
DB1-C-27-1	1	8/27/2003	20 U	0.03 U	0.00755 U
DB1-C-28-1	1	8/27/2003	20 U	0.03 U	0.00755 U
DB1-C-29-4	4	8/25/2003	20 U	0.03 U	0.00755 U
DB1-C-30-4	4	8/25/2003	20 U	0.03 U	0.00755 U
DB1-C-31-4	4	8/25/2003	20 U	0.03 U	0.00755 U
DB1-C-31wall-2	2	8/25/2003	20 U	0.03 U	0.00755 U

Table 2: Samples Used to Calculate 95 Percent Upper Confidence Limits on the Means

Sample Identification (ID)	Sample Depth (feet bgs)	Sample Date	TPH (mg/kg)[1]	Benzene (mg/kg)[2]	Total cPAHs TEQ (mg/kg)[3]
DB1-C-3-4	4	9/19/2003	20 U	0.03 U	0.00755 U
DB1-C-4-4	4	9/19/2003	20 U	0.03 U	0.00755 U
DB1-C-5-4	4	9/22/2003	20 U	0.03 U	0.00755 U
DB1-C-6-4	4	9/24/2003	20 U	0.03 U	0.00755 U
DB1-C-7-4	4	9/24/2003	20 U	0.03 U	0.00755 U
DB1-C-8-4	4	9/25/2003	20 U	0.03 U	0.00755 U
DB1-C-9-4	4	9/26/2003	20 U	0.03 U	0.00755 U
DB1-D-10-4	4	9/26/2003	20 U	0.03 U	0.00755 U
DB1-D-11-4	4	9/29/2003	20 U	0.03 U	0.00755 U
DB1-D-12-3	3	10/1/2003	20 U	0.03 U	0.00755 U
DB1-D-1-3	3	9/12/2003	20 U	0.03 U	0.00755 U
DB1-D-13-3	3	10/1/2003	20 U	0.03 U	0.00755 U
DB1-D-14-3	3	10/1/2003	20 U	0.03 U	0.00755 U
DB1-D-15-2	2	10/1/2003	20 U	0.03 U	0.00755 U
DB1-D-16-1.5	1.5	9/16/2003	20 U	0.03 U	0.00755 U
DB1-D-17-1	1	9/16/2003	20 U	0.03 U	0.00755 U
DB1-D-18-1	1	9/15/2003	46.25 U	0.07 U	0.017375 U
DB1-D-19-1	1	9/15/2003	20 U	0.03 U	0.00755 U
DB1-D-20-3	3	9/8/2003	20 U	0.03 U	0.00755 U
DB1-D-21-3	3	9/8/2003	20 U	0.03 U	0.00755 U
DB1-D-22-2	2	9/8/2003	20 U	0.03 U	0.00755 U
DB1-D-23-1	1	8/29/2003	20 U	0.03 U	0.00755 U
DB1-D-2-4	4	9/12/2003	20 U	0.03 U	0.00755 U
DB1-D-24-1	1	8/29/2003	133.3	0.03 U	0.00755 U
DB1-D-25-1.5	1.5	8/28/2003	20 U	0.03 U	0.00755 U
DB1-D-26-1.5	1.5	8/28/2003	20 U	0.03 U	0.00755 U
DB1-D-27-1	1	8/27/2003	20 U	0.03 U	0.00755 U
DB1-D-28-1	1	8/27/2003	20 U	0.03 U	0.00755 U
DB1-D-29-2	2	8/26/2003	139.7	0.04	0.00868
DB1-D-30-3	3	8/25/2003	20 U	0.03 U	0.00805
DB1-D-31-1	1	9/3/2003	20 U	0.03 U	0.00755 U
DB1-D-3-3.5	3.5	9/19/2003	20 U	0.03 U	0.00755 U
DB1-D-4-4	4	9/19/2003	29.3	0.03 U	0.00755 U
DB1-D-5-4	4	9/22/2003	68.3	0.06 U	0.0151 U
DB1-D-6-4	4	9/24/2003	20 U	0.03 U	0.00755 U
DB1-D-7-4	4	9/24/2003	20 U	0.03 U	0.00755 U
DB1-D-8-4	4	9/25/2003	20 U	0.03 U	0.00755 U
DB1-D-9-4	4	10/3/2003	20 U	0.03 U	0.00755 U
DB1-D-9-7	7	9/25/2003	20 U	0.03 U	0.00755 U
DB1-E-10-2.5	2.5	9/19/2003	56.65 U	0.09 U	0.02117 U
DB1-E-11-2	2	9/19/2003	43.55 U	0.07 U	0.01659 U
DB1-E-12-2	2	9/19/2003	42.95 U	0.06 U	0.01656 U
DB1-E-13-2	2	9/19/2003	20 U	0.03 U	0.00755 U
DB1-E-1-4	4	9/16/2003	28.3	0.03 U	0.00755 U
DB1-E-14-1	1	9/16/2003	31.9	0.03 U	0.00755 U
DB1-E-15-1.5	1.5	9/16/2003	20 U	0.03 U	0.00755 U
DB1-E-16-1	1	9/16/2003	20 U	0.03 U	0.00755 U

Table 2: Samples Used to Calculate 95 Percent Upper Confidence Limits on the Means

Sample Identification (ID)	Sample Depth (feet bgs)	Sample Date	TPH (mg/kg)[1]	Benzene (mg/kg)[2]	Total cPAHs TEQ (mg/kg)[3]
DB1-E-17-1	1	9/16/2003	40.75 U	0.06 U	0.01529 U
DB1-E-18-1	1	9/15/2003	20 U	0.03 U	0.00755 U
DB1-E-19-1	1	9/15/2003	20 U	0.03 U	0.00755 U
DB1-E-20-3	3	9/8/2003	20 U	0.03 U	0.00755 U
DB1-E-21-2	2	9/8/2003	20 U	0.03 U	0.00755 U
DB1-E-22-1	1	9/8/2003	20 U	0.03 U	0.00755 U
DB1-E-2-3	3	9/12/2003	20 U	0.03 U	0.00755 U
DB1-E-23-2.5	2.5	8/29/2003	20 U	0.03 U	0.00766
DB1-E-24-1.5	1.5	8/29/2003	20 U	0.03 U	0.00755 U
DB1-E-25-1.5	1.5	8/28/2003	20 U	0.03 U	0.00755 U
DB1-E-26-1.5	1.5	8/28/2003	20 U	0.03 U	0.00755 U
DB1-E-27-1	1	8/27/2003	29.4	0.03 U	0.00755 U
DB1-E-28-1	1	8/27/2003	37.6	0.03 U	0.00778
DB1-E-29-4	4	8/26/2003	20 U	0.03 U	0.00755 U
DB1-E-30-3	3	8/26/2003	20 U	0.03 U	0.00755 U
DB1-E-3-3.5	3.5	9/19/2003	20 U	0.03 U	0.00755 U
DB1-E-4-3	3	9/19/2003	20 U	0.03 U	0.00755 U
DB1-E-5-3	3	9/19/2003	43.35 U	0.07 U	0.01658 U
DB1-E-6-3	3	9/19/2003	20 U	0.03 U	0.00755 U
DB1-E-7-2.5	2.5	9/19/2003	20 U	0.03 U	0.00755 U
DB1-E-8-2.5	2.5	9/19/2003	20 U	0.03 U	0.00755 U
DB1-E-9-2.5	2.5	9/19/2003	20 U	0.03 U	0.00755 U
DB1-F-10-2	2	9/17/2003	20 U	0.03 U	0.00755 U
DB1-F-11-2	2	9/17/2003	44.65 U	0.07 U	0.01664 U
DB1-F-12-2	2	9/17/2003	20 U	0.03 U	0.00755 U
DB1-F-13-2	2	9/17/2003	20 U	0.03 U	0.00755 U
DB1-F-14-1.5	1.5	9/16/2003	20 U	0.03 U	0.00755 U
DB1-F-1-5	5	9/16/2003	20 U	0.03 U	0.00755 U
DB1-F-15-1.5	1.5	9/18/2003	20 U	0.03 U	0.00755 U
DB1-F-16-1.5	1.5	9/18/2003	20 U	0.03 U	0.00755 U
DB1-F-17-1	1	9/16/2003	20 U	0.03 U	0.00755 U
DB1-F-18-1.5	1.5	9/15/2003	20 U	0.03 U	0.00755 U
DB1-F-19-1	1	9/15/2003	30.9	0.03 U	0.00755 U
DB1-F-1wall-2.5	2.5	9/16/2003	20 U	0.03 U	0.00755 U
DB1-F-20-1	1	9/8/2003	26.6	0.03 U	0.00755 U
DB1-F-21-1.5	1.5	9/15/2003	20 U	0.03 U	0.00755 U
DB1-F-22-1	1	9/8/2003	29.1	0.03 U	0.00755 U
DB1-F-2-3	3	9/16/2003	20	0.03 U	0.00755 U
DB1-F-23-1	1	8/29/2003	20 U	0.03 U	0.00755 U
DB1-F-24-1	1	8/29/2003	20 U	0.03 U	0.00755 U
DB1-F-25-1.5	1.5	8/28/2003	174.2	0.03 U	0.00767
DB1-F-26-1.5	1.5	9/5/2003	20 U	0.03 U	0.00755 U
DB1-F-27-1.5	1.5	9/5/2003	20 U	0.03 U	0.00755 U
DB1-F-28-1	1	8/27/2003	20 U	0.03 U	0.00755 U
DB1-F-29-0.5	0.5	8/26/2003	20 U	0.03 U	0.00755 U
DB1-F-30-1	1	8/26/2003	24.42	0.03	0.00755 U
DB1-F-3-2.5	2.5	9/18/2003	20 U	0.03 U	0.00755 U

Table 2: Samples Used to Calculate 95 Percent Upper Confidence Limits on the Means

Sample Identification (ID)	Sample Depth (feet bgs)	Sample Date	TPH (mg/kg)[1]	Benzene (mg/kg)[2]	Total cPAHs TEQ (mg/kg)[3]
DB1-F-4-2	2	9/18/2003	20 U	0.03 U	0.00755 U
DB1-F-5-2	2	9/18/2003	20 U	0.03 U	0.00755 U
DB1-F-6-1.5	1.5	9/18/2003	20 U	0.03 U	0.00755 U
DB1-F-7-2	2	9/18/2003	20 U	0.03 U	0.00755 U
DB1-F-8-2	2	9/18/2003	20 U	0.03 U	0.00755 U
DB1-F-9-2	2	9/18/2003	20 U	0.03 U	0.00755 U
DB1-G-10-2	2	9/17/2003	50.05 U	0.08 U	0.018875 U
DB1-G-11-2	2	9/17/2003	47.05 U	0.07 U	0.01807 U
DB1-G-12-2	2	9/17/2003	20 U	0.03 U	0.00755 U
DB1-G-13-2	2	9/17/2003	79.8	0.09 U	0.02266 U
DB1-G-14-1	1	9/16/2003	60.75 U	0.09 U	0.02269 U
DB1-G-1-5	5	9/12/2003	20 U	0.03 U	0.00755 U
DB1-G-15-1	1	9/16/2003	40.55 U	0.06 U	0.01513 U
DB1-G-16-1	1	9/16/2003	64.5	0.07 U	0.017395 U
DB1-G-17-1	1	9/16/2003	20 U	0.06 U	0.01465 U
DB1-G-18-1	1	9/15/2003	20 U	0.03 U	0.00755 U
DB1-G-19-1.5	1.5	9/17/2003	203.4	0.03 U	0.00755 U
DB1-G-1wall-2.5	2.5	9/12/2003	20 U	0.03 U	0.00755 U
DB1-G-20-1	1	9/8/2003	62.2	0.03 U	0.00775
DB1-G-21-0.5	0.5	9/8/2003	58.3	0.03 U	0.03828
DB1-G-22-1	1	9/15/2003	20 U	0.03 U	0.00755 U
DB1-G-2-3	3	9/12/2003	20 U	0.03 U	0.00755 U
DB1-G-23-0.5	0.5	8/29/2003	20 U	0.03 U	0.00755 U
DB1-G-24-1	1	8/29/2003	20 U	0.03 U	0.00755 U
DB1-G-25-1.5	1.5	8/28/2003	36.08	0.03 U	0.00768
DB1-G-26-1.5	1.5	8/28/2003	41.15 U	0.06 U	0.015815 U
DB1-G-27-1	1	8/27/2003	96.2	0.03 U	0.00767
DB1-G-28-1	1	8/27/2003	56.4 U	0.09 U	0.02116 U
DB1-G-29-2.5	2.5	8/26/2003	20 U	0.03 U	0.00755 U
DB1-G-30-0.5	0.5	8/26/2003	20 U	0.03 U	0.00755 U
DB1-G-3-2	2	9/12/2003	20 U	0.03 U	0.00755 U
DB1-G-4-2.5	2.5	9/17/2003	20 U	0.03 U	0.00755 U
DB1-G-5-3	3	9/17/2003	20 U	0.03 U	0.00755 U
DB1-G-6-3	3	9/17/2003	20 U	0.03 U	0.00755 U
DB1-G-7-3	3	9/17/2003	48.65 U	0.07 U	0.01815 U
DB1-G-8-3	3	9/17/2003	46.15 U	0.07 U	0.017375 U
DB1-G-9-2	2	9/17/2003	20 U	0.03 U	0.00755 U
DB1-H-10-4	4	9/8/2003	20 U	0.03 U	0.00755 U
DB1-H-11-4.5	4.5	9/12/2003	20 U	0.03 U	0.00755 U
DB1-H-12-4	4	9/8/2003	28.9	0.03 U	0.00755 U
DB1-H-13-4	4	9/8/2003	20 U	0.03 U	0.00755 U
DB1-H-14-3	3	9/5/2003	20 U	0.03 U	0.00755 U
DB1-H-15-2	2	9/5/2003	42.7	0.03 U	0.00755 U
DB1-H-16-2	2	9/5/2003	25.8	0.03 U	0.00755 U
DB1-H-17-4	4	9/5/2003	20 U	0.03 U	0.00755 U
DB1-H-18-5	5	9/5/2003	42.3 U	0.06 U	0.015865 U
DB1-H-18wall-2	2	9/5/2003	20 U	0.03 U	0.00755 U

Table 2: Samples Used to Calculate 95 Percent Upper Confidence Limits on the Means

Sample Identification (ID)	Sample Depth (feet bgs)	Sample Date	TPH (mg/kg)[1]	Benzene (mg/kg)[2]	Total cPAHs TEQ (mg/kg)[3]
DB1-H-19-2	2	9/4/2003	20 U	0.03 U	0.00755 U
DB1-H-20-1.5	1.5	9/10/2003	20 U	0.03 U	0.00755 U
DB1-H-20wall-3	3	9/4/2003	20 U	0.03 U	0.00755 U
DB1-H-21-2	2	9/2/2003	20 U	0.03 U	0.00755 U
DB1-H-22-5	5	9/2/2003	20 U	0.03 U	0.00755 U
DB1-H-22wall-2	2	9/2/2003	20 U	0.03 U	0.00755 U
DB1-H-23-4	4	8/29/2003	26.8	0.03 U	0.00755 U
DB1-H-24-4	4	8/29/2003	31.7	0.03 U	0.00755 U
DB1-H-25-3	3	8/29/2003	20 U	0.03 U	0.00755 U
DB1-H-26-3	3	8/29/2003	20 U	0.03 U	0.00755 U
DB1-H-2-7	7	9/11/2003	20 U	0.03 U	0.00755 U
DB1-H-27-1.5	1.5	9/5/2003	20 U	0.03 U	0.00755 U
DB1-H-28-1	1	8/27/2003	20 U	0.03 U	0.00755 U
DB1-H-29-5	5	8/25/2003	20 U	0.03 U	0.00755 U
DB1-H-2wall-3	3	9/11/2003	20 U	0.03 U	0.00755 U
DB1-H-30-5	5	8/25/2003	20 U	0.03 U	0.00755 U
DB1-H-30wall-1	1	9/3/2003	44	0.03 U	0.00755 U
DB1-H-3-5	5	9/11/2003	20 U	0.03 U	0.00755 U
DB1-H-4-4	4	9/11/2003	20 U	0.03 U	0.00755 U
DB1-H-5-3	3	9/11/2003	20 U	0.03 U	0.00755 U
DB1-H-6-3	3	9/11/2003	20 U	0.03 U	0.00755 U
DB1-H-7-4	4	9/11/2003	20 U	0.03 U	0.00755 U
DB1-H-8-4	4	9/11/2003	20 U	0.03 U	0.00755 U
DB1-H-9-4	4	9/8/2003	20 U	0.03 U	0.00755 U
DB1-I-10-5	5	9/8/2003	20 U	0.03 U	0.00755 U
DB1-I-10wall-2	2	9/8/2003	46.55 U	0.07 U	0.017395 U
DB1-I-11-5	5	9/8/2003	20 U	0.03 U	0.00755 U
DB1-I-11wall-2	2	9/8/2003	20 U	0.03 U	0.00755 U
DB1-I-12-3	3	9/8/2003	26.4	0.03 U	0.00755 U
DB1-I-13-5	5	9/8/2003	20 U	0.03 U	0.00755 U
DB1-I-13wall-2	2	9/12/2003	20 U	0.03 U	0.00755 U
DB1-I-14-3	3	9/5/2003	20 U	0.03 U	0.0151 U
DB1-I-15-5	5	9/5/2003	20 U	0.03 U	0.00755 U
DB1-I-15wall-2	2	9/10/2003	20 U	0.03 U	0.00755 U
DB1-I-16-5	5	9/5/2003	20 U	0.03 U	0.00755 U
DB1-I-16wall-3	3	9/10/2003	20 U	0.03 U	0.00755 U
DB1-I-17-4	4	9/5/2003	20 U	0.03 U	0.00755 U
DB1-I-18-5	5	9/4/2003	20 U	0.03 U	0.00755 U
DB1-I-18wall-3	3	9/10/2003	25.4	0.03 U	0.00755 U
DB1-I-19-5	5	9/4/2003	20 U	0.03 U	0.00755 U
DB1-I-19wall-2	2	9/4/2003	20 U	0.03 U	0.00755 U
DB1-I-20-5	5	9/4/2003	20 U	0.03 U	0.00755 U
DB1-I-20wall-2	2	9/4/2003	45.1	0.03 U	0.00755 U
DB1-I-21-3	3	9/2/2003	20 U	0.03 U	0.00755 U
DB1-I-22-3	3	9/2/2003	20 U	0.03 U	0.00755 U
DB1-I-23-2	2	8/29/2003	20 U	0.03 U	0.00755 U
DB1-I-24-3	3	8/29/2003	20 U	0.03 U	0.00755 U

Table 2: Samples Used to Calculate 95 Percent Upper Confidence Limits on the Means

Sample Identification (ID)	Sample Depth (feet bgs)	Sample Date	TPH (mg/kg)[1]	Benzene (mg/kg)[2]	Total cPAHs TEQ (mg/kg)[3]
DB1-I-25-3	3	8/29/2003	20 U	0.03 U	0.00755 U
DB1-I-26-1	1	8/29/2003	20 U	0.03 U	0.00755 U
DB1-I-2-7	7	9/11/2003	20 U	0.03 U	0.00755 U
DB1-I-27-1	1	8/27/2003	20 U	0.03 U	0.00755 U
DB1-I-28-1	1	8/27/2003	20 U	0.03 U	0.00755 U
DB1-I-29-5	5	8/25/2003	20 U	0.03 U	0.00755 U
DB1-I-2wall-3	3	9/11/2003	20 U	0.03 U	0.00755 U
DB1-I-30-5	5	8/25/2003	20 U	0.03 U	0.00755 U
DB1-I-30wall-1	1	9/3/2003	20 U	0.03 U	0.00755 U
DB1-I-3-5	5	9/11/2003	20 U	0.03 U	0.00755 U
DB1-I-3wall-2	2	9/11/2003	54.4	0.03 U	0.00755 U
DB1-I-4-5	5	9/11/2003	20 U	0.03 U	0.00755 U
DB1-I-4wall-2	2	9/11/2003	20 U	0.03 U	0.00755 U
DB1-I-5-4	4	9/11/2003	20 U	0.03 U	0.00755 U
DB1-I-6-5	5	9/11/2003	20 U	0.03 U	0.00755 U
DB1-I-6wall-2	2	9/11/2003	20 U	0.03 U	0.00755 U
DB1-I-7-5	5	9/16/2003	20 U	0.03 U	0.00755 U
DB1-I-7wall-2.5	2.5	9/16/2003	38.5	0.03 U	0.00755 U
DB1-I-8-1	1	9/11/2003	86.2	0.03 U	0.00755 U
DB1-I-8wall-3	3	9/11/2003	20 U	0.03 U	0.00755 U
DB1-I-9-0.5	0.5	9/8/2003	105.5	0.09 U	0.02268 U
EX-A1-C-16-7	7	11/15/2007	23.3 U	0.0303 U	NA
EX-A1-C-16-NSW-3	3	11/15/2007	261	0.0301 U	0.00892
EX-A1-C-17-3	3	11/15/2007	213	0.06	0.0154
EX-A1-D-16-12	12	11/19/2007	23.6 U	0.0299 U	NA
EX-A1-D-17-12	12	11/15/2007	24.5 U	0.0294 U	NA
EX-A1-D-17-ESW-10	10	11/15/2007	22.8 U	0.0272 U	NA
EX-A1-D-17-ESW-5	5	11/15/2007	23 U	0.0316 U	NA
EX-A1-E-15-15	15	11/8/2007	24 U	0.0299 U	NA
EX-A1-E-16-15	15	11/8/2007	22.6 U	0.0279 U [0.0311 U]	NA [NA]
EX-A1-E-17-12	12	11/14/2007	23.7 U	0.0291 U	NA
EX-A1-E-17-ESW-4	4	11/15/2007	24 U	0.06	NA
EX-A1-F-15-15	15	11/8/2007	23.6 U	0.0270 U	NA
EX-A1-F-16-15	15	11/8/2007	23.3 U	0.14	NA
EX-A1-F-17-12	12	11/14/2007	24.1 U	0.0301 U	NA
EX-A1-F-17-3	3	10/29/2007	21.8 U	0.0267 U	NA
EX-A1-F-18-4	4	10/29/2007	1500 J	0.0979 [0.0591]	0.0432 [0.0441]
EX-A1-F-18-5	5	11/5/2007	22 U	0.0273 U [0.0291 U]	NA [NA]
EX-A1-G-15-15	15	11/8/2007	22.9 U	0.0289 U	NA
EX-A1-G-16-15	15	10/31/2007	23 U	0.04	NA
EX-A1-G-17-15	15	10/29/2007	23.5 U	0.0291 U	NA
EX-A1-H-15-15	15	11/8/2007	24.8 U	0.0291 U	NA
EX-A1-H-16-15	15	10/31/2007	23.1 U	0.0303 U	NA
EX-A1-H-17-15	15	10/29/2007	24.6 U	0.0298 U [0.0282 U]	NA [NA]
EX-A1-I-16-15	15	10/31/2007	24.2 U	0.0285 U	NA
EX-A1-I-17-15	15	10/29/2007	24.9 U	0.0317 U	NA
EX-A1-J-16-15	15	10/31/2007	24.8 U	0.0306 U	NA

Table 2: Samples Used to Calculate 95 Percent Upper Confidence Limits on the Means

Sample Identification (ID)	Sample Depth (feet bgs)	Sample Date	TPH (mg/kg)[1]	Benzene (mg/kg)[2]	Total cPAHs TEQ (mg/kg)[3]
EX-A1-J-17-15	15	10/29/2007	26.4 U	0.0316 U	NA
EX-A1-J-19-8	8	10/23/2007	24.6 U	0.0312 U	NA
EX-A1-K-17-15	15	10/30/2007	24.8 U	0.0308 U	NA
EX-A1-K-18-12	12	10/23/2007	22.8 U	0.0278 U	NA
EX-A1-K-18-SSW-3	3	10/30/2007	20.7 U	0.0282 U	NA
EX-A1-K-18-SSW-8	8	10/30/2007	22.3 U	0.0291 U	NA
EX-A1-K-19-3	3	10/30/2007	23 U	0.0322 U	NA
EX-A1-L-17-12	12	11/8/2007	22.9 U	0.12	NA
EX-A2-O-10-10	10	1/28/2008	119 J	0.0299 U	0.0239
EX-A2-O-11-10	10	1/28/2008	23 U	0.0270 U	NA
EX-A2-O-12-10	10	1/28/2008	25.3 U	0.0305 U	NA
EX-A2-O-13-10	10	1/28/2008	25.5 U	0.0351 U	NA
EX-A2-O-9-10	10	1/28/2008	852 J	0.369 U [0.344 U]	0.0515 [0.0484]
EX-A2-P-10-11	11	1/30/2008	25.2 U	0.0350 U	NA
EX-A2-P-11-11	11	1/30/2008	22.3 U	0.0301 U	NA
EX-A2-P-12-10	10	1/30/2008	62.7 J	0.0275 U	0.00921
EX-A2-P-13-10	10	1/30/2008	25.3 U	0.0318 U	NA
EX-A2-P-9-15	15	1/30/2008	23.5 U	0.0289 U	NA
EX-A2-Q-10-12	12	2/1/2008	23.9 U	0.0364 U	NA
EX-A2-Q-11-12	12	2/1/2008	24.4 U	0.0366 U	NA
EX-A2-Q-12-13	13	2/1/2008	24.1 U	0.0324 U	NA
EX-A2-Q-9-12	12	2/1/2008	23.4 U	0.0333 U	NA
EX-A2-R-10-12	12	2/15/2008	24.3 U	0.0422 U [0.0375 U]	NA [NA]
EX-A2-R-11-12	12	2/15/2008	28.2 U	0.0484 U	NA
EX-A2-R-12-12	12	2/15/2008	24.5 U	0.0380 U	NA
EX-A2-R-13-12	12	2/22/2008	26.7 U	0.0433 U	NA
EX-A2-S-12-12	12	2/22/2008	25.8 U	0.0406 U	NA
EX-A2-S-13-6	6	2/15/2008	932 J	0.0356 U	0.00861
EX-A3-AA-5-10	10	9/26/2007	23.9 U	0.0290 U	NA
EX-A3-AA-6-10	10	9/21/2007	21.6 U	0.0309 U	NA
EX-A3-AA-7-10	10	9/21/2007	24.7 U	0.0333 U	NA
EX-A3-AA-7-ESW-4	4	9/20/2007	24.8 U	0.0307 U	NA
EX-A3-BB-6-10	10	9/21/2007	24.7 U	0.0296 U [0.0299 U]	NA [NA]
EX-A3-BB-7-10	10	9/21/2007	23.4 U	0.07	NA
EX-A3-BB-7-ESW-4	4	9/21/2007	123	0.16	0.00997
EX-A3-CC-6-10	10	10/1/2007	28.7 J	2.76	NA
EX-A3-CC-7-10	10	10/1/2007	27.1	1.21 [1.73]	NA [NA]
EX-A3-CC-7-ESW-4	4	10/2/2007	156	0.11	0.00876
EX-A3-DD-6-10	10	10/2/2007	23.4 U	0.09	NA
EX-A3-Y-4-8	8	9/21/2007	19.9 U	0.0214 U	NA
EX-A3-Y-4-NSW-4	4	9/20/2007	317 J	0.0267 U	0.00868
EX-A3-Y-4-WSW-4	4	9/20/2007	19.1 U	0.0114 U	NA
EX-A3-Y-5-8	8	9/21/2007	20.4 U	0.0275 U	NA
EX-A3-Y-5-NSW-4	4	9/20/2007	252 J	0.0498 U	0.00880
EX-A3-Y-6-10	10	9/25/2007	26.6	0.39	NA
EX-A3-Y-6-NSW-4	4	9/20/2007	106 J	0.0232 U	0.00793
EX-A3-Z-4-10	10	9/21/2007	25.7	0.03	NA

Table 2: Samples Used to Calculate 95 Percent Upper Confidence Limits on the Means

Sample Identification (ID)	Sample Depth (feet bgs)	Sample Date	TPH (mg/kg)[1]	Benzene (mg/kg)[2]	Total cPAHs TEQ (mg/kg)[3]
EX-A3-Z-5-10	10	9/21/2007	22.6 U	0.0275 U	NA
EX-A3-Z-6-10	10	9/21/2007	37.4	0.19	0.00944
EX-A3-Z-7-10	10	9/21/2007	21.7 U	0.05	NA
EX-A3-Z-7-ESW-4	4	9/20/2007	20.2 U	0.0207 U	NA
EX-A4-F-9-9	9	10/17/2007	40.9	0.06	NA
EX-A4-F-9-ESW-4	4	10/17/2007	36.9	0.0349 U	0.0100
EX-A4-G-6-9	9	10/1/2007	24.8 U	0.0307 U	NA
EX-A4-G-7-9	9	9/27/2007	24.7 U	0.0295 U	NA
EX-A4-G-8-9	9	9/27/2007	23 U	0.0311 U	NA
EX-A4-G-9-9	9	10/17/2007	24.3 U	0.0295 U	NA
EX-A4-G-9-ESW-4	4	10/17/2007	87 J	0.0290 U [0.0283 U]	0.00853 [0.00868]
EX-A4-H-6-9	9	9/27/2007	24.2 U	0.0269 U [0.0295 U]	NA [NA]
EX-A4-H-7-9	9	9/27/2007	25.3 U	0.0318 U	NA
EX-A4-H-8-4	4	9/12/2007	2060 J	0.0286 U	0.0858
EX-A4-H-8-9	9	9/27/2007	24 U	0.09	NA
EX-A4-H-9-9	9	10/17/2007	33.1 U	0.32	NA
EX-A4-H-9-ESW-4	4	10/17/2007	256	0.0273 U	0.00861
EX-A4-I-6-9	9	9/21/2007	39.5 U	0.0565 U	NA
EX-A4-I-7-9	9	10/16/2007	24.3 U	0.0372 U	NA
EX-A4-I-8-9	9	10/16/2007	24.5 U	0.0396 U	NA
EX-A4-J-6-9	9	9/21/2007	23.6 U	0.0288 U	NA
EX-A4-J-6-SSW-9	9	9/21/2007	238	0.0304 U	0.0383
EX-A4-J-7-9	9	9/21/2007	23.8 U	0.0299 U	NA
EX-A4-J-7-SSW-4	4	9/21/2007	241	0.0342 U	0.0388
EX-A4-J-8-9	9	10/16/2007	23.7 U	0.0340 U	NA
EX-A4-K-8-9	9	10/16/2007	24.6 U	0.0367 U	NA
EX-AW-E-23-5(2)	5	9/17/2008	23.8 U	0.0363 U	NA
EX-AW-E-24-10	10	9/11/2008	45.6	0.0354 U	0.00891
EX-AW-E-24-NSW-5	5	9/11/2008	521 J	0.0363 U	0.00892
EX-AW-E-25-10	10	9/11/2008	122	0.0405 U	0.00982
EX-AW-E-25-ESW-5	5	9/11/2008	209 J	0.0327 U [0.0339 U]	0.00846 [0.00838]
EX-AW-E-25-NSW-5	5	9/11/2008	34.1	0.0373 U	0.00898
EX-AW-F-23-5(2)	5	9/12/2008	23.2 U	0.0339 U	NA
EX-AW-F-24-5	5	9/11/2008	31.1	0.0345 U	NA
EX-AW-F-25-5	5	9/11/2008	137 J	0.0277 U	0.0181
EX-AW-F-25-ESW-5	5	9/11/2008	79.7	0.0372 U	0.00846
EX-B10-N-6-10	10	2/8/2008	24.8 U	0.0361 U	NA
EX-B10-O-6-10	10	2/8/2008	24.5 U	0.0352 U	NA
EX-B10-O-7-12	12	1/16/2008	23.9 U	0.0302 U [0.0330 U]	NA [NA]
EX-B10-O-8-12	12	1/16/2008	24.9 U	0.0316 U	NA
EX-B10-P-6-10	10	2/8/2008	30.3	0.0400 U	NA
EX-B10-P-7-15	15	1/30/2008	32.7	0.0328 U	NA
EX-B10-P-8-15	15	1/30/2008	24 U	0.0322 U	NA
EX-B10-Q-6-11	11	2/8/2008	28.2	0.0343 U	NA
EX-B10-Q-7-15	15	1/30/2008	24.5 U	0.0309 U	NA
EX-B11-Q-8-14	14	1/30/2008	40.8 J	0.0306 U [0.0317]	0.00891 [NA]
EX-B11-R-6-5	5	2/8/2008	1860 J	0.0346 U [0.0340 U]	0.0224 [0.0258]

Table 2: Samples Used to Calculate 95 Percent Upper Confidence Limits on the Means

Sample Identification (ID)	Sample Depth (feet bgs)	Sample Date	TPH (mg/kg)[1]	Benzene (mg/kg)[2]	Total cPAHs TEQ (mg/kg)[3]
EX-B11-R-7-12	12	1/22/2008	23.5 U	0.03	NA
EX-B11-R-8-12	12	1/30/2008	34.6	0.03	NA
EX-B11-R-9-12	12	2/12/2008	23.3 U	0.06	NA
EX-B11-S-10-2	2	2/15/2008	25.7 U	0.0408 U	NA
EX-B11-S-11-12	12	2/14/2008	24.8 U	0.0398 U	NA
EX-B11-S-7-12	12	1/22/2008	27.2	0.04	NA
EX-B11-S-7-WSW-5	5	1/18/2008	21.5 U	0.0290 U	NA
EX-B11-S-8-12	12	1/30/2008	29.7	0.0287 U	NA
EX-B11-S-9-12	12	2/12/2008	122 J	0.04	0.00929
EX-B11-T-10-10	10	2/14/2008	24.3 U	0.0342 U	NA
EX-B11-T-11-12	12	2/14/2008	23 U	0.0306 U	NA
EX-B11-T-11-ESW-6	6	2/15/2008	25.1 U	0.0382 U	NA
EX-B11-T-7-12	12	1/22/2008	116 J	0.03	0.00891
EX-B11-T-7-WSW-5	5	1/18/2008	29 J	0.0290 U	NA
EX-B11-T-8-12	12	1/30/2008	27.4	0.23	NA
EX-B11-T-9-12	12	2/12/2008	25.1 U	0.19	NA
EX-B11-U-11-5	5	2/12/2008	563 J	0.0429 U	0.0260
EX-B11-U-7-5	5	1/18/2008	21.7 U	0.0290 U	NA
EX-B13-AA-2-10	10	9/26/2007	34.6	0.03	NA
EX-B13-AA-2-NSW-4	4	9/19/2007	139	0.0306 U	0.0126
EX-B13-AA-2-WSW-4	4	9/19/2007	21.8 U	0.0303 U	NA
EX-B13-AA-3-10	10	9/26/2007	25.2 U	0.0322 U	NA
EX-B13-AA-3-NSW-4	4	9/19/2007	20.6 U	0.0265 U	NA
EX-B13-AA-4-10	10	9/26/2007	23.1 U	0.0313 U	NA
EX-B13-BB-2-10	10	9/25/2007	23.5 U	0.0336 U	NA
EX-B13-BB-2-WSW-4	4	9/19/2007	1910 J	0.48	0.0335
EX-B13-BB-3-10	10	9/25/2007	21.2 U	0.0281 U [0.0319 U]	NA [NA]
EX-B13-BB-4-10	10	9/25/2007	24.6 U	0.0283 U	NA
EX-B13-BB-5-10	10	9/27/2007	22.4 U	0.0295 U	NA
EX-B13-CC-1-4	4	10/10/2007	52.4	0.0432 U	NA
EX-B13-CC-2-10	10	10/8/2007	22 U	0.0278 U	NA
EX-B13-CC-3-10	10	9/27/2007	23.5 U	0.0285 U	NA
EX-B13-CC-4-10	10	9/27/2007	23.4 U	0.0279 U	NA
EX-B13-CC-5-10	10	9/27/2007	24.3 U	0.0299 U	NA
EX-B13-DD-1-4	4	10/8/2007	29.1 U	0.0408 U	NA
EX-B13-DD-2-10	10	10/8/2007	23.1 U	0.0291 U	NA
EX-B13-DD-3-10	10	10/2/2007	21.8 U	0.0279 U	NA
EX-B13-DD-4-10	10	10/2/2007	25	0.17	NA
EX-B13-DD-5-10	10	10/2/2007	22.5 U	0.06	NA
EX-B13-EE-1-4	4	10/8/2007	23.7 U	0.0283 U	NA
EX-B13-EE-2-10	10	10/8/2007	22.5 U	0.0272 U	NA
EX-B13-EE-3-10	10	10/5/2007	22.6 U	0.0298 U	NA
EX-B13-EE-3-SSW-4	4	10/5/2007	28.3	0.05	NA
EX-B13-EE-4-10	10	10/5/2007	21.9 U	0.0296 U [0.0292 U]	NA [NA]
EX-B13-EE-4-SSW-4	4	10/5/2007	24.7 U	0.0314 U	NA
EX-B13-FF-2-4	4	10/9/2007	24.9 U	0.0302 U	NA
EX-B13-FF-3-10	10	10/9/2007	28.7	0.04	NA

Table 2: Samples Used to Calculate 95 Percent Upper Confidence Limits on the Means

Sample Identification (ID)	Sample Depth (feet bgs)	Sample Date	TPH (mg/kg)[1]	Benzene (mg/kg)[2]	Total cPAHs TEQ (mg/kg)[3]
EX-B13-FF-3-ESW-4	4	10/9/2007	24.7 U	0.0289 U	NA
EX-B13-GG-3-4	4	10/9/2007	24.9 U	0.14	NA
EX-B14-DD-7-2.5	2.5	8/23/2007	304	1.85	0.0121
EX-B14-DD-8-6	6	9/4/2007	160 J	0.0999 [0.0912]	0.00945 [0.00929]
EX-B14-DD-NSW-2.5	2.5	8/23/2007	350 J	0.0885 J [1.32 J]	0.0112 [0.0244]
EX-B14-EE-5-4	4	9/10/2007	466 J	0.40	NA
EX-B14-EE-6-8	8	9/10/2007	23.2 U	0.24	NA
EX-B14-EE-7-8	8	8/23/2007	36.1 U	0.0581 U	NA
EX-B14-EE-8-4	4	8/23/2007	24.7 U	0.26	NA
EX-B14-FF-6-4	4	9/7/2007	27.6	0.21	NA
EX-B14-FF-7-8	8	8/23/2007	41.6 U	0.0763 U	NA
EX-B14-FF-8-4SW	4	8/22/2007	671	0.0505 U	0.0119
EX-B14-FF-WSW-4	4	8/23/2007	115	0.10	0.0107
EX-B14-GG-7-8	8	8/23/2007	23.5 U	0.0266 U	NA
EX-B14-GG-WSW-4	4	8/23/2007	575	0.0275 U	0.0218
EX-B14-HH-6-4	4	8/23/2007	137	0.0302 U [0.0285 U]	0.0107 [0.0107]
EX-B14-HH-6F	6	8/23/2007	55.2	0.0260 U	0.0110
EX-B14-HH-7-4SW	4	8/23/2007	53.5 J	0.0277 U	0.0117
EX-B15-HH-2-4	4	8/28/2007	25.9 U	0.09	NA
EX-B15-HH-3-ESW-4	4	8/28/2007	23.5 U	0.0319 U	NA
EX-B15-HH-3-NSW-4	4	8/28/2007	25.4 U	0.36	NA
EX-B15-II-2-8	8	8/28/2007	39.5	0.06	NA
EX-B15-II-2-WSW-4	4	8/28/2007	51.9	1.10	NA
EX-B15-II-3-8	8	8/28/2007	22.6 U	0.0264 U	NA
EX-B15-II-4-ESW-4	4	8/28/2007	1040 J	0.0316 U	0.0115
EX-B16-MM-1-6SW	6	8/20/2007	1030 J	0.305 U	0.00911
EX-B17-RR-1-6SW	6	8/20/2007	128 J	0.0488 U	0.0113
EX-B17-SS-1-6SW	6	8/20/2007	23.3 U	0.0270 U	NA
EX-B18-UU-1-6SW	6	8/17/2007	1910 J	0.290 U [0.288 U]	0.0435 [0.0103]
EX-B18-VV-1-6SW	6	8/17/2007	4980 J	1.56 U	0.0457
EX-B1-C-46-4(2)	4	9/2/2008	142 J	0.0302 U	NA
EX-B1-C-47-4	4	8/8/2008	411 J	0.0309 U	0.0414 U
EX-B1-D-43-4	4	8/19/2008	2020 J	4.39	NA
EX-B1-D-44-12	12	8/18/2008	65.9	0.121 U	0.0369 U
EX-B1-D-44-NSW-4(2)	4	9/2/2008	287	0.05	0.0188
EX-B1-D-45-12	12	8/14/2008	102 J	0.224 [0.0598 U]	NA [NA]
EX-B1-D-45-NSW-4	4	9/2/2008	100 J	0.0316 U	0.0152
EX-B1-D-46-12	12	8/11/2008	237 J	0.113 U	0.0431
EX-B1-D-47-4	4	8/8/2008	277 J	0.0349 U	0.123
EX-B1-E-41-8	8	8/27/2008	336	0.0325 U	0.0205
EX-B1-E-41-NSW-4	4	8/27/2008	26.3	0.0314 U	NA
EX-B1-E-42-8	8	8/27/2008	265	0.0327 U	0.0172
EX-B1-E-42-NSW-4	4	8/27/2008	383	0.16	0.0714
EX-B1-E-43-12	12	8/21/2008	93 U	0.259 U	NA
EX-B1-E-44-12	12	8/19/2008	60.9 U	0.143 U	NA
EX-B1-E-45-12	12	8/14/2008	43.6 U	0.106 U	NA
EX-B1-E-46-12	12	8/13/2008	51.4 U	0.133 U	NA

Table 2: Samples Used to Calculate 95 Percent Upper Confidence Limits on the Means

Sample Identification (ID)	Sample Depth (feet bgs)	Sample Date	TPH (mg/kg)[1]	Benzene (mg/kg)[2]	Total cPAHs TEQ (mg/kg)[3]
EX-B1-E-47-4	4	8/8/2008	37.4	0.0336 U	0.0172
EX-B1-E-47-SSW-4(2)	4	9/2/2008	21.2 U	0.0280 U	NA
EX-B1-F-42-8	8	8/27/2008	270	0.0332 U	0.0165
EX-B1-F-42-SSW-4	4	8/27/2008	21.2 U	0.0327 U [0.0306 U]	NA [NA]
EX-B1-F-43-4	4	8/21/2008	542 J	0.0288 U	0.0184
EX-B1-F-45-10	10	8/15/2008	35 U	0.0671 U	NA
EX-B1-F-45-SSW-4	4	8/18/2008	232 J	0.0296 U	0.0719
EX-B1-F-47-4(2)	4	9/2/2008	21.5 U	0.0291 U	NA
EX-B20-F-19-6	6	10/18/2007	44.8	0.05	NA
EX-B20-F-19-NSW-3	3	10/26/2007	21.7 U	0.0271 U	NA
EX-B20-F-20-10	10	10/30/2007	71.4	0.0290 U	0.0230
EX-B20-F-20-NSW-4	4	10/30/2007	21.8 U	0.0286 U [0.0292 U]	NA [NA]
EX-B20-F-21-4	4	10/17/2007	23.6 U	0.0316 U	NA
EX-B20-G-13-12	12	11/26/2007	116 J	0.0268 U	0.00823
EX-B20-G-14-12	12	11/20/2007	23.6 U	0.0292 U	NA
EX-B20-G-14-WSW-4	4	11/20/2007	83.9	0.0299 U	0.00815
EX-B20-G-18-15	15	10/18/2007	23.7 U	0.0276 U	NA
EX-B20-G-19-15	15	10/18/2007	24.2 U	0.0377 U	NA
EX-B20-G-20-15	15	10/18/2007	23 U	0.04	NA
EX-B20-G-21-10	10	10/17/2007	1200 J	0.271 U	0.00944
EX-B20-G-21-ESW-5	5	10/26/2007	52.9	0.0273 U	0.00891
EX-B20-H-10-4	4	11/30/2007	345	0.0291 U	0.00858
EX-B20-H-11-4	4	11/29/2007	21.7 U	0.0298 U	NA
EX-B20-H-12-6	6	11/29/2007	52	0.0284 U [0.0291 U]	0.00823 [0.00831]
EX-B20-H-12-NSW-2	2	11/29/2007	22 U	0.0262 U	NA
EX-B20-H-13-12	12	11/26/2007	24.3 U	0.0330 U	NA
EX-B20-H-14-12	12	11/20/2007	89.4	0.0319 U	0.00959
EX-B20-H-14-WSW-4	4	11/20/2007	43.7	0.0277 U [0.0306 U]	0.00876 [0.00846]
EX-B20-H-18-15	15	10/18/2007	23.9 U	0.0299 U [0.0301 U]	NA [NA]
EX-B20-H-19-15	15	10/18/2007	23.5 U	0.0276 U	NA
EX-B20-H-20-15	15	10/18/2007	34.7	0.11	NA
EX-B20-H-21-10	10	10/18/2007	584	0.0683 U	0.0153
EX-B20-H-21-ESW-5	5	10/26/2007	80.4 J	0.0271 U	0.00891
EX-B20-I-10-10	10	11/29/2007	24.8 U	0.0308 U	NA
EX-B20-I-11-10	10	11/29/2007	29.3	0.0329 U	NA
EX-B20-I-11-NSW-6	6	11/29/2007	82.9 J	0.0299 U	0.00815
EX-B20-I-12-10	10	11/29/2007	27.6	0.0296 U	NA
EX-B20-I-13-12	12	11/26/2007	23 U	0.0291 U	NA
EX-B20-I-14-12	12	11/20/2007	25.4 U	0.0314 U	NA
EX-B20-I-15-15	15	11/5/2007	26.4 U	0.0315 U	NA
EX-B20-I-18-15	15	10/19/2007	24.6 U	0.04	NA
EX-B20-I-19-15	15	10/18/2007	26.3 U	0.0361 U [0.0326 U]	NA [NA]
EX-B20-I-20-8	8	10/18/2007	24.7 U	0.0303 U	NA
EX-B20-I-21-4	4	10/30/2007	92.3 J	0.0254 U	0.0231
EX-B20-I-9-9	9	10/17/2007	31 U	0.0440 U	NA
EX-B20-J-10-10	10	11/29/2007	40.4	0.0340 U	NA
EX-B20-J-11-11	11	12/13/2007	24.6 U	0.0301 U	NA

Table 2: Samples Used to Calculate 95 Percent Upper Confidence Limits on the Means

Sample Identification (ID)	Sample Depth (feet bgs)	Sample Date	TPH (mg/kg)[1]	Benzene (mg/kg)[2]	Total cPAHs TEQ (mg/kg)[3]
EX-B20-J-12-10	10	11/28/2007	24.2 U	0.03	NA
EX-B20-J-13-12	12	11/26/2007	23.8 U	0.0304 U	NA
EX-B20-J-14-12	12	11/20/2007	46.8	0.0302 U	0.00891
EX-B20-J-15-15	15	11/5/2007	25.9 U	0.0346 U	NA
EX-B20-J-18-15	15	10/19/2007	23.8 U	0.0293 U	NA
EX-B20-J-20-4	4	10/30/2007	34.3	0.0355 U	NA
EX-B20-J-9-9	9	10/17/2007	64.8 J	0.0310 U	0.00906
EX-B20-K-10-10	10	11/30/2007	25.2 U	0.0315 U	NA
EX-B20-K-11-10	10	11/29/2007	24.1 U	0.0290 U	NA
EX-B20-K-12-12	12	11/29/2007	25 U	0.0310 U	NA
EX-B20-K-13-12	12	11/26/2007	25.5 U	0.0305 U	NA
EX-B20-K-14-12	12	11/20/2007	23.9 U	0.0283 U	NA
EX-B20-K-15-15	15	11/5/2007	23.7 U	0.0282 U	NA
EX-B20-K-16-15	15	10/31/2007	24 U	0.0279 U	NA
EX-B20-K-7-5	5	1/10/2008	122 J	0.0349 U	0.00936
EX-B20-K-9-9	9	10/16/2007	29.8	0.0385 U	NA
EX-B20-L-10-10	10	11/30/2007	24.6 U	0.0310 U	NA
EX-B20-L-11-10	10	12/7/2007	25.6 U	0.0322 U	NA
EX-B20-L-12-12	12	11/29/2007	23.9 U	0.0321 U	NA
EX-B20-L-13-12	12	11/26/2007	24.9 U	0.0295 U	NA
EX-B20-L-14-12	12	11/20/2007	23.8 U	0.0292 U	NA
EX-B20-L-15-15	15	11/5/2007	23.9 U	0.0282 U	NA
EX-B20-L-16-15	15	10/31/2007	24.7 U	0.0297 U	NA
EX-B20-L-7-5	5	2/8/2008	191 J	0.0256 U	0.00956
EX-B20-L-8-10	10	12/11/2007	30	0.0337 U	NA
EX-B20-L-8-WSW5	5	1/7/2008	392 J	0.0410 [0.0430]	0.0104 [0.00973]
EX-B20-L-9-10	10	12/11/2007	25 U	0.0320 U	NA
EX-B20-M-10-12	12	12/7/2007	30.6	0.04	NA
EX-B20-M-11-12	12	12/7/2007	24.8 U	0.0314 U	NA
EX-B20-M-12-12	12	12/7/2007	21.8 U	0.0299 U [0.0310 U]	NA [NA]
EX-B20-M-13-14	14	12/7/2007	26.9 U	0.0332 U	NA
EX-B20-M-14-11	11	12/7/2007	23.4 U	0.0306 U	NA
EX-B20-M-15-11	11	12/7/2007	22.8 U	0.0316 U	NA
EX-B20-M-7-10	10	2/8/2008	24.1 U	0.0376 U	NA
EX-B20-M-8-12	12	1/16/2008	30.1	0.0297 U	NA
EX-B20-M-9-12	12	1/16/2008	31.4	0.0319 U	NA
EX-B20-N-10-12	12	1/8/2008	22.9 U	0.0292 U	NA
EX-B20-N-11-12	12	1/8/2008	26.7	0.0292 U	NA
EX-B20-N-12-12	12	1/8/2008	23.3 U	0.0282 U	NA
EX-B20-N-13-12	12	1/8/2008	24.3 U	0.0310 U	NA
EX-B20-N-14-12	12	12/11/2007	24.1 U	0.0308 U	NA
EX-B20-N-7-8	8	1/16/2008	29.1	0.0324 U	NA
EX-B20-N-7-WSW-4	4	1/16/2008	307 J	0.0293 U	0.0152
EX-B20-N-8-12	12	1/16/2008	25 U	0.0318 U	NA
EX-B20-N-9-12	12	1/16/2008	24.7 U	0.0313 U	NA
EX-B21-ESW-2	2	10/11/2007	22.2 U	0.0354 U	NA
EX-B21-FLOOR-4	4	10/11/2007	23.2 U	0.0303 U	NA

Table 2: Samples Used to Calculate 95 Percent Upper Confidence Limits on the Means

Sample Identification (ID)	Sample Depth (feet bgs)	Sample Date	TPH (mg/kg)[1]	Benzene (mg/kg)[2]	Total cPAHs TEQ (mg/kg)[3]
EX-B21-NSW-2	2	10/11/2007	59.5 J	0.0300 U	0.00883
EX-B2-E-33(2)-6	6	2/27/2008	354 J	0.0345 U	0.00872
EX-B2-E-33-6	6	2/25/2008	224 J	0.0326 U	0.00883
EX-B2-E-34-6	6	2/25/2008	187 J	0.0331 U	0.00923
EX-B2-E-35(3)-6	6	3/5/2008	1590 J	0.0370 U	0.0993
EX-B2-E-35-6	6	2/22/2008	2020 J	0.0336 U	0.117
EX-B2-E-36-6	6	2/27/2008	577 J	0.0420 U	0.0243
EX-B2-E-40-4	4	1/23/2008	100 J	0.0313 U	0.00922
EX-B2-E-41(2)-5	5	2/4/2008	1020 J	0.0289 U	0.0879
EX-B2-E-41-4	4	1/23/2008	403 J	0.0262 U [0.0264 U]	0.0528 [0.120]
EX-B2-F-32-12	12	3/3/2008	45 U	0.108 U	NA
EX-B2-F-33-12	12	2/28/2008	33 U	0.0656 U [0.0670 U]	NA [NA]
EX-B2-F-34-11	11	2/28/2008	32.5 U	0.0603 U	NA
EX-B2-F-35-12	12	2/25/2008	37.8 U	0.105 U	NA
EX-B2-F-36-13	13	2/22/2008	443	0.0790 U	0.0205
EX-B2-F-36-NSW-6	6	2/22/2008	356 J	0.0409 U	0.0305
EX-B2-F-37-13	13	2/22/2008	35.5 U	0.0705 U	NA
EX-B2-F-37-NSW-6	6	2/22/2008	64.4	0.0378 U	0.00929
EX-B2-F-38(2)-14	14	2/6/2008	31.5 U	0.0570 U	NA
EX-B2-F-38-8	8	1/31/2008	1930 J	0.0357 U	0.111
EX-B2-F-38-NSW(2)-5	5	2/6/2008	680 J	0.0350 J	0.0317
EX-B2-F-38-NSW(2)-6	6	3/5/2008	606 J	0.0307 U	0.0339
EX-B2-F-38-NSW-4	4	1/31/2008	61 J	0.0295 U [0.0212 U]	0.00831 [0.0287]
EX-B2-F-38-WSW-5	5	1/31/2008	173 J	0.0291 U	0.00909
EX-B2-F-39(2)-12	12	2/5/2008	31.4 U	0.0580 U	NA
EX-B2-F-39-8	8	1/28/2008	1270 J	0.0290 U [0.0287 U]	0.0894 [0.00886]
EX-B2-F-39-NSW-4	4	1/28/2008	56.3	0.0308 U	0.00853
EX-B2-F-40-8	8	1/25/2008	117	0.17	0.00914
EX-B2-F-41-8	8	1/23/2008	194 J	0.0288 U	0.00847
EX-B2-F-41-ESW(2)-5	5	2/4/2008	1120	3.30	0.0753
EX-B2-G-32-6	6	2/26/2008	2400 J	0.139 J	0.00959
EX-B2-G-33(2)-6	6	2/28/2008	60.3 J	0.0340 U	0.00891
EX-B2-G-34-10	10	2/25/2008	21.9 U	0.0308 U	NA
EX-B2-G-34-SSW-6	6	2/25/2008	75.9 J	0.0429 U	0.0323
EX-B2-G-35-10	10	2/22/2008	49.2 U	0.119 U	NA
EX-B2-G-35-SSW-6	6	2/22/2008	180 J	0.0361 U [0.0404 U]	0.0167 [0.0474]
EX-B2-G-36-12	12	2/22/2008	57.9	0.0423 U	0.0240
EX-B2-G-37-13	13	2/22/2008	25.9 U	0.0414 U	NA
EX-B2-G-38(2)-13	13	2/6/2008	23.5 U	0.0332 U	NA
EX-B2-G-38-8	8	1/31/2008	1440 J	0.0279 U	0.0702
EX-B2-G-38-WSW-5	5	1/31/2008	1070 J	0.0305 U	0.0516
EX-B2-G-39(2)-11	11	2/5/2008	42	0.0662 U	NA
EX-B2-G-39-SSW-4	4	1/28/2008	57.4	0.0271 U	0.00861
EX-B2-G-40-8	8	1/25/2008	106	0.0317 U	0.00883
EX-B2-G-40-SSW-4	4	1/25/2008	57.3	0.0287 U	0.00906
EX-B2-G-41-8	8	1/24/2008	296 J	0.0354 U	0.00891
EX-B2-G-41-ESW-4	4	1/24/2008	802	0.0356 U	0.0415

Table 2: Samples Used to Calculate 95 Percent Upper Confidence Limits on the Means

Sample Identification (ID)	Sample Depth (feet bgs)	Sample Date	TPH (mg/kg)[1]	Benzene (mg/kg)[2]	Total cPAHs TEQ (mg/kg)[3]
EX-B2-G-41-SSW-4	4	1/24/2008	80	0.0341 U	0.00853
EX-B2-H-35-6	6	2/27/2008	101	0.0833 U	0.0123
EX-B2-H-36-6	6	2/22/2008	771 J	0.0426 U	0.0225
EX-B2-H-37(2)-6	6	3/5/2008	900 J	0.0349 U	0.00868
EX-B2-H-38(2)-10	10	2/6/2008	22.1 U	0.0293 U	NA
EX-B2-H-38-WSW(2)-5	5	2/6/2008	231 J	0.0329 U	0.0160
EX-B3-E-32-6	6	2/26/2008	27.1 U	0.0474 U	NA
EX-B3-F-31-12	12	3/10/2008	31.5 U	0.0604 U	NA
EX-B3-F-31-NSW-6	6	3/10/2008	31.2	0.0306 U	0.00891
EX-B3-G-29-5	5	3/11/2008	23.1 U	0.0356 U	NA
EX-B3-G-29-NSW-4	4	3/11/2008	191 J	0.0313 U	0.0300
EX-B3-G-29-SSW-5	5	3/11/2008	22.7 U	0.0377 U [0.0345 U]	NA [NA]
EX-B3-G-30-12	12	3/11/2008	23.8 U	0.0352 U	NA
EX-B3-G-30-NSW-6	6	3/11/2008	302 J	0.11	0.0184
EX-B3-G-30-SSW-6	6	3/10/2008	22.8 U	0.0322 U	NA
EX-B3-G-31-12	12	3/10/2008	25 U	0.0368 U	NA
EX-B3-G-31-SSW-6	6	3/10/2008	49	0.0427 U	NA
EX-B4-B-23-6	6	2/25/2008	31.9 J	0.0297 U [0.0321 U]	0.0145 [NA]
EX-B4-B-24-6	6	2/25/2008	24.3 U	0.0366 U	NA
EX-B5-B-20(2)-4	4	2/28/2008	24.2 U	0.0354 U	NA
EX-B5-B-20-4	4	2/22/2008	1070	0.0363 U	0.111
EX-B6-C-15-3	3	11/19/2007	24.8 U	0.0335 U	NA
EX-B6-D-13-3	3	11/19/2007	87.6	0.0269 U	0.00846
EX-B6-D-14-10	10	11/19/2007	27.7	0.0321 U	NA
EX-B6-D-14-NSW-3	3	11/19/2007	29.3 U	0.0369 U	NA
EX-B6-D-15-12	12	11/19/2007	27.9	0.0332 U [0.0323 U]	NA [NA]
EX-B6-E-13-4	4	11/19/2007	261 J	0.0261 U [0.0270 U]	0.00853 [0.00853]
EX-B6-E-14-10	10	11/19/2007	23.8 U	0.0312 U	NA
EX-B6-F-14-10	10	11/19/2007	24.6 U	0.0302 U	NA
EX-B6-F-14-WSW-3	3	11/19/2007	58.7	0.0275 U	0.00846
EX-B8-G-4-9	9	10/1/2007	36	0.0308 U	0.00921
EX-B8-G-4-WSW-4	4	10/1/2007	384 J	0.0271 U	0.0808
EX-B8-G-5-9	9	10/1/2007	25.9 U	0.0319 U	NA
EX-B8-H-3-10	10	9/10/2008	24.6 U	0.0385 U	NA
EX-B8-H-3-NSW-5	5	9/10/2008	39.3	0.0322 U	0.0266
EX-B8-H-3-WSW-5	5	9/10/2008	404 J	0.0427 U	0.0439
EX-B8-H-4-9	9	10/1/2007	23.6 U	0.0324 U	NA
EX-B8-H-5-9	9	10/1/2007	24.2 U	0.0353 U	NA
EX-B8-I-3-10	10	9/10/2008	25.1 U	0.0412 U	NA
EX-B8-I-3-WSW-5(2)	5	9/11/2008	710	0.0525 U	0.0589
EX-B8-I-4-9	9	10/1/2007	23.8 U	0.08	NA
EX-B8-I-5-9	9	10/1/2007	23.6 U	0.0292 U	NA
EX-B8-J-3-10	10	9/10/2008	23.7 U	0.0369 U	NA
EX-B8-J-3-SSW-5	5	9/10/2008	653 J	0.0302 U [0.0338 U]	0.00793 U [0.00793 U]
EX-B8-J-3-WSW-5	5	9/10/2008	551 J	0.0302 U	0.00800 U

Table 2: Samples Used to Calculate 95 Percent Upper Confidence Limits on the Means

Sample Identification (ID)	Sample Depth (feet bgs)	Sample Date	TPH (mg/kg)[1]	Benzene (mg/kg)[2]	Total cPAHs TEQ (mg/kg)[3]
EX-B8-J-4-5	5	10/23/2007	315	0.0251 U	0.0170
EX-B8-J-4-SSW-2.5	2.5	10/23/2007	21.9 U	0.0331 U	NA
EX-B8-J-5-4	4	10/1/2007	82 J	0.0272 U	0.00831
EX-B8-J-5-9	9	10/1/2007	22.9 U	0.0366 U	NA
EX-B9-M-4-11	11	2/20/2008	23 U	0.0315 U	NA
EX-B9-M-4-NSW-6	6	2/19/2008	1410 J	0.329 U	0.00907
EX-B9-M-4-WSW-6	6	2/19/2008	1420 J	0.336 U	0.0173
EX-B9-M-5-11	11	2/19/2008	26.2 U	0.0411 U	NA
EX-B9-M-5-NSW-6	6	2/19/2008	167 J	0.0285 U	0.00823
EX-B9-M-6-11	11	2/19/2008	25 U	0.0364 U [0.0453 U]	NA [NA]
EX-B9-M-6-NSW-6	6	2/19/2008	39	0.0383 U	NA
EX-B9-N-3-5	5	9/9/2008	21.6 U	0.0331 U	NA
EX-B9-N-4-11	11	2/20/2008	24.1 U	0.0349 U	NA
EX-B9-N-4-WSW-6	6	2/20/2008	543 J	0.0338 U	0.00891
EX-B9-N-5-12	12	2/13/2008	23.6 U	0.0343 U	NA
EX-B9-O-3-10	10	9/9/2008	30.1	0.0353 U	NA
EX-B9-O-3-WSW-5	5	9/9/2008	21 U	0.0322 U	NA
EX-B9-O-4-12	12	2/20/2008	41.7	0.0373 U [0.0373 U]	NA [NA]
EX-B9-O-4-WSW-6	6	2/20/2008	88.4 J	0.0322 U	0.00800
EX-B9-O-5-12	12	2/13/2008	23.8 U	0.0365 U [0.0354 U]	NA [NA]
EX-B9-P-3-10	10	9/9/2008	32.4	0.0360 U	NA
EX-B9-P-3-SSW-5	5	9/9/2008	21.2 U	0.0320 U	NA
EX-B9-P-3-WSW-5	5	9/9/2008	20.8 U	0.0327 U	NA
EX-B9-P-4-12	12	2/20/2008	30.2	0.0396 U	NA
EX-B9-P-4-SSW(2)-6	6	2/25/2008	1510 J	0.332 U	0.0194
EX-B9-P-4-SSW-6	6	2/20/2008	2580 J	0.295 U	0.0316
EX-B9-P-4-WSW-6	6	2/20/2008	23.4 U	0.0333 U	NA
EX-B9-P-5-12	12	2/13/2008	22.9 U	0.0315 U	NA
EX-B9-Q-5-6	6	2/13/2008	93.4	0.0175 U	0.0145
EX-RRT-ZZ-2-4	4	8/1/2008	46.9	0.0552 U	NA
EX-RRT-ZZ-2-ESW-3	3	8/1/2008	78.2 J	0.0800 U	NA
EX-SDTI-5-NSW-4	4	8/22/2007	25 U	0.0320 U	NA
EX-SDTI-5-SSW-4	4	8/22/2007	25.6 U	0.0344 U	NA
EX-SDTI-ESW-4	4	8/22/2007	51.2	0.0400 U	0.0107
EX-SDTI-FF-S-8	8	8/22/2007	99.8	0.0333 U	0.00951
EX-SDTI-GG-ESW-4	4	8/22/2007	24 U	0.0304 U	NA
EX-SDTI-GG-S-8	8	8/22/2007	50.8	0.0286 U	0.00936
EX-SDTI-GG-WSW-4	4	8/22/2007	55.2	0.0322 U	0.00929
EX-SDTI-WSW-4	4	8/22/2007	30.8	0.08	NA
EX-WW-G-27-2SW	2	8/7/2007	67 J	0.0287 U	0.00924
EX-WW-G-27-4	4	8/7/2007	21.6 U	0.0299 U	NA
EX-WW-H-27-2.5	2.5	8/7/2007	79.6 J	0.0384 U	0.0321
EX-WW-H-28-2	2	8/7/2007	95.6 J	0.0294 U	0.00891
EX-WW-H-29-1	1	8/7/2007	101 J	0.0335 U	0.00808
EX-WW-I-26-1	1	8/7/2007	58.7 J	0.0254 U	0.00934
ISP-E-17-2	2	9/17/2008	20.8 U	0.0310 U	NA
ISP-E-18-2	2	9/17/2008	31.7	0.0312 U	0.0248

Table 2: Samples Used to Calculate 95 Percent Upper Confidence Limits on the Means

Sample Identification (ID)	Sample Depth (feet bgs)	Sample Date	TPH (mg/kg)[1]	Benzene (mg/kg)[2]	Total cPAHs TEQ (mg/kg)[3]
ISP-E-19-2	2	9/22/2008	96.9 J	0.0337 U	0.00868 U
ISP-E-20-2	2	9/22/2008	180 J	0.0333 U	0.0212
ISP-E-21-2	2	9/22/2008	55.6 J	0.0318 U	0.00850
ISP-F-17-2	2	9/17/2008	20.9 U	0.0319 U	NA
ISP-F-18-2	2	9/17/2008	64.1	0.0267 U	0.0170
ISP-F-19-2	2	9/22/2008	30.8	0.0329 U	0.0523
ISP-F-20-2	2	9/22/2008	28.1	0.0351 U	0.0498
ISP-F-21-2	2	9/22/2008	22.1 U	0.0344 U	NA
ISP-G-17-2	2	9/17/2008	20.9 U	0.0314 U	NA
ISP-G-18-2	2	9/17/2008	21.1 U	0.0314 U	NA
ISP-G-19-2(2)	2	9/25/2008	135	0.0344 U	0.0161
ISP-G-20-2	2	9/22/2008	27.7	0.0328 U	0.00823 U
ISP-G-21-2	2	9/22/2008	118 J	0.0322 U	0.0335
MW-129R-4.5	4.5	10/14/2008	1030 J	0.0303 U	0.0439
MW-129R-7.0	7	10/14/2008	3010	0.0446 U	0.0479 U
MW-502-6.0	6	10/14/2008	23.1 U	0.0337 U	NA
MW-511-8.5	8.5	10/14/2008	23.2 U	0.0378 U [0.0361 U]	NA [NA]
MW-527-12	12	6/22/2012	716	0.11 U W	NA
MW-527-13.5	13.5	6/22/2012	1620.5	0.11 U W	NA
MW-527-17	17	6/22/2012	15.45 U	0.068 U W	NA
MW-527-8	8	6/14/2012	352.4	0.02	NA
MW-527-9	9	6/22/2012	635.5	0.053 U W	NA
MW-528-15	15	6/22/2012	440	0.025 U W	NA
MW-528-17	17	6/22/2012	11.4 U	0.08	NA
MW-528-8	8	6/14/2012	26.55	0.02	NA
RRT-YY-2-6	6	8/4/2008	76.3 J	0.105 U	NA
RRT-YY-2-WSW-3	3	8/4/2008	63.3 J	0.0397 U [0.0357 U]	0.00808 U [0.00808 U]
RRT-ZZ-2-NSW-3	3	8/4/2008	93.5 J	0.0349 U	0.00853 U
RRT-ZZ-3-NSW-3	3	8/4/2008	23.8 U	0.0382 U	NA
SB-10-11.0	11	4/4/2008	23.2 U	0.0341 U [0.0350 U]	NA [NA]
SB-1-11.5	11.5	4/3/2008	22.5 U	0.0304 U	NA
SB-11-11.0	11	4/4/2008	29.5 U	0.0556 U	NA
SB-12-11.5	11.5	4/4/2008	24.1 U	0.0348 U	NA
SB-13-11	11	4/11/2008	26.8 U	0.0465 U	NA
SB-14-11	11	4/11/2008	25 U	0.0385 U	NA
SB-15-10.5	10.5	4/14/2008	23.9 U	0.0354 U [0.0366 U]	NA [NA]
SB-16-9.5	9.5	4/14/2008	21.9 U	0.0312 U	NA
SB-17-11.5	11.5	4/14/2008	23.3 U	0.0321 U	NA
SB-18-11	11	4/11/2008	1410 J	0.71	0.00842
SB-19-12	12	4/11/2008	22.5 U	0.0292 U	NA
SB-20-9.5	9.5	4/14/2008	23.3 U	0.0323 U	NA
SB-2-11	11	4/3/2008	32.4 U	0.0609 U	NA
SB-21-10.5	10.5	4/14/2008	24.4 U	0.0348 U	NA
SB-22-10	10	4/11/2008	24.5 U	0.0371 U [0.0371 U]	NA [NA]
SB-23-11	11	4/11/2008	24.3 U	0.0357 U	NA

