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Revised Voluntary Cleanup Program
Soil No Further Action Request and
Remedial Action Summary Report
Former Unocal Bulk Plant 0138
Coupeville, Washington

December 30, 1998

For
Unocal AMG – West Division

GeoEngineers

December 30, 1998

Consulting Engineers and Geoscientists
Offices in Washington, Oregon, and Alaska

Unocal AMG – West Division
P.O. Box 2004
Edmonds, Washington 98020

Attention: Dr. Mark Brearley, R.G.

Revised Voluntary Cleanup Program
Soil No Further Action Request and
Remedial Action Summary Report
Former Unocal Bulk Plant 0138
Coupeville, Washington
File No. 7104-001-00/0161-205-00

GeoEngineers was recently notified by North Creek Analytical Inc. laboratory that soil chemical analytical data were incorrectly reported for some projects completed during a period in 1998. A laboratory error resulted in an incorrect determination of soil moisture content. This error consequently caused detected concentrations of analytes to be overestimated by approximately 7 to 28 percent. If analytes were not originally detected in a sample, the data were not affected.

GeoEngineers received a revised analytical report for the above-mentioned project. It is our opinion that the revised data change the conclusions drawn from the data in the original report titled "Voluntary Cleanup Program, Soil No Further Action Request and Remedial Action Summary Report" dated July 15, 1998. Based on our review of these data, we are providing a revised report with the following changes:

- Revised hazard index for sample TP-2-8, ratio of aliphatic to aromatic compounds and MTCA Method B soil direct contact cleanup level for total petroleum hydrocarbons (TPH).
- Revised Table 2, Table C-1 and Table C-2.

As a result of the revised data, the site-specific MTCA Method B soil cleanup level for TPH has increased from 3,235 mg/kg to 3,666 mg/kg. We have attached the revised report for your files and will forward the revised report to all parties copied in the July 15, 1998 report.

GeoEngineers, Inc.
8410 154th Avenue N.E.
Redmond, WA 98052
Telephone (425) 861-6000
Fax (425) 861-6050
www.geoengineers.com

Please call us at (425) 861-6000 if you have questions regarding the revised report for your project.

Respectfully submitted,

GeoEngineers, Inc.

Charles S. Lindsay, P.G., P.HG.
Associate

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Attachment

cc: Ron Timm
Washington State Dept. of Ecology
Northwest Regional Office
3190 - 160th Avenue
Bellevue, WA 98008-5452

GeoEngineers

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Consulting Engineers and Geoscientists
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Unocal AMG - West Division
P.O. Box 2004
Edmonds, Washington 98020

Attention: Dr. Mark Brearley, R.G.

We are submitting two copies of our "Revised Voluntary Cleanup Program, Soil No Further Action Request and Remedial Action Summary Report, Former Unocal Bulk Plant 0138." The site is located southwest of the intersection between Coveland and Alexander Streets in Coupeville, Washington. This report supercedes our "Voluntary Cleanup Program, Soil No Further Action Request and Remedial Action Summary Report" dated July 15, 1998.

We appreciate the opportunity to be of continued service to Unocal. Please call if you have questions regarding this report.

Yours very truly,

GeoEngineers, Inc.

Charles S. Lindsay, P.G., P.HG.
Associate

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GeoEngineers, Inc.
8410 154th Avenue N.E.
Redmond, WA 98052
Telephone (425) 861-6000
Fax (425) 861-6050
www.geoengineers.com

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INTRODUCTION AND SITE DESCRIPTION

This report presents a summary of current site conditions, a review of subsurface assessment and independent remedial actions conducted to date, and the application of the Washington State Department of Ecology's (Ecology) *Interim Interpretative and Policy Statement, Cleanup of Total Petroleum Hydrocarbons* (Interim TPH Policy) to residual petroleum in soil at former Unocal Bulk Plant 0138. The former bulk plant is located southwest of the intersection between Coveland and Alexander Streets in Coupeville, Washington. The approximate location of the site is shown on the Vicinity Map, Figure 1. The general layout of the site prior to removal of the bulk plant facilities, the approximate locations of on-site monitoring wells, limits of remedial excavations and soil sampling locations are shown in Figure 2. A generalized hydrogeologic cross section of the site is shown in Figure 3. A summary of chemical analytical data for selected soil samples obtained from the final limits of the remedial excavations and from selected on-site explorations are presented in Table 1.

Based on conditions described in this summary report, Unocal is requesting a "no further action" (NFA) determination for soil under the Model Toxics Control Act (MTCA) and the Interim TPH Policy, with a restrictive covenant to prohibit shallow ground water use at the site.

PREVIOUS SITE STUDIES

GeoEngineers has provided environmental services at the site from 1989 to 1998. The contents of reports previously prepared for Unocal include (1) specific details about site assessment, remedial action and ground water sampling activities that have been completed at the site; (2) figures showing sample locations; (3) exploration logs; and (4) chemical analytical for soil and ground water samples. The following reports have been completed for the site:

- "Report of Remedial Actions, Diesel Storage Tank Removal" dated October 6, 1989.
- "Report of Geotechnical Services, Subsurface Contamination Study" dated January 30, 1990.
- "Project Status" dated November 2, 1990.
- "Report of Geoenvironmental Services, Remedial Action and Supplemental Subsurface Contamination Study" dated March 18, 1992.
- "Results of Ground Water Sampling and Soil Stockpile Sampling" dated January 22, 1993.
- "Report of Hydrogeologic Services, Supplemental Ground Water Contamination Study" dated July 12, 1995.

- Ground water monitoring reports dated between March 1992 and April 7, 1998 for routine monitoring events.

The following text generally summarizes the documented history of previous site characterization and remedial activities. The reader is referred to the previous reports for a complete description of site studies.

- The bulk plant was operated by Unocal between approximately 1927 and 1989.
- One partially below-grade 6,000-gallon diesel storage tank was removed from the site in September 1989.
- Subsurface conditions at the site were explored in November 1989 by drilling six exploratory borings and excavating three test pits. Ground water monitoring wells (MW-1 through MW-6) were completed in the exploratory borings at the approximate locations shown in Figure 2.
- One 550-gallon heating oil underground storage tank (UST) and associated product lines were removed and five remedial excavations were completed at the site in August and October 1990.
- One boring (B-1), five on-site monitoring wells (MW-7 through MW-11) and two off-site monitoring wells (MW-12 and MW-13) were completed, and approximately 850 cubic yards of contaminated soil were excavated from remedial excavations and test pits at the site between March and July 1991.
- The results of our previous site studies indicate that residual petroleum hydrocarbons at concentrations greater than MTCA Method A cleanup levels remain at depths greater than 10 feet in the general vicinities of the former heating oil UST and the former fuel loading rack near MW-4, MW-5 and MW-11 (Figure 2). Petroleum hydrocarbons were detected in soil samples obtained in these areas at concentrations up to 1,642 milligrams per kilogram (mg/kg) (Table 1). Most of the subsurface soil contamination less than 15 feet deep was removed during remedial excavation activities at the site in 1990 and 1991.
- Quarterly ground water monitoring has been conducted at the site since August 1991. BETX (benzene, ethylbenzene, toluene, and xylenes) and petroleum hydrocarbon concentrations greater than MTCA Method A cleanup levels are present in ground water samples obtained from two of the on-site monitoring wells (MW-5 and MW-9).

HYDROGEOLOGIC INFORMATION

The following is a general summary of site hydrogeologic conditions. A more detailed analysis of the site and regional hydrogeologic conditions is presented in our "Report of Hydrogeologic Services, Supplemental Ground Water Contamination Study" dated July 12, 1995.

- At least two aquifer systems appear to be present in the vicinity of the site: (1) a shallow perched aquifer located in more permeable sand and gravel lenses within the upper portion of the till/glaciomarine drift, and (2) a confined aquifer located in the advance outwash deposits.
- The shallow perched aquifer occurs within local isolated lenses of relatively permeable sand and gravel located in the upper portion of the till/glaciomarine drift.
- The perched ground water is generally located at a depth of approximately 20 to 40 feet.
- The thickness of the perched aquifer is influenced by relief on the underlying less permeable till/glaciomarine drift.
- All of the existing ground water monitoring wells at and near the bulk plant property appear to be completed within the perched aquifer.
- Soil heterogenities within the perched aquifer unit and variations in monitoring well screen depths/lengths result in an inconsistent ground water flow direction and hydraulic gradient (slope). However, based on water levels observed in the on- and off-site monitoring wells and the surface topography in the vicinity of the site, it is likely that ground water flow within the perched aquifer is generally to the north in the immediate vicinity of the bulk plant site.
- The deeper aquifer within the advance outwash consists of stratified sand and gravel deposits that are interbedded with relatively low-permeability zones of silt and clay.
- The potentiometric surface of the deeper aquifer appears to slope downward to the north toward Penn Cove and is located at a depth of approximately 120 feet to 140 feet below ground surface in the vicinity of the site (Figure 3).
- The total thickness of the deeper aquifer in the advance outwash is unknown but appears to be at least 50 feet in the vicinity of the site.
- The Town of Coupeville Well No. 1 and on-site well PW-1 appear to be completed within the advance outwash aquifer.
- The advance outwash aquifer is confined (static water levels within PW-1 and Well No. 1 are significantly higher than the elevation of the top of the aquifer unit) by the overlying till/glaciomarine unit.
- Aquifer testing indicates that the lower confined aquifer is not in hydraulic continuity with the perched aquifer.
- Petroleum hydrocarbons have not been detected in water samples obtained from on-site well PW-1 and the Town of Coupeville production Well No. 1.
- PW-1 was decommissioned in accordance with Washington Administrative Code (WAC) 173-160 in 1995.

1998 SCOPE OF SERVICES

GeoEngineers' specific scope of our 1998 services is listed below.

1. Monitor the excavation of two test pit explorations to an approximate depth of 15 feet below ground surface (bgs). Obtain soil samples from the test pits at approximate 1-foot depth intervals for soil classification, field screening and chemical analyses.
2. Submit one soil sample from each test pit for chemical analysis of BETX by EPA Method 8021B; gasoline-range hydrocarbons by Ecology Method NWTPH-Gx; and diesel- and heavy oil-range hydrocarbons by Ecology Method NWTPH-Dx. Submit one soil sample from each test pit for chemical analysis of BETX, naphthalene and methyl tert butylether (MTBE) by EPA Method 8260; polynuclear aromatic hydrocarbons (PAHs) by EPA Method 8270; and volatile petroleum hydrocarbons (VPH) and extractable petroleum hydrocarbons (EPH) by Ecology's Interim TPH Policy analytical methods.
3. Evaluate the soil data relative to Ecology's Interim TPH Policy. Develop a site-specific MTCA Method B cleanup level for TPH in soil beneath the site.

1998 SUBSURFACE EXPLORATIONS

GeoEngineers monitored the excavation of two test pits (TP-1 and TP-2) at the former bulk plant site on April 27, 1998. The approximate locations of the test pits are shown on Figure 2. The purpose of the test pit exploration activities was to obtain soil samples from the previously identified areas of petroleum contamination based on 1989 through 1991 data for residual samples. Selected soil samples were submitted to an analytical laboratory for hydrocarbon fractionation analysis of residual petroleum using the June 1997 Ecology Methods (Publication ECY 97-602). The resulting chemical analytical data were used to evaluate current concentrations of petroleum in subsurface soil with regard to the Interim TPH Policy.

Test pit TP-1 was completed in the area of MW-4 and MW-11 where soil contamination was previously detected at depths of 10 to 20 feet bgs. Test pit TP-2 was completed near MW-5 where gasoline-related compounds in ground water were last detected in August 1997 at concentrations exceeding the MTCA Method A cleanup levels. Petroleum hydrocarbons at concentrations greater than MTCA Method A cleanup limits also were previously detected in a soil sample obtained from a depth of 23 feet bgs in MW-5. The 1998 test pits were completed to depths of approximately 15 feet bgs. Incidental petroleum-like odors and slight sheens were observed in samples from depths of 3, 4, 13 and 15 feet bgs in TP-1, and from depths of 5, 7 and 8 feet bgs in TP-2. Ground water seepage was encountered in TP-1 at a depth of approximately 13 feet bgs. The test pit logs are provided in Appendix A.

