
REMEDIAL EXCAVATION REPORT

DEQ Site No. 03-93-0008

~~DEPT OF ENVIRONMENTAL QUALITY
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SEP 28 2000

Property Location:

~~NORTHWEST REGION~~
DELCO PETROLEUM CO. LLC

17873 SE McLoughlin Blvd.

Milwaukie, Oregon

April 3, 2000

Prepared For:

Delco Petroleum Company, LLC

14 Long Leaf Drive
Hamilton, New Jersey 08690

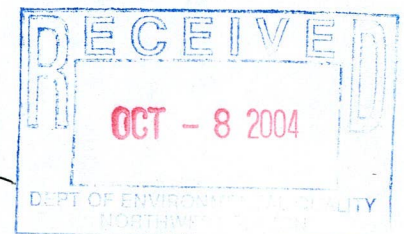
Prepared By:

GeoPro Geologic Services
Post Office Box 26
Battle Ground, WA 98604



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Project Number 990621-A4



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- Appendix C – UST LEAK DETECTION TESTING REPORTS
- Appendix D – UST RECYCLER RECEIPT
- Appendix E – EXCAVATION SOIL DISPOSAL LOAD REPORT
- Appendix F – MONITOR WELL LOGS (MW-14 AND MW-15) AND WELL SURVEY
- Appendix G – LABORATORY REPORTS



1. INTRODUCTION

1.1. PURPOSE AND SCOPE OF WORK

The purpose of this report is to summarize remediation by excavation of petroleum contaminated soil, and, removal and installation of underground storage tanks and associated facilities at the Delco Petroleum Company LLC ("Delco") service station, 17873 SE McLoughlin Boulevard, Milwaukie, Oregon 97267 ("Site"). The landowner contact is Mr. Devinder Dhillon of Delco Petroleum Co., LLC, 14 Long Leaf Drive, Hamilton, New Jersey 08690 ("Client" and "Landowner"). GeoPro Geologic Services ("Consultant") was authorized by Client to begin work on July 1, 1999, as amended through Agreement.

For further information on the following documentation related to the removal and construction of the service station facility, please contact OR UST Service Provider Licensee RE ID 774, ADDR ID 111589, Pacific Northern Environmental, Corp., 1081 Columbia Blvd., Longview, WA 98632, whose services and responsibilities included removing the previous Petroleum UST System and installing the new Petroleum UST System at the Site pursuant to appropriate regulations.

UST Decommissioning/Change-in-Service Report 30-Day Notice, and/or
UST Decommissioning/Change-in-Service Report Checklist, and/or
UST Decommissioning/Change-in-Service Report, and/or
EPA Notification for Underground Storage Tanks, and/or
UST System Retrofitting or Upgrading Checklist and Registration Form, and/or
General Permit Registration Form.

Previous environmental Site work prior to decommissioning the old Petroleum UST System and installing the new Petroleum UST System is summarized in a report submitted to the Oregon Department of Environmental Quality ("DEQ") titled "Quarterly Report, July 1999, Groundwater Monitoring, Flying J-Milwaukie #2, DEQ Site No. 03-93-0008", dated August 4, 1999 by GeoPro Geologic Services. Planned remedial excavation and replacement of underground storage tanks was submitted as a "Work Plan" dated August 11, 1999 and subsequently approved by DEQ. Two (2) additional groundwater monitoring wells were installed as a supplement to the Work Plan at the direction of DEQ.

Analysis of soil and groundwater samples collected from borings and monitor wells in May 1993 indicated that groundwater contamination exceeded cleanup levels due to apparent gasoline and/or diesel leakage from the UST's, piping, and/or associated facilities. Free product was observed during sampling of groundwater monitor well MW-3 from July 1994 through January 1995.

The decommissioned UST's referenced herein may have been installed in 1978 or earlier by the previous landowner, Flying J Inc., 50 West 990 South, P.O. Box 678, Brigham City UT 84302 who apparently purchased the property on December 6, 1976. Delco reportedly purchased the property on February 2, 1994.

The landowner decided that the excavation of soil as the source of contamination was necessary to reduce the risk of groundwater contamination. Groundwater cleanup is the primary goal of DEQ.