Table 2: Samples Used to Calculate 95 Percent Upper Confidence Limits on the Means

Sample Identification (ID)	Sample Depth (feet bgs)	Sample Date	TPH (mg/kg)[1]	Benzene (mg/kg)[2]	Total cPAHs TEQ (mg/kg)[3]
SB-24-10	10	4/11/2008	25.9 U	0.0398 U	NA
SB-25-11	11	4/11/2008	24 U	0.0359 U	NA
SB-26-10.5	10.5	4/14/2008	23.2 U	0.0339 U	NA
SB-27-10	10	4/14/2008	307 J	0.20	0.00896
SB-28-9	9	4/11/2008	32.3	0.0313 U	0.00838 U
SB-29-9	9	4/8/2008	30.6	0.07	NA
SB-30-9.5	9.5	4/10/2008	23.2 U	0.0343 U	NA
SB-3-10.5	10.5	4/3/2008	23.8 U	0.0335 U	NA
SB-3-12	12	4/3/2008	23.9 U	0.0372 U	NA
SB-31-9.5	9.5	4/10/2008	26.1 U	0.0420 U	NA
SB-32-9.5	9.5	4/10/2008	29.7 U	0.0541 U [0.0538 U]	NA [NA]
SB-33-11	11	4/10/2008	27 U	0.0471 U	NA
SB-34-11	11	4/10/2008	23.5 U	0.0344 U	NA
SB-35-9	9	4/10/2008	25.9 U	0.0442 U	NA
SB-36-12	12	4/10/2008	21.2 U	0.0252 U	NA
SB-37-9	9	4/8/2008	23.8 U	0.224 [0.225]	NA [NA]
SB-38-10	10	4/8/2008	24.5 U	0.11	0.00929 U
SB-38-8.5	8.5	4/8/2008	24.1 U	0.07	NA
SB-39-14	14	4/10/2008	22.2 U	0.0285 U	NA
SB-40-11	11	4/10/2008	24.1 U	0.0365 U	NA
SB-4-10.5	10.5	4/4/2008	22.3 U	0.0307 U	NA
SB-41-10	10	4/10/2008	23.6 U	0.0346 U	NA
SB-42-10	10	4/9/2008	28.5 U	0.0464 U [0.0821]	NA [NA]
SB-43-11.5	11.5	4/9/2008	26.8 U	0.0420 U	NA
SB-44-11	11	4/9/2008	23.3 U	0.21	NA
SB-45-10	10	4/8/2008	22.9 U	0.21	NA
SB-46-10.5	10.5	4/8/2008	22.5 U	0.0311 U	NA
SB-46-6	6	4/8/2008	22.8 U	0.0323 U	NA
SB-47-10	10	4/9/2008	26.2 U	0.0437 U	NA
SB-48-11.5	11.5	4/9/2008	27.7 U	0.0459 U	NA
SB-49-10.5	10.5	4/9/2008	23.4 U	0.0333 U	NA
SB-50-10.5	10.5	4/9/2008	24.1 U	0.0350 U	NA
SB-5-11.5	11.5	4/4/2008	21.7 U	0.04	NA
SB-51-9.5	9.5	4/8/2008	24.1 U	0.0350 U	NA
SB-52-9.5	9.5	4/8/2008	22.6 U	0.0317 U	NA
SB-53-10.5	10.5	4/9/2008	33.8	0.0309 U	NA
SB-54-10.5	10.5	4/9/2008	24.3 U	0.0373 U	NA
SB-55-11.5	11.5	4/7/2008	32.5 U	0.0606 U	NA
SB-56-14.5	14.5	4/8/2008	23.3 U	0.0337 U	NA
SB-57-10.5	10.5	4/7/2008	22.3 U	0.0307 U	NA
SB-58-11.0	11	4/7/2008	23.3 U	0.0359 U	NA
SB-59-5.5	5.5	4/8/2008	22.5 U	0.0311 U	NA
SB-60-10.5	10.5	4/7/2008	39.4	0.0825 [0.0864]	NA [NA]
SB-6-11.0	11	4/4/2008	23.6 U	0.0356 U	NA
SB-61-10.5	10.5	4/7/2008	30.7 U	0.0511 U	NA
SB-62-10.5	10.5	4/7/2008	32.7 U	0.0607 U	NA
SB-63-6.0	6	4/7/2008	1010 J	0.157 J	NA

Table 2: Samples Used to Calculate 95 Percent Upper Confidence Limits on the Means

Sample Identification (ID)	Sample Depth (feet bgs)	Sample Date	TPH (mg/kg)[1]	Benzene (mg/kg)[2]	Total cPAHs TEQ (mg/kg)[3]
SB-64-5.5	5.5	4/7/2008	1010 J	0.139 J	0.0452 U
SB-64-7.0	7	4/7/2008	97.9	0.33	NA
SB-67-5.5	5.5	6/24/2008	24.1 U	0.0398 U	NA
SB-70-12.5	12.5	6/25/2008	23.4 U	0.0366 U	NA
SB-70-20.5	20.5	6/25/2008	23.4 U	0.0340 U	NA
SB-70-6.0	6	6/24/2008	22.1 U	0.0371 U	NA
SB-70-7.0	7	6/25/2008	23.2 U	0.0369 U	NA
SB-7-11.5	11.5	4/4/2008	22.9 U	0.0334 U	NA
SB-71-15.5	15.5	6/25/2008	50.9	0.0363 U	0.00876 U
SB-71-24.0	24	6/25/2008	23.7 U	0.0366 U	NA
SB-71-8.0	8	6/25/2008	23.6 U	0.0368 U	NA
SB-72-15.5	15.5	6/25/2008	24 U	0.0348 U	NA
SB-72-24.5	24.5	6/25/2008	25.2 U	0.0400 U [0.0421 U]	NA
SB-72-6.5	6.5	6/25/2008	23.6 U	0.0371 U	NA
SB-73-15.0	15	6/26/2008	24.1 U	0.0369 U	NA
SB-73-6.0	6	6/26/2008	26.5 U	0.0445 U	NA
SB-74-15	15	6/26/2008	24.5 U	0.0380 U	NA
SB-74-6.0	6	6/26/2008	24.4 U	0.0375 U	NA
SB-75-15.0	15	6/26/2008	24.9 U	0.0398 U	NA
SB-75-6.0	6	6/26/2008	24.7 U	0.0406 U	NA
SB-76-10.5	10.5	6/30/2008	2540 J	0.0501 U	0.190
SB-76-14	14	6/30/2008	23.4 U	0.0288 U [0.0355 U]	NA
SB-76-4.5	4.5	6/30/2008	29.1	0.0389 U	NA
SB-77-14	14	6/30/2008	23.5 U	0.0336 U	NA
SB-77-6	6	6/30/2008	24.2 U	0.0392 U	NA
SB-78-10	10	6/30/2008	35.1 J	0.0325 U	NA
SB-78-12.5	12.5	6/30/2008	24.3 U	0.0353 U	NA
SB-78-5.5	5.5	6/30/2008	1310	6.57 J	0.0183
SB-78-8.5	8.5	6/30/2008	22.8 U	0.0351 U	NA
SB-79-11.5	11.5	6/30/2008	27.5 U	0.0550 U	NA
SB-79-5	5	6/30/2008	22.1 U	0.0344 U	NA
SB-8-11.0	11	4/4/2008	22.5 U	0.05	NA
SB-81-15.5	15.5	6/30/2008	23.1 U	0.0333 U	NA
SB-81-5	5	6/30/2008	105 J	0.0301 U	0.0896
SB-81-9.5	9.5	6/30/2008	25.5 U	0.0414 U	NA
SB-82-7	7	7/1/2008	23.7 U	0.0349 U	NA
SB-82-9	9	7/1/2008	27.5 U	0.0455 U	NA
SB-83-7	7	7/1/2008	34.4	0.0333 U	0.00891
SB-83-8.5	8.5	7/1/2008	40.7	0.0502 U	0.0108
SB-84-6	6	7/1/2008	69.1	0.0610 U	0.0119
SB-84-8	8	7/1/2008	37 U	0.0745 U	NA
SB-85-5.5	5.5	7/2/2008	92.5	0.0357 U	0.0225
SB-85-7.5	7.5	7/2/2008	214 J	0.114 U	NA
SB-86-4.5	4.5	7/2/2008	112 J	0.0324 U	0.0182
SB-86-6.5	6.5	7/2/2008	29.1 U	0.0513 U	NA
SB-87-14.0	14	7/25/2008	24.7 U	0.05	NA
SB-87-6.0	6	7/25/2008	243 J	0.06	0.0535

Table 2: Samples Used to Calculate 95 Percent Upper Confidence Limits on the Means

Sample Identification (ID)	Sample Depth (feet bgs)	Sample Date	TPH (mg/kg)[1]	Benzene (mg/kg)[2]	Total cPAHs TEQ (mg/kg)[3]
SB-88-8.0	8	7/25/2008	137	0.0145 U	0.0167
SB-9-11.0	11	4/4/2008	22.8 U	0.04	NA
STRM-1floor-8	8	10/24/2003	20 U	0.03 U	0.00755 U
STRM-1wall-4	4	10/24/2003	20 U	0.03 U	0.00755 U
STRM-2Floor-6	6	10/28/2003	20 U	0.03 U	0.00755 U
STRM-2wallW-3	3	10/28/2003	1542.5 D	0.03 U	0.02155
STRM-3WallW-3	3	10/27/2003	20 U	0.03 U	0.00755 U
STRM-4wallW-3	3	10/24/2003	20 U	0.03 U	0.00755 U
SWLY-A-10wall-3.75	3.75	11/11/2003	20 U	0.03 U	0.00755 U
SWLY-A-11WALL-3.75	3.75	11/25/2003	35.84	0.03 U	0.00755 U
SWLY-A-12WALL-3.75	3.75	11/25/2003	1285.6 D	0.06 U	0.0906
SWLY-A-13WALL-3.75	3.75	11/25/2003	34.5	0.03 U	0.00755 U
SWLY-A-15wall-3.75	3.75	12/1/2003	111.6	0.03 U	0.03775 U
SWLY-A-17wall-3.75	3.75	12/1/2003	1779 D	0.12 U	0.0461
SWLY-A-18wall-3.75	3.75	12/2/2003	20 U	0.03 U	0.00755 U
SWLY-A-19wall-3.75	3.75	12/2/2003	131.5	0.11	0.00755 U
SWLY-A-1Wall-3.75	3.75	10/14/2003	20 U	0.03 U	0.03755
SWLY-A-20WALL-3.75	3.75	12/4/2003	43.5	0.03 U	0.02855
SWLY-A-21WALL-3.75	3.75	12/4/2003	59	0.13	0.00755 U
SWLY-A-2Wall-3.75	3.75	10/14/2003	20 U	0.03 U	0.00755 U
SWLY-A-3Wall-3.75	3.75	10/14/2003	222.4	0.03 U	0.03797
SWLY-A-4Wall-3.75	3.75	10/16/2003	555.5 D	0.03 U	0.02108
SWLY-A-7WALL-3.75	3.75	11/6/2003	1178 D	0.30 U	0.00763
SWLY-A-8WALL-3.75	3.75	11/6/2003	724 D	0.06 U	0.00755 U
SWLY-C-1Wall-3.75	3.75	10/16/2003	20 U	0.03 U	0.00755 U
SWLY-D-1Wall-3.75	3.75	10/16/2003	20 U	0.03 U	0.00755 U
SWLY-D-21wall-3.75	3.75	12/5/2003	163.6	0.03 U	0.00834
SWLY-D-2Wall-3.75	3.75	10/16/2003	120.4	0.03 U	0.00755 U
SWLY-D-3 Wall-3.75	3.75	10/17/2003	2923.2 D	4.47 D	0.02865
SWLY-D-4Wall-3.75	3.75	10/21/2003	20 U	0.03 U	0.00755 U
SWLY-D-5WALL-3.75	3.75	11/6/2003	109.4	0.03 U	0.00755 U
SWLY-D-6WALL-3.75	3.75	11/6/2003	20 U	0.03 U	0.00755 U
SWLY-D-7Wall-3.75	3.75	11/10/2003	20 U	0.03 U	0.00755 U
SWLY-D-7-Wall-3.75	3.75	11/7/2003	20 U	0.03 U	0.00755 U
SWLY-E-10-3.75	3.75	11/12/2003	93.1	0.03 U	0.00755 U
SWLY-E-11-3.75	3.75	11/13/2003	20 U	0.03 U	0.00755 U
SWLY-E-21wall-3.75	3.75	12/5/2003	162.5	0.03 U	0.00773
SWLY-E-8wall-3.75	3.75	11/11/2003	20 U	0.03 U	0.00755 U
SWLY-E-9wall-3.75	3.75	11/11/2003	20 U	0.03 U	0.00755 U
SWLY-F-12-3.75	3.75	11/14/2003	25.8	0.03 U	0.00755 U
SWLY-F-13-3.75	3.75	11/14/2003	20 U	0.03 U	0.00755 U
SWLY-F-21wall-3.75	3.75	11/24/2003	20 U	0.03 U	0.00755 U
SWLY-G-14-3.75	3.75	11/17/2003	20 U	0.30	0.00755 U
SWLY-G-15-3.75	3.75	11/20/2003	20 U	0.03 U	0.00782
SWLY-G-16-3.75	3.75	11/20/2003	36.9	0.03 U	0.00755 U
SWLY-G-17-3.75	3.75	11/20/2003	20 U	0.03 U	0.00755 U
SWLY-G-21wall-3.75	3.75	11/24/2003	20 U	0.03 U	0.00755 U

Table 2: Samples Used to Calculate 95 Percent Upper Confidence Limits on the Means

Sample Identification (ID)	Sample Depth (feet bgs)	Sample Date	TPH (mg/kg)[1]	Benzene (mg/kg)[2]	Total cPAHs TEQ (mg/kg)[3]
SWLY-H-18-3.75	3.75	11/21/2003	20 U	0.03 U	0.00755 U
SWLY-H-19-3.75	3.75	11/21/2003	20 U	0.03 U	0.00755 U
SWLY-H-21wall-3.75	3.75	11/24/2003	20 U	0.03 U	0.00755 U
SWLY-I-20wall-3.75	3.75	11/24/2003	20 U	0.03 U	0.00755 U
SWLY-I-21wall-3.75	3.75	11/24/2003	1255.9 D	0.03 U	0.03775 U

Notes:
Benzene analyzed by Environmental Protection Agency (EPA) Method 8021B.
cPAHs analyzed by EPA Method 8270 SIM.
Gasoline analyzed by method NWTPH-G.
Diesel and Heavy Oil (Lube) analyzed by method NWTPH-D Extended.
[1]Total petroleum hydrocarbons (TPH) calculated by summing the concentrations of gasoline, diesel and heavy oil. If one or more TPH constituents were reported as Non-Detect, half of the reporting limit value was added to the total.
[2]If benzene was reported as non-detect, the value shown is the reporting limit. Half of the reporting limit value shown in this table was used in the statistical analysis.

[3] Total carcinogenic polynuclear aromatic hydrocarbons (cPAHs) adjusted for toxicity (TEQ) according to WAC 173-340-708(8). If one or more adjusted cPAH constituents were reported as Non-Detect, half of the reporting limit was used in calculations.
NA = indicates analysis not conducted.
[ ] = bracketed data indicate duplicate sample.
D: sample was diluted
U: not detected
J: indicates an estimated value.
W: reporting limits were raised due to sample foaming
mg/kg = milligrams per kilogram

Table 3: Samples Located in the Areas of Future Remedial Actions

Sample Identification (ID)	Sample Depth (feet bgs)	Sample Date	Sample Location
B10-0.5-1	0.5-1	8/25/2011	Within planned excavation area near Detention Basin No 2 (DB-2)
B10-1.5-2	1.5-2	8/25/2011	
B10-2.5-3	2.5-3	8/25/2011	
B10-3.5-4	3.5-4	8/25/2011	
B11-10-10.5	10-10.5	8/23/2011	
B11-11-11.5	11-11.5	8/23/2011	
B11-13.5-14	13.5-14	8/23/2011	
B11-4.5-5	4.5-5	8/23/2011	
B11-7.5-8	7.5-8	8/23/2011	
B11-8.5-9	8.5-9	8/23/2011	
B11-9.5-10	9.5-10	8/23/2011	
B13-10-10.5	10-10.5	8/23/2011	
B13-11.5-12	11.5-12	8/23/2011	
B13-4.5-5	4.5-5	8/23/2011	
B13-6-6.5	6-6.5	8/23/2011	
B13-7-7.5	7-7.5	8/23/2011	
B13-9-9.5	9-9.5	8/23/2011	
B16-3.5-4	3.5-4	8/24/2011	
B16-4.5-5	4.5-5	8/24/2011	
B16-4-4.5	4-4.5	8/24/2011	
B16-6-6.5	6-6.5	8/24/2011	
B17-3.5-4	3.5-4	8/24/2011	
B17-4.5-5	4.5-5	8/24/2011	
B17-4-4.5	4-4.5	8/24/2011	
B17-5.5-6	5.5-6	8/24/2011	
B4-13-13.5	13-13.5	8/22/2011	
B4-14.5-15	14.5-15	8/22/2011	
B4-4.5-5	4.5-5	8/22/2011	
B4-9.5-10	9.5-10	8/22/2011	
B5-11.5-12	11.5-12	8/22/2011	
B5-13.5-14	13.5-14	8/22/2011	
B5-4.5-5	4.5-5	8/22/2011	
B5-9-9.5	9-9.5	8/22/2011	
B6-11-11.5	11-11.5	8/22/2011	
B6-13-13.5	13-13.5	8/22/2011	
B6-4.5-5	4.5-5	8/22/2011	
B6-7-7.5	7-7.5	8/22/2011	
B6-9-9.5	9-9.5	8/22/2011	
B7-14-14.5	14-14.5	8/22/2011	

Table 3: Samples Located in the Areas of Future Remedial Actions

Sample Identification (ID)	Sample Depth (feet bgs)	Sample Date	Sample Location
B7-4.5-5	4.5-5	8/22/2011	Within planned excavation area near Detention Basin No 2 (DB-2)
B7-8-8.5	8-8.5	8/22/2011	
B7-9.5-10	9.5-10	8/22/2011	
B8-11-11.5	11-11.5	8/23/2011	
B8-13.5-14	13.5-14	8/23/2011	
B8-14.5-15	14.5-15	8/23/2011	
B8-4.5-5	4.5-5	8/23/2011	
B8-7.5-8	7.5-8	8/23/2011	
B8-9.5-10	9.5-10	8/23/2011	
B9-10.5-11	10.5-11	8/23/2011	
B9-11-11.5	11-11.5	8/23/2011	
B9-12.5-13	12.5-13	8/23/2011	
B9-4.5-5	4.5-5	8/23/2011	
B9-8.5-9	8.5-9	8/23/2011	
B9-9.5-10	9.5-10	8/23/2011	
EX-A4-F-6-4	4	9/12/2007	
EX-A4-F-7-4	4	9/12/2007	
EX-A4-F-8-6	6	10/17/2007	
EX-A4-F-8-7	7	11/7/2007	
EX-A4-F-8-NSW-3.5	3.5	11/13/2007	
EX-A4-F-8-NSW-4	4	11/7/2007	
EX-A4-F-9-NSW-3.5	3.5	11/7/2007	
EX-A4-F-9-NSW-4	4	10/17/2007	
EX-B7-B4-4	4	8/1/2008	
EX-B7-B-4-5	5	9/10/2008	
EX-B8-F-4-4	4	10/1/2007	
EX-B8-F-4-9	9	10/22/2007	
EX-B8-F-4-NSW-4	4	10/22/2007	
EX-B8-F-4-WSW-4	4	10/1/2007	
EX-B8-F-5-4	4	10/1/2007	
EX-B8-F-5-NSW-6	6	10/9/2007	
MW-510-12.5	12.5	10/8/2008	
MW-510-6.5	6.5	10/8/2008	

Table 3: Samples Located in the Areas of Future Remedial Actions

Sample Identification (ID)	Sample Depth (feet bgs)	Sample Date	Sample Location
EX-A2-N-16-SSW-6	6	2/20/2008	Within radius of influence (ROI) of the dual-phase extraction (DPE) system near the Washington State Department of Transportation (WSDOT) stormwater line
EX-A2-O-15-SSW-6	6	2/20/2008	
EX-A2-P-14-12	12	2/22/2008	
EX-A2-Q-13-12	12	2/22/2008	
EX-A2-Q-14-6	6	2/20/2008	
EX-A2-R-14-6	6	2/20/2008	
EX-A2-S-12-SSW-6	6	2/15/2008	
EX-A3-Y-7-10	10	9/25/2007	
EX-A3-Y-7-ESW-4	4	9/20/2007	
EX-A3-Y-7-NSW-4	4	9/20/2007	
EX-B11-U-10-10	10	2/14/2008	
EX-B11-U-10-SSW-5	5	2/12/2008	
EX-B11-U-8-14	14	1/30/2008	
EX-B11-U-9-12	12	1/31/2008	
EX-B11-V-8-5	5	1/31/2008	
EX-B11-V-9-5	5	1/31/2008	
EX-B20-M-16-15	15	11/9/2007	
EX-B20-M-16-SSW-12	12	11/9/2007	
EX-B20-M-17-10	10	11/9/2007	
EX-B20-M-17-ESW-5	5	11/9/2007	
EX-B20-M-17-SSW-6	6	1/28/2008	
EX-B20-N-15-12	12	12/11/2007	
EX-B20-N-16-12	12	11/13/2007	
EX-B20-O-14-12	12	1/18/2008	
EX-B20-O-15-12	12	1/18/2008	
MW-525-10.5	10.5	6/18/2012	
MW-525-12.5	12.5	6/18/2012	
MW-525-4	4	6/14/2012	
MW-525-6	6	6/14/2012	
MW-526-12.5	12.5	6/18/2012	
MW-526-4	4	6/14/2012	
MW-531-12	12	6/18/2012	
MW-531-6	6	6/14/2012	
MW-532-10	10	6/18/2012	
MW-532-13.5	13.5	6/18/2012	
MW-532-6	6	6/18/2012	
MW-532-7	7	6/18/2012	
SB-65-16.0	16	6/26/2008	
SB-65-20	20	6/26/2008	

Table 3: Samples Located in the Areas of Future Remedial Actions

Sample Identification (ID)	Sample Depth (feet bgs)	Sample Date	Sample Location
SB-65-23	23	6/26/2008	Within radius of influence (ROI) of the dual-phase extraction (DPE) system near the Washington State Department of Transportation (WSDOT) stormwater line
SB-65-6.5	6.5	6/26/2008	
SB-65-8.0	8	6/26/2008	
SB-66-11.5	11.5	6/30/2008	
SB-66-15	15	6/30/2008	
SB-66-6.0	6	6/26/2008	
SB-68-13.5	13.5	6/25/2008	
SB-68-15.0	15	6/25/2008	
SB-68-4.0	4	6/24/2008	
SB-68-5.5	5.5	6/24/2008	
SB-69-12.0	12	6/26/2008	
SB-69-15.0	15	6/26/2008	
SB-69-6.0	6	6/26/2008	
SB-80-11.0	11	6/26/2008	
SB-80-7.5	7.5	6/26/2008	

feet bgs: feet below ground surface

Design & Consultancy for natural and built assets

CHEVRON ENVIRONMENTAL MANAGEMENT COMPANY
FORMER UNOCAL BULK FUEL TERMINAL
EDMONDS, WASHINGTON
FINAL FEASABILITY STUDY REPORT - APPENDIX E

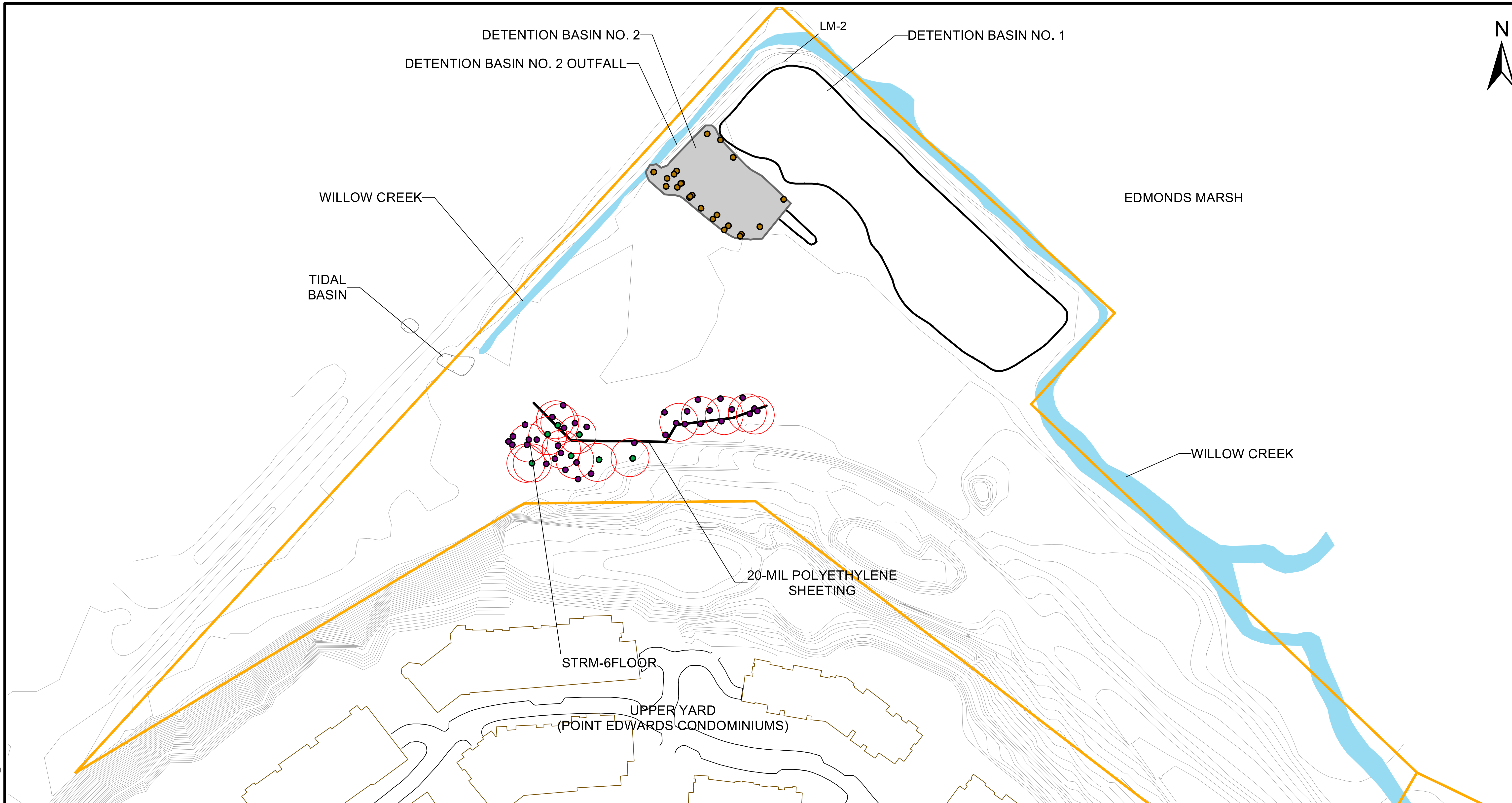
Table 4: Data Summary and 95 Percent Upper Confidence Levels on the Mean

Constituent	Total Number of Samples	Detection Frequency (%) [a]	Minimum (mg/kg)	Maximum (mg/kg)	Mean of Detects (mg/kg)	95% UCL (mg/kg)	95% UCL Method	EPC [b] (mg/kg)	Basis for EPC	REL or CUL (mg/kg)	Does EPC Exceed REL or CUL?
Benzene	988	10%	0.00095	6.57	0.0573	0.104	95% Chebyshev (Mean, Sd) UCL	0.104	95% UCL	18	No
Benzene - detects only	100	100%	0.004	6.57	0.391	0.824	95% Chebyshev (Mean, Sd) UCL	0.824	95% UCL	18	No
cPAH TEQ	575	37%	0.0005213	0.19	0.0146	0.0181	95% Chebyshev (Mean, Sd) UCL	0.0181	95% UCL	0.14	No
cPAH TEQ - detects only	214	100%	0.0005213	0.19	0.024	0.0321	95% Chebyshev (Mean, Sd) UCL	0.0321	95% UCL	0.14	No
TPH	988	35%	5.5	4980	135	188	95% Chebyshev (Mean, Sd) UCL	188	95% UCL	2,775	No
TPH - detects only	348	100%	8.45	4980	340	478	95% Chebyshev (Mean, Sd) UCL	478	95% UCL	2,775	No

Notes:
[a] The detection frequency represents the detection frequency of the raw data set (i.e., before non-detects were treated as detects at one-half the reporting limit.
[b] The exposure point concentration (EPC) is the lower of the 95% UCL (USEPA 2016) or the maximum detected concentration. A minimum of eight samples and five detections is required to calculate a 95% UCL. When these criteria are not met, the maximum detected concentration is selected as the EPC.

Abbreviations:
% = percent
cPAH TEQ = carcinogenic polycyclic aromatic hydrocarbons adjusted for toxicity
CUL = cleanup level
mg/kg = milligram per kilogram
REL = remediation level
Sd = standard deviation
TPH = total petroleum hydrocarbons
UCL = upper confidence limit

References:
USEPA. 2016. ProUCL Statistical Program—Version 5.1.002. May. Available at: https://www.epa.gov/land-research/proucl-software.



LEGEND

- ESTIMATED DPE ROI - 30 FOOT RADIUS OF INFLUENCE
- EXCAVATION BOUNDARY
- LOWER YARD PROPERTY BOUNDARY

0 150 300
SCALE IN FEET

NOTES:
1. 20-MIL POLYETHYLENE SHEETING INSTALLED UPON COMPLETION OF PHASE I EXCAVATION. SHEETING REACHES TO APPROXIMATELY 7.5 FEET ABOVE MEAN SEA LEVEL.
2. SOUTHEAST PORTION OF WSDOT STORMWATER LINE HAS NOT BEEN SURVEYED.

TPH - TOTAL PETROLEUM HYDROCARBONS
MG/KG - MILLIGRAMS PER KILOGRAM
CPAH - CARCINOGENIC POLYNUCLEAR AROMATIC HYDROCARBONS, ADJUSTED FOR TOXICITY
CUL - CLEANUP LEVEL

CHEVRON ENVIRONMENTAL MANAGEMENT COMPANY
FORMER UNOCAL BULK FUEL TERMINAL
EDMONDS, WASHINGTON
FINAL FEASABILITY STUDY REPORT - APPENDIX E

Samples Located in the Areas of Future Remedial Actions

ARCADIS

FIGURE
1

CITY:HIGHLANDS RANCH, CO DIV/GROUP:(ENV/GIS) DB: B GRIFFITH
Path: Z:\GISProjects_ENV\Chevron_Edmonds\MXD\Point_Selections.mxd Date: 4/14/2017 Time: 12:11:03 PM

Attachment 1: ProUCL Output

UCL Statistics for Uncensored Full Data Sets

User Selected Options	
Date/Time of Computation	ProUCL 5.15/3/2017 11:06:42 AM
From File	Updated B_TPH_cPAH for ProUCL.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Result (benzene - detects only)

	General Statistics		
Total Number of Observations	100	Number of Distinct Observations	94
		Number of Missing Observations	0
Minimum	0.004	Mean	0.391
Maximum	6.57	Median	0.0989
SD	0.994	Std. Error of Mean	0.0994
Coefficient of Variation	2.54	Skewness	4.307
	Normal GOF Test		
Shapiro Wilk Test Statistic	0.401	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk P Value	0	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.385	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.0889	Data Not Normal at 5% Significance Level	
	Data Not Normal at 5% Significance Level		
	Assuming Normal Distribution		
95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	0.556	95% Adjusted-CLT UCL (Chen-1995)	0.6
		95% Modified-t UCL (Johnson-1978)	0.563
	Gamma GOF Test		
A-D Test Statistic	9.974	**Anderson-Darling Gamma GOF Test**	
5% A-D Critical Value	0.815	Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.244	**Kolmogorov-Smirnov Gamma GOF Test**	
5% K-S Critical Value	0.0944	Data Not Gamma Distributed at 5% Significance Level	
	Data Not Gamma Distributed at 5% Significance Level		
	Gamma Statistics		
k hat (MLE)	0.533	k star (bias corrected MLE)	0.523
Theta hat (MLE)	0.734	Theta star (bias corrected MLE)	0.747
nu hat (MLE)	106.5	nu star (bias corrected)	104.7
MLE Mean (bias corrected)	0.391	MLE Sd (bias corrected)	0.541
		Approximate Chi Square Value (0.05)	82.06
Adjusted Level of Significance	0.0476	Adjusted Chi Square Value	81.77
	Assuming Gamma Distribution		
95% Approximate Gamma UCL (use when n>=50))	0.499	95% Adjusted Gamma UCL (use when n<50)	0.501
	Lognormal GOF Test		
Shapiro Wilk Test Statistic	0.921	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk P Value	2.1045E-6	Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.109	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.0889	Data Not Lognormal at 5% Significance Level	
	Data Not Lognormal at 5% Significance Level		
	Lognormal Statistics		
Minimum of Logged Data	-5.521	Mean of logged Data	-2.12
Maximum of Logged Data	1.883	SD of logged Data	1.298
	Assuming Lognormal Distribution		
95% H-UCL	0.39	90% Chebyshev (MVUE) UCL	0.415
95% Chebyshev (MVUE) UCL	0.478	97.5% Chebyshev (MVUE) UCL	0.566
99% Chebyshev (MVUE) UCL	0.739		

Nonparametric Distribution Free UCL Statistics
Data do not follow a Discernible Distribution (0.05)

Attachment 1: ProUCL Output

Nonparametric Distribution Free UCLs

95% CLT UCL	0.555	95% Jackknife UCL	0.556
95% Standard Bootstrap UCL	0.554	95% Bootstrap-t UCL	0.648
95% Hall's Bootstrap UCL	0.599	95% Percentile Bootstrap UCL	0.563
95% BCA Bootstrap UCL	0.614		
90% Chebyshev(Mean, Sd) UCL	0.689	95% Chebyshev(Mean, Sd) UCL	0.824
97.5% Chebyshev(Mean, Sd) UCL	1.012	99% Chebyshev(Mean, Sd) UCL	1.38

Suggested UCL to Use

95% Chebyshev (Mean, Sd) UCL	0.824

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Result (benzene)

General Statistics

Total Number of Observations	988	Number of Distinct Observations	317
		Number of Missing Observations	0
Minimum	9.5000E-4	Mean	0.0573
Maximum	6.57	Median	0.015
SD	0.335	Std. Error of Mean	0.0107
Coefficient of Variation	5.851	Skewness	13.79

Normal GOF Test

Shapiro Wilk Test Statistic	0.126	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	0	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.433	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.0285	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	0.0749	95% Adjusted-CLT UCL (Chen-1995)	0.0799
		95% Modified-t UCL (Johnson-1978)	0.0756

Gamma GOF Test

A-D Test Statistic	1.012E+28	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.814	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.38	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.0304	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	0.596	k star (bias corrected MLE)	0.595
Theta hat (MLE)	0.0961	Theta star (bias corrected MLE)	0.0963
nu hat (MLE)	1179	nu star (bias corrected)	1176
MLE Mean (bias corrected)	0.0573	MLE Sd (bias corrected)	0.0743
		Approximate Chi Square Value (0.05)	1098
Adjusted Level of Significance	0.0498	Adjusted Chi Square Value	1098

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	0.0614	95% Adjusted Gamma UCL (use when n<50)	0.0614

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.613	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk P Value	0	Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.295	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.0285	Data Not Lognormal at 5% Significance Level

Data Not Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-6.959	Mean of logged Data	-3.896
Maximum of Logged Data	1.883	SD of logged Data	0.86

Attachment 1: ProUCL Output

Assuming Lognormal Distribution

95% H-UCL	0.0311	90% Chebyshev (MVUE) UCL	0.0322
95% Chebyshev (MVUE) UCL	0.0335	97.5% Chebyshev (MVUE) UCL	0.0353
99% Chebyshev (MVUE) UCL	0.0387		

Nonparametric Distribution Free UCL Statistics
Data do not follow a Discernible Distribution (0.05)

Nonparametric Distribution Free UCLs

95% CLT UCL	0.0749	95% Jackknife UCL	0.0749
95% Standard Bootstrap UCL	0.0748	95% Bootstrap-t UCL	0.0848
95% Hall's Bootstrap UCL	0.0807	95% Percentile Bootstrap UCL	0.0762
95% BCA Bootstrap UCL	0.0807		
90% Chebyshev(Mean, Sd) UCL	0.0893	95% Chebyshev(Mean, Sd) UCL	0.104
97.5% Chebyshev(Mean, Sd) UCL	0.124	99% Chebyshev(Mean, Sd) UCL	0.163

Suggested UCL to Use

95% Chebyshev (Mean, Sd) UCL	0.104

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Result (cPAH TEQ - detects only)

General Statistics

Total Number of Observations	214	Number of Distinct Observations	164
		Number of Missing Observations	0
Minimum	5.2130E-4	Mean	0.024
Maximum	0.19	Median	0.0112
SD	0.0272	Std. Error of Mean	0.00186
Coefficient of Variation	1.133	Skewness	2.602

Normal GOF Test

Shapiro Wilk Test Statistic	0.69	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	0	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.227	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.061	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	0.0271	95% Adjusted-CLT UCL (Chen-1995)	0.0274
		95% Modified-t UCL (Johnson-1978)	0.0271

Gamma GOF Test

A-D Test Statistic	9.967	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.779	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.189	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.0636	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	1.186	k star (bias corrected MLE)	1.173
Theta hat (MLE)	0.0202	Theta star (bias corrected MLE)	0.0205
nu hat (MLE)	507.8	nu star (bias corrected)	502
MLE Mean (bias corrected)	0.024	MLE Sd (bias corrected)	0.0222
		Approximate Chi Square Value (0.05)	451
Adjusted Level of Significance	0.0489	Adjusted Chi Square Value	450.7

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	0.0267	95% Adjusted Gamma UCL (use when n<50)	0.0267

Attachment 1: ProUCL Output

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.883	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk P Value	0	Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.21	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.061	Data Not Lognormal at 5% Significance Level	

Data Not Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-7.559	Mean of logged Data	-4.207
Maximum of Logged Data	-1.661	SD of logged Data	1.024

Assuming Lognormal Distribution

95% H-UCL	0.0293	90% Chebyshev (MVUE) UCL	0.0315
95% Chebyshev (MVUE) UCL	0.0344	97.5% Chebyshev (MVUE) UCL	0.0384
99% Chebyshev (MVUE) UCL	0.0464		

Nonparametric Distribution Free UCL Statistics
Data do not follow a Discernible Distribution (0.05)

Nonparametric Distribution Free UCLs

95% CLT UCL	0.0271	95% Jackknife UCL	0.0271
95% Standard Bootstrap UCL	0.0271	95% Bootstrap-t UCL	0.0274
95% Hall's Bootstrap UCL	0.0275	95% Percentile Bootstrap UCL	0.0272
95% BCA Bootstrap UCL	0.0275		
90% Chebyshev(Mean, Sd) UCL	0.0296	95% Chebyshev(Mean, Sd) UCL	0.0321
97.5% Chebyshev(Mean, Sd) UCL	0.0356	99% Chebyshev(Mean, Sd) UCL	0.0425

Suggested UCL to Use

95% Chebyshev (Mean, Sd) UCL	0.0321

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Result (cPAH TEQ)

General Statistics

Total Number of Observations	575	Number of Distinct Observations	193
		Number of Missing Observations	0
Minimum	5.2130E-4	Mean	0.0146
Maximum	0.19	Median	0.00755
SD	0.0189	Std. Error of Mean	7.8620E-4
Coefficient of Variation	1.288	Skewness	4.204

Normal GOF Test

Shapiro Wilk Test Statistic	0.477	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	0	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.348	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.0373	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	0.0159	95% Adjusted-CLT UCL (Chen-1995)	0.0161
		95% Modified-t UCL (Johnson-1978)	0.0159

Gamma GOF Test

A-D Test Statistic	90.64	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.771	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.328	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.0394	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Attachment 1: ProUCL Output

Gamma Statistics

k hat (MLE)	1.564	k star (bias corrected MLE)	1.557
Theta hat (MLE)	0.00936	Theta star (bias corrected MLE)	0.0094
nu hat (MLE)	1798	nu star (bias corrected)	1790
MLE Mean (bias corrected)	0.0146	MLE Sd (bias corrected)	0.0117
		Approximate Chi Square Value (0.05)	1693
Adjusted Level of Significance	0.0496	Adjusted Chi Square Value	1693

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	0.0155	95% Adjusted Gamma UCL (use when n<50)	0.0155

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.698	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk P Value	0	Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.319	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.0373	Data Not Lognormal at 5% Significance Level

Data Not Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-7.559	Mean of logged Data	-4.577
Maximum of Logged Data	-1.661	SD of logged Data	0.742

Assuming Lognormal Distribution

95% H-UCL	0.0144	90% Chebyshev (MVUE) UCL	0.0149
95% Chebyshev (MVUE) UCL	0.0156	97.5% Chebyshev (MVUE) UCL	0.0165
99% Chebyshev (MVUE) UCL	0.0182		

Nonparametric Distribution Free UCL Statistics
Data do not follow a Discernible Distribution (0.05)

Nonparametric Distribution Free UCLs

95% CLT UCL	0.0159	95% Jackknife UCL	0.0159
95% Standard Bootstrap UCL	0.0159	95% Bootstrap-t UCL	0.0161
95% Hall's Bootstrap UCL	0.0161	95% Percentile Bootstrap UCL	0.016
95% BCA Bootstrap UCL	0.0161		
90% Chebyshev(Mean, Sd) UCL	0.017	95% Chebyshev(Mean, Sd) UCL	0.0181
97.5% Chebyshev(Mean, Sd) UCL	0.0195	99% Chebyshev(Mean, Sd) UCL	0.0225

Suggested UCL to Use

95% Chebyshev (Mean, Sd) UCL	0.0181

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Result (TPH - detects only)

General Statistics

Total Number of Observations	348	Number of Distinct Observations	307
		Number of Missing Observations	0
Minimum	8.45	Mean	339.9
Maximum	4980	Median	94.55
SD	589.4	Std. Error of Mean	31.59
Coefficient of Variation	1.734	Skewness	3.29

Normal GOF Test

Shapiro Wilk Test Statistic	0.592	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	0	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.288	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.0479	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	392	95% Adjusted-CLT UCL (Chen-1995)	397.9
		95% Modified-t UCL (Johnson-1978)	393

Attachment 1: ProUCL Output

Gamma GOF Test

A-D Test Statistic	19.7	**Anderson-Darling Gamma GOF Test**	
5% A-D Critical Value	0.811	Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.184	**Kolmogorov-Smirnov Gamma GOF Test**	
5% K-S Critical Value	0.0512	Data Not Gamma Distributed at 5% Significance Level	

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	0.617	k star (bias corrected MLE)	0.613
Theta hat (MLE)	551.1	Theta star (bias corrected MLE)	554.2
nu hat (MLE)	429.3	nu star (bias corrected)	427
MLE Mean (bias corrected)	339.9	MLE Sd (bias corrected)	434
		Approximate Chi Square Value (0.05)	380.1
Adjusted Level of Significance	0.0493	Adjusted Chi Square Value	379.9

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	381.9	95% Adjusted Gamma UCL (use when n<50)	382.1

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.91	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk P Value	0	Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.0988	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.0479	Data Not Lognormal at 5% Significance Level	

Data Not Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	2.134	Mean of logged Data	4.831
Maximum of Logged Data	8.513	SD of logged Data	1.347

Assuming Lognormal Distribution

95% H-UCL	370.2	90% Chebyshev (MVUE) UCL	400.4
95% Chebyshev (MVUE) UCL	441.8	97.5% Chebyshev (MVUE) UCL	499.2
99% Chebyshev (MVUE) UCL	612.1		

Nonparametric Distribution Free UCL Statistics
Data do not follow a Discernible Distribution (0.05)

Nonparametric Distribution Free UCLs

95% CLT UCL	391.9	95% Jackknife UCL	392
95% Standard Bootstrap UCL	391.2	95% Bootstrap-t UCL	401.5
95% Hall's Bootstrap UCL	400.5	95% Percentile Bootstrap UCL	397
95% BCA Bootstrap UCL	397.2		
90% Chebyshev(Mean, Sd) UCL	434.7	95% Chebyshev(Mean, Sd) UCL	477.7
97.5% Chebyshev(Mean, Sd) UCL	537.2	99% Chebyshev(Mean, Sd) UCL	654.3

Suggested UCL to Use

95% Chebyshev (Mean, Sd) UCL	477.7

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Result (TPH)

General Statistics

Total Number of Observations	988	Number of Distinct Observations	409
		Number of Missing Observations	0
Minimum	5.5	Mean	134.8
Maximum	4980	Median	24.3
SD	380.9	Std. Error of Mean	12.12
Coefficient of Variation	2.825	Skewness	5.672

Attachment 1: ProUCL Output

Normal GOF Test

Shapiro Wilk Test Statistic	0.352	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk P Value	0	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.372	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.0285	Data Not Normal at 5% Significance Level	

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	154.8	95% Adjusted-CLT UCL (Chen-1995)	157.1
		95% Modified-t UCL (Johnson-1978)	155.1

Gamma GOF Test

A-D Test Statistic	180.2	**Anderson-Darling Gamma GOF Test**	
5% A-D Critical Value	0.821	Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.324	**Kolmogorov-Smirnov Gamma GOF Test**	
5% K-S Critical Value	0.0306	Data Not Gamma Distributed at 5% Significance Level	

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	0.533	k star (bias corrected MLE)	0.532
Theta hat (MLE)	253	Theta star (bias corrected MLE)	253.5
nu hat (MLE)	1053	nu star (bias corrected)	1051
MLE Mean (bias corrected)	134.8	MLE Sd (bias corrected)	184.8
		Approximate Chi Square Value (0.05)	976.7
Adjusted Level of Significance	0.0498	Adjusted Chi Square Value	976.6

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	145	95% Adjusted Gamma UCL (use when n<50)	145.1

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.686	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk P Value	0	Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.267	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.0285	Data Not Lognormal at 5% Significance Level	

Data Not Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	1.705	Mean of logged Data	3.723
Maximum of Logged Data	8.513	SD of logged Data	1.156

Assuming Lognormal Distribution

95% H-UCL	87.62	90% Chebyshev (MVUE) UCL	92.09
95% Chebyshev (MVUE) UCL	97.28	97.5% Chebyshev (MVUE) UCL	104.5
99% Chebyshev (MVUE) UCL	118.6		

Nonparametric Distribution Free UCL Statistics
Data do not follow a Discernible Distribution (0.05)

Nonparametric Distribution Free UCLs

95% CLT UCL	154.7	95% Jackknife UCL	154.8
95% Standard Bootstrap UCL	154.7	95% Bootstrap-t UCL	156.8
95% Hall's Bootstrap UCL	157.3	95% Percentile Bootstrap UCL	155.5
95% BCA Bootstrap UCL	155.9		
90% Chebyshev(Mean, Sd) UCL	171.2	95% Chebyshev(Mean, Sd) UCL	187.6
97.5% Chebyshev(Mean, Sd) UCL	210.5	99% Chebyshev(Mean, Sd) UCL	255.4

Suggested UCL to Use

95% Chebyshev (Mean, Sd) UCL	187.6

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

APPENDIX F

Groundwater Flow Model

Infrastructure · Water · Environment · Buildings

Imagine the result

Chevron Environmental Management Company

Groundwater Flow Model for the Former Unocal Edmonds Bulk Fuel Terminal

November 8, 2013

Robert Porsche
Senior Hydrogeologist

Michael P. Fleischner

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Former Unocal Edmonds Bulk Fuel Terminal, Edmonds, Washington

Groundwater Flow Model for the Former Unocal Edmonds Bulk Fuel Terminal

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Tables

Figures

Attachments

1. Introduction

Chevron Environmental Management Company (Chevron) retained ARCADIS, Inc. (ARCADIS) to develop a three-dimensional numerical groundwater flow model for the Former Unocal Edmonds Bulk Fuel Terminal (Site) located at 11720 Unoco Road, Edmonds, Washington (Figure 1). The purpose of the groundwater flow model is to simulate groundwater flow conditions at the Site, predict the hydraulic performance and effectiveness of four alternative groundwater remedial scenarios, and overall support the completion of the Site feasibility study (FS). Existing Site-related information, including hydrogeologic data collected by ARCADIS were utilized in developing the groundwater flow model.

This Report is being submitted under Agreed Order (No.DE 4460) which requires the Union Oil Company of California (Unocal), a wholly owned indirect subsidiary of the Chevron Corporation, to conduct an interim action to remediate soil, groundwater and sediments, and to monitor groundwater in the Lower Yard.

1.1 Background

Unocal operated the Terminal from 1923 to 1991. Fuel was brought to the Terminal on ships, pumped to the storage tanks in the Upper Yard, and loaded from the tanks into rail cars and trucks for delivery to customers. In addition, an asphalt plant operated at the Terminal from 1953 to the late 1970s.

Impacted media at the Site have been extensively characterized and remediated through numerous phases of site investigation and remedial activities which are documented in the FS. Previous remedial actions conducted between 2001 and 2008 have addressed potential impacts in the Upper Yard, Lower Yard and in the sediments of Willow Creek. Site-specific data and documents regarding historical Site operations, environmental investigations, and remediation are provided in the FS.

This analysis is focused on areas with remaining impacts as described in the FS. The areas with remaining impacts that are addressed in this groundwater modeling report are shown on Figure 2.

1.2 Site Description

The Site is located in Edmonds, Washington, adjacent to Puget Sound (Figure 1). As defined in the Agreed Order, the Site consists of three areas, the Upper Yard, Lower Yard and the Willow Creek Fish Hatchery (fish hatchery). Each area is currently a separate property but was once owned by Unocal. The Upper and Lower Yards were areas of operation for the former terminal. Although the fish hatchery was included in the Agreed Order, it was not used for operations or storage at the facility and is currently owned by the City of Edmonds. The Upper Yard was remediated to cleanup standards in 2003 and is now the location of a condominium complex. As part of the Agreed Order, monitoring is ongoing at the Lower Yard, which is the focus of this groundwater model.

The Lower Yard is approximately 22 acres in area, located north of the Upper Yard (Figure 2). The western boundary of the Lower Yard is the BNSF Railway (BNSF) property, and the northwestern boundary is Willow Creek and the BNSF railway. Further west of the Lower Yard is the Port of Edmonds Marina and Puget Sound. North and northeast of the Lower Yard are the Edmonds Marsh (also known as the Union Oil Marsh) and Willow Creek. East of the Lower Yard is the Edmonds Marsh and Willow Creek, and southeast is the Willow Creek Fish Hatchery. At its nearest point (the southwest corner of the Lower Yard), the Lower Yard boundary is approximately 160 feet from the Puget Sound shoreline.

A Site storm water conveyance system consisting of 12 storm drains collects surface water runoff from the Lower Yard and discharges into two storm-water detention basins designated as Detention Basin No.1 (DB-1) and DB-2 (Figure 2). Site storm-water is conveyed directly to DB-2 via gravity flow, and then is pumped from DB-2 to Willow Creek under Industrial Stormwater General Permit No. SO3-002953C. DB-1 acts as a retention pond for overflow from DB-2 during storm events. DB-1 is bounded to the northwest, northeast, and southeast by a manmade berm. The berm runs along the eastern property boundary, adjacent to Willow Creek. DB-1 is an un-lined pond with one above-ground pump and a piping system to the DB-2 outfall on the bank of Willow Creek. DB-2 has an impermeable liner, and two submersible pumps and a piping system to the DB-2 outfall.

Willow Creek runs along the northern portion of the western boundary and the entirety of the eastern boundary of the Lower Yard. Willow Creek is approximately 10 feet wide and is underlain by silt and sand material. The creek banks on the Site property boundary are steeply sloped and vegetated with native and non-native vegetation. Water depths in Willow Creek vary from 0 to 4 feet deep, depending on season and tidal cycles (ARCADIS, 2012a).

1.3 Scope and Objectives

The scope of the groundwater flow modeling tasks included:

- Reviewing historical data and refining the CSM;
- Developing, constructing, and calibrating the Site groundwater flow model; and
- Using the calibrated Site groundwater flow model to simulate and predict the performance of four potential groundwater remedial scenarios.

The objectives of the Site groundwater flow model are to:

- Develop a steady-state groundwater flow model calibrated for average flow conditions to support feasibility screening of alternative groundwater remedial scenarios;
- Develop conceptual-level design parameters for the four groundwater remedial scenarios, such as:
    - Number, location, and pumping rates of hypothetical extraction wells necessary for hydraulic containment
    - Location, dimensions, and pumping rate of a hypothetical groundwater interceptor trench for hydraulic containment
    - Construction dewatering rates during hypothetical soil excavation activities below the water table
- Simulate the four alternative remedial scenarios and perform predictive analyses to evaluate effectiveness.

2. Conceptual Site Model

A conceptual site model (CSM) is a narrative description of the principle components of a groundwater flow system and is developed from regional, local, and site-specific data. The primary components of a groundwater flow system include: (1) areal extent, configuration, and type of aquifers and aquitards; (2) hydraulic properties of aquifers and aquitards; (3) natural groundwater recharge and discharge zones; (4) anthropogenic influence on groundwater (sources and sinks); and, (5) areal and vertical distribution of groundwater hydraulic head potential. These aquifer system components serve as the framework for the construction of a numerical groundwater flow model. A comprehensive CSM was developed in 2013 (ARCADIS, 2013) and was the basis for developing the Site groundwater flow model. Following the development of the CSM, additional groundwater parameter data collection activities (i.e., pumping and slug tests) were completed to support development of the Site groundwater flow model. The CSM will not be reiterated herein; however a discussion of the data collection activities and results is presented below.

The CSM (ARCADIS 2013) summarized information from historical Site documents including facility history reports, subsurface investigations, groundwater investigations, interim action activities, and feasibility studies. Specific data and documents often referred to in the CSM report are the:

- Final compliance soil samples collected in 2007/2008 during remedial excavation activities and documented in the Phase I Remedial Implementation As-Built Report (ARCADIS, 2009);
- FINAL Phase II Remedial Implementation As-Built Report (ARCADIS, 2010a);
- 2008 site investigation work that was conducted in the vicinity of the Washington State Department of Transportation (WSDOT) stormwater line and the former asphalt warehouse (ARCADIS, 2010b);
- 2011 site investigation work that incorporated a tidal study, pumping tests and investigated soil conditions in the vicinity of Detention Pond No.2 (DB-2) (ARCADIS, 2012a); and
- Summary of the investigation activities conducted as part of the Revised Feasibility Study Work Plan (ARCADIS, 2012b) in August of 2012 which included additional groundwater monitoring well installation, additional groundwater sampling and sediment sampling.

Please refer to the historical documents for the historical data, tables, figures, and laboratory reports.

2.1 Local and Site Geology

Local and Site geology are thoroughly described in the CSM (ARCADIS, 2013) and FS and are shown on Figures 3 and 4 herein.

As shown on Figures 3 and 4, five hydrostratigraphic units have been identified in the Lower Yard and are discussed in detail below:

1. *2008 Fill* (Figures 3 and 4). The 2007-2008 Interim Action excavations were backfilled to 6 to 12 inches above the observed groundwater table in the open excavations with poorly graded coarse gravel (⅜ to 1 inch) with little to no fines. Backfill material above the coarse gravel to ground surface was a mixture of very fine to medium sand, trace silt, and fine to medium gravel materials.

2. *1929 Fill* (Figures 3 and 4). This unit consists of silty sands with gravel and sandy silts with gravel. During the 2007-2008 Interim Action excavations, subsurface materials encountered from ground surface to a depth of 8 to 15 feet below ground surface (bgs) were mostly fill material placed circa 1929 or later, during the creation of the Lower Yard facility.

3. *Marsh Deposits* (Figure 4). In many areas of the Lower Yard, beneath the 1929 Fill, there is a layer ranging from 1 foot to 15 feet thick composed of silt and sandy silt with large amounts of organic matter such as peat, and wood debris. This layer is encountered at depths ranging from 8 to 14 feet bgs, directly below the 1929 Fill material, and is interpreted to be representative of the former marsh horizon beneath the Lower Yard. This layer is typically demarcated by a 6 to 12 inch thick layer of decomposing vegetation.

4. *Beach Deposits* (Figures 3 and 4). Below the 1929 Fill and Marsh Deposits, a poorly graded sand formation of very fine to medium sand with fine gravel is present, containing organic material such as driftwood and seashells. This layer is interpreted to be representative of the former beach environment in the area prior to creation of the Lower Yard.

5. *Whidbey Formation* (Figures 3 and 4). This material is a poorly graded sand layer consisting of very fine to medium sand with fine gravel and is distinct from the overlying materials in the Lower Yard. It is present to the maximum explored depth of 41.8 feet bgs by Unocal. This unit contains interbedded sand with silt, and interbedded silt and sandy silt are also present. The interbeds range in thickness from less than 1 inch to several feet, and appear to be laterally discontinuous. This unit is interpreted to be alluvium, and is likely part of the Whidbey Formation.

2.2 Site Hydrogeology

Groundwater in the Lower Yard occurs under unconfined conditions and is typically first encountered at depths varying between approximately 5 and 10 feet below ground (Figures 3 and 4). Based on the results of high-resolution water level measurements obtained during a four-week tidal study performed at the Site in 2011, groundwater at the Site is influenced by daily tidal cycles in Puget Sound, which was found to have a tidal range of approximately 14 feet adjacent to the Site (ARCADIS, 2013). Results of the tidal study and routine groundwater monitoring data indicated the following:

- Shallow groundwater levels at the Site fluctuated on the order of approximately 0.1 to 1.2 feet in response to tidal fluctuations in Puget Sound;

- Groundwater levels in monitoring wells screened in the Whidbey Formation fluctuated on the order of approximately 0.02 to 0.3 feet in response to tidal fluctuations in Puget Sound;

- Surface water elevations in Willow Creek and in Edmonds Marsh north of the Site fluctuated on the order of approximately 0.02 to 3.7 feet;

- Groundwater level fluctuations were correlated with surface water level fluctuations, which indicates that groundwater at the Site is hydraulically connected to and interacts with surface water in Puget Sound, Willow Creek, and Edmonds Marsh;

- Groundwater elevations are higher than elevations in DB-1;

- Groundwater at the Site is not hydraulically connected with DB-2, except under high water level conditions;

- Conductivity of Site groundwater exceeds 1,000 microsiemens per centimeter (μs/cm) in many locations along the perimeter of the Site, indicating that groundwater at the Site is naturally subject to salt water intrusion due to tidal fluctuations at Puget Sound.

A groundwater elevation contour map based on data collected during the third quarter of 2013 is presented as Figure 2. As shown, groundwater elevations in the third quarter of 2013 varied between approximately 5.5 and 10.5 feet above mean sea level (ft amsl). The direction of the Site hydraulic gradient was oriented north toward Edmonds Marsh and northwest toward Puget Sound, and the magnitude of the hydraulic gradient averaged approximately 0.002 feet per foot (ft/ft; Figure 2).

Also as shown on Figure 2, there is a potentiometric mound located in the southeast Lower Yard area which is discussed further in the CSM (ARCADIS 2013). This potentiometric mound occurs in a topographically low area of the Site that is also located at the base of a steep hill. The potentiometric mound is associated with localized increased recharge to the water table (i.e., surface water infiltration) due primarily to topography.

Results of hydraulic conductivity tests conducted at Site monitoring wells in 2011 indicate that hydraulic conductivity values vary over approximately three to four orders of magnitude, depending on location, throughout the Lower Yard (ARCADIS, 2012a). Specifically, the 2011 hydraulic conductivity test results varied between approximately 0.06 feet per day (ft/day) and 345 ft/day. This information indicates that subsurface materials at the Site are highly heterogeneous. Furthermore, it was found that the 1929 Fill has a much lower permeability than the 2008 Fill. Particularly, hydraulic conductivity of the 1929 Fill ranged from approximately 0.2 to 15 ft/day and hydraulic conductivity of the 2008 Fill ranged from approximately 2.5 to 345 ft/day (ARCADIS, 2012a).

2.3 2013 Pumping Tests

2.3.1 Short-term, single-well constant-rate pumping tests

To support development of the Site groundwater flow model, short-term, single-well pumping tests were conducted at six monitoring wells (MW-122, MW-147, MW-510, MW-203, MW-511, and MW-522). During testing, these wells were pumped at a relatively constant rate, and changes in water levels were recorded using submerged pressure transducers equipped with a data logger and confirmed with manual depth-to-water measurements. Test durations varied between approximately 30 and 45 minutes. Appropriate flow rates for test analyses were identified based on periodic flow rate measurements and total pumping volumes recorded by site personnel during each test.

Drawdown and recovery data measured at each test well were analyzed using the AQTESOLV for Windows® software (Duffield, 2007). Two analytical models were used to analyze test data; drawdown data were evaluated using the Cooper-Jacob (1946) straight-line approximation of the Theis solution, and recovery data were analyzed using the Theis residual-drawdown method (Theis 1935) for several tests. Applicability of the Cooper-Jacob solution to drawdown data was assessed using test diagnostics (radial flow plots and derivative analysis). Time-drawdown data for several of the tests indicated variations in the flow rate; for these tests, an approximate fit was obtained to provide a general estimate of transmissivity and hydraulic conductivity. A summary of the analytical solutions applied to drawdown and/or recovery data for each test, and resultant hydraulic conductivity estimates, are presented in Table 1. The data and analyses are provided in Attachment 1. As shown, estimated hydraulic conductivity values measured in 2013 were found to vary between approximately 0.36 ft/day and 51 ft/day.

2.3.2 Slug Tests

A series of slug tests were conducted at five monitoring wells (MW-108, MW-109, MW-126, MW-522, MW-530) and three piezometers (P-4, P-8, P-16). Each series consisted of one to three slug tests at each well. Slug tests were performed on each monitoring well by submerging a disposable bailer below the water table, waiting until water levels returned to static conditions, and then removing the bailer from the well (i.e., slug out test or rising-head test) while measuring the water-level response until static conditions were again reached. Use of empty disposable bailers to create displacement instead of solid slugs precludes analysis of falling-head test data (slug-in) because it violates the assumption of instantaneous slug introduction. A pressure transducer equipped with a data logger was used to record changes in water level within the well during each test.

Response data (i.e., elapsed time and corresponding changes in water levels) collected during each test were converted to displacement data and analyzed using AQTESOLV for Windows® (Duffield, 2007) to obtain near-well hydraulic conductivity estimates (Table 2). Appropriate and applicable analytical solutions available in AQTESOLV were applied following the guidelines presented in *The Design, Performance, and Analysis of Slug Tests (*Butler, 1998). The Bouwer and Rice (1976) straight-line solution was selected for test data which exhibited the double-straight line pattern associated with filter pack drainage for wells screened across the water table. The Bouwer-Rice recommended head range for the best curve fit was employed for tests which did not exhibit effects of filter pack drainage. Test data collected at MW-530, P-4, and P-8 displayed a concave-upward shape on a semi-log (log-linear) plot, which is associated with horizontal flow conditions; consequently, the rising-head tests conducted at these wells were analyzed using the Cooper et al. (1967) model for fully-transient conditions. Water level responses to both tests conducted at MW-510 were coincident (very similar), therefore analysis of the second test was not necessary. Three tests were conducted at MW-530; the first test conducted at this well was not analyzed due to excessive noise in test data. AQTESOLV solution plots are provided in Attachment 2.

As shown in Table 2, estimated near-well hydraulic conductivities for site wells varied from 0.02 ft/day to 17.3 ft/day. Note that slug test results can be significantly impacted by drilling-induced disturbances (e.g., well skin effects and/or borehole damage) and insufficient well development. The impacts and effects caused by these near-well disturbances are difficult to avoid when performing slug tests and analyzing results. As such, hydraulic conductivity estimates derived from slug tests should be considered to be the lower bound of the hydraulic conductivity of the formation in the vicinity of the well (Butler, 1998). An example of this effect is shown by comparison of hydraulic conductivities estimated for well MW-522 from pumping test data (24 ft/day) and slug test data (17.3 ft/day).

The results from these tests were compiled with hydraulic conductivity estimates from previous investigations and used in parameterization of the groundwater flow model.

3. Groundwater Flow Model Construction

The primary phases in the development of the Site groundwater flow model included construction of a finite-difference grid for the model area, specification of model structure, assignment of boundary conditions, specification of hydraulic parameter values and zones, and selection of appropriate water-level measurements for calibration of the model. These elements form the hydrogeologic conceptual site model, which serves as the basis for the construction and subsequent calibration of the numerical model to observed groundwater flow conditions at the Site.

3.1 Code Selection and Description

For the construction and calibration of the numerical groundwater flow model at the Site, ARCADIS selected the simulation program MODFLOW, a publicly-available groundwater flow simulation program developed by the U.S. Geological Survey (USGS) (McDonald and Harbaugh, 1988). MODFLOW is thoroughly documented, widely used by consultants, government agencies and researchers, and is consistently accepted in regulatory and litigation proceedings. In addition, ARCADIS has developed utilities for use with MODFLOW to ease in the construction and calibration of groundwater models.

MODFLOW can simulate transient or steady-state saturated groundwater flow in one, two, or three dimensions and offers a variety of boundary conditions including specified head, areal recharge, injection or extraction wells, evapotranspiration, horizontal flow barriers (HFB), drains, and rivers or streams. Aquifers simulated by MODFLOW can be confined or unconfined, or convertible between confined and unconfined conditions. For the Site, which consists of a heterogeneous geologic system with variable unit thicknesses and boundary conditions, MODFLOW's three-dimensional capability and boundary condition versatility are essential for the proper simulation of groundwater flow conditions.

3.2 Model Discretization

The finite-difference technique employed in MODFLOW to simulate hydraulic head distributions in multi-aquifer systems requires horizontal and vertical discretization, or subdivision of the continuous aquifer system into a set of discrete blocks that form a three-dimensional model grid. Water levels computed for each block represent an average water level over the volume of the block. Thus, adequate discretization (i.e., a sufficiently fine grid) is required to resolve features of interest, and yet not be computationally burdensome. MODFLOW allows the use of variable grid spacing such that a model may have a finer grid in areas of interest where greater accuracy is required and a coarser grid in areas requiring less detail.

The Site groundwater model grid is shown on Figure 5. As shown, the model grid covers approximately 1.5 square miles. The boundaries of the model grid were specified to coincide with surface water bodies where present. Assigned head boundaries were selected based on estimated regional water level contours. The finite-difference grid is composed of 207 rows, 211 columns, and 4 layers for a total of 142,280 active nodes (Figure 5). The model grid was constructed using a variably spaced grid; in the area where groundwater remediation alternatives are being considered the grid cell size is 10 feet by 10 feet. At the perimeter of the model grid the largest cell size increases to a maximum of 100 feet by 200 feet.

CTECH Development Corporation’s Mining Visualization System (MVS) was utilized as part of the model development using lithologic information available from site monitoring wells and piezometers and limited, available information from soil borings completed in the surrounding area (off-site). This MVS-based representation of hydrostratigraphy was imported in the Groundwater Vistas (Rumbaugh and Rumbaugh, 2007) groundwater flow model interface and formed the basis for vertical discretization. A memorandum discussing the analysis of Site geologic data using MVS and additional figures produced through MVS is presented in Attachment 3.

The Site groundwater model layers are shown on Figure 6. The four model layers were defined to provide an approximate vertical profile of the Site hydrostratigraphy and also to allow for simulation of partially-penetrating extraction wells or interceptor trenches. Vertical discretization was also accomplished by assigning different hydraulic conductivity zones throughout the various layers as shown in Figure 6, to account for vertical heterogeneity.

Outside the vicinity of the Site, model layer elevations and trends were extended to the model boundaries.

3.3 Boundary Conditions

External boundary conditions must be imposed to define the spatial boundaries of the model on all sides of the model grid. In addition to these external boundary conditions, internal boundary conditions such as sources and sinks of groundwater including wells, drains, and rivers can be included within the model's boundaries. A boundary condition can represent different types of physical boundaries, depending on the rules that govern groundwater flow across the boundary.

The Site groundwater flow model boundary conditions are shown on Figure 7. As shown, there are five types of boundary conditions used in the Site groundwater flow model:

1. Constant head boundaries are used to represent relatively constant sources or sinks of groundwater, including large surface water features such as Puget Sound, and either provide or remove groundwater depending on the hydraulic gradient direction near the boundary;

2. River-type boundaries are used to represent rivers and streams which may either be sources of sinks of groundwater;

3. General head boundaries are used to represent constant fluxes of groundwater to or from a model;

4. Drains, which remove groundwater; and

5. Inactive or no-flow boundaries.

As shown on Figure 7, the western and northern model boundaries are coincident with the Puget Sound and were represented in the Site groundwater flow model using constant-head cells with surface water elevations derived from gauging data provided by NOAA. The constant head boundaries at Puget Sound were specified at the average surface water elevation in Puget Sound during model calibration, and adjusted to account for high-tide scenarios during predictive simulations. Puget Sound is assumed to fully penetrate the full thickness of the model domain and therefore constant head cells were applied to model layers 1 through 4.