Soil samples with the highest field screening results (TP-1-15 and TP-2-8) were selected for chemical analysis from each of the two areas with previously documented petroleum-related soil contamination. The samples were submitted for chemical analysis of PAHs, MTBE, BETX, naphthalene, VPH and EPH using Interim TPH Policy analytical methods. An additional soil sample from each test pit with high field screening results (TP-1-13 and TP-2-7) was selected

for chemical analysis of petroleum hydrocarbons by Ecology methods for comparison purposes. The samples were submitted for chemical analysis of BETX by EPA Method 8021B; and gasoline, diesel- and heavy oil-range hydrocarbons by Ecology NWTPH series methods. Field screening and chemical analytical results for the soil samples are summarized in Table 2. The laboratory report and our review of the laboratory quality control program are included in Appendix B.

As summarized in Table 2, diesel-range hydrocarbons were detected at concentrations exceeding the MTCA Method A cleanup level in samples from both test pits; gasoline-range hydrocarbons were detected at a concentration exceeding the MTCA Method A cleanup level in soil sample TP-1-13. Volatile and extractable petroleum hydrocarbons were detected in both samples analyzed. BETX, MTBE, naphthalene by EPA Method 8260 and carcinogenic PAHs were not detected in samples TP-1-15 and TP-2-8.

INTERIM TPH POLICY EVALUATION

GENERAL

Our studies at the site indicate that residual petroleum hydrocarbons in soil, consisting primarily of gasoline- and diesel-range hydrocarbons, are present in the vicinity of the former heating oil UST and the former loading rack. The MTCA Method A cleanup levels for total petroleum hydrocarbons in soil (200 milligrams per kilogram [mg/kg] for diesel- and heavy oil-range hydrocarbons and 100 mg/kg for gasoline-range hydrocarbons) cannot be adjusted to account for specific properties of petroleum products, such as the possible absence of the more toxic constituents (i.e., volatile and/or carcinogenic fractions of hydrocarbons). The Interim TPH Policy allows for calculation of a site-specific MTCA Method B cleanup level for the petroleum hydrocarbons in soil based on the actual constituents present in the petroleum. Unocal requested that GeoEngineers use the Interim TPH Policy methodology to (1) calculate a MTCA Method B TPH direct contact soil cleanup level for the site, and (2) evaluate the risk of remaining petroleum hydrocarbons in soil at the site. The reader is referred to Appendix C of this report and the Interim TPH Policy for background information and assumptions that pertain to the use of the Interim TPH Policy.

SOIL DIRECT CONTACT PATHWAY

Petroleum products contain multiple fractions and individual compounds that have associated noncarcinogenic health effects. MTCA stipulates that individual hazard quotients associated with these fractions are additive, and that the total hazard index (the sum of all individual hazard quotients) should not exceed 1.0 for the risk to be considered acceptable.

Using the maximum detected concentrations of total aliphatic and total aromatic hydrocarbons (sample TP-2-8), we calculated a residential hazard index of 0.13 for the petroleum hydrocarbons remaining in soil at the site. The ratio of aliphatic compounds to

aromatic compounds in this sample is about 70 percent aliphatics and 30 percent aromatics. The soil direct contact calculation for sample TP-2-8 is presented in Appendix C, in Table C-1.

Benzene and carcinogenic PAHs (cPAHs) were not detected in samples TP-1-15 and TP-2-8. Also, benzene was not previously detected at concentrations exceeding the MTCA Method A cleanup level in soil samples obtained from explorations or the limits of remedial excavations. We estimated the carcinogenic risk for benzene and cPAHs, assuming a concentration for each of one-half the laboratory detection limit, as shown in Table C-1. The resulting individual and total carcinogenic risks are at least one order of magnitude less than the risk limits specified under MTCA of one in one million and one in one hundred thousand, respectively, for Method B. Therefore, existing concentrations of these constituents in soil are protective of human health for individual and total carcinogenic risk for a residential scenario.

Our calculations indicate that the site-specific MTCA Method B cleanup level for TPH is 3,666 mg/kg. This calculation is based on the residual direct contact exposure, the reference dose values, and the total aliphatic and aromatic compound fractions for sample TP-2-8 (Table 3).

SOIL TO GROUND WATER PATHWAY

Actual ground water monitoring results for ground water samples obtained from existing monitoring well MW-5 since 1989 indicate that occasionally gasoline-range hydrocarbon concentrations sometimes slightly exceed the MTCA Method A ground water cleanup level of 1 mg/l. MW-5 is situated in the vicinity of the former heating oil UST and the 1998 test pit exploration TP-2. Continued monitoring of perched ground water is planned to directly evaluate the soil to ground water pathway over time. Based on our previous investigations and testing, it is our opinion that dissolved-phase hydrocarbons in the perched non-potable aquifer will not be transported to the deeper potable aquifer in the vicinity of the site.

CONCLUSIONS

The proposed site-specific direct contact MTCA Method B cleanup level for residual TPH in soil beneath the site is 3,666 mg/kg. TPH concentrations detected in the soil samples obtained from explorations and the limits of the remedial excavations located near the former heating oil UST and the former loading rack were all less than 2,000 mg/kg. Three of those soil samples with residual TPH were obtained from depths exceeding 20 feet bgs (soil samples from MW-4, MW-5 and 900927-4). The highest TPH concentration encountered during our 1998 sampling in areas of known residual soil contamination was less than 600 mg/kg. Soil contamination was encountered in TP-1 in the vicinity of the former loading rack at depths less than 15 feet; soil contamination in TP-2 in the vicinity of the former heating oil UST was present from about 5 to at least 15 feet. Residual TPH concentrations beneath the site do not pose a risk to human health by direct contact, evaluated using Interim TPH Policy methods, assuming that soil at depths of 15 feet or less is in potential direct contact with humans, as stated in MTCA. Based on the current site conditions and application of Ecology's Interim

TPH Policy direct contact evaluation of residual soil contamination beneath the site, it is our opinion that a No Further Action status for soil is warranted.

The concentrations of one or more petroleum-related compounds in monitoring wells MW-5 and MW-9 completed in the perched aquifer intermittently exceed MTCA Method A ground water cleanup levels. A NFA for ground water is not requested at this time. Continued monitoring of ground water is planned to directly evaluate perched non-potable ground water conditions. Unocal proposes a restrictive covenant to prohibit ground water use at the site until four quarters of monitoring data indicate that petroleum hydrocarbon concentrations in ground water beneath the site no longer exceed MTCA Method A cleanup levels.

LIMITATIONS

This report has been prepared for use by Unocal and its authorized agents. This report is not intended for use by others, and the information contained herein is not applicable to other sites. Regulatory policy regarding risk-based evaluations of petroleum hydrocarbon contamination continues to be formulated by Ecology. The Interim TPH Policy is a conservative and temporary measure intended to allow for the use of a risk-based approach to petroleum hydrocarbons while final policy is developed. The policy described herein is subject to future regulatory revisions.

Within the limitations of scope, schedule and budget, our services have been executed in accordance with generally accepted environmental science practices in this area at the time this report was prepared. No warranty or other conditions, express or implied, should be understood.

We appreciate the opportunity to assist you with this project. Please call if you have any questions.

Respectfully submitted,

GeoEngineers, Inc.

Charles S. Lindsay, P.G., P.HG.
Associate

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TABLE 1
SOIL CHEMICAL ANALYTICAL RESULTS FOR RESIDUAL SOIL SAMPLES WITH CONTAMINANT CONCENTRATIONS EXCEEDING MTCA METHOD A CLEANUP LEVELS

FORMER UNOCAL BULK PLANT 0138
COUPEVILLE, WASHINGTON

Soil Sample Number[1]	Sample Depth (feet bgs)	Date Sampled	B E T X[2]				Gasoline-range Hydrocarbons[3] (mg/kg)	Diesel-range Hydrocarbons[3] (mg/kg)	Total Petroleum Hydrocarbons[4] (mg/kg)
			B	E	T	X			
MW-4	20.5	11/07/89	<0.025	<0.025	<0.025	<0.025	--	--	580
MW-5	23.0	11/08/89	<0.13	<0.13	1.3	4.4	--	--	1,500
900927-4	28.0	09/27/90	--	--	--	--	125	<10	1,642
910306-4	10.0	03/06/91	--	--	--	--	--	--	330

Notes:
[1]Approximate sample locations are shown in Figure 2.
[2]B = benzene, E = ethylbenzene, T = toluene, X = xylenes. BETX analyzed by EPA Method 8020.
[3]Analyzed by EPA Method 8015.
[4]Analyzed by EPA Method 418.1.
mg/kg = milligrams per kilogram
"--" = not analyzed.

TABLE 2 (Page 1 of 3)
SUMMARY OF SOIL FIELD SCREENING AND CHEMICAL ANALYTICAL RESULTS
APRIL 1998 EXPLORATIONS
FORMER UNOCAL BULK PLANT 0138
COUPEVILLE, WASHINGTON

Description	Sample Number [1]				MTCA Method B Cleanup Level[2] (mg/kg)
	TP-1-13	TP-1-15	TP-2-7	TP-2-8	
Date Sampled	4/27/98	4/27/98	4/27/98	4/27/98	
Depth of Sample (feet bgs)	13.0	15	7.0	8.0	
Field Screening Results[3]					
Sheen	SS	SS	SS	SS	
BETX[4] (mg/kg)					
Benzene	<0.500	--	<0.0500	--	34.5
Ethylbenzene	<0.500	--	<0.0500	--	8,000
Toluene	<0.500	--	<0.0500	--	16,000
Xylenes	<1.00	--	<0.100	--	160,000
TPH[5] (mg/kg)					3,666
Gasoline-range	171	--	61.6	--	
Diesel-range	405	--	381	--	
Heavy Oil-range	<25.0	--	26.2	--	
VPH[6] (mg/kg)					
Aliphatics					
EC5-EC6	--	<20.0	--	<20.0	
EC6-EC8	--	<20.0	--	<20.0	
EC8-EC10	--	<20.0	--	<20.0	
EC10-EC12	--	<20.0	--	27.0	
Aromatics					
EC8-EC10	--	<20.0	--	<20.0	
EC10-EC12	--	<20.0	--	28.4	
EC12-EC13	--	23.0	--	34.7	
Other Volatile Petroleum Hydrocarbons[6] (mg/kg)					
Benzene	--	<0.100	--	<0.100	34.5
Ethylbenzene	--	<0.100	--	<0.100	8,000
Toluene	--	<0.100	--	<0.100	16,000
Xylenes	--	<0.500	--	<0.500	160,000
Naphthalene	--	<0.100	--	<0.100	3,200
MTBE	--	<1.00	--	<1.00	NE

Notes appear on Page 3 of 3

Table 2 (Page 2 of 3)

Description	Sample Number [1]				MTCA Method B Cleanup Level[2] (mg/kg)
	TP-1-13	TP-1-15	TP-2-7	TP-2-8	
EPH[7] (mg/kg)					
Aliphatics					
EC8-EC10	--	<5.00	--	<5.00	
EC10-EC12	--	<5.00	--	12.3	
EC12-EC16	--	57.4	--	115	
EC16-EC21	--	52.7	--	129	
EC21-EC34	--	6.30	--	24.5	
Aromatics					
EC8-EC10	--	--	--	--	
EC10-EC12	--	<5.00	--	<5.00	
EC12-EC16	--	23.2	--	36.0	
EC16-EC21	--	21.6	--	49.5	
EC21-EC34	--	<5.00	--	13.7	
PAHs[7] (mg/kg)					
Carcinogenic					
Benzo(a)anthracene	--	<0.0100	--	<0.0100	0.137
Benzo(b)fluoranthene	--	<0.0100	--	<0.0100	0.137
Benzo(k)fluoranthene	--	<0.0100	--	<0.0100	0.137
Benzo(a)pyrene	--	<0.0100	--	<0.0100	0.137
Chrysene	--	<0.0100	--	<0.0100	0.137
Dibenzo(a,h)anthracene	--	<0.0100	--	<0.0100	0.137
Indeno(1,2,3-cd)pyrene	--	<0.0100	--	<0.0100	0.137
Noncarcinogenic					
Naphthalene	--	0.0116	--	0.0230	3,200
Acenaphthene	--	<0.0100	--	<0.0100	4,800
Acenaphthylene	--	<0.0100	--	<0.0100	NE
Anthracene	--	0.0548	--	<0.0100	24,000
Benzo(ghi)perylene	--	<0.0100	--	<0.0100	NE
Fluorene	--	0.0895	--	0.100	3,200
Fluoranthene	--	<0.0100	--	0.0130	3,200
Phenanthrene	--	0.184	--	<0.0100	NE
Pyrene	--	0.0123	--	0.0130	2,400
2-methylnaphthalene	--	0.143	--	<0.0100	NE

Notes appear on Page 3 of 3.