1.2. LOCATION

The Delco Petroleum Company, LLC service station at 17873 SE McLoughlin Boulevard, Milwaukie, Oregon 97267 ("Site") is a commercial property surrounded by commercial properties to the north, south and east, and, residential properties to the west, within the SE/4 of the SW/4, Section 18, Township 2 South, Range

2 East (WM) in Clackamas County, Oregon (see Figure 1 - "Location Map"). The approximate 0.7-acre, nominal 100-foot elevation MSL Site is Tax Lot 1700 adjacent to "Ed's Mufflers and Brakes" to the north and "Busters Restaurant" to the south on the west side of SE McLoughlin Boulevard (Oregon State Highway 99). The Site has also been referenced as "Milwaukie Fuel Stop", "Delco Company", and/or "Flying J". The Site is located in a community locally called "Jennings Lodge" of the town of Milwaukie, which is essentially a southeastern suburb of Portland, Oregon. The Willamette River flows northerly approximately one-half mile west of the Site and the Clackamas River westerly into the Willamette approximately one and one-half miles south of the Site.

Prior to remedial activities, the Site was an active service station which contained one (1) diesel underground storage tank ("UST") with a nominal capacity of 8,000-gallons, and three (3) gasoline UST's each with a nominal capacity of 12,000-gallons in a 'tank field' located in the north-central portion of the Site (see Figure 2 - "Pre-Excavation Site Map and Cross-Section A-A' Index"). Three (3) gasoline pump islands were located beneath a canopy in the east-central portion of the Site, and, one (1) diesel pump was located approximately above the previous diesel UST on the northern edge of the property. The Site also contains a building with a service station office and connected "Jiffy Lube" (sub-leased) of three (3) service bays for auto lubrication and oil changing.

Following remedial excavation, the station was placed back in service with two (2) new 10,000-gallon and one (1) 8,000-gallon gasoline UST's, and one (1) 8,000-gallon diesel UST, piping, leak detection system, pump islands and canopy. The pump islands and canopy were re-built in essentially the same location and configuration as prior to remediation activities. However, the diesel pump location was moved from above the diesel UST and incorporated into the gasoline pump islands. The eastern portion of the Site was re-surfaced with asphalt (see Figure 3 - "Post-Excavation Site Map and Cross-Section B-B' Index").

2. PREVIOUS WORK

2.1. PREVIOUS ENVIRONMENTAL REPORTS

In addition to the above referenced reports by GeoPro, previous Site work has been summarized in the following reports:

- "*Environmental Assessment-Phase I*", Jiffy Lube International Store #1012, apparently for Pennzoil Company, June 10, 1993, 11pp., Figures, Tables, and Appendices.
- "*Phase II Environmental Assessment Report*", by Delta Environmental Consultants, Inc., Bellevue, WA, undated, 4pp., Figures, Tables, and Appendices.
- "*Phase III Environmental Assessment Report*", for Jiffy Lube, Milwaukie, OR, by Delta Environmental Consultants, Inc., Bellevue, WA, undated, 6pp., Figures, Tables, and Appendices.
- "*Cleanup Standards for Benzene, Toluene, Ethylbenzene, Xylene, and TPH per EPA Guidance Document EPA 910/9-91-036*", for Eclipse Environmental Consulting, Richland, WA, by Columbia Energy & Environmental Services, Inc., Richland, WA, June 15, 1994, 5pp. and Tables.
- "*Quarterly Groundwater Monitoring Report*", for Delco Company (formerly Flying J), by Northwest Envirocon, Inc., Vancouver, WA, December 19, 1994.

- “*Third Quarterly Ground Water Monitoring Report*”, for Delco Company (formerly Flying J), by Northwest Envirocon, Inc., Vancouver, WA, June 15, 1995, 6pp. and Appendices.
- “*Fourth Quarterly Ground Water Monitoring Report*”, for Delco Company (formerly Flying J), by Northwest Envirocon, Inc., Vancouver, WA, June 22, 1995, 7pp. and Appendices.
- “*Fifth Quarterly Ground Water Monitoring Report*”, for Delco Company (formerly Flying J), by Northwest Envirocon, Inc., Vancouver, WA, October 18, 1995, 7pp. and Appendices.
- “*Delco Project Summary Report*”, for Delco Company (formerly Flying J), by Northwest Envirocon, Inc., Vancouver, WA, December 20, 1995, 6pp. and Appendices.
- “*Sixth Quarterly Ground Water Monitoring Report*”, for Delco Company (formerly Flying J), by Northwest Envirocon, Inc., Vancouver, WA, February 15, 1996, 7pp. and Appendices.
- “*Seventh Quarterly Ground Water Monitoring Report*”, for Delco Company (formerly Flying J), by Northwest Envirocon, Inc., Vancouver, WA, May 15, 1996, 7pp. and Appendices.
- “*Ground Water Monitoring Report*”, for Delco Company, by Northwest Envirocon, Inc., Vancouver, WA, September 30, 1996, 10pp. and data information.
- “*Eighth Quarterly Ground Water Monitoring Report*”, for Delco Company (formerly Flying J), by Northwest Envirocon, Inc., Vancouver, WA, November 8, 1996, 8pp. and Appendices.
- “*Ninth Quarterly Ground Water Monitoring Report*”, for Delco Company (formerly Flying J), by Northwest Envirocon, Inc., Vancouver, WA, February 21, 1997, 8pp. and Appendices.
- “*First Quarter 1998 Ground Water Monitoring Report*”, for Delco Company (formerly Flying J), by Northwest Envirocon, Inc., Vancouver, WA, February 12, 1998, 8pp. and Appendices.