Also as shown on Figure 7, the southern, northern, and eastern model boundaries were selected to be coincident with physically-based features, Deer Creek on the south and Shelleberger Creek on the north and east. These creeks were simulated in the Site groundwater flow model as river boundaries. Surface water elevations along Deer and Shelleberger Creeks were derived from the USGS topographic map and were used to specify the water levels in the river boundaries. Willow Creek was simulated as an internal river boundary. Surface water elevations along Willow Creek were derived from the USGS topographic map.

The southeastern perimeter of the Site groundwater flow model was assigned as a general head boundary through all model layers, representing regional groundwater flow entering the model domain from upland portions of the groundwater system. Data from the USGS were used to specify the general head boundaries.

DB-1 was simulated as an internal drain-type boundary which removes groundwater from the model because surface water elevations in DB-1 are lower than groundwater elevations measured in nearby monitoring wells. Furthermore, DB-1 is unlined and surface water is pumped out of DB-1 and into Willow Creek.

Precipitation infiltration, also known as recharge, is also considered a boundary condition because recharge can add water to the top of the model at the water table. Recharge reaching the water table was simulated using three zones in model layer 1 and was specified using knowledge of ground surface cover, topography, and annual precipitation rates. The off-site areas of the model, and portion of the site were assigned an initial recharge rate of 3.6 inches per year (in/yr), which is approximately 10% of annual recharge. Locally, higher precipitation rates were assigned. On the east side of the Lower Yard, a groundwater mound is regularly observed at the site. This mound was replicated in the model through the assignment of an area of elevated recharge representing run-off from the adjacent Upper Yard; a recharge rate of approximately 15 in/yr, which is approximately 40% of annual recharge. On the north side of the Lower Yard, an elevated recharge rate of 24 in/yr (approximately 60% of annual recharge) was applied to the gravel covered areas of the site. (*NOAA Online Weather Data, NOWData, Daily Climate Normals, 1981-2010, Precipitation, Seattle Tacoma Intl Ap* (NOAA, 2013). Recharge rates were also adjusted during calibration.

The bottom of the Site groundwater flow model was assigned as a no-flow boundary condition.

3.4 Hydraulic Parameters

The main hydraulic parameter that had to be specified in the Site groundwater flow model is soil hydraulic conductivity, because hydraulic conductivity governs groundwater flow rates and patterns under steady-state flow conditions. Specific yield and storativity are also important aquifer characteristics, but these storage parameters govern groundwater flow under transient conditions and were therefore not utilized.

The Site groundwater flow model was initialized using hydraulic conductivity values based on Site-specific hydraulic conductivity testing data, where available. For areas of the model domain without hydraulic conductivity testing data, hydraulic conductivity values were specified based on literature values associated with known soil types. During calibration, hydraulic conductivity zones were added and parameter values were adjusted within reasonable ranges to minimize the difference between observed and simulated groundwater elevations.

The final, calibrated hydraulic conductivity distributions for model layers 1 through 4 are shown on Figures 8 through 11, respectively. The hydraulic conductivity zones assigned in the model are summarized in Table 3.

As shown on Figure 8, model layer 1 is the most heterogeneous layer due to the presence of multiple soil types and excavated areas containing backfill. The hydraulic conductivity zones shown on Figure 8 represent 1929 fill materials, 2008 fill materials, off-shore gravel deposits, and the Whidbey formation and associated glacial deposits. The remainder of the hydraulic conductivity zones in layer 1 was specified during calibration. Hydraulic conductivity values used in layer 1 varied between 0.1 and 75 ft/day.

As shown on Figure 9, model layer 2 contained five hydraulic conductivity zones representing fill materials, marsh deposits, beach deposits, off-shore gravel deposits, and the Whidbey formation. Hydraulic conductivity values used in layer 2 varied between 0.25 and 75 ft/day.

As shown on Figure 10, model layer 3 contained three hydraulic conductivity zones representing marsh deposits, off-shore gravel deposits, and the Whidbey formation. Hydraulic conductivity values used in layer 3 varied between 1.5 and 75 ft/day.

As shown on Figure 11, model layer 4 consisted of the Whidbey formation with a hydraulic conductivity of 1.5 ft/day.

3.5 Calibration Targets

Calibration targets are a set of field measurements, typically groundwater elevations, used to test the ability of the groundwater flow model to reproduce observed conditions within a groundwater flow system. For the calibration of a steady-state (time-invariant) model, the goal in selecting calibration targets is to define a set of water-level measurements that represent the average elevation of the water table or potentiometric surface at locations throughout the Site.

Table 4 presents the monitoring wells and water-level elevations selected for the calibration of the Site groundwater flow model. As shown, calibration targets selected for the Site groundwater flow model are the average water-level elevations calculated from quarterly groundwater-level measurements collected in 2013 that comprise a total of 69 monitoring wells located throughout the site. This calibration target set was selected because it represents average groundwater elevation conditions.

4. Groundwater Flow Model Calibration

Calibration of a groundwater flow model refers to the process of estimating unknown model parameters, for example at un-sampled locations, by adjusting parameters within reasonable ranges until simulated groundwater levels are consistent with measured groundwater levels. Model calibration is typically an iterative procedure that involves adjustment of hydraulic properties or boundary conditions to achieve the best match between simulated and measured groundwater levels. Boundary condition values and hydraulic conductivity values at un-sampled locations were adjusted during calibration of the Site groundwater flow model.

4.1 Calibration Procedure

As discussed above, the Site groundwater flow model was calibrated using average groundwater levels measured at 69 Site monitoring wells in 2013 (Table 4). A representative groundwater contour map of the water table (i.e., layer 1) is shown on Figure 2.

Calibration of the Site groundwater flow model required numerous individual computer simulations. The parameter values and shapes of the hydraulic conductivity zones in the model were gradually varied within reason until an acceptable match was achieved with the CSM. Calibration was achieved using MODFLOW and parameter estimation techniques designed for use with MODFLOW.

4.2 Calibration Results

Calibration results for the final, calibrated Site groundwater flow model are shown visually as a scatter-plot on Figure 12. As shown, simulated groundwater levels were consistent with measured groundwater levels as indicated by a Pearson correlation coefficient of approximately 0.85. This result shows that the model is reasonably calibrated for the intended purpose. The scatter in the simulated and measured datasets is due primarily to the fact that groundwater at the Site is tidally influenced and groundwater levels fluctuate daily, which introduces uncertainty in groundwater level measurements. The scatter in the simulated and measured datasets is also due to the heterogeneity of soils at the Site.

Model calibration was also evaluated by analyzing simulated hydraulic head distributions across the Site and residual statistics, as described below.

4.2.1 Simulated Hydraulic Head Distributions

Another way to evaluate model calibration is by comparing contour maps of simulated and measured groundwater elevations to ensure that the Site groundwater flow model is capable of simulating actual hydraulic gradient patterns.

A contour map of simulated groundwater elevations at the water table (i.e., in layer 1) is presented as Figure 13. A visual comparison of Figure 13 (simulated groundwater elevations) and Figure 2 (measured groundwater elevations) shows that the Site groundwater flow model accurately simulates hydraulic gradient patterns present at the Site. Specifically, Figure 13 shows that the direction of the simulated hydraulic gradient is oriented north toward Edmonds Marsh and northwest toward Puget Sound, and the magnitude of the simulated hydraulic gradient averages approximately 0.002 ft/ft. Furthermore, the Site groundwater flow model accurately predicts the location and magnitude of the potentiometric mound located in the southeast Lower Yard area.

4.2.2 Analysis of Residuals

A “residual” is defined as the mathematical difference between a simulated and measured value, and the goal of model calibration is to minimize the sum of all residuals within a model. Therefore, analyzing residuals is another method for evaluating the robustness of model calibration.

Table 4 shows the residuals for each of the calibration targets in the calibrated Site groundwater flow model. These residuals were calculated by subtracting simulated groundwater elevations from observed groundwater elevations at the target locations. Thus, a negative residual indicates a location where the model has over-predicted the measured groundwater elevation and a positive residual indicates a location where the model has under-predicted the measured groundwater elevation.

As shown in Table 4, the Site groundwater model residuals are within approximately 10% of the observed head range (i.e., plus or minus 0.75 feet) and 90% of the calibration targets have residuals less than or equal to 1 foot, which indicates the model is well calibrated for its intended purpose. A summary of the residual statistics is shown below:

Table 5. Summary of Calibration Statistics

Model Calibration Statistic	Value
Number of Calibration Targets	69
Range in Measured Values	7.37 feet
Minimum Residual	-2.82 ft msl
Maximum Residual	2.06 ft msl
Residual Mean	0.01 ft msl
Residual Standard Deviation	0.75 ft
Residual Standard Deviation / Range	0.10

As shown, model residuals varied between approximately -2.82 and 2.06 ft msl which is consistent with the calibration scatter plot shown on Figure 13**.** This result indicates that simulated groundwater elevations were within approximately two to three feet of measured average groundwater elevations, which is considered acceptable given the tidally influenced nature of the groundwater system at the Site and the high degree of heterogeneity. The residual mean of 0.01 ft indicates that there is very little to negligible bias in the model predictions; in other words under-predicted values balanced out over-predicted values. The residual standard deviation of 0.75 feet also indicates that the Site groundwater flow model is well-calibrated. Importantly, the value of residual standard deviation divided by total range of measured values was 0.10 (i.e., 10%), which is generally considered to be an indication of a well-calibrated model (Anderson and Woessner, 1992).

These results indicate that a high degree of calibration has been achieved for the Site groundwater flow model. Overall the model shows a good match between simulated and measured groundwater elevations and is suitable for its intended purpose.

5. Evaluation of Potential Groundwater Remediation Scenarios

The calibrated Site groundwater flow model was used to evaluate four potential groundwater remediation scenarios as follows:

1. Hydraulic containment using a series of groundwater extraction wells.

2. Hydraulic containment using a groundwater interceptor trench.

3. Soil excavation near DB-1 and DB-2.

4. Soil excavation near the WSDOT owned storm drain line (south side of Lower Yard).

To accomplish this, internal boundary conditions such as extraction wells, high hydraulic conductivity zones, or vertical flow barriers were added to the Site groundwater flow model as necessary to simulate each scenario. After the internal boundary conditions were added, the Site groundwater flow model was run at steady-state conditions to estimate average flow rates and predict resulting changes in groundwater flow patterns. External boundary conditions were also modified during evaluation of the potential remediation scenarios to predict potential groundwater flow rates and patterns that may occur under high tide conditions and extreme rainfall events. High tides were simulated by raising the assigned constant head elevation by 5 ft. The extreme rainfall event incorporated both a high tide condition and a doubling of assigned recharge rates.

To evaluate the effectiveness of the hydraulic containment scenarios (i.e., Scenarios 1 and 2), the Site groundwater flow model was used to estimate the extent of the capture zone resulting from hypothetical groundwater extraction. A "capture zone" is defined as the spatial area that contributes groundwater to the pumping system; in other words, a capture zone is an area of hydraulic containment. The objective of these simulations was to adjust the locations of the simulated extraction wells or interceptor trenches, and to adjust the simulated groundwater extraction rates, until the shape of the predicted capture zone fully encompassed the target remediation area.

For the soil excavation area scenarios (i.e., Scenarios 3 and 4), the Site groundwater flow model was used to estimate the construction dewatering rates that would be required during remediation.

The following subsections describe the evaluation of these potential remediation scenarios.

5.1 Remediation Scenario 1 – Hydraulic Containment Using Extraction Wells

Remediation scenario 1 involves hydraulic containment of remaining impacts near DB-1 and DB-2 as shown on Figure 14 using a series of six groundwater extraction wells. A conceptual layout of the six groundwater extraction wells and the resulting predicted capture zone is shown on Figure 14. As shown, it is theoretically possible to hydraulically contain the remaining impacts near DB-1 and DB-2 using groundwater extraction wells pumping at a long-term average combined rate of approximately 3 to 5 gallons per minute, which would include both high-tide conditions and short-duration rainfall events.

This scenario is based on the following assumptions and limitations:

- The extraction wells would need to be installed to total depths of approximately 15 to 20 feet below ground;
- The intake portion of the extraction wells would need to extend to an elevation of approximately 0.25 ft msl or lower (i.e., drain elevation);
- The extraction wells are 100% efficient; and,
- The potential exists for pumping-induced salt-water intrusion to further degrade groundwater quality.

5.2 Remediation Scenario 2 – Hydraulic Containment Using an Interceptor Trench

Remediation scenario 2 involves hydraulic containment of remaining impacts near DB-1 and DB-2 as shown on Figure 15 using a groundwater interceptor trench. A conceptual layout of the groundwater interceptor trench and the resulting predicted capture zone is shown on Figure 15. As shown, it is theoretically possible to hydraulically contain the remaining impacts near DB-1 and DB-2 using a groundwater interceptor trench pumping at a long-term average rate of approximately 4 to 7 gallons per minute, which would include both high-tide conditions and short-duration rainfall events.

This scenario is based on the following assumptions and limitations:

- The interceptor trench would be installed to a total depth of approximately 15 to 20 feet below ground;
- The intake portion of the interceptor trench would need to extend to an elevation of approximately 0.25 ft msl or lower (i.e., drain elevation);

- The backfill of the interceptor trench would need to have a hydraulic conductivity of 1,000 feet per day; and,
- The potential exists for pumping-induced salt-water intrusion to further degrade groundwater quality.

5.3 Remediation Scenario 3 – Soil Excavation near DB-1 and DB-2

Remediation scenario 3 involves excavating remaining impacts below the water table near DB-1 and DB-2 from the approximate area shown on Figure 16 using conventional soil excavation and construction dewatering equipment. A conceptual layout of the excavation and the resulting predicted changes in groundwater flow patterns are shown on Figure 16. As shown, it is theoretically possible to excavate the remaining impacts near DB-1 and DB-2 using a construction dewatering strategy that would require an average pumping rate of approximately 10 gallons per minute. High tide or short-duration rainfall events may result in the need for excavation dewatering at an average rate of 23 gallons per minute.

This scenario is based on the following assumptions and limitations:

- The total depth of the construction dewatering system would need to be approximately 15 to 20 feet below ground;

- The intake portion of the construction dewatering system would need to extend to an elevation of approximately 0.25 ft msl or lower (i.e., drain elevation);

- Faster dewatering rates during the initial phase of excavation may be required; and,

- The potential exists for pumping-induced salt-water intrusion to further degrade groundwater quality.

5.4 Remediation Scenario 4 – Soil Excavation near the WSDOT storm drain

Remediation scenario 4 involves excavating remaining impacts below the water table near the WSDOT storm drain from the approximate area shown on Figure 17 using conventional sheet pile walls, soil excavation and construction dewatering equipment. A conceptual layout of the excavation and the resulting predicted changes in groundwater flow patterns are shown on Figure 17. As shown, it is theoretically possible to excavate the remaining impacts near the WSDOT storm drain using sheet pile walls and a construction dewatering strategy that would require an average pumping rate of approximately 60 gallons per minute. High tide or short-duration rainfall events may result in the need for excavation dewatering at an average rate of 75 gallons per minute.

This scenario is based on the following assumptions and limitations:

- The total depth of the construction dewatering system would need to be approximately 30 feet below ground;
- The intake portion of the construction dewatering system would need to extend to an elevation of approximately -15 ft msl or lower (i.e., drain elevation);
- The excavation may encounter fill materials, beach deposits, and marsh deposits, and would terminate at the top of the Whidbey Formation;
- The hydraulic conductivity of the sheet pile walls is 0.003 feet per day.
- Faster dewatering rates during the initial phase of excavation may be required; and,
- The potential exists for pumping-induced salt-water intrusion to further degrade groundwater quality.

6. Summary

Historic and recent hydrogeologic data collected at the Former Unocal Edmonds Bulk Fuel Terminal Site in Edmonds, Washington, and additional regional information found in the literature were used to construct and calibrate a three-dimensional groundwater flow model for the Site. The model was constructed to support the evaluation of four potential remediation scenarios. The model was used to evaluate groundwater flow under both existing (present day) conditions and the various remediation scenarios.

Results of the work provided conceptual design layouts and estimated groundwater extraction rates, and demonstrate that the four remediation scenarios are theoretically possible. However, the assumptions and limitations associated with each scenario should be carefully evaluated during completion of the feasibility study.

7. References

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Table 1

Constant-Rate Pumping Test Results

Unocal Edmonds Bulk Fuel Terminal Lower Yard

11720 Unoco Road

Edmonds, Washington

Well ID	Date	Static Depth-to-Water (ft bTOC)	Calculated Water Column in well (ft)	Pumping Duration (min)	Pumping Rate (gpm)	Maximum Drawdown (ft)	Method of Analysis	Estimated Transmissivity (ft^2/day)	Calculated Hydraulic Conductivity (ft/day)
MW-122	3/5/2013	7.26	35.36	44.94	3.36	3.28	Cooper-Jacob	165	17
							Theis Recovery	188	19
MW-147	3/5/2013	5.29	8.11	29.95	3.67	1.69	Cooper-Jacob	360	47
							Theis Recovery	396	51
MW-510	3/6/2013	6.11	6.59	39.88	0.22	3.35	Cooper-Jacob	6.4	0.93
							Theis Recovery	2.5	0.36
MW-203	3/4/2013	22.23	8.37	29.87	2.50	0.94	Cooper-Jacob	191	21
MW-511	3/4/2013	7.16	7.84	29.90	3.50	2.54	Cooper-Jacob	97	12
MW-522	3/5/2013	8.20	5.05	29.83	0.55	0.62	Cooper-Jacob	117	24

Notes:

1. bTOC = below the top of casing

2. Cooper-Jacob modification of the Theis method. Cooper, H.H. and C.E. Jacob, 1946. A generalized graphical method for evaluating formation constants and summarizing well field history, Am. Geophys. Union Trans., vol. 27, pp. 526-534.

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4. Hydraulic conductivity was calculated by dividing estimated transmissivity results by the saturated screen length for each well.

Table 2
Slug Testing Results

Unocal Edmonds Bulk Fuel Terminal Lower Yard
11720 Unoco Road
Edmonds, Washington

Well ID	Test ID	Date	Static Depth-to-Water (ft bTOC)	Calculated In-Well Water Column (ft)	Initial Displacement (Ho, ft)	Screened across the Water Table?	Method of Analysis	Estimated Hydraulic Conductivity (ft/day)
MW-108	1	3/6/2013	5.45	9.67	1.50	YES	Bouwer-Rice (6.11b)[1]	0.02
MW-109	1	3/7/2013	6.88	8.22	1.68	YES	Bouwer-Rice (6.11b)	0.091
MW-126	1	3/6/2013	4.05	9.75	1.62	YES	Bouwer-Rice (6.11b)	0.23
	2	3/7/2013	3.90	9.90	1.63	YES	Bouwer-Rice (6.11b)	0.21
MW-522	1	3/7/2013	8.09	5.16	1.67	YES	Bouwer-Rice (6.11b)	17.3
	2	3/7/2013	8.09	5.16	1.68	YES	NA[2]	NA
MW-530	1	3/6/2013	4.58	6.39	1.34	NO	NA[3]	NA
	2	3/7/2013	4.56	6.59	1.10	NO	Cooper-Bredehoeft-Papadopulos[4]	1.2
	3	3/7/2013	4.56	6.59	1.29	NO	Cooper-Bredehoeft-Papadopulos	0.88
P-16	1	3/6/2013	2.44	10.71	1.33	NO	Bouwer-Rice (3.1)[5]	0.85
P-4	1	3/7/2013	7.50	14.55	1.49	NO	Cooper-Bredehoeft-Papadopulos	0.34
P-8	1	3/7/2013	7.49	16.89	1.50	NO	Cooper-Bredehoeft-Papadopulos	0.3
	2	3/7/2013	7.49	16.89	0.62	NO	Cooper-Bredehoeft-Papadopulos	0.34

Notes:

1. Bouwer-Rice (1976) method, unconfined solution, with the Butler (6.11b) effective casing correction for wells screened across the water table (Butler, 1998).

2. Analysis of test not performed due to coincidence of repeat test data

3. Analysis of test not performed due to high levels of noise in test results

4. Hydraulic conductivity calculated by dividing estimated transmissivity by the saturated screen length for tests analyzed using the CBP solution.

Table 3.
Groundwater Flow Model Parameters

Unocal Edmonds Bulk Fuel Terminal Lower Yard
11720 Unoco Road
Edmonds, Washington

Model Parameter	Model Layer	Modeled Range		Notes / Boundary Location / Unit Description
Areal Recharge (in/yr)	1	3.6, 15, and 24		model wide, east Lower Yard and North Lower Yard
Shelleberger Creek Stage (ft absl)	1	180 to 0		eastern model boundary
Deer Creek Stage (ft absl)	1	238 to 0		southern model boundary
Willow Creek Stage (ft absl)	1	145 to 0		internal boundary
Puget Sound Elevation (ft absl)	1 - 4	0		northern and western model boundary
Drain Elevation (DB-1)	1	6		on-site retention basin
General Head Boundary Elevation (ft absl)	1 - 4	290		southeastern model boundary
Hydraulic Conductivity (ft/d)		**Horizontal**	**Vertical**	
2008 Fill	1	25	1.5e-1	Coarse Sand, Gravel
1929 Fill	1	0.75	0.75	Silty Soil, Debris
Marsh Deposits	1, 2	0.85	8.5e-4	Silt
Beach Deposits	3	45	4.0e-1	Sand
Off-shore Gravel	1, 2, 3	75	75	Gravel
Whidbey Formation	1, 2, 3, 4	1.5	5e-1	Sand to Semi-Consolidated Sand

notes:
in/yr inches per year.
ft absl feet above sea level.
ft/d feet per day.

Table 4.
Calibration Targets and Residuals

Unocal Edmonds Bulk Fuel Terminal Lower Yard
11720 Unoco Road
Edmonds, Washington

Well ID	Model Layer	Model Row	Model Column	Simulated Heads (ft msl)	Observed Heads (ft msl)	Residual[1] (ft)
LM-2	1	56	91	5.06	6.17	1.11
MW-8R	1	84	62	6.05	6.04	-0.01
MW-13U	1	90	98	8.17	8.76	0.59
MW-20R	1	81	67	6.20	5.87	-0.33
MW-101	1	75	72	6.25	6.44	0.19
MW-104	1	78	70	5.85	6.21	0.36
MW-108	1	60	99	6.17	6.35	0.18
MW-109	1	68	107	6.31	6.51	0.20
MW-122	4	82	108	7.59	8.02	0.43
MW-126	1	89	73	6.17	8.23	2.06
MW-129R	1	82	106	7.56	7.14	-0.42
MW-131	1	74	98	7.31	6.92	-0.39
MW-135	1	93	119	10.02	7.46	-2.56
MW-136	1	99	125	8.73	8.41	-0.32
MW-139R	1	68	80	6.45	7.04	0.59
MW-143	1	88	70	6.18	7.88	1.70
MW-147	1	89	57	6.04	5.94	-0.10
MW-149R	1	98	49	6.45	5.75	-0.70
MW-151	1	94	57	6.17	6.49	0.32
MW-203	1	100	109	11.49	8.66	-2.83
MW-500	1	92	113	12.44	12.62	0.18
MW-501	1	88	109	12.27	12.16	-0.11
MW-502	1	85	92	7.74	7.99	0.25
MW-503	1	82	93	7.61	7.34	-0.27
MW-504	1	77	94	7.50	7.04	-0.46
MW-505	1	76	90	7.30	7.06	-0.24
MW-506	1	73	95	7.37	7.07	-0.30
MW-507	1	71	92	7.11	6.95	-0.16
MW-508	1	70	88	6.38	6.99	0.61
MW-509	1	70	84	6.65	7.07	0.42
MW-510	1	64	83	6.40	6.29	-0.11
MW-511	1	87	83	7.67	8.12	0.45
MW-512	1	82	82	7.12	7.05	-0.07
MW-513	1	78	80	6.94	7.06	0.12
MW-514	1	80	79	6.92	7.05	0.13
MW-515	1	74	78	6.66	7.05	0.39

Table 4.
Calibration Targets and Residuals

Unocal Edmonds Bulk Fuel Terminal Lower Yard
11720 Unoco Road
Edmonds, Washington

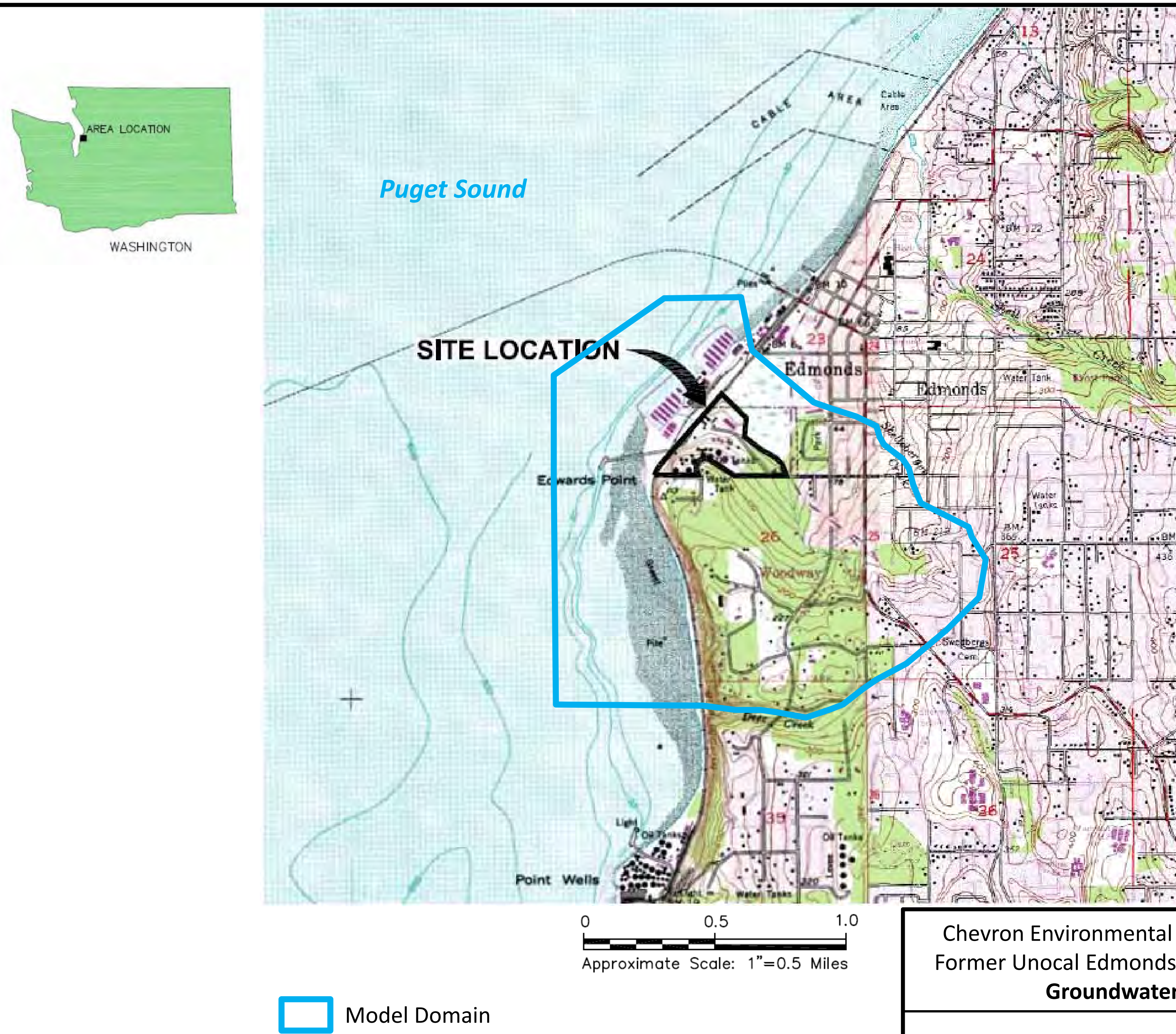
Well ID	Model Layer	Model Row	Model Column	Simulated Heads (ft msl)	Observed Heads (ft msl)	Residual[(1)] (ft)
MW-516	1	76	77	6.62	7.05	0.43
MW-517	1	77	76	6.58	7.04	0.46
MW-518	1	71	76	6.31	6.48	0.17
MW-519	1	87	68	6.25	6.04	-0.21
MW-520	1	85	66	6.24	6.06	-0.18
MW-521	1	87	65	6.25	6.03	-0.22
MW-522	1	83	63	6.13	6.02	-0.11
MW-523	1	86	60	6.05	6.03	-0.02
MW-524	1	93	54	6.17	6.08	-0.09
MW-525	1	84	73	6.39	6.62	0.23
MW-526	1	84	83	7.24	7.99	0.75
MW-527	1	98	117	10.82	10.08	-0.74
MW-528	1	100	121	10.78	10.27	-0.51
MW-529	1	64	82	6.15	5.86	-0.29
MW-530	1	54	91	5.96	5.78	-0.18
MW-531	1	84	71	6.20	5.89	-0.31
MW-532	1	86	73	6.32	6.80	0.48
P-1	1	86	107	11.42	12.82	1.40
P-2	3	88	108	8.78	8.42	-0.36
P-3	1	89	109	12.78	12.10	-0.68
P-4	3	92	113	9.82	8.55	-1.27
P-5	1	93	113	13.13	12.24	-0.89
P-6	1	94	116	11.94	13.12	1.18
P-7	3	94	116	10.34	8.74	-1.60
P-8	3	86	107	8.25	8.35	0.10
P-9	1	73	96	7.39	7.04	-0.35
P-10	1	69	89	6.19	6.93	0.74
P-11	1	69	88	6.33	7.04	0.71
P-12	1	66	84	6.55	6.55	0.00
P-13	1	65	82	6.52	7.32	0.80
P-14	1	64	83	6.38	6.13	-0.25
P-15	1	61	85	6.26	5.95	-0.31
P-16	1	63	87	6.09	6.28	0.19

notes:

(1) Residuals are computed by subtracting observed water levels from simulated water levels.

ft : feet.

ft msl : feet above mean sea level.



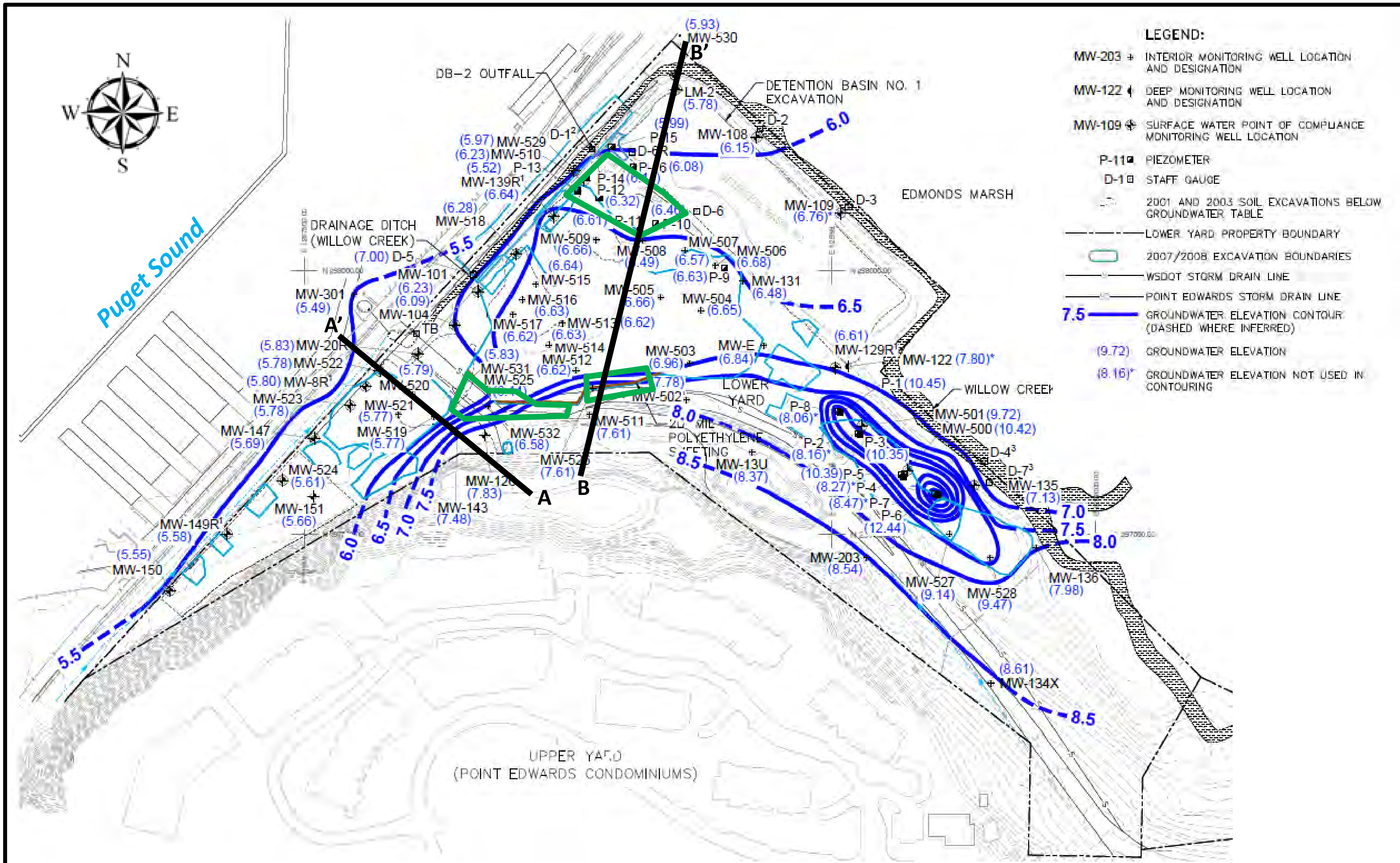
Chevron Environmental Management Company
Former Unocal Edmonds Terminal, Edmonds, WA
Groundwater Flow Model

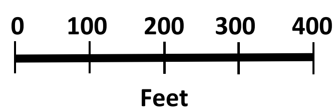
Site Location

ARCADIS

FIGURE
1

Source: USGS Quads., 7.5 Min. Series (Topographic) – Edmonds East, Wash., and Edmonds West, Wash.





Potential Remediation Area (Approx)

Cross Section Location

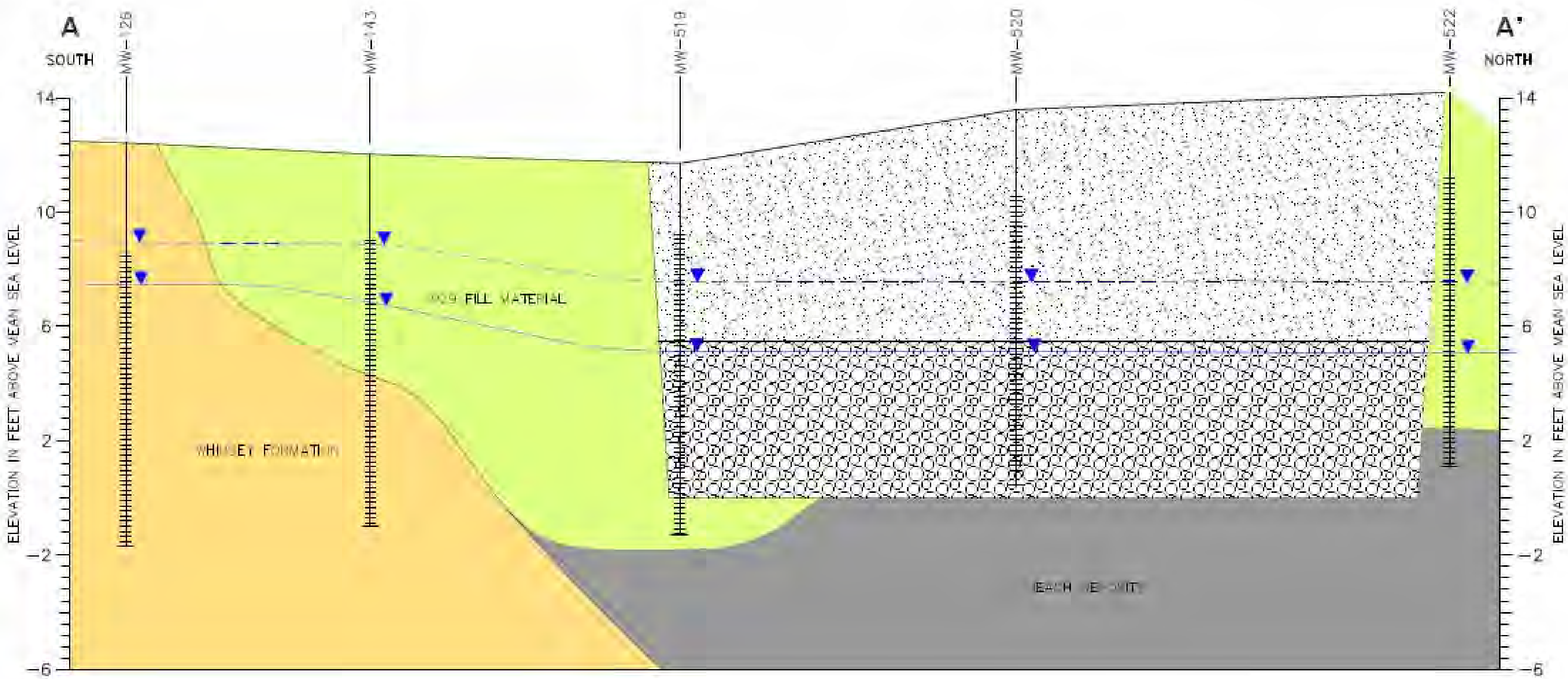
Source: Third Quarter 2013 Groundwater Monitoring Report.

Chevron Environmental Management Company
Former Unocal Edmonds Terminal, Edmonds, WA
Groundwater Flow Model

Site Map with Groundwater Contours, Cross Sections, and Potential Remediation Areas

ARCADIS

FIGURE
2



VERTICAL EXAGGERATION: 5x

0 4' 8'

VERTICAL SCALE

0 20' 40'

HORIZONTAL SCALE

LEGEND:

- MW-126 — WELL OR BORING ID
- GROUND SURFACE
- HISTORIC HIGH WATER LEVEL
- HISTORIC LOW WATER LEVEL
- LITHOLOGIC CONTACT (DASHED WHERE INFERRED)
- SCREENED INTERVAL
- BOTTOM OF BORING

- 1929 FILL MATERIAL
- BEACH DEPOSITS
- TRANSITIONAL SILT BED
- WHIDBEY FORMATION
- MARSH DEPOSITS
- 2007/2008 FILL (GRAVEL)
- 2007/2008 FILL (SILT, SAND AND GRAVEL)
- (35' SE)— OFFSET DISTANCE FROM CROSS SECTION PROFILE

NOTES:

- HORIZONTAL DATUM: WASHINGTON STATE COORDINATE SYSTEM NORTH ZONE (NAD 83/98).
- VERTICAL DATUM: N.A.V.D. 88
- UNITS: U.S. SURVEY FEET
- HORIZONTAL AND VERTICAL CONTROL ESTABLISHED BY GPS VIA VERTICAL REFERENCE STATION NETWORK (VRSN).

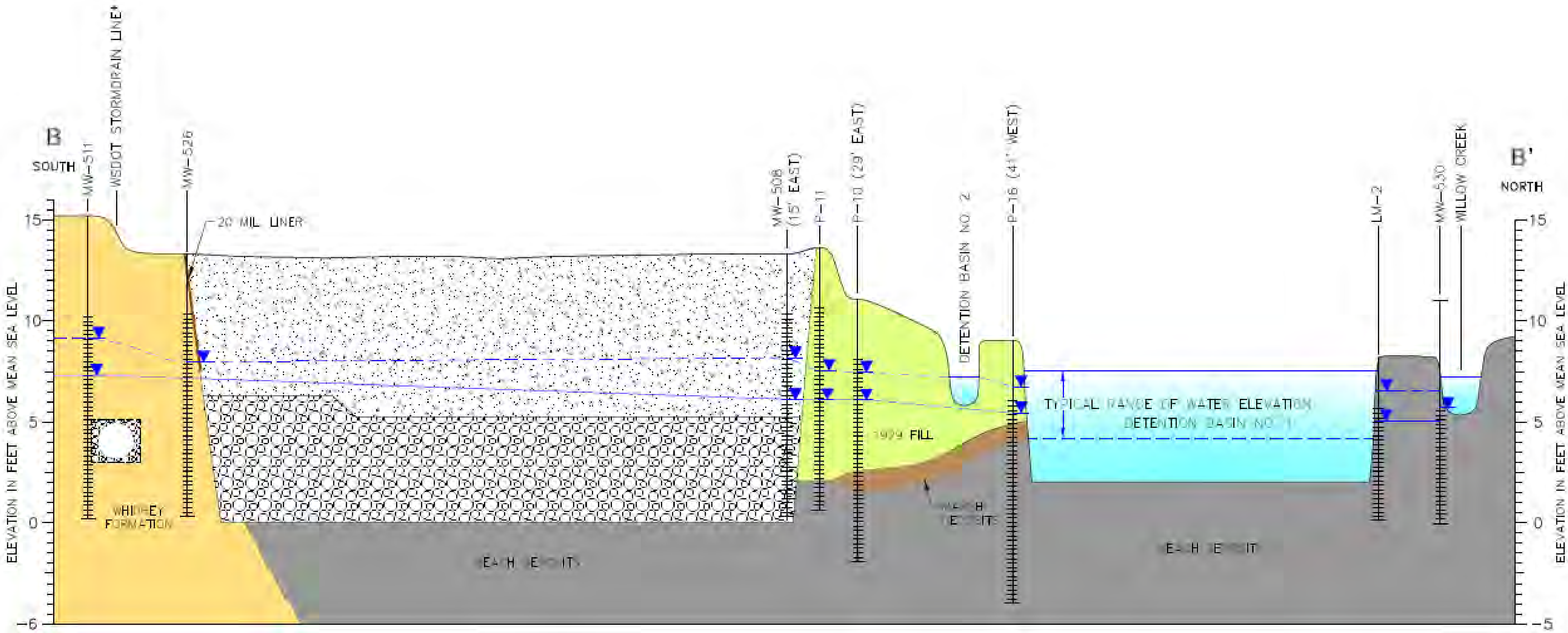
Source: Site Conceptual Model.

Chevron Environmental Management Company
Former Unocal Edmonds Terminal, Edmonds, WA
Groundwater Flow Model

Cross Section A – A'

ARCADIS

FIGURE
3



LEGEND:

- WELL OR BORING ID
- GROUND SURFACE
- HISTORIC HIGH WATER LEVEL
- HISTORIC LOW WATER LEVEL
- LITHOLOGIC CONTACT (DASHED WHERE INFERRED)
- SCREENED INTERVAL
- BOTTOM OF BORING

- 1929 FILL MATERIAL
- BEACH DEPOSITS
- WHIDBEY FORMATION
- MARSH DEPOSITS
- 2007/2008 FILL (GRAVEL)
- 2007/2008 FILL (SILT, SAND AND GRAVEL)
- (29' E)=OFFSET DISTANCE FROM CROSS SECTION PROFILE

VERTICAL EXAGGERATION: 10x

VERTICAL SCALE: 0, 5', 10'

HORIZONTAL SCALE: 0, 50', 100'

NOTES:

1. WSDOT STORMDRAIN LINE LOCATION IS APPROXIMATE AND DRAWN TO A NON EXAGGERATED SCALE FOR CLARITY.
2. HORIZONTAL DATUM: WASHINGTON STATE COORDINATE SYSTEM NORTH ZONE (NAD 83/98). VERTICAL DATUM: N.A.V.D. 88 UNITS: U.S. SURVEY FEET HORIZONTAL AND VERTICAL CONTROL ESTABLISHED BY GPS VIA VERTICAL REFERENCE STATION NETWORK (VRSN).

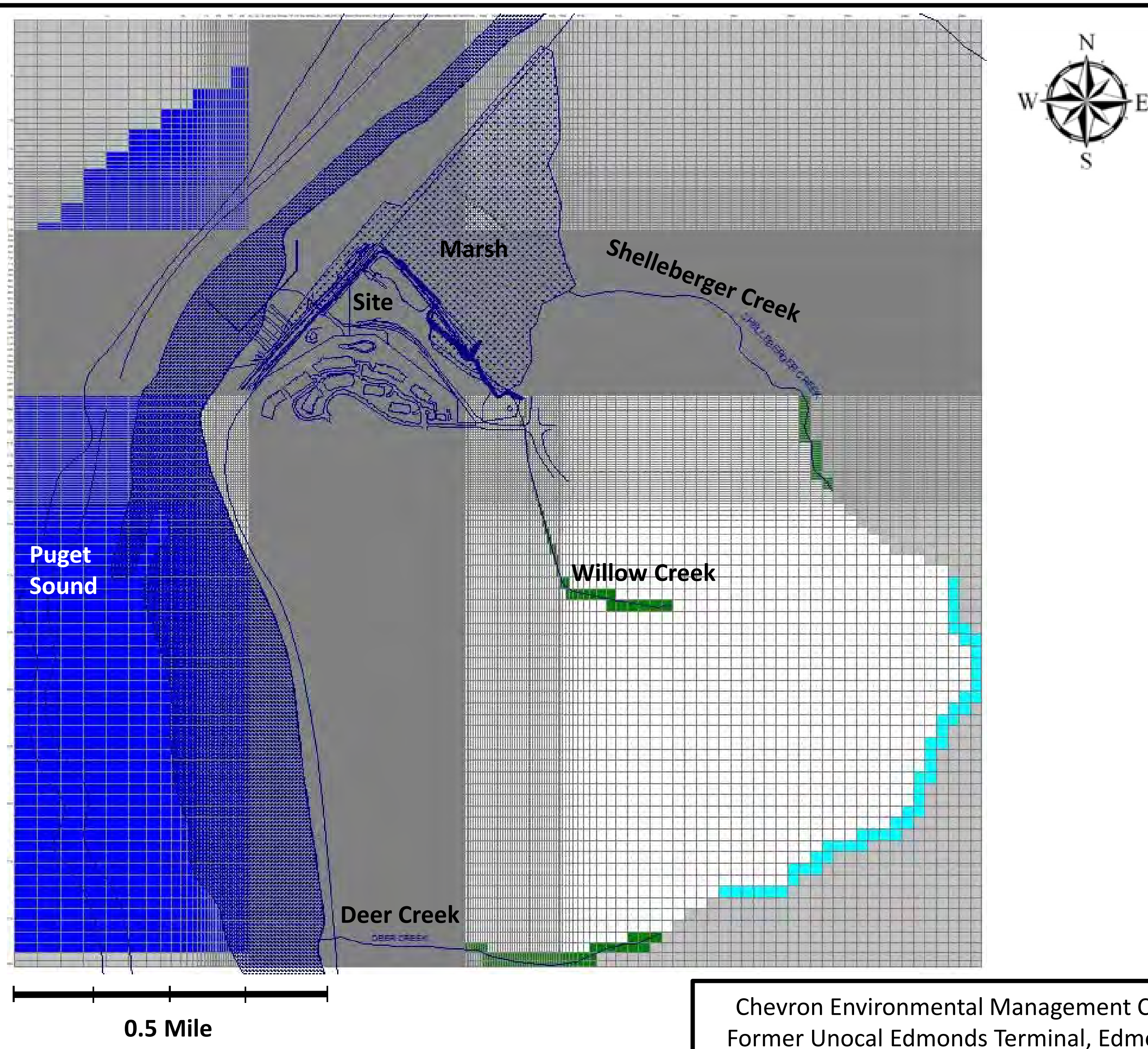
Source: Site Conceptual Model.

Chevron Environmental Management Company
Former Unocal Edmonds Terminal, Edmonds, WA
Groundwater Flow Model

Cross Section B – B'

ARCADIS

FIGURE 4



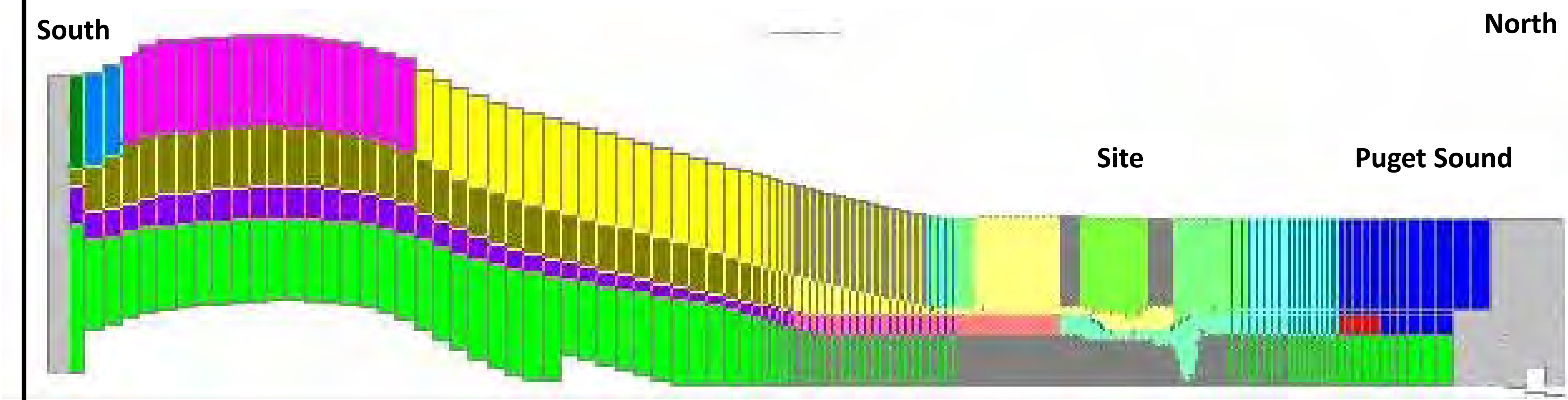
Notes:
Total number of grid blocks = 142,280
Smallest grid block = 10' x 10' at Site
Largest grid blocks = 100' x 200' at Model Perimeter

Chevron Environmental Management Company
Former Unocal Edmonds Terminal, Edmonds, WA
Groundwater Flow Model

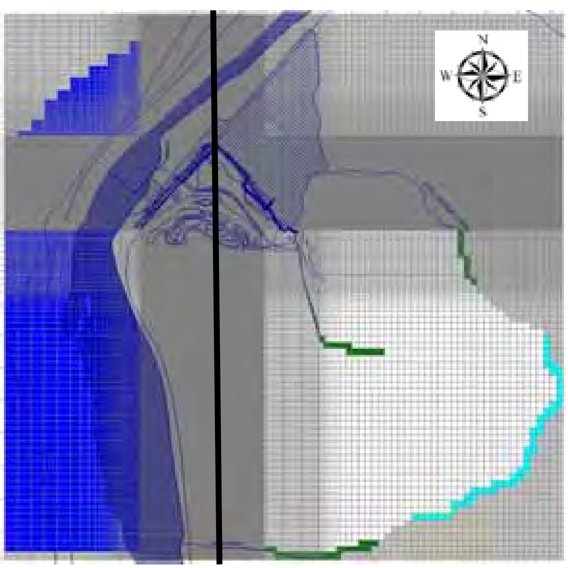
Model Grid

ARCADIS

FIGURE 5



Cross Section Location



Note: Colors Represent Hydraulic Conductivity Values (Feet/Day)

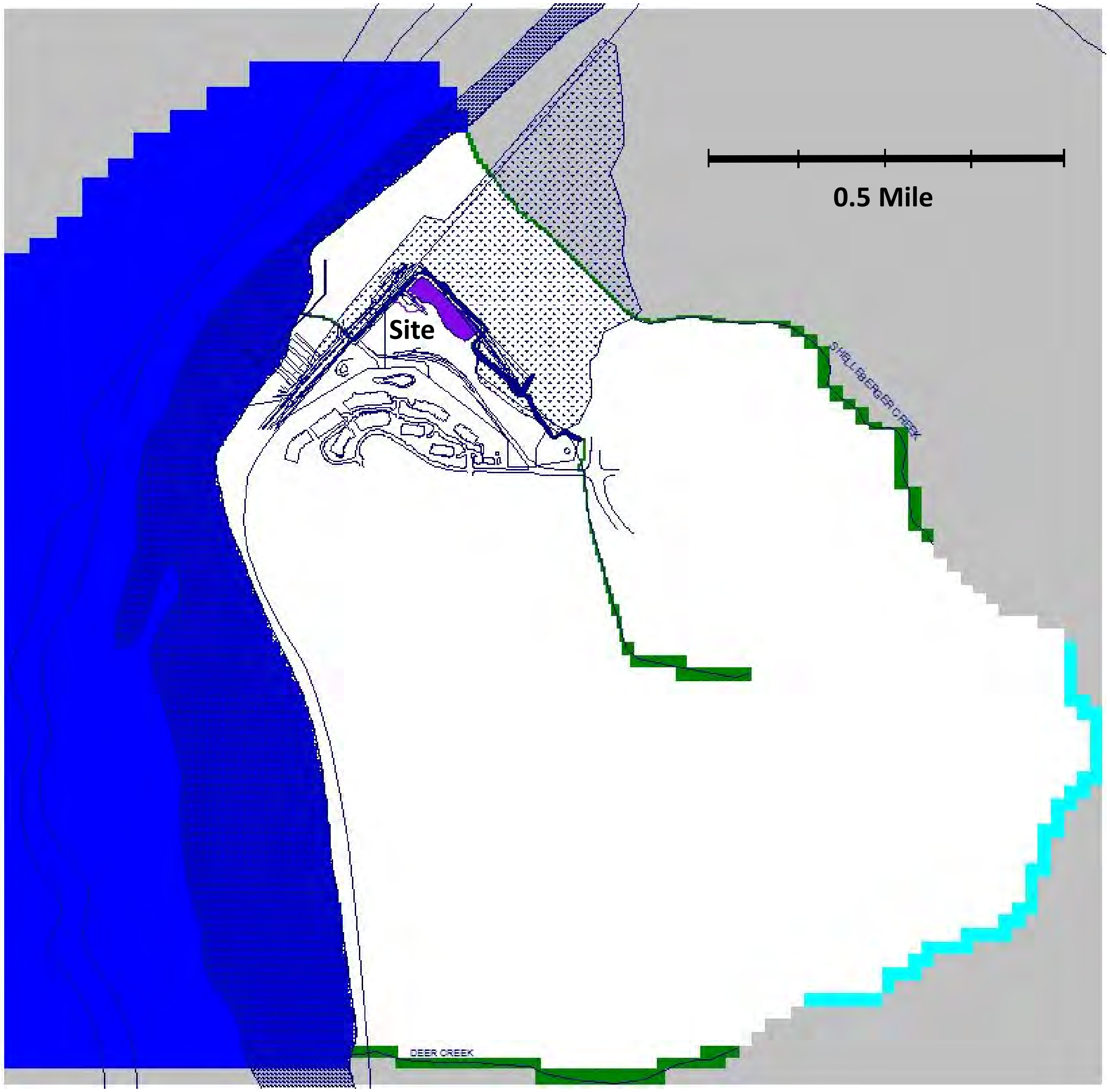
Cyan	0.75	Green	0.25	Dark red	0.1
Teal	5	Yellow	0.5		
Magenta	40	Red	75		
Olive	0.75	Blue	75		

Chevron Environmental Management Company
Former Unocal Edmonds Terminal, Edmonds, WA
Groundwater Flow Model

Model Layers

ARCADIS

FIGURE
6



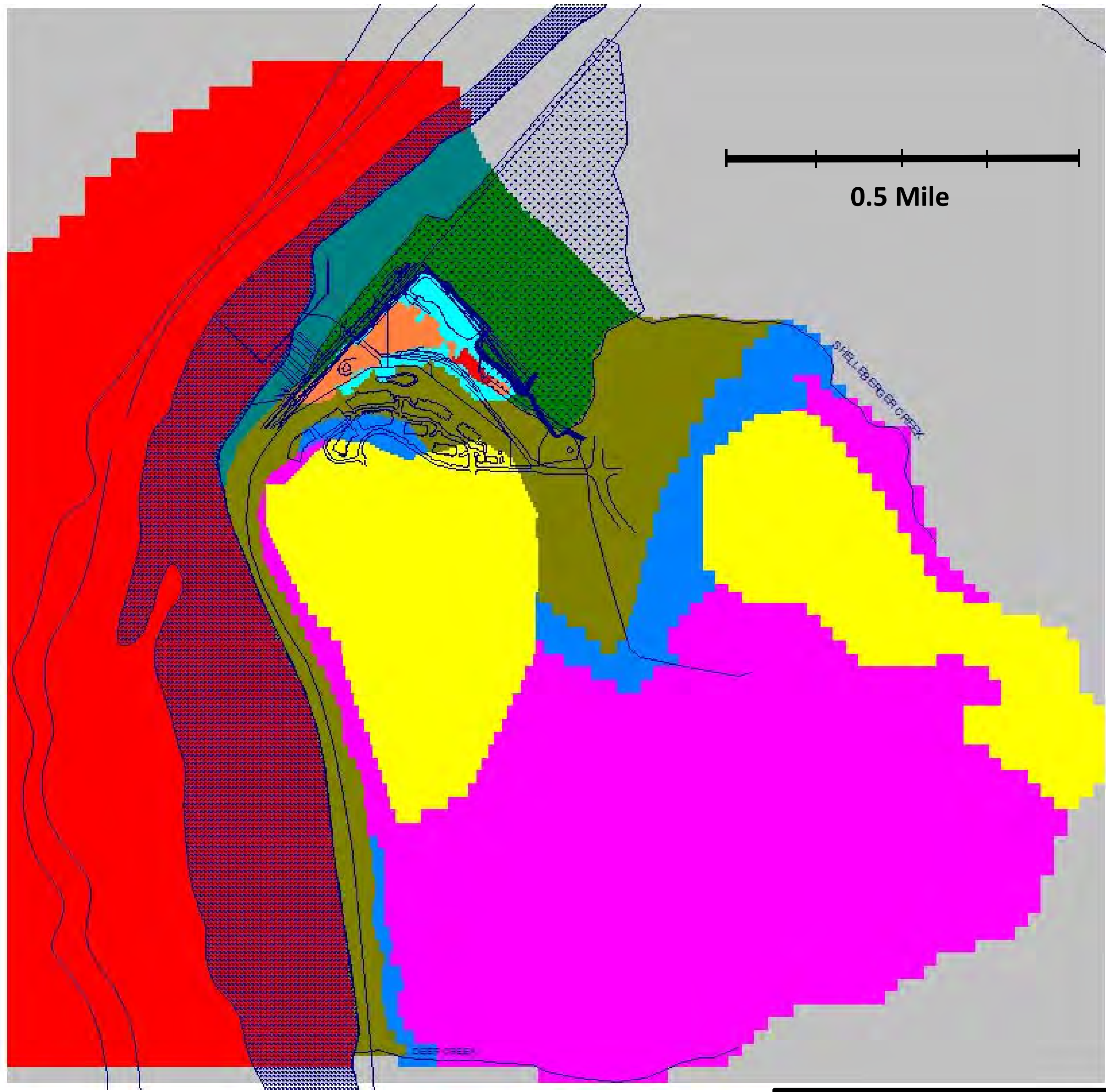
Constant Head Boundary (Puget Sound)
River-Type Boundary
General Head Boundary
Drain
Inactive (No-Flow)

Chevron Environmental Management Company
Former Unocal Edmonds Terminal, Edmonds, WA
Groundwater Flow Model

Boundary Conditions

ARCADIS

FIGURE
7



Hydraulic Conductivity (Feet/Day)

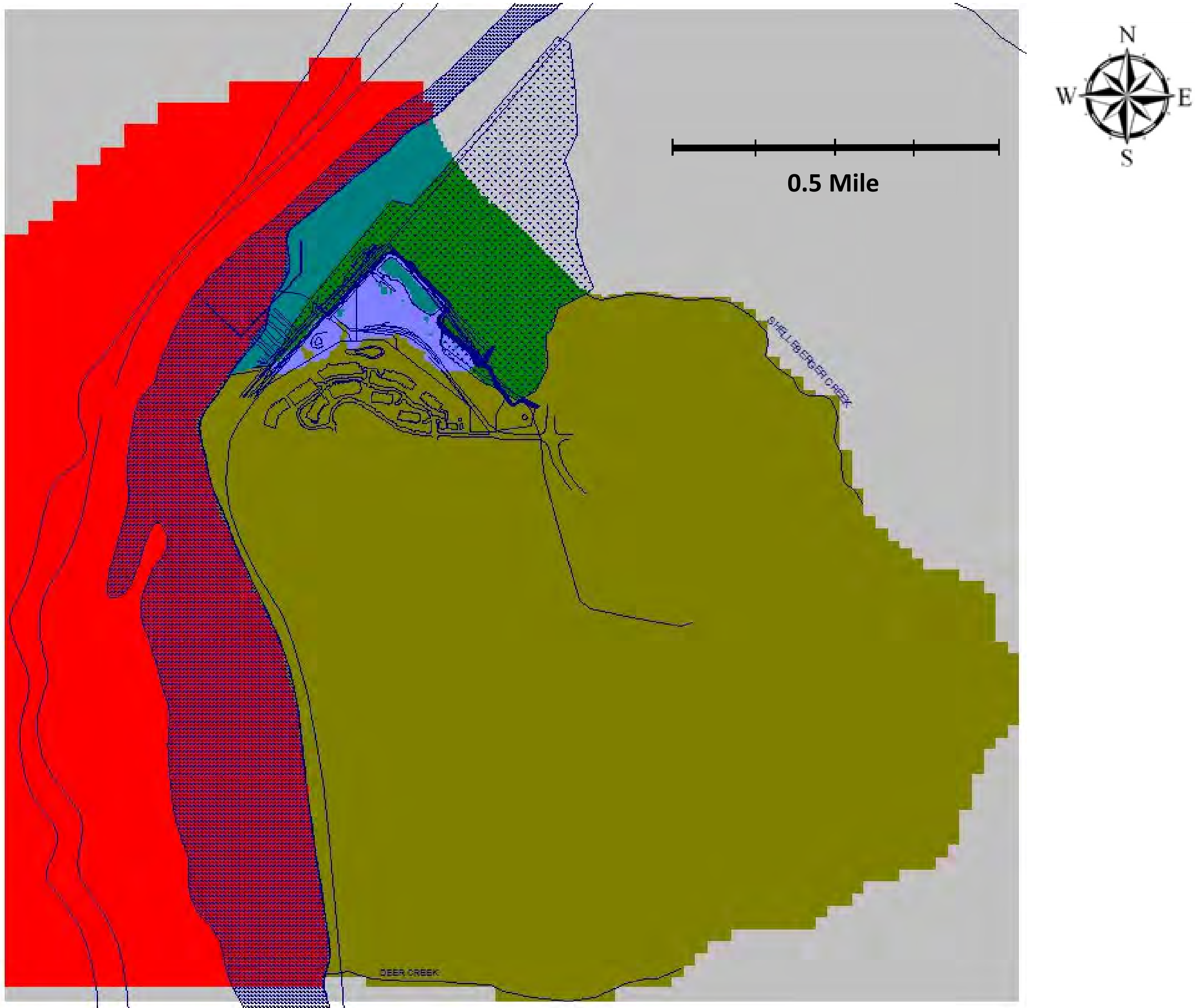
Cyan	0.75
Teal	5
Magenta	40
Olive	0.75
Green	0.25
Yellow	0.5
Red	75
Blue	75
Dark red	0.1

Chevron Environmental Management Company
Former Unocal Edmonds Terminal, Edmonds, WA
Groundwater Flow Model

Hydraulic Conductivity Distribution – Layer 1

ARCADIS

FIGURE
8



Hydraulic Conductivity (Feet/Day)

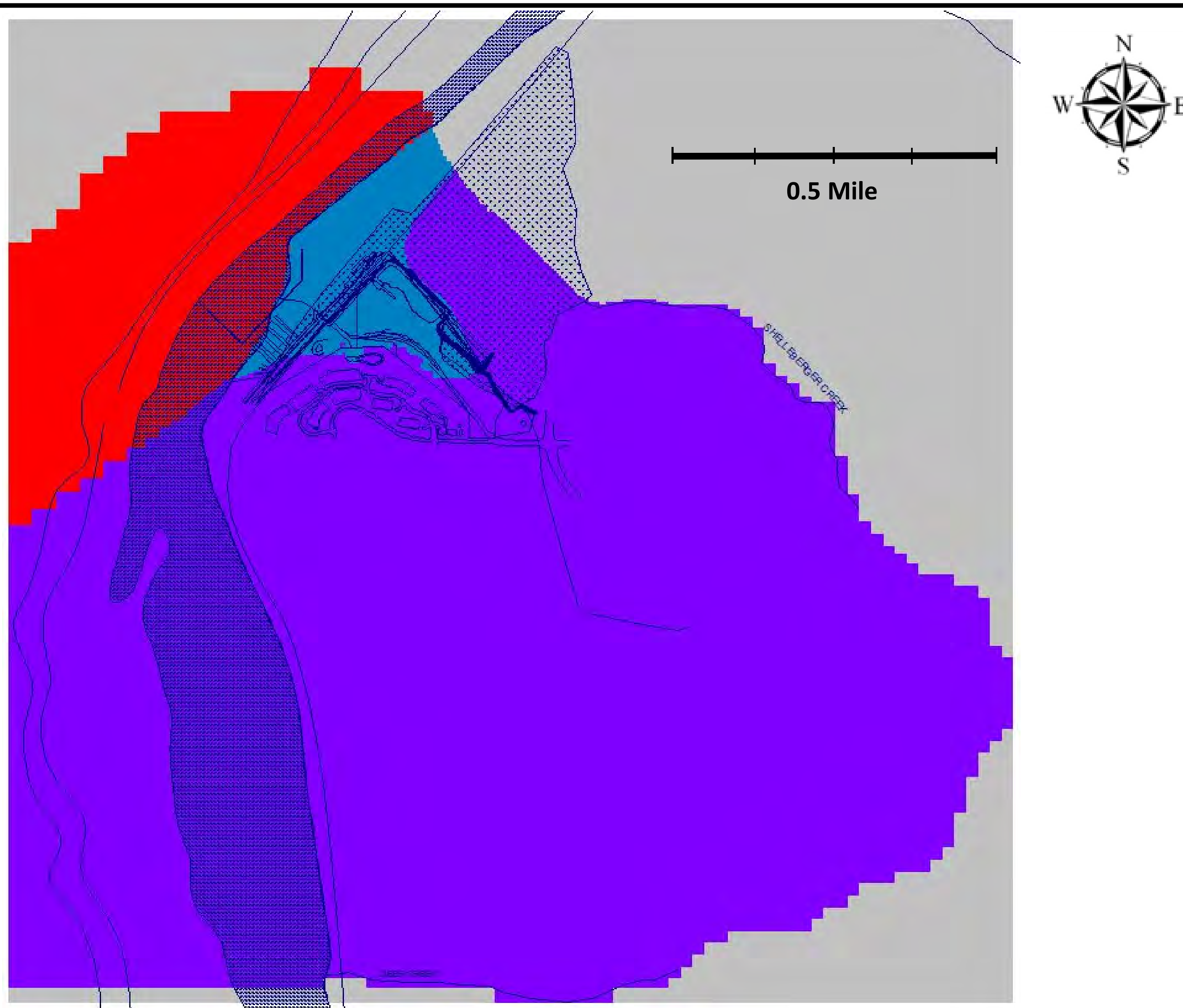
- 5
- 0.75
- 0.25
- 0.85
- 75

Chevron Environmental Management Company
Former Unocal Edmonds Terminal, Edmonds, WA
Groundwater Flow Model

Hydraulic Conductivity Distribution – Layer 2

ARCADIS

FIGURE
9



Hydraulic Conductivity (Feet/Day)