Notes:

[1]Approximate exploration locations are shown in Figure 2.

[2] From MTCA Cleanup Levels and Risk Calculations (CLARC II) Update February 1996 Publication #94-145

[3] Field screening procedures are described in Appendix A. NS = no sheen, SS = slight sheen

[4]Analyzed by EPA Method 8021B.

[5]TPH = total petroleum hydrocarbons. Gasoline-, diesel- and heavy oil-range hydrocarbons analyzed by Ecology NWTPH series.

[6]VPH = volatile petroleum hydrocarbons, BETX, naphthalene, and methyl tert butylether (MTBE) by Ecology Method (June 1997) and EPA Method 8260.

[7]EPH = extractable petroleum hydrocarbons and polynuclear aromatic hydrocarbons (PAHs) by Ecology Method (June 1997) and EPA Method 8270.

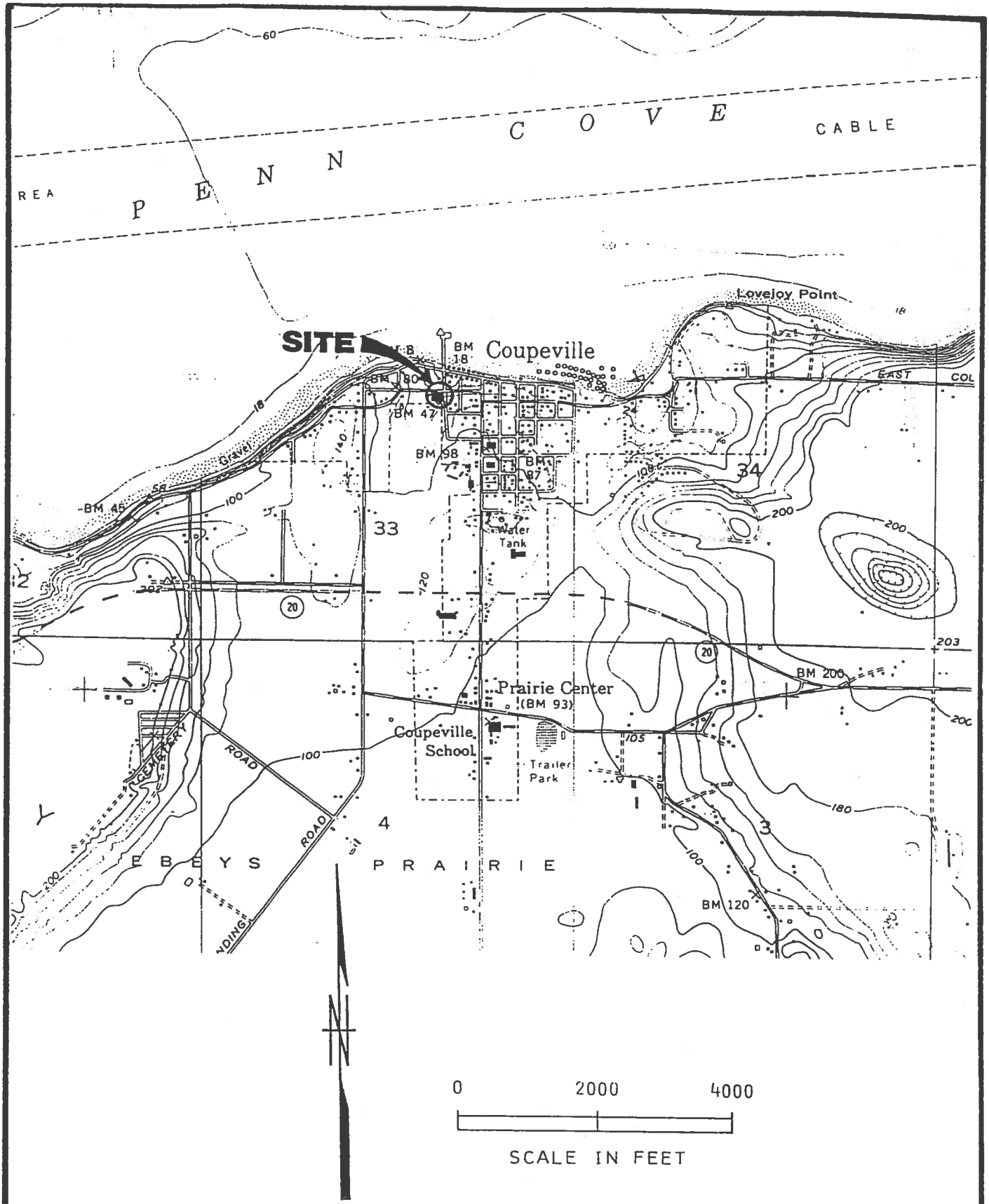
mg/kg = milligrams per kilogram

-- = not analyzed or measured

ppm = parts per million

NE = not established

Chemical analyses conducted by North Creek Analytical of Bothell, Washington. The laboratory reports are presented in Appendix B.



REFERENCE: USGS 7.5' TOPOGRAPHIC QUADRANGLE MAP "COUPEVILLE, WASH."

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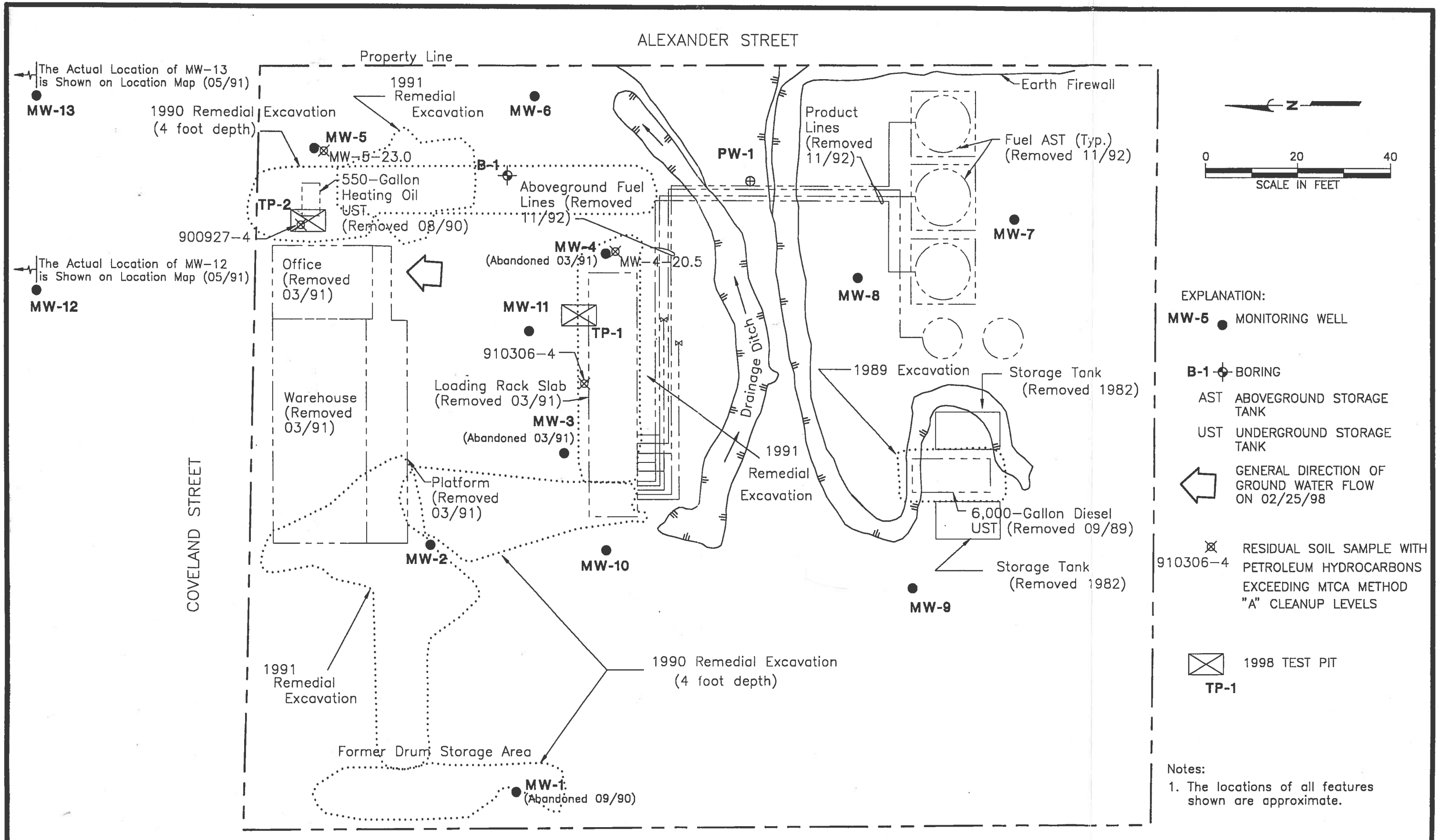
VICINITY MAP

FIGURE 1



Reference: Drawing entitled "Coupeville, Washington, Coveland and Alexander Streets, Bulk Plant, General Arrangement," by Unocal, dated 04/22/81.

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SITE PLAN AND 1998 TEST PITS

FIGURE 2

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NORTH

SOUTH

Elevation in Feet Above/Below Mean Sea Level

100
50
0
−50
−100
−150
−200

Coupeville Well No. 1

Unocal Bulk Plant 0138

MW-13
MW-12
MW-5
MW-6
PW-1
MW-7

PENN COVE

Hard, Silt and Clay with Varying Amounts of Fine Sand (Till/Glaciomarine Drift)

Silt and Clay with Varying Amounts of Fine Sand (Till/Glaciomarine Drift)

Hard, Silt and Clay with Varying Amounts of Fine Sand

Dense, Fine to Medium Sand with Occasional Gravel (Perched Aquifer)

Sand and Gravel with Minor Lenses of Silt and Clay (Confined Aquifer/Advance Outwash)

?

Vertical Scale — 1"=50'
Horizontal Scale — 1"=100'
Vertical Exaggeration — 2x

EXPLANATION:

MW-13 — WELL LOCATION AND NUMBER

STATIC WATER LEVEL

SCREEN INTERVAL

NOTE:
Hydrogeologic contacts are dashed where approximate, dotted where inferred.

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GENERALIZED HYDROGEOLOGIC CROSS SECTION

FIGURE 3

CSL:SPS 01612058.DWG 0161205B04T6.4:051195

APPENDIX A

APPENDIX A

FIELD EXPLORATION PROGRAM

GENERAL

Subsurface conditions at the site were explored on April 27, 1998 by completing two test pits (TP-1 and TP-2) using a track-mounted excavator operated by Glacier Environmental of Mukilteo, Washington. A representative of our staff selected the exploration locations, examined and classified the soils encountered, and prepared a detailed log of each exploration. Soils encountered were visually classified in general accordance with ASTM D-2488-94, which is described in Figure A-1. The test pit logs are presented in Figures A-2 and A-3.

SOIL SAMPLING

The test pits extended to a depth of approximately 15 feet bgs. Soil samples were obtained with a stainless steel spoon that was decontaminated before each sampling attempt with an Alconox solution wash and a distilled water rinse. Soil samples were obtained at approximately 1-foot-depth intervals for field screening.

Selected samples from the test pits were selected for chemical analysis, based on field screening results. The samples were placed in laboratory-prepared sample containers and packed tightly to minimize headspace. The soil samples were kept cool before and during transport to the laboratory. Chain-of-custody procedures were followed in transporting the soil samples to the laboratory.

FIELD SCREENING OF SOIL SAMPLES

Soil samples obtained from the explorations were screened in the field for evidence of petroleum-related contamination using (1) visual examination and (2) sheen screening. The results of headspace and sheen screening are included in the test pit logs.

Visual screening consists of inspecting the soil for stains indicative of petroleum-related contamination. Visual screening is generally more effective when contamination is related to heavy petroleum hydrocarbons, such as motor oil or hydraulic oil, or when hydrocarbon concentrations are high. Sheen screening and headspace vapor screening are more sensitive methods that have been effective in detecting contamination at concentrations less than regulatory cleanup guidelines.