2.2. PIPING SYSTEM LEAK

Apparently a previous surface spill from a nozzle estimated at 81-gallons was reported in April 1988, but was cleaned up satisfactorily. On February 18, 1993, an ‘Initial Report Form For UST Cleanup Project’ was prepared by Flying J Inc. for a reported pipeline free-product release that apparently was discovered on January 12, 1993 (see Appendix A – “1993 Pipeline Leak and Cleanup”) while installing a second stage vapor system. A map is not included in available documentation, however, it is assumed that the referenced pipeline ran from the UST’s eastward toward Monitor Well MW-2 (see Figure 2). During remedial excavation in September 1999, an abandoned set of pipelines was found between the UST’s and MW-2 (see Figure 4 - “Exposed Diesel UST and Gasoline Pipelines”).

Groundwater was not encountered during excavation for retrofitting of the piping system in January 1993 according to the report to DEQ prepared by Flying J. Apparently a composite soil sample was collected from the excavation trench on January 12, 1993 and analyzed for Total Petroleum Hydrocarbons - Gasoline (“TPHg”), benzene, toluene, ethylbenzene, xylenes (“BTEX”) and lead. The results of analyzing the composite soil sample were gasoline at 1,000 (“mg/kg”), non-detection of benzene and toluene, ethylbenzene was

detected at 13 mg/kg, xylenes were detected at 21 mg/kg, and lead was not detected indicating that the source was unleaded gasoline.

Excavated soil from the January 1993 trench was apparently stockpiled west of the Jiffy Lube building and later sampled on July 18, 1994. The results of sampling the spoil pile indicated non-detection of gasoline, diesel at 164 kg/mg, and heavy oils/diesel at 206 and 330 mg/kg (see Wy'East Laboratory Report, Appendix A).

2.3. JIFFY LUBE UST DECOMMISSIONING

Five (5) Jiffy Lube UST's, 1,500-gallons each, were decommissioned by excavation and disposal between November 21 and December 20, 1994 according to a Decommissioning/Service Change Report submitted to DEQ on March 9, 1995 (see Appendix B – "1994 Jiffy Lube UST Decommissioning Report"). Soil contamination within the UST excavation was reported to DEQ, however, there is no apparent available record of sampling and analyzing soil samples from the excavation. The UST's apparently contained motor oil.

2.4. UST LEAK TESTS

Four (4) previous Flying J UST's were tested for tightness by Hydrocarbon Specialty Contractors, Inc., Spokane, WA on December 10, 1993, which resulted in passing tests (see Appendix C – "UST Leak Detection Testing Reports"). On December 17, 1994, the four UST's were tested for leakage by NDE Environmental Corp., Austin, TX and passed.

On September 3, 1994, NDE Environmental Corp., Austin, TX tested the gasoline lines. The Regular and Unleaded lines passed, but the Premium gasoline line leak detector failed the test (see Appendix C).

On January 23, 1998, Tanknology, Austin, TX tested the UST's and lines. The lines and the gasoline UST's passed, but the diesel UST failed (see Appendix C).

Apparently there may have been leakage over time from the Premium gasoline pipeline and the diesel UST piping.

2.5. INITIAL ENVIRONMENTAL ASSESSMENTS

"Phase I" and "Phase II" Environmental Assessments were completed by Delta Environmental Consultants Inc. ("Delta"), 3150 Richards Road, Suite 100, Bellevue, Washington 98005 between May 12 and May 27, 1993. Phase I was completed to assess the historical and potential environmental impacts to the Site. Phase II involved drilling five soil borings to collect and analyze soil samples. The Site was known as "Jiffy Lube International Store #1012", located at 17869 SE McLoughlin Boulevard, Milwaukie, Oregon. Phase I concluded that "...it appears there is potential for environmental concerns on the subject property".