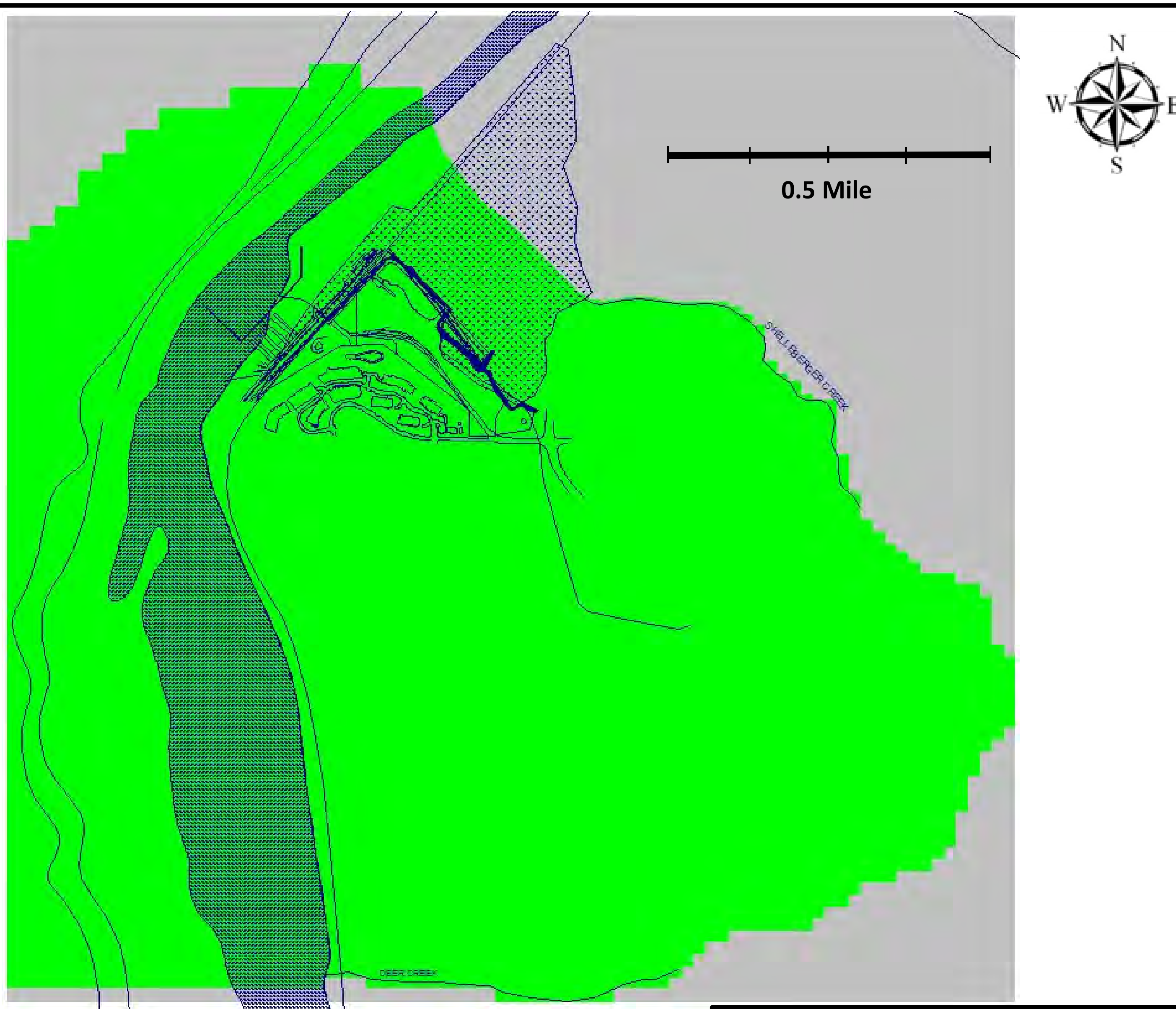
- 1.5
- 75
- 45

Chevron Environmental Management Company
Former Unocal Edmonds Terminal, Edmonds, WA
Groundwater Flow Model

Hydraulic Conductivity Distribution – Layer 3

ARCADIS

FIGURE
10



Hydraulic Conductivity (Feet/Day)

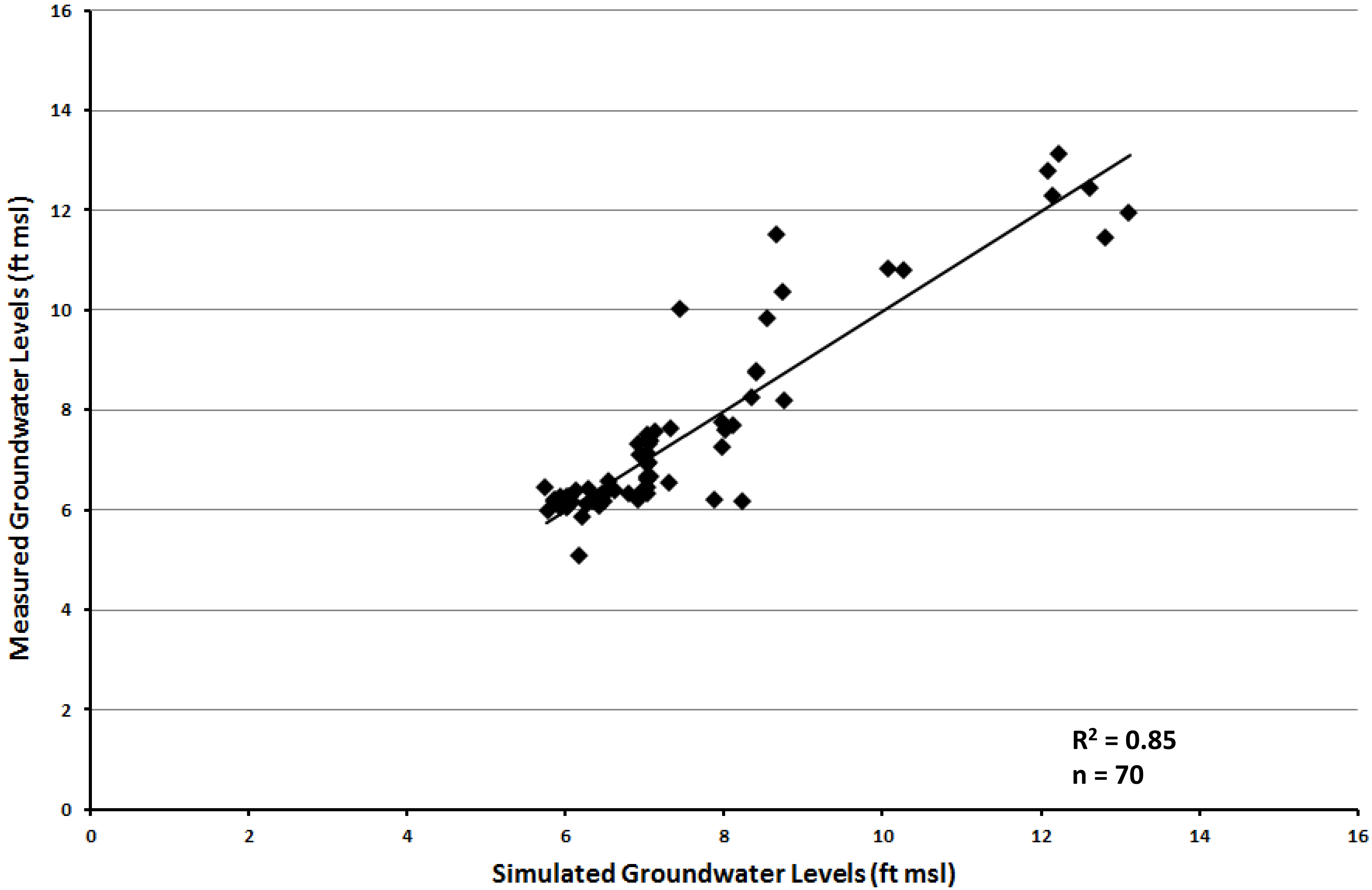
1.5

Chevron Environmental Management Company
Former Unocal Edmonds Terminal, Edmonds, WA
Groundwater Flow Model

Hydraulic Conductivity Distribution – Layer 4

ARCADIS

FIGURE **11**

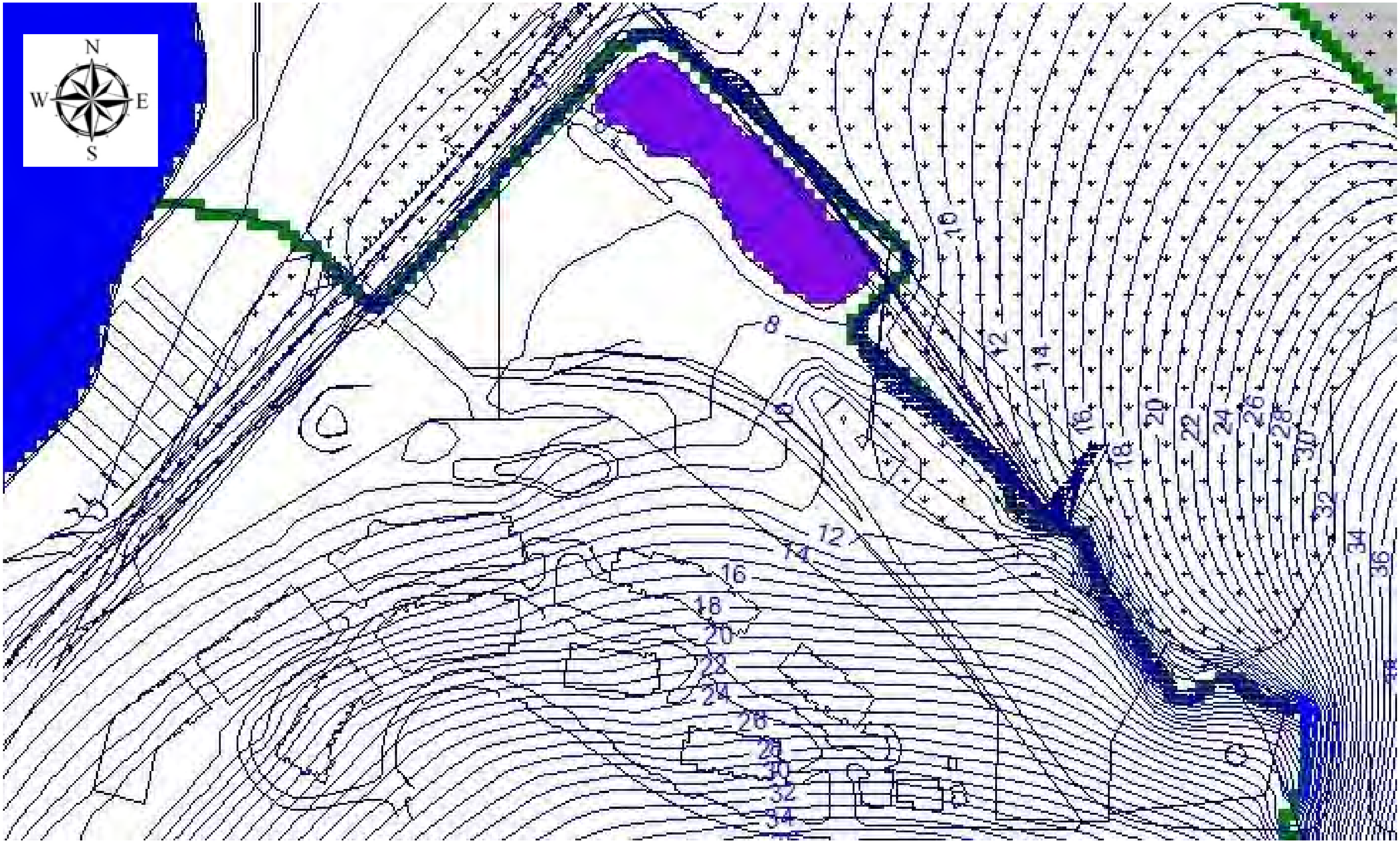


Chevron Environmental Management Company
Former Unocal Edmonds Terminal, Edmonds, WA
Groundwater Flow Model

Calibration Scatter Plot

ARCADIS

FIGURE
12



Legend

- Puget Sound
- Detention Basin #1
- Creek/River
- Simulated Potentiometric Contour (ft msl)

Note: Simulation performed under steady-state, average groundwater flow condition.

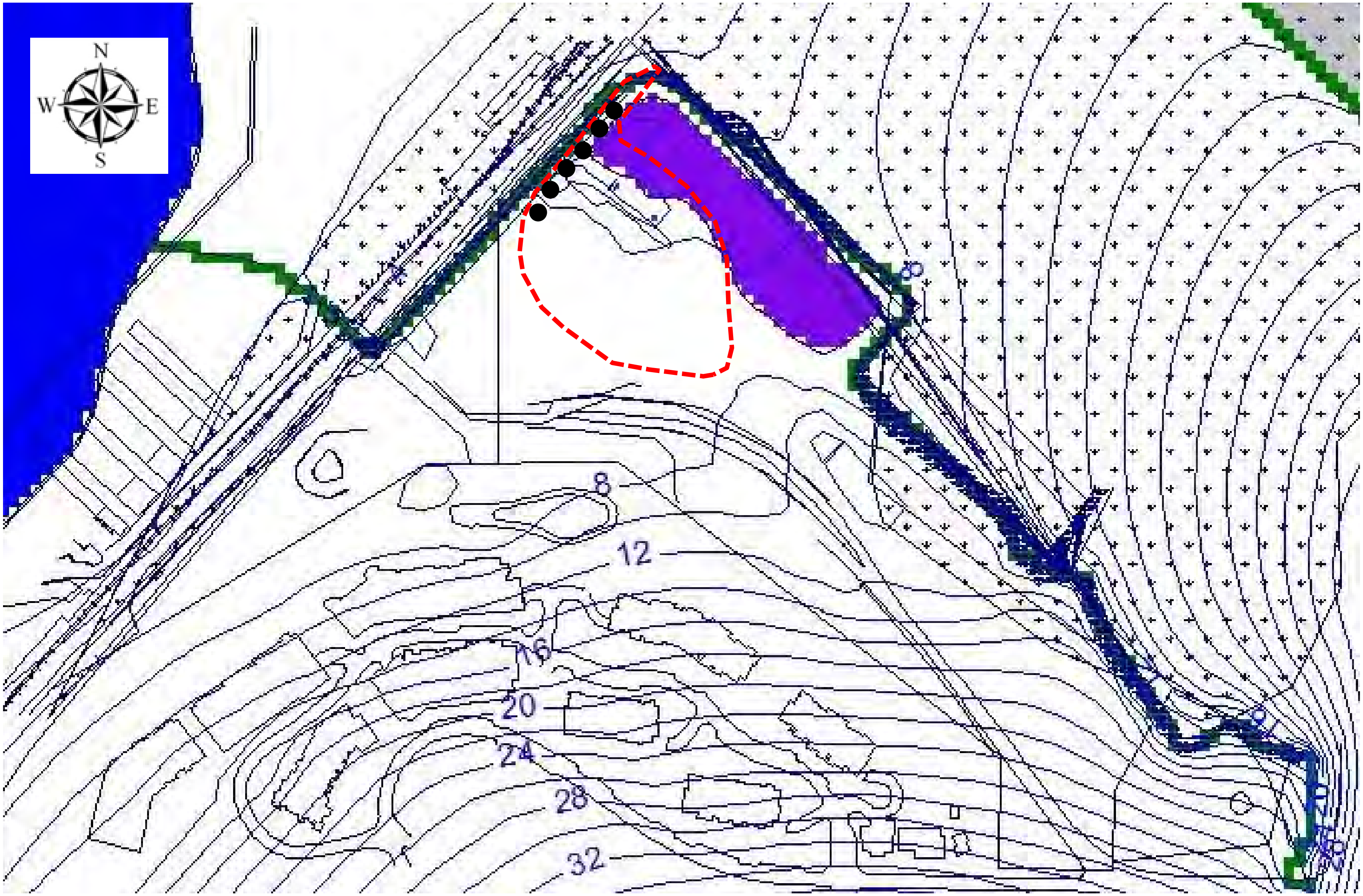
0 100 200 300 400
Feet

Chevron Environmental Management Company
Former Unocal Edmonds Terminal, Edmonds, WA
Groundwater Flow Model

Simulated Potentiometric Surface
Calibrated Condition

ARCADIS

FIGURE
13



Legend

- Puget Sound
- Detention Basin #1
- Creek/River
- Simulated Potentiometric Contour (ft msl)
- Hypothetical Extraction Well
- Predicted Groundwater Capture Zone (approx)

0 100 200 300 400

Feet

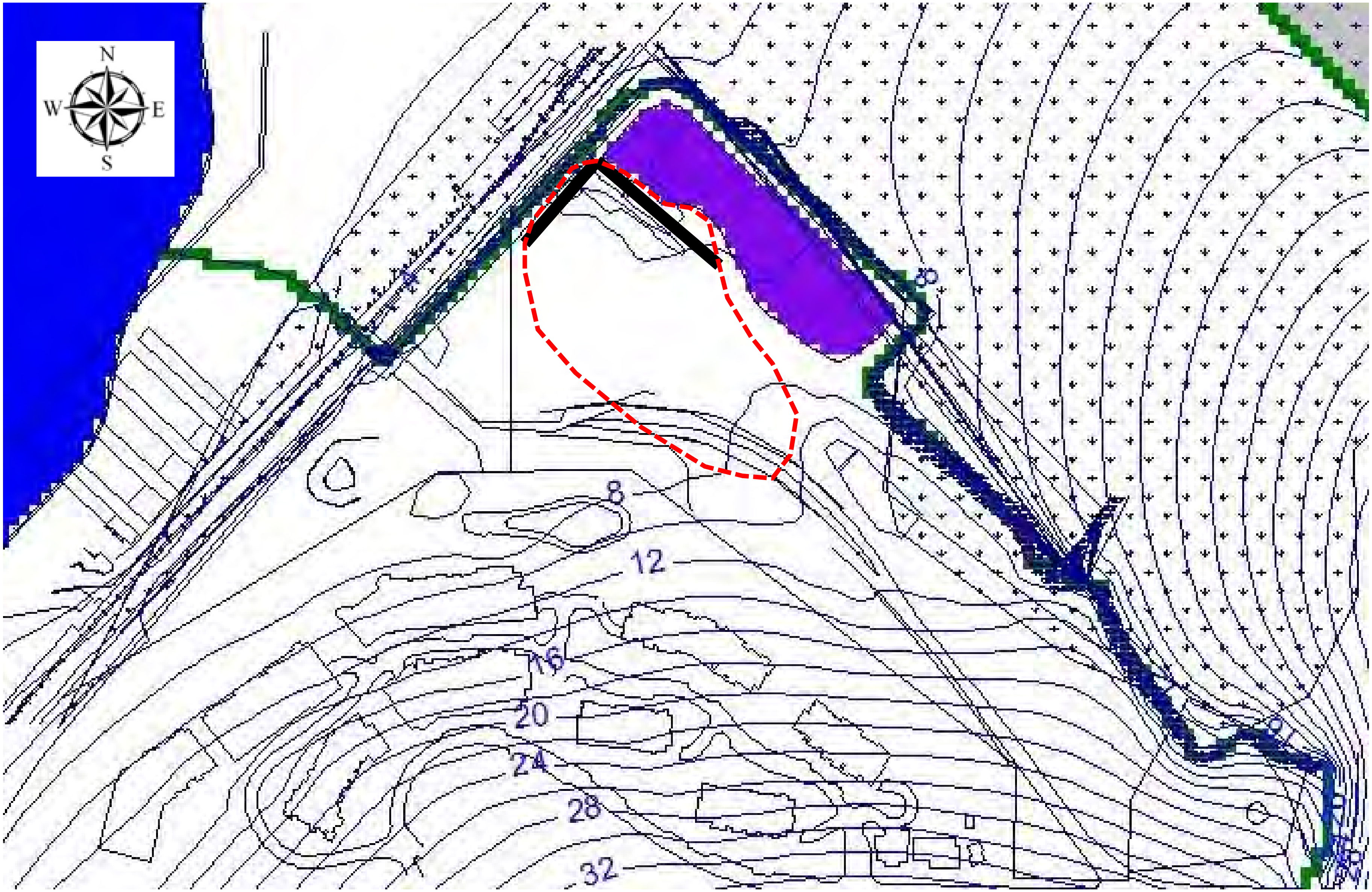
Note: Simulation performed under steady-state, average groundwater flow condition.

Chevron Environmental Management Company
Former Unocal Edmonds Terminal, Edmonds, WA
Groundwater Flow Model

Remediation Scenario 1
6 Extraction Wells (3 to 5 GPM)

ARCADIS

FIGURE
14



Legend

- Puget Sound
- Detention Basin #1
- Creek/River
- Simulated Potentiometric Contour (ft msl)
- Hypothetical Groundwater Interceptor Trench
- Predicted Groundwater Capture Zone (approx)

Note: Simulation performed under steady-state, average groundwater flow condition.

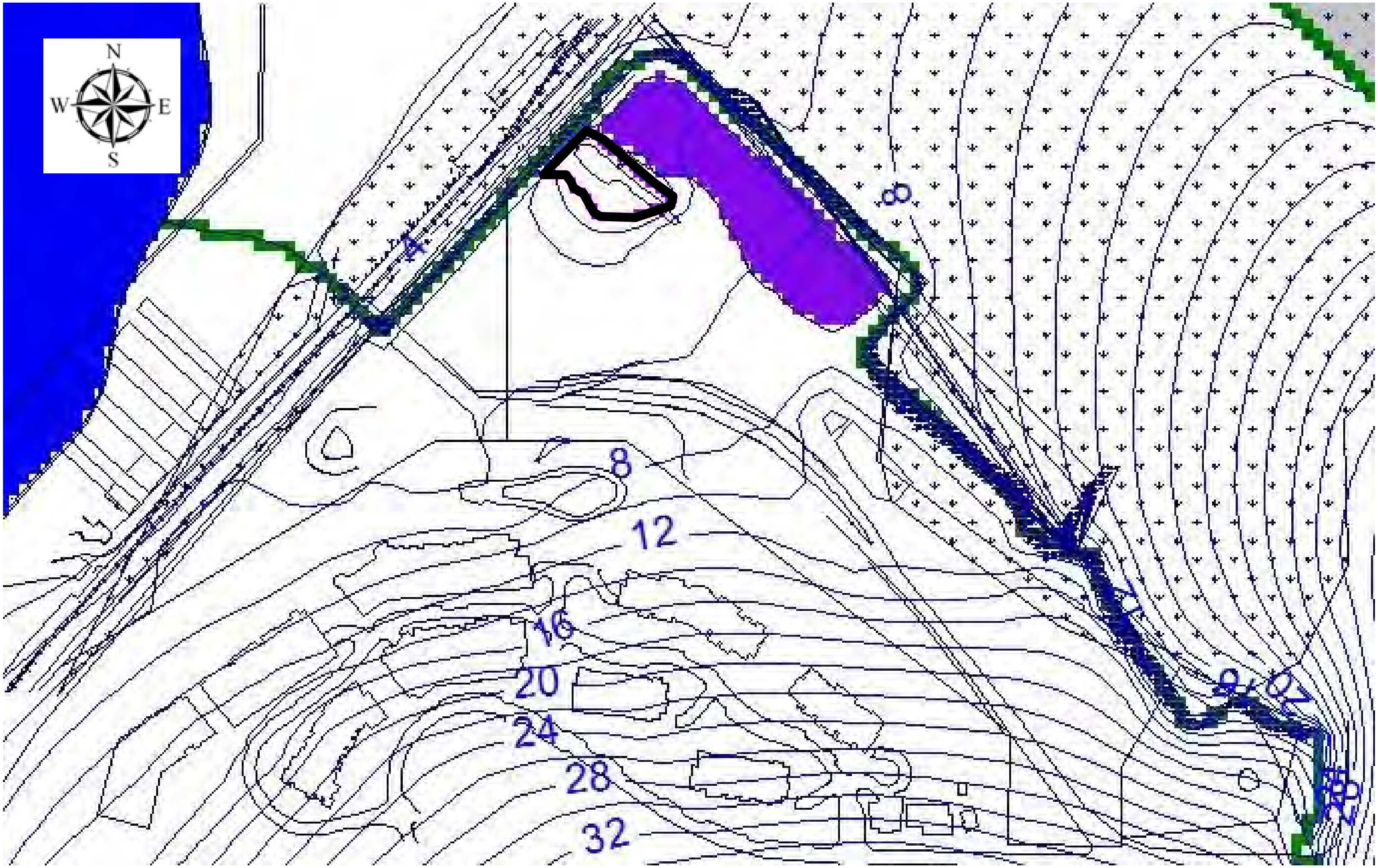
0 100 200 300 400
Feet

Chevron Environmental Management Company
Former Unocal Edmonds Terminal, Edmonds, WA
Groundwater Flow Model

Remediation Scenario 2
Groundwater Interceptor Trench (4 to 7 GPM)

ARCADIS

FIGURE
15



Legend

- Puget Sound
- Detention Basin #1
- Creek/River
- Simulated Potentiometric Contour (ft msl)
- Limits of Soil Excavation (Approx)

Note: Simulation performed under steady-state, average groundwater flow condition.

Chevron Environmental Management Company
Former Unocal Edmonds Terminal, Edmonds, WA
Groundwater Flow Model

Remediation Scenario 3
Soil Excavation Near DB-1 and DB-2

ARCADIS

FIGURE
16

Legend

- Puget Sound
- Detention Basin #1
- Creek/River
- Simulated Potentiometric Contour (ft msl)
- Limits of Soil Excavation (Approx)

0 100 200 300 400

Feet

Note: Simulation performed under steady-state, average groundwater flow condition.

Chevron Environmental Management Company
Former Unocal Edmonds Terminal, Edmonds, WA
Groundwater Flow Model

Remediation Scenario 4
Soil Excavation Near Storm Drain

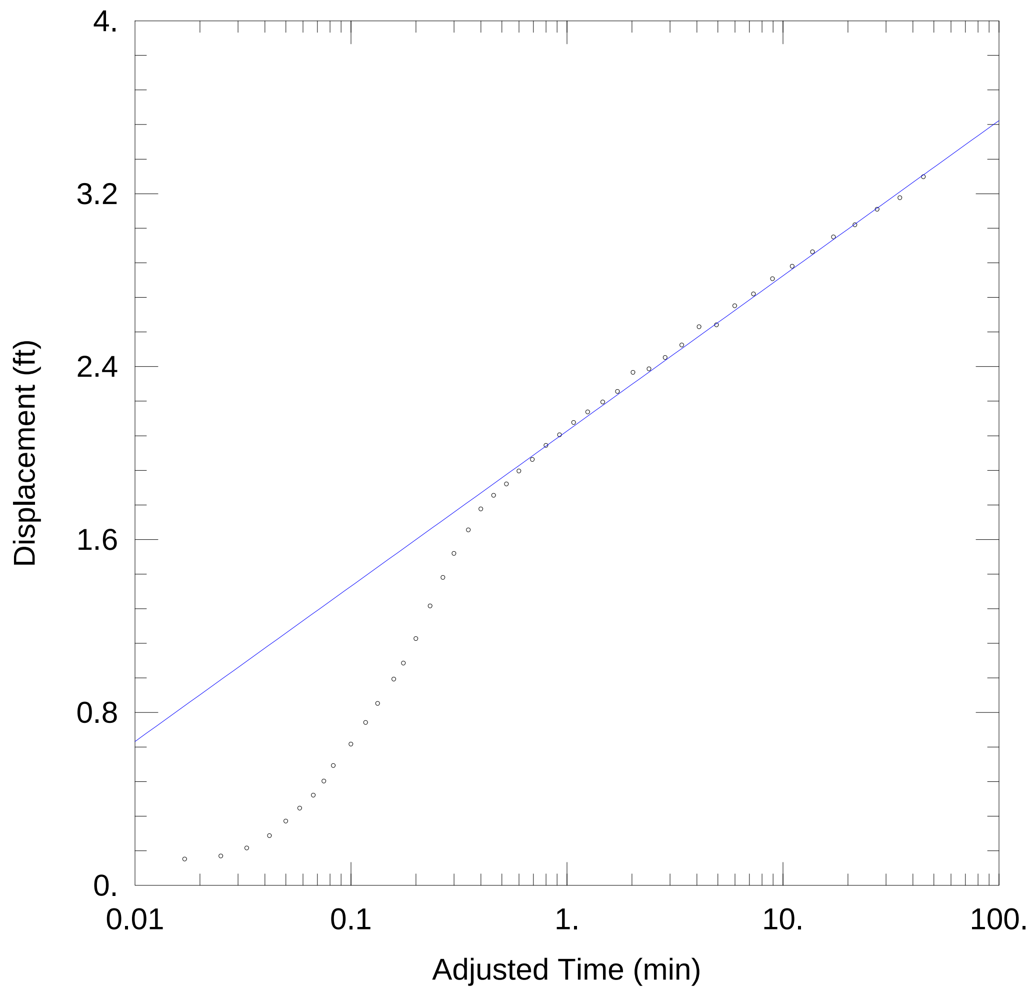
ARCADIS

FIGURE
17

ARCADIS

Attachment 1

Constant-Rate Pumping Test Plots



MW-122 CONSTANT-RATE TEST

PROJECT INFORMATION

Company: ARCADIS
Client: CHEVRON
Location: EDMONDS, WASHINGTON
Test Well: MW-122
Test Date: 3/5/13

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
MW-122	0	0

Observation Wells

Well Name	X (ft)	Y (ft)
◦ MW-122	0	0

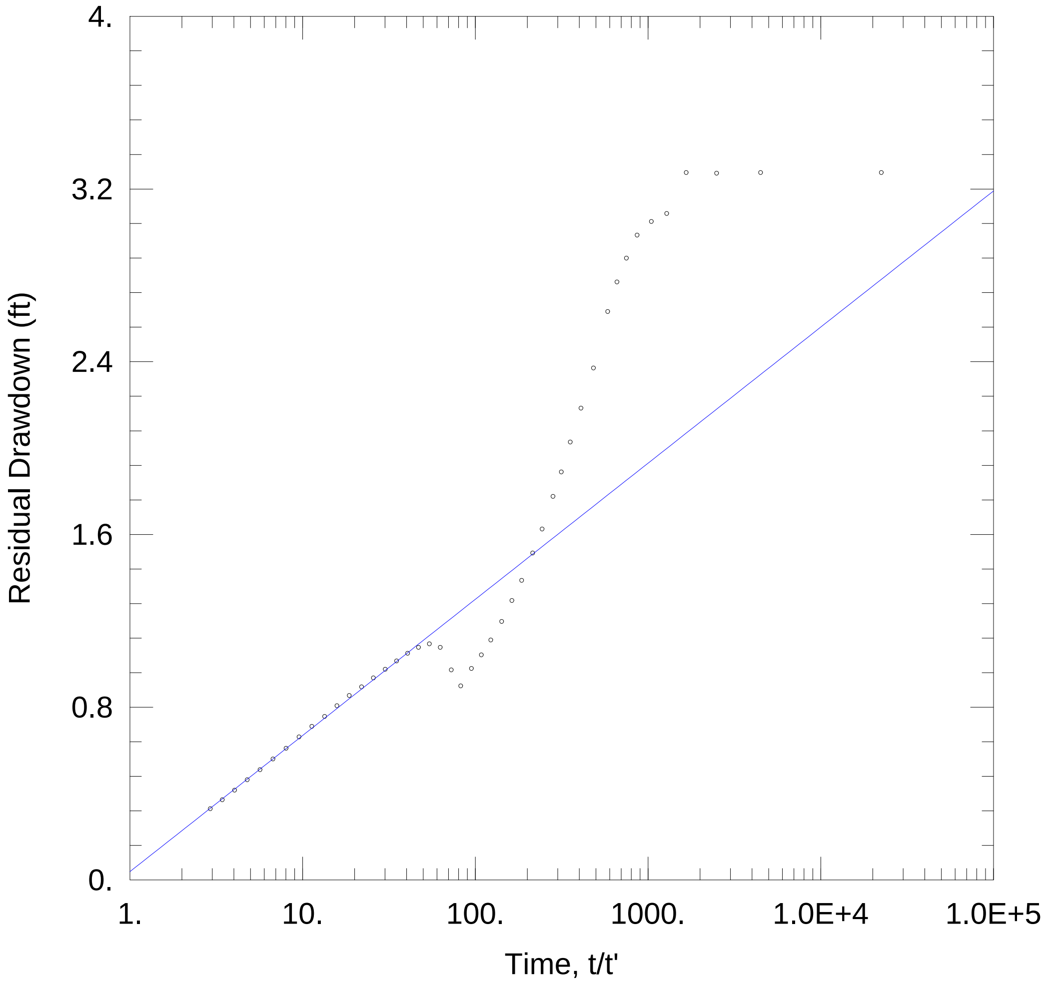
SOLUTION

Aquifer Model: Confined

Solution Method: Cooper-Jacob

T = 165. ft^2/day

S = 0.0028



MW-122 CONSTANT-RATE TEST

PROJECT INFORMATION

Company: ARCADIS
Test Well: MW-122
Test Date: 3/5/13

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
MW-122	0	0

Observation Wells

Well Name	X (ft)	Y (ft)
◦ MW-122	0	0

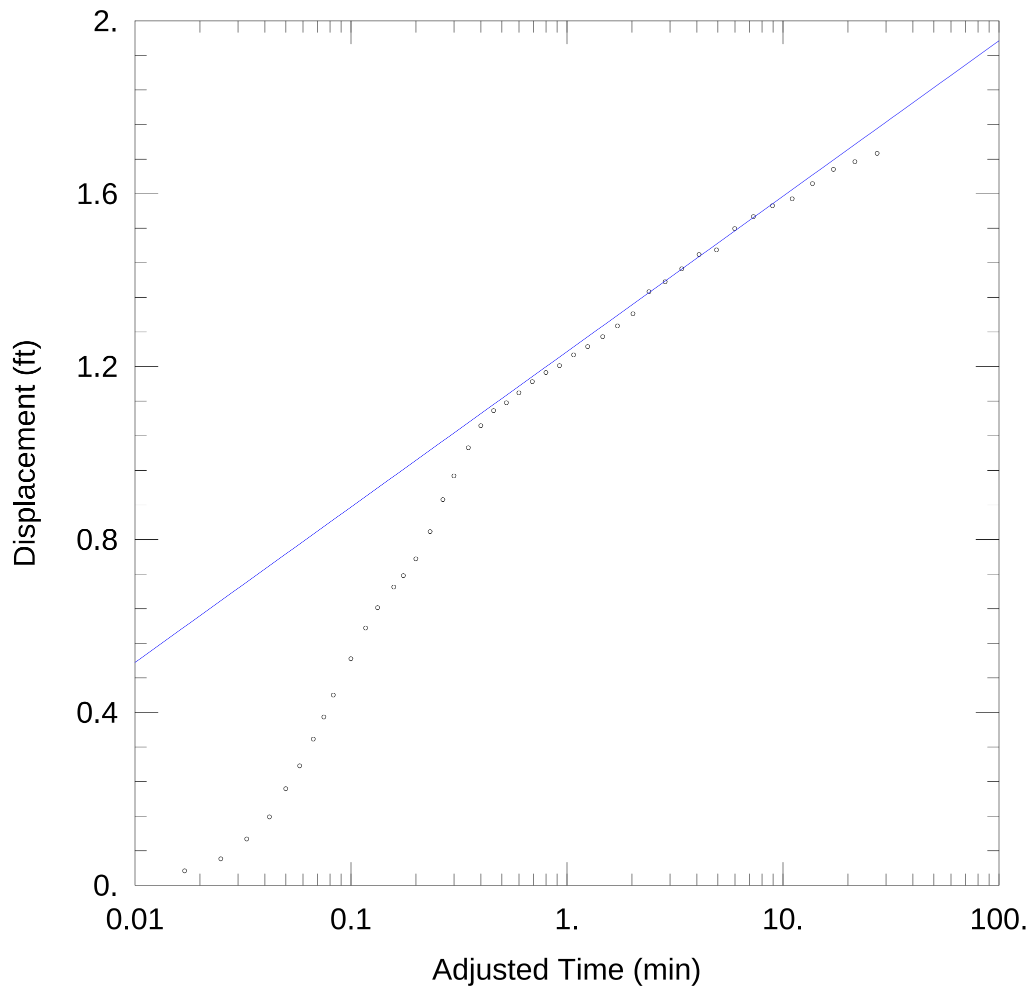
SOLUTION

Aquifer Model: Confined

Solution Method: Theis (Recovery)

T = 188. ft^2/day

S/S' = 0.87



MW-147 CONSTANT-RATE TEST

PROJECT INFORMATION

Company: ARCADIS
Client: CHEVRON
Location: EDMONDS, WASHINGTON
Test Well: MW-147
Test Date: 3/5/13

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
MW-147	0	0

Observation Wells

Well Name	X (ft)	Y (ft)
◦ MW-147	0	0

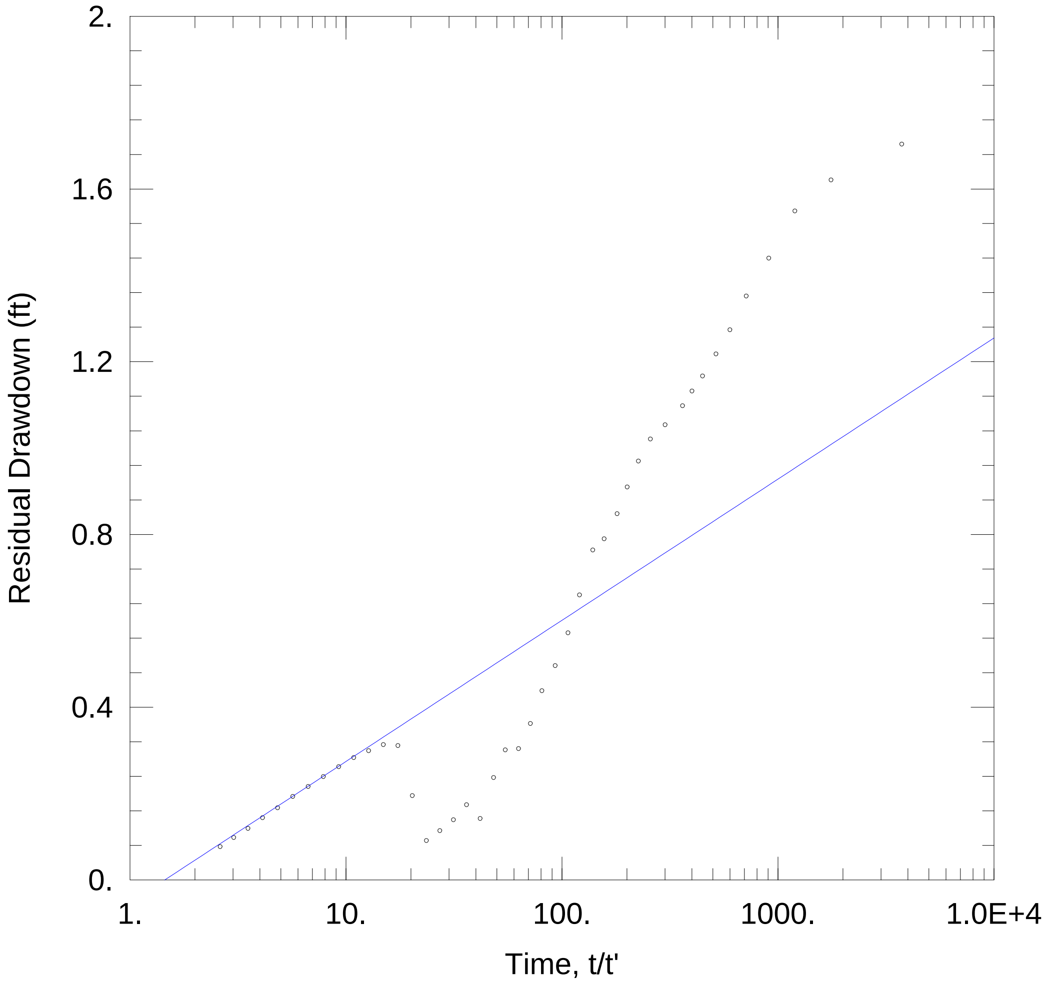
SOLUTION

Aquifer Model: Confined

Solution Method: Cooper-Jacob

T = 360. ft^2/day

S = 0.0019



MW-147 CONSTANT-RATE TEST

PROJECT INFORMATION

Company: ARCADIS
Client: CHEVRON
Location: EDMONDS, WASHINGTON
Test Well: MW-147
Test Date: 3/5/13

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
MW-147	0	0

Observation Wells

Well Name	X (ft)	Y (ft)
◦ MW-147	0	0

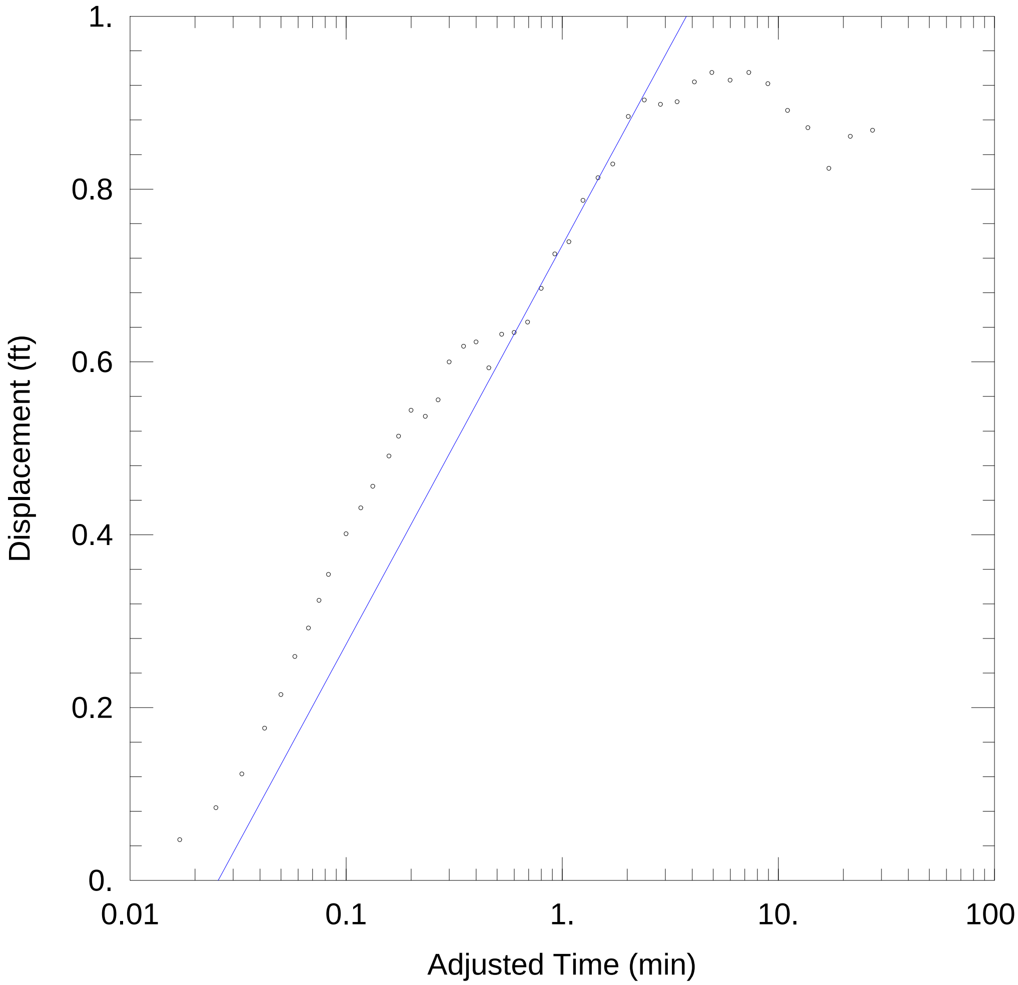
SOLUTION

Aquifer Model: Confined

Solution Method: Theis (Recovery)

T = 396. ft^2/day

S/S' = 1.45



MW-203 CONSTANT-RATE TEST

PROJECT INFORMATION

Company: ARCADIS
Client: CHEVRON
Location: EDMONDS, WASHINGTON
Test Well: MW-203
Test Date: 3/4/13

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
MW-203	0	0

Observation Wells

Well Name	X (ft)	Y (ft)
◦ MW-203	0	0

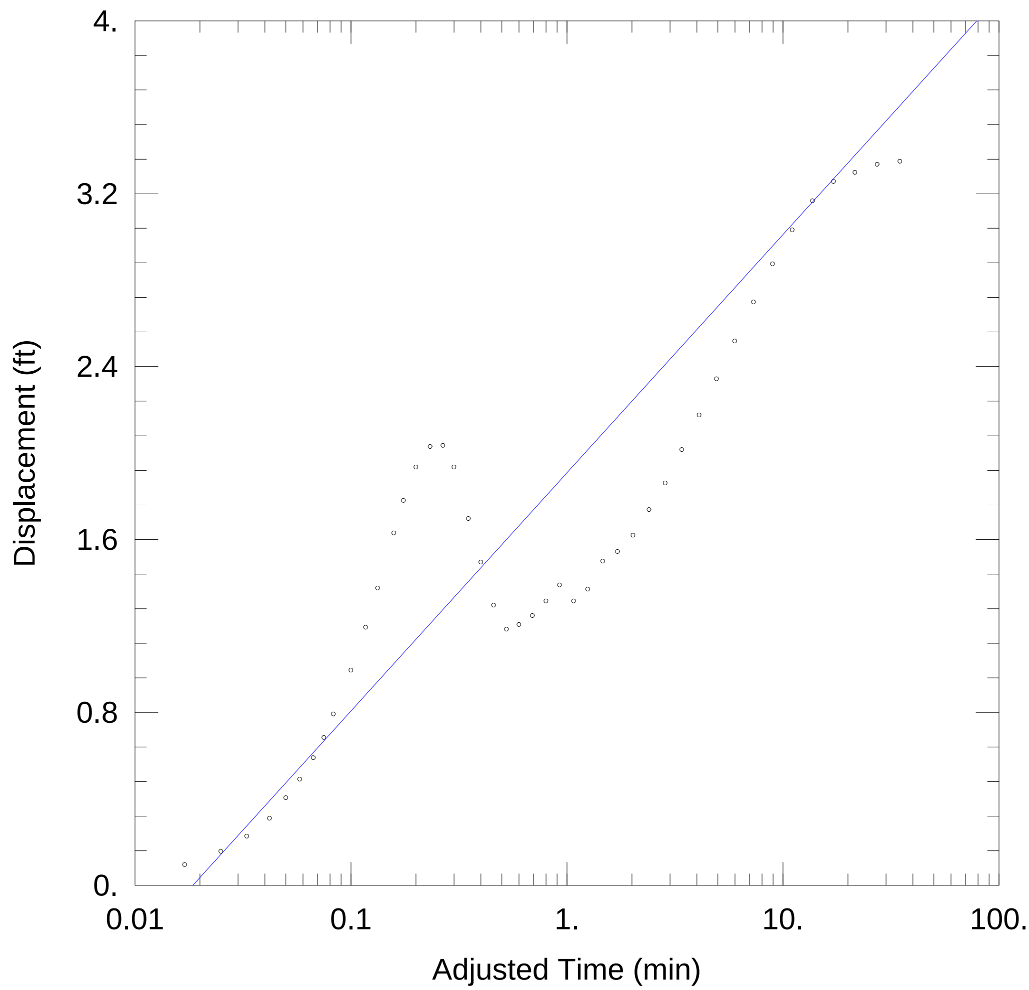
SOLUTION

Aquifer Model: Confined

Solution Method: Cooper-Jacob

T = 191. ft^2/day

S = 0.07



MW-510 CONSTANT-RATE TEST

PROJECT INFORMATION

Company: ARCADIS
Client: CHEVRON
Location: EDMONDS, WASHINGTON
Test Well: MW-510
Test Date: 3/6/13

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
MW-510	0	0

Observation Wells

Well Name	X (ft)	Y (ft)
◦ MW-510	0	0

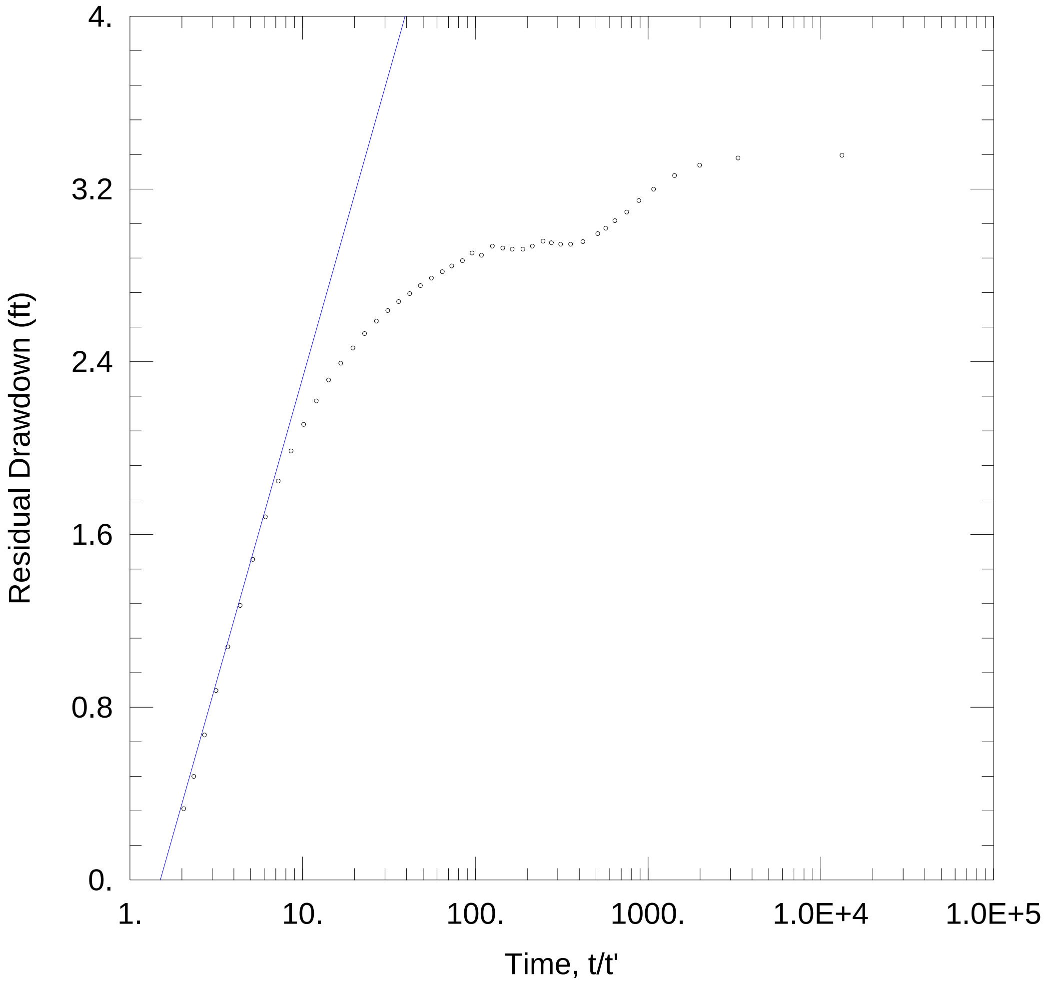
SOLUTION

Aquifer Model: Confined

Solution Method: Cooper-Jacob

T = 6.4 ft^2/day

S = 0.0017



MW-510 CONSTANT-RATE TEST

PROJECT INFORMATION

Company: ARCADIS
Client: CHEVRON
Location: EDMONDS, WASHINGTON
Test Well: MW-510
Test Date: 3/6/13

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
MW-510	0	0

Observation Wells

Well Name	X (ft)	Y (ft)
◦ MW-510	0	0

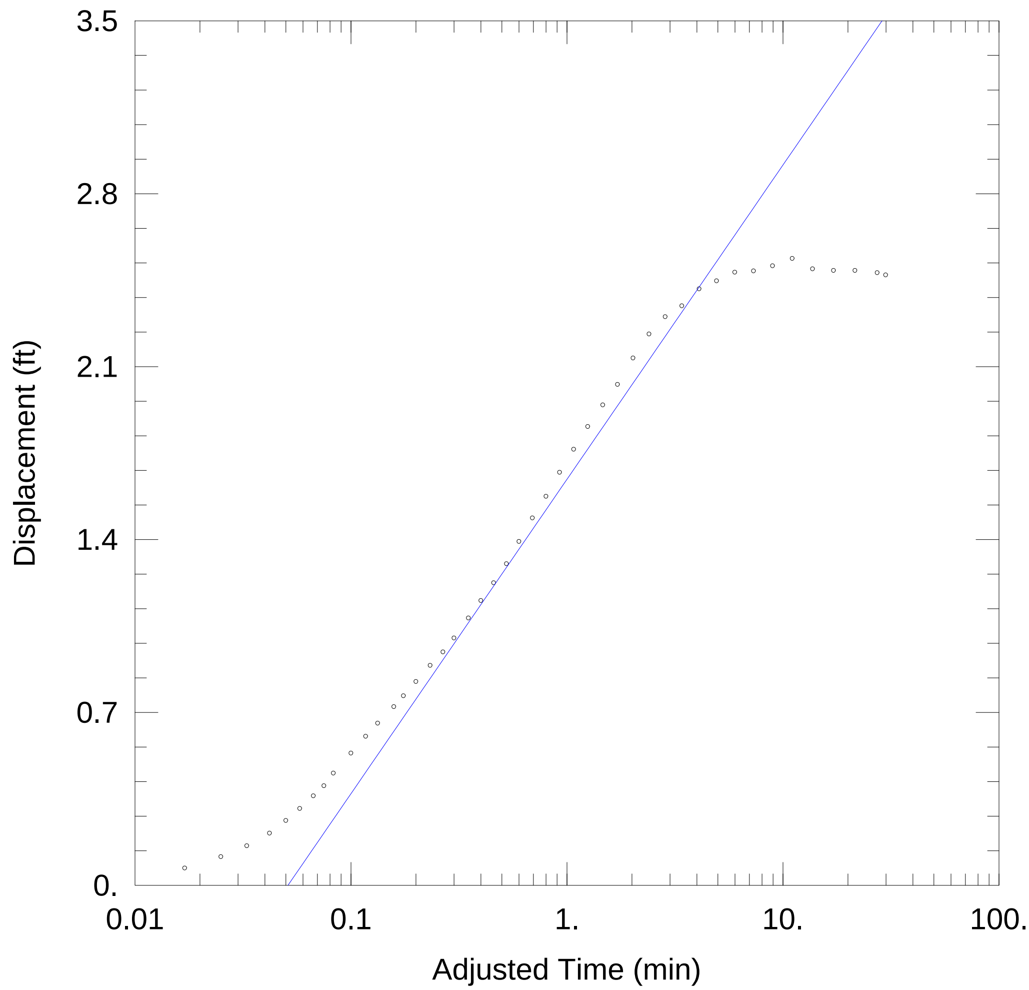
SOLUTION

Aquifer Model: Confined

Solution Method: Theis (Recovery)

T = 2.5 ft^2/day

S/S' = 1.5



MW-511 CONSTANT-RATE TEST

PROJECT INFORMATION

Company: ARCADIS
Client: CHEVRON
Location: EDMONDS, WASHINGTON
Test Well: MW-511
Test Date: 3/4/13

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
MW-511	0	0

Observation Wells

Well Name	X (ft)	Y (ft)
◦ MW-511	0	0

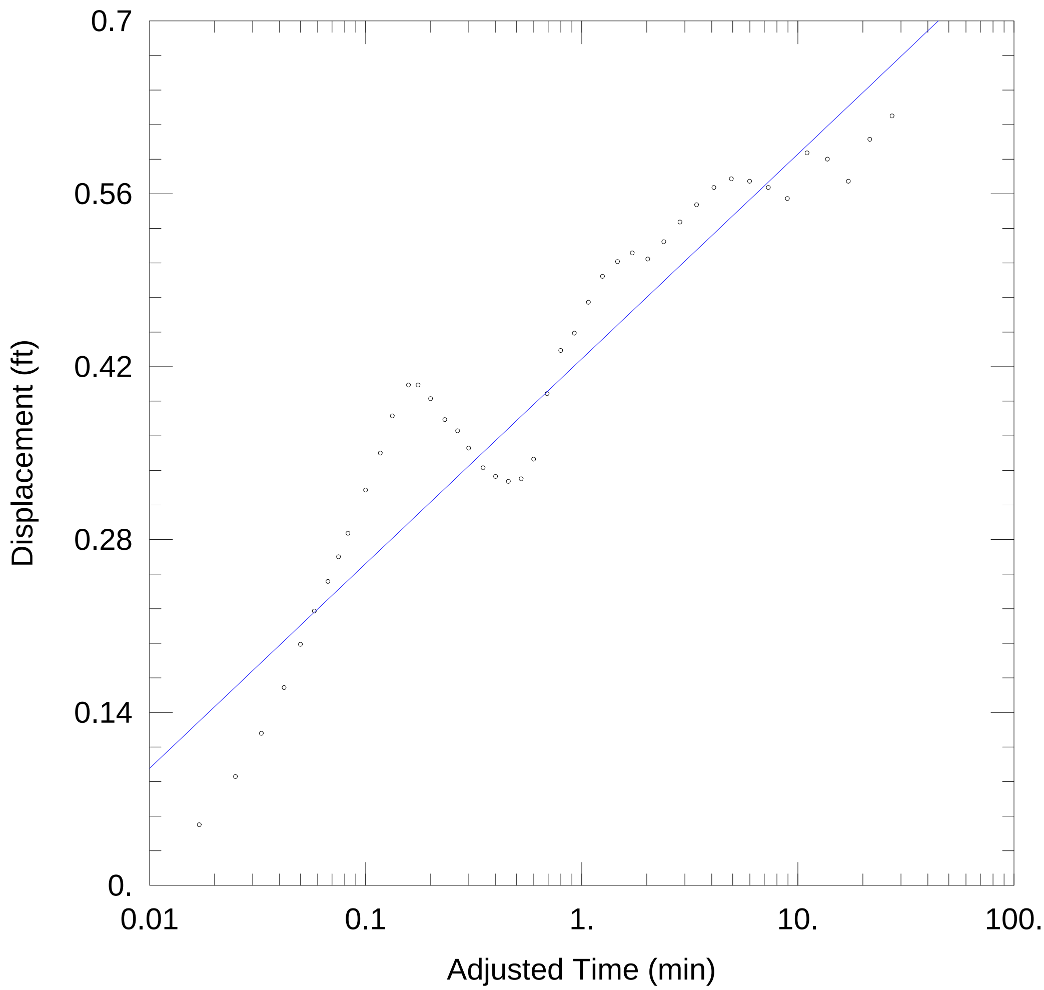
SOLUTION

Aquifer Model: Confined

Solution Method: Cooper-Jacob

T = 97. ft^2/day

S = 0.071



MW-522 CONSTANT-RATE TEST

PROJECT INFORMATION

Company: ARCADIS
Client: CHEVRON
Location: EDMONDS, WASHINGTON
Test Well: MW-522
Test Date: 3/5/13

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
MW-522	0	0

Observation Wells

Well Name	X (ft)	Y (ft)
◦ MW-522	0	0

SOLUTION

Aquifer Model: Confined

Solution Method: Cooper-Jacob

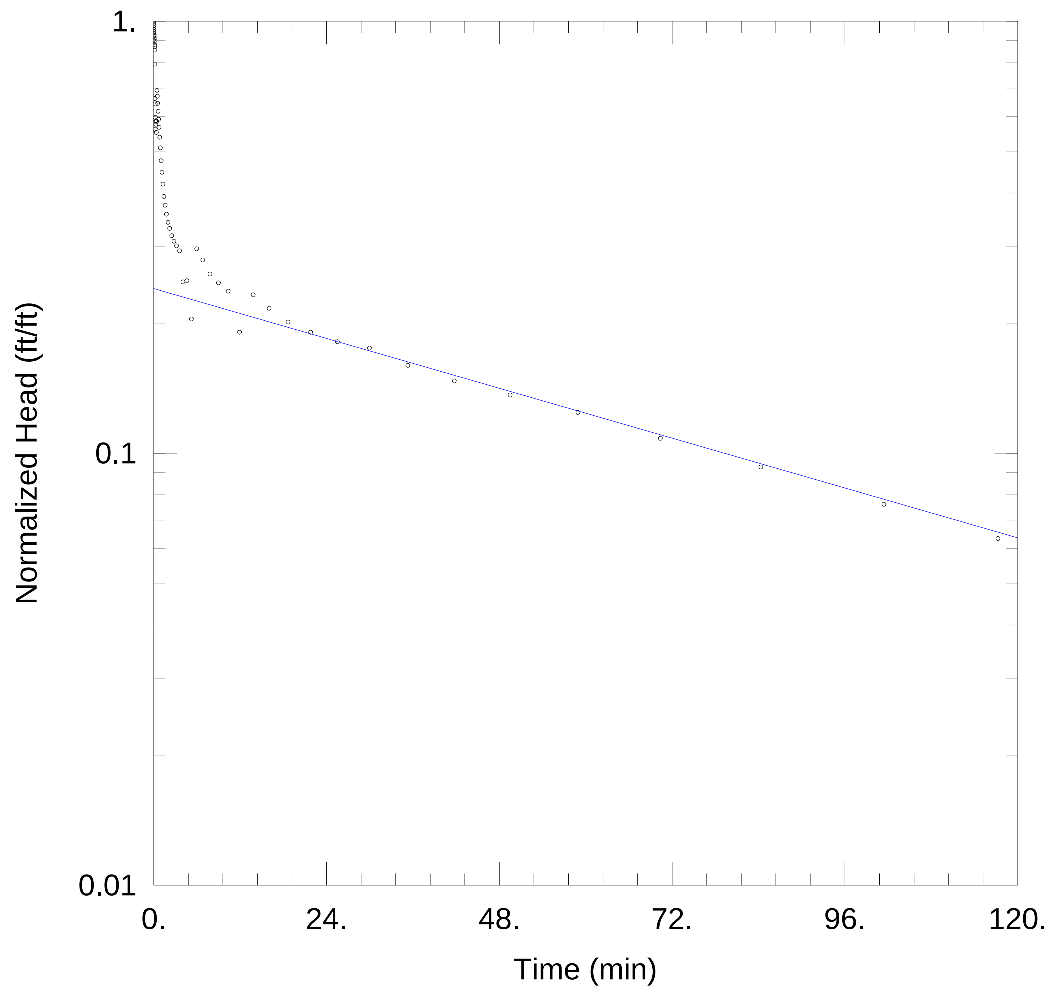
T = 117. ft^2/day

S = 0.0045

ARCADIS

Attachment 2

Slug Test Plots



MW-108 RISING HEAD TEST 1

PROJECT INFORMATION

Company: ARCADIS
Client: CHEVRON
Location: EDMONDS, WASHINGTON
Test Well: MW-108
Test Date: 3/6/13

WELL DATA (MW-108)

Initial Displacement: 1.498 ft
Total Well Penetration Depth: 9.6 ft
Casing Radius: 0.0417 ft

Static Water Column Height: 9.67 ft
Screen Length: 9.6 ft
Well Radius: 0.17 ft
Gravel Pack Porosity: 0.35

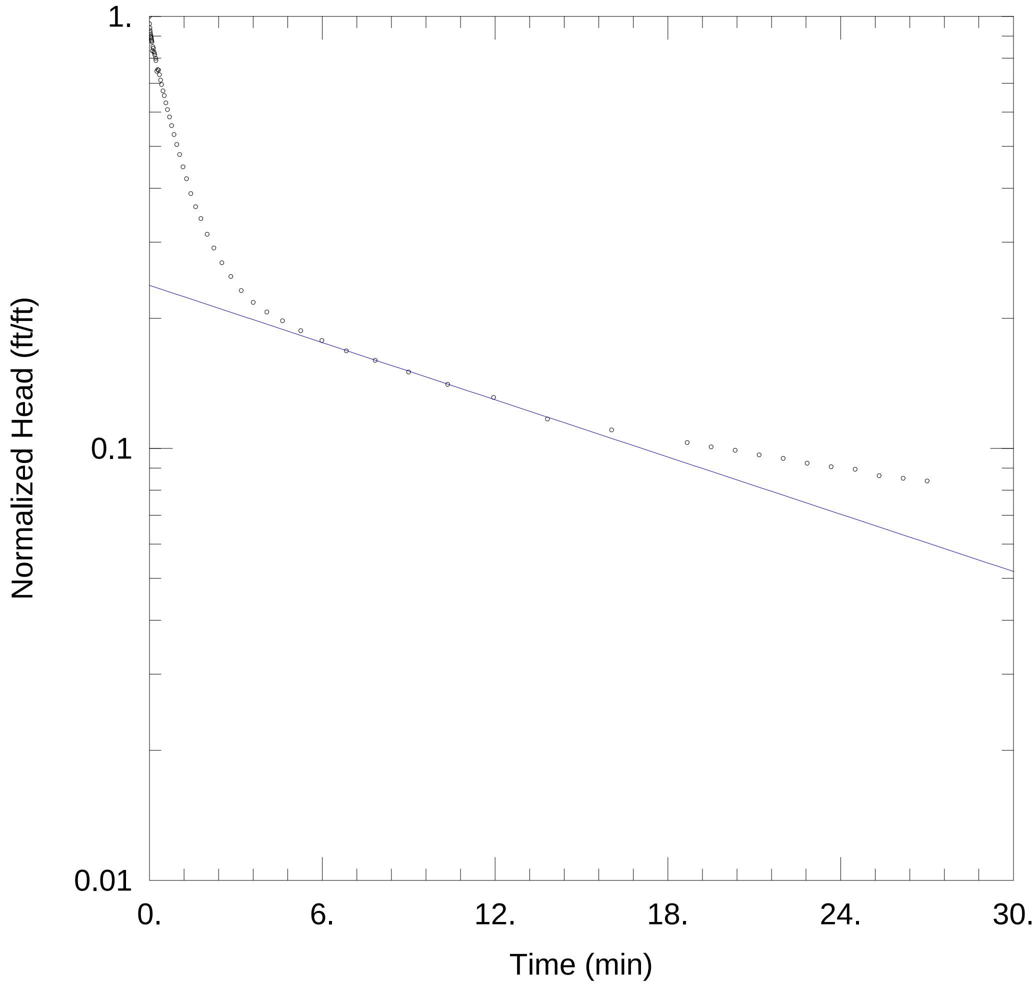
SOLUTION

Aquifer Model: Unconfined

Solution Method: Bouwer-Rice

K = 0.02 ft/day

y0 = 0.36 ft



MW-109 RISING HEAD TEST 1

PROJECT INFORMATION

Company: ARCADIS
Client: CHEVRON
Location: EDMONDS, WASHINGTON
Test Well: MW-109
Test Date: 3/7/13

WELL DATA (MW-109)

Initial Displacement: 1.678 ft
Total Well Penetration Depth: 8.09 ft
Casing Radius: 0.0417 ft

Static Water Column Height: 8.22 ft
Screen Length: 8.09 ft
Well Radius: 0.17 ft
Gravel Pack Porosity: 0.35

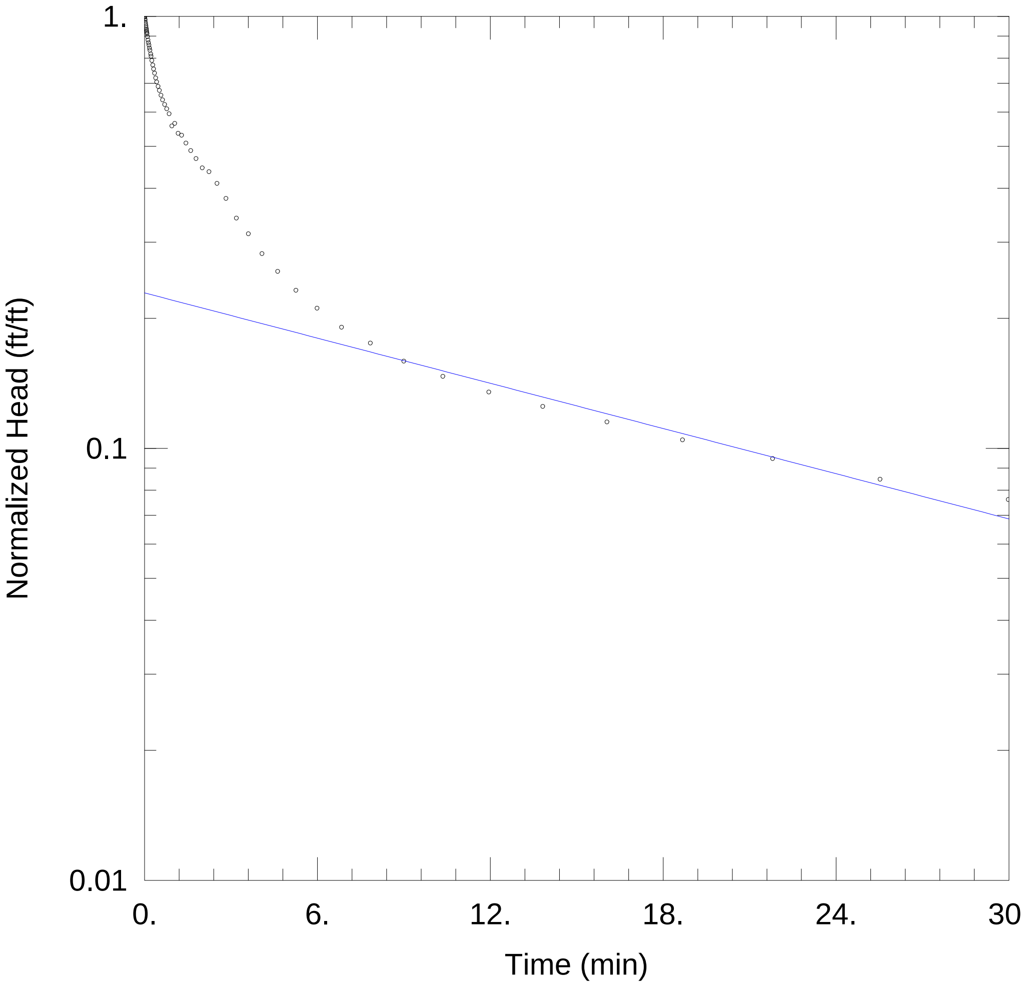
SOLUTION

Aquifer Model: Unconfined

Solution Method: Bouwer-Rice

K = 0.091 ft/day

y0 = 0.4 ft



MW-126 RISING HEAD TEST 1

PROJECT INFORMATION

Company: ARCADIS
Client: CHEVRON
Location: EDMONDS, WASHINGTON
Test Well: MW-126
Test Date: 3/6/13

WELL DATA (MW-126)