Sheen screening involves placing soil in a pan of water and observing the water surface for signs of sheen. Sheen classifications are as follows:

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

SOIL CLASSIFICATION SYSTEM

MAJOR DIVISIONS			GROUP SYMBOL	GROUP NAME
COARSE GRAINED SOILS More Than 50% Retained on No. 200 Sieve	GRAVEL More Than 50% of Coarse Fraction Retained on No. 4 Sieve	CLEAN GRAVEL	GW	WELL-GRADED GRAVEL, FINE TO COARSE GRAVEL
			GP	POORLY-GRADED GRAVEL
		GRAVEL WITH FINES	GM	SILTY GRAVEL
			GC	CLAYEY GRAVEL
	SAND More Than 50% of Coarse Fraction Passes No. 4 Sieve	CLEAN SAND	SW	WELL-GRADED SAND, FINE TO COARSE SAND
			SP	POORLY-GRADED SAND
		SAND WITH FINES	SM	SILTY SAND
			SC	CLAYEY SAND
FINE GRAINED SOILS More Than 50% Passes No. 200 Sieve	SILT AND CLAY Liquid Limit Less Than 50	INORGANIC	ML	SILT
			CL	CLAY
		ORGANIC	OL	ORGANIC SILT, ORGANIC CLAY
	SILT AND CLAY Liquid Limit 50 or More	INORGANIC	MH	SILT OF HIGH PLASTICITY, ELASTIC SILT
			CH	CLAY OF HIGH PLASTICITY, FAT CLAY
		ORGANIC	OH	ORGANIC CLAY, ORGANIC SILT
HIGHLY ORGANIC SOILS			PT	PEAT

NOTES:

1. Field classification is based on visual examination of soil in general accordance with ASTM D2488-90.
2. Soil classification using laboratory tests is based on ASTM D2487-90.
3. Descriptions of soil density or consistency are based on interpretation of blow count data, visual appearance of soils, and/or test data.

SOIL MOISTURE MODIFIERS:

Dry - Absence of moisture, dusty, dry to the touch

Moist - Damp, but no visible water

Wet - Visible free water or saturated, usually soil is obtained from below water table

GEI 85-85 Rev. 05/93

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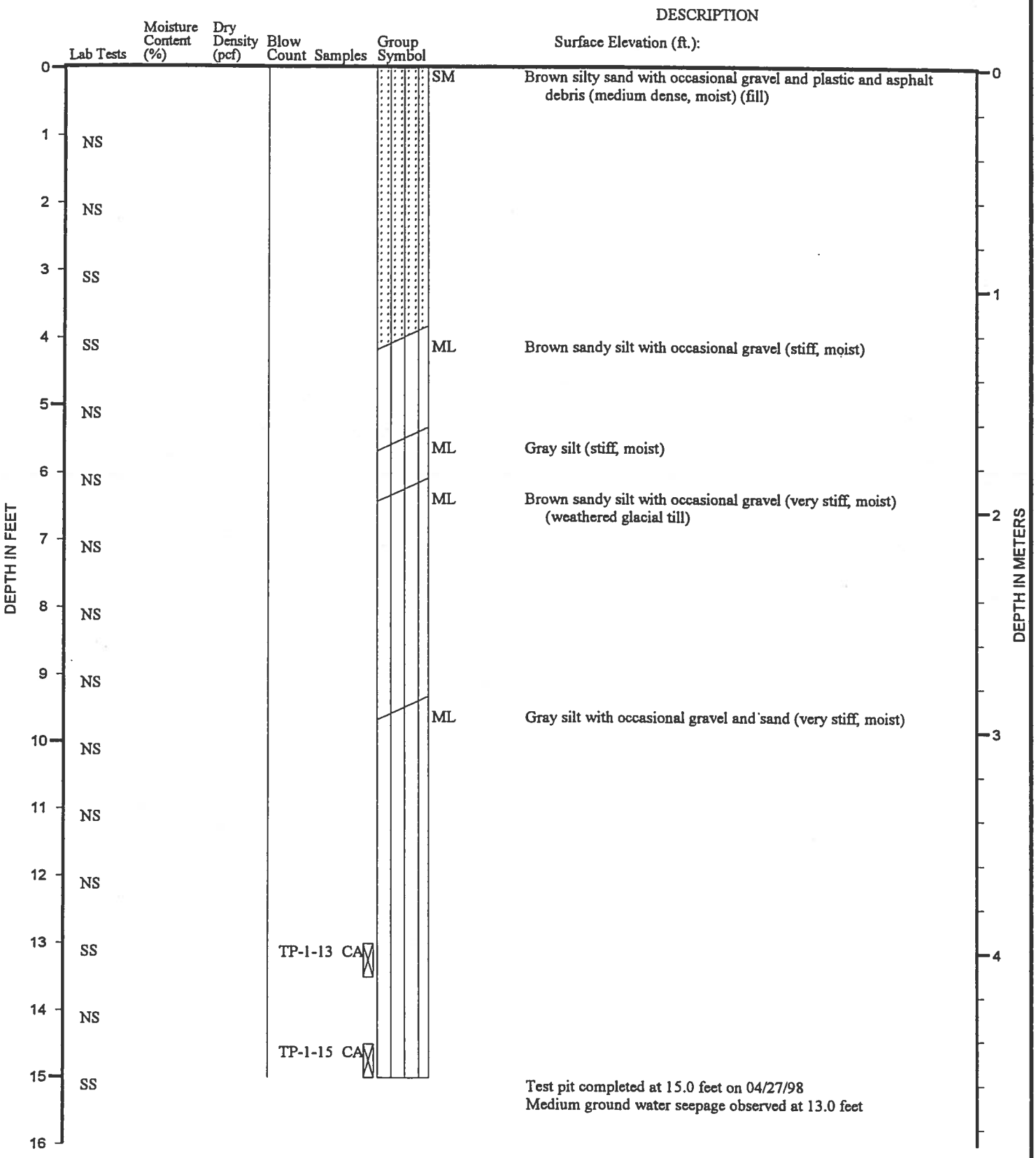
SOIL CLASSIFICATION SYSTEM

FIGURE A-1

TEST DATA

TEST PIT TP-1



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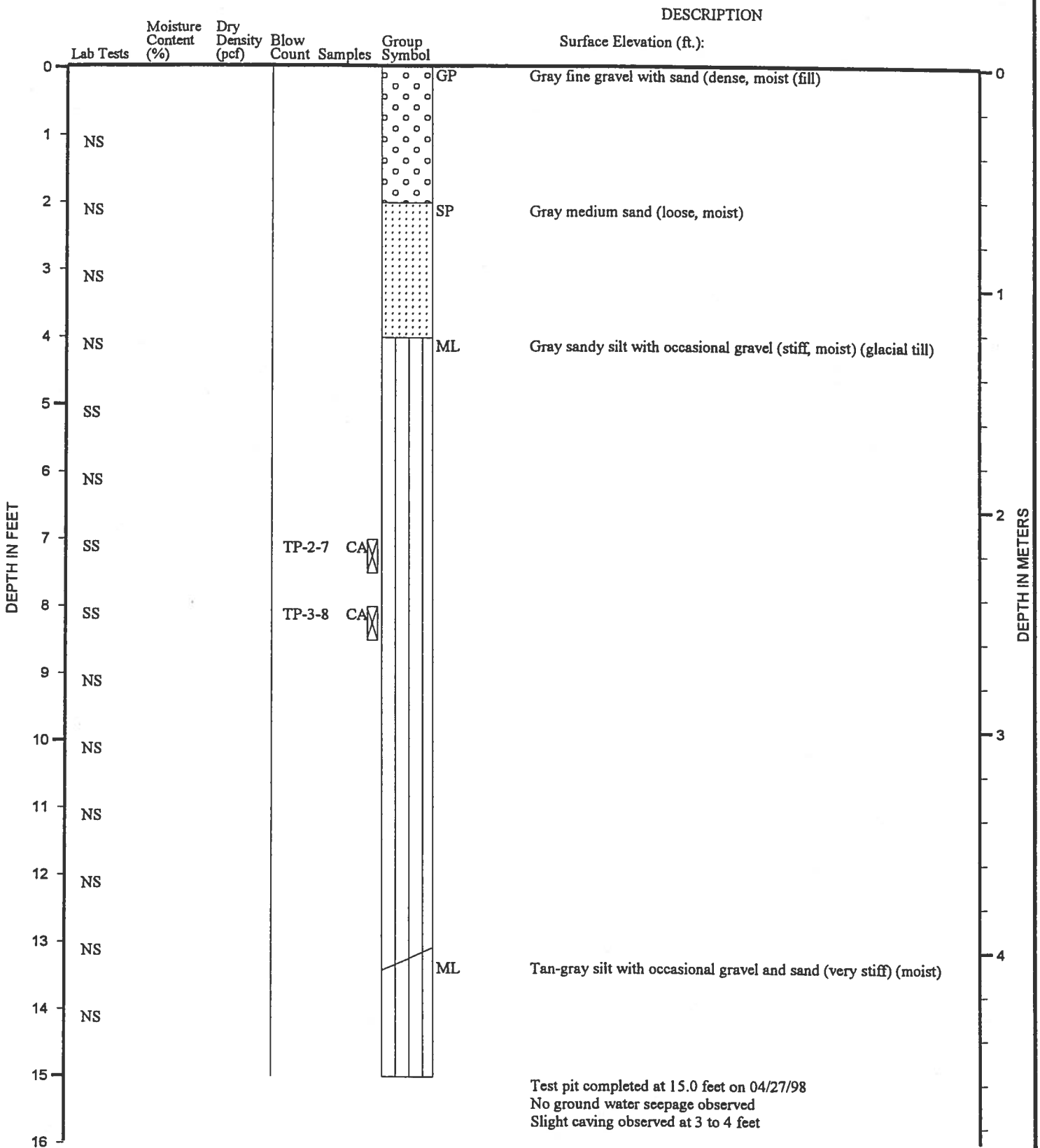
LOG OF TEST PIT

FIGURE A-2

TEST DATA

TEST PIT TP-2



GeoEngineers

LOG OF TEST PIT

FIGURE A-3

APPENDIX B

APPENDIX B

CHEMICAL ANALYTICAL PROGRAM

ANALYTICAL METHODS

Chain-of-custody procedures were followed during the transport of the field samples to the analytical laboratory. The soil samples were held in cold storage pending extraction and/or analysis. The analytical results, analytical methods reference and laboratory quality control records are included in this appendix. The analytical results also are summarized in the text and Table 2 of this report.

ANALYTICAL DATA REVIEW

The laboratory maintains an internal quality assurance program as documented in its laboratory quality assurance manual. The laboratory uses a combination of blanks, surrogate recoveries, duplicates, matrix spike recoveries, matrix spike duplicate recoveries, blank spike recoveries and blank spike duplicate recoveries to evaluate the validity of the analytical results. The laboratory also uses data quality goals for individual chemicals or groups of chemicals based on the long-term performance of the test methods. The data quality goals were included in the laboratory reports, where appropriate. The laboratory compared each group of samples with the existing data quality goals and noted any exceptions in the laboratory report. Data quality exceptions documented by the laboratory in the laboratory reports are reviewed by GeoEngineers using the applicable data validation guidelines from the following documents: "Laboratory Data Validation Functional Guidelines for Evaluating Inorganic Analyses" dated July 1988 (EPA document number EPA540/R94/083) and "USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review" dated February 1994 (EPA document number EPA540/R94/012).

ANALYTICAL DATA REVIEW SUMMARY

No significant data quality exceptions were noted in the laboratory report or during our review. Based on our data quality review, it is our opinion that the analytical data are of acceptable quality for their intended use.