Between June 18 and June 21, 1993, Delta performed a "Phase III" Environmental Assessment as summarized in an undated report by Patricia A. Crump and Daniel S. Whitman of Delta. Phase III involved the drilling and installation of six (6) groundwater monitoring wells: MW-1, MW-2, MW-3, MW-4, MW-5, and MW-6. Soil samples from the borings for the monitor wells were analyzed for BTEX and TPH (see Table 1 –

“Phase III Soil Sampling Analytical Results”). Petroleum hydrocarbons were detected in soil samples from all borings. Groundwater samples collected from each monitor well were analyzed for BTEX, TPH, and TPH-G. Benzene was detected in groundwater samples from wells MW-1 through MW-5. Toluene was detected in water samples from MW-1, MW-3, and MW-4. Ethylbenzene and xylenes were detected in all groundwater samples, but apparently exceeded DEQ action levels only in well MW-3. Apparently no constituents were detected in the water sample from well MW-6.

Table 1 – PHASE III SOIL SAMPLING ANALYTICAL RESULTS

Boring	Sample	Depth *	Date *	Analytical Test Results, mg/kg (ppm)								
				TPH-G	TPH-D	TPH-ID Gasoline	TPH-ID Diesel	TPH	B	T	E	X
MW-1	S-2	5-6.5 ft	6/18/93	87	550	>20	<50	110	510	44	150	1,050
MW-2	S-1	5-6.5 ft	6/18/93	29	1,200	>20	>50	1,100	23,000	320	9,800	40,470
MW-3	S-2	5-6.5 ft	6/18/93	62	180	>20	>50	680	3,800	49,000	51,000	289,000
MW-4	S-2	5-6.5 ft	6/18/93	<10		>20	>50	120	4,600	520	6,000	10,500
MW-5	S-2	5-6.5 ft	6/18/93	13		>20	<50	210	2,900	84	1,300	3,250
MW-6	S-2	5-6.5 ft	6/18/93	<10	23	>20	>50	160	<30	<30	<30	<30

Notes: “<” = Below Reporting Limit of laboratory, and may be accepted as practically non-detectable, or very low concentration and not; ND = Not Detected at or above reporting limit; TPH = Total Petroleum Hydrocarbons, TPH-G = gasoline-range hydrocarbons, TPH-D = diesel-range hydrocarbons, B=benzene, T=toluene, E=ethylbenzene, X=total xylenes; blank boxes = not analyzed.

Delta concluded from water level measurements taken during Phase III that the groundwater gradient was approximately 0.001-feet/foot between MW-1 and MW-5 in a west to northwest direction. Groundwater was encountered at approximately seven (7)-feet below ground surface during the drilling of the monitor wells. Silty sands were reportedly beneath the Site, with silty clay occurring at shallow depths.

2.6. FREE PRODUCT

As reported in the “Third Quarterly Ground Water Monitoring Report” by NWE dated June 15, 1995, free product was observed only in Monitor Well MW-3 during sampling on January 24, 1995. As stated in the report: “Manual removal of free product from MW-3 was conducted on a weekly basis from July 19, 1994 to October 30, 1994; and biweekly from November 6, 1994 until January 24, 1995.” The free product “smelled like gasoline, was dark brown-black in color”, and was one (1)-inch thick in MW-3 on July 19, 1994. No measurable layer of free product was observed during sampling of MW-3 on October 2, 1994, after which “residue” was observed in the bailer during subsequent sampling events.

As reported in the “Fourth Quarterly Ground Water Monitoring Report” by NWE dated June 22, 1995, free product was observed only in Monitor Well MW-7 (which replaced MW-3) during sampling on June 20, 1995. As stated in the report: “The bailed free product and ground water from MW-7 is stored in a 55-gallon drum on the site.”

No free product was reported in any monitor wells on and after September 29, 1995 (Fifth Quarterly Ground Water Monitoring Report).

* Table revised from p. 6, Table 1, Quarterly Report July 1999

* Table revised from p. 6, Table 1, Quarterly Report July 1999

2.7. GROUNDWATER

2.7.1. MONITOR WELLS

Since June 1993, fifteen (15) groundwater monitor wells have been installed to monitor groundwater levels and collect water samples. Ten (10) monitoring wells are currently accessible for obtaining groundwater samples (see Figure 3).

Monitoring Well MW-3 was decommissioned on February 20, 1995 caused by site characterization excavation activities (apparently a backhoe or similar) which removed soil around MW-3 to a depth of four (4)-to five (5)-feet and destroyed the annular seal. Monitor Well MW-7 was previously installed on January 27, 1995 as an anticipated monitoring location replacement for well MW-3. Also on January 27, 1995, monitor wells MW-8 and MW-9 were installed at the Site.