Initial Displacement: 1.616 ft
Total Well Penetration Depth: 9.65 ft
Casing Radius: 0.083 ft

Static Water Column Height: 9.75 ft
Screen Length: 9.65 ft
Well Radius: 0.33 ft
Gravel Pack Porosity: 0.35

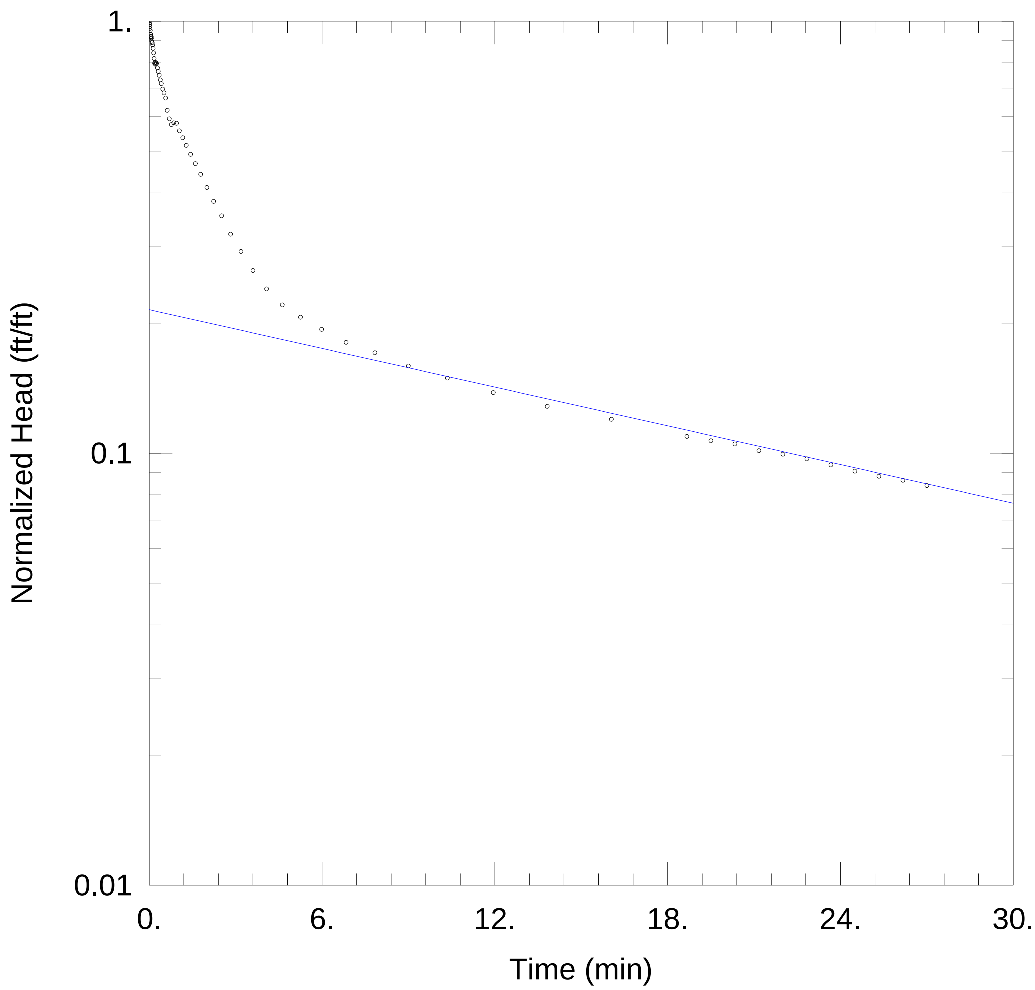
SOLUTION

Aquifer Model: Unconfined

Solution Method: Bouwer-Rice

K = 0.23 ft/day

y0 = 0.37 ft



MW-126 RISING HEAD TEST 2

PROJECT INFORMATION

Company: ARCADIS
Client: CHEVRON
Location: EDMONDS, WASHINGTON
Test Well: MW-126
Test Date: 3/7/13

WELL DATA (MW-126)

Initial Displacement: 1.63 ft
Total Well Penetration Depth: 9.8 ft
Casing Radius: 0.083 ft

Static Water Column Height: 9.9 ft
Screen Length: 9.8 ft
Well Radius: 0.33 ft
Gravel Pack Porosity: 0.35

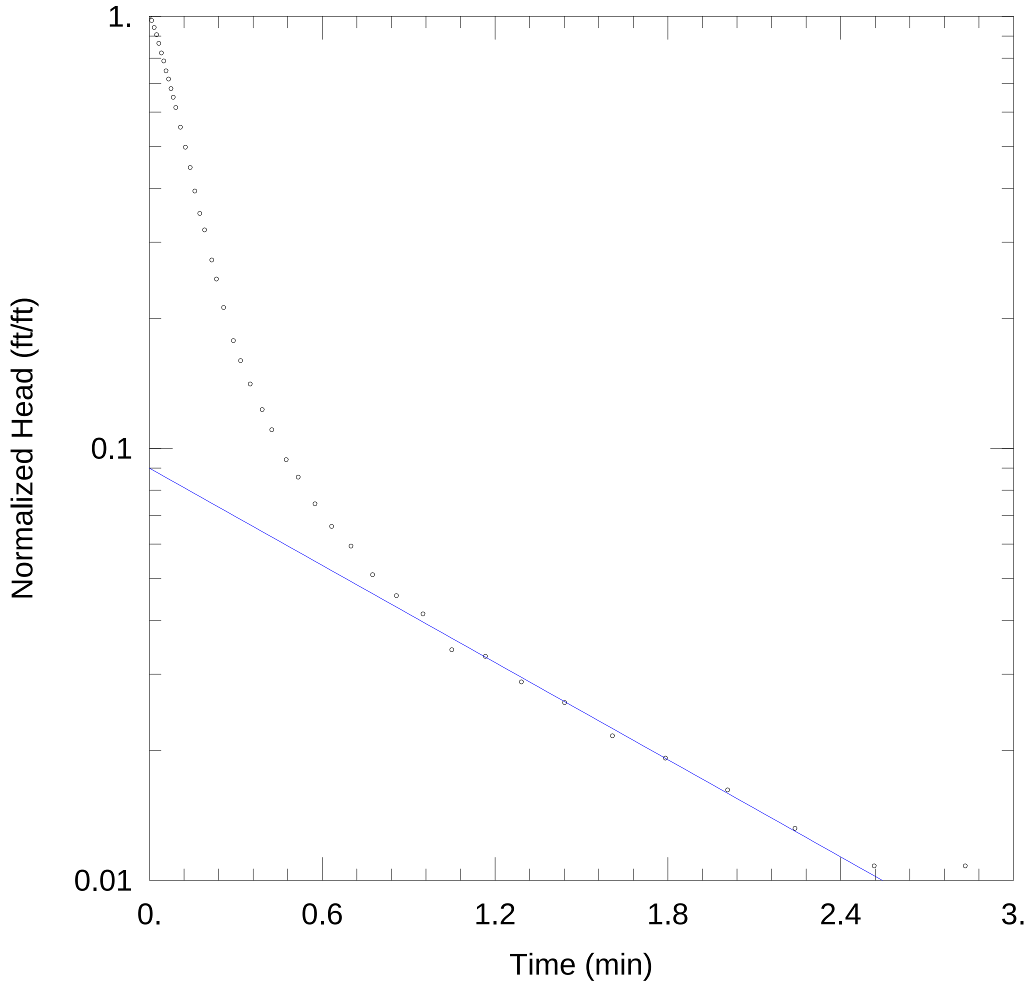
SOLUTION

Aquifer Model: Unconfined

Solution Method: Bouwer-Rice

K = 0.21 ft/day

y0 = 0.35 ft



MW-522 RISING HEAD TEST 1

PROJECT INFORMATION

Company: ARCADIS
Client: CHEVRON
Location: EDMONDS, WASHINGTON
Test Well: MW-522
Test Date: 3/7/13

WELL DATA (MW-522)

Initial Displacement: 1.668 ft
Total Well Penetration Depth: 4.91 ft
Casing Radius: 0.083 ft

Static Water Column Height: 5.16 ft
Screen Length: 4.91 ft
Well Radius: 0.33 ft
Gravel Pack Porosity: 0.35

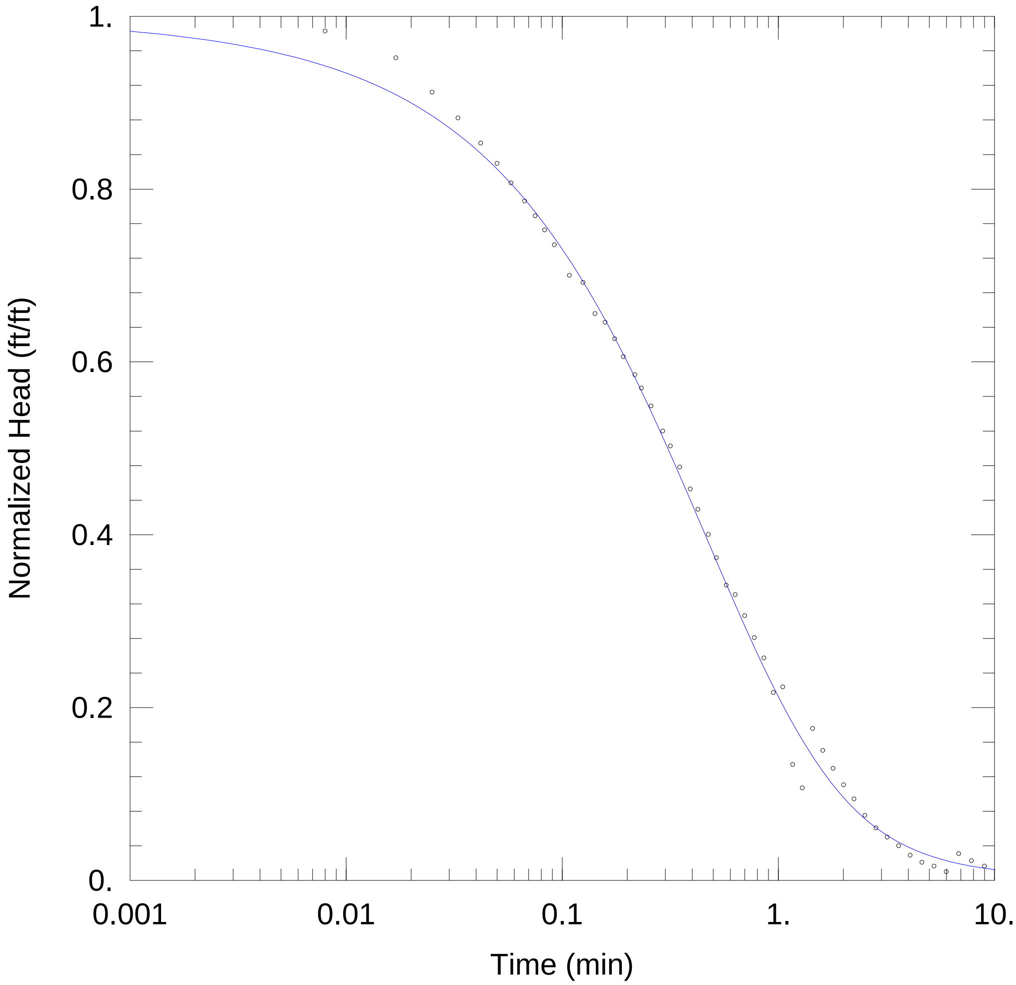
SOLUTION

Aquifer Model: Unconfined

Solution Method: Bouwer-Rice

K = 17.3 ft/day

y0 = 0.15 ft



MW-530 RISING HEAD TEST 2

PROJECT INFORMATION

Company: ARCADIS
Client: CHEVRON
Location: EDMONDS, WASHINGTON
Test Well: MW-530
Test Date: 3/7/13

WELL DATA (MW-530)

Initial Displacement: 1.104 ft
Total Well Penetration Depth: 6.56 ft
Casing Radius: 0.0417 ft

Static Water Column Height: 6.59 ft
Screen Length: 5. ft
Well Radius: 0.08 ft

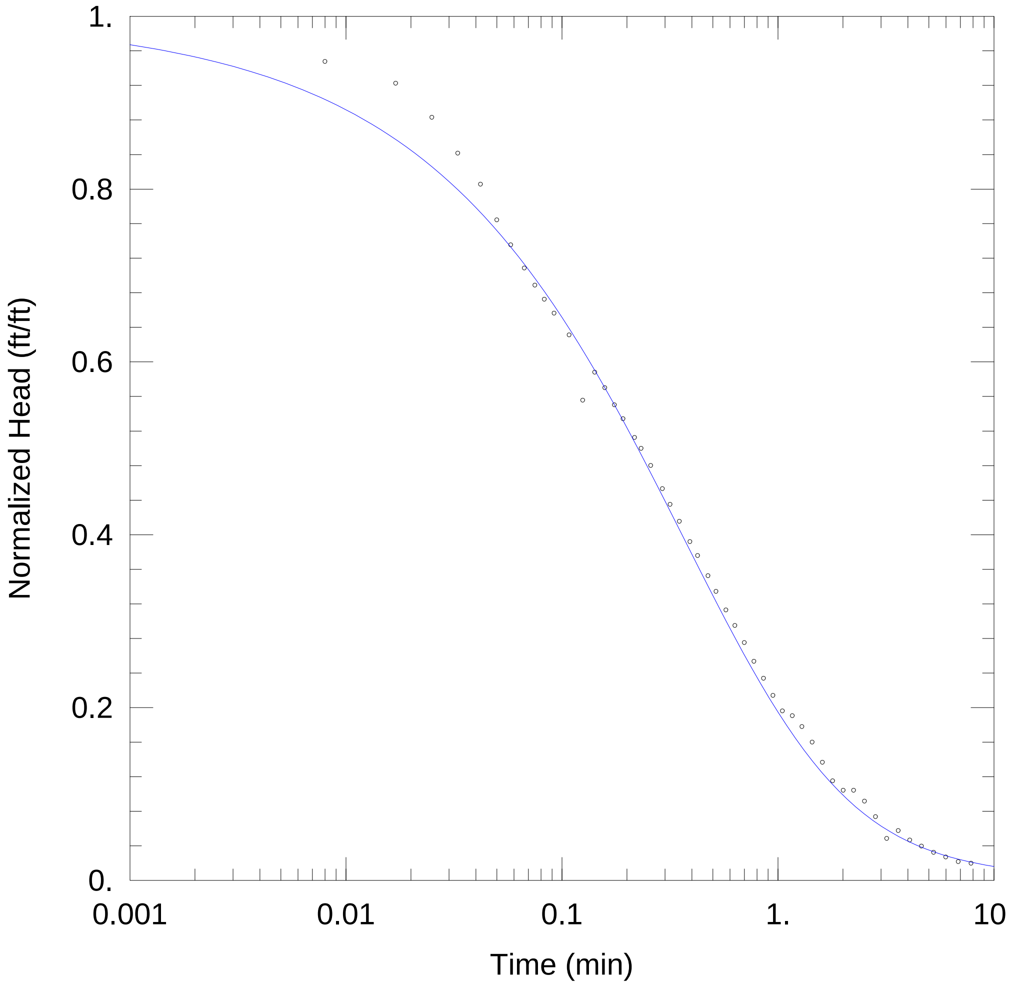
SOLUTION

Aquifer Model: Confined

Solution Method: Cooper-Bredehoeft-Papadopulos

T = 5.9 ft^2/day

S = 0.0053



MW-530 RISING HEAD TEST 3

PROJECT INFORMATION

Company: ARCADIS
Client: CHEVRON
Location: EDMONDS, WASHINGTON
Test Well: MW-530
Test Date: 3/7/13

WELL DATA (MW-530)

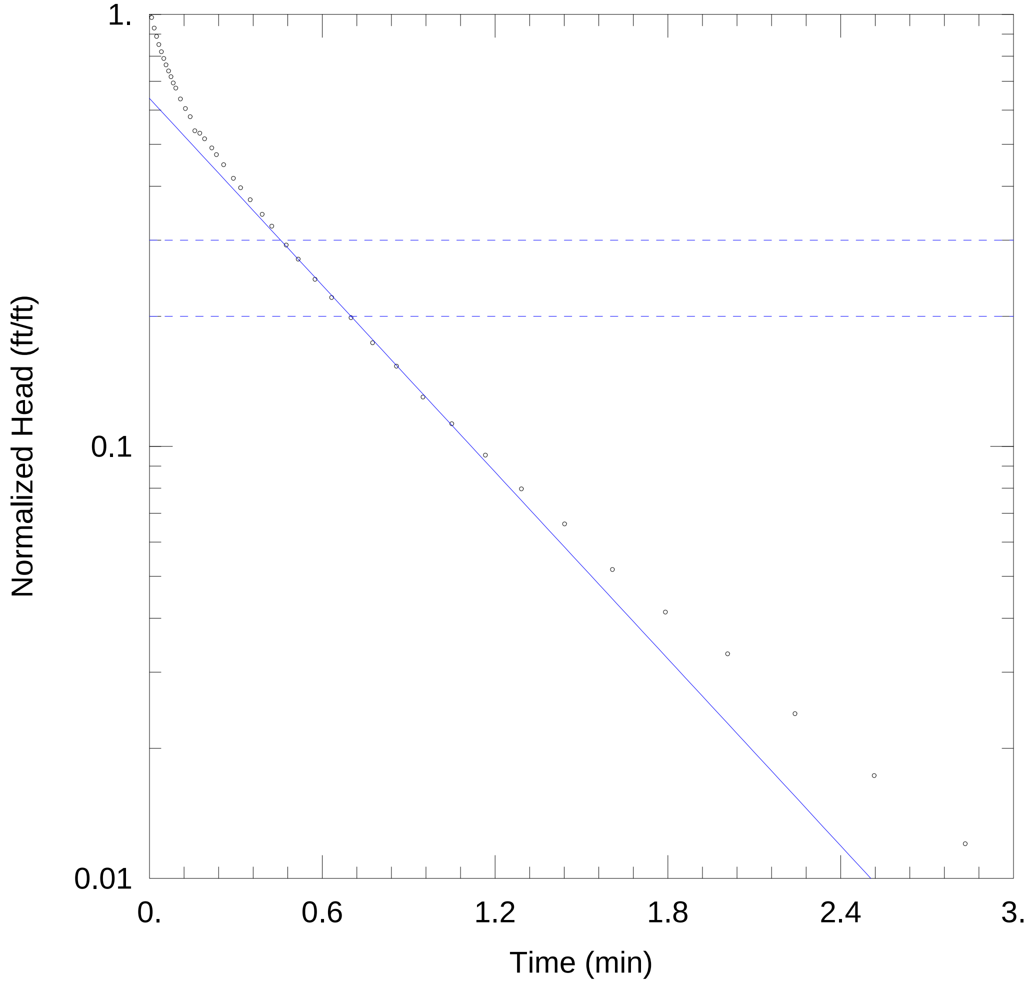
Initial Displacement: 1.287 ft
Total Well Penetration Depth: 6.56 ft
Casing Radius: 0.0417 ft

Static Water Column Height: 6.59 ft
Screen Length: 5. ft
Well Radius: 0.083 ft

SOLUTION

Aquifer Model: Confined
$T = 4.4\ ft^2/day$

Solution Method: Cooper-Bredehoeft-Papadopulos
S = 0.029



P-16 RISING HEAD TEST 1

PROJECT INFORMATION

Company: ARCADIS
Client: CHEVRON
Location: EDMONDS, WASHINGTON
Test Well: P-16
Test Date: 3/6/13

WELL DATA (P-16)

Initial Displacement: 1.331 ft
Total Well Penetration Depth: 10.56 ft
Casing Radius: 0.0417 ft

Static Water Column Height: 10.71 ft
Screen Length: 10. ft
Well Radius: 0.13 ft
Gravel Pack Porosity: 0.35

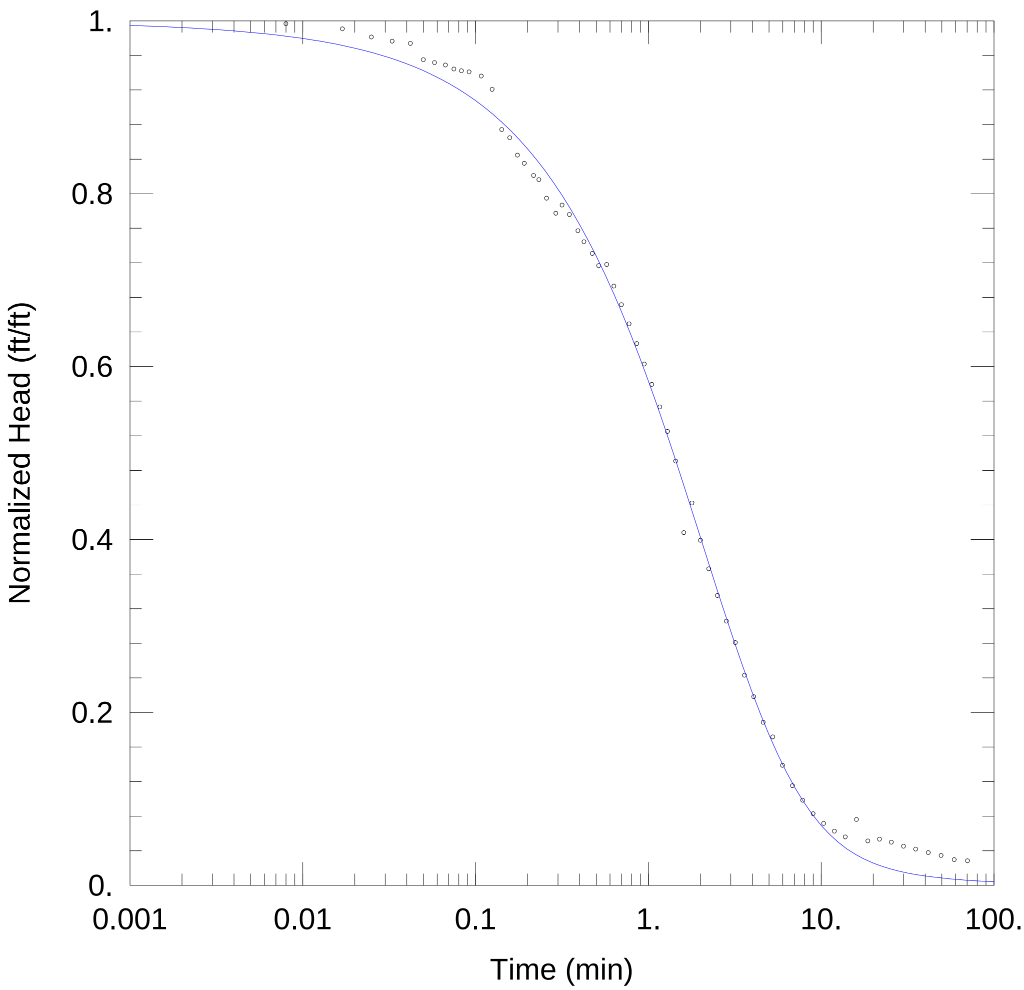
SOLUTION

Aquifer Model: Unconfined

K = 0.85 ft/day

Solution Method: Bouwer-Rice

y0 = 0.85 ft



P-4 RISING HEAD TEST 1

PROJECT INFORMATION

Company: ARCADIS
Client: CHEVRON
Location: EDMONDS, WASHINGTON
Test Well: P-4
Test Date: 3/7/13

WELL DATA (P-4)

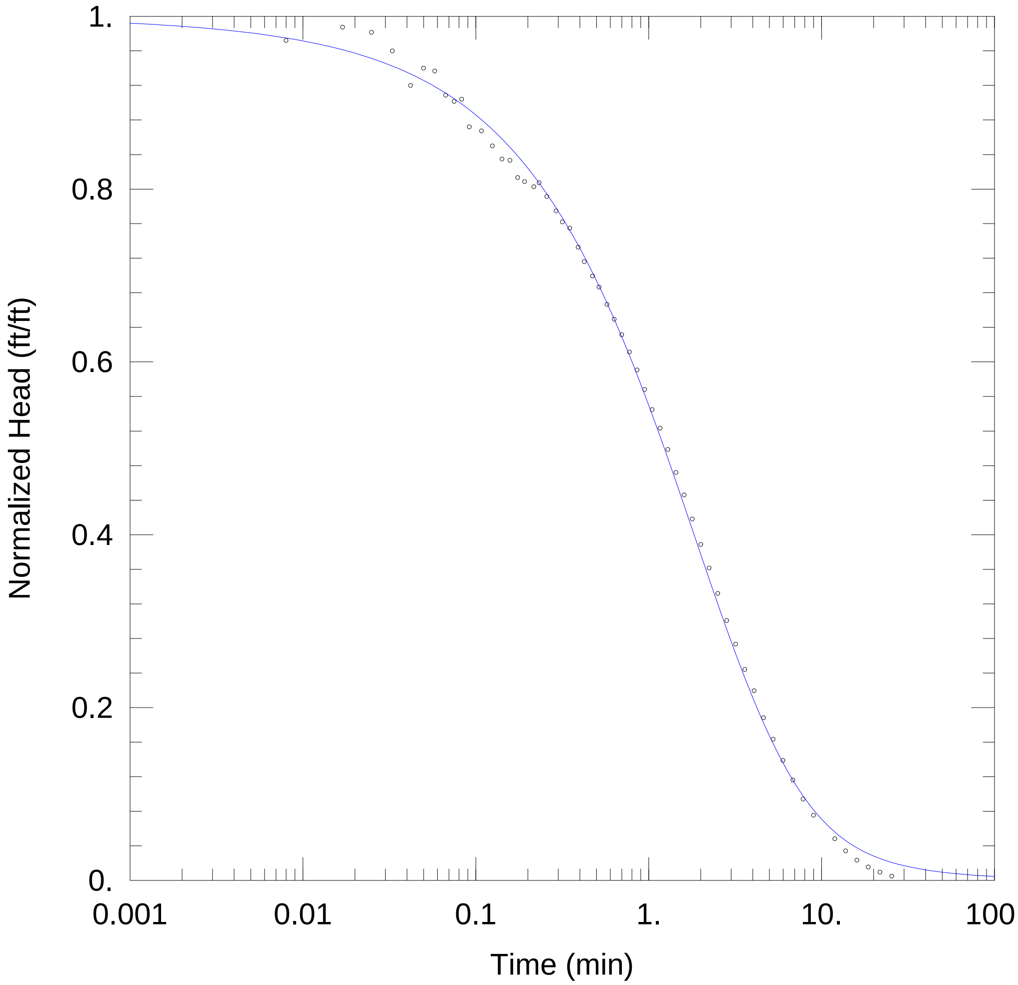
Initial Displacement: 1.486 ft
Total Well Penetration Depth: 15. ft
Casing Radius: 0.0417 ft

Static Water Column Height: 14.55 ft
Screen Length: 5. ft
Well Radius: 0.33 ft

SOLUTION

Aquifer Model: Confined
$T = 1.7\ ft^2/day$

Solution Method: Cooper-Bredehoeft-Papadopulos
S = 0.0001



P-8 RISING HEAD TEST 1

PROJECT INFORMATION

Company: ARCADIS
Client: CHEVRON
Location: EDMONDS, WASHINGTON
Test Well: P-8
Test Date: 3/7/13

WELL DATA (P-8)

Initial Displacement: 1.5 ft
Total Well Penetration Depth: 17.51 ft
Casing Radius: 0.0417 ft

Static Water Column Height: 16.89 ft
Screen Length: 5. ft
Well Radius: 0.33 ft

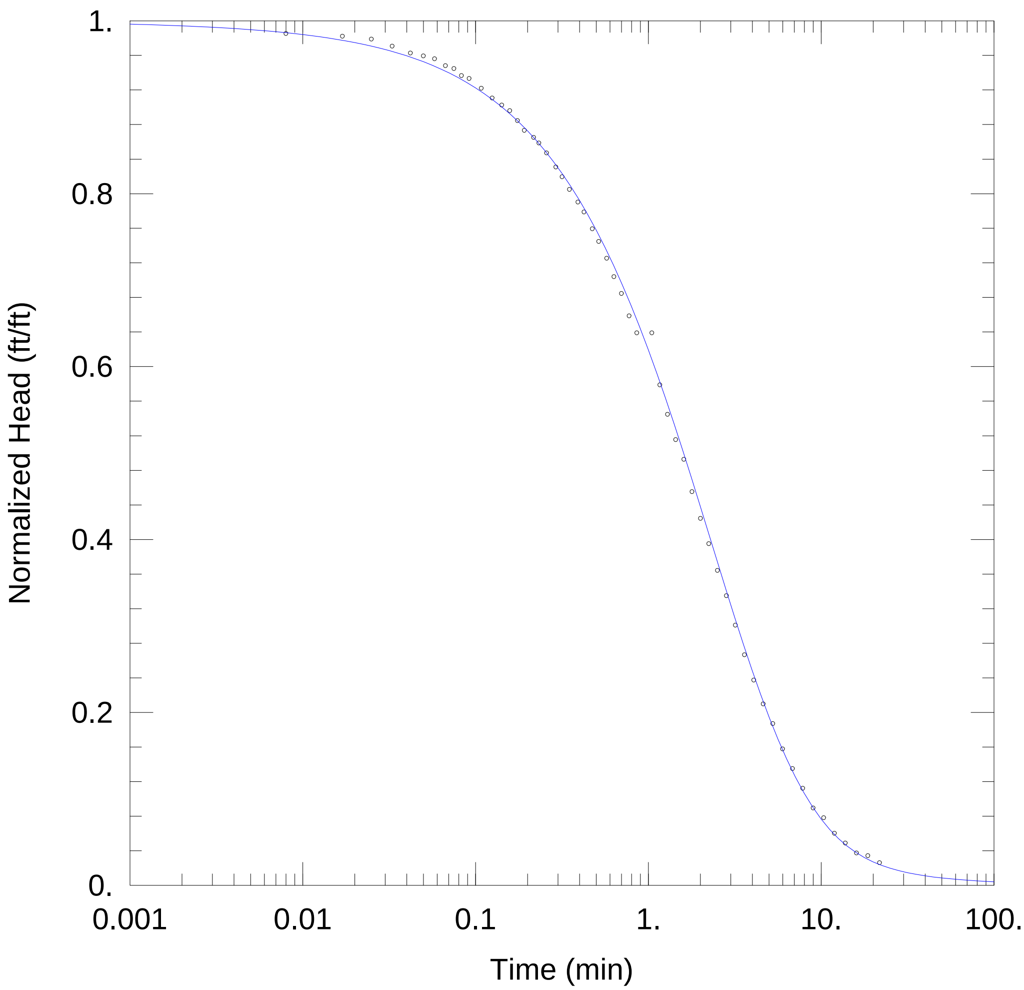
SOLUTION

Aquifer Model: Confined

$T = 1.5\ ft^2/day$

Solution Method: Cooper-Bredehoeft-Papadopulos

S = 0.00029



P-8 RISING HEAD TEST 2

PROJECT INFORMATION

Company: ARCADIS
Client: CHEVRON
Location: EDMONDS, WASHINGTON
Test Well: P-8
Test Date: 3/7/13

WELL DATA (P-8)

Initial Displacement: 0.615 ft
Total Well Penetration Depth: 17.51 ft
Casing Radius: 0.0417 ft

Static Water Column Height: 16.89 ft
Screen Length: 5. ft
Well Radius: 0.33 ft

SOLUTION

Aquifer Model: Confined

Solution Method: Cooper-Bredehoeft-Papadopulos

T = 1.7 ft^2/day

S = 4.9E-5

Attachment 3

Memorandum: Analysis of Site Geologic Data Using Mining Visualization Software (MVS)

ARCADIS U.S., Inc.
1687 Cole Blvd.
Suite 200
Lakewood
Colorado 80401
Tel 303 231 9115
Fax 303 231 9571

MEMO

To:
Scott Zorn

Copies:
Eric Rogoff
Jim Bognar
Project File

From:
Dave Lipson, Loren North, Rob Porsche

Date:
December 12, 2013

ARCADIS Project No.:
B0045362

Subject:
Analysis of Site Geologic Data Using Mining Visualization Software (MVS)
Chevron Environmental Management Company
Former Unocal Edmonds Bulk Fuel Terminal, Edmonds, Washington

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Introduction

ARCADIS utilized the Mining Visualization System (MVS) software to analyze and visualize geologic data from the Former Unocal Edmonds Bulk Fuel Terminal located in Edmonds, Washington (Site) and support development of the Site groundwater flow model which is being used to assist with feasibility screening of potential remedial alternatives (Figures A-1 and A-2). MVS was developed by C-Tech Development Corporation to efficiently manage, analyze, and help visualize large and complex geologic datasets such as the data from the Site. MVS can import and then use multiple types of digital information such as aerial photographs, topographic maps, digital elevation models, geographic information system (GIS) data, geologic data, water level data, analytical data, AutoCAD drawings, computer model output, data from other subsurface tools [*e.g.*, CPT, MIP, TarGOST, geophysical logs). The software can organize these various data types, analyze them in terms of spatial and volumetric relationships, and clearly display the results in a graphical format. MVS is known throughout the environmental industries for its ability to visualize the most challenging site conceptual models and complex datasets.

Methods

The following data types were imported into a Site-specific MVS model:

- Aerial photograph (source: Google Earth Pro, image date 10-1-2009);

- GIS and CAD drawings of site boundaries, historical excavations, roads, and other site features;
- Geologic data from soil boring and monitoring well construction logs; and
- Digital topographic data from the United States Geologic Survey (USGS).

After all of the data were entered, statistical Kriging methods were used to interpolate the geologic data and estimate the three-dimensional extent and distribution of the various soil layers at the Site. There are five different soil layers present at the Site that were included in the construction and calibration of the Site groundwater flow model and, by extension, analysis of potential remediation scenarios involving groundwater extraction. The five different Site soil layers include:

1. *2008 Fill*. The 2007-2008 Interim Action excavations were backfilled to 6 to 12 inches above the observed groundwater table in the open excavations with poorly graded coarse gravel (⅜ to 1 inch) with little to no fines. Backfill material above the coarse gravel to ground surface was a mixture of very fine to medium sand, trace silt, and fine to medium gravel materials.

2. *1929 Fill*. This 1929 fill consists of silty sands with gravel and sandy silts with gravel. During the 2007-2008 Interim Action excavations, subsurface materials encountered from ground surface to a depth of 8 to 15 feet below ground surface (bgs) were mostly fill material placed circa 1929 or later, during the creation of the Lower Yard facility.

3. *Marsh Deposits*. In many areas of the Lower Yard, beneath the 1929 Fill, there is a layer ranging from 1 foot to 15 feet thick composed of silt and sandy silt with large amounts of organic matter such as peat, and wood debris. This layer is encountered at depths ranging from 8 to 14 feet bgs, directly below the 1929 Fill material, and is interpreted to be representative of the former marsh horizon beneath the Lower Yard. This layer is typically demarcated by a 6 to 12 inch thick layer of decomposing vegetation.

4. *Beach Deposits*. Below the 1929 Fill and Marsh Deposits, a poorly graded sand formation of very fine to medium sand with fine gravel is present, containing organic material such as driftwood and seashells. This layer is interpreted to be representative of the former beach environment in the area prior to creation of the Lower Yard.

5. *Whidbey Formation*. This material is a poorly graded sand layer consisting of very fine to medium sand with fine gravel and is distinct from the overlying materials in the Lower Yard. It is present to the maximum explored depth of 41.8 feet bgs by Unocal. This unit contains interbedded sand with silt, and interbedded silt and sandy silt are also present. The interbeds range in thickness from less than 1 inch to several feet, and appear to be laterally discontinuous. This unit is interpreted to be alluvium, and is likely part of the Whidbey Formation.

Kriging is a spatial averaging technique that uses a linear combination of weights at known data points to estimate data values at unknown locations. Kriging uses a variogram (a.k.a. semivariogram) which is a representation of the spatial and data differences between some or all possible "pairs" of points in the measured data set. The variogram then describes the weighting factors that will be applied for the interpolation. Unlike other estimation procedures, kriging provides a measure of the error and associated confidence in the estimates.

For the Site, the traditional MVS modeling method of using geologic data alone to delineate the extent and distribution of the soil layers was supplemented with additional information. To expand on the geologic data, observations made during the recent remedial excavations were utilized to create points that defined both their surficial and sloped excavated extents, assuming all the replaced material was modern fill. This method allowed the kriging algorithm to better define the related excavation contacts while minimally impacting the distribution of historic and natural materials in the boring logs.

The final model was detail checked against existing geologic cross sections and the geologic contact elevations from the boring logs.

Results

Results of the MVS geologic data modeling were used to create a three-dimensional framework of the various soil types that was used to support development and calibration of the Site groundwater flow model. The groundwater flow model is a three-dimensional model that incorporates soil heterogeneities based on MVS analysis. The groundwater flow model is discussed elsewhere in the report.

Results of MVS geologic model are presented as graphical visualizations of the distribution and extent of the five Site soil layers on Figures A-3 through A-14.

Figure A-3 shows the Site plan in the MVS model and includes an aerial photograph, the Site groundwater monitoring well network, Detention Basin 1, Detention Basin 2, Willow Creek, and the historical remedial soil excavation areas.

Figure A-4 shows the Site monitoring well network from an oblique angle, and indicates the various soil layers identified at the monitoring wells.

Figure A-5 shows a map of the interpreted extent and distribution of the soil layers encountered at the Site. It is notable that not all of the soil layers can be seen in this view, because some soil layers exist beneath other soil layers. Because of this, the following figures show individual soil layers.

Figure A-6 shows a map of the interpreted extent and distribution of natural soil layer at the Site, including the marsh deposits, beach deposits, and Whidbey formation. As shown, marsh deposits fringe the surface water features at the Site (i.e., Willow Creek and the detention basins) and also exist within the marshlands. Furthermore, this view shows marsh deposits atop beach deposits, with both soil layers underlain by the Whidbey formation.

Figure A-7 shows a map of the interpreted extent and distribution of the fill layers at the Site, including the 2008 fill, 2008 fill gravel, and 1929 fill.

Figure A-8 shows a map of the interpreted extent and distribution of only the 2008 fill.

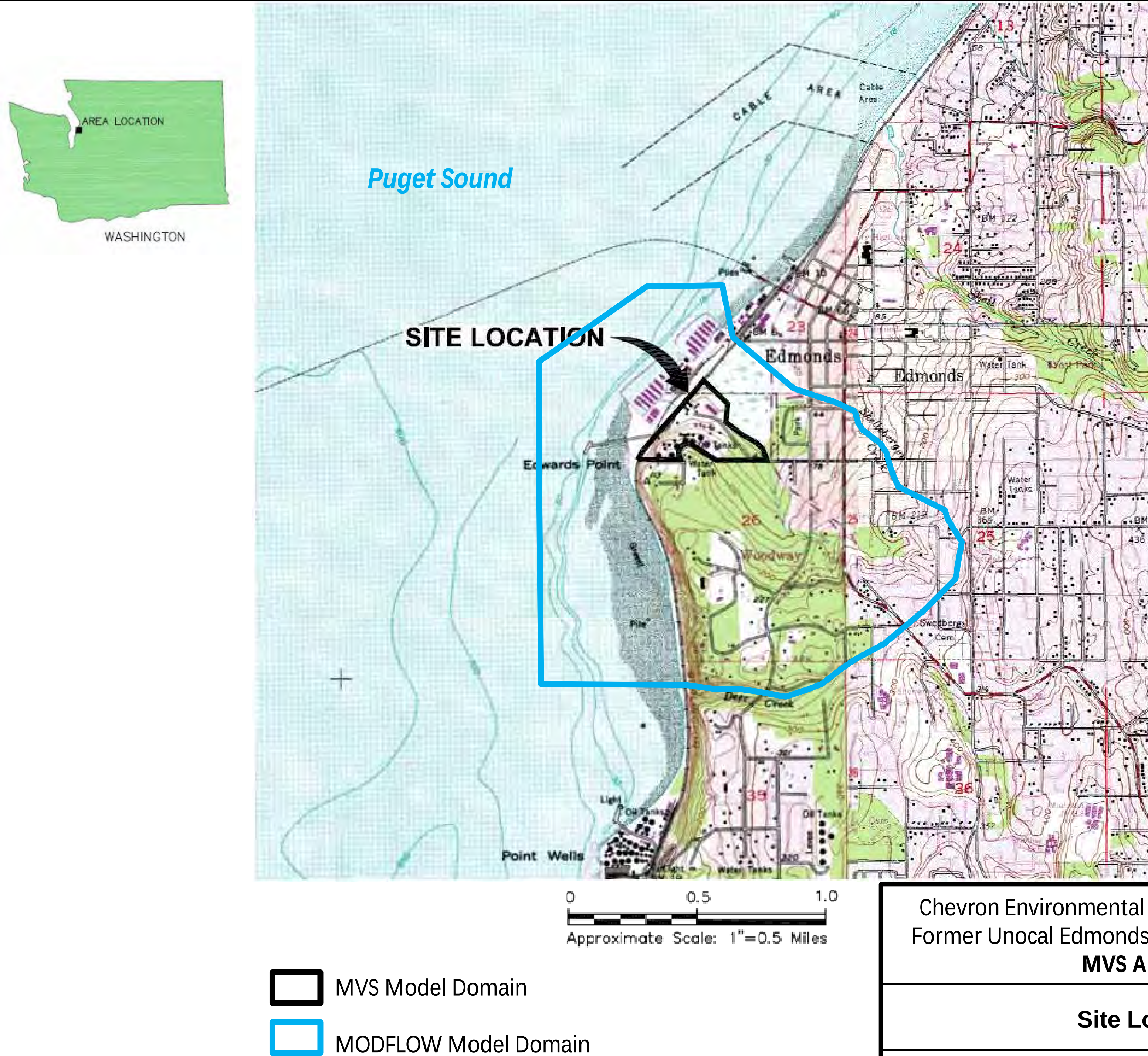
Figure A-9 shows a map of the interpreted extent and distribution of only the 1929 fill.

Figure A-10 shows a map of the interpreted extent and distribution of only the marsh deposits.

Figure A-11 shows a map of the interpreted extent and distribution of only the beach deposits.

Figure A-12 shows a geologic cross section extending north to south through the Site to show the vertical relationships between the various soil layers. As shown, the fill layers site atop the marsh deposits and, in some areas, they sit atop beach deposits. The Whidbey formation underlies the entire Site.

Figure A-13 shows a close-up geologic cross section extending northwest to southeast through the potential remediation areas. This view shows the vertical relationships between the various soil layers in this area. As shown, the potential remediation areas are limited to fill types, and are underlain by marsh and beach deposits.



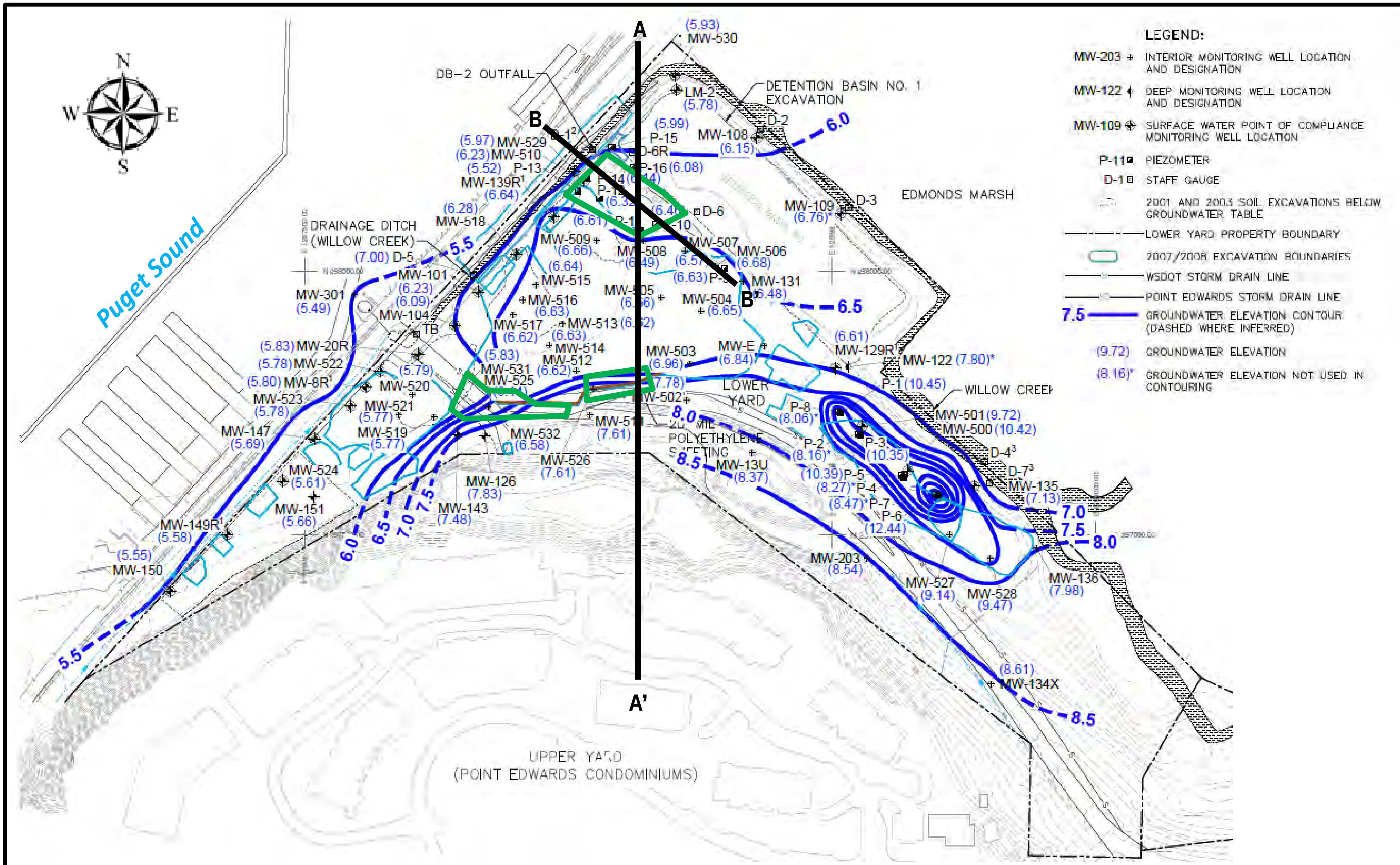
Source: USGS Quads., 7.5 Min. Series (Topographic) – Edmonds East, Wash., and Edmonds West, Wash.

Chevron Environmental Management Company
Former Unocal Edmonds Terminal, Edmonds, WA
MVS Analysis

Site Location

ARCADIS

FIGURE
A-1



0 100 200 300 400

Feet

Potential Remediation Area (Approx)

Cross Section Location

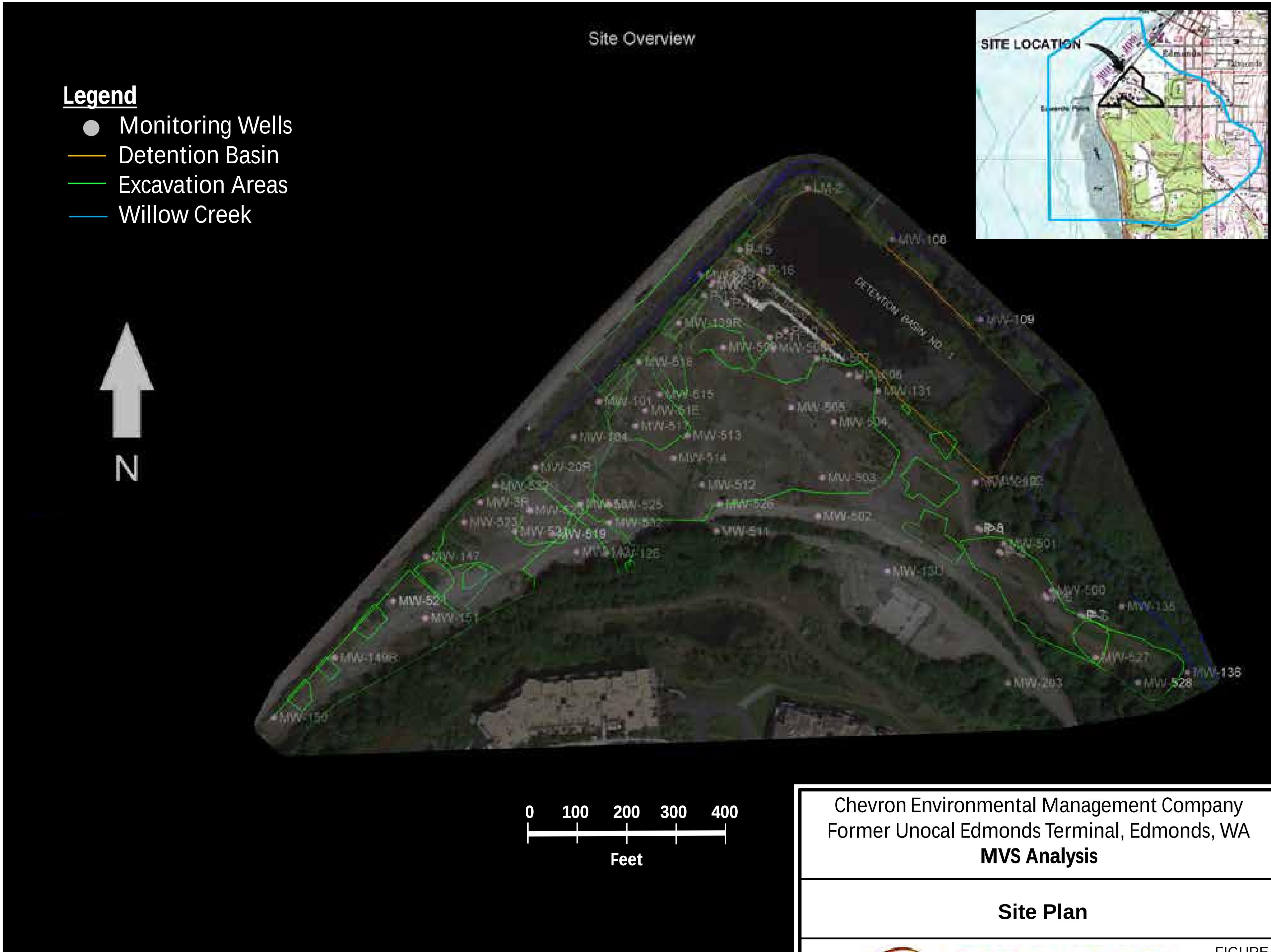
Source: Third Quarter 2013 Groundwater Monitoring Report.

Chevron Environmental Management Company
Former Unocal Edmonds Terminal, Edmonds, WA
MVS Analysis

Site Map with Groundwater Contours, Cross Sections, and Potential Remediation Areas

ARCADIS

FIGURE
A-2

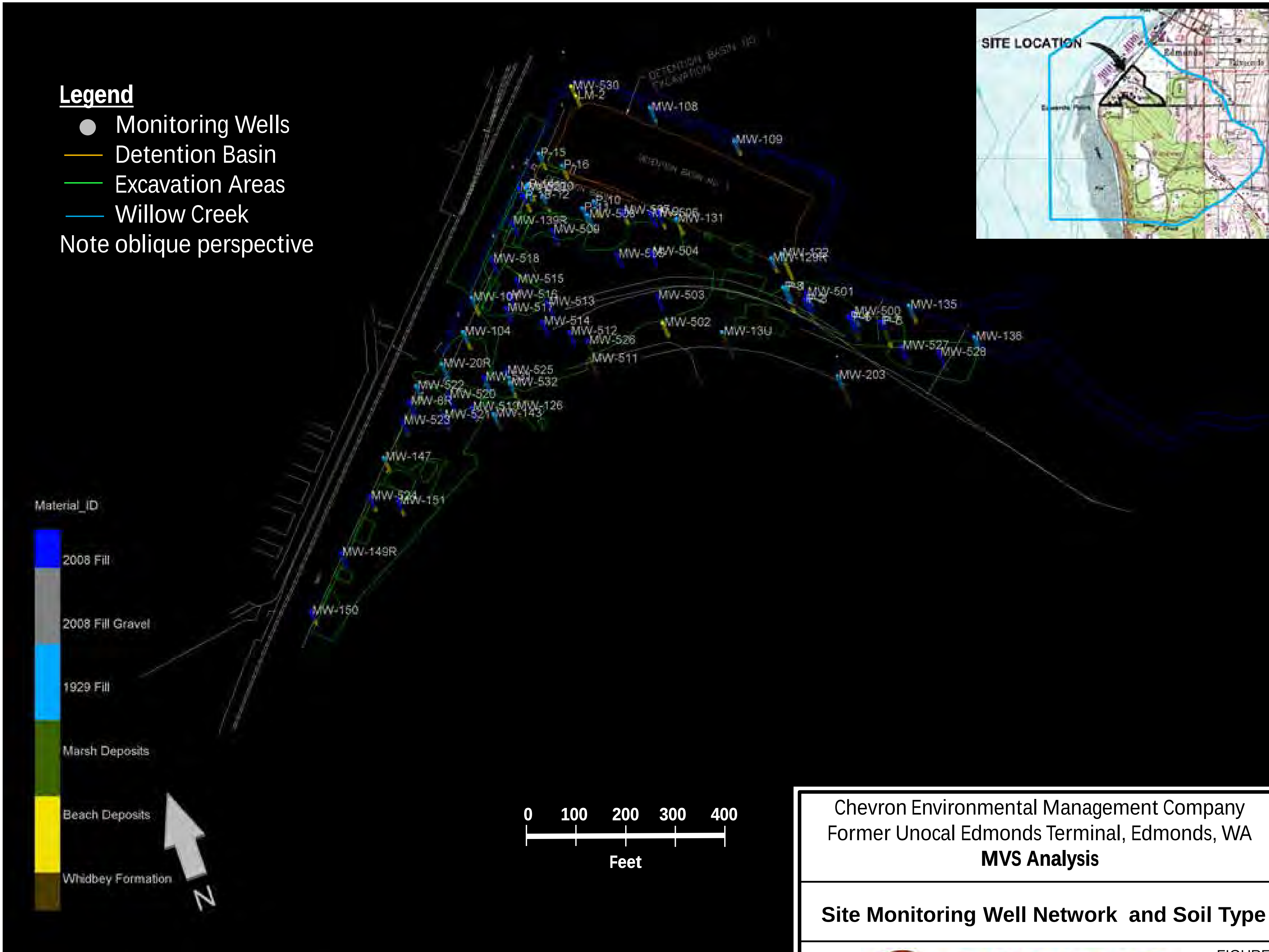


Chevron Environmental Management Company
Former Unocal Edmonds Terminal, Edmonds, WA
MVS Analysis

Site Plan

ARCADIS

FIGURE
A-3

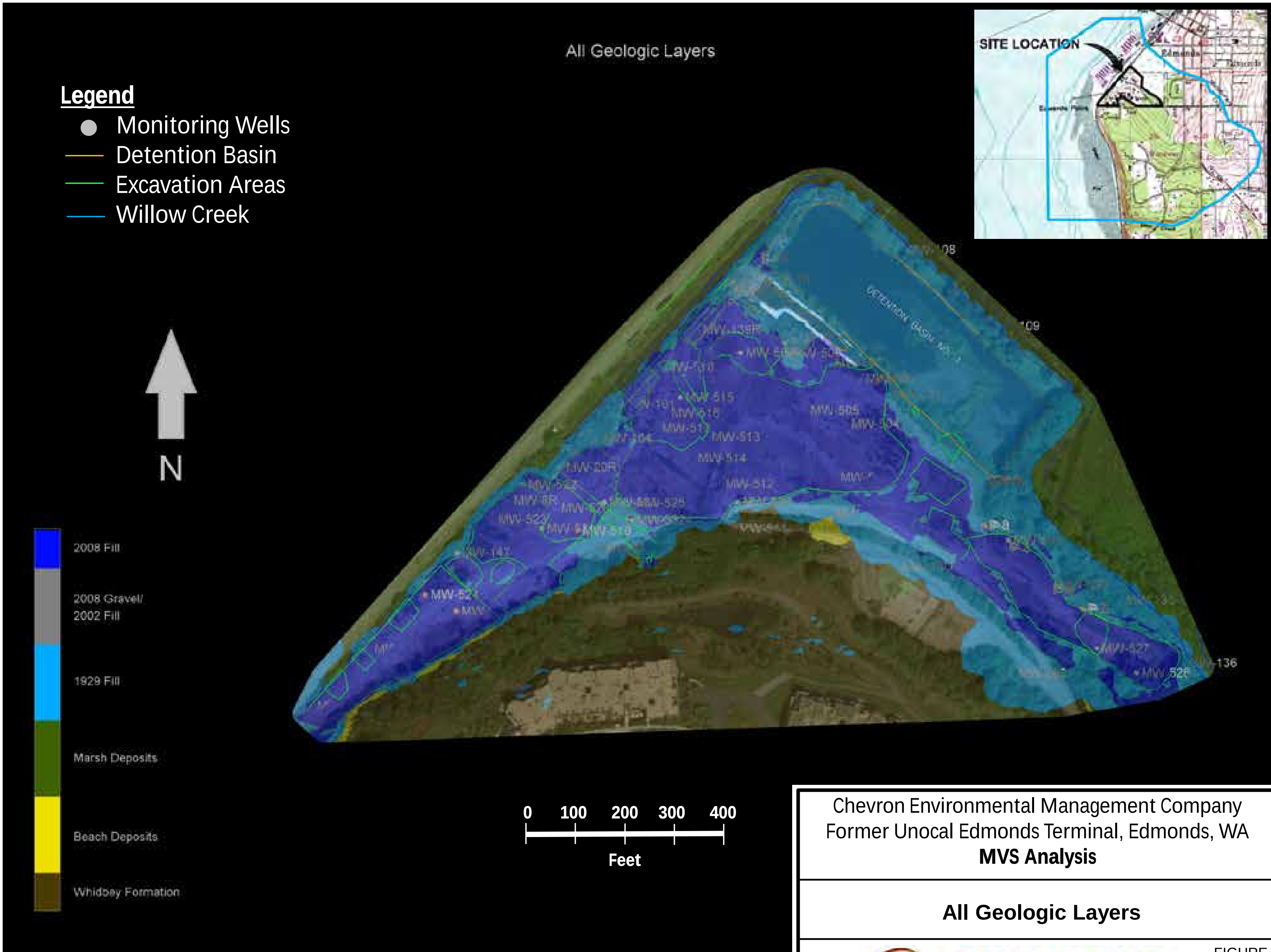


Chevron Environmental Management Company
Former Unocal Edmonds Terminal, Edmonds, WA
MVS Analysis

Site Monitoring Well Network and Soil Type

ARCADIS

FIGURE
A-4

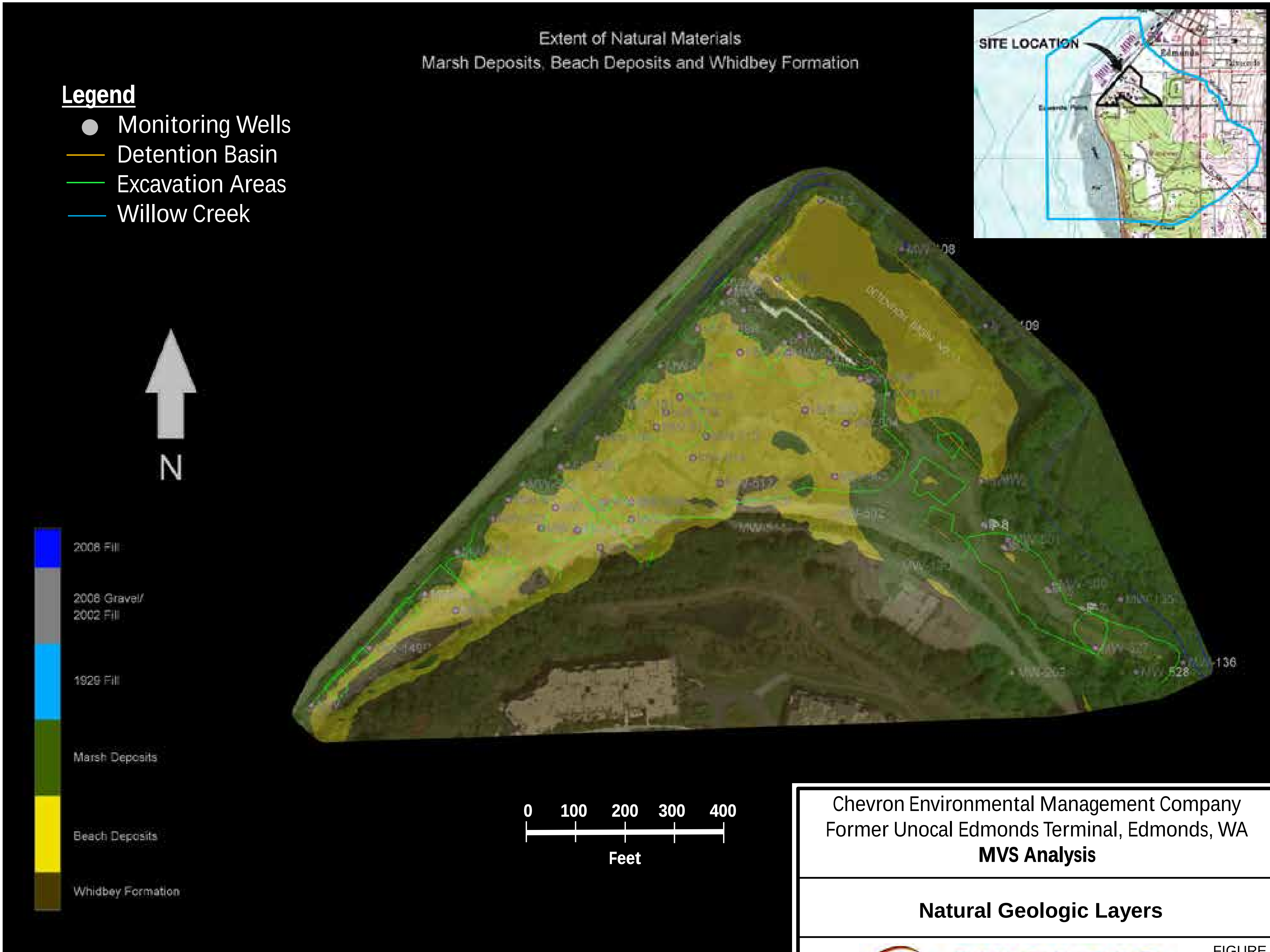


Chevron Environmental Management Company
Former Unocal Edmonds Terminal, Edmonds, WA
MVS Analysis

All Geologic Layers

ARCADIS

FIGURE
A-5

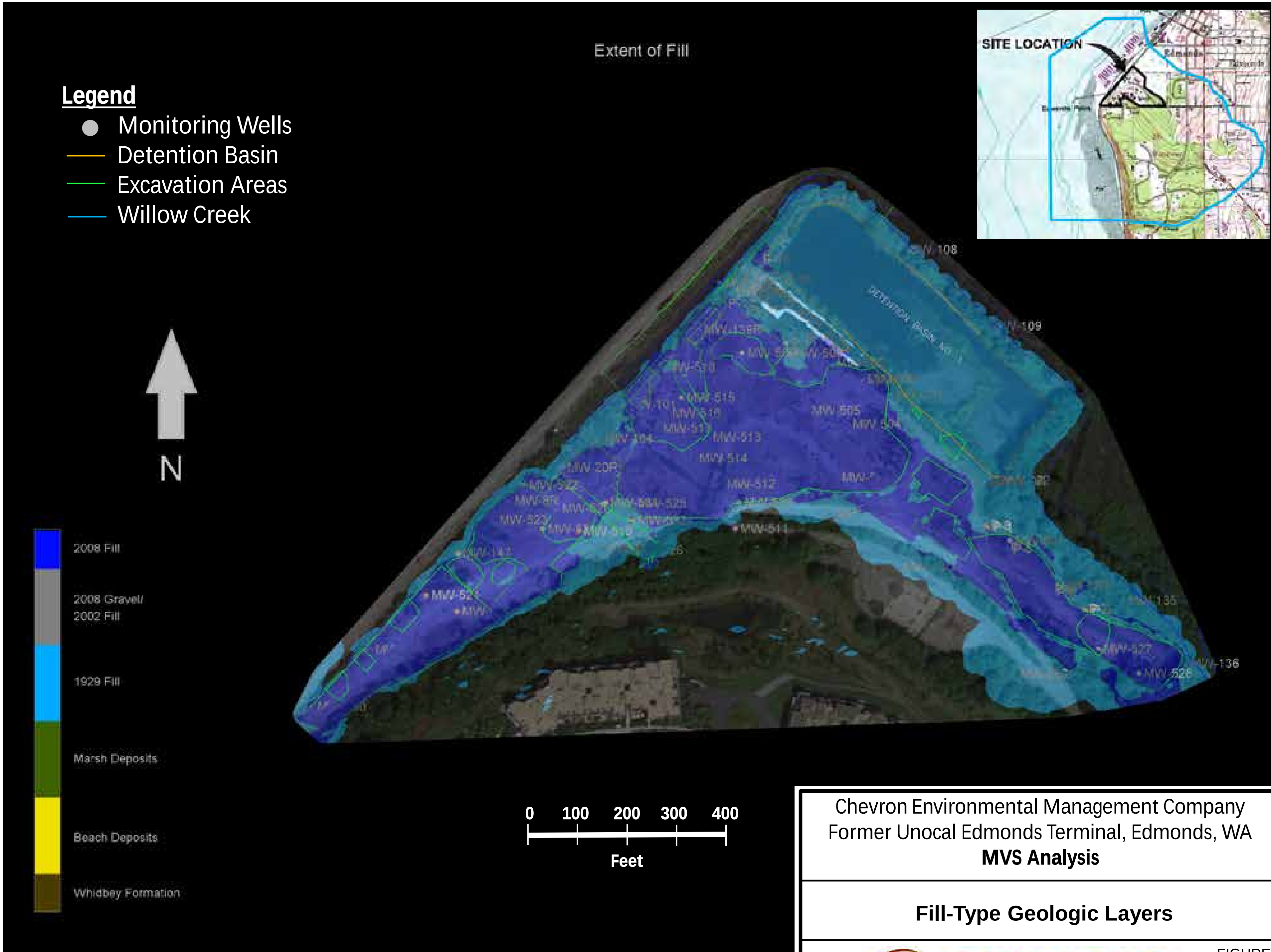


Chevron Environmental Management Company
Former Unocal Edmonds Terminal, Edmonds, WA
MVS Analysis

Natural Geologic Layers

ARCADIS

FIGURE
A-6

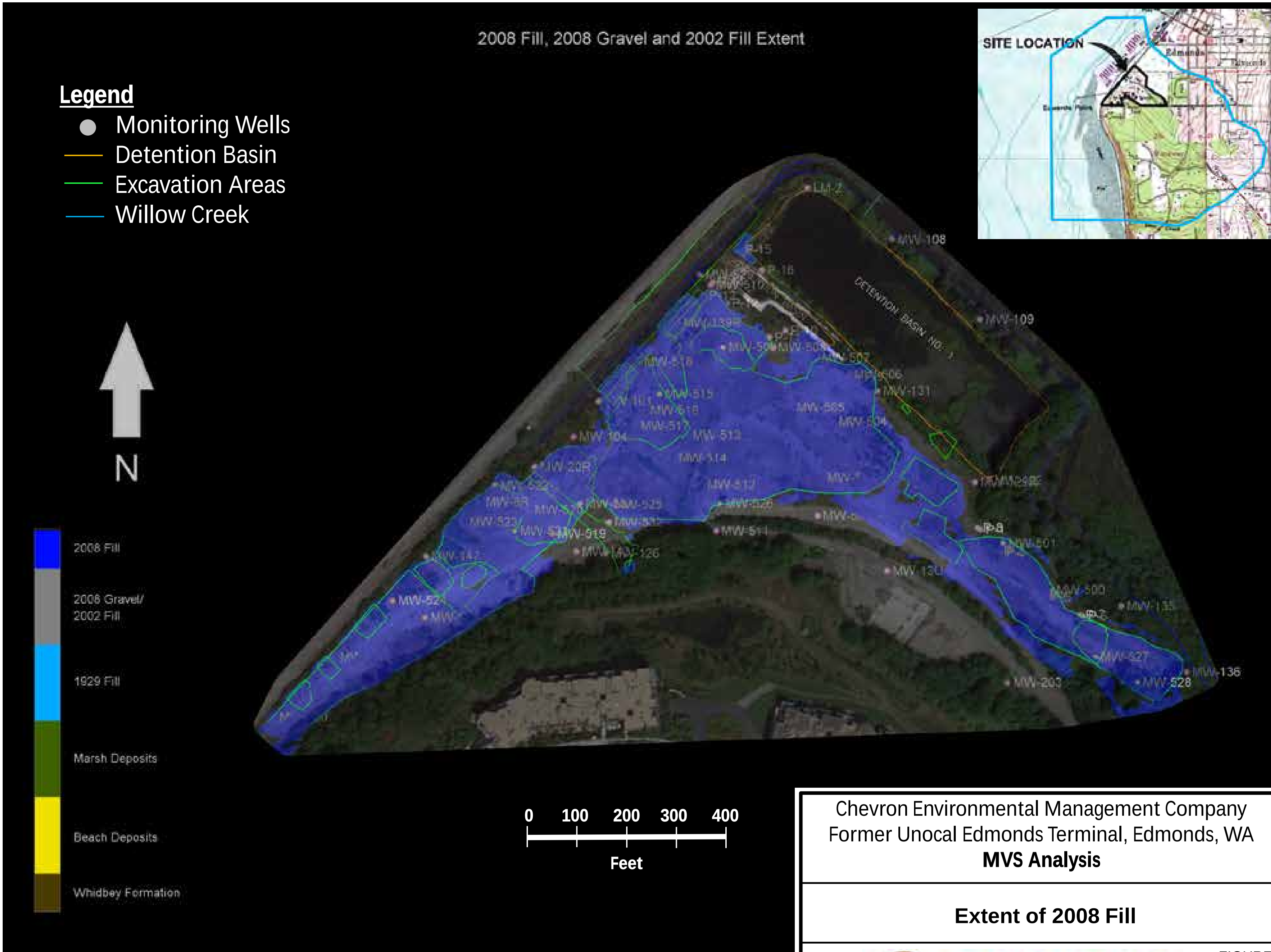


Chevron Environmental Management Company
Former Unocal Edmonds Terminal, Edmonds, WA
MVS Analysis