NORTH CREEK ANALYTICAL
Environmental Laboratory Services

BOTHELL ▪ (425) 420-9200 ▪ FAX 420-9210
SPOKANE ▪ (509) 924-9200 ▪ FAX 924-9290
PORTLAND ▪ (503) 906-9200 ▪ FAX 906-9210

Geo Engineers - Bellingham	Project: UNOCAL BP #0138	Sampled: 4/27/98
600 Dupont St.	Project Number: 9161-205-00	Received: 4/28/98
Bellingham, WA 98225	Project Manager: Charles Lindsay	Reported: 11/5/98 12:11

ANALYTICAL REPORT FOR SAMPLES:

Sample Description	Laboratory Sample Number	Sample Matrix	Date Sampled
MW-5	B804586-01	Water	4/27/98
MW-9	B804586-02	Water	4/27/98
TP-1-15	B804586-03	Soil	4/27/98
TP-1-13	B804586-04	Soil	4/27/98
TP-2-8	B804586-05	Soil	4/27/98
TP-2-7	B804586-06	Soil	4/27/98

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The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

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Bellingham, WA 98225	Project Manager:	Charles Lindsay	Reported: 11/5/98 12:11

Gasoline Hydrocarbons (Toluene to Dodecane) and BTEX by WTPH-G and EPA 8021B
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Analyte	Batch Number	Date Prepared	Date Analyzed	Surrogate Limits	Reporting Limit	Result	Units	Notes*
MW-5			**B804586-01**				**Water**	
Gasoline Range Hydrocarbons	0580276	5/8/98	5/8/98		50.0	**139**	ug/l	
Benzene	"	"	"		0.500	ND	"	
Toluene	"	"	"		0.500	ND	"	
Ethylbenzene	"	"	"		0.500	**6.38**	"	
Xylenes (total)	"	"	"		1.00	**7.20**	"	
Surrogate: 4-BFB (FID)	"	"	"	*50.0-150*		*113*	*%*	
Surrogate: 4-BFB (PID)	"	"	"	*50.0-150*		*94.8*	"	
MW-9			**B804586-02**				**Water**	
Gasoline Range Hydrocarbons	0580276	5/8/98	5/8/98		50.0	**1930**	ug/l	
Benzene	"	"	"		1.25	**110**	"	
Toluene	"	"	"		0.500	**0.583**	"	
Ethylbenzene	"	"	"		1.25	**111**	"	
Xylenes (total)	"	"	"		1.00	**27.0**	"	
Surrogate: 4-BFB (FID)	"	"	"	*50.0-150*		*NR*	*%*	*1*
Surrogate: 4-BFB (PID)	"	"	"	*50.0-150*		*124*	"	
TP-1-13			**B804586-04**				**Soil**	
Gasoline Range Hydrocarbons	0580062	5/4/98	5/5/98		50.0	**171**	mg/kg dry	2
Benzene	"	"	"		0.500	ND	"	
Toluene	"	"	"		0.500	ND	"	
Ethylbenzene	"	"	"		0.500	ND	"	
Xylenes (total)	"	"	"		1.00	ND	"	
Surrogate: 4-BFB (FID)	"	"	"	*50.0-150*		*NR*	*%*	*3*
Surrogate: 4-BFB (PID)	"	"	"	*50.0-150*		*160*	"	*3*
TP-2-7			**B804586-06**				**Soil**	
Gasoline Range Hydrocarbons	0580062	5/4/98	5/5/98		5.00	**61.6**	mg/kg dry	2
Benzene	"	"	"		0.0500	ND	"	
Toluene	"	"	"		0.0500	ND	"	
Ethylbenzene	"	"	"		0.0500	ND	"	
Xylenes (total)	"	"	"		0.100	ND	"	
Surrogate: 4-BFB (FID)	"	"	"	*50.0-150*		*109*	*%*	
Surrogate: 4-BFB (PID)	"	"	"	*50.0-150*		*104*	"	

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**Refer to end of report for text of notes and definitions.*

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Bellingham, WA 98225	Project Manager:	Charles Lindsay	Reported: 11/5/98 12:11

Volatile Petroleum Hydrocarbons by modified WDOE Interim TPH Policy Method
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TP-2-8 Aliphatics 5-6 10, 6-8 10, 8-10 10, 10-12 27.0, 12-16 115, 16-21 129, 21-34 24.5, 325.5
TP-2-8 Aromatics 8-10 10, 10-12 25.4, 12-16 36.0 ~~34.7~~, 16-21 49.5, 21-34 13.7, 137.6

Analyte	Batch Number	Date Prepared	Date Analyzed	Surrogate Limits	Reporting Limit	Result	Units	Notes*
TP-1-15			**B804586-03**				**Soil**	
C5-C6 A	020	5/1/98	5/1/98		20.0	ND	mg/kg dry	
C6-C8 A		"	"		20.0	ND	"	
C8-C10 A		"	"		20.0	ND	"	
C10-C12		"	"		20.0	ND	"	
C8-C10 A		"	"		20.0	ND	"	
C10-C12 Aromatics		"	"		20.0	ND	"	
C12-C13 Aromatics		"	"		20.0	**23.0**	"	
Surrogate: 4-BFB (FID)		"	"	*60.0-140*		*134*	*%*	
Surrogate: 4-BFB (PID)		"	"	*60.0-140*		*122*	"	
TP-2-8			**B804586-05**				**Soil**	
C5-C6 Aliphatics	0580020	5/1/98	5/1/98		20.0	ND	mg/kg dry	
C6-C8 Aliphatics	"	"	"		20.0	ND	"	
C8-C10 Aliphatics	"	"	"		20.0	ND	"	
C10-C12 Aliphatics	"	"	"		20.0	**27.0**	"	2
C8-C10 Aromatics	"	"	"		20.0	ND	"	
C10-C12 Aromatics	"	"	"		20.0	**28.4**	"	2
C12-C13 Aromatics	"	"	"		20.0	**34.7**	"	2
Surrogate: 4-BFB (FID)	"	"	"	*60.0-140*		*147*	*%*	*1*
Surrogate: 4-BFB (PID)	"	"	"	*60.0-140*		*125*	"	

North Creek Analytical - Bothell

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600 Dupont St.	Project Number:	9161-205-00	Received: 4/28/98
Bellingham, WA 98225	Project Manager:	Charles Lindsay	Reported: 11/5/98 12:11

BTEX, MTBE and Naphthalene by WDOE Interim TPH Policy Method using GC/MS
North Creek Analytical - Bothell

Analyte	Batch Number	Date Prepared	Date Analyzed	Surrogate Limits	Reporting Limit	Result	Units	Notes*
TP-1-15			**B804586-03**				Soil	
Methyl tert-butyl ether	0580152	5/5/98	5/5/98		1.00	ND	mg/kg dry	
Benzene	"	"	"		0.100	ND	"	
Toluene	"	"	"		0.100	ND	"	
Ethylbenzene	"	"	"		0.100	ND	"	
m,p-Xylene	"	"	"		0.400	ND	"	
o-Xylene	"	"	"		0.100	ND	"	
Naphthalene	"	"	"		0.100	ND	"	
Surrogate: 2-Bromopropene	"	"	"	*70.0-130*		*90.5*	%	
Surrogate: 1,2-DCA-d4	"	"	"	*70.0-130*		*96.5*	"	
Surrogate: Toluene-d8	"	"	"	*70.0-130*		*95.2*	"	
Surrogate: 4-BFB	"	"	"	*70.0-130*		*93.9*	"	
TP-2-8			**B804586-05**				Soil	
Methyl tert-butyl ether	0580152	5/5/98	5/5/98		1.00	ND	mg/kg dry	
Benzene	"	"	"		0.100	ND	"	
Toluene	"	"	"		0.100	ND	"	
Ethylbenzene	"	"	"		0.100	ND	"	
m,p-Xylene	"	"	"		0.400	ND	"	
o-Xylene	"	"	"		0.100	ND	"	
Naphthalene	"	"	"		0.100	ND	"	
Surrogate: 2-Bromopropene	"	"	"	*70.0-130*		*97.0*	%	
Surrogate: 1,2-DCA-d4	"	"	"	*70.0-130*		*100*	"	
Surrogate: Toluene-d8	"	"	"	*70.0-130*		*101*	"	
Surrogate: 4-BFB	"	"	"	*70.0-130*		*96.5*	"	

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600 Dupont St.	Project Number:	9161-205-00	Received: 4/28/98
Bellingham, WA 98225	Project Manager:	Charles Lindsay	Reported: 11/5/98 12:11

Diesel Hydrocarbons (C12-C24) and Heavy Oil (C24-C40) by WTPH-D (extended) with Silica Gel Clean-up
North Creek Analytical - Bothell

Analyte	Batch Number	Date Prepared	Date Analyzed	Surrogate Limits	Reporting Limit	Result	Units	Notes*
MW-5			**B804586-01**				**Water**	
Diesel Range Hydrocarbons	0580030	5/1/98	5/4/98		0.250	ND	mg/l	
Heavy Oil Range Hydrocarbons	"	"	"		0.750	ND	"	
Surrogate: 2-FBP	"	"	"	*50.0-150*		*79.5*	*%*	
MW-9			**B804586-02**				**Water**	
Diesel Range Hydrocarbons	0580030	5/1/98	5/4/98		0.250	ND	mg/l	
Heavy Oil Range Hydrocarbons	"	"	"		0.750	ND	"	
Surrogate: 2-FBP	"	"	"	*50.0-150*		*110*	*%*	
TP-1-13			**B804586-04**				**Soil**	
Diesel Range Hydrocarbons	0480865	4/30/98	5/1/98		10.0	**405**	mg/kg dry	2
Heavy Oil Range Hydrocarbons	"	"	"		25.0	ND	"	
Surrogate: 2-FBP	"	"	"	*50.0-150*		*117*	*%*	
TP-2-7			**B804586-06**				**Soil**	
Diesel Range Hydrocarbons	0480865	4/30/98	4/30/98		10.0	**381**	mg/kg dry	2,4
Heavy Oil Range Hydrocarbons	"	"	"		25.0	ND	"	
Surrogate: 2-FBP	"	"	"	*50.0-150*		*95.9*	*%*	

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SPOKANE ▪ (509) 924-9200 ▪ FAX 924-9290
PORTLAND ▪ (503) 906-9200 ▪ FAX 906-9210

Geo Engineers - Bellingham	Project:	UNOCAL BP #0138	Sampled: 4/27/98
600 Dupont St.	Project Number:	9161-205-00	Received: 4/28/98
Bellingham, WA 98225	Project Manager:	Charles Lindsay	Reported: 11/5/98 12:11

Extractable Petroleum Hydrocarbons by modified WDOE Interim TPH Policy Method
North Creek Analytical - Bothell

Analyte	Batch Number	Date Prepared	Date Analyzed	Surrogate Limits	Reporting Limit	Result	Units	Notes*
TP-1-15			B804586-03				Soil	
C8-C10 Aliphatics	0580086	5/4/98	5/6/98		5.00	ND	mg/kg dry	
C10-C12 Aliphatics	"	"	"		5.00	ND	"	
C12-C16 Aliphatics	"	"	"		5.00	**57.4**	"	2
C16-C21 Aliphatics	"	"	"		5.00	**52.7**	"	2
C21-C34 Aliphatics	"	"	"		5.00	**6.30**	"	2
C10-C12 Aromatics	"	"	"		5.00	ND	"	
C12-C16 Aromatics	"	"	"		5.00	**23.2**	"	2
C16-C21 Aromatics	"	"	"		5.00	**21.6**	"	2
C21-C34 Aromatics	"	"	"		5.00	ND	"	
Extractable Petroleum Hydrocarbons	"	"	"		5.00	**161**	"	2
Surrogate: 2-FBP	"	"	"	*50.0-150*		*82.0*	*%*	
Surrogate: Octacosane	"	"	"	*50.0-150*		*61.8*	"	
Surrogate: Undecane	"	"	"	*30.0-150*		*64.7*	"	
TP-2-8			B804586-05				Soil	
C8-C10 Aliphatics	0580086	5/4/98	5/6/98		5.00	ND	mg/kg dry	
C10-C12 Aliphatics	"	"	"		5.00	**12.3**	"	2
C12-C16 Aliphatics	"	"	"		5.00	**115**	"	2
C16-C21 Aliphatics	"	"	"		5.00	**129**	"	2
C21-C34 Aliphatics	"	"	"		5.00	**24.5**	"	2
C10-C12 Aromatics	"	"	"		5.00	ND	"	
C12-C16 Aromatics	"	"	"		5.00	**36.0**	"	2
C16-C21 Aromatics	"	"	"		5.00	**49.5**	"	2
C21-C34 Aromatics	"	"	"		5.00	**13.7**	"	2
Extractable Petroleum Hydrocarbons	"	"	"		5.00	**380**	"	2
Surrogate: 2-FBP	"	"	"	*50.0-150*		*84.1*	*%*	
Surrogate: Octacosane	"	"	"	*50.0-150*		*61.7*	"	
Surrogate: Undecane	"	"	"	*30.0-150*		*67.0*	"	

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Steve Chang, Project Manager

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600 Dupont St.	Project Number:	9161-205-00	Received: 4/28/98
Bellingham, WA 98225	Project Manager:	Charles Lindsay	Reported: 11/5/98 12:11