During remedial excavation, wells MW-2, MW-4, MW-7, and MW-8 were decommissioned. MW-14 was installed on November 17, 1999 in the general location of MW-7; and, MW-15 was also installed on November 17, 1999 as a replacement for MW-4 and MW-8. MW-14 and MW-15 are constructed with four (4)-inch PVC and all other wells are constructed with two (2)-inch PVC. (see Appendix F – “Monitor Well Logs (MW-14 and MW-15) and Well Survey”). One monitoring well, MW-11, was installed off-site in a down-gradient direction on August 17, 1996, to the northwest, on “Ed’s Muffler & Brakes” property.

The following Table 2 – “Monitor Well Installation Summary” includes reported well installation methods.

Table 2 – MONITOR WELL INSTALLATION SUMMARY

Monitor Well	Date Installed	Elevation (ft)	Total Depth (ft bgs)	SWL When Drilled	Casing & Screen Size	Screened Interval	Filter Pack	Annular Seal Bottom	General Lithology
MW-1	6/18/93	99.37	15.0	5.02	2-inch PVC	5-15 ft	10/20 4-15 ft	4 ft	clay
MW-2 destroyed	6/18/93	98.51	14.0	4.2	2-inch PVC	4-14 ft	10/20: 3-14 ft	3 ft	clay
MW-3 destroyed	6/18/93	98.57	15.0	4.0	2-inch PVC	5-15 ft	10/20: 4-15 ft	4 ft	clay, sandy silt
MW-4 destroyed	6/18/93	99.00	15.0	4.76	2-inch PVC	5-15 ft	10/20: 4-15 ft	4 ft	clay, fn sand
MW-5	6/19/93	100.41	15.0	6.14	2-inch PVC	5-15 ft	10/20: 4-15 ft	4 ft	clay, fn sand
MW-6	6/19/93	100.01	14.5	5.71	2-inch PVC	5-14.5 ft	10/20: 3.5-14.5 ft	3.5 ft	silty fn sand
MW-7 destroyed	1/27/95	98.96	19.0	unk	4-inch PVC	4-19 ft	10/20: 3-19 ft	unk (13?)	clayey silt, silty sand
MW-8 destroyed	1/27/95	99.63	20.0	unk	4-inch PVC	5-20 ft	10/20: 3-20 ft	unk (14.5?)	clayey silt, silty sand
MW-9	1/27/95	99.42	15.0	unk	2-inch PVC	5-15 ft	10/20: 3-15 ft	unk (10?)	clayey silt
MW-10	8/12/96	98.50	15.0	9.0	2-inch PVC	10-15 ft	10/20: 8-15 ft	8 ft	gray clay
MW-11	8/12/96	99.64	15.0	9.0	2-inch PVC	10-15 ft	10/20: 8-15 ft	8 ft	gray clay
MW-12	8/12/96	100.26	15.0	9.0	2-inch PVC	10-15 ft	10/20: 8-15 ft	8 ft	gray clay
MW-13	8/12/96	99.85	15.0	9.0	2-inch PVC	10-15 ft	10/20: 8-15 ft	8 ft	gray clay
MW-14	11/17/99	95.65	9.0	5.0	4-inch PVC	4-9 ft	10/20: 4-9 ft	4 ft	crushed rock
MW-15	11/17/99	96.42	15.5	5.0	4-inch PVC	5.5-15.5 ft	10/20: 4.5-15.5 ft	4.5 ft	pea gravel

Notes:

Elevations are from Barbieri surveys.

2.7.2. GROUNDWATER LEVELS

Groundwater levels fluctuate as indicated in the following Table 3 – “Groundwater Levels” and Figure 5 - “Static Groundwater Levels Below Ground Surface”, and Figure 6 – “Mean Groundwater Static Levels (Elevation)”. From January 1995 through July 1999, water levels have fluctuated beneath the Site up to 6.35-feet.

Table 3 – GROUNDWATER LEVELS (feet)