Fill-Type Geologic Layers

ARCADIS

FIGURE
A-7



Chevron Environmental Management Company
Former Unocal Edmonds Terminal, Edmonds, WA
MVS Analysis

Extent of 2008 Fill

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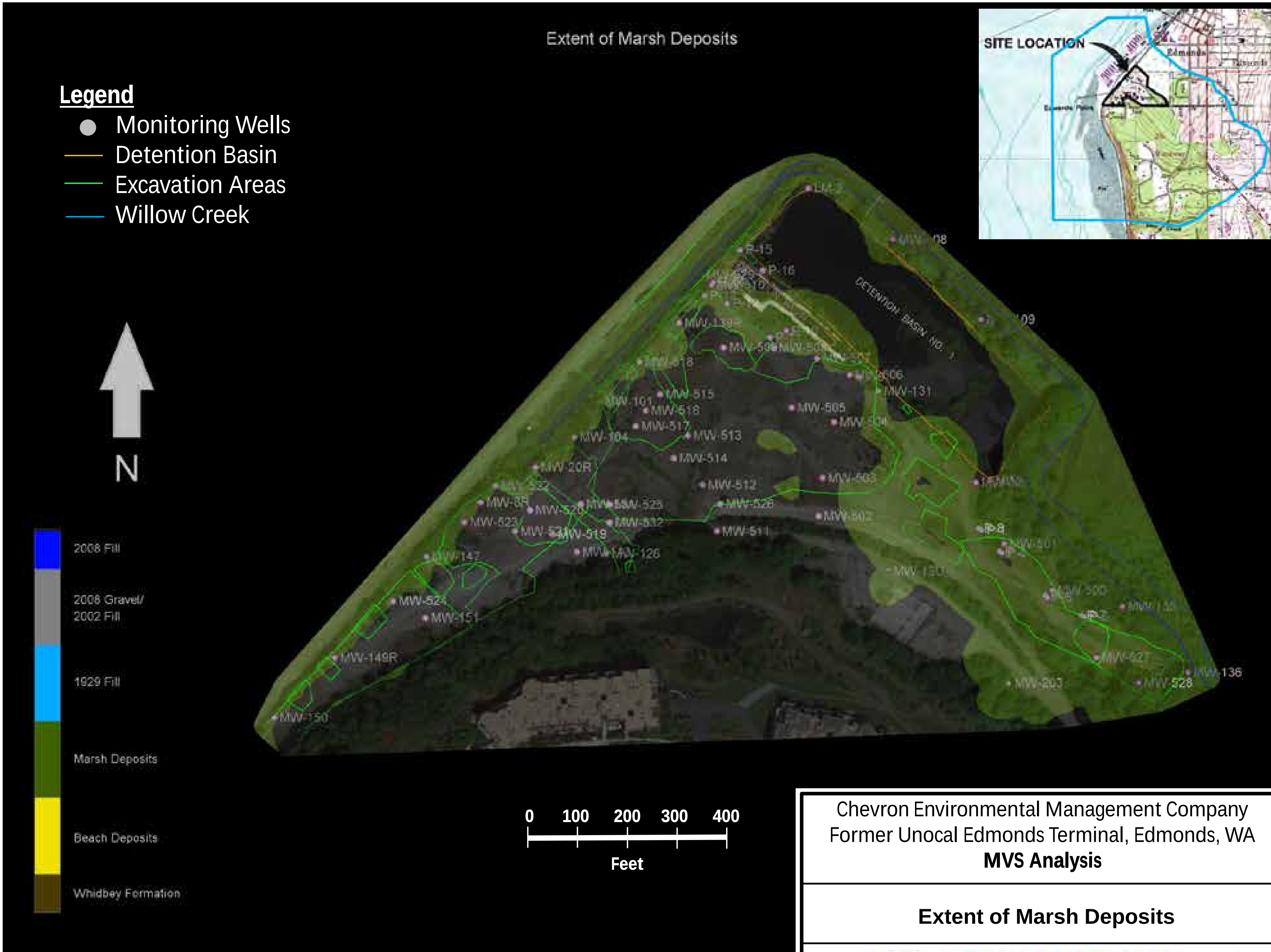
FIGURE
A-8

Chevron Environmental Management Company
Former Unocal Edmonds Terminal, Edmonds, WA
MVS Analysis

Extent of 1929 Fill

ARCADIS

FIGURE
A-9



Chevron Environmental Management Company
Former Unocal Edmonds Terminal, Edmonds, WA
MVS Analysis

Extent of Marsh Deposits

ARCADIS

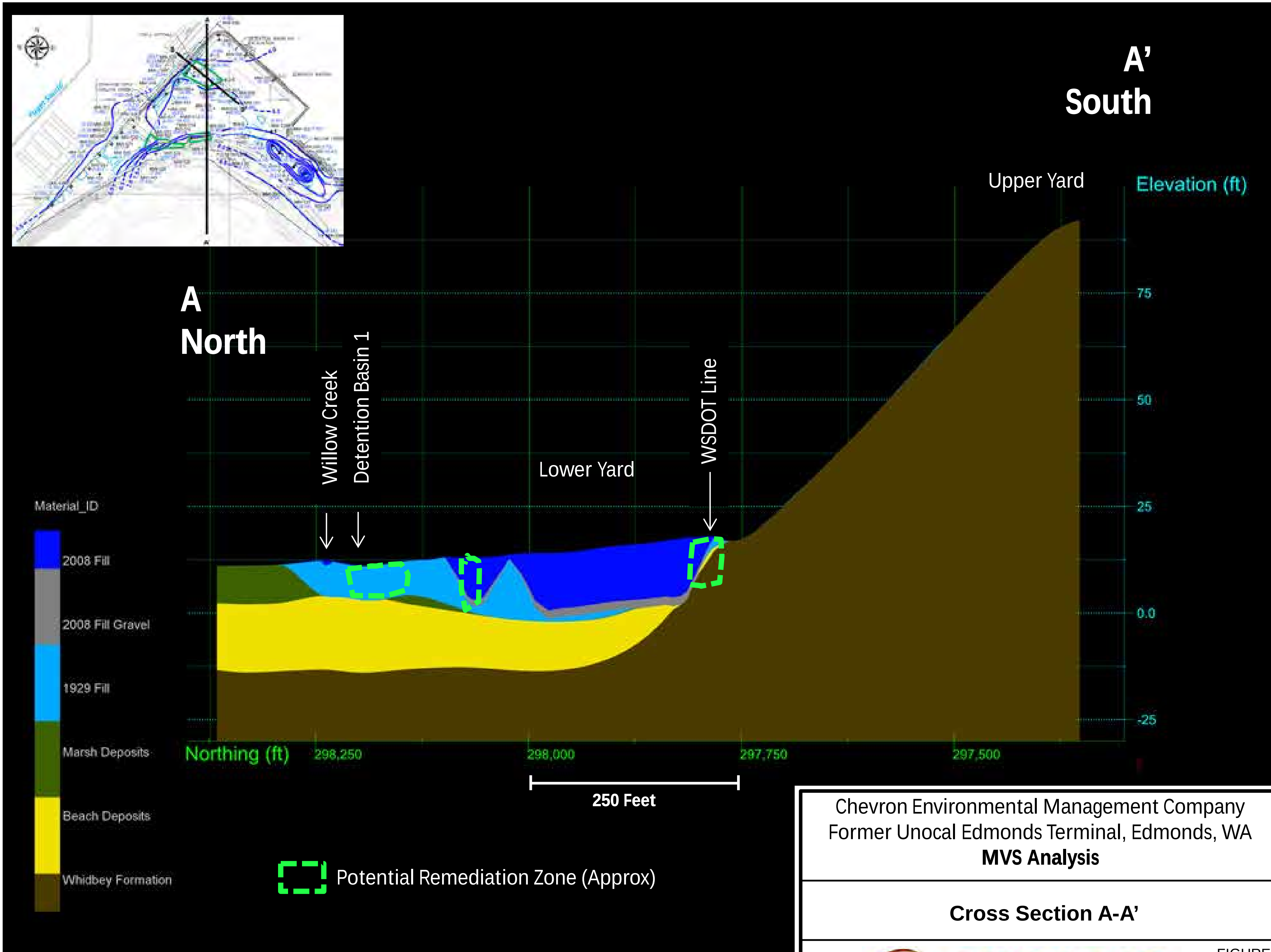
FIGURE
A-10

Chevron Environmental Management Company
Former Unocal Edmonds Terminal, Edmonds, WA
MVS Analysis

Extent of Beach Deposits

ARCADIS

FIGURE
A-11



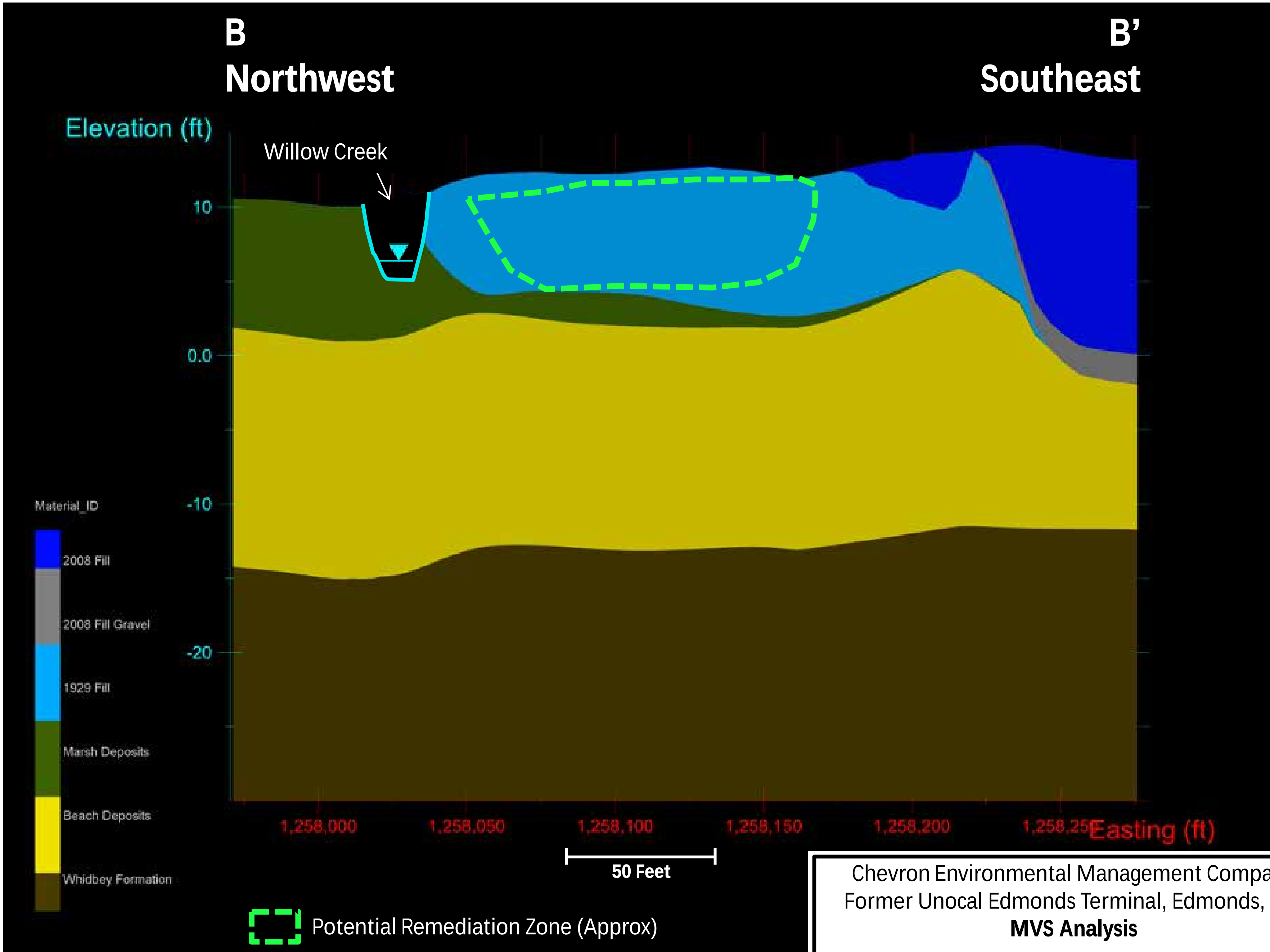
Chevron Environmental Management Company
Former Unocal Edmonds Terminal, Edmonds, WA
MVS Analysis

Cross Section A-A'

ARCADIS

FIGURE
A-12

Note: Elevation in ft msl.



Chevron Environmental Management Company
Former Unocal Edmonds Terminal, Edmonds, WA
MVS Analysis

Cross Section B-B'

ARCADIS

FIGURE
A-13

Note: Elevation in ft msl.

APPENDIX G

DPE Pilot Test Summary

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Tel 206.325.5254
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ENVIRONMENT

David L. South
Senior Engineer
Washington State Department of Ecology
Toxics Cleanup Program, NWRO
3190 160th Avenue Southeast
Bellevue, Washington 98008-5452

Date:
March 8, 2016

Contact:
Scott Zorn

Phone:
206.726.4709

Email:
Scott.Zorn@arcadis-us.com

Our ref:
B0045362.0006

Dual-Phase Extraction Pilot Test Summary
Former Unocal Edmonds Bulk Fuel Terminal
11720 Unoco Road
Edmonds, Washington

Dear Mr. South:

On behalf of Chevron Environmental Management Company (Chevron), ARCADIS U.S., Inc. (ARCADIS) prepared this letter to summarize the Dual-Phase Extraction Pilot Test (DPE Summary) for the former Union Oil Company of California (Unocal) Edmonds Bulk Fuel Terminal, located at 11720 Unoco Road, Edmonds, Washington (Site; Figure 1). This DPE Summary is being submitted to present the results of DPE pilot testing to confirm the implementability of the technology as described in the Public Review Draft Interim Action Work Plan (IAWP; ARCADIS 2015).

Two pilot tests were performed during the first quarter of 2015. The first mobilization was completed from February 17 through 21, 2015. Based on the result of the first mobilization, a second pumping test was conducted from March 30 through April 1 in order to determine more specifically the appropriate extraction well depth and screen interval, as well as, improve overall pumping rate estimates and account for observed subsurface heterogeneity.

Dual-Phase Extraction Pilot Test

The pilot test plan was described in the IAWP (ARCADIS 2015) and proposed the installation of two DPE wells (DPE-1 and DPE-2) and two piezometers (PZ-1 and PZ-2) near the Washington State Department of Transportation (WSDOT) stormwater line. The initial plan was to perform extraction on well DPE-1 while monitoring water levels and induced vacuum in piezometers PZ-1 and PZ-2, extraction well DPE-2, and several existing monitoring wells (AS-1, MW-525, MW-531, and MW-532). During the initial pilot testing of DPE-1, the project team observed a groundwater yield of less than 1 gallon per minute (gpm) under vacuum conditions. This observed pumping rate was lower than pumping rates from historical pumping tests (2 to 3 gpm) that were performed under normal non-vacuum-enhanced conditions. After reviewing the results of the DPE-1 pilot test, pilot test was moved from DPE-1 to DPE-2.

Data collected from pilot testing on DPE-1 and DPE-2 indicated a variation in pumping rates from less than 1 gpm to more than 8 gpm. Due to this variation, the project team remobilized to the site and installed one additional DPE well (DPE-3) and one additional observation well (PZ-3). A second round of pilot testing of well DPE-3 was performed from March 30 through April 1, 2015. DPE and pilot test wells were installed using Schedule 40 polyvinyl chloride (PVC) and advanced using a hollow stem auger (HSA), as described below. The pilot test well layout is shown on Figures 2 and 3.

Pilot Test Well Construction Details

Six new monitoring wells were installed prior to pilot testing. The new wells included three DPE wells (DPE-1, DPE-2, and DPE-3) and three piezometers (PZ-1, PZ-2, and PZ-3). Piezometers PZ-1 and PZ-2 were advanced as 2-inch-diameter wells to 25 feet below ground surface (bgs), with 20 feet of 2-inch-diameter, 0.02-inch slotted screen. Wells DPE-1 and DPE-2 were installed to a total depth of 30 feet bgs, with 5 feet of 4-inch-diameter solid casing from 25 to 30 feet bgs to act as a sump, followed by 20 feet of 4-inch-diameter, 0.02-inch slotted screen from 25 to 5 feet bgs and 4-inch-diameter solid casing to surface. Wells DPE-3 and PZ-3, both 4-inch-diameter wells, were installed to a total depth of 22 feet bgs with a 4-foot sump from 22 to 18 feet bgs, followed by 14 feet of 0.02-inch slotted screen from 18 to 4 feet bgs and solid casing from 4 feet bgs to the surface. Well PZ-3 was installed as a dual-purpose well with the potential to be converted to a DPE well. Well construction details are provided in Table 1a and boring logs are included as Attachment A. Tables 1b and 1c presents the general setup of the pilot test, including the well pumped and the wells monitored, during the first mobilization and the second mobilization respectively.

Pilot Test Implementation

DPE pilot test equipment included a mobile DPE trailer with a rotary claw blower and a portable compressor connected to a downhole submersible pump.

An above grade hose was used to connect the vapor extraction portion of the DPE trailer to a manifold and then to the DPE well through a wellhead adaptor. The DPE trailer housed the rotary claw blower, an air/water separator tank, and the flow and vacuum gauges. The DPE blower effluent was treated using a Falco 300 electric catalytic oxidizer before being discharged to the air. Prior to implementing the DPE pilot testing, ARCADIS verified with the Puget Sound Clean Air Agency, a Notice of Construction application and Order of Approval were not required for short-term pilot testing.

The groundwater extraction portion of the DPE pilot test system included a portable electric compressor that powered a downwell top-loading pneumatic pump (QED AP4 long). The pneumatic pump discharged groundwater through a flow meter, into aboveground piping, and then into an aboveground tank.

Following a review of DPE-1 pumping data, additional pilot testing was conducted at wells DPE-2 and DPE-3 using a downhole electric submersible pump (Grundfos SQE 15) to handle the higher flow rates observed during pilot testing on DPE-2 and DPE-3. The electric submersible pump was powered by an on-site generator and discharged to a double-walled groundwater storage tanks. The water in these tanks was then analyzed and compared to the applicable constituents of concerns (COCs). Based on these results, the stored groundwater was either discharged to detention basin 2 (DB-2) or properly disposed of by Emerald Services. Analytical results are show in Table 2.

Pilot Test Results

Pilot test data were collected from the mobile remediation system gauges, extraction well gauges, and surrounding monitoring wells. System and pumping well data included groundwater pumping rate, system and wellhead vacuum, extraction well depth to water, vapor flow rates, vapor temperature, and vapor concentrations. Monitoring well data included depth to water, induced vacuum, and monitoring well volatile organic compound (VOC) headspace concentrations.

Monitoring well data collected during the DPE-1 and DPE-2 pilot tests are summarized in Table 3; monitoring well data collected during the DPE-3 pilot test are summarized in Table 4. Extraction well and system data collected from DPE-1 and DPE-2 are summarized in Table 5; extraction well and system data collected during the DPE-3 pilot test are summarized in Table 6.

Induced vacuum radius of influence (ROI) and distance versus groundwater drawdown graphs for each pilot test are included in Attachment B. To calculate the induced vacuum ROI, the normalized vacuum (vacuum observed at the monitoring wells, divided by the vacuum applied to the extraction well) was plotted on an arithmetic scale (y-axis) and radial distance from the extraction well on a logarithmic scale (x-axis) for all observation points. This distance (on the x-axis) represents the observed vacuum ROI equal to 1 percent of the applied vacuum using the spatially averaged vacuum data. The ROI based on 1 percent of normalized vacuum is the Chevron standard used to conservatively account for site heterogeneities as described in the 2010 Soil Vapor Extraction Guidance Document (Chevron 2010).

VOC concentrations were collected from wellheads, the vapor extraction manifold, and the pre- and post-treatment effluent stack using a handheld VOC meter. VOC concentration and vapor flow rates from the extraction manifold were used to calculate an estimated hourly mass removal rate. Pilot test results are presented in Tables 3 through 6.

DPE-1 Pilot Test Results

A downhole pneumatic pump was used in DPE-1 pilot test, along with the mobile DPE trailer, to extract both groundwater and vapor. Pilot test data were collected approximately every hour for the first 20 hours of the pilot test and every 2 hours thereafter, for a total operational time of approximately 40 hours. Wells DPE-2, PZ-1, PZ-2, AS-1, MW-525, MW-531, and MW-532 were monitored for depth to water, headspace VOC concentrations, and induced vacuum. DPE-1 pilot test data is provided in Tables 3 and 5.

DPE-1 pilot test data are summarized below:

- Groundwater pumping rates ranged from 0.65 to 1.05 gpm.
- Extraction well casing vacuum ranged from 271 to approximately 300 inches of water.
- Extraction well groundwater drawdown ranged from approximately 14.5 to 18.77 feet below static groundwater elevation.
- Vapor flow rates ranged from 36.58 to 128.16 standard cubic feet per minute (scfm) during the test.

- Mass removal estimates increased throughout the test, starting at approximately 0.7 pound per day (lb/day) to a high of 28 lbs/day (17 hours into the test), with an estimated 16.5 lbs/day at the end of DPE-1 pilot test.

- The induced vacuum influence observed was greater than 1 percent of normalized vacuum at a horizontal distance of 23 feet (MW-525) from the extraction well.

- Minimal drawdown was observed in wells surrounding the extraction well during the DPE-1 pilot test, with approximately 0.53 foot of drawdown observed at PZ-1, which is located approximately 7 feet from the extraction well.

The DPE-1 pilot test results show that elevated mass removal rates and reasonable vacuum ROI can be achieved; however, pumping rates and drawdown were lower than expected. Heaving sands were noted during installation of DPE-1 and may have compromised the well screen, resulting in the observed lower yield and drawdown. Based on these results, the project team performed a second pilot test using well DPE-2.

DPE-2 Pilot Test Results

The project team began the DPE-2 pilot test using the downhole pneumatic pump; however, the pneumatic pump could not sustain the desired drawdown under vacuum while pumping at approximately 5.5 to 6 gpm. After approximately 1.5 hours of pumping, the pneumatic pump was exchanged for an electric submersible pump. Pilot test data were collected approximately every hour for the first 16 hours and then every 2 hours thereafter, for a total operational time of approximately 44 hours. Wells DPE-1, PZ-1, PZ-2, AS-1, MW-525, MW-531, and MW-532 were monitored for depth to water, headspace VOC concentrations, and induced vacuum. DPE-2 pilot test data is provided in Tables 3 and 5. Additionally, a cross-section showing the drawdown at 80 hours after the beginning of the pilot test (after 34 hours of pumping at DPE-2) is presented on Figure 4. The location of the cross-section is showed on Figure 3.

DPE-2 pilot test data are summarized below:

- Groundwater pumping rates ranged from approximately 7 to 9 gpm.

- Extraction well casing vacuum ranged from approximately 183 to 268 inches of water.
- Extraction well groundwater drawdown ranged from approximately 12.5 to 16.2 feet below static water elevation.
- Vapor flow rates ranged from 38 to 117 scfm, averaging approximately 78 scfm during the test.
- Mass removal estimates increased from approximately 0.9 lb/day to 12.7 lbs/day approximately 14 hours into the test. Mass removal rates then decreased to 3.7 lbs/day at the end of the test.
- The induced vacuum influence observed was greater than 1 percent of normalized vacuum at a horizontal distance of 38 feet (MW-525) from the extraction well.
- Drawdown of approximately 1.4 feet was observed in monitoring well PZ-2, approximately 23 feet horizontally from extraction well DPE-2; drawdown of approximately 1 foot was observed in DPE-1, 30 feet horizontally from extraction well DPE-3.
- After 34 hours of pumping activities at extraction well DPE-2, groundwater elevations were drawn down to a level that would allow access to all know soil impacts above site cleanup levels (CULs) in the impacted area. Cross-Section A-A’ showing draw down in extraction well DPE-2 is presented on Figure 4.

The DPE-2 pilot test results show that mass removal rates, reasonable vacuum ROI, and the target groundwater drawdown depth can be achieved. Groundwater yield was similar to expected conditions, with an average pumping rate of 7.5 gpm while under vacuum. Additional pumping wells should adequately dewater the target smear zone.

Based on the variation between pumping rates in wells DPE-1 and DPE-2, the project team performed an additional pilot test on well DPE-3. Well DPE-3 was installed to target groundwater extraction within the finer grained 1929 fill surrounding the WSDOT stormwater line, which was observed from approximately 4 to 22 feet bgs. Pilot test results from DPE-3 are discussed below.

DPE-3 Pilot Test Results

The DPE-3 pilot test was performed using an electric submersible pump. Pilot test data were collected approximately every hour for the first 10 hours, then every 2 hours for the next 20 hours and every hour thereafter. The total operational time of the DPE-3 pilot test was approximately 34 hours. Wells DPE-1, DPE-2, PZ-1, PZ-2, PZ-3, AS-1, MW-525, MW-531, and MW-532 were monitored for depth to water, headspace VOC concentrations, and induced vacuum. DPE-3 pilot test data is provided in Tables 4 and 6.

DPE-3 pilot test data are summarized below:

- Groundwater pumping rates ranged from approximately 8.7 to 13.3 gpm.
- Extraction well casing vacuum ranged from approximately 129 to 163 inches of water.
- Extraction well groundwater drawdown ranged from approximately 3.5 to 12.5 feet below static groundwater elevation.
- Vapor flow rates ranged from 95 to 112 scfm, averaging approximately 78 scfm during the test.
- Mass removal estimates increased from approximately 1.1 to 5 lbs/day at the end of the test.
- The induced vacuum influence observed was greater than 1 percent of normalized vacuum at a horizontal distance of 10 feet (PZ-3) from the extraction well.
- Drawdown of approximately 3.6 feet was observed in monitoring well PZ-3, approximately 10 feet horizontally from extraction well DPE-2; drawdown of approximately 2.2 feet was observed in DPE-1, 29 feet horizontally from extraction well DPE-3.

The DPE-3 pilot test results show that mass removal rates, reasonable vacuum ROI, and the target drawdown depth can be achieved. Induced vacuum greater than 1 percent of normalized vacuum was observed at approximately 10 feet horizontally from the extraction well. This induced vacuum ROI was lower than expected compared to results observed during DPE-1 and DPE-2 pilot testing.

Groundwater yield was greater than the rate observed during DPE-2 pilot testing, with an average pumping rate of 9.8 gpm while under vacuum. The greatest extent of groundwater drawdown was observed during the DPE-3 pilot test, with 3.6 feet of drawdown below static groundwater observed 10 feet horizontally from the extraction well.

Summary

The DPE pilot test was performed to aid in the full-scale design of the DPE system proposed in the IAWP (ARCADIS 2015). The full-scale design will focus remediation on the remaining COCs in shallow soil that exceed the Model Toxics Control Act Method B CULs near the WSDOT stormwater line. Pilot test results indicate that groundwater drawdown to below target soil is feasible. Pilot test data indicate that wells installed within the 1929 fill, similar to DPE-2 and DPE-3 construction, can create a drawdown of greater than 2.2 feet at a distance of 30 feet horizontally from the pumping wells after approximately 34 hours of pumping.

Average vapor mass VOC removal rates using PID readings and system air flow ranged from 3.1 lbs/day during DPE-3 pilot testing to 13.8 lbs/day observed during DPE-1 pilot testing, indicating that mass can be removed through DPE implementation.

Based on pilot test data, extraction wells will be installed on a maximum of 50 foot centers targeting a design ROI of 30 feet. Wells will be spaced closer in areas of highest soil impacts. Remediation wells will be installed to approximately 19 feet with 15 feet of screen allowing for pump intakes to be adjusted to target shallow soil impacts. The treatment system will be designed to operate at a pumping rate of 3 gpm on all remediation wells, with a target pumping rate of up to 13 gpm on wells with vacuum enhanced dewatering. Due to the high air flow rates observed ranging from 36 to 128 scfm, vacuum enhance dewatering will be applied to a subset of 4 to 6 wells. Focusing vacuum enhanced dewatering on a subset of wells will increase the overall operational efficiency of the proposed remediation system and improve maintenance and optimization downtime. A full-scale remediation system design and operation and maintenance plan will be submitted to Ecology prior to system construction.

If you have any questions regarding the information presented in this DPE Summary, please contact Scott Zorn at 206.713.8292.

Sincerely,

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Senior Engineer

Scott Zorn
Project Manager

Copies:
Kim Jolitz, Chevron

Tables

Figures

Attachments

References

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ARCADIS

Tables

TABLE 1a
Well Construction Details
Chevron Environmental Management Company
Pilot Test Summary Memorandum
Former Unocal Edmonds Bulk Fuel Terminal
Edmonds, Washington

Well Name	Completion Date	Well Diameter (inches)	Total Depth of Boring (feet)	Total Depth of Well (feet)	Riser Length - *well box to screen* (feet)	Screen Length - *riser to sump* (feet)	Sump Lenth - *screen to bottom* (feet)
DPE-1	2/10/2015	4	30	30	5	20	5
DPE-2	2/11/2015	4	30	30	5	20	5
DPE-3	3/24/2015	4	22	22	5	13	4
PZ-1	2/11/2015	2	25	25	5	20	NA
PZ-2	2/10/2015	2	25	25	5	20	NA
PZ-3	3/23/2015	4	22	22	5	13	4

Notes:
NA = not applicable

TABLE 1b
Pilot Test DPE-1 and DPE-2 Setup
Chevron Environmental Management Company
Pilot Test Summary Memorandum
Former Unocal Edmonds Bulk Fuel Terminal
Edmonds, Washington

	Baseline Data			
	Well ID	Date	DTW (ft BTOC)	DTB (ft BTOC)
Pumped wells / monitoring wells	DPE-1	02.16.15	6.19	28.80
	DPE-2	02.16.15	5.8	29.35
Monitoring wells	PZ-1	02.16.15	6.31	25.01
	PZ-2	02.16.15	6.04	23.89
	AS-1	02.16.15	6.2	18.32
	MW-525	02.16.15	5.6	12.45
	MW-531	02.16.15	7.07	12.84
	MW-532	02.16.15	6.25	12.55
Witness wells (tide)	MW-20R	02.16.15	6.01	14.23
	MW-512	02.16.15	5.76	12.73
	MW-514	02.16.15	3.96	12.60
	MW-518	02.16.15	7.8	13.36
	MW-526	02.16.15	4.35	13.03
	MW-20R	02.21.15	6.22	14.23
	MW-512	02.21.15	5.99	12.73
	MW-514	02.21.15	4.21	12.60
	MW-518	02.21.15	7.96	13.36
	MW-526	02.21.15	4.55	13.03

	DPE-1 Pumping test				
	Well ID	Distance from pumped well (ft)	DTW- beginning of test[1] (ft BTOC)	DTW- end of test[1] (ft BTOC)	Maximum Drawdown (ft BTOC)
Pumped well	DPE-1	0	20.76	24.94	18.77
Monitoring wells	DPE-2	30	5.85	5.95	0.23
	PZ-1	7	6.54	6.59	0.53
	PZ-2	15	6.2	6.30	0.59
	AS-1	5	6.61	6.61	0.64
	MW-525	23	5.63	5.58	0.45
	MW-531	40	7.03	7.17	0.25
	MW-532	23	6.53	6.54	0.44

	DPE-2 Pumping test				
	Well ID	Distance from pumped well (ft)	DTW- beginning of test[2] (ft BTOC)	DTW- end of test[2] (ft BTOC)	Maximum Drawdown (ft BTOC)
Pumped well	DPE-2	0	11	18.90	16.2
Monitoring wells	DPE-1	30	6.72	7.10	1.21
	PZ-1	45	6.62	6.94	0.78
	PZ-2	23	6.73	7.36	1.49
	AS-1	35	6.61	7.02	1
	MW-525	38	5.82	6.30	0.9
	MW-531	68	7.23	7.32	0.35
	MW-532	10	6.52	7.21	1.3

Note:

hh:mm = hour:minute DTW = depth to water BTOC = below top of casing
min = minute ft = feet DTB = depth to bottom

[1] = DPE-1 Pumping test was implemented from 2.17.15 16:30 to 2.19.15 8:30

[2] = DPE-2 Pumping test was implemented from 2.19.15 14:00 to 2.21.15 10:00

TABLE 1c
Pilot Test DPE-3 Setup
Chevron Environmental Management Company
Pilot Test Summary Memorandum
Former Unocal Edmonds Bulk Fuel Terminal
Edmonds, Washington

	Baseline Data			
	Well ID	Date	DTW (ft BTOC)	DTB (ft BTOC)
Pumped well	DPE-3	03.30.15	4.63	25.01
Monitoring wells	DPE-1	03.30.15	6.26	28.80
	DPE-2	03.30.15	5.92	29.35
	PZ-1	03.30.15	6.41	23.89
	PZ-2	03.30.15	6.2	18.32
	PZ-3	03.30.15	5.54	18.32
	AS-1	03.30.15	6.35	25.00
	MW-525	03.30.15	5.73	12.45
	MW-531	03.30.15	7.18	12.84
	MW-532	03.30.15	6.38	12.84

	DPE-3 Pumping test				
	Well ID	Distance from pumped well (ft)	DTW- beginning of test[1] (ft BTOC)	DTW- end of test[1] (ft BTOC)	Maximum Drawdown (ft BTOC)
Pumped well	DPE-3	0	16.04	16.50	12.47
Monitoring wells	DPE-1	29	8.17	8.40	2.73
	DPE-2	48	6.54	6.75	0.9
	PZ-1	31.5	7.80	8.09	1.89
	PZ-2	31	7.39	7.95	1.8
	PZ-3	10	9.02	9.02	3.82
	AS-1	25	7.84	8.21	2.02
	MW-525	5	10.13	9.56	4.49
	MW-531	57	7.23	7.31	0.22
	MW-532	40	6.95	7.65	1.32

Note:

hh:mm = hour:minute
DTW = depth to water
BTOC = below top of casing
min = minute
ft = feet
DTB = depth to bottom

[1] = DPE-3 Pumping test was implemented from 3.30.15 10:30 to 3.31.15 20:00

TABLE 2
Groundwater Storage Tank Analytical Results
Chevron Environmental Management Company
Pilot Test Summary Memorandum
Former Unocal Edmonds Bulk Fuel Terminal
Edmonds, Washington

Sample ID	Date	Time	Gasoline Range Organics by NWTPH-Gx C7 - C12 (µg/L)	Benzene by 8021B (µg/L)	Diesel Range Organics by NWTPH-Dx (µg/L)	Heavy Range Organics by NWTPH-Dx (µg/L)	Zinc by EPA 200.7 (µg/L)	Copper by EPA 200.8 (µg/L)	Lead by EPA 200.8 (µg/L)	Turbidity by EPA 180.1 (NTU)	Total Alkalinity by SM 2320 (µg/L as CaC03)	Total Hardness by SM 2340 (µg/L as CaC03)	pH	Total cPAHs Adjusted for Toxicity (µg/L)	Comments
			GC Volatiles		GC Petroleum		Metals			Wet Chemistry					
B-TANK-1	2/20/2015	14:30	<50	<0.2	<29	<67	4.3	3.4	0.72	22.2	118,000	90,300	6.78	<0.0151	
BAKER-DPE-3-PILOT2	3/30/2015	14:30	830	170	110	<68	7.1	2.3	0.47	48.4	201,000	194,000	NA	<0.0151	Observed LNAPL on surface of water

Notes:
< = The compound was analyzed for but not detected. The associated value is the compound method detection limit.
cPAHs = Carcinogenic Polynuclear Aromatic Hydrocarbons, by EPA Method 8270C-HVI. cPAHs adjusted for toxicity according to WAC 173-340-708(8) and Air Toxics Hot Spots Program Risk Assessment
(µg/L) = micrograms per liter.
EPA = Environmental Protection Agency.
NWTPH = Northwest Total Petroleum Hydrocarbons
LNAPL = Light non-aqueous phase liquid.
NTU = nephelometric turbidity units
NA = Not Analyzed.

TABLE 3
Monitoring Well Network Data – Pilot Test DPE-1 DPE-2
Chevron Environmental Management Company
Pilot Test Summary Memorandum
Former Unocal Edmonds Bulk Fuel Terminal
Edmonds, Washington

Well ID	Date	Time (hh:mm)	Elapsed Time (hr)	Distance from pumped well (ft)	Headspace VOCs (ppmv)	Vacuum ("H2O)	DTW (ft BTOC)	DTB (ft BTOC)	Static DTW (ft BTOC)	Drawdown (ft BTOC)	Note
DPE-1	02.16.15	10:10	--	--	306.7	--	6.19	28.8	6.19	--	
	02.17.15	16:29	0.00	0	509.0	271.8	20.76	28.8	6.19	14.57	Beginning of DPE-1 test
		17:30	1.02		390.0	271.8	20.72	28.8	6.19	14.53	
		18:30	2.02			271.8	20.75	28.8	6.19	14.56	
		19:30	3.02		352.5	278.6	20.78	28.8	6.19	14.59	
		21:00	4.52		377.3	285.4	20.77	28.8	6.19	14.58	
		21:45	5.27		376.4	278.6	20.75	28.8	6.19	14.56	
		22:30	6.02		349.7	278.6	20.80	28.8	6.19	14.61	
		23:30	7.02		631.0	278.6	20.75	28.8	6.19	14.56	
	02.18.15	0:30	8.02		422.9	278.6	20.80	28.8	6.19	14.61	
		1:30	9.02		381.3	275.9	20.77	28.8	6.19	14.58	
		2:30	10.02		682.6	278.6	20.76	28.8	6.19	14.57	
		3:30	11.02		621.4	278.6	20.80	28.8	6.19	14.61	
		4:30	12.02		681.5	278.6	20.78	28.8	6.19	14.59	
		5:30	13.02		704.1	278.6	20.80	28.8	6.19	14.61	
		6:30	14.02		355.2	278.6	20.78	28.8	6.19	14.59	
		7:35	15.10		346.7	278.6	20.75	28.8	6.19	14.56	
		8:30	16.02		426.1	339.8	20.77	28.8	6.19	14.58	
		10:30	18.02		465.0	278.6	20.72	28.8	6.19	14.53	
		12:30	20.02		418.0	292.2	24.93	28.8	6.19	18.74	Lowered pump
		14:30	22.02		405	285.4	24.95	28.8	6.19	18.76	
		16:30	24.02		384	299.0	24.96	28.8	6.19	18.77	
		18:30	26.02		424	299.0	24.95	28.8	6.19	18.76	
		20:30	28.02		426.4	292.2	24.93	28.8	6.19	18.74	
		22:30	30.02		473.5	292.2	24.78	28.8	6.19	18.59	
	02.19.15	0:30	32.02		416.7	299.0	24.81	28.8	6.19	18.62	
		2:30	34.02		459.1	299.0	24.80	28.8	6.19	18.61	
		4:30	36.02		476.2	292.2	24.88	28.8	6.19	18.69	
		6:30	38.02		483.6	292.2	24.85	28.8	6.19	18.66	
		8:30	40.02		384	292.2	24.94	28.8	6.19	18.75	End of DPE-1 test
	02.19.15	14:01	45.53	30	1.50	1.1	6.72	28.8	6.19	0.53	Beginning of DPE-2 test
		15:34	47.08		0.00	1.0	6.69	28.8	6.19	0.5	
		17:27	48.97		0.00	1.2	6.60	28.8	6.19	0.41	
		19:14	50.75		0.00	2.1	7.03	28.8	6.19	0.84	Use of Grundfoss
		20:18	51.82		0.10	1.7	7.17	28.8	6.19	0.98	
		21:26	52.95		0.00	1.8	7.25	28.8	6.19	1.06	
		22:25	53.93		0.10	2.1	7.28	28.8	6.19	1.09	
		23:33	55.07		0.00	2.1	7.30	28.8	6.19	1.11	
	02.20.15	0:37	56.13		0.00	1.5	7.33	28.8	6.19	1.14	
		1:39	57.17		0.00	1.8	7.31	28.8	6.19	1.12	
		2:35	58.10		0.00	1.7	7.30	28.8	6.19	1.11	
		3:23	58.90		0.00	1.9	7.29	28.8	6.19	1.1	
		4:34	60.08		0.00	2.0	7.25	28.8	6.19	1.06	
		5:48	61.32		0.00	1.9	7.23	28.8	6.19	1.04	
		6:31	62.03		0.10	1.6	7.23	28.8	6.19	1.04	

TABLE 3
Monitoring Well Network Data – Pilot Test DPE-1 DPE-2
Chevron Environmental Management Company
Pilot Test Summary Memorandum
Former Unocal Edmonds Bulk Fuel Terminal
Edmonds, Washington

Well ID	Date	Time (hh:mm)	Elapsed Time (hr)	Distance from pumped well (ft)	Headspace VOCs (ppmv)	Vacuum ("H2O)	DTW (ft BTOC)	DTB (ft BTOC)	Static DTW (ft BTOC)	Drawdown (ft BTOC)	Note
DPE-1	02.20.15	7:32	63.05	30	0.00	3.7	7.35	28.8	6.19	1.16	
		8:04	63.58		0.00	1.4	7.11	28.8	6.19	0.92	
		9:15	64.77		0.00	1.4	7.10	28.8	6.19	0.91	
		10:35	66.10		0.00	0.9	7.21	28.8	6.19	1.02	
		12:06	67.62		0.00	1.4	7.20	28.8	6.19	1.01	
		14:11	69.70		0.00	1.4	7.22	28.8	6.19	1.03	
		16:10	71.68		0.00	1.2	7.27	28.8	6.19	1.08	
		17:56	73.45		0.00	1.0	7.18	28.8	6.19	0.99	
		20:05	75.60		0.00	1.8	7.25	28.8	6.19	1.06	
		22:05	77.60		0.00	0.8	7.28	28.8	6.19	1.09	
		23:53	79.40		0.10	0.7	7.20	28.8	6.19	1.01	
	02.21.15	1:54	81.42		0.10	1.0	7.31	28.8	6.19	1.12	
		4:03	83.57		0.30	1.5	7.40	28.8	6.19	1.21	
		6:14	85.75		0.10	1.4	7.20	28.8	6.19	1.01	
		8:05	87.60		0.00	1.0	7.22	28.8	6.19	1.03	
		10:06	89.62		0.00	1.0	7.10	28.8	6.19	0.91	
DPE-2	02.16.15	10:10	--	--	30.0	--	5.80	29.35	5.80	--	Time recorded is approximate
	02.17.15	16:22	0	30	0.0	1.8	5.85	29.35	5.80	0.05	Beginning of DPE-1 test
		17:26	1.07		0.0	1.8	5.85	29.35	5.80	0.05	
		18:37	2.25		0.2	1.5	5.90	29.35	5.80	0.10	
		19:28	3.10		0.2	1.7	5.93	29.35	5.80	0.13	
		20:31	4.15		0.1	1.4	5.95	29.35	5.80	0.15	
		21:38	5.27		0.1	1.5	5.95	29.35	5.80	0.15	
		22:25	6.05		0.2	1.4	5.99	29.35	5.80	0.19	
		23:31	7.15		0.1	1.4	6.00	29.35	5.80	0.20	
	02.18.15	0:36	8.23		0.1	1.5	5.96	29.35	5.80	0.16	
		1:22	9.00		0.1	1.4	5.99	29.35	5.80	0.19	
		2:15	9.88		0.2	1.2	5.95	29.35	5.80	0.15	
		3:41	11.32		0.1	1.4	5.93	29.35	5.80	0.13	
		4:15	11.88		0.1	1.0	5.97	29.35	5.80	0.17	
		5:12	12.83		0.1	1.5	5.90	29.35	5.80	0.10	
		6:24	14.03		0.0	1.2	5.90	29.35	5.80	0.10	
		7:22	15.00		0.2	1.1	5.92	29.35	5.80	0.12	
		8:38	16.27		0.1	1.4	5.94	29.35	5.80	0.14	
		10:25	18.05		0.3	1.0	5.97	29.35	5.80	0.17	
		12:36	20.23		0.1	1.7	5.93	29.35	5.80	0.13	
		14:45	22.38		0.1	2.0	5.90	29.35	5.80	0.10	
		16:34	24.20		0.0	1.6	5.90	29.35	5.80	0.10	
		18:23	26.02		0.2	1.5	5.90	29.35	5.80	0.10	
		20:23	28.02		0.0	1.5	6.00	29.35	5.80	0.20	
		22:28	30.10		0.0	1.4	6.00	29.35	5.80	0.20	
	02.19.15	0:41	32.32		0.0	1.4	6.03	29.35	5.80	0.23	
		2:40	34.30		0.0	1.4	6.00	29.35	5.80	0.20	
		4:23	36.02		0.1	1.4	6.03	29.35	5.80	0.23	
		6:22	38.00		0.0	1.2	5.98	29.35	5.80	0.18	
		8:49	40.45		0.0	1.4	5.95	29.35	5.80	0.15	End of DPE-1 test

Well ID	Date	Time (hh:mm)	Elapsed Time (hr)	Distance from pumped well (ft)	Headspace VOCs (ppmv)	Vacuum ("H2O)	DTW (ft BTOC)	DTB (ft BTOC)	Static DTW (ft BTOC)	Drawdown (ft BTOC)	Note
DPE-2	02.19.15	14:00	45.63	0	70.0	81.5	11.00	29.35	5.80	5.20	Beginning of test in DPE-2, VOCs reading was post-dilution
		15:30	47.13		90.1	81.5	11.20	29.35	5.80	5.40	VOCs reading was post-dilution
		17:20	48.97		--	--	10.55	29.35	5.80	4.75	
		19:30	51.13		74.9	183.5	18.85	29.35	5.80	13.05	Use Grundfoss, VOCs reading was post-dilution
		20:30	52.13		399.4	183.5	18.75	29.35	5.80	12.95	
		21:30	53.13		426.8	197.1	18.60	29.35	5.80	12.80	
		22:30	54.13		380.7	190.3	18.40	29.35	5.80	12.60	
		23:30	55.13		--	190.3	18.40	29.35	5.80	12.60	
	02.20.15	0:30	56.13		356.0	190.3	18.40	29.35	5.80	12.60	
		1:30	57.13		371.8	190.3	18.80	29.35	5.80	13.00	
		2:30	58.13		490.1	190.3	18.80	29.35	5.80	13.00	
		3:30	59.13		--	190.3	18.30	29.35	5.80	12.50	
		4:30	60.13		411.9	190.3	18.50	29.35	5.80	12.70	
		5:30	61.13		426.5	190.3	18.40	29.35	5.80	12.60	
		6:30	62.13		426.8	190.3	18.55	29.35	5.80	12.75	
		7:30	63.13		--	190.3	18.35	29.35	5.80	12.55	
		8:00	63.63		--	190.3	19.25	29.35	5.80	13.45	
		9:00	64.63		390.0	190.3	19.63	29.35	5.80	13.83	
		10:00	65.63		--	203.9	19.35	29.35	5.80	13.55	
		12:00	67.63		359.0	190.3	21.45	29.35	5.80	15.65	
		14:00	69.63		370.0	197.1	21.92	29.35	5.80	16.12	
		16:00	71.63		245.0	244.6	19.00	29.35	5.80	13.20	
		18:00	73.63		316.0	244.6	20.93	29.35	5.80	15.13	
		20:00	75.63		310.0	255.5	22.00	29.35	5.80	16.20	
		22:00	77.63		296.0	247.3	22.00	29.35	5.80	16.20	
	02.21.15	0:00	79.63		156.0	222.9	22.00	29.35	5.80	16.20	
		2:00	81.63		396.0	244.6	22.00	29.35	5.80	16.20	
		4:00	83.63		313.0	244.6	22.00	29.35	5.80	16.20	
		6:00	85.63		374.3	271.8	17.72	29.35	5.80	11.92	
		8:00	87.63		175.5	265.0	19.18	29.35	5.80	13.38	
		10:00	89.63		216.7	268.4	18.90	29.35	5.80	13.10	End of DPE-2 test
PZ-1	02.16.15	10:10	--	--	223.1	--	6.31	25.01	6.31	--	Time recorded is approximate
	02.17.15	16:31	0	7	6.6	0.0	6.54	25.01	6.31	0.23	Beginning of DPE-1 test
		17:31	1.00		3.6	0.0	6.53	25.01	6.31	0.22	
		18:43	2.20		3.2	0.0	6.57	25.01	6.31	0.26	
		19:33	3.03		2.5	0.0	6.63	25.01	6.31	0.32	
		20:44	4.22		2.6	0.0	6.70	25.01	6.31	0.39	
		21:35	5.07		1.9	0.0	6.76	25.01	6.31	0.45	
		22:29	5.97		1.9	0.3	6.80	25.01	6.31	0.49	
		23:37	7.10		4.2	0.0	6.82	25.01	6.31	0.51	
	02.18.15	0:47	8.27		1.6	0.0	6.84	25.01	6.31	0.53	
		1:34	9.05		1.3	0.0	6.80	25.01	6.31	0.49	
		2:26	9.92		0.8	0.0	6.80	25.01	6.31	0.49	
		3:48	11.28		4.5	2.4	6.70	25.01	6.31	0.39	
		4:21	11.83		3.5	2.0	6.60	25.01	6.31	0.29	

TABLE 3
Monitoring Well Network Data – Pilot Test DPE-1 DPE-2
Chevron Environmental Management Company
Pilot Test Summary Memorandum
Former Unocal Edmonds Bulk Fuel Terminal
Edmonds, Washington

Well ID	Date	Time (hh:mm)	Elapsed Time (hr)	Distance from pumped well (ft)	Headspace VOCs (ppmv)	Vacuum ("H2O)	DTW (ft BTOC)	DTB (ft BTOC)	Static DTW (ft BTOC)	Drawdown (ft BTOC)	Note
PZ-1	02.18.15	5:51	13.33	7	6.0	1.8	6.62	25.01	6.31	0.31	
		6:37	14.10		2.0	1.2	6.53	25.01	6.31	0.22	
		7:27	14.93		0.6	1.4	6.59	25.01	6.31	0.28	
		8:44	16.22		3.0	2.0	6.61	25.01	6.31	0.30	
		10:32	18.02		4.9	1.4	6.66	25.01	6.31	0.35	
		12:43	20.20		10.4	2.8	6.63	25.01	6.31	0.32	
		14:52	22.35		18.5	3.0	6.53	25.01	6.31	0.22	
		16:42	24.18		12.1	2.4	6.51	25.01	6.31	0.20	
		18:31	26.00		7.2	2.3	6.52	25.01	6.31	0.21	
		20:27	27.93		9.5	2.5	6.56	25.01	6.31	0.25	
		22:35	30.07		9.7	2.4	6.72	25.01	6.31	0.41	
	02.19.15	0:46	32.25		0.7	0.8	6.82	25.01	6.31	0.51	
		2:49	34.30		0.4	1.4	6.82	25.01	6.31	0.51	
		4:27	35.93		0.3	1.0	6.72	25.01	6.31	0.41	
		6:29	37.97		4.6	2.4	6.54	25.01	6.31	0.23	
		8:59	40.47		0.6	1.5	6.59	25.01	6.31	0.28	End of DPE-1 test
	02.19.15	14:03	45.53	45	7.8	0.7	6.62	25.01	6.31	0.31	Beginning of DPE-2 test
		15:39	47.13		0.8	0.6	6.62	25.01	6.31	0.31	
		17:30	48.98		0.7	0.5	6.55	25.01	6.31	0.24	
		19:15	50.73		0.5	0.9	6.72	25.01	6.31	0.41	Use of Grundfoss
		20:20	51.82		0.1	0.7	6.79	25.01	6.31	0.48	
		21:31	53.00		0.1	0.7	6.92	25.01	6.31	0.61	
		22:27	53.93		1.0	0.7	6.93	25.01	6.31	0.62	
		23:36	55.08		1.8	0.7	6.98	25.01	6.31	0.67	
	02.20.15	0:38	56.12		4.3	0.9	7.03	25.01	6.31	0.72	
		1:42	57.18		4.3	0.8	7.05	25.01	6.31	0.74	
		2:40	58.15		6.3	0.6	7.02	25.01	6.31	0.71	
		3:26	58.92		0.6	0.7	7.01	25.01	6.31	0.70	
		4:40	60.15		4.8	0.6	7.00	25.01	6.31	0.69	
		5:50	61.32		3.7	0.6	6.95	25.01	6.31	0.64	
		6:34	62.05		6.8	0.7	6.87	25.01	6.31	0.56	
		7:35	63.07		2.0	0.5	6.85	25.01	6.31	0.54	
		8:08	63.62		1.7	0.8	6.83	25.01	6.31	0.52	
		9:17	64.77		1.1	0.7	6.83	25.01	6.31	0.52	
		10:37	66.10		0.4	0.6	6.87	25.01	6.31	0.56	
		12:10	67.65		2.1	1.0	6.95	25.01	6.31	0.64	
		14:15	69.73		0.7	1.0	6.96	25.01	6.31	0.65	
		16:10	71.65		1.1	0.0	6.95	25.01	6.31	0.64	
		17:58	73.45		0.6	0.1	6.90	25.01	6.31	0.59	
		19:51	75.33		2.3	0.9	6.86	25.01	6.31	0.55	
		22:04	77.55		4.2	0.7	6.95	25.01	6.31	0.64	
		23:56	79.42		0.8	0.3	6.95	25.01	6.31	0.64	
	02.21.15	1:56	81.42		4.4	0.7	7.09	25.01	6.31	0.78	
		4:07	83.60		2.9	0.7	7.03	25.01	6.31	0.72	
		6:15	85.73		1.6	0.7	6.92	25.01	6.31	0.61	
		8:10	87.65		1.3	0.9	6.93	25.01	6.31	0.62	
		10:10	89.65		0.1	0.0	6.94	25.01	6.31	0.63	End of DPE-2 test

TABLE 3
Monitoring Well Network Data – Pilot Test DPE-1 DPE-2
Chevron Environmental Management Company
Pilot Test Summary Memorandum
Former Unocal Edmonds Bulk Fuel Terminal
Edmonds, Washington

Well ID	Date	Time (hh:mm)	Elapsed Time (hr)	Distance from pumped well (ft)	Headspace VOCs (ppmv)	Vacuum ("H2O)	DTW (ft BTOC)	DTB (ft BTOC)	Static DTW (ft BTOC)	Drawdown (ft BTOC)	Note
PZ-2	02.16.15	10:10	--	--	101.6	--	6.04	23.89	6.04	--	Time recorded is approximate
	02.17.15	16:28	0	15	0.0	9.5	6.20	23.89	6.04	0.16	Beginning of DPE-1 test
		17:28	1.00		0.0	9.4	6.14	23.89	6.04	0.1	
		18:39	2.18		0.2	9.4	6.21	23.89	6.04	0.17	
		19:30	3.03		0.2	9.1	6.25	23.89	6.04	0.21	
		20:39	4.18		0.1	8.8	6.29	23.89	6.04	0.25	
		21:32	5.07		0.2	8.7	6.38	23.89	6.04	0.34	
		22:27	5.98		0.0	8.0	6.38	23.89	6.04	0.34	
		23:34	7.10		0.1	8.7	6.35	23.89	6.04	0.31	
	02.18.15	0:42	8.23		0.1	8.9	6.26	23.89	6.04	0.22	
		1:30	9.03		0.1	8.4	6.45	23.89	6.04	0.41	
		2:21	9.88		0.1	7.7	6.35	23.89	6.04	0.31	
		3:45	11.28		0.0	8.1	6.32	23.89	6.04	0.28	
		4:21	11.88		0.1	7.4	6.31	23.89	6.04	0.27	
		4:57	12.48		0.1	8.0	6.40	23.89	6.04	0.36	
		6:29	14.02		0.0	7.4	6.21	23.89	6.04	0.17	
		7:24	14.93		0.1	8.0	6.32	23.89	6.04	0.28	
		8:41	16.22		0.1	7.5	6.36	23.89	6.04	0.32	
		10:29	18.02		0.1	5.2	6.43	23.89	6.04	0.39	
		12:39	20.18		0.1	9.1	6.30	23.89	6.04	0.26	
		14:49	22.35		0.1	10.2	6.20	23.89	6.04	0.16	
		16:37	24.15		0.1	8.7	6.23	23.89	6.04	0.19	
		18:27	25.98		0.0	8.7	6.31	23.89	6.04	0.27	
		20:25	27.95		0.0	8.0	6.23	23.89	6.04	0.19	
		22:31	30.05		0.0	8.0	6.36	23.89	6.04	0.32	
	02.19.15	0:43	32.25		0.0	7.2	6.38	23.89	6.04	0.34	
		2:46	34.30		0.0	7.9	6.32	23.89	6.04	0.28	
		4:25	35.95		0.0	8.1	6.63	23.89	6.04	0.59	
		6:25	37.95		0.0	8.0	6.25	23.89	6.04	0.21	
		8:54	40.43		0.0	7.9	6.30	23.89	6.04	0.26	End of DPE-1 test
	02.19.15	13:58	45.50	23.00	0.0	3.7	6.73	23.89	6.04	0.69	Beginning of DPE-2 test
		15:31	47.05		0.0	3.7	6.80	23.89	6.04	0.76	
		17:25	48.95		0.0	3.5	6.65	23.89	6.04	0.61	
		19:13	50.75		0.0	6.0	7.15	23.89	6.04	1.11	Use of Grundfoss
		20:16	51.80		0.0	4.9	7.23	23.89	6.04	1.19	
		21:24	52.93		0.0	4.8	7.30	23.89	6.04	1.26	
		22:24	53.93		0.1	5.1	7.30	23.89	6.04	1.26	
		23:32	55.07		0.0	4.7	7.33	23.89	6.04	1.29	
	02.20.15	0:37	56.15		0.0	4.5	7.40	23.89	6.04	1.36	
		1:34	57.10		0.0	4.5	7.35	23.89	6.04	1.31	
		2:34	58.10		0.0	4.5	7.32	23.89	6.04	1.28	
		3:21	58.88		0.0	4.1	7.32	23.89	6.04	1.28	
		4:26	59.97		0.0	4.4	7.32	23.89	6.04	1.28	
		5:46	61.30		0.0	4.2	7.32	23.89	6.04	1.28	
		6:31	62.05		0.1	4.1	7.40	23.89	6.04	1.36	

Well ID	Date	Time (hh:mm)	Elapsed Time (hr)	Distance from pumped well (ft)	Headspace VOCs (ppmv)	Vacuum ("H2O)	DTW (ft BTOC)	DTB (ft BTOC)	Static DTW (ft BTOC)	Drawdown (ft BTOC)	Note
PZ-2	02.20.15	7:33	63.08	23.00	0.3	1.4	7.19	23.89	6.04	1.15	
		8:03	63.58		0.0	4.0	7.25	23.89	6.04	1.21	
		9:15	64.78		0.0	3.8	7.22	23.89	6.04	1.18	
		10:34	66.10		0.0	4.1	7.36	23.89	6.04	1.32	
		12:04	67.60		0.0	4.4	7.35	23.89	6.04	1.31	
		14:10	69.70		0.0	4.1	7.22	23.89	6.04	1.18	
		16:09	71.68		0.0	4.7	7.47	23.89	6.04	1.43	
		17:57	73.48		0.0	4.1	7.36	23.89	6.04	1.32	
		19:50	75.37		0.0	4.7	7.40	23.89	6.04	1.36	
		22:06	77.63		0.0	3.9	7.43	23.89	6.04	1.39	
		23:51	79.38		0.0	2.7	7.29	23.89	6.04	1.25	
	02.21.15	1:54	81.43		0.0	4.0	7.53	23.89	6.04	1.49	
		4:02	83.57		0.0	4.1	7.32	23.89	6.04	1.28	
		6:12	85.73		0.0	3.1	7.34	23.89	6.04	1.3	
		8:05	87.62		0.0	4.2	7.34	23.89	6.04	1.3	
		10:05	89.62		0.0	3.8	7.36	23.89	6.04	1.32	End of DPE-2 test
AS-1	02.16.15	10:10	--	--	14.7	--	6.20	18.32	6.20	--	Time recorded is approximate
	02.17.15	16:30	0	5	1.2	0.0	6.61	18.32	6.20	0.41	Beginning of DPE-1 test
		17:30	1.00		1.1	0.0	6.59	18.32	6.20	0.39	
		18:42	2.20		1.2	0.0	6.62	18.32	6.20	0.42	
		19:32	3.03		1.4	0.0	6.66	18.32	6.20	0.46	
		20:42	4.20		1.0	0.0	6.72	18.32	6.20	0.52	
		21:34	5.07		1.1	0.0	6.75	18.32	6.20	0.55	
		22:28	5.97		0.7	0.0	6.80	18.32	6.20	0.6	
		23:35	7.08		1.2	0.0	6.84	18.32	6.20	0.64	
	02.18.15	0:45	8.25		1.4	0.5	6.83	18.32	6.20	0.63	
		1:32	9.03		1.0	0.0	6.80	18.32	6.20	0.6	
		2:24	9.90		1.1	0.0	6.80	18.32	6.20	0.6	
		3:46	11.27		1.5	0.1	6.80	18.32	6.20	0.6	
		4:25	11.92		1.9	0.0	6.60	18.32	6.20	0.4	
		5:54	13.40		2.5	0.2	6.70	18.32	6.20	0.5	
		6:33	14.05		2.0	0.0	6.67	18.32	6.20	0.47	
		7:26	14.93		2.5	0.0	6.63	18.32	6.20	0.43	
		8:43	16.22		34.6	0.0	6.69	18.32	6.20	0.49	
		10:31	18.02		8.1	0.0	6.69	18.32	6.20	0.49	
		12:42	20.20		8.5	0.0	6.71	18.32	6.20	0.51	
		14:51	22.35		9.7	0.0	6.63	18.32	6.20	0.43	
		16:40	24.17		7.4	0.0	6.60	18.32	6.20	0.4	
		18:30	26.00		4.9	0.0	6.60	18.32	6.20	0.4	
		20:26	27.93		2.7	0.0	6.64	18.32	6.20	0.44	
		22:39	30.15		3.2	0.0	6.74	18.32	6.20	0.54	
	02.19.15	0:45	32.25		15.4	0.0	6.78	18.32	6.20	0.58	
		2:55	34.42		9.9	0.0	6.80	18.32	6.20	0.6	
		4:26	35.93		25.7	0.5	6.70	18.32	6.20	0.5	
		6:26	37.93		17.2	0.0	6.62	18.32	6.20	0.42	
		8:55	40.42		8.7	0.0	6.61	18.32	6.20	0.41	End of DPE-1 test

Well ID	Date	Time (hh:mm)	Elapsed Time (hr)	Distance from pumped well (ft)	Headspace VOCs (ppmv)	Vacuum ("H2O)	DTW (ft BTOC)	DTB (ft BTOC)	Static DTW (ft BTOC)	Drawdown (ft BTOC)	Note
AS-1	02.19.15	14:05	45.58	35	11.7	0.0	6.61	18.32	6.20	0.41	Beginning of DPE-2 test
		15:37	47.12		6.1	0.0	6.62	18.32	6.20	0.42	
		17:28	48.97		7.4	0.0	6.57	18.32	6.20	0.37	
		19:15	50.75		6.3	0.0	6.81	18.32	6.20	0.61	Use of Grundfoss
		20:17	51.78		6.6	0.0	6.89	18.32	6.20	0.69	
		21:27	52.95		3.0	0.0	6.97	18.32	6.20	0.77	
		22:36	54.10		2.8	0.0	7.00	18.32	6.20	0.8	
		23:35	55.08		8.9	0.0	7.08	18.32	6.20	0.88	
	02.20.15	0:42	56.20		5.8	0.0	7.10	18.32	6.20	0.9	
		1:44	57.23		4.9	0.0	7.10	18.32	6.20	0.9	
		2:38	58.13		8.8	0.0	7.08	18.32	6.20	0.88	
		3:25	58.92		7.5	0.0	7.10	18.32	6.20	0.9	
		4:39	60.15		7.1	0.0	7.05	18.32	6.20	0.85	
		5:55	61.42		9.9	0.0	7.00	18.32	6.20	0.8	
		6:33	62.05		27.8	0.0	6.93	18.32	6.20	0.73	
		7:34	63.07		12.8	0.0	6.92	18.32	6.20	0.72	
		8:07	63.62		3.8	0.0	6.91	18.32	6.20	0.71	
		9:16	64.77		7.5	0.0	6.92	18.32	6.20	0.72	
		10:36	66.10		8.7	0.0	6.93	18.32	6.20	0.73	
		12:08	67.63		14.1	0.0	6.92	18.32	6.20	0.72	
		14:12	69.70		4.5	0.0	7.02	18.32	6.20	0.82	
		16:10	71.67		7.6	0.0	7.04	18.32	6.20	0.84	
		18:00	73.50		3.6	0.0	6.98	18.32	6.20	0.78	
		19:55	75.42		3.6	0.0	6.96	18.32	6.20	0.76	
		22:09	77.65		3.0	0.0	7.00	18.32	6.20	0.8	
		23:54	79.40		5.2	0.0	7.20	18.32	6.20	1	
	02.21.15	1:55	81.42		3.0	0.0	7.13	18.32	6.20	0.93	
		4:05	83.58		4.0	0.0	7.15	18.32	6.20	0.95	
		6:13	85.72		4.8	0.0	7.01	18.32	6.20	0.81	
		8:07	87.62		3.9	0.0	7.01	18.32	6.20	0.81	
		10:08	89.63		3.5	0.0	7.02	18.32	6.20	0.82	End of DPE-2 test
MW-20R	02.16.15	10:22	--	--	0.0	--	6.01	14.23	--	--	
	02.21.15	10:21	--	--	0.0	--	6.22	14.23	--	--	
MW-512	02.16.15	10:24	--	--	0.7	--	5.76	12.73	--	--	
	02.21.15	10:33	--	--	0.6	--	5.99		--	--	
MW-514	02.16.15		--	--	0.1	--	3.96	12.60	--	--	
	02.21.15	10:29	--	--	0.0	--	4.21		--	--	
MW-518	02.16.15	10:26	--	--	0.3	--	7.80	13.36	--	--	
	02.21.15	10:26	--	--	0.1	--	7.96		--	--	
MW-525	02.16.15	10:10	--	--	69.0	--	5.60	12.45	5.6	--	Time recorded is approximate
	02.17.15	16:34	0	23	5.8	4.4	5.63	12.45	5.6	0.03	Beginning of DPE-1 test
		17:35	1.02		2.2	5.1	5.55	12.45	5.6	-0.05	
		18:45	2.18		106.6	5.0	5.50	12.45	5.6	-0.10	
		19:30	2.93		3.6	4.2	5.74	12.45	5.6	0.14	
		20:48	4.23		202.2	4.5	5.61	12.45	5.6	0.01	
		21:38	5.07		8.0	3.3	5.82	12.45	5.6	0.22	