Polynuclear Aromatic Hydrocarbons by GC/MS-SIM
North Creek Analytical - Bothell

Analyte	Batch Number	Date Prepared	Date Analyzed	Surrogate Limits	Reporting Limit	Result	Units	Notes*
TP-1-15			**B804586-03**				**Soil**	
Acenaphthene	0580086	5/4/98	5/6/98		0.0100	ND	mg/kg dry	
Acenaphthylene	"	"	"		0.0100	ND	"	
Anthracene	"	"	"		0.0100	**0.0548**	"	2
Benzo (a) anthracene	"	"	"		0.0100	ND	"	
Benzo (a) pyrene	"	"	"		0.0100	ND	"	
Benzo (b) fluoranthene	"	"	"		0.0100	ND	"	
Benzo (ghi) perylene	"	"	"		0.0100	ND	"	
Benzo (k) fluoranthene	"	"	"		0.0100	ND	"	
Chrysene	"	"	"		0.0100	ND	"	
Dibenz (a,h) anthracene	"	"	"		0.0100	ND	"	
Fluoranthene	"	"	"		0.0100	ND	"	
Fluorene	"	"	"		0.0100	**0.0895**	"	2
Indeno (1,2,3-cd) pyrene	"	"	"		0.0100	ND	"	
2-Methylnaphthalene	"	"	"		0.0100	**0.143**	"	2
Naphthalene	"	"	"		0.0100	**0.0116**	"	2
Phenanthrene	"	"	"		0.0100	**0.184**	"	2
Pyrene	"	"	"		0.0100	**0.0123**	"	2
Surrogate: p-Terphenyl-d14	"	"	"	*30.0-150*		*45.3*	*%*	
TP-2-8			**B804586-05**				**Soil**	
Acenaphthene	0580086	5/4/98	5/6/98		0.0100	ND	mg/kg dry	
Acenaphthylene	"	"	"		0.0100	ND	"	
Anthracene	"	"	"		0.0100	ND	"	
Benzo (a) anthracene	"	"	"		0.0100	ND	"	
Benzo (a) pyrene	"	"	"		0.0100	ND	"	
Benzo (b) fluoranthene	"	"	"		0.0100	ND	"	
Benzo (ghi) perylene	"	"	"		0.0100	ND	"	
Benzo (k) fluoranthene	"	"	"		0.0100	ND	"	
Chrysene	"	"	"		0.0100	ND	"	
Dibenz (a,h) anthracene	"	"	"		0.0100	ND	"	
Fluoranthene	"	"	"		0.0100	**0.0130**	"	2
Fluorene	"	"	"		0.0100	**0.100**	"	2
Indeno (1,2,3-cd) pyrene	"	"	"		0.0100	ND	"	
2-Methylnaphthalene	"	"	"		0.0100	ND	"	
Naphthalene	"	"	"		0.0100	**0.0230**	"	2
Phenanthrene	"	"	"		0.0100	ND	"	
Pyrene	"	"	"		0.0100	**0.0130**	"	2
Surrogate: p-Terphenyl-d14	"	"	"	*30.0-150*		*50.9*	*%*	

North Creek Analytical - Bothell

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Roy B Chang, Project Manager

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Geo Engineers - Bellingham	Project:	UNOCAL BP #0138	Sampled:	4/27/98
600 Dupont St.	Project Number:	9161-205-00	Received:	4/28/98
Bellingham, WA 98225	Project Manager:	Charles Lindsay	Reported:	11/5/98 12:11

Dry Weight Determination
North Creek Analytical - Bothell

Sample Name	Lab ID	Matrix	Result	Units
TP-1-15	B804586-03	Soil	86.4	%
TP-1-13	B804586-04	Soil	85.6	%
TP-2-8	B804586-05	Soil	87.0	%
TP-2-7	B804586-06	Soil	87.2	%

North Creek Analytical - Bothell

Joy B Chang, Project Manager

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Geo Engineers - Bellingham	Project:	UNOCAL BP #0138	Sampled: 4/27/98
600 Dupont St.	Project Number:	9161-205-00	Received: 4/28/98
Bellingham, WA 98225	Project Manager:	Charles Lindsay	Reported: 11/5/98 12:11

Gasoline Hydrocarbons (Toluene to Dodecane) and BTEX by WTPH-G and EPA 8021B/Quality Control
North Creek Analytical - Bothell

Analyte	Date Analyzed	Spike Level	Sample Result	QC Result	Units	Reporting Limit / Recov. Limits	Recov. %	RPD Limit	RPD %	Notes*
Batch: 0580062	**Date Prepared: 5/4/98**					**Extraction Method: EPA 5030B (P/T)**				
Blank	**0580062-BLK1**									
Gasoline Range Hydrocarbons	5/4/98			**ND**	mg/kg dry	**5.00**				
Benzene	"			**ND**	"	**0.0500**				
Toluene	"			**ND**	"	**0.0500**				
Ethylbenzene	"			**ND**	"	**0.0500**				
Xylenes (total)	"			**ND**	"	**0.100**				
Surrogate: 4-BFB (FID)	"	*4.00*		*4.90*	"	*50.0-150*	*123*			
Surrogate: 4-BFB (PID)	"	*4.00*		*4.68*	"	*50.0-150*	*117*			
LCS	**0580062-BS1**									
Gasoline Range Hydrocarbons	5/4/98	25.0		24.2	mg/kg dry	75.0-125	96.8			
Surrogate: 4-BFB (FID)	"	*4.00*		*4.59*	"	*50.0-150*	*115*			
Duplicate	**0580062-DUP1**		**B805021-02**							
Gasoline Range Hydrocarbons	5/5/98		ND	6.79	mg/kg dry			50.0		
Surrogate: 4-BFB (FID)	"	*4.94*		*4.92*	"	*50.0-150*	*99.6*			
Duplicate	**0580062-DUP2**		**B804663-02**							
Gasoline Range Hydrocarbons	5/5/98		ND	ND	mg/kg dry			50.0		
Surrogate: 4-BFB (FID)	"	*4.63*		*5.01*	"	*50.0-150*	*108*			
Matrix Spike	**0580062-MS1**		**B804663-10**							
Benzene	5/5/98	0.542	ND	0.533	mg/kg dry	60.0-140	**98.3**			
Toluene	"	0.542	ND	0.558	"	60.0-140	**103**			
Ethylbenzene	"	0.542	ND	0.544	"	60.0-140	**100**			
Xylenes (total)	"	1.62	ND	1.65	"	60.0-140	**102**			
Surrogate: 4-BFB (PID)	"	*4.33*		*4.50*	"	*50.0-150*	*104*			
Matrix Spike Dup	**0580062-MSD1**		**B804663-10**							
Benzene	5/5/98	0.542	ND	0.524	mg/kg dry	60.0-140	**96.7**	20.0	**1.64**	
Toluene	"	0.542	ND	0.548	"	60.0-140	**101**	20.0	**1.96**	
Ethylbenzene	"	0.542	ND	0.532	"	60.0-140	**98.2**	20.0	**1.82**	
Xylenes (total)	"	1.62	ND	1.62	"	60.0-140	**100**	20.0	**1.98**	
Surrogate: 4-BFB (PID)	"	*4.33*		*4.58*	"	*50.0-150*	*106*			
Batch: 0580276	**Date Prepared: 5/8/98**					**Extraction Method: EPA 5030B (P/T)**				
Blank	**0580276-BLK1**									
Gasoline Range Hydrocarbons	5/8/98			**ND**	ug/l	**50.0**				

North Creek Analytical - Bothell

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Geo Engineers - Bellingham	Project:	UNOCAL BP #0138	Sampled: 4/27/98
600 Dupont St.	Project Number:	9161-205-00	Received: 4/28/98
Bellingham, WA 98225	Project Manager:	Charles Lindsay	Reported: 11/5/98 12:11

Gasoline Hydrocarbons (Toluene to Dodecane) and BTEX by WTPH-G and EPA 8021B/Quality Control
North Creek Analytical - Bothell

Analyte	Date Analyzed	Spike Level	Sample Result	QC Result	Units	Reporting Limit / Recov. Limits	Recov. %	RPD Limit	RPD %	Notes*
Blank (continued)	0580276-BLK1									
Benzene	5/8/98			ND	ug/l	0.500				
Toluene	"			ND	"	0.500				
Ethylbenzene	"			ND	"	0.500				
Xylenes (total)	"			ND	"	1.00				
Surrogate: 4-BFB (FID)	"	*48.0*		*49.6*	"	*50.0-150*	*103*			
Surrogate: 4-BFB (PID)	"	*48.0*		*43.1*	"	*50.0-150*	*89.8*			
LCS	0580276-BS1									
Gasoline Range Hydrocarbons	5/8/98	500		536	ug/l	70.0-130	107			
Surrogate: 4-BFB (FID)	"	*48.0*		*52.2*	"	*50.0-150*	*109*			
Duplicate	0580276-DUP1		B804641-03							
Gasoline Range Hydrocarbons	5/8/98		33700	36500	ug/l			25.0	7.98	
Surrogate: 4-BFB (FID)	"	*48.0*		*59.1*	"	*50.0-150*	*123*			
Duplicate	0580276-DUP2		B804641-07							
Gasoline Range Hydrocarbons	5/8/98		248	202	ug/l			25.0	20.4	
Surrogate: 4-BFB (FID)	"	*48.0*		*54.9*	"	*50.0-150*	*114*			
Matrix Spike	0580276-MS1		B804641-04							
Benzene	5/8/98	10.0	ND	8.83	ug/l	70.0-130	88.3			
Toluene	"	10.0	0.564	8.58	"	70.0-130	80.2			
Ethylbenzene	"	10.0	ND	8.71	"	70.0-130	87.1			
Xylenes (total)	"	30.0	ND	26.0	"	70.0-130	86.7			
Surrogate: 4-BFB (PID)	"	*48.0*		*43.4*	"	*50.0-150*	*90.4*			
Matrix Spike Dup	0580276-MSD1		B804641-04							
Benzene	5/8/98	10.0	ND	9.06	ug/l	70.0-130	90.6	15.0	2.57	
Toluene	"	10.0	0.564	8.62	"	70.0-130	80.6	15.0	0.498	
Ethylbenzene	"	10.0	ND	8.74	"	70.0-130	87.4	15.0	0.344	
Xylenes (total)	"	30.0	ND	25.8	"	70.0-130	86.0	15.0	0.811	
Surrogate: 4-BFB (PID)	"	*48.0*		*43.5*	"	*50.0-150*	*90.6*			

North Creek Analytical - Bothell

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Geo Engineers - Bellingham	Project:	UNOCAL BP #0138	Sampled: 4/27/98
600 Dupont St.	Project Number:	9161-205-00	Received: 4/28/98
Bellingham, WA 98225	Project Manager:	Charles Lindsay	Reported: 11/5/98 12:11

Volatile Petroleum Hydrocarbons by modified WDOE Interim TPH Policy Method/Quality Control
North Creek Analytical - Bothell

Analyte	Date Analyzed	Spike Level	Sample Result	QC Result	Units	Reporting Limit / Recov. Limits	Recov. %	RPD Limit	RPD %	Notes*
Batch: 0580020	**Date Prepared: 5/1/98**					**Extraction Method: EPA 5030B (MeOH)**				
Blank	**0580020-BLK1**									
C5-C6 Aliphatics	5/5/98			**ND**	mg/kg dry	**5.00**				
C6-C8 Aliphatics	"			**ND**	"	**5.00**				
C8-C10 Aliphatics	"			**ND**	"	**5.00**				
C10-C12 Aliphatics	"			**ND**	"	**5.00**				
C8-C10 Aromatics	"			**ND**	"	**5.00**				
C10-C12 Aromatics	"			**ND**	"	**5.00**				
C12-C13 Aromatics	"			**ND**	"	**5.00**				
Surrogate: 4-BFB (FID)	"	*4.00*		*5.61*	"	*60.0-140*	*140*			
Surrogate: 4-BFB (PID)	"	*4.00*		*4.95*	"	*60.0-140*	*124*			
LCS	**0580020-BS1**									
C5-C6 Aliphatics	5/1/98	2.00		1.64	mg/kg dry	70.0-130	82.0			
C6-C8 Aliphatics	"	1.00		1.22	"	70.0-130	122			
C8-C10 Aliphatics	"	1.00		1.28	"	70.0-130	128			
C10-C12 Aliphatics	"	1.00		1.13	"	70.0-130	113			
C8-C10 Aromatics	"	4.00		3.73	"	70.0-130	93.3			
C10-C12 Aromatics	"	1.00		1.03	"	70.0-130	103			
C12-C13 Aromatics	"	2.00		1.78	"	70.0-130	89.0			
Surrogate: 4-BFB (FID)	"	*4.00*		*5.56*	"	*60.0-140*	*139*			
Surrogate: 4-BFB (PID)	"	*4.00*		*4.92*	"	*60.0-140*	*123*			
Duplicate	**0580020-DUP1**		**B804454-15**							
C5-C6 Aliphatics	5/1/98		ND	ND	mg/kg dry			25.0		
C6-C8 Aliphatics	"		ND	ND	"			25.0		
C8-C10 Aliphatics	"		ND	ND	"			25.0		
C10-C12 Aliphatics	"		106	100	"			25.0	**5.83**	
C8-C10 Aromatics	"		ND	ND	"			25.0		
C10-C12 Aromatics	"		122	120	"			25.0	**1.65**	
C12-C13 Aromatics	"		278	278	"			25.0	**0**	
Surrogate: 4-BFB (FID)	"	*4.59*		*ND*	"	*60.0-140*	*NR*			*1*
Surrogate: 4-BFB (PID)	"	*4.59*		*ND*	"	*60.0-140*	*NR*			*1*