Monitor Well	Date	SWL Below Casing	SWL Elevation	Monitor Well	Date	SWL Below Casing	SWL Elevation
MW-1	6/21/93	nr	94.65	MW-6	6/21/93	nr	94.58
	1/24/95	3.97	95.70		1/24/95	4.75	95.54
	6/20/95	4.67	95.00		6/20/95	5.28	95.01
	9/29/95	6.91	92.76		9/29/95	7.38	92.99
	2/15/96	3.00	96.67		2/15/96	3.17	97.12
	4/26/96	3.74	95.93		4/26/96	4.27	96.02
	10/29/96	5.82	93.85		10/29/96	6.47	93.82
	1/15/97	2.74	96.93		1/15/97	3.33	96.96
	1/27/98	4.51	95.16		1/27/98	5.01	95.28
MW-2	7/27/99	5.66	93.71		7/27/99	6.25	93.76
	6/21/93	nr	94.59	MW-7	6/20/95	4.61	94.34
	1/24/95	2.97	95.82	MW-8	6/20/95	4.68	94.94
	6/20/95	3.77	95.02	MW-9	6/20/95	4.88	94.83
	9/29/95	6.48	92.31	MW-10	9/29/95	6.73	92.99
	2/15/96	1.87	96.92		2/15/96	3.39	96.32
	4/26/96	3.16	95.63		4/26/96	4.42	95.30
	10/29/96	5.00	93.79		10/29/96	5.66	94.06
	1/15/97	2.23	96.56		1/15/97	2.34	97.38
MW-3	1/27/98	3.75	95.04		1/27/98	4.91	94.81
	7/27/99	5.18	93.32		7/27/99	5.64	93.78
	6/21/93	nr	94.57	MW-11	9/18/96	5.18	93.59
	1/24/95	2.89	95.68		10/29/96	4.94	93.83
MW-4	6/21/93	nr	94.54		1/15/97	2.03	96.74
	1/24/95	3.56	95.74		1/27/98	3.61	95.16
	6/20/95	4.28	95.02		7/27/99	4.82	93.68
	9/29/95	7.20	92.10	MW-12	9/18/96	6.54	93.44
	2/15/96	2.57	96.73		10/29/96	6.37	93.61
	4/26/96	3.75	95.55		1/15/97	4.38	95.60
	10/29/96	5.55	93.75		1/27/98	5.66	94.32
	1/15/97	2.75	96.55		7/27/99	6.42	93.22
MW-5	1/27/98	4.26	95.04		9/18/96	7.19	93.35
	7/27/99	5.57	93.43		10/29/96	6.68	93.86
	6/21/93	nr	94.52		1/15/97	4.72	95.82
	1/24/95	4.94	95.72		1/27/98	4.96	95.58
	6/20/95	5.63	95.03		7/27/99	6.88	93.38
	9/29/95	8.22	92.44	MW-13	9/18/96	5.19	94.92
	2/15/96	3.77	96.89		10/29/96	6.29	93.82
	4/26/96	5.00	95.66		1/15/97	3.13	96.98
	10/29/96	6.95	93.71		1/27/98	4.86	95.25
	1/15/97	4.02	96.64		7/27/99	6.00	93.85
	1/27/98	5.62	95.04				
	7/27/99	5.99	94.42				

Notes: SWL in feet below top of casing.

Water levels not observed during excavation (through December 1999).

2.7.3. GROUNDWATER GRADIENTS

A survey by Barbieri & Associates, Inc., 7017 NE Hwy 99, Suite 204, Vancouver, WA 98665 of monitor well PVC casing tops was completed on July 27, 1999, and on February 1, 2000 (MW-14 and MW-15) based on relative elevations and X-Y coordinates. The groundwater flow direction is estimated to be north-northwesterly based on July 1999 static water level measurements (see Figure 8 – “July 1999 Groundwater Gradient”). This flow direction would be expected since the Willamette River flows northerly to the west of the Site. The inferred groundwater gradient from Monitor Well MW-13 (4884.4892N, 5056.2117E) to Monitor Well MW-11 (5035.1486N, 4984.8006E) is approximately 0.63-feetV per 150.7-feetH, or 0.0042-feet per foot. Based on water level measurements taken in July 1999, an isolated high groundwater peak occurred in the vicinity of Monitor Well MW-5. The cause of this high groundwater is unknown, however a zone of low permeability, such as, the excavated partly visqueen-enveloped auto parts dump encountered in the northwest area of the remedial excavation could have caused it.

2.7.4. GROUNDWATER ANALYSES

A summary of previously reported groundwater sampling analyses is shown below in the Table 4 – “Groundwater Sampling Analyses” and in Figure 7 – “Groundwater Analyses (Selected Wells)”.

Table 4 – GROUNDWATER SAMPLING ANALYSES (µg/l except TPH-Dx mg/l)