Well ID	Date	Time (hh:mm)	Elapsed Time (hr)	Distance from pumped well (ft)	Headspace VOCs (ppmv)	Vacuum ("H2O)	DTW (ft BTOC)	DTB (ft BTOC)	Static DTW (ft BTOC)	Drawdown (ft BTOC)	Note
MW-525	02.17.15	22:31	5.95	23	318.7	4.7	5.65	12.45	5.6	0.05	
		23:39	7.08		6.8	4.0	5.97	12.45	5.6	0.37	
	02.18.15	0:50	8.27		356.1	5.0	5.70	12.45	5.6	0.10	
		1:38	9.07		268.4	3.4	5.70	12.45	5.6	0.10	
		2:33	9.98		292.8	4.2	5.67	12.45	5.6	0.07	
		3:51	11.28		248.1	4.3	5.65	12.45	5.6	0.05	
		4:29	11.92		203.4	3.8	5.58	12.45	5.6	-0.02	
		5:55	13.35		279.6	4.1	5.65	12.45	5.6	0.05	
		6:40	14.10		276.8	3.9	5.54	12.45	5.6	-0.06	
		7:29	14.92		202.6	4.1	5.60	12.45	5.6	0.00	
		8:50	16.27		5.4	2.9	5.79	12.45	5.6	0.19	
		10:36	18.03		205.0	3.4	5.69	12.45	5.6	0.09	
		12:47	20.22		145.7	4.7	5.57	12.45	5.6	-0.03	
		14:54	22.33		174.4	5.2	5.50	12.45	5.6	-0.10	
		16:45	24.18		208.70	4.3	5.55	12.45	5.6	-0.05	
		18:34	26.00		116.4	4.5	5.55	12.45	5.6	-0.05	
		20:29	27.92		80.7	4.3	5.77	12.45	5.6	0.17	
		22:37	30.05		76.3	4.0	5.65	12.45	5.6	0.05	
	02.19.15	0:49	32.25		103.8	3.8	5.95	12.45	5.6	0.35	
		2:51	34.28		55.7	4.0	6.05	12.45	5.6	0.45	
		4:29	35.92		6.1	3.7	5.83	12.45	5.6	0.23	
		6:34	38.00		90.9	4.1	5.80	12.45	5.6	0.20	
		9:03	40.48		126.8	4.2	5.58	12.45	5.6	-0.02	End of DPE-1 test
	02.19.15	14:09	45.58	38	81.0	2.7	5.82	12.45	5.6	0.22	Beginning of DPE-2 test
		15:38	47.07		70.4	2.6	5.89	12.45	5.6	0.29	
		17:33	48.98		107.7	2.5	5.83	12.45	5.6	0.23	
		19:18	50.73		93.4	4.0	5.96	12.45	5.6	0.36	Use of Grundfoss
		20:24	51.83		134.4	3.6	6.08	12.45	5.6	0.48	
		21:33	52.98		161.40	3.5	6.17	12.45	5.6	0.57	
		22:29	53.92		171.6	3.6	6.17	12.45	5.6	0.57	
		23:39	55.08		57.7	3.2	6.23	12.45	5.6	0.63	
	02.20.15	0:45	56.18		129.4	3.0	6.35	12.45	5.6	0.75	
		1:31	56.95		164.2	3.4	6.40	12.45	5.6	0.8	
		2:45	58.18		93.1	3.1	6.25	12.45	5.6	0.65	
		3:28	58.90		67.2	3.3	6.23	12.45	5.6	0.63	
		4:44	60.17		121.6	3.2	6.20	12.45	5.6	0.6	
		5:52	61.30		64.2	2.6	6.25	12.45	5.6	0.65	
		6:36	62.03		5.6	2.1	6.31	12.45	5.6	0.71	
		7:37	63.05		7.7	2.9	6.28	12.45	5.6	0.68	
		8:11	63.62		23.3	3.0	6.13	12.45	5.6	0.53	
		9:20	64.77		5.6	2.7	6.15	12.45	5.6	0.55	
		10:39	66.08		38.6	2.3	6.30	12.45	5.6	0.7	
		12:14	67.67		12.1	3.4	6.20	12.45	5.6	0.6	
		14:16	69.70		54.3	3.1	6.41	12.45	5.6	0.81	
		16:14	71.67		8.4	2.9	6.35	12.45	5.6	0.75	
		18:01	73.45		27.3	2.5	6.28	12.45	5.6	0.68	
		19:59	75.42		30.4	2.5	6.33	12.45	5.6	0.73	

TABLE 3
Monitoring Well Network Data – Pilot Test DPE-1 DPE-2
Chevron Environmental Management Company
Pilot Test Summary Memorandum
Former Unocal Edmonds Bulk Fuel Terminal
Edmonds, Washington

Well ID	Date	Time (hh:mm)	Elapsed Time (hr)	Distance from pumped well (ft)	Headspace VOCs (ppmv)	Vacuum ("H2O)	DTW (ft BTOC)	DTB (ft BTOC)	Static DTW (ft BTOC)	Drawdown (ft BTOC)	Note
MW-525	02.20.15	21:10	76.60	38	20.7	2.0	6.35	12.45	5.6	0.75	
		23:58	79.40		20.7	1.7	6.35	12.45	5.6	0.75	
	02.21.15	1:58	81.40		5.0	2.2	6.47	12.45	5.6	0.87	
		4:10	83.60		19.4	2.5	6.50	12.45	5.6	0.9	
		6:20	85.77		0.6	2.4	6.31	12.45	5.6	0.71	
		8:14	87.67		19.9	3.1	6.26	12.45	5.6	0.66	
		10:14	89.67		5.7	3.1	6.30	12.45	5.6	0.7	End of DPE-2 test
MW-526	02.16.15	10:30	--	--	119.5	--	4.35	13.03	--	--	
	02.21.15	10:42	--	--	88.14	--	4.55		--	--	
MW-531	02.16.15	10:10	--	--	0.6	--	7.07	12.84	7.07	--	Time recorded is approximate
	02.17.15	16:32	0	40	3.9	0.0	7.03	12.84	7.07	-0.04	Beginning of DPE-1 test
		17:33	1.02		0.5	0.0	7.03	12.84	7.07	-0.04	
		18:47	2.25		0.7	0.0	7.02	12.84	7.07	-0.05	
		19:34	3.03		0.3	0.0	7.04	12.84	7.07	-0.03	
		20:46	4.23		0.2	0.0	7.11	12.84	7.07	0.04	
		21:36	5.07		1.2	0.0	7.18	12.84	7.07	0.11	
		22:30	5.97		0.4	0.0	7.20	12.84	7.07	0.13	
		23:38	7.10		0.5	0.0	7.25	12.84	7.07	0.18	
	02.18.15	0:49	8.28		0.9	0.0	--	12.84	7.07	--	
		1:36	9.07		0.9	0.0	7.29	12.84	7.07	0.22	
		2:29	9.95		0.2	0.0	7.32	12.84	7.07	0.25	
		3:50	11.30		0.5	0.0	7.30	12.84	7.07	0.23	
		4:28	11.93		0.7	0.0	7.26	12.84	7.07	0.19	
		5:52	13.33		0.0	0.0	7.23	12.84	7.07	0.16	
		6:39	14.12		0.0	0.0	7.30	12.84	7.07	0.23	
		7:28	14.93		0.1	0.0	7.19	12.84	7.07	0.12	
		8:46	16.23		0.1	0.0	7.17	12.84	7.07	0.1	
		10:34	18.03		0.1	0.3	7.19	12.84	7.07	0.12	
		12:45	20.22		0.1	0.3	7.21	12.84	7.07	0.14	
		14:45	22.22		0.1	0.4	7.17	12.84	7.07	0.1	
		16:04	23.53		0.1	0.0	7.12	12.84	7.07	0.05	
		18:32	26.00		0.0	0.3	7.05	12.84	7.07	-0.02	
		20:28	27.93		1.4	0.0	7.08	12.84	7.07	0.01	
		22:41	30.15		0.0	0.0	7.20	12.84	7.07	0.13	
	02.19.15	0:48	32.27		0.0	0.0	7.29	12.84	7.07	0.22	
		2:52	34.33		0.0	0.0	7.31	12.84	7.07	0.24	
		4:28	35.93		0.0	0.0	7.29	12.84	7.07	0.22	
		6:31	37.98		0.00	0.0	7.22	12.84	7.07	0.15	
		9:01	40.48		0.0	0.0	7.17	12.84	7.07	0.1	End of DPE-1 test
	02.19.15	14:07	45.58	68	0.0	0.0	7.23	12.84	7.07	0.16	Beginning of DPE-2 test
		15:42	47.17		0.0	0.0	7.21	12.84	7.07	0.14	
		17:31	48.98		0.0	0.0	7.15	12.84	7.07	0.08	
		19:17	50.75		0.0	0.0	7.04	12.84	7.07	-0.03	Use of Grundfoss
		20:22	51.83		0.0	0.0	7.12	12.84	7.07	0.05	
		21:32	53.00		0.0	0.0	7.17	12.84	7.07	0.1	
		22:28	53.93		0.0	0.0	7.20	12.84	7.07	0.13	

TABLE 3
Monitoring Well Network Data – Pilot Test DPE-1 DPE-2
Chevron Environmental Management Company
Pilot Test Summary Memorandum
Former Unocal Edmonds Bulk Fuel Terminal
Edmonds, Washington

Well ID	Date	Time (hh:mm)	Elapsed Time (hr)	Distance from pumped well (ft)	Headspace VOCs (ppmv)	Vacuum ("H2O)	DTW (ft BTOC)	DTB (ft BTOC)	Static DTW (ft BTOC)	Drawdown (ft BTOC)	Note
MW-531	02.19.15	23:37	55.08	68	0.0	0.0	7.25	12.84	7.07	0.18	
	02.20.15	0:41	56.15		0.0	0.0	7.30	12.84	7.07	0.23	
		1:41	57.15		0.0	0.0	7.31	12.84	7.07	0.24	
		2:43	58.18		0.40	0.0	7.36	12.84	7.07	0.29	
		3:27	58.92		0.2	0.0	7.34	12.84	7.07	0.27	
		4:42	60.17		0.00	0.0	7.32	12.84	7.07	0.25	
		5:45	61.22		0.0	0.0	7.30	12.84	7.07	0.23	
		6:35	62.05		0.4	0.0	7.30	12.84	7.07	0.23	
		7:36	63.07		0.0	0.0	7.27	12.84	7.07	0.2	
		8:10	63.63		0.3	0.0	7.25	12.84	7.07	0.18	
		9:18	64.77		0.1	0.0	7.25	12.84	7.07	0.18	
		10:28	65.93		0.1	0.0	7.25	12.84	7.07	0.18	
		12:11	67.65		0.0	0.0	7.28	12.84	7.07	0.21	
		14:14	69.70		0.0	0.0	7.32	12.84	7.07	0.25	
		16:12	71.67		0.0	0.0	7.30	12.84	7.07	0.23	
		18:00	73.47		0.0	0.0	7.27	12.84	7.07	0.2	
		19:57	75.42		0.0	0.0	7.25	12.84	7.07	0.18	
		22:09	77.62		0.0	0.0	7.28	12.84	7.07	0.21	
		23:57	79.42		0.1	0.0	7.35	12.84	7.07	0.28	
	02.21.15	1:57	81.42		0.0	0.0	7.40	12.84	7.07	0.33	
		4:09	83.62		0.0	0.0	7.42	12.84	7.07	0.35	
		6:16	85.73		0.0	0.0	7.38	12.84	7.07	0.31	
		8:12	87.67		0.0	0.0	7.32	12.84	7.07	0.25	
		10:12	89.67		0.0	0.0	7.32	12.84	7.07	0.25	End of DPE-2 test
MW-532	02.16.15	10:10	--	--	36.0	--	6.25	12.55	6.25	--	Time recorded is approximate
	02.17.15	16:26	0.00	23	0.0	0.0	6.53	12.55	6.25	0.28	Beginning of DPE-1 test
		17:27	1.02		0.3	0.4	6.52	12.55	6.25	0.27	
		18:38	2.20		0.3	0.3	6.53	12.55	6.25	0.28	
		19:29	3.05		0.0	0.3	6.54	12.55	6.25	0.29	
		20:37	4.18		0.3	0.4	6.54	12.55	6.25	0.29	
		21:30	5.07		0.3	0.4	6.59	12.55	6.25	0.34	
		22:26	6.00		0.3	0.3	6.60	12.55	6.25	0.35	
		23:33	7.12		0.1	0.1	6.65	12.55	6.25	0.4	
	02.18.15	0:39	8.22		0.1	0.2	6.69	12.55	6.25	0.44	
		1:28	9.03		0.6	0.3	6.61	12.55	6.25	0.36	
		2:18	9.87		3.9	0.3	6.64	12.55	6.25	0.39	
		3:43	11.28		0.1	0.5	6.60	12.55	6.25	0.35	
		4:18	11.87		2.0	0.4	6.59	12.55	6.25	0.34	
		5:45	13.32		0.5	0.5	6.57	12.55	6.25	0.32	
		6:26	14.00		1.4	0.5	6.53	12.55	6.25	0.28	
		7:23	14.95		0.6	0.5	6.54	12.55	6.25	0.29	
		8:39	16.22		0.9	0.5	6.55	12.55	6.25	0.3	
		10:27	18.02		4.0	0.4	6.55	12.55	6.25	0.3	
		12:38	20.20		1.4	0.6	6.59	12.55	6.25	0.34	
		14:47	22.35		1.4	0.7	6.50	12.55	6.25	0.25	
		16:36	24.17		2.2	0.5	6.53	12.55	6.25	0.28	
		18:25	25.98		0.3	0.5	6.55	12.55	6.25	0.3	

TABLE 3
Monitoring Well Network Data – Pilot Test DPE-1 DPE-2
Chevron Environmental Management Company
Pilot Test Summary Memorandum
Former Unocal Edmonds Bulk Fuel Terminal
Edmonds, Washington

Well ID	Date	Time (hh:mm)	Elapsed Time (hr)	Distance from pumped well (ft)	Headspace VOCs (ppmv)	Vacuum ("H2O)	DTW (ft BTOC)	DTB (ft BTOC)	Static DTW (ft BTOC)	Drawdown (ft BTOC)	Note
MW-532	02.18.15	20:24	27.97	23	0.40	0.5	6.55	12.55	6.25	0.3	
		22:24	29.97		0.5	0.5	6.58	12.55	6.25	0.33	
	02.19.15	0:42	32.27		0.1	0.4	6.65	12.55	6.25	0.4	
		2:43	34.28		0.20	0.4	6.63	12.55	6.25	0.38	
		4:24	35.97		0.6	0.5	6.61	12.55	6.25	0.36	
		6:23	37.95		0.0	0.4	6.58	12.55	6.25	0.33	
		8:51	40.42		0.1	0.5	6.54	12.55	6.25	0.29	End of DPE-1 test
	02.19.05	13:57	45.52	10	0.0	5.1	6.52	12.55	6.25	0.27	Beginning of DPE-2 test
		15:30	47.07		1.3	5.8	6.55	12.55	6.25	0.3	
		17:23	48.95		0.0	5.4	6.65	12.55	6.25	0.4	
		19:12	50.77		0.0	11.4	7.55	12.55	6.25	1.3	Use of Grundfoss
		20:15	51.82		0.00	9.3	6.73	12.55	6.25	0.48	
		21:20	52.90		0.1	9.6	6.82	12.55	6.25	0.57	
		22:23	53.95		0.1	6.1	7.05	12.55	6.25	0.8	
		23:31	55.08		0.0	7.8	6.90	12.55	6.25	0.65	
	02.20.15	0:35	56.15		0.0	7.9	7.00	12.55	6.25	0.75	
		1:32	57.10		0.0	7.7	6.93	12.55	6.25	0.68	
		2:32	58.10		0.1	7.2	7.41	12.55	6.25	1.16	
		3:20	58.90		0.0	7.3	7.31	12.55	6.25	1.06	
		4:25	59.98		0.0	7.0	7.20	12.55	6.25	0.95	
		5:44	61.30		0.0	6.9	7.09	12.55	6.25	0.84	
		6:30	62.07		0.1	6.2	7.29	12.55	6.25	1.04	
		7:30	63.07		0.1	6.9	7.21	12.55	6.25	0.96	
		8:30	64.07		0.0	6.7	6.98	12.55	6.25	0.73	
		9:12	64.77		0.0	6.2	6.97	12.55	6.25	0.72	
		10:31	66.08		0.0	7.2	7.27	12.55	6.25	1.02	
		12:03	67.62		0.0	7.0	7.25	12.55	6.25	1.00	
		14:09	69.72		0.0	6.8	7.09	12.55	6.25	0.84	
		16:08	71.70		0.0	7.2	7.26	12.55	6.25	1.01	
		17:58	73.53		0.0	7.4	7.12	12.55	6.25	0.87	
		20:01	75.58		0.1	7.8	7.35	12.55	6.25	1.10	
		22:01	77.58		0.0	6.5	7.34	12.55	6.25	1.09	
		23:50	79.40		0.0	2.3	7.25	12.55	6.25	1.00	
	02.21.15	1:53	81.45		0.1	6.5	7.50	12.55	6.25	1.25	
		4:00	83.57		0.0	6.2	7.50	12.55	6.25	1.25	
		6:10	85.73		0.0	3.8	7.34	12.55	6.25	1.09	
		8:03	87.62		0.0	6.8	7.17	12.55	6.25	0.92	
		10:02	89.60		0.0	6.7	7.21	12.55	6.25	0.96	End of DPE-2 test

Note:

hh:mm = hour:minute
min = minute
gal = gallon
gpm = gallon per minute
°F = Fahrenheit
ft = feet

DTW = depth to water
DPE = dual phase extraction
"Hg = inches of mercury
"H2O= inches of water
ES = Electric Submersible
scfm = standard cubic feet per minute

ppmv = parts per million by volume
lb = pound
VOCs = Volatile organic compounds

[a]Mass removal rate calculated using average VOCs concentrations between time period for instances following post-dilution concentrations readings
Mass Removal Rate Equation: ((Average VOCs)/1000000)*(Average Volumetric Air Flow Rate))*(1440 min/day)*(1/379 ft3 air/mole)*(86.2lb/lb mole)
with: VOCs in ppmv Air flow rate in scfm Mass Removal Rate in lb/day
Vacuum Equation: Vacuum = DPE Vacuum*13.59 with: Vacuum in "H2O DPE Vacuum in "Hg

TABLE 4
Monitoring Well Network Data – Pilot Test DPE-3
Chevron Environmental Management Company
Pilot Test Summary Memorandum
Former Unocal Edmonds Bulk Fuel Terminal
Edmonds, Washington

Well ID	Date	Time (hh:mm)	Elapsed Time (hr)	Distance from pumped well (ft)	Headspace VOCs (ppmv)	Vacuum ("H2O)	DTW (ft BTOC)	DTB (ft BTOC)	Static DTW (ft BTOC)	Drawdown (ft below Static DTW)	Note
DPE-1	03.30.15	8:21	--	29	30.9	--	6.26	28.8	6.26	--	
	03.30.15	10:53	0.00	29	1.3	0.0	8.17	28.8	6.26	1.91	Beginning of DPE-3 test
		11:51	0.97		6.6	0.0	8.32	28.8	6.26	2.06	Pulling full vacuum at DPE-3
		12:50	1.95		2.0	0.0	8.35	28.8	6.26	2.09	
		13:49	2.93		--	0.3	8.35	28.8	6.26	2.09	
		15:38	4.75		--	0.3	8.37	28.8	6.26	2.11	
		16:50	5.95		--	0.3	8.38	28.8	6.26	2.12	
		17:51	6.97		--	0.0	7.88	28.8	6.26	1.62	Blower Stopped
		18:53	8.00		--	0.7	8.34	28.8	6.26	2.08	
		20:24	9.52		170.6	0.6	8.48	28.8	6.26	2.22	
		21:25	10.53		8.9	0.9	8.65	28.8	6.26	2.39	
		23:18	12.42		8.6	0.6	8.59	28.8	6.26	2.33	
	03.31.15	1:15	14.37		130.5	0.5	8.54	28.8	6.26	2.28	
		3:28	16.58		36.7	0.6	8.53	28.8	6.26	2.27	
		5:24	18.52		82.2	0.6	8.45	28.8	6.26	2.19	
		7:20	20.45		2.4	0.7	8.47	28.8	6.26	2.21	
		8:41	21.80		51.7	0.9	8.45	28.8	6.26	2.19	
		10:48	23.92		39.5	1.3	8.49	28.8	6.26	2.23	
		12:43	25.83		61.3	1.3	8.48	28.8	6.26	2.22	
		14:46	27.88		53.5	1.3	8.47	28.8	6.26	2.21	
		16:50	29.95		34.1	0.9	8.43	28.8	6.26	2.17	
		17:46	30.88		2.7	0.8	8.40	28.8	6.26	2.14	
		18:51	31.97		24.8	0.9	8.40	28.8	6.26	2.14	
		20:02	33.15		25.1	0.9	8.99	28.8	6.26	2.73	End of DPE-3 test
		21:15	34.37		27.7	--	6.50	28.8	6.26	0.24	
		22:15	35.37		20.0	--	6.85	28.8	6.26	0.59	
		23:11	36.30		40.2	--	6.70	28.8	6.26	0.44	
	04.01.15	0:12	37.32		26.9	--	6.65	28.8	6.26	0.39	

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Edmonds, Washington

Well ID	Date	Time (hh:mm)	Elapsed Time (hr)	Distance from pumped well (ft)	Headspace VOCs (ppmv)	Vacuum ("H2O)	DTW (ft BTOC)	DTB (ft BTOC)	Static DTW (ft BTOC)	Drawdown (ft below Static DTW)	Note
DPE-2	03.30.15	8:30	--	48	10.0	--	5.92	29.35	5.92	--	
		10:50	0	48	1.5	0.0	6.54	29.35	5.92	0.62	Beginning of DPE-3 test
		11:58	1.13		0.2	0.0	6.61	29.35	5.92	0.69	Pulling full vacuum at DPE-3
		12:59	2.15		0.2	0.0	6.65	29.35	5.92	0.73	
		13:55	3.08		--	0.0	6.65	29.35	5.92	0.73	
		15:35	4.75		--	0.0	6.67	29.35	5.92	0.75	
		16:56	6.10		--	0.0	6.68	29.35	5.92	0.76	
		18:00	7.17		--	0.0	6.51	29.35	5.92	0.59	Blower Stopped
		19:02	8.20		--	0.7	6.70	29.35	5.92	0.78	
		20:01	9.18		0.0	0.4	6.73	29.35	5.92	0.81	
		21:00	10.17		1.6	0.3	6.78	29.35	5.92	0.86	
		23:00	12.17		3.5	0.3	6.75	29.35	5.92	0.83	
	03.31.15	1:07	14.28		7.7	0.0	6.75	29.35	5.92	0.83	
		3:23	16.55		4.0	0.3	6.74	29.35	5.92	0.82	
		5:20	18.50		4.4	4.0	6.77	29.35	5.92	0.85	
		7:17	20.45		3.2	0.3	6.81	29.35	5.92	0.89	
		8:47	21.95		14.0	0.4	6.77	29.35	5.92	0.85	
		10:56	24.10		25.0	0.7	6.80	29.35	5.92	0.88	
		12:50	26.00		30.3	0.6	6.77	29.35	5.92	0.85	
		14:52	28.03		33.0	0.7	6.78	29.35	5.92	0.86	
		16:56	30.10		24.7	0.5	6.76	29.35	5.92	0.84	
		17:53	31.05		26.0	0.4	6.75	29.35	5.92	0.83	
		18:57	32.12		9.3	0.4	6.75	29.35	5.92	0.83	
		20:10	33.33		3.5	0.4	6.82	29.35	5.92	0.90	End of DPE-3 test
		21:20	34.50		13.6	--	6.25	29.35	5.92	0.33	
		22:20	35.50		18.0	--	6.15	29.35	5.92	0.23	
		23:16	36.43		25.3	--	6.15	29.35	5.92	0.23	
	04.01.15	0:19	37.48		8.6	--	6.12	29.35	5.92	0.20	

TABLE 4
Monitoring Well Network Data – Pilot Test DPE-3
Chevron Environmental Management Company
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Former Unocal Edmonds Bulk Fuel Terminal
Edmonds, Washington

Well ID	Date	Time (hh:mm)	Elapsed Time (hr)	Distance from pumped well (ft)	Headspace VOCs (ppmv)	Vacuum ("H2O)	DTW (ft BTOC)	DTB (ft BTOC)	Static DTW (ft BTOC)	Drawdown (ft below Static DTW)	Note
DPE-3	03.30.15	8:03	--	0	375.1	--	4.63	25.01	4.63	--	
	03.30.15	10:37	0	0	35.1	142.7	16.04	25.01	4.63	11.41	Beginning of DPE-3 test
		12:05	1.47		53.0	142.7	7.60	25.01	4.63	2.97	Pulling full vacuum at DPE-3
		13:05	2.47		62.1	142.7	8.20	25.01	4.63	3.57	
		14:01	3.40		72.2	142.7	8.70	25.01	4.63	4.07	
		15:50	5.22		67.2	163.1	9.45	25.01	4.63	4.82	
		17:02	6.42		71.0	163.1	10.15	25.01	4.63	5.52	
		18:09	7.53		--	0.0	15.70	25.01	4.63	11.07	Blower Stopped
		19:10	8.55		90.0	135.9	10.30	25.01	4.63	5.67	
		20:00	9.38		84.2	135.9	10.80	25.01	4.63	6.17	
		23:30	12.88		97.0	135.9	12.00	25.01	4.63	7.37	
	03.31.15	1:00	14.38		95.6	129.1	12.50	25.01	4.63	7.87	
		3:33	16.93		107.9	129.1	13.09	25.01	4.63	8.46	
		5:32	18.92		112.0	129.1	13.40	25.01	4.63	8.77	
		7:25	20.80		115.0	122.3	13.75	25.01	4.63	9.12	
		8:53	22.27		116.0	135.9	14.00	25.01	4.63	9.37	
		11:01	24.40		132.0	135.9	13.92	25.01	4.63	9.29	
		12:59	26.37		140.0	145.4	13.80	25.01	4.63	9.17	
		14:58	28.35		130.0	149.5	14.28	25.01	4.63	9.65	
		17:02	30.42		130.0	148.0	17.10	25.01	4.63	12.47	
		18:00	31.38		131.0	106.0	16.72	25.01	4.63	12.09	
		19:03	32.43		132.0	108.0	16.80	25.01	4.63	12.17	
		20:13	33.60		130.0	108.0	16.50	25.01	4.63	11.87	
		21:25	34.80		389.1	--	7.10	25.01	4.63	2.47	End of DPE-3 test
		22:24	35.78		433.6	--	6.90	25.01	4.63	2.27	
		23:20	36.72		381.2	--	6.84	25.01	4.63	2.21	
	04.01.15	0:21	37.73		488.9	--	6.80	25.01	4.63	2.17	

Well ID	Date	Time (hh:mm)	Elapsed Time (hr)	Distance from pumped well (ft)	Headspace VOCs (ppmv)	Vacuum ("H2O)	DTW (ft BTOC)	DTB (ft BTOC)	Static DTW (ft BTOC)	Drawdown (ft below Static DTW)	Note
PZ-1	03.30.15	8:15	--	31.5	80.3	--	6.41	23.89	6.41	--	
		10:44	0	31.5	2.0	0.0	7.80	23.89	6.41	1.39	Beginning of DPE-3 test
		11:47	1.05		1.4	0.0	8.01	23.89	6.41	1.6	Pulling full vacuum at DPE-3
		12:46	2.03		0.8	0.0	8.05	23.89	6.41	1.64	
		13:44	3.00		--	0.0	8.05	23.89	6.41	1.64	
		15:40	4.93		--	0.0	8.03	23.89	6.41	1.62	
		16:46	6.03		--	0.0	8.03	23.89	6.41	1.62	
		17:45	7.02		--	0.0	7.69	23.89	6.41	1.28	Blower Stopped
		18:48	8.07		--	0.4	8.00	23.89	6.41	1.59	
		20:30	9.77		91.6	0.0	8.14	23.89	6.41	1.73	
		21:29	10.75		282.1	0.4	8.30	23.89	6.41	1.89	
		23:24	12.67		43.5	0.0	8.27	23.89	6.41	1.86	
	03.31.15	1:17	14.55		12.7	0.0	8.24	23.89	6.41	1.83	
		3:30	16.77		33.2	0.0	8.20	23.89	6.41	1.79	
		5:28	18.73		7.1	0.0	8.15	23.89	6.41	1.74	
		7:22	20.63		14.9	0.4	8.10	23.89	6.41	1.69	
		8:37	21.88		15.4	0.3	8.11	23.89	6.41	1.7	
		10:42	23.97		6.5	0.5	8.19	23.89	6.41	1.78	
		13:05	26.35		149.2	0.8	8.14	23.89	6.41	1.73	
		14:42	27.97		5.7	0.0	8.18	23.89	6.41	1.77	
		16:46	30.03		4.5	0.0	8.09	23.89	6.41	1.68	
		17:42	30.97		1.3	0.0	8.08	23.89	6.41	1.67	
		18:47	32.05		0.7	0.0	8.09	23.89	6.41	1.68	
		19:57	33.22		--	--	--	23.89	6.41		End of DPE-3 test

TABLE 4
Monitoring Well Network Data – Pilot Test DPE-3
Chevron Environmental Management Company
Pilot Test Summary Memorandum
Former Unocal Edmonds Bulk Fuel Terminal
Edmonds, Washington

Well ID	Date	Time (hh:mm)	Elapsed Time (hr)	Distance from pumped well (ft)	Headspace VOCs (ppmv)	Vacuum ("H2O)	DTW (ft BTOC)	DTB (ft BTOC)	Static DTW (ft BTOC)	Drawdown (ft below Static DTW)	Note
PZ-2	03.30.15	8:24	--	31	367.2	--	6.20	18.32	6.20	--	
	03.30.15	10:56	0	31	21.0	0.0	7.39	18.32	6.20	1.19	Beginning of DPE-3 test
		11:53	0.95		0.4	0.3	7.54	18.32	6.20	1.34	Pulling full vacuum at DPE-3
		12:52	1.93		0.3	0.4	7.61	18.32	6.20	1.41	
		13:51	2.92		0.5	0.4	7.63	18.32	6.20	1.43	
		15:37	4.68		0.5	0.5	7.70	18.32	6.20	1.5	
		16:52	5.93		0.4	0.4	7.72	18.32	6.20	1.52	
		17:54	6.97		1.7	0.0	7.44	18.32	6.20	1.24	Blower Stopped
		18:56	8.00		0.5	0.8	7.74	18.32	6.20	1.54	
		20:21	9.42		0.0	0.7	7.82	18.32	6.20	1.62	
		21:24	10.47		0.0	0.8	7.92	18.32	6.20	1.72	
		23:16	12.33		0.0	0.8	7.95	18.32	6.20	1.75	
	03.31.15	1:12	14.27		0.0	0.6	7.96	18.32	6.20	1.76	
		3:28	16.53		0.0	0.9	8.00	18.32	6.20	1.8	
		5:22	18.43		0.0	0.9	7.92	18.32	6.20	1.72	
		7:20	20.40		0.0	0.9	7.95	18.32	6.20	1.75	
		8:43	21.78		0.0	1.1	7.95	18.32	6.20	1.75	
		10:50	23.90		0.0	1.4	8.00	18.32	6.20	1.8	
		12:45	25.82		0.0	1.4	7.97	18.32	6.20	1.77	
		14:48	27.87		0.0	1.4	7.98	18.32	6.20	1.78	
		16:52	29.93		0.1	1.3	7.95	18.32	6.20	1.75	
		17:48	30.87		0.0	1.1	7.93	18.32	6.20	1.73	
		18:53	31.95		0.0	1.1	7.95	18.32	6.20	1.75	
		20:05	33.15		0.0	1.1	7.96	18.32	6.20	1.76	End of DPE-3 test
		21:16	34.33		0.2	--	7.00	18.32	6.20	0.8	
		22:16	35.33		1.5	--	6.85	18.32	6.20	0.65	
		23:12	36.27		8.6	--	6.78	18.32	6.20	0.58	
	04.01.15	0:13	37.28		19.5	--	6.74	18.32	6.20	0.54	

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Well ID	Date	Time (hh:mm)	Elapsed Time (hr)	Distance from pumped well (ft)	Headspace VOCs (ppmv)	Vacuum ("H2O)	DTW (ft BTOC)	DTB (ft BTOC)	Static DTW (ft BTOC)	Drawdown (ft below Static DTW)	Note
PZ-3	03.30.15	8:33	--	10	737.5	--	5.54	18.32	5.54	--	
	03.30.15	11:02	0	10	16.9	0.4	9.02	18.32	5.54	3.48	Beginning of DPE-3 test
		12:00	0.97		0.9	1.0	9.18	18.32	5.54	3.64	Pulling full vacuum at DPE-3
		13:01	1.98		0.6	1.0	9.18	18.32	5.54	3.64	
		13:57	2.92		0.5	1.0	9.19	18.32	5.54	3.65	
		15:33	4.52		0.6	1.0	9.18	18.32	5.54	3.64	
		16:58	5.93		0.7	1.1	9.18	18.32	5.54	3.64	
		18:03	7.02		1.7	0.0	8.07	18.32	5.54	2.53	Blower Stopped
		19:05	8.05		0.5	1.3	9.13	18.32	5.54	3.59	
		20:33	9.52		0.5	1.3	9.25	18.32	5.54	3.71	
		21:35	10.55		0.0	0.9	9.36	18.32	5.54	3.82	
		23:28	12.43		0.0	1.1	9.28	18.32	5.54	3.74	
	03.31.15	1:21	14.32		0.0	0.9	9.31	18.32	5.54	3.77	
		3:35	16.55		0.0	1.3	9.30	18.32	5.54	3.76	
		5:31	18.48		0.0	0.9	9.20	18.32	5.54	3.66	
		7:24	20.37		0.1	1.3	9.16	18.32	5.54	3.62	
		8:49	21.78		0.0	1.4	9.19	18.32	5.54	3.65	
		10:58	23.93		0.0	1.9	9.21	18.32	5.54	3.67	
		12:53	25.85		0.0	2.0	9.16	18.32	5.54	3.62	
		14:54	27.87		0.1	2.1	9.15	18.32	5.54	3.61	
		16:58	29.93		0.1	1.4	9.12	18.32	5.54	3.58	
		17:56	30.90		0.1	1.3	9.03	18.32	5.54	3.49	
		18:59	31.95		0.0	0.6	9.02	18.32	5.54	3.48	
		20:11	33.15		0.0	0.7	9.02	18.32	5.54	3.48	End of DPE-3 test
		21:22	34.33		2.7	--	6.10	18.32	5.54	0.56	
		22:22	35.33		12.9	--	5.95	18.32	5.54	0.41	
		23:18	36.27		23.7	--	6.16	18.32	5.54	0.62	
	04.01.15	0:19	37.28		24.9	--	6.93	18.32	5.54	1.39	

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Well ID	Date	Time (hh:mm)	Elapsed Time (hr)	Distance from pumped well (ft)	Headspace VOCs (ppmv)	Vacuum ("H2O)	DTW (ft BTOC)	DTB (ft BTOC)	Static DTW (ft BTOC)	Drawdown (ft below Static DTW)	Note
AS-1	03.30.15	8:18	--	25	4.7	--	6.35	25	6.35	--	
	03.30.15	10:47	0	25	0.4	0.0	7.84	25	6.35	1.49	Beginning of DPE-3 test
		11:49	1.03		0.7	0.0	8.05	25	6.35	1.7	Pulling full vacuum at DPE-3
		12:48	2.02		0.7	0.0	8.11	25	6.35	1.76	
		13:46	2.98		1.4	0.0	8.11	25	6.35	1.76	
		15:39	4.87		2.2	0.0	8.17	25	6.35	1.82	
		16:48	6.02		1.3	0.0	8.13	25	6.35	1.78	
		17:48	7.02		0.9	0.0	7.72	25	6.35	1.37	Blower Stopped
		18:50	8.05		1.9	0.0	8.14	25	6.35	1.79	
		20:26	9.65		2.1	0.0	8.28	25	6.35	1.93	
		21:26	10.65		0.8	0.3	8.33	25	6.35	1.98	
		23:20	12.55		0.8	0.0	8.37	25	6.35	2.02	
	03.31.15	1:15	14.47		1.2	0.0	8.35	25	6.35	2	
		3:29	16.70		0.8	0.0	8.32	25	6.35	1.97	
		5:27	18.67		1.0	0.0	8.29	25	6.35	1.94	
		7:21	20.57		0.7	0.0	8.25	25	6.35	1.9	
		8:39	21.87		0.0	0.0	8.29	25	6.35	1.94	
		10:45	23.97		0.2	0.0	8.32	25	6.35	1.97	
		12:41	25.90		0.2	0.0	8.37	25	6.35	2.02	
		14:44	27.95		0.4	0.0	8.32	25	6.35	1.97	
		16:48	30.02		0.2	0.0	8.23	25	6.35	1.88	
		17:44	30.95		0.1	0.0	8.20	25	6.35	1.85	
		18:49	32.03		0.0	0.0	8.21	25	6.35	1.86	
		20:00	33.22		0.4	1.2	8.25	25	6.35	1.9	End of DPE-3 test
		21:13	34.43		1.2	--	7.01	25	6.35	0.66	
		22:13	35.43		0.5	--	6.99	25	6.35	0.64	
		23:09	36.37		1.3	--	6.80	25	6.35	0.45	
	04.01.15	0:10	37.38		0.1	--	6.95	25	6.35	0.6	

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MW-525	03.30.15	8:36	--	5	117.4	--	5.73	12.45	5.73	--	
	03.30.15	11:05	0	5	242.5	1.5	10.13	12.45	5.73	4.40	Beginning of DPE-3 test
		12:03	0.97		0.4	3.7	10.22	12.45	5.73	4.49	Pulling full vacuum at DPE-3
		13:03	1.97		0.3	5.7	10.05	12.45	5.73	4.32	
		13:59	2.90		0.3	6.0	9.94	12.45	5.73	4.21	
		15:32	4.45		0.3	6.2	9.95	12.45	5.73	4.22	
		17:00	5.92		0.3	4.0	9.97	12.45	5.73	4.24	
		18:06	7.02		2.4	0.0	8.55	12.45	5.73	2.82	Blower Stopped
		19:08	8.05		0.3	6.3	9.78	12.45	5.73	4.05	
		20:31	9.43		0.5	3.9	10.00	12.45	5.73	4.27	
		21:32	10.45		0.1	5.5	9.98	12.45	5.73	4.25	
		23:26	12.35		0.0	5.6	9.91	12.45	5.73	4.18	
	03.31.15	1:20	14.25		0.0	3.2	10.10	12.45	5.73	4.37	
		3:32	16.45		0.0	5.7	9.85	12.45	5.73	4.12	
		5:30	18.42		12.1	3.9	9.89	12.45	5.73	4.16	
		7:24	20.32		0.0	4.9	9.83	12.45	5.73	4.10	
		8:51	21.77		0.0	5.2	9.75	12.45	5.73	4.02	
		11:00	23.92		0.0	8.2	9.74	12.45	5.73	4.01	
		12:56	25.85		0.0	8.4	9.59	12.45	5.73	3.86	
		14:56	27.85		0.0	8.2	9.68	12.45	5.73	3.95	
		17:00	29.92		0.0	6.6	9.62	12.45	5.73	3.89	
		17:58	30.88		0.0	6.2	9.58	12.45	5.73	3.85	
		19:01	31.93		0.0	6.1	9.56	12.45	5.73	3.83	
		20:12	33.12		0.0	6.1	9.54	12.45	5.73	3.81	End of DPE-3 test
		21:23	34.30		3.8	--	6.25	12.45	5.73	0.52	
		22:23	35.30		385.5	--	6.25	12.45	5.73	0.52	
		23:19	36.23		294.1	--	6.80	12.45	5.73	1.07	
	04.01.15	0:20	37.25		196.6	--	6.10	12.45	5.73	0.37	

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MW-531	03.30.15	8:12	--	57	0.2	--	7.18	12.84	7.18	--	
	03.30.15	10:41	0	57	0.3	0.0	7.23	12.84	7.18	0.05	Beginning of DPE-3 test
		11:45	1.07		0.2	0.0	7.23	12.84	7.18	0.05	Pulling full vacuum at DPE-3
		12:45	2.07		0.2	0.0	7.23	12.84	7.18	0.05	
		13:42	3.02		0.2	0.0	7.24	12.84	7.18	0.06	
		15:43	5.03		0.2	0.0	7.22	12.84	7.18	0.04	
		16:44	6.05		0.4	0.0	7.21	12.84	7.18	0.03	
		17:42	7.02		1.0	0.0	7.21	12.84	7.18	0.03	Blower Stopped
		18:45	8.07		0.2	0.0	7.24	12.84	7.18	0.06	
		20:31	9.83		0.3	0.0	7.26	12.84	7.18	0.08	
		21:37	10.93		0.4	0.0	7.29	12.84	7.18	0.11	
		23:30	12.82		0.2	0.0	7.33	12.84	7.18	0.15	
	03.31.15	1:24	14.72		0.3	0.0	7.34	12.84	7.18	0.16	
		3:40	16.98		0.0	0.0	7.35	12.84	7.18	0.17	
		5:29	18.80		0.5	0.0	7.33	12.84	7.18	0.15	
		7:24	20.72		0.1	0.0	7.29	12.84	7.18	0.11	
		8:35	21.90		0.0	0.0	7.29	12.84	7.18	0.11	
		10:40	23.98		0.0	0.0	7.32	12.84	7.18	0.14	
		12:38	25.95		0.0	0.0	7.33	12.84	7.18	0.15	
		14:40	27.98		0.1	0.0	7.34	12.84	7.18	0.16	
		16:44	30.05		0.0	0.0	7.33	12.84	7.18	0.15	
		17:39	30.97		0.0	0.0	7.30	12.84	7.18	0.12	
		18:45	32.07		0.0	0.0	7.31	12.84	7.18	0.13	
		19:55	33.23		0.0	0.0	7.34	12.84	7.18	0.16	End of DPE-3 test
		21:14	34.55		0.0	--	7.35	12.84	7.18	0.17	
		22:14	35.55		0.0	--	7.35	12.84	7.18	0.17	
		23:10	36.48		0.0	--	7.40	12.84	7.18	0.22	
	04.01.15	0:11	37.50		0.0	--	7.40	12.84	7.18	0.22	

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MW-532	03.30.15	8:27	--	40	6.3	--	6.38	12.84	6.38	--	
	03.30.15	10:59	0	40	2.7	0.0	6.95	12.84	6.38	0.57	Beginning of DPE-3 test
		11:56	0.95		2.0	0.0	7.12	12.84	6.38	0.74	Pulling full vacuum at DPE-3
		12:55	1.93		0.9	0.0	7.21	12.84	6.38	0.83	
		13:53	2.90		1.2	0.0	7.28	12.84	6.38	0.9	
		15:36	4.62		3.2	0.0	7.32	12.84	6.38	0.94	
		16:54	5.92		3.1	0.0	7.36	12.84	6.38	0.98	
		17:57	6.97		2.7	0.0	7.29	12.84	6.38	0.91	Blower Stopped
		18:59	8.00		1.4	0.0	7.36	12.84	6.38	0.98	
		20:15	9.27		3.2	0.0	7.43	12.84	6.38	1.05	
		21:22	10.38		1.5	0.0	7.53	12.84	6.38	1.15	
		23:14	12.25		0.9	0.0	7.57	12.84	6.38	1.19	
	03.31.15	1:11	14.20		1.4	0.0	7.60	12.84	6.38	1.22	
		3:25	16.43		0.7	0.0	7.70	12.84	6.38	1.32	
		5:22	18.38		0.8	0.0	7.65	12.84	6.38	1.27	
		7:18	20.32		0.8	0.0	7.63	12.84	6.38	1.25	
		8:45	21.77		0.4	0.0	7.64	12.84	6.38	1.26	
		10:53	23.90		0.1	0.4	7.68	12.84	6.38	1.3	
		12:48	25.82		0.2	0.4	7.67	12.84	6.38	1.29	
		14:50	27.85		1.4	0.4	7.69	12.84	6.38	1.31	
		16:54	29.92		0.3	0.0	7.66	12.84	6.38	1.28	
		17:51	30.87		0.2	0.0	7.62	12.84	6.38	1.24	
		18:55	31.93		0.2	0.0	7.65	12.84	6.38	1.27	
		20:08	33.15		0.3	0.0	7.67	12.84	6.38	1.29	End of DPE-3 test
		21:18	34.32		0.1	--	7.26	12.84	6.38	0.88	
		22:18	35.32		0.6	--	7.10	12.84	6.38	0.72	
		23:14	36.25		1.1	--	6.99	12.84	6.38	0.61	
	04.01.15	0:15	37.27		0.2	--	6.93	12.84	6.38	0.55	

Note:

hh:mm = hour:minute
min = minute
gal = gallon
gpm = gallon per minute
°F = Fahrenheit
ft = feet

DTW = depth to water
DPE = dual phase extraction
"Hg = inches of mercury
"H2O= inches of water
ES = Electric Submersible
scfm = standard cubic feet per minute

ppmv = parts per million by volume
lb = pound
VOCs = Volatile organic compounds

[a]Mass removal rate calculated using average VOCs concentrations between time period for instances following post-dilution concentrations readings
Mass Removal Rate Equation:
((Average VOCs)/1000000)*(Average Volumetric Air Flow Rate))*(1440 min/day)*(1/379 ft3
with: VOCs in ppmv Air flow rate in scfm Mass Removal Rate in lb/day
Vacuum Equation: Vacuum = DPE Vacuum*13.59 with: Vacuum in "H2O DPE Vacuum in "Hg

Date	Time (hh:mm)	Elapsed Time Since Last Measurement (min)	Operating Period (cumulative mins)	Cumulative Gallons (totalizer, gal)	Calculated pumping rate (gpm)	Cycle counter (0.65 gallons per cycle)	Manifold Bleed Valve Open	DTW Interface probe (ft)	DPE Vacuum ("Hg)	Blower Inlet Vacuum ("Hg)	Temperature at Measurment point (°F)	Air Flow Meter (scfm)	VOCs (ppmv)	Mass Removal Rate[a] (lb/day)	Cumulative Mass Removed (lb)	Note
DPE-1 test																
02.17.15	12:05	--	--	3513.68	--	263	yes	21.86	23.10	--	--	--	--	--	--	Beginning of test in DPE-1
	13:15	70.00	70	3625.77	1.60	347	50%	21.43	6.00	6.00	64.5	12.46	163.3	0.7	--	
	14:20	65.00	135	3676.12	0.77	435	no	21.23	20.00	20.00	65.7	16.92	191.0	0.9	0.038	
	14:57	37.00	172	--	--	477	no	20.72	20.00	20.00	68.2	17.50	227.0	1.2	0.069	
	16:30	93.00	265	3789.35	1.22	641	no	20.76	20.00	20.00	69.1	26.03	509.0	2.6	0.238	
	17:30	60.00	325	3828.32	0.65	749	no	20.72	20.00	20.00	61.2	36.58	390.0	4.6	0.430	
	18:30	60.00	385	3995.47	2.79	826	no	20.75	20.00	20.00	61.1	82.42	--	8.9	0.800	
	19:30	60.00	445	4035.07	0.66	919	no	20.78	20.50	20.50	58.4	100.11	352.5	8.9	1.170	
	21:00	90.00	535	4087.82	0.59	1001	no	20.77	21.00	20.30	49.0	85.10	377.3	11.1	1.862	
	21:45	45.00	580	4129.01	0.92	1066	no	20.75	20.50	20.10	55.0	102.65	376.4	11.6	2.224	
	22:30	45.00	625	4166.05	0.82	1124	no	20.80	20.50	20.50	52.8	104.20	349.7	12.3	2.608	
	23:30	60.00	685	4215.95	0.83	1198	no	20.75	20.50	20.10	61.2	102.40	631.0	16.6	3.300	
02.18.15	0:30	60.00	745	4279.59	1.06	1277	no	20.80	20.50	20.10	57.2	100.86	422.9	17.5	4.030	
	1:30	60.00	805	4313.62	0.57	1350	no	20.77	20.30	20.00	57.4	123.26	381.3	14.8	4.645	
	2:30	60.00	865	4363.01	0.82	1426	no	20.76	20.50	20.10	60.9	111.58	682.6	20.5	5.498	
	3:30	60.00	925	4426.53	1.06	1504	no	20.80	20.50	20.10	61.3	113.42	621.4	24.0	6.499	
	4:30	60.00	985	4468.11	0.69	1573	no	20.78	20.50	20.10	54.7	122.47	681.5	25.2	7.547	
	5:30	60.00	1045	4518.10	0.83	1650	no	20.80	20.50	20.10	56.9	125.10	704.1	28.1	8.717	
	6:30	60.00	1105	4554.40	0.60	1722	no	20.78	20.50	20.10	59.1	118.86	355.2	21.2	9.599	
	7:35	65.00	1170	4605.99	0.79	1800	no	20.75	20.50	20.10	58.4	127.52	346.7	14.2	10.238	
	8:30	55.00	1225	4682.17	1.39	1919	no	20.72	25.00	25.00	67.8	83.72	426.1	13.4	10.749	
	10:30	120.00	1345	4756.50	0.62	2033	no	20.72	20.50	20.00	73.6	112.45	465.0	14.3	11.941	
	12:30	120.00	1465	4762.81	0.05	2215	no	24.93	21.50	21.00	72.6	106.60	418.0	15.8	13.261	
	14:30	120.00	1585	4823.06	0.50	2314	no	24.95	21.00	20.30	74.7	115.16	405.0	14.9	14.507	
	16:30	120.00	1705	4929.53	0.89	2470	no	24.96	22.00	21.50	68.6	116.02	384.0	14.9	15.751	
	18:30	120.00	1825	5011.34	0.68	2617	no	24.95	22.00	21.00	67.4	118.43	424.0	15.5	17.044	
	20:30	120.00	1945	5104.55	0.78	2767	no	24.93	21.50	21.00	69.8	116.59	426.4	16.4	18.407	
	22:30	120.00	2065	5201.95	0.81	2924	no	24.78	21.50	21.00	66.5	113.74	473.5	17.0	19.822	
02.19.15	0:30	120.00	2185	5393.92	1.60	3070	no	24.81	22.00	20.50	65.8	128.16	416.7	17.6	21.291	
	2:30	120.00	2305	5499.91	0.88	3224	no	24.80	22.00	21.00	64.0	121.40	459.1	17.9	22.782	
	4:30	120.00	2425	5576.27	0.64	3365	no	24.88	21.50	21.00	65.4	102.75	476.2	17.2	24.213	
	6:30	120.00	2545	5665.65	0.74	3507	no	24.85	21.50	20.60	64.2	113.90	483.6	17.0	25.632	
	8:30	120.00	2665	5783.17	0.98	3698	no	24.94	21.50	21.00	65.7	118.33	384.0	16.5	27.006	End of test in DPE-1
DPE-2 test																
02.19.15	14:00	330.00	2995	6042.22	--	4190	no	11.00	6.00	6.00	53.9	38.11	70.0	0.9	27.207	Beginning of test in DPE-2
	15:30	90.00	3085	6603.76	6.24	5096	no	11.20	6.00	6.00	54.8	43.80	90.1	1.1	27.274	VOCs reading was post-dilution
	19:30	240.00	3325	7917.00	5.47	Switch to ES	yes	18.50	13.50	12.60	54.8	86.58	74.9	1.8	27.567	Use Grundfoss, VOCs reading was post-dilution
	20:30	60.00	3385	8432.00	8.58	--	50%	18.75	13.50	12.90	69.0	92.13	399.4	12.1	28.069	
	21:30	60.00	3445	8942.00	8.50	--	50%	18.60	14.50	13.50	57.4	82.69	426.8	11.8	28.562	
	22:30	60.00	3505	9451.00	8.48	--	50%	18.40	14.00	13.20	56.5	81.71	380.7	10.9	29.015	
	23:30	60.00	3565	9933.00	8.03	--	50%	18.40	14.00	12.90	59.8	81.34	--	10.1	29.435	
02.20.15	0:30	60.00	3625	10439.00	8.43	--	50%	18.50	14.00	13.20	60.4	87.57	356.0	10.1	29.855	
	1:30	60.00	3685	10800.00	6.02	--	50%	18.80	14.00	13.00	61.1	89.40	371.8	10.5	30.294	
	2:30	60.00	3745	11325.00	8.75	--	50%	18.80	14.00	13.10	62.9	82.31	490.1	12.1	30.799	
	3:30	60.00	3805	11778.00	7.55	--	50%	18.30	14.00	13.10	63.9	86.52	--	12.7	31.327	
	4:30	60.00	3865	12221.00	7.38	--	50%	18.50	14.00	13.00	64.1	88.41	411.9	12.7	31.855	
	5:30	60.00	3925	12677.00	7.60	--	50%	18.40	14.00	13.10	63.8	91.43	426.5	12.3	32.369	
	6:30	60.00	3985	13000.00	5.38	--	50%	18.55	14.00	13.10	64.5	89.40	426.8	12.6	32.895	
	7:30	60.00	4045	13548.00	9.13	--	50%	18.35	14.00	13.00	65.2	83.59	--	11.6	33.379	
	8:00	30.00	4075	13895.00	11.57	--	50%	19.25	14.00	13.00	62.7	84.63	--	11.6	33.621	
	9:00	60.00	4135	14250.40	5.92	--	50%	19.63	14.00	13.20	58.4	89.60	390.0	11.6	34.105	
	10:00	60.00	4195	14883.00	10.54	--	50%	19.35	15.00	15.00	52.8	85.48	--	10.6	34.547	
	12:00	120.00	4315	15472.00	4.91	--	50%	21.45	14.00	14.50	53.3	84.55	359.0	10.0	35.380	
	14:00	120.00	4435	16367.00	7.46	--	50%	21.92	14.50	15.00	54.7	87.70	370.0	10.3	36.237	
	16:00	120.00	4555	17392.00	8.54	--	50%	19.00	18.00	18.00	52.1	105.08	245.0	9.7	37.046	
	18:00	120.00	4675	18287.00	7.46	--	50%	20.93	18.00	18.00	50.9	117.36	316.0	10.2	37.897	
	20:00	120.00	4795	19123.00	6.97	--	30%	22.00	18.80	18.80	62.4	62.14	310.0	9.2	38.664	
	22:00	120.00	4915	19925.00	6.68	--	30%	22.00	18.20	18.20	61.8	64.50	296.0	6.3	39.188	
02.21.15	0:00	120.00	5035	20762.00	6.98	--	30%	22.00	16.40	15.50	62.7	73.46	156.0	5.1	39.613	
	2:00	120.00	5155	21621.00	7.16	--	30%	22.00	18.00	17.20	61.0	62.42	369.0	5.8	40.100	
	4:00	120.00	5275	22411.00	6.58	--	30%	22.00	18.00	17.70	63.4	66.21	313.0	7.2	40.699	
	6:00	120.00	5395	23325.00	7.62	--	20%	17.72	20.00	20.00	60.0	51.26	374.3	6.6	41.249	
	8:00	120.00	5515	24253.00	7.73	--	20%	19.18	19.50	20.00	58.5	52.05	175.5	4.7	41.637	
	10:00	120.00	5635	25163.00	7.58	--	20%	18.90	19.75	20.00	51.6	62.90	216.7	3.7	41.945	End of test in DPE-2

Note:

hh:mm = hour:minute
min = minute
gal = gallon
gpm = gallon per minute
°F = Fahrenheit

ft = feet
DTW = depth to water
DPE = dual phase extraction
"Hg = inches of mercury
ES = Electric Submersible

scfm = standard cubic feet per minute
ppmv = parts per million by volume
lb = pound
VOCs = Volatile organic compounds

[a]Mass removal rate calculated using average VOCs concentrations between time period for instances following post-dilution concentrations readings
Mass Removal Rate Equation:
((Average VOCs)/1000000)*(Average Volumetric Air Flow Rate))*(1440 min/day)*(1/379 ft3 air/mole)*(86.2lb/lb mole)
with: VOCs in ppmv Air flow rate in scfm Mass Removal Rate in lb/day

TABLE 6
System and Extraction Well Data – Pilot Test DPE-3
Chevron Environmental Management Company
Pilot Test Summary Memorandum
Former Unocal Edmonds Bulk Fuel Terminal
Edmonds, Washington

Date	Time (hh:mm)	Elapsed Time Since Last Measurement (min)	Operating Period (cumulative hrs)	Cumulative Gallons (totalizer, gal)	Calculated pumping rate (gpm)	Manifold Bleed Valve Open	DTW Interface probe (ft)	DPE Vacuum ("Hg)	Blower Inlet Vacuum ("Hg)	Temperature at Measurment point (°F)	Air Flow Meter (scfm)	VOCs (ppmv)	Mass Removal Rate[a] (lb/day)	Cumulative Mass Removed (lb)	Note
DPE-3 test															
03.30.15	9:00	--	--	25808.11			4.63								
	11:00	120	0	27049.11	225.41	no	8.50	10.5	13.50	61.2	100	35	1.1	0.096	Beginning of test
	12:00	60	1	27594.11	9.08	no	7.60	10.5	14.00	58.9	95	51	1.4	0.153	
	13:00	60	2	28001.11	6.78	no	8.20	10.5	14.00	57.5	95	60	1.7	0.225	
	14:00	60	3	28802.11	13.35	no	8.85	10.5	14.00	59.8	95	68	2.0	0.308	
	16:00	120	5	29806.11	8.37	no	9.65	12.0	14.00	61.9	97	69	2.2	0.487	
	17:00	60	6	30471.11	11.08	no	10.10	12.0	13.80	63.5	97	78	2.3	0.584	
	18:00	60	7	31075.11	10.07	no	14.00	0.0	0.00	--	--	--	2.8	0.702	SVE System restarting but pumping continued
	19:00	60	8	31696.94	10.36	no	10.30	10.0	13.50	63.1	97	100	2.8	0.820	
	20:00	60	9	32219.00	8.70	no	10.80	10.0	13.80	57.6	97	100	3.2	0.952	
	21:00	60	10	32982.00	12.72	no	11.30	10.0	13.80	55.5	97	90	3.0	1.078	
	23:00	120	12	34168.00	9.88	no	11.90	9.5	13.80	55.4	97	111	3.2	1.344	
03.31.15	1:00	120	14	35359.00	9.93	no	12.50	9.5	13.80	55.9	97	109	3.5	1.636	
	3:00	120	16	36582.00	10.19	no	--	9.5	13.80	54.2	97	115	3.6	1.932	
	5:00	120	18	37767.11	9.88	no	13.40	9.5	13.80	55.1	97	112	3.6	2.233	
	7:00	120	20	38826.11	8.83	no	13.75	9.0	13.80	53.4	97	115	3.6	2.533	
	9:00	120	22	39907.11	9.01	no	13.95	9.0	13.80	56.1	99	116	3.7	2.842	
	11:00	120	24	41200.11	10.78	no	13.95	10.0	14.20	55.2	99	132	4.0	3.177	
	13:00	120	26	42366.11	9.72	no	13.80	10.7	14.50	55.9	81	140	4.0	3.511	
	15:00	120	28	43508.11	9.52	no	14.20	11.0	14.40	61.7	77	130	3.5	3.802	
	17:00	120	30	44694.11	9.88	no	17.12	8.00	10.70	56.7	45	130	2.6	4.019	Reduced well head vacuum
	18:00	60	31	45266.11	9.53	no	16.72	8.00	10.90	56.0	46	131	1.9	4.100	
	19:00	60	32	45820.00	9.23	no	16.40	8.00	10.80	54.2	45	132	2.0	4.181	
	20:00	60	33	46460.00	10.67	no	16.50	8.00	10.90	54.7	45	130	1.9	4.262	

Note:

hh:mm = hour:minute
gal = gallon
gpm = gallon per minute
°F = Fahrenheit

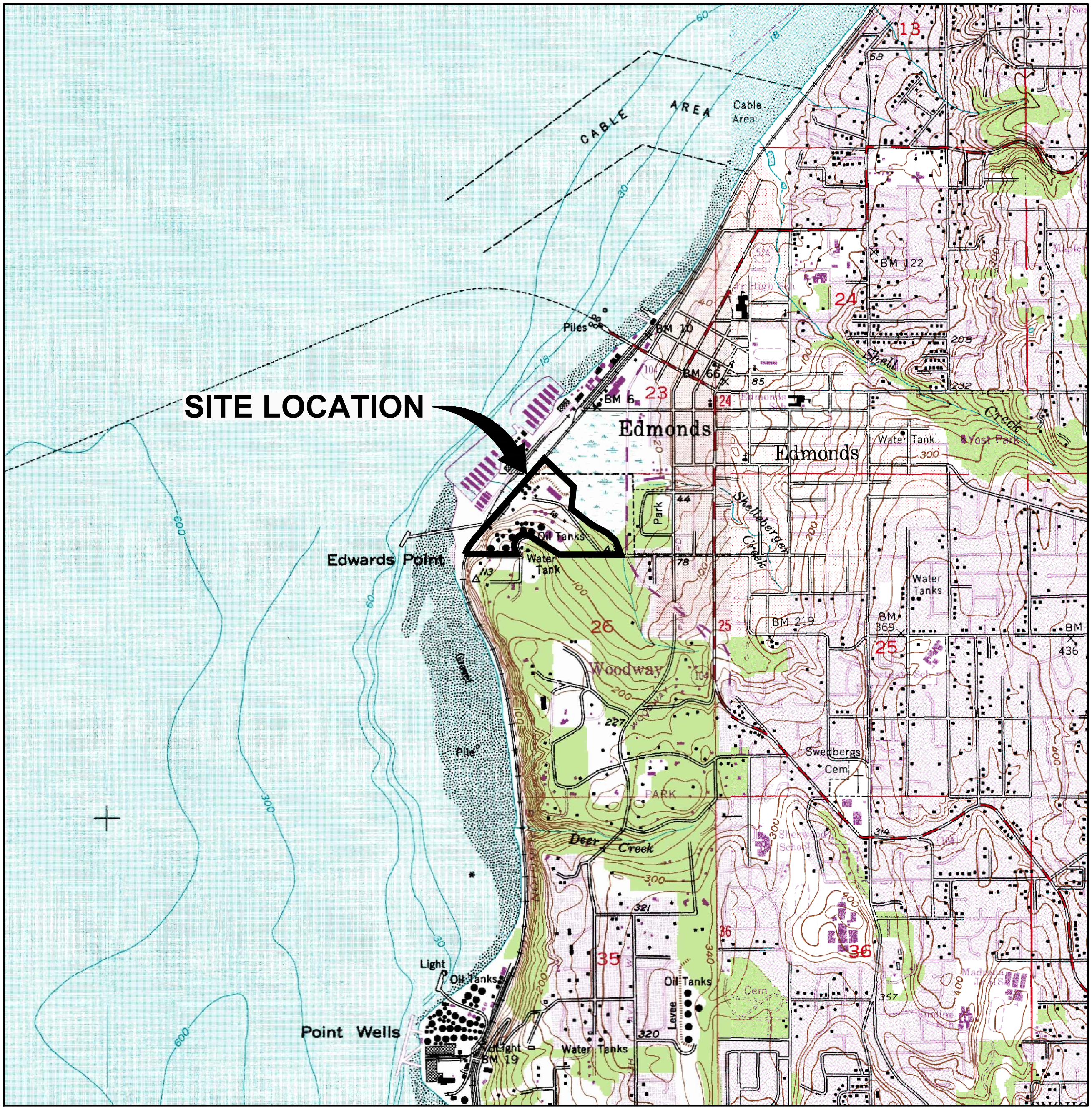
ft = feet
DTW = depth to water
"Hg = inches of mercury
ES = Electric Submersible

scfm = standard cubic feet per minute
ppmv = parts per million by volume
VOCs = Volatile organic compounds
SVE = Soil Vapor Extraction

[a]Mass removal rate calculated using average VOCs concentrations between time period for instances following post-dilution concentrations readings
Mass Removal Rate Equation:
((Average VOCs)/1000000)*(Average Volumetric Air Flow Rate))*(1440 min/day)*(1/379 ft3 air/mole)*(86.2lb/lb mole)
with: VOCs in ppmv Air flow rate in scfm Mass Removal Rate in lb/day

ARCADIS

Figures



REFERENCE: USGS QUADS., 7.5 MIN. SERIES (TOPOGRAPHIC) - EDMONDS EAST, WASH. AND EDMONDS WEST, WASH.

0 0.5 1.0

Approximate Scale: 1"=0.5 Miles

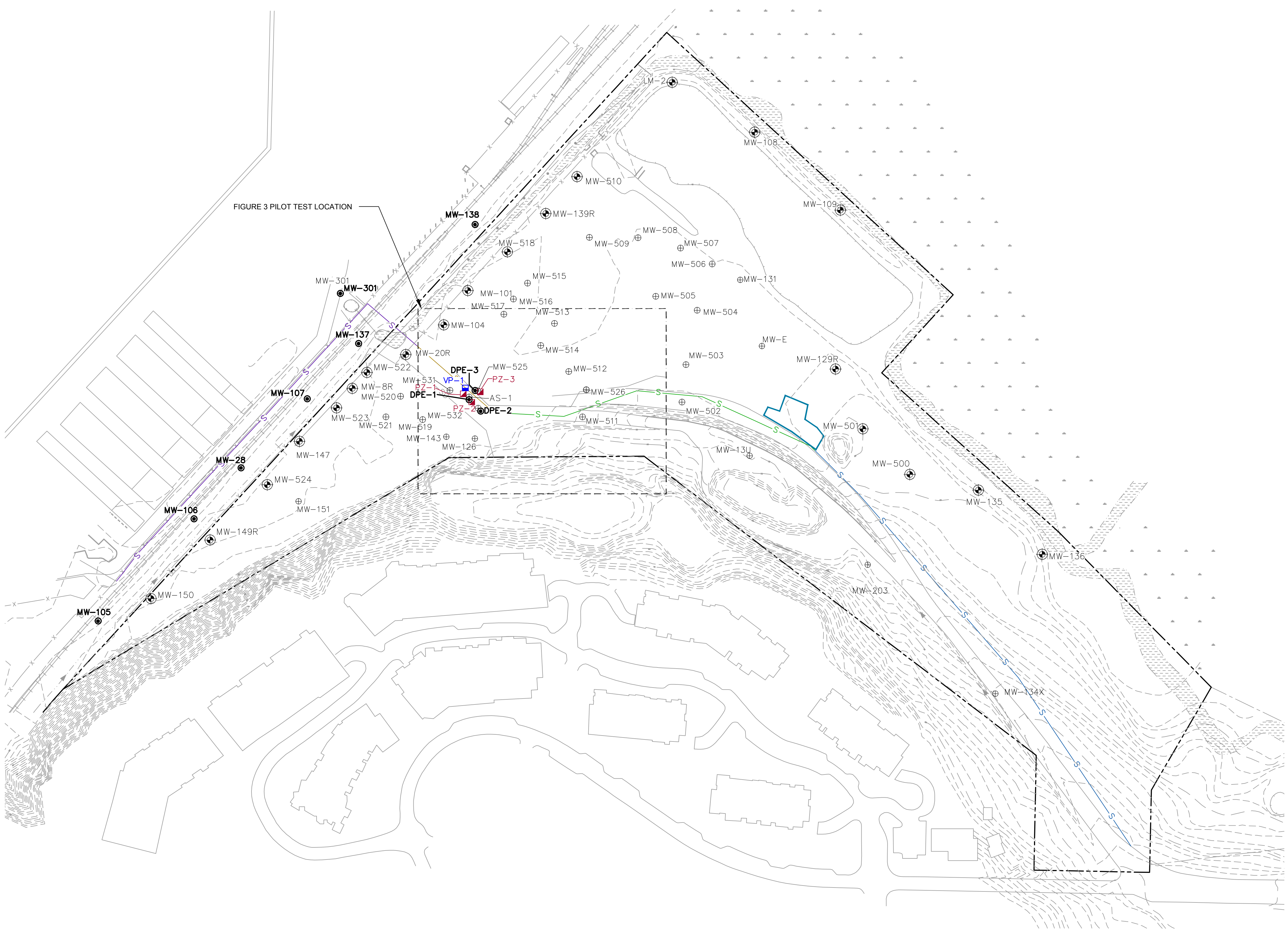
WASHINGTON

CHEVRON ENVIRONMENTAL MANAGEMENT COMPANY
FORMER UNOCAL BULK FUEL TERMINAL
EDMONDS, WASHINGTON
PILOT TEST SUMMARY MEMORANDUM

SITE LOCATION MAP

ARCADIS

FIGURE
1



LEGEND:

DPE-1	DPE WELL LOCATION
MW-203	INTERIOR MONITORING WELL LOCATION AND DESIGNATION
MW-108	PERIMETER MONITORING WELL LOCATION
PZ-1	PIEZOMETER WELL LOCATION
VP-1	SOIL VAPOR PROBE / SAMPLING LOCATION
	PROPERTY BOUNDARY
S	WSDOT STORMWATER LINE
SD	POINT EDWARDS STORM DRAIN LINE

NOTES:

1. BUILDING AND ROAD INFORMATION DIGITIZED FROM GOOGLE EARTH AERIAL PHOTO. TOPOGRAPHIC CONTOURS WERE OBTAINED FROM AN UNKNOWN SOURCE. ALL LOCATIONS ARE APPROXIMATE AND SHALL BE VERIFIED IN THE FIELD BY CONTRACTOR PRIOR TO CONSTRUCTION.
2. HORIZONTAL DATUM: WASHINGTON STATE COORDINATE SYSTEM NORTH ZONE (NAD 83/98).
VERTICAL DATUM: N.A.V.D. 88
UNITS: U.S. SURVEY FEET
HORIZONTAL AND VERTICAL CONTROL ESTABLISHED BY GPS VIA VERTICAL REFERENCE STATION NETWORK (VRSN).
3. SOUTHEAST PORTION OF WSDOT STORMWATER LINE HAS NOT BEEN SURVEYED.
4. LOCATION OF EXISTING POWER SUPPLY PANEL HAS NOT BEEN SURVEYED.