North Creek Analytical - Bothell

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Geo Engineers - Bellingham	Project:	UNOCAL BP #0138	Sampled: 4/27/98
600 Dupont St.	Project Number:	9161-205-00	Received: 4/28/98
Bellingham, WA 98225	Project Manager:	Charles Lindsay	Reported: 11/5/98 12:11

BTEX, MTBE and Naphthalene by WDOE Interim TPH Policy Method using GC/MS/Quality Control
North Creek Analytical - Bothell

Analyte	Date Analyzed	Spike Level	Sample Result	QC Result	Units	Reporting Limit / Recov. Limits	Recov. %	RPD Limit	RPD %	Notes*
Batch: 0580152	**Date Prepared: 5/5/98**					**Extraction Method: EPA 5030B [MeOH]**				
Blank	**0580152-BLK1**									
Methyl tert-butyl ether	5/5/98			**ND**	mg/kg dry	**1.00**				
Benzene	"			**ND**	"	**0.100**				
Toluene	"			**ND**	"	**0.100**				
Ethylbenzene	"			**ND**	"	**0.100**				
m,p-Xylene	"			**ND**	"	**0.400**				
o-Xylene	"			**ND**	"	**0.100**				
Naphthalene	"			**ND**	"	**0.100**				
Surrogate: 2-Bromopropene	"	*2.00*		*2.00*	"	*70.0-130*	*100*			
Surrogate: 1,2-DCA-d4	"	*2.00*		*1.99*	"	*70.0-130*	*99.5*			
Surrogate: Toluene-d8	"	*2.00*		*1.95*	"	*70.0-130*	*97.5*			
Surrogate: 4-BFB	"	*2.00*		*1.91*	"	*70.0-130*	*95.5*			
LCS	**0580152-BS1**									
Benzene	5/5/98	1.00		0.974	mg/kg dry	70.0-130	97.4			
Toluene	"	1.00		0.891	"	70.0-130	89.1			
Surrogate: 2-Bromopropene	"	*2.00*		*2.05*	"	*70.0-130*	*102*			
Surrogate: 1,2-DCA-d4	"	*2.00*		*2.17*	"	*70.0-130*	*109*			
Surrogate: Toluene-d8	"	*2.00*		*2.02*	"	*70.0-130*	*101*			
Surrogate: 4-BFB	"	*2.00*		*1.99*	"	*70.0-130*	*99.5*			
Matrix Spike	**0580152-MS1**		**B804651-02**							
Benzene	5/6/98	1.08	ND	1.09	mg/kg dry	70.0-130	**101**			
Toluene	"	1.08	ND	1.01	"	70.0-130	**93.5**			
Surrogate: 2-Bromopropene	"	*2.16*		*2.07*	"	*70.0-130*	*95.8*			
Surrogate: 1,2-DCA-d4	"	*2.16*		*2.32*	"	*70.0-130*	*107*			
Surrogate: Toluene-d8	"	*2.16*		*2.13*	"	*70.0-130*	*98.6*			
Surrogate: 4-BFB	"	*2.16*		*2.10*	"	*70.0-130*	*97.2*			
Matrix Spike Dup	**0580152-MSD1**		**B804651-02**							
Benzene	5/6/98	1.08	ND	1.11	mg/kg dry	70.0-130	**103**	20.0	**1.96**	
Toluene	"	1.08	ND	1.02	"	70.0-130	**94.4**	20.0	**0.958**	
Surrogate: 2-Bromopropene	"	*2.16*		*2.08*	"	*70.0-130*	*96.3*			
Surrogate: 1,2-DCA-d4	"	*2.16*		*2.33*	"	*70.0-130*	*108*			
Surrogate: Toluene-d8	"	*2.16*		*2.12*	"	*70.0-130*	*98.1*			
Surrogate: 4-BFB	"	*2.16*		*2.10*	"	*70.0-130*	*97.2*			

North Creek Analytical - Bothell

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Geo Engineers - Bellingham	Project:	UNOCAL BP #0138	Sampled: 4/27/98
600 Dupont St.	Project Number:	9161-205-00	Received: 4/28/98
Bellingham, WA 98225	Project Manager:	Charles Lindsay	Reported: 11/5/98 12:11

Diesel Hydrocarbons (C12-C24) and Heavy Oil (C24-C40) by WTPH-D (extended) with Silica Gel Clean-up/Quality Control
North Creek Analytical - Bothell

Analyte	Date Analyzed	Spike Level	Sample Result	QC Result	Units	Reporting Limit / Recov. Limits	Recov. %	RPD Limit	RPD %	Notes*
Batch: 0480865	**Date Prepared: 4/30/98**					**Extraction Method: EPA 3550B**				
Blank	**0480865-BLK1**									
Diesel Range Hydrocarbons	4/30/98			**ND**	mg/kg dry	**10.0**				
Heavy Oil Range Hydrocarbons	"			**ND**	"	**25.0**				
Surrogate: 2-FBP	"	*10.7*		*7.14*	"	*50.0-150*	*66.7*			
LCS	**0480865-BS1**									
Diesel Range Hydrocarbons	4/30/98	66.7		54.5	mg/kg dry	60.0-120	81.7			
Surrogate: 2-FBP	"	*10.7*		*8.56*	"	*50.0-150*	*80.0*			
Duplicate	**0480865-DUP1**	**B804586-04**								
Diesel Range Hydrocarbons	5/1/98		405	383	mg/kg dry			56.0	**5.58**	
Surrogate: 2-FBP	"	*12.5*		*10.9*	"	*50.0-150*	*87.2*			
Batch: 0580030	**Date Prepared: 5/1/98**					**Extraction Method: EPA 3520C/600 Series**				
Blank	**0580030-BLK1**									
Diesel Range Hydrocarbons	5/4/98			**ND**	mg/l	**0.250**				
Heavy Oil Range Hydrocarbons	"			**ND**	"	**0.750**				
Surrogate: 2-FBP	"	*0.320*		*0.224*	"	*50.0-150*	*70.0*			
LCS	**0580030-BS1**									
Diesel Range Hydrocarbons	5/4/98	2.00		1.48	mg/l	60.0-120	74.0			
Surrogate: 2-FBP	"	*0.320*		*0.253*	"	*50.0-150*	*79.1*			
Duplicate	**0580030-DUP2**	**B804656-03**								
Diesel Range Hydrocarbons	5/4/98		ND	ND	mg/l			44.0		
Surrogate: 2-FBP	"	*0.641*		*0.610*	"	*50.0-150*	*95.2*			

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Geo Engineers - Bellingham	Project:	UNOCAL BP #0138	Sampled: 4/27/98
600 Dupont St.	Project Number:	9161-205-00	Received: 4/28/98
Bellingham, WA 98225	Project Manager:	Charles Lindsay	Reported: 11/5/98 12:11

Extractable Petroleum Hydrocarbons by modified WDOE Interim TPH Policy Method/Quality Control
North Creek Analytical - Bothell

Analyte	Date Analyzed	Spike Level	Sample Result	QC Result	Units	Reporting Limit / Recov. Limits	Recov. %	RPD Limit	RPD %	Notes*
Batch: 0580086	**Date Prepared: 5/4/98**					**Extraction Method: EPA 3550B**				
Blank	**0580086-BLK1**									
C8-C10 Aliphatics	5/5/98			ND	mg/kg dry	5.00				
C10-C12 Aliphatics	"			ND	"	5.00				
C12-C16 Aliphatics	"			ND	"	5.00				
C16-C21 Aliphatics	"			ND	"	5.00				
C21-C34 Aliphatics	"			ND	"	5.00				
C10-C12 Aromatics	"			ND	"	5.00				
C12-C16 Aromatics	"			ND	"	5.00				
C16-C21 Aromatics	"			ND	"	5.00				
C21-C34 Aromatics	"			ND	"	5.00				
Extractable Petroleum Hydrocarbons	"			ND	"	5.00				
Surrogate: 2-FBP	"	*12.0*		*8.65*	"	*50.0-150*	*72.1*			
Surrogate: Octacosane	"	*12.0*		*3.23*	"	*50.0-150*	*26.9*			6
Surrogate: Undecane	"	*12.0*		*7.18*	"	*30.0-150*	*59.8*			
LCS	**0580086-BS1**									
Extractable Petroleum Hydrocarbons	5/5/98	167		95.5	mg/kg dry	30.0-120	57.2			
Surrogate: 2-FBP	"	*12.0*		*9.14*	"	*50.0-150*	*76.2*			
Surrogate: Octacosane	"	*12.0*		*4.60*	"	*50.0-150*	*38.3*			6
Surrogate: Undecane	"	*12.0*		*8.00*	"	*30.0-150*	*66.7*			
LCS Dup	**0580086-BSD1**									
Extractable Petroleum Hydrocarbons	5/5/98	167		96.9	mg/kg dry	30.0-120	58.0	40.0	1.39	
Surrogate: 2-FBP	"	*12.0*		*9.35*	"	*50.0-150*	*77.9*			
Surrogate: Octacosane	"	*12.0*		*5.16*	"	*50.0-150*	*43.0*			6
Surrogate: Undecane	"	*12.0*		*7.78*	"	*30.0-150*	*64.8*			
Matrix Spike	**0580086-MS1**		**B805033-01**							
Extractable Petroleum Hydrocarbons	5/6/98	219	ND	134	mg/kg dry	30.0-120	**61.2**			
Surrogate: 2-FBP	*5/5/98*	*15.8*		*11.3*	"	*50.0-150*	*71.5*			
Surrogate: Octacosane	*5/6/98*	*15.8*		*8.13*	"	*50.0-150*	*51.5*			
Surrogate: Undecane	"	*15.8*		*10.8*	"	*30.0-150*	*68.4*			

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**Refer to end of report for text of notes and definitions.*

Chang, Project Manager

NORTH CREEK ANALYTICAL
Environmental Laboratory Services

BOTHELL ▪ (425) 420-9200 ▪ FAX 420-9210
SPOKANE ▪ (509) 924-9200 ▪ FAX 924-9290
PORTLAND ▪ (503) 906-9200 ▪ FAX 906-9210

Geo Engineers - Bellingham	Project:	UNOCAL BP #0138	Sampled: 4/27/98
600 Dupont St.	Project Number:	9161-205-00	Received: 4/28/98
Bellingham, WA 98225	Project Manager:	Charles Lindsay	Reported: 11/5/98 12:11

Polynuclear Aromatic Hydrocarbons by GC/MS-SIM/Quality Control
North Creek Analytical - Bothell