Well	Date	B	T	E	X	TPH Gas	MTBE	TPH-Dx
MW-1	6/22/93	910	1,300	470	2,090			
	7/18/94	770	14	264	272			
	10/28/94	729	16	269	145			
	1/24/95	62	29	349	315			
	6/20/95	619	10	66	377			
	9/29/95	3,700	43	1,050	895			
	2/15/96	727	8	92	261			
	4/26/96	497	17	180	159			
	10/29/96	231	5	18	15			
	1/15/97	83	ND	9	13			
	1/27/98	411	11	66	82			
	7/24/99	340	4.29	9.60	ND	2,330	112	ND
MW-2	6/22/93	140	13	20	75			
	7/18/94	25	ND	ND	187			
	10/28/94	53	ND	4	4			
	1/24/95	108	ND	6	8			
	6/20/95	240	ND	ND	4			
	9/29/95	208	ND	ND	ND			
	2/15/96	26	ND	ND	ND			
	4/26/96	56	ND	ND	ND			
	10/29/96	54	ND	ND	ND			
	1/15/97	9	ND	ND	ND			
	1/27/98	34	ND	ND	ND			
	7/23/99	1.54	ND	ND	ND	ND	113	ND
MW-3	6/22/93	1,600	3,800	1,900	10,100			
	7/18/94	226	141	58	286			
	10/28/94	18,400	17,400	3,200	20,200			
	1/24/95	19,900	21,200	6,170	31,500			
MW-4	6/22/93	3,500	1,500	420	2,360			
	7/18/94	7,460	134	2,730	8,120			
	10/28/94	8,400	161	5,320	4,724			
	1/24/95	14,900	4,200	1,630	7,500			
	6/20/95	5,130	281	3,150	16,400			
	9/29/95	12,900	70	2,090	733			
	2/15/96	4,490	522	1,500	2,390			
	4/26/96	4,330	257	1,160	3,320			
	10/29/96	490	15	123	442			
	1/15/97	4,540	149	739	2,210			
	1/27/98	2,960	133	513	1,070			
	7/25/99	2,910	ND	109	ND	10,300	ND	2.57 ¹
MW-5	6/22/93	500	750	180	1,090			
	7/18/94	237	24	ND	187			
	10/28/94	141	ND	28	35			
	1/24/95	726	10	36	125			
	6/20/95	150	18	4	70			
	9/29/95	386	3	75	63			
	2/15/96	23	ND	ND	9			
	4/26/96	310	ND	34	30			
	10/29/96	350	2	23	49			
	1/15/97	33	ND	2	5			
	1/27/98	901	5	17	60			
	7/25/99	35.7	ND	ND	ND	118	ND	ND

¹ MW-4 Heavy Oil Hydrocarbons detected at 0.627 mg/l. All other well samples were ND for Heavy Oil Hydrocarbons.

Table 4 - GROUNDWATER SAMPLING ANALYSES (µg/l except TPH-Dx mg/l) - continued

Well	Date	B	T	E	X	TPH Gas	MTBE	TPH-Dx
MW-6	7/18/94	14	7	7	26			
	10/28/94	ND	ND	ND	ND			
	1/24/95	ND	ND	ND	ND			
	6/20/95	ND	ND	ND	ND			
	9/29/95	ND	ND	ND	ND			
	2/15/96	ND	ND	ND	ND			
	4/26/96	ND	ND	ND	ND			
	10/29/96	ND	ND	ND	ND			
	1/15/97	ND	ND	ND	ND			
	1/27/98	ND	ND	ND	ND			
	7/24/99	ND	ND	ND	ND	ND	ND	ND
MW-7	6/20/95	4,230	6,410	11,700	16,700			
	9/29/95	540	4	117	74			
	2/15/96	117	26	13	629			
	4/26/96	276	31	70	309			
	10/29/96	298	5	16	55			
	1/15/97	258	50	60	225			
	1/27/98	309	121	315	1,560			
MW-8	6/20/95	2,830	312	253	2,830			
	9/29/95	1,164	70	211	290			
	2/15/96	384	38	111	496			
	4/26/96	163	ND	41	208			
	10/29/96	ND	ND	ND	ND			
	1/15/97	944	153	130	1,690			
	1/27/98	522	63	230	469			
MW-9	6/20/95	ND	ND	ND	2			
	9/29/95	ND	ND	ND	ND			
	2/15/96	ND	ND	ND	ND			
	4/26/96	71	ND	12	9			
	10/29/96	ND	ND	ND	ND			
	1/15/97	55	ND	10	15			
	1/27/98	ND	ND	ND	ND			
	7/23/99	ND	ND	ND	ND	ND	ND	ND
MW-10	9/18/96	ND	ND	ND	ND	ND		
	10/29/96	ND	ND	ND	ND			
	1/15/97	ND	ND	ND	ND			
	1/27/98	ND	ND	ND	ND			
	7/23/99	ND	ND	ND	ND	ND	ND	ND
MW-11	9/18/96	ND	ND	ND	ND	ND		
	10/29/96	ND	ND	ND	ND			
	1/15/97	ND	ND	ND	ND			
	1/27/98	ND	ND	ND	ND			
	7/24/99	ND	ND	ND	ND	ND	ND	0.542
MW-12	9/18/96	ND	ND	ND	ND	ND		
	10/29/96	ND	ND	ND	ND			
	1/15/97	ND	ND	ND	ND			
	1/27/98	ND	ND	ND	ND			
	7/24/99	ND	ND	ND	ND	ND	ND	ND
MW-13	9/18/96	ND	ND	ND	ND	ND		
	10/29/96	ND	ND	ND	ND			
	1/15/97	ND	ND	ND	ND			
	1/27/98	ND	ND	ND	ND			
	7/23/99	ND	ND	ND	ND	ND	ND	ND