0 100' 200'
GRAPHIC SCALE

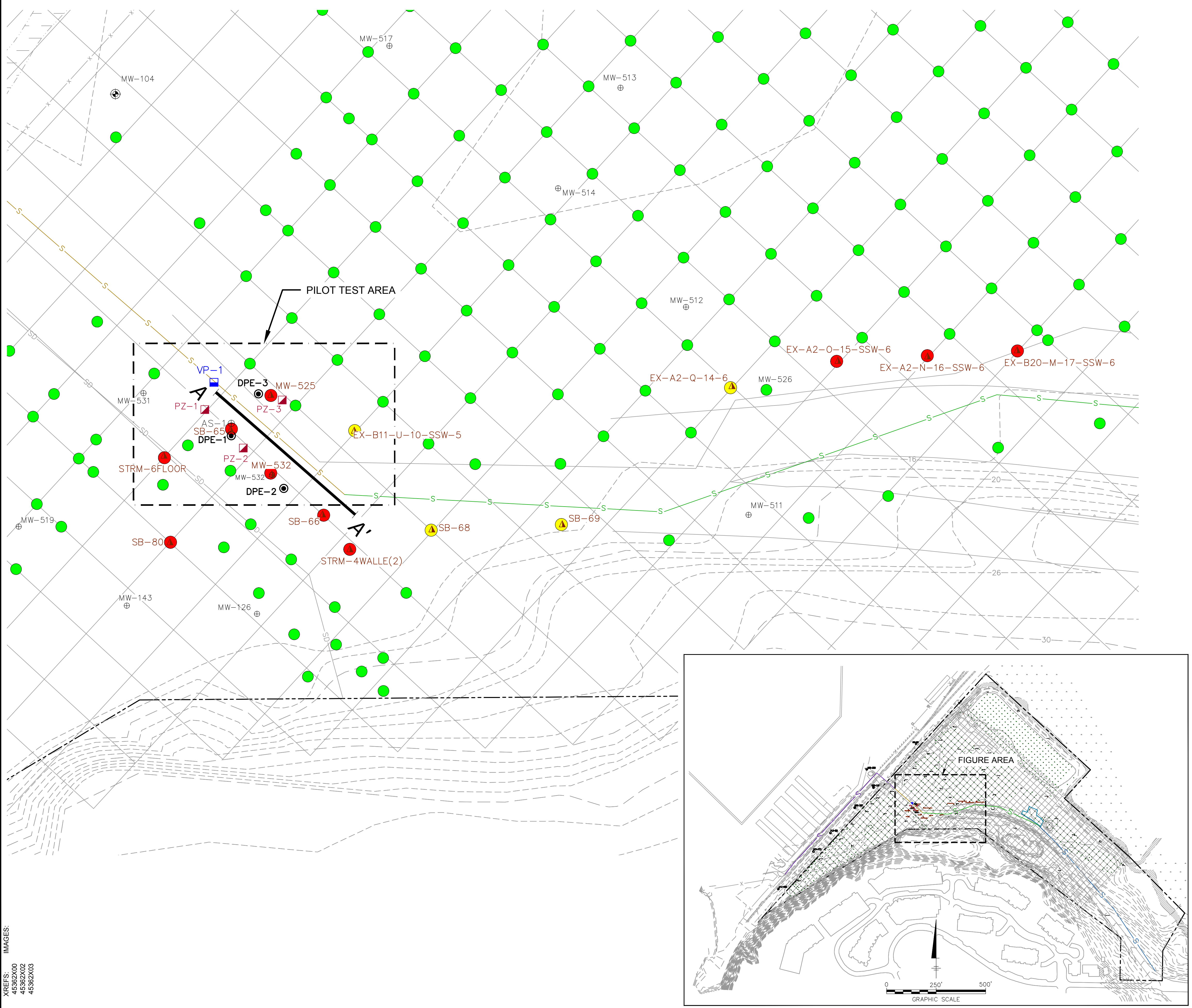
CHEVRON ENVIRONMENTAL MANAGEMENT COMPANY
FORMER UNOCAL BULK FUEL TERMINAL
EDMONDS, WASHINGTON
PILOT TEST SUMMARY MEMORANDUM

SITE MAP

ARCADIS

FIGURE
2

CITY:SYRACUSE-NY DIV/GROUP:ENVCAD DB:G.STEINBERGER LD: PIC:M.FLEISCHNER PM:S.ZORN TM:P.CAMPBELL LYR:(Opt)ON=*;OFF=*REF*
C:\Users\jharris\Desktop\ENVCAD\B0045362\0006\00003\Pilot Test Summary Memo\DWG\45362G02.dwg LAYOUT: 2 SAVED: 2/22/2016 3:43 PM ACADVER: 19.1S (LMS TECH) PAGESETUP: SETUP1 PLOTSTYLETABLE: PLTFULL.CTB PLOTTED: 3/3/2016 2:14 PM BY: HARRIS, JESSICA
XREFS: 45362X00 45362X02 45362X03 IMAGES:



LEGEND:

DPE-1	DPE WELL LOCATION
MW-203	INTERIOR MONITORING WELL LOCATION AND DESIGNATION
MW-108	PERIMETER MONITORING WELL LOCATION
PZ-1	PIEZOMETER WELL LOCATION
VP-1	SOIL VAPOR PROBE / SAMPLING LOCATION
	PROPERTY BOUNDARY
S	WSDOT STORMWATER LINE
SD	POINT EDWARDS STORM DRAIN LINE
A' A'	CROSS SECTION A-A'
(yellow)	SOIL SAMPLE LOCATION WITH ANALYTE CONCENTRATIONS EXCEEDING SITE CULs OR RELs
(red)	SOIL SAMPLE LOCATION WITH ANALYTE CONCENTRATIONS EXCEEDING TWICE THE CUL
(green)	SOIL SAMPLE LOCATION WITH ANALYTE CONCENTRATIONS LESS THAN SOIL CULs/RELs

NOTES:

1. BUILDING AND ROAD INFORMATION DIGITIZED FROM GOOGLE EARTH AERIAL PHOTO. TOPOGRAPHIC CONTOURS WERE OBTAINED FROM AN UNKNOWN SOURCE. ALL LOCATIONS ARE APPROXIMATE AND SHALL BE VERIFIED IN THE FIELD BY CONTRACTOR PRIOR TO CONSTRUCTION.
2. HORIZONTAL DATUM: WASHINGTON STATE COORDINATE SYSTEM NORTH ZONE (NAD 83/98).
VERTICAL DATUM: N.A.V.D. 88
UNITS: U.S. SURVEY FEET
HORIZONTAL AND VERTICAL CONTROL ESTABLISHED BY GPS VIA VERTICAL REFERENCE STATION NETWORK (VRSN).
3. SOUTHEAST PORTION OF WSDOT STORMWATER LINE HAS NOT BEEN SURVEYED.
4. LOCATION OF EXISTING POWER SUPPLY PANEL HAS NOT BEEN SURVEYED.

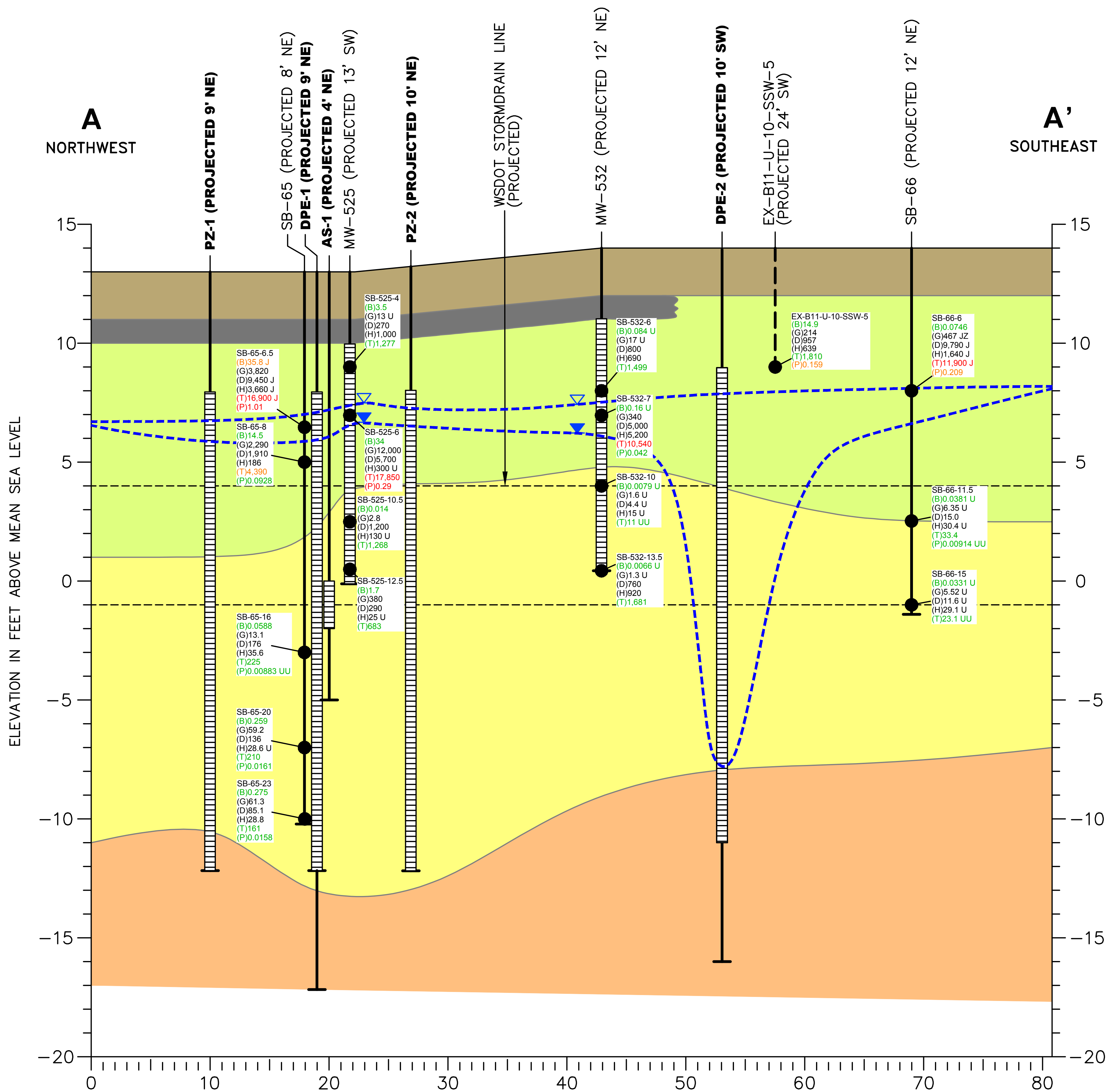
0 20' 40'
GRAPHIC SCALE

CHEVRON ENVIRONMENTAL MANAGEMENT COMPANY
FORMER UNOCAL BULK FUEL TERMINAL
EDMONDS, WASHINGTON
PILOT TEST SUMMARY MEMORANDUM

PILOT TEST LAYOUT

ARCADIS

FIGURE
3



LEGEND:

MW-532 (PROJECTED 12' NE) — WELL OR BORING ID, PROJECTED DISTANCE AND DIRECTION **(BOLD REPRESENTS AS/DPE WELLS)**

GROUND SURFACE

HISTORICAL HIGH WATER LEVEL

DPE PILOT TEST STATIC WATER LEVEL AND DRAW DOWN AT ~80 HOURS OF PUMPING

HISTORICAL LOW WATER LEVEL

LITHOLOGIC CONTACT (DASHED WHERE INFERRED)

SB-532-7 (B)0.16 U (G)340 (D)5,000 (H)5,200 (T)10,540 (P)0.042 — SAMPLE ID AND DEPTH
B = BENZENE (mg/kg)
G = GASOLINE RANGE ORGANICS (mg/kg)
D = DIESEL RANGE ORGANICS (mg/kg)
H = HEAVY RANGE ORGANICS (mg/kg)
T = TOTAL HYDROCARBONS (mg/kg)
P = TOTAL PAHs (mg/kg)

SCREENED INTERVAL

BOTTOM OF BORING

ASPHALT

SAND/GRAVEL BACKFILL

SILTY SAND WITH GRAVEL (1929 FILL) MEDIUM TO FINE, LOW PLASTIC FINES

SILTY SAND, FINE TO VERY FINE

FINE TO VERY FINE SAND

(12' NE)= OFFSET DISTANCE FROM CROSS SECTION
PAH POLYNUCLEAR AROMATIC HYDROCARBONS
mg/kg MILLIGRAMS PER KILOGRAM
NE NORTHEAST
SW SOUTHWEST
CUL CLEANUP LEVEL

SOIL CLEANUP LEVELS	
BENZENE = 18 mg/kg	GREEN = BELOW CUL
TPH = 2,775 mg/kg	ORANGE = ABOVE CUL
TOTAL CPAHs = 0.14 mg/kg	RED = >2x CUL

VERTICAL EXAGGERATION: 2x

0 5' 10'
VERTICAL SCALE

0 10' 20'
HORIZONTAL SCALE

CHEVRON ENVIRONMENTAL MANAGEMENT COMPANY
FORMER UNOCAL BULK FUEL TERMINAL
EDMONDS, WASHINGTON
PILOT TEST SUMMARY MEMORANDUM

DPE CROSS SECTION A-A'

ARCADIS

FIGURE 4

CITY: PHOENIX, AZ DIV/GROUP: ENVCAD DB: A. REYES, T. HUTCHINS-WASS, J. HARRIS LAYOUT: 4 SAVED: 3/3/2016 4:19 PM ACADVER: 19.1S (LMS TECH) PAGESETUP: ---- PLOTSTYLETABLE: ARCADIS.CTB PLOTTED: 3/3/2016 4:21 PM BY: OBERLANDER, ROSEANNE
G:\ENVCAD\Minneapolis-MN\ACT\B0045362\0006\00003\DWG\45362G04.dwg

ARCADIS

Attachment A

Boring Logs

Date Start/Finish: 2/10/2015
Drilling Company: Cascade Drilling
Driller's Name: Curtis A.
Drilling Method: Hollow Stem Auger
Auger Size: 10" Outer Diameter
Rig Type: Truck Mounted
Sampling Method: Split Spoon

Northing: NE
Easting: NE
Casing Elevation: NE

Borehole Depth: 30' bgs
Surface Elevation: NE

Descriptions By: SLM

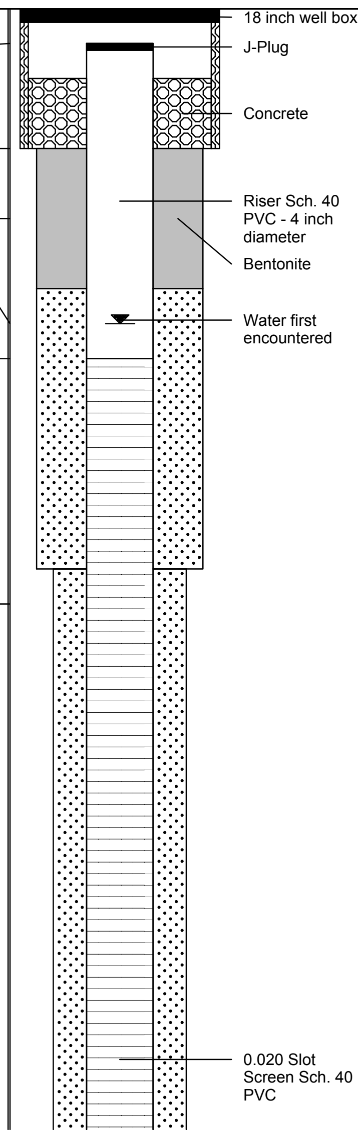
Well/Boring ID: DPE-1

Client: Chevron EMC

Location: Edmonds Terminal, 11720 Unoco Rd, Edmonds, WA

DEPTH	ELEVATION	Sample Run Number	Sample/Int/Type	Recovery (feet)	Blow Counts	N-Value	PID Headspace (ppm)	Analytical Sample	USCS Code	Stratigraphic Description
0	0									Topsoil
										Fill
			2-2.5	0	NA	NA	NA			No recovery, 12 inches of asphalt
5	-5	HA	4.5 - 5	.5	NA	NA	162.9		SM	Silty Sand, medium to fine sand, trace small gravel, well graded, dark brown, wet, HCLO
		HA	7-7.5	0	NA	NA	NA			No recovery, too wet for hand auger
		1	8.5 -10	1.0	1 1 1	2	730.1		SP	Sand, medium grain, poorly graded, dark brown, wet, HCLO
10	-10									
		2	11-12.5	0	NA	NA	NA			Sample interval missed by driller
		3	13.5 -15	1.5	1 2 1	3	296		SP	Same As Above at the 10 foot interval
15	-15									

Well/Boring Construction



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Remarks: bgs = below ground surface
NA = Not Available
ppm = parts per million
NE = Not Established
HA = Hand Auger
HCLO = Hydrocarbon like odor

Project Number:B0045362
Data File:

Date: 5/20/2015 Created/Edited by:RwL

Date Start/Finish: 2/10/2015 **Drilling Company:** Cascade Drilling **Driller's Name:** Curtis A. **Drilling Method:** Hollow Stem Auger **Auger Size:** 10" Outer Diameter **Rig Type:** Truck Mounted **Sampling Method:** Split Spoon	**Northing:** NE **Easting:** NE **Casing Elevation:** NE **Borehole Depth:** 30' bgs **Surface Elevation:** NE **Descriptions By:** SLM	**Well/Boring ID: DPE-1** **Client:** Chevron EMC **Location:** Edmonds Terminal, 11720 Unoco Rd, Edmonds, WA

DEPTH	ELEVATION	Sample Run Number	Sample/Int/Type	Recovery (feet)	Blow Counts	N-Value	PID Headspace (ppm)	Analytical Sample	USCS Code	Geologic Column	Stratigraphic Description	Well/Boring Construction
		4	16-17.5	1.5	1 1 1	2	463				Same As Above	
		5	18.5-20	1.5	1 2 2	4	343		SP		Sand, medium to fine grain, poorly graded, silt seam at 19 feet, dark brown, wet, HCLO	#2/12 Sand
20	-20											
		6	21-22.5	1.5	2 2 1	3	421		SP		Sand, medium to fine grain, poorly graded, dark brown, wet, HCLO, noticible sheen	
		7	23.5-25	1.5	1 1 1	2	359				Same As Above	
25	-25											
		8	26-27.5	0	NA	NA	NA				No recovery due to well heaving - the driller inserted a well plug	
		9	27.5-29	1.5	NA	NA	582		CM		Clay and Silt, dense, woody debris, dark brown, wet, no odor	Sump Sch. 40 PVC
		10	29-30	1.0	NA	NA	582				Same as Above, the bottom two intervals were combined and screened	
30	-30											

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Project Number:B0045362
Data File:

Date: 5/20/2015 Created/Edited by:RwL

Date Start/Finish: 2/10/2015
Drilling Company: Cascade Drilling
Driller's Name: Curtis A.
Drilling Method: Hollow Stem Auger
Auger Size: 10" Outer Diameter
Rig Type: Truck Mounted
Sampling Method: Split Spoon

Northing: NE
Easting: NE
Casing Elevation: NE

Borehole Depth: 30' bgs
Surface Elevation: NE

Descriptions By: SLM

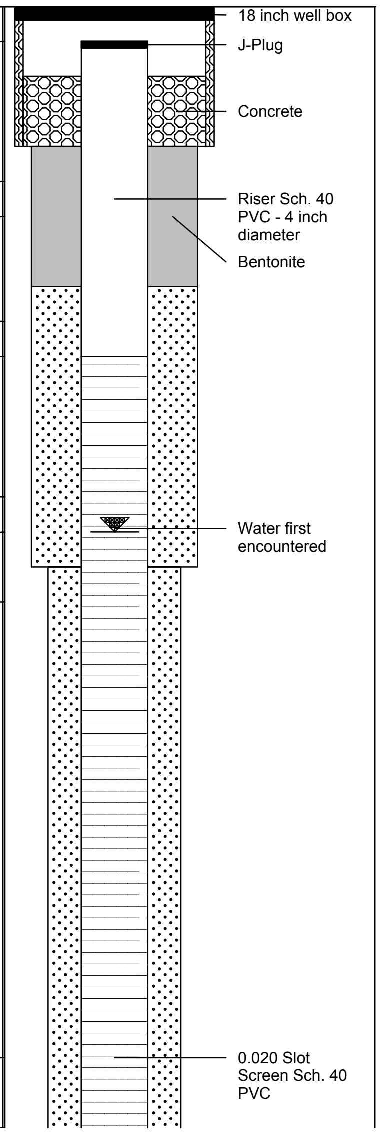
Well/Boring ID: DPE-2

Client: Chevron EMC

Location: Edmonds Terminal, 11720 Unoco Rd, Edmonds, WA

DEPTH	ELEVATION	Sample Run Number	Sample/Int/Type	Recovery (feet)	Blow Counts	N-Value	PID Headspace (ppm)	Analytical Sample	USCS Code	Geologic Column	Stratigraphic Description
0	0										Topsoil
		HA	2.5-3	.5	NA	NA	0.7		SG		Sand, small Gravel, fine to course grain size, well graded, brown, no HCLO
		HA	4.5 - 5	.5	NA	NA	77.7		SP		Sand, medium to fine grain, poorly graded, grey, no HCLO
5	-5										
		HA	7-7.5	.5	NA	NA	20.5		SG		Sand, coarse to medium grain, trace small gravel, grey, wet
		1	8.5 -10	1.5	1 2 1	3	4.3		SP		Sand, medium grain, poorly graded, grey, wet, no HCLO
10	-10										
		2	11-12.5	1.5	2 5 4	9	1.4				Same As Above
		3	13.5 -15	1.5	4 7 2	9	13.4				Same As Above
15	-15										

Well/Boring Construction



ARCADIS
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HA = Hand Auger
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Project Number:B0045362
Data File:
Date: 5/20/2015
Created/Edited by:RwL

Date Start/Finish: 2/10/2015
Drilling Company: Cascade Drilling
Driller's Name: Curtis A.
Drilling Method: Hollow Stem Auger
Auger Size: 10" Outer Diameter
Rig Type: Truck Mounted
Sampling Method: Split Spoon

Northing: NE
Easting: NE
Casing Elevation: NE

Borehole Depth: 30' bgs
Surface Elevation: NE

Descriptions By: SLM

Well/Boring ID: DPE-2

Client: Chevron EMC

Location: Edmonds Terminal, 11720 Unoco Rd, Edmonds, WA

DEPTH	ELEVATION	Sample Run Number	Sample/Int/Type	Recovery (feet)	Blow Counts	N-Value	PID Headspace (ppm)	Analytical Sample	USCS Code	Geologic Column	Stratigraphic Description	Well/Boring Construction
		4	16-17.5	1.5	7 9 10	19	12.7		SP		Sand, medium grain, porrly graded, brown, no HCLO, wet	
		5	18.5-20	1.5	6 8 9	17	7.1				Same As Above	#2/12 Sand
20	-20											
		6	21-22.5	1.5	7 9 10	19	3.5				Same As Above	
		7	23.5-25	1.5	16 20 20	40	7.4		SP		Sand, medium to fine grain, poorly graded, dark grey, no HCLO, wet	
25	-25											
		8	26-27.5	1.5	11 16 25	41	5.6		SM		Silty Sand, medium to fine grain, poorly graded, brown, no HCLO, wet	Sump Sch. 40 PVC
		9	28.5-30	1.5	6 10 15	25	4.5		SM		Silty Sand, medium grain, poorly graded, brown, No HCLO, wet	
30	-30											

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Remarks: bgs = below ground surface
NA = Not Available
ppm = parts per million
NE = Not Established
HA = Hand Auger
HCLO = Hydrocarbon like odor

Project Number:B0045362
Data File:

Date: 5/20/2015 Created/Edited by:RwL

Date Start/Finish: 3/23/15 - 3/24/15
Drilling Company: Cascade Drilling
Driller's Name: James G.
Drilling Method: Hollow Stem Auger
Auger Size: 10" Outer Diameter
Rig Type: Truck Mounted
Sampling Method: Split Spoon

Northing: NE
Easting: NE
Casing Elevation: NE

Borehole Depth: 22' bgs
Surface Elevation: NE

Descriptions By: RL/RB

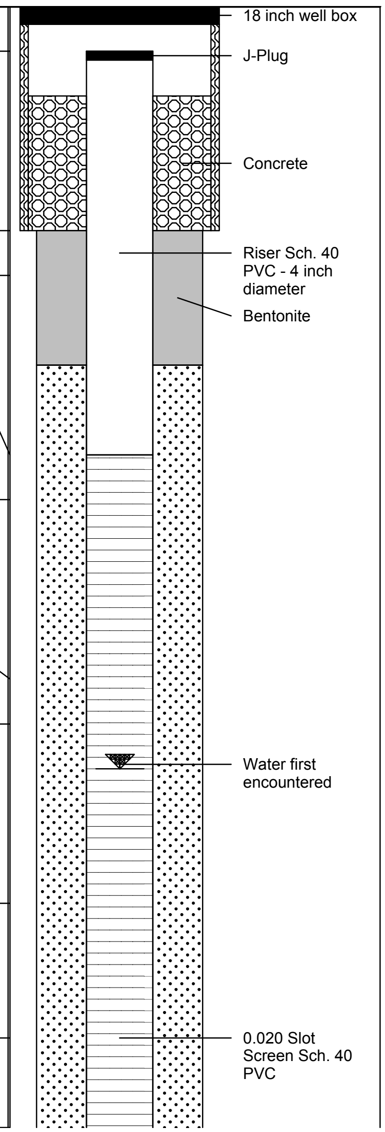
Well/Boring ID: **DPE-3**

Client: Chevron EMC

Location: Edmonds Terminal, 11720 Unoco Rd, Edmonds, WA

DEPTH	ELEVATION	Sample Run Number	Sample/Int/Type	Recovery (feet)	Blow Counts	N-Value	PID Headspace (ppm)	Analytical Sample	USCS Code	Geologic Column	Stratigraphic Description
0	0										Topsoil and gravel/cobbles
											Fill
		HA	2.5-3	.5	NA	NA	132.8		SP		Sand fill - poorly graded medium sand, loose, brown, dry, HCLO
											Cleared past 20-Mil Polyethylene sheeting at 4.5 feet bgs, which delineates Phase I 2007/2008 excavation and un-excavated soils around the WSDOT Stormwater Line
5	-5	HA	5-5.5	.5	NA	NA	807		CH		Clay with trace Organics - clay has medium to high plasticity, organics are woody debris, thick black substance with sheen, dark brown to grey and black color, moist, HCLO
		HA	7.5-8	.5	NA	NA	1,035		SC		Sand with Clay and Organics - Sand fine to coarse, well graded, clay has low plasticity, organics are roots, grey, wet, HCLO
											cleared hole with air knife and vacuum to 8.5 feet bgs
10	-10	1	10-11.5	1.5	6 6 9	15	1,267				Sand with little Gravel and trace Silt - well graded, sand is fine to coarse, gravel is small to medium and subrounded, grey, wet, HCLO
									SG		

Well/Boring Construction



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ppm = parts per million
NE = Not Established
HA = Hand Auger
HCLO = Hydrocarbon like odor

Project Number:B0045362
Data File:
Date: 5/20/2015
Created/Edited by:RwL

Date Start/Finish: 3/23/15 - 3/24/15 **Drilling Company:** Cascade Drilling **Driller's Name:** James G. **Drilling Method:** Hollow Stem Auger **Auger Size:** 10" Outer Diameter **Rig Type:** Truck Mounted **Sampling Method:** Split Spoon	**Northing:** NE **Easting:** NE **Casing Elevation:** NE **Borehole Depth:** 22' bgs **Surface Elevation:** NE **Descriptions By:** RL/RB	**Well/Boring ID: DPE-3** **Client:** Chevron EMC **Location:** Edmonds Terminal, 11720 Unoco Rd, Edmonds, WA

DEPTH	ELEVATION	Sample Run Number	Sample/Int/Type	Recovery (feet)	Blow Counts	N-Value	PID Headspace (ppm)	Analytical Sample	USCS Code	Geologic Column	Stratigraphic Description	Well/Boring Construction
		2	12.5-14	1.5	9 12 14	26	981				Same as Above - Chunck of wood found at 14 feet bgs	#2/12 Sand
15	-15	3	15-16.5	1.5	10 11 11	22	563				Sand with trace Gravel - sand is fine to coarse, gravel is very small and subrounded, wood chunck found at 16 feet bgs, grey, wet, HCLO	
		4	17.5-19	1.5	12 16 18	34	594		SW		Same as Above - small lenses of woody debris, decreasing gravel content	
20	-20	5	20-21.5	1.5	6 12 10	22	346				Same as Above - woody debris throughout with a large chunck at 21.5 feet bgs	Sump Sch. 40 PVC

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ppm = parts per million
NE = Not Established
HA = Hand Auger
HCLO = Hydrocarbon like odor

Date Start/Finish: 2/10/2015
Drilling Company: Cascade Drilling
Driller's Name: Curtis A.
Drilling Method: Hollow Stem Auger
Auger Size: 10" Outer Diameter
Rig Type: Truck Mounted HSA
Sampling Method: Split Spoon

Northing: NE
Easting: NE
Casing Elevation: NE

Borehole Depth: 25 feet bgs
Surface Elevation: NE

Descriptions By: SLM

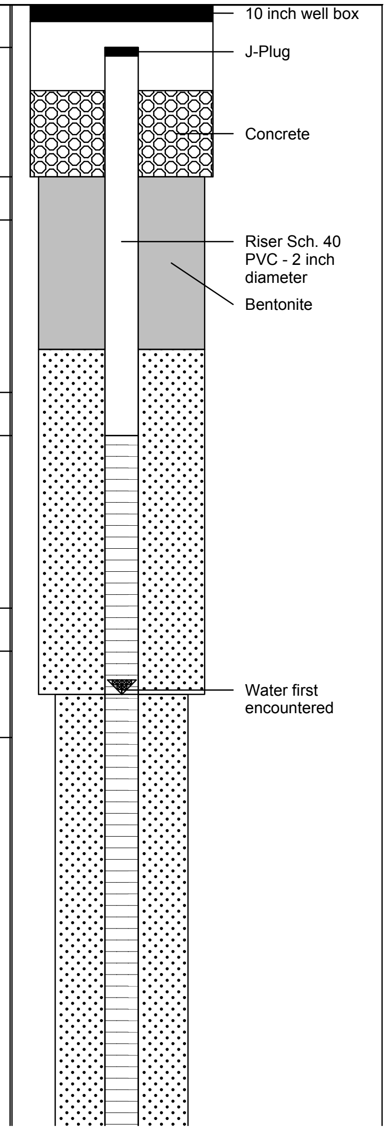
Well/Boring ID: PZ-1

Client: Chevron EMC

Location: Edmonds Terminal, 11720 Unoco Rd, Edmonds, WA

DEPTH	ELEVATION	Sample Run Number	Sample/Int/Type	Recovery (feet)	Blow Counts	N-Value	PID Headspace (ppm)	Analytical Sample	USCS Code	Geologic Column	Stratigraphic Description
0	0										Topsoil
		HA	2-2.5	.5	NA	NA	NA				No Recovery, Asphalt removed
		HA	4.5 - 5	.5	NA	NA	377		SP		Sand, medium, poorly graded, brown, HCLO, dry
5	-5										
		HA	7-7.5	.5	NA	NA	740		SP		Sand, medium grain, trace small gravel, poorly graded, wet
		1	8.5 -10	1.5	1 1 2	3	721				Sand, medium grain, poorly graded, dark grey, wet, HCLO
10	-10										
		2	11-12.5	1.5	1 2 2	4	136.4				Same As Above

Well/Boring Construction



Remarks: bgs = below ground surface
NA = Not Available
ppm = parts per million
NE = Not Established
HA = Hand Auger
HCLO = Hydrocarbon like odor

Date Start/Finish: 2/10/2015 **Drilling Company:** Cascade Drilling **Driller's Name:** Curtis A. **Drilling Method:** Hollow Stem Auger **Auger Size:** 10" Outer Diameter **Rig Type:** Truck Mounted HSA **Sampling Method:** Split Spoon	**Northing:** NE **Easting:** NE **Casing Elevation:** NE **Borehole Depth:** 25 feet bgs **Surface Elevation:** NE **Descriptions By:** SLM	**Well/Boring ID:** **PZ-1** **Client:** Chevron EMC **Location:** Edmonds Terminal, 11720 Unoco Rd, Edmonds, WA

DEPTH	ELEVATION	Sample Run Number	Sample/Int/Type	Recovery (feet)	Blow Counts	N-Value	PID Headspace (ppm)	Analytical Sample	USCS Code	Geologic Column	Stratigraphic Description	Well/Boring Construction
		3	13.5-15	1.5	2 2 4	6	347.0		SP		Same As Above	
15	-15											0.020 Slot Screen Sch. 40 PVC
		4	16-17.5	1.5	5 4 3	7	374.6				Same As Above	#2/12 Sand
		5	18.5-20	1.5	5 4 4	8	327				Same As Above	
20	-20											
		6	21-22.5	1.5	5 10 9	19	165.1		SW		Sand, medium to fine grain, small gravel, well graded, dark grey, HCLO	
		7	23.5-25	1.5	10 14 11	25	10.5		SM		Silty Sand, very fine to fine grain, poorly graded, no HCLO, wet	
25	-25											

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HA = Hand Auger
HCLO = Hydrocarbon like odor

Project Number:B0045362
Data File:
Date: 5/20/2015 Created/Edited by:RwL

Date Start/Finish: 2/10/2015
Drilling Company: Cascade Drilling
Driller's Name: Curtis A.
Drilling Method: Hollow Stem Auger
Auger Size: 10" Outer Diameter
Rig Type: Truck Mounted HSA
Sampling Method: Split Spoon

Northing: NE
Easting: NE
Casing Elevation: NE

Borehole Depth: 25 feet bgs
Surface Elevation: NE

Descriptions By: SLM

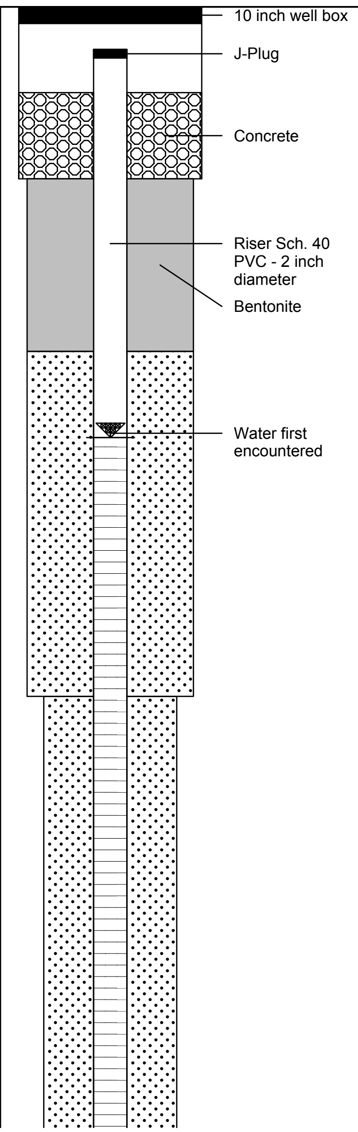
Well/Boring ID: **PZ-2**

Client: Chevron EMC

Location: Edmonds Terminal, 11720 Unoco Rd, Edmonds, WA

DEPTH	ELEVATION	Sample Run Number	Sample/Int/Type	Recovery (feet)	Blow Counts	N-Value	PID Headspace (ppm)	Analytical Sample	USCS Code	Geologic Column	Stratigraphic Description
0	0										Topsoil
		HA	2-2.5	.5	NA	NA	NA				No Recovery, Asphalt removed
		HA	4.5 - 5	.5	NA	NA	98.1		SP		Sand, medium to fine grain, poorly graded, brown, no HCLO, wet
5	-5										
		HA	7-7.5	.5	NA	NA	583		SP		Sand, fine grain, poorly graded, brown, HCLO, wet
		1	8.5 -10	1.5	0 1 1	2	419				Sand, medium grain, poorly graded, dark grey, HCLO, wet
10	-10								SP		
		2	11-12.5	1.5	4 5 6	11	122				Same As Above

Well/Boring Construction



Remarks: bgs = below ground surface
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HA = Hand Auger
HCLO = Hydrocarbon like odor

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Date Start/Finish: 2/10/2015
Drilling Company: Cascade Drilling
Driller's Name: Curtis A.
Drilling Method: Hollow Stem Auger
Auger Size: 10" Outer Diameter
Rig Type: Truck Mounted HSA
Sampling Method: Split Spoon

Northing: NE
Easting: NE
Casing Elevation: NE

Borehole Depth: 25 feet bgs
Surface Elevation: NE

Descriptions By: SLM

Well/Boring ID: **PZ-2**

Client: Chevron EMC

Location: Edmonds Terminal, 11720 Unoco Rd, Edmonds, WA

DEPTH	ELEVATION	Sample Run Number	Sample/Int/Type	Recovery (feet)	Blow Counts	N-Value	PID Headspace (ppm)	Analytical Sample	USCS Code	Geologic Column	Stratigraphic Description	Well/Boring Construction
		3	13.5 -15	1.5	2 2 2	4	34.8		SP		Sand, medium to coarse grain, poorly graded, dark grey to brown, HCLO, wet	
15	-15											0.020 Slot Screen Sch. 40 PVC
		4	16-17.5	1.5	5 4 5	9	69.1				Same As Above	#2/12 Sand
									SP			
		5	18.5 -20	1.5	5 5 5	10	44.8				Same As Above	
20	-20											
		6	21-22.5	1.5	7 9 40	49	34.7		SM		Silty Sand, medium grain, poorly graded, brown, HCLO, wet	
		7	23.5 -25	0	50/5	100	NA		OP		Recovery limited to wood chuncks seen in split spoon	
25	-25											

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HA = Hand Auger
HCLO = Hydrocarbon like odor

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Project Number:B0045362
Data File:

Date: 5/20/2015 Created/Edited by:RwL

Date Start/Finish: 3/23/15
Drilling Company: Cascade Drilling
Driller's Name: James G.
Drilling Method: Hollow Stem Auger
Auger Size: 10" Outer Diameter
Rig Type: Truck Mounted
Sampling Method: Split Spoon

Northing: NE
Easting: NE
Casing Elevation: NE

Borehole Depth: 22' bgs
Surface Elevation: NE

Descriptions By: RL/RB

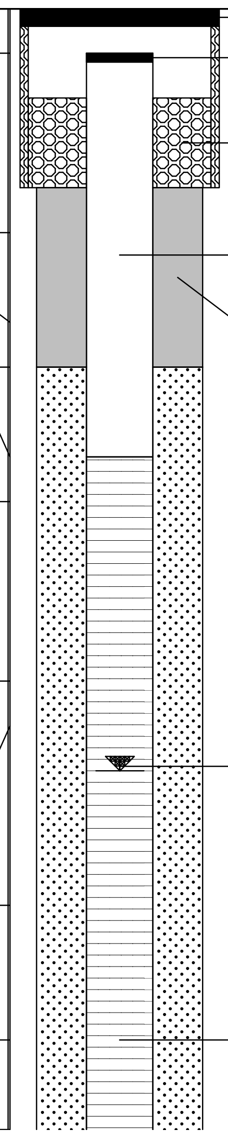
Well/Boring ID: PZ-3

Client: Chevron EMC

Location: Edmonds Terminal, 11720 Unoco Rd, Edmonds, WA

DEPTH	ELEVATION	Sample Run Number	Sample/Int/Type	Recovery (feet)	Blow Counts	N-Value	PID Headspace (ppm)	Analytical Sample	USCS Code	Geologic Column	Stratigraphic Description
0	0										Topsoil and sand/gravel/cobbles
											Fill - Sand/gravel/cobbles
											Cleared past 20-Mil Polyethylene sheeting at 3.5 feet bgs, which delineates Phase I 2007/2008 excavation and un-excavated soils around the WSDOT Stormwater Line
		HA	3.5 -4	.5	NA	NA	98.3		SG		Sand with Gravel - sand is medium to very coarse grain, gravel is small to large with trace cobbles, angular to subrounded, well graded, brown, moist, HCLO
5	-5	HA	5- 5.5	.5	NA	NA	322.6		CH		Clay with trace Gravel and Organic material - clay has high plasticity, gravel is medium and sub angular, organic material comprised of woody debris, grey, moist, HCLO
											At 5.5 feet bgs, encountered plastic fabric debris - brittle and weak
		HA	7.5 -8	.5	NA	NA	919.2				Sand with little Silt and Organics - sand is well graded, silt has low plasticity, woody debris comprised of small roots and sticks, grey, very moist, strong HCLO
											cleared hole with air knife and vacuum to 9.5 feet bgs
10	-10	1	10- 11.5	1.5	5 7 7	14	889				Sand with little Silt, trace Gravel and Organics, sand well graded, silt low plasticity, gravel subangualr, organics comprised of bark pieces, grey, wet, HCLO
									SW		

Well/Boring Construction



Remarks:
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HA = Hand Auger
HCLO = Hydrocarbon like odor

Date Start/Finish: 3/23/15 **Drilling Company:** Cascade Drilling **Driller's Name:** James G. **Drilling Method:** Hollow Stem Auger **Auger Size:** 10" Outer Diameter **Rig Type:** Truck Mounted **Sampling Method:** Split Spoon	**Northing:** NE **Easting:** NE **Casing Elevation:** NE **Borehole Depth:** 22' bgs **Surface Elevation:** NE **Descriptions By:** RL/RB	**Well/Boring ID:** **PZ-3** **Client:** Chevron EMC **Location:** Edmonds Terminal, 11720 Unoco Rd, Edmonds, WA

DEPTH	ELEVATION	Sample Run Number	Sample/Int/Type	Recovery (feet)	Blow Counts	N-Value	PID Headspace (ppm)	Analytical Sample	USCS Code	Geologic Column	Stratigraphic Description	Well/Boring Construction
		2	12.5-14	1.5	6 6 6	12	391				Same as above	#2/12 Sand
15	-15	3	15-16.5	1.5	9 10 10	20	469				Same as above with a lense of brown high plasticity clay at 16 feet bgs, lense less than one inch thick. Decreasing amount of woody debris and silt	
		4	17.5-19	1.5	9 12 10	22	432		SP		Sand - medium to coarse grain, little woody debris that appears to be a chunck of a larger piece of wood, wet, grey, HCLO	
20	-20	5	20-21.5	1.5	8 10 9	19	160				Same as above - thin high plasticity, borwn clay lense at 21 feet bgs, lense is less than one quarter inch thick with consistent lithology on either side, grey, HCLO	Sump Sch. 40 PVC

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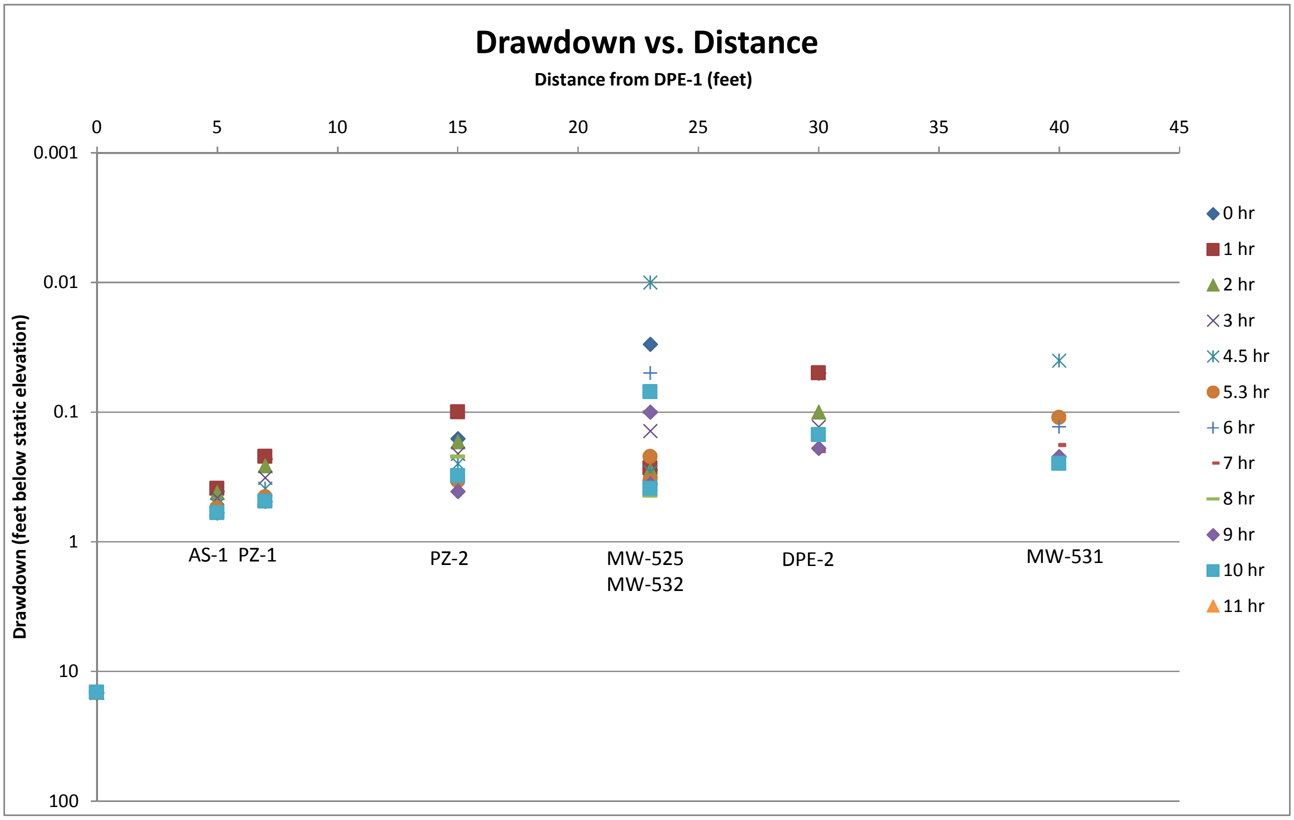
Attachment B

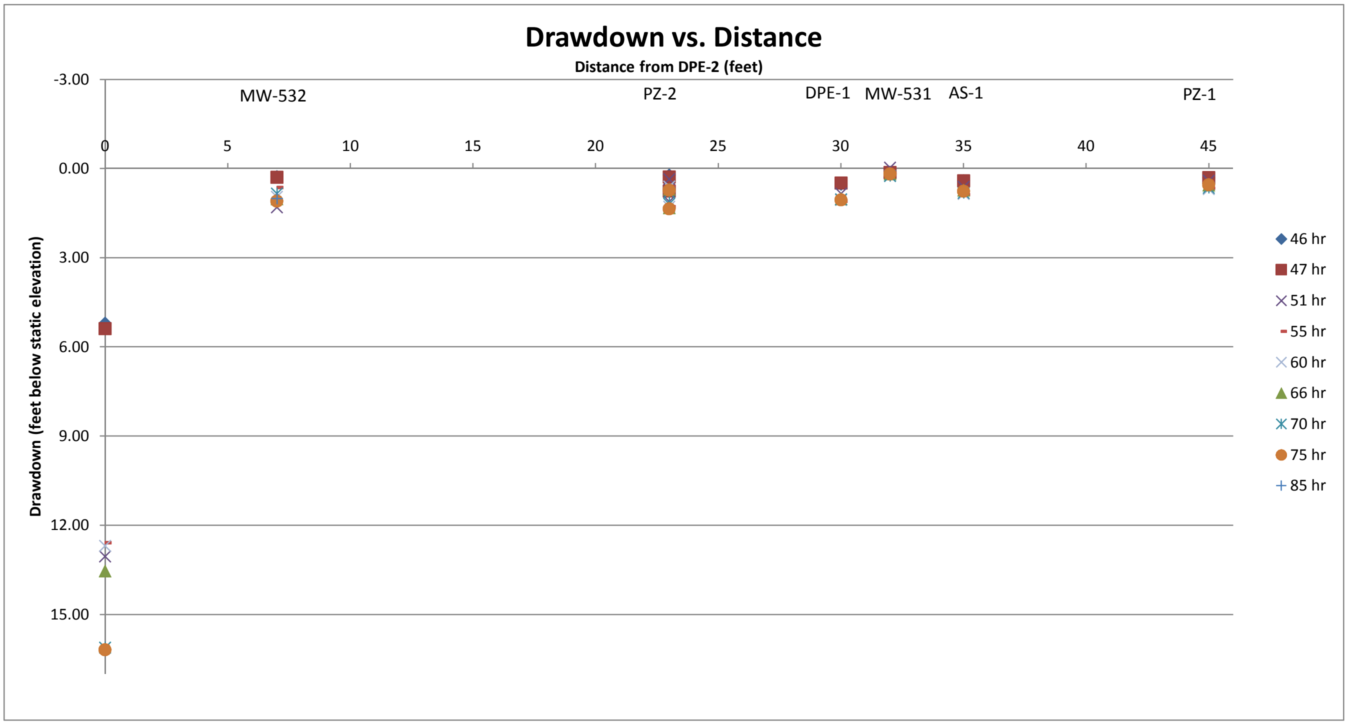
Pilot Test Data



DPE-1 Test

	Time elapsed (hr)	0	1	2	3	4	5	6	7	8	9	10	11
Well	Distance (feet)	Drawdown (feet below static groundwater elevation)											
DPE-1	0	14.57	14.53	14.56	14.59	14.58	14.56	14.61	14.56	14.61	14.58	14.57	14.61
AS-1	5	0.41	0.39	0.42	0.46	0.52	0.55	0.6	0.64	0.63	0.6	0.6	0.6
PZ-1	7	0.23	0.22	0.26	0.32	0.39	0.45	0.49	0.51	0.53	0.49	0.49	0.39
PZ-2	15	0.16	0.1	0.17	0.21	0.25	0.34	0.34	0.31	0.22	0.41	0.31	0.28
MW-525	23	0.03	-0.05	-0.1	0.14	0.01	0.22	0.05	0.37	0.1	0.1	0.07	0.05
MW-532	23	0.28	0.27	0.28	0.29	0.29	0.34	0.35	0.4	0.44	0.36	0.39	0.35
DPE-2	30	0.05	0.05	0.1	0.13	0.15	0.15	0.19	0.2	0.16	0.19	0.15	0.13
MW-531	40	-0.04	-0.04	-0.05	-0.03	0.04	0.11	0.13	0.18	--	0.22	0.25	0.23

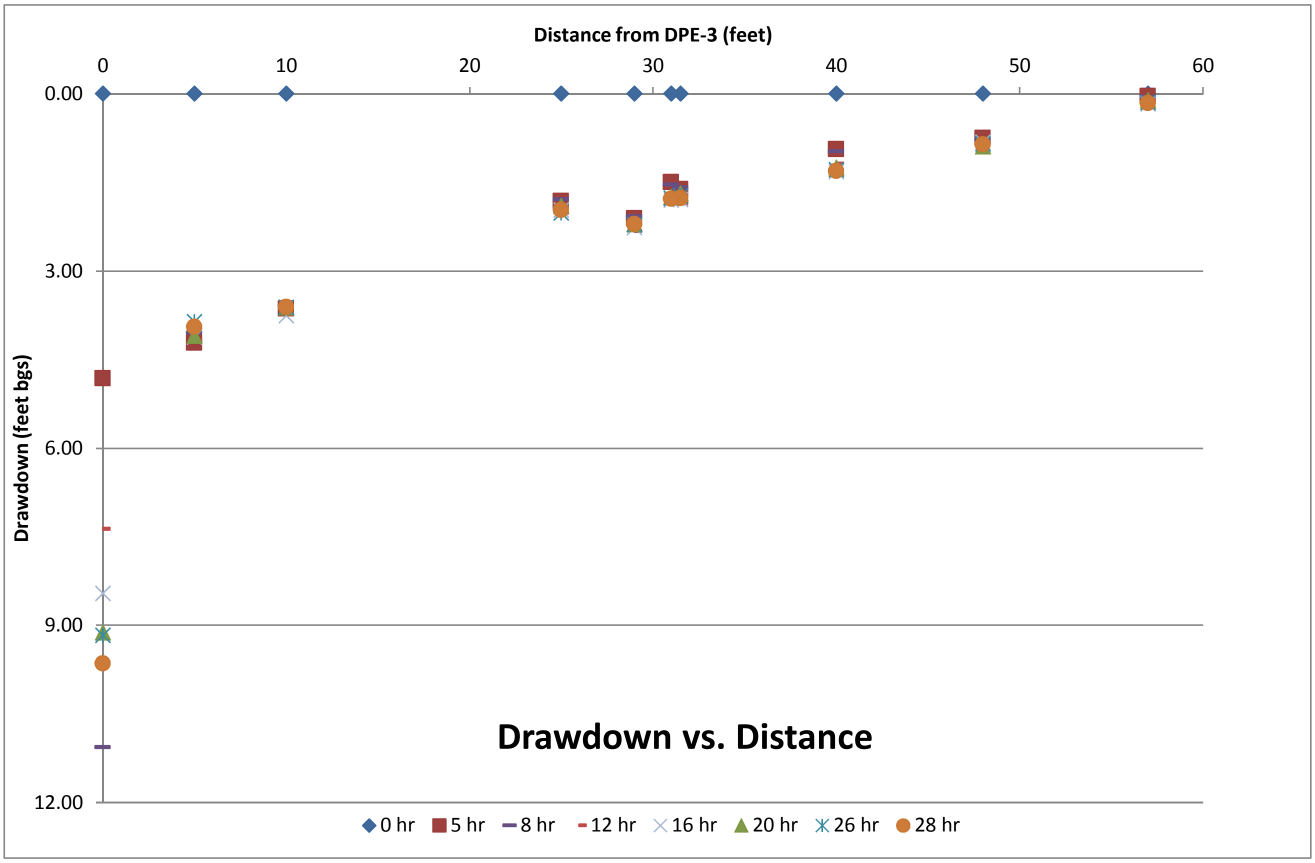
Note:
hr = hour
bgs = below ground surface
DPE = dual phase extraction



DPE-2 Test

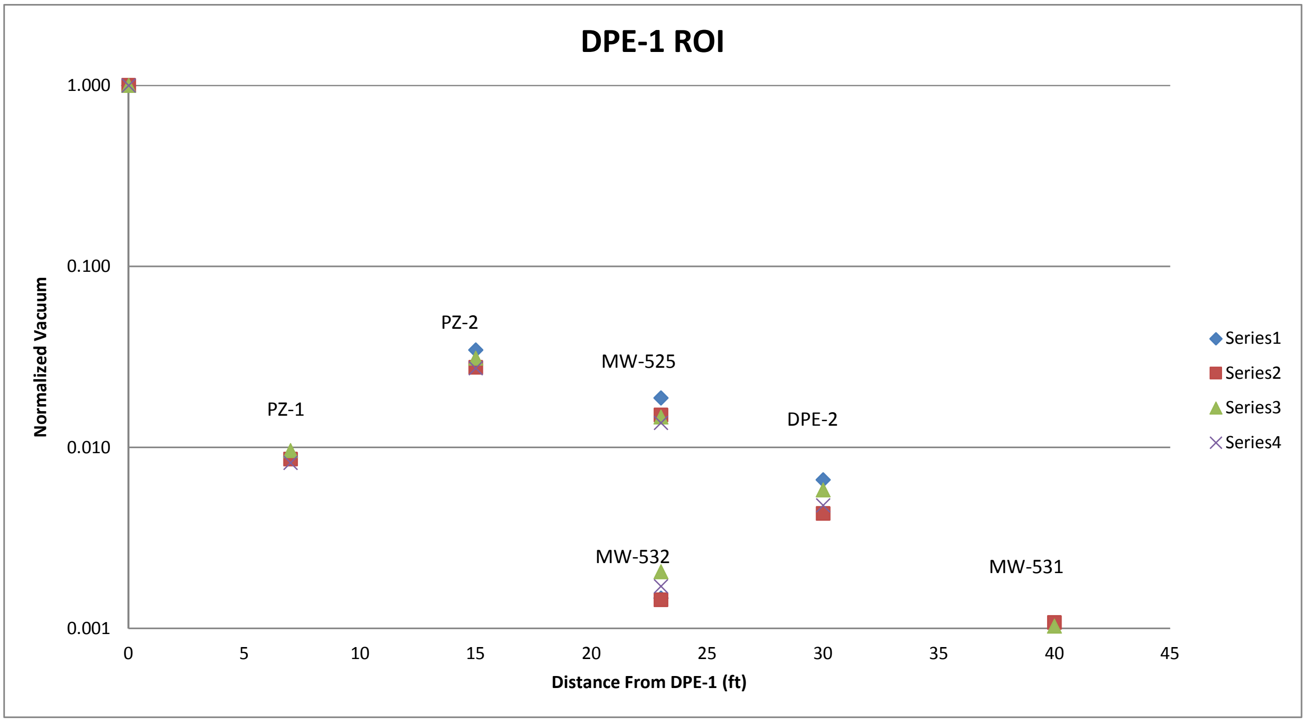
	Time elapsed (hr)	46 hr	47 hr	49 hr	51 hr	52 hr	53 hr	54 hr	55 hr	56 hr	57 hr	58 hr	59 hr	60 hr	61 hr	62 hr	66 hr	70 hr	75 hr	85 hr
Well	**Distance (feet)**	**Drawdown (feet below static groundwater elevation)**																		
DPE-1	30	0.53	0.50	0.41	0.84	0.98	1.06	1.09	1.11	1.14	1.12	1.11	Measu	1.06	1.04	1.04	1.02	1.03	1.06	1.01
DPE-2	0	5.20	5.40	4.75	13.05	12.95	12.80	12.60	12.60	12.60	13.00	13.00	12.50	12.70	12.60	12.75	13.55	16.12	16.20	11.92
PZ-1	45	0.31	0.31	0.24	0.41	0.48	0.61	0.62	0.67	0.72	0.74	0.71	0.70	0.69	0.64	0.56	0.56	0.65	0.55	0.61
PZ-2	23	0.69	0.76	0.61	1.11	1.19	1.26	1.26	1.29	1.36	1.31	1.28	1.28	1.28	1.28	1.36	1.32	1.18	1.36	1.30
AS-1	35	0.41	0.42	0.37	0.61	0.69	0.77	0.80	0.88	0.90	0.90	0.88	0.90	0.85	0.80	0.73	0.73	0.82	0.76	0.81
MW-525	23	0.22	0.29	0.23	0.36	0.48	0.57	0.57	0.63	0.75	0.80	0.65	0.63	0.60	0.65	0.71	0.70	0.81	0.73	0.71
MW-531	32	0.16	0.14	0.08	-0.03	0.05	0.10	0.13	0.18	0.23	0.24	0.29	0.27	0.25	0.23	0.23	0.18	0.25	0.18	0.31
MW-532	7	0.27	0.30	0.40	1.30	0.48	0.57	0.80	0.65	0.75	0.68	1.16	1.06	0.95	0.84	1.04	1.02	0.84	1.10	1.09

Note:
hr = hour
bgs = below ground surface
DPE = dual phase extraction



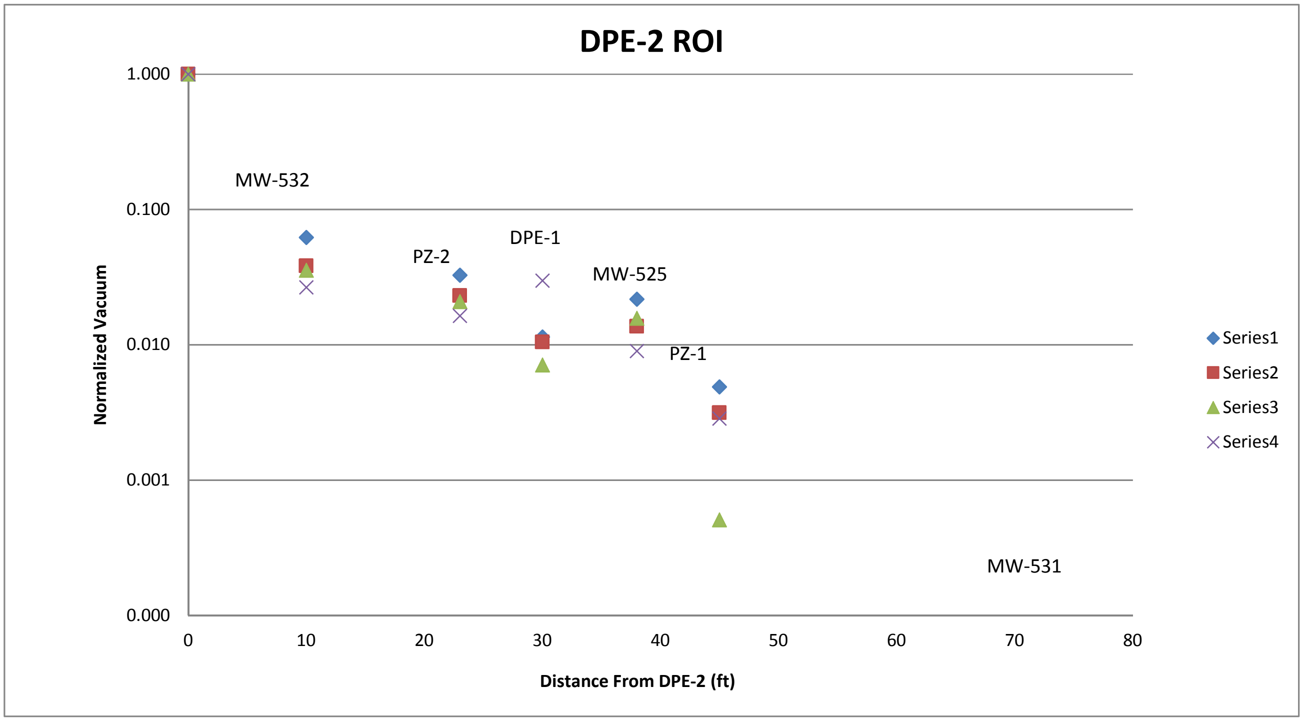
	Time elapsed (hr)	0 hr	5 hr	8 hr	12 hr	16 hr	20 hr	26 hr	28 hr
Well	**Distance (feet)**	**Drawdown (feet bgs)**							
DPE-1	29	0.00	2.11	2.08	2.33	2.27	2.21	2.22	2.21
DPE-2	48	0.00	0.75	0.78	0.83	0.82	0.89	0.85	0.86
DPE-3	0	0.00	4.82	11.07	7.37	8.46	9.12	9.17	9.65
PZ-1	31.5	0.00	1.62	1.59	1.86	1.79	1.69	1.73	1.77
PZ-2	31	0.00	1.50	1.54	1.75	1.80	1.75	1.77	1.78
PZ-3	10	0.00	3.64	3.59	3.74	3.76	3.62	3.62	3.61
AS-1	25	0.00	1.82	1.79	2.02	1.97	1.90	2.02	1.97
MW-525	5	0.00	4.22	4.05	4.18	4.12	4.10	3.86	3.95
MW-531	57	0.00	0.04	0.06	0.15	0.17	0.11	0.15	0.16
MW-532	40	0.00	0.94	0.98	1.19	1.32	1.25	1.29	1.31

Note:
hr = hour
bgs = below ground surface
DPE = dual phase extraction



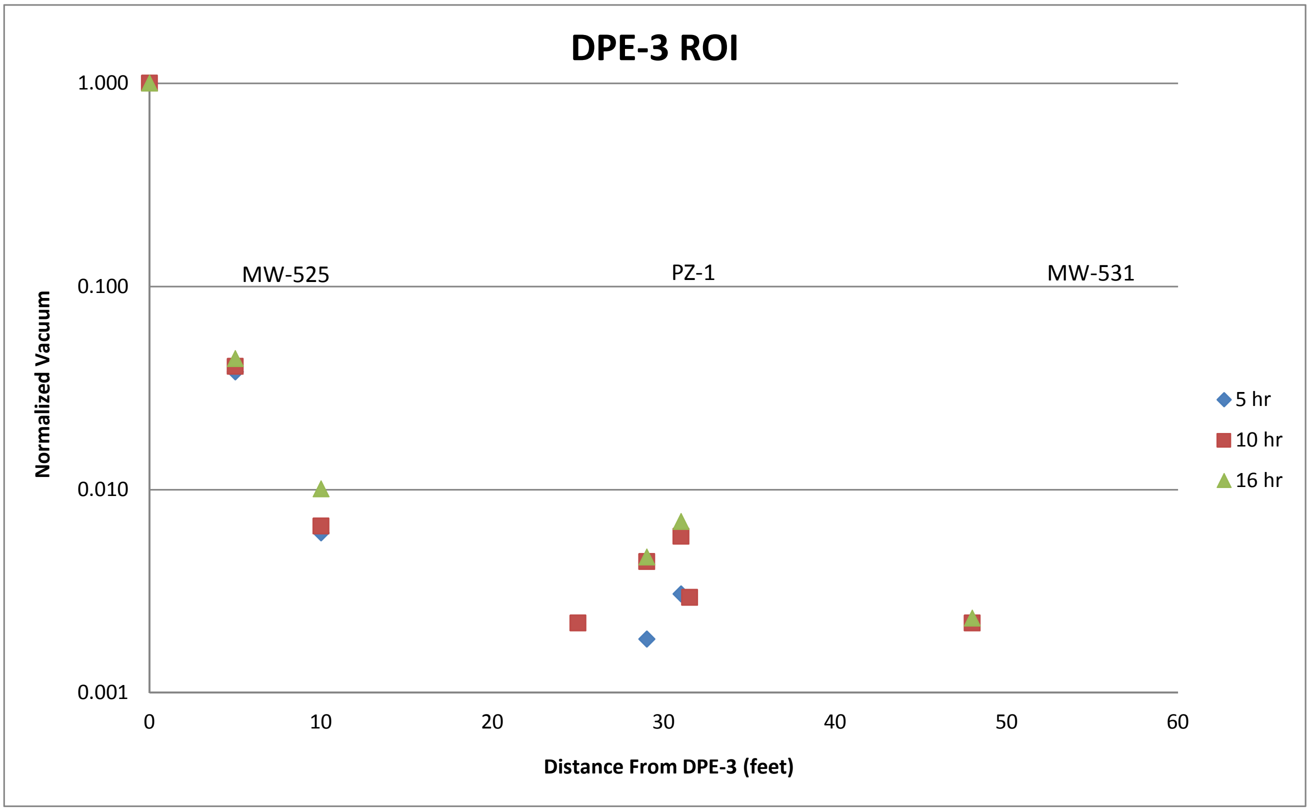
Time elapsed (hr)		1 hr		10 hr		20 hr		30 hr	
Vacuum ("H2O)		Vacuum	Normalized Vacuum	Vacuum	Normalized Vacuum	Vacuum	Normalized Vacuum	Vacuum	Normalized Vacuum
Well	**Distance (feet)**								
DPE-1	0	271.800	1.000	278.595	1.000	292.185	1.000	292.185	1.000
DPE-2	30	1.800	0.007	1.200	0.004	1.700	0.006	1.4	0.005
PZ-1	7	0.000	0.000	2.400	0.009	2.800	0.010	2.4	0.008
PZ-2	15	9.400	0.035	7.700	0.028	9.100	0.031	8	0.027
MW-525	23	5.100	0.019	4.200	0.015	4.300	0.015	4	0.014
MW-531	40	0.000	0.000	0.300	0.001	0.300	0.001	0	0.000
MW-532	23	0.400	0.001	0.400	0.001	0.600	0.002	0.5	0.002

Note:
hr = hour
DPE = dual phase extraction
"H2O = inches of water



Time elapsed (hr)		50 hr		60 hr		70 hr		80 hr	
Vacuum ("H2O)		Vacuum	Normalized Vacuum	Vacuum	Normalized Vacuum	Vacuum	Normalized Vacuum	Vacuum	Normalized Vacuum
Well	Distance (feet)								
DPE-2	0	183.465	1.000	190.260	1.000	197.055	1.000	244.62	1.000
MW-532	10	11.400	0.062	7.300	0.038	7.000	0.036	6.5	0.027
PZ-2	23	6.000	0.033	4.400	0.023	4.100	0.021	4	0.016
DPE-1	30	2.100	0.011	2.000	0.011	1.400	0.007	7.31	0.030
MW-525	38	4.000	0.022	2.600	0.014	3.100	0.016	2.2	0.009
PZ-1	45	0.900	0.005	0.600	0.003	0.100	0.001	0.7	0.003
MW-531	68	0.000	0.000	0.000	0.000	0.000	0.000	0	0.000

Note:
hr = hour
DPE = dual phase extraction
"H2O = inches of water



Time elapsed (hr)		5 hr		10 hr		16 hr	
Vacuum ("H2O)		Vacuum	Normalized Vacuum	Vacuum	Normalized Vacuum	Vacuum	Normalized Vacuum
Well	Distance (feet)						
DPE-3	0	163.080	1.000	135.900	1.000	129.105	1.000
MW-525	5	6.200	0.038	5.500	0.040	5.700	0.044
PZ-3	10	1.000	0.006	0.900	0.007	1.300	0.010
AS-1	25	0.000	0.000	0.300	0.002	0.000	0.000
DPE-1	29	0.300	0.002	0.600	0.004	0.600	0.005
PZ-2	31	0.500	0.003	0.800	0.006	0.900	0.007
PZ-1	31.5	0.000	0.000	0.400	0.003	0.000	0.000
DPE-2	48	0.000	0.000	0.300	0.002	0.300	0.002
MW-532	40	0.000	0.000	0.000	0.000	0.000	0.000
MW-531	57	0.000	0.000	0.000	0.000	0.000	0.000

Note:
hr = hour
DPE = dual phase extraction
"H2O = inches of water

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