Analyte	Date Analyzed	Spike Level	Sample Result	QC Result	Units	Reporting Limit / Recov. Limits	Recov. %	RPD Limit	RPD %	Notes*
Batch: 0580086	**Date Prepared: 5/4/98**					**Extraction Method: EPA 3550B**				
Blank	**0580086-BLK1**									
Acenaphthene	5/6/98			ND	mg/kg dry	0.0100				
Acenaphthylene	"			ND	"	0.0100				
Anthracene	"			ND	"	0.0100				
Benzo (a) anthracene	"			ND	"	0.0100				
Benzo (a) pyrene	"			ND	"	0.0100				
Benzo (b) fluoranthene	"			ND	"	0.0100				
Benzo (ghi) perylene	"			ND	"	0.0100				
Benzo (k) fluoranthene	"			ND	"	0.0100				
Chrysene	"			ND	"	0.0100				
Dibenz (a,h) anthracene	"			ND	"	0.0100				
Fluoranthene	"			ND	"	0.0100				
Fluorene	"			ND	"	0.0100				
Indeno (1,2,3-cd) pyrene	"			ND	"	0.0100				
2-Methylnaphthalene	"			ND	"	0.0100				
Naphthalene	"			ND	"	0.0100				
Phenanthrene	"			ND	"	0.0100				
Pyrene	"			ND	"	0.0100				
Surrogate: p-Terphenyl-d14	"	*0.250*		*0.103*	"	*30.0-150*	*41.2*			
LCS	**0580086-BS1**									
Chrysene	5/6/98	0.0667		0.0433	mg/kg dry	10.0-125	64.9			
Fluorene	"	0.0667		0.0433	"	11.0-116	64.9			
Indeno (1,2,3-cd) pyrene	"	0.0667		0.0473	"	10.0-147	70.9			
Surrogate: p-Terphenyl-d14	"	*0.250*		*0.109*	"	*30.0-150*	*43.6*			
LCS Dup	**0580086-BSD1**									
Chrysene	5/6/98	0.0667		0.0560	mg/kg dry	10.0-125	84.0	28.0	25.7	
Fluorene	"	0.0667		0.0520	"	11.0-116	78.0	32.0	18.3	
Indeno (1,2,3-cd) pyrene	"	0.0667		0.0673	"	10.0-147	101	34.0	35.0	7
Surrogate: p-Terphenyl-d14	"	*0.250*		*0.135*	"	*30.0-150*	*54.0*			
Matrix Spike	**0580086-MS1**	**B805033-01**								
Chrysene	5/6/98	0.0876	ND	0.0613	mg/kg dry	10.0-125	**70.0**			
Fluorene	"	0.0876	ND	0.0596	"	10.0-154	**68.0**			
Indeno (1,2,3-cd) pyrene	"	0.0876	ND	0.0666	"	10.0-144	**76.0**			
Surrogate: p-Terphenyl-d14	"	*0.329*		*0.146*	"	*30.0-150*	*44.4*			

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**Refer to end of report for text of notes and definitions.*

Joy B Chang, Project Manager

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Environmental Laboratory Services

BOTHELL ▪ (425) 420-9200 ▪ FAX 420-9210
SPOKANE ▪ (509) 924-9200 ▪ FAX 924-9290
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Notes and Definitions

#	Note
1	The surrogate recovery for this sample cannot be accurately quantified due to interference from coeluting organic compounds present in the sample.
2	The dry-weight corrected result for this analyte is based upon a total solids value which has been amended from previously reported data.
3	The surrogate recovery for this sample is not available due to sample dilution required from high analyte concentration and/or matrix interferences.
4	The heavy oil range organics present are due to hydrocarbons eluting primarily in the diesel range.
5	Analyses are not controlled on RPD values from sample concentrations less than 10 times the reporting limit.
6	The Surrogate recovery is below the established control limits. Review of associated QC indicates the low recovery does not represent an out-of-control condition for the batch.
7	The RPD value for this QC sample is above the established control limit. Review of associated QC indicates the high RPD does not represent an out-of-control condition for the batch.
DET	Analyte DETECTED
ND	Analyte NOT DETECTED at or above the reporting limit
NR	Not Reported
dry	Sample results reported on a dry weight basis
Recov.	Recovery
RPD	Relative Percent Difference

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Chang, Project Manager

APPENDIX C

APPENDIX C

USE OF INTERIM TPH POLICY

INTERIM TPH POLICY METHODS

The MTCA cleanup regulations require that the evaluation of soil contamination and determination of soil cleanup levels be based on consideration of (1) direct contact, and (2) protection of ground water. Similarly, the Interim TPH Policy requires consideration of both components in evaluating petroleum contamination and arriving at a soil cleanup level. Since ground water contamination is present at the site and Unocal is not requesting an NFA for ground water at this site, we did not evaluate the soil-to-ground water pathway using the Interim TPH Policy. Identification of the hydrocarbon fractions and quantification of their toxicity and transport characteristics (using surrogates) were required to evaluate the level of contamination and calculate a soil cleanup level for the site's petroleum constituents in accordance with the Interim TPH Policy. Considerations of current and future site use also were necessary to apply the appropriate MTCA method. For this site, it was assumed that the highest potential beneficial use of the property is residential; therefore, MTCA Method B was used for evaluation of contamination and in calculating a soil cleanup level.

The MTCA Method B formula for evaluating soil contamination and calculating a human health risk-based soil cleanup based on direct contact, as applied in the Interim TPH Policy, considers only the soil ingestion exposure pathway. This was considered sufficient for contamination evaluation and calculation of a TPH cleanup level in soil. Soil-to-ground water transport of and subsequent ingestion of ground water also was considered in our assessment. The reader is referred to the Interim TPH Policy (Ecology Publication ECY 97-600) for background information and assumptions that pertain to the use of the Interim TPH policy.

TOXICITY

Petroleum products typically are composed of thousands of individual chemicals. Toxicity criteria that relate the intake (dose) of a chemical to a response are available for only a handful of the individual chemicals that may be present in petroleum products. A cleanup level based on toxicity cannot be calculated for individual chemicals (or for petroleum products) unless a toxicity criterion, such as a reference dose for a non-carcinogen or a potency factor for a carcinogen, is available. The Interim TPH Policy uses a surrogate approach to account for compound-specific data that is not yet available. In the surrogate approach, a reference compound is identified as a representative of individual petroleum hydrocarbon fractions. These reference compounds are selected because their toxicity is relatively well characterized in that either a reference dose or potency factor is available, or a dose-response value can be

developed from available toxicity data. The toxicity criterion identified for the reference compound is then assumed to represent a surrogate toxicity criterion for the associated hydrocarbon fraction.

For the purpose of identifying surrogate toxicity criteria for hydrocarbon fractions, petroleum hydrocarbons are divided into broad chemical classes. Surrogate toxicity criteria are then identified for each group of compounds using the methods described above. Ecology has selected one compound representing the aliphatic fractions (n-hexane) and one compound representing the aromatic fractions (pyrene) that likely have the most conservative toxicity criteria. Surrogate criteria for other hydrocarbon fractions are likely multiples of these. Until sufficient data are made available for developing surrogate toxicity criteria for the other hydrocarbon fractions, the Ecology Interim TPH Policy requires that (1) all aliphatics be grouped together, (2) all aromatics be grouped together, and (3) the aliphatic and aromatic groups be represented by the toxicity criteria for n-hexane and pyrene, respectively. This surrogate approach was used in our calculation of the Method B cleanup level in soil based on direct contact.

The surrogate method used in the Interim TPH Policy for evaluation of contamination and in calculating petroleum hydrocarbon cleanup levels does not account for the noncarcinogenic toxicity contribution of ethylbenzene, toluene, and xylene. It also does not account for the carcinogenic health effect contribution from benzene and carcinogenic PAHs that may be present in the petroleum product. These compounds are quantified and evaluated separately, and cleanup levels are calculated for each compound using their specific reference dose or potency factors.

Although a reference dose value is not available for benzene for noncarcinogenic health effects, these health effects are accounted for in evaluating the contamination and in calculating the TPH cleanup level by the surrogate approach. The Interim TPH Policy assumes that benzene has noncarcinogenic health effects as well as its carcinogenic health effects and assumes that the reference dose for benzene is equal to the surrogate value for aromatics (0.03 mg/kg/day).

The hydrocarbon compounds are all considered noncarcinogenic, based on the toxicity information currently available. Therefore, only reference dose (ORfD) values are provided.

FATE AND TRANSPORT

The fate and transport of hydrocarbons in the subsurface is a significant component of the Interim TPH Policy. Similar to the approach discussed above for toxicity, surrogate physical and chemical properties of different hydrocarbon fractions are used to represent and evaluate hydrocarbons movement through and into soil, water and air. Based largely on studies completed by the National TPH Criteria Working Group, the Ecology Interim TPH policy uses six aliphatic fractions, five aromatic fractions, and benzene and toluene in evaluating the fate and transport of petroleum products. The TPH Criteria Working Group grouped the numerous

TPH constituents into the aliphatic and aromatic fractions based on the similarity of their chemical properties. Constituent chemical properties such as equivalent carbon number, soil-water sorption coefficient, organic-carbon partition coefficient, octanol-water partition coefficient, and Henry's Law Constant, dictate how they are transported in different media and where used to select the hydrocarbon fractions.

Although MTCA requires that each potential transport pathway of concern be evaluated, the Interim TPH Policy specifically mentions two transport pathways: (1) soil-to-ground water and (2) soil to indoor air confined space. As stated above, we did not evaluate the soil-to-ground water pathway using Interim TPH Policy methods (Raoult's Law) at this site because known ground water contamination is present. Specific methods for evaluating the soil to indoor air confined space pathway are not addressed in the Interim TPH Policy.

TABLE C-1
RESIDENTIAL HAZARD INDEX AND CARCINOGENIC RISK FOR DIRECT CONTACT
SAMPLE TP-2-8

FORMER UNOCAL BULK PLANT 0138
COUPEVILLE, WASHINGTON

Compound	Detected Soil Concentration[1] (mg/kg)	ORfD	Residential		
			Factor	Multiplier	HQ
Total aliphatics	325.5	0.06	1.25E-05	2.08E-04	6.78E-02
Total aromatics	137.6	0.03	See Below	See Below	See Below
Benzene	0.05	NA	NA	NA	NA
Ethylbenzene	0.05	0.1	1.25E-05	1.25E-04	0.00
Toluene	0.05	0.2	1.25E-05	6.25E-05	3.13E-06
Xylenes	0.25	2	1.25E-05	6.25E-06	1.56E-06
Total aromatic+B-E-X	137.4	0.03	1.25E-05	4.17E-04	5.73E-02
Hazard Index					**0.13**

Notes:

[1]The highest concentration for each compound or fraction detected by VPH or EPH. Values not detected are assumed as 1/2 of the detection limit.

Total TPH (sum of aliphatic and aromatics) = 463.1
% total allphatics 70.29%
% total aromatics 29.71%

ORfD = oral reference dose
Factor = residential factor as defined in Interim Policy
Multiplier = Factor/ORfD
HQ = hazard quotient
Hazard Index = sum of HQs
NA = not applicable

Carcinogens	Detected Soil Concentration[1] (mg/kg)	OCPF (kg-day/mg)	Risk
Benzene	0.050	0.029	1.45E-09
cPAHs[2]	0.350	7.3	2.56E-06
Total Risk			2.56E-06

Notes:

[1]Benzene and cPAHs were not detected; therefore, an assumed concentration equal to one half the laboratory detection limit was used for this calculation. cPAHs refers to the sum of the seven carcinogenic PAH compounds.

[2]Individual carcinogenic risk for each cPAH is less than 1 E-06.

mg/kg = milligrams per kilogram
kd-day/mg = kilogram*day per milligram
OCPF = oral cancer potency factor
Risk = Soil Concentration * OCPF * 1x10E-06
Total Risk = sum of benzene risk and cPAH risk

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TABLE C-2
MTCA METHOD B SOIL CLEANUP LEVEL CALCULATION[1]
BASED ON RESIDENTIAL DIRECT CONTACT

FORMER UNOCAL BULK PLANT 0138

COUPEVILLE, WASHINGTON

Compound	Soil Conc. (mg/kg)	ORfD	Residential		
			Factor	Multiplier	HQ
Total aliphatic	2,577	0.06	1.25E-05	2.08E-04	5.37E-01
Total aromatic	1,089	0.03	See Below	See Below	See Below
Benzene	0.396	NA	NA	NA	NA
Ethylbenzene	0.396	0.1	1.25E-05	1.25E-04	4.95E-05
Toluene	0.396	0.2	1.25E-05	6.25E-05	2.48E-05
Xylenes	1.979	2	1.25E-05	6.25E-06	1.24E-05
Total aromatic+B-E-X	1,087	0.03	1.25E-05	4.17E-04	4.53E-01
Hazard Index					**0.99**

MTCA Method B Cleanup level for TPH	3,666	

NOTES:

[1]The MTCA Method B cleanup level is the TPH concentration (sum of aliphatics and aromatics) which results in a Hazard Index of 0.99 with same proportions of aliphatics, aromatics, and BETX as the sample tested.

Total Hydrocarbon Concentration =	3,666 mg/kg
% Total aliphatic fraction =	70.29 %
% Total aromatic fraction =	29.71 %
% Total benzene fraction =	0.01 %
% Total ethylbenzene fraction =	0.01 %
% Total toluene fraction =	0.01 %
% Total xylene fraction =	0.05 %
% Total aromatic+B-E-X fraction =	29.67 %

mg/kg = milligrams per kilogram
ORfD = oral reference dose
Factor = residential factor
Mulitiplier = Factor/ORfD
HQ = hazard quotient (soil concentration [mg/kg]) (factor)/ORfD
TPH = total petroleum hydrocarbons
NA = not applicable

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