Table 4 Notes: ND = Not Detected at or above reporting limit; TPH-Gas = gasoline-range hydrocarbons; TPH-Dx = diesel-range hydrocarbons; B=benzene, T=toluene, E=ethylbenzene, X=total xylenes; MTBE = methyl tert-butyl ether; blank boxes = not analyzed. Gasoline hydrocarbons were analyzed per NWTPH-Gx Method and BTEX/MTBE were analyzed per EPA Method 8020A. Diesel and Heavy Range Hydrocarbons were analyzed per NWTPH-Dx Method. Total xylenes include m,p- and o-xylenes.

2.7.4.1 Benzene Concentrations in Groundwater

Benzene is a volatile monoaromatic hydrocarbon found in gasoline. Hydrocarbon mixtures separate and partition based on the makeup of individual chemicals. Benzene tends to degrade faster than toluene; toluene faster than ethylbenzene; ethylbenzene faster than xylenes. A relatively high ratio of benzene to toluene, toluene to ethylbenzene, and ethylbenzene to xylenes in groundwater could indicate fresher gasoline while the higher inverse ratios could tend to indicate fresher gasoline occurring in soil. In general, the more water soluble and volatile compounds are lost most rapidly from contaminated soil. Benzene is depleted relatively rapidly from gasoline-saturated soil, while ethylbenzene and xylenes tend to increase in concentration.² Benzene is ten times more soluble than ethylbenzene and xylenes and therefore is leached ten times faster, assuming dissolution rather than volatilization is the dominant weathering process.

A series of chronological gradient maps indicating benzene concentrations in groundwater are included in Figures 10A through 10F – “Benzene Concentration Contours (Groundwater)”. The data used for the contours is shown in Table 4.

The benzene contours in Figure 10F for June 22, 1993 indicate prior leakage, apparently due to the gasoline pipeline breakage in January 1993. The higher benzene concentrations appear to be downgradient, within the vicinity of Monitor Well MW-4, indicating that a large portion of the original benzene from an apparent source near MW-2 along the gasoline pipelines had been depleted and migrated downgradient. A little over a year later, on July 18, 1994, the concentrations had greatly decreased near Monitor Well MW-2 and the pipeline, and increased northwesterly as dissolution occurred. The contours of July 18, 1994 may also indicate a slight depression of the groundwater table due to the weight of the product floating on the water. Free product was collected from MW-3 (same location as MW-7) on July 19, 1994. MW-3 (MW-7) is located immediately north of the gasoline pipeline.

On September 3, 1994, NDE Environmental Corp., Austin, TX tested the gasoline lines. The Regular and Unleaded lines passed, but the Premium gasoline line leak detector failed the test (see Appendix C). Mean benzene concentrations from groundwater samples are shown in Figure 9 – “Benzene Groundwater Mean Concentrations”. A peak in the concentrations occurs in late 1994 and early 1995. The benzene concentration contours for January 24, 1995 (see Figure 10E) indicate a large increase along the gasoline pipeline and near MW-2. This indicates that the replacement gasoline pipeline may have leaked, or the elbows (or pipeline bends) may have again leaked in late 1994 through early 1995. As discussed below, an area of high concentration of gasoline contaminated soil was excavated from around MW-2 and the gasoline pipeline elbows/bends as it turned southward toward the pump islands.

After the installation of a submersible pump in MW-8 in late January 1995, the benzene concentration contours through 1997 indicate the decreasing concentrations as the groundwater was pumped through MW-8. For example, the benzene concentration contours of February 15, 1996 (Figure 10C) indicate hydrodynamic control by pumping had been established. In early 1996, apparently the submersible pumps required maintenance and were replaced in MW-8 and MW-7 on May 2, 1996. Dissolution and partitioning of benzene from the contaminated source soil apparently continued to occur until the time of remedial excavation.

2.7.4.2 Benzene to Toluene Ratio Concentrations in Groundwater

The ratio of benzene to toluene concentration in groundwater samples is shown in Figure 11 – “Ratio Benzene to Toluene (Groundwater)”. The higher ratios may indicate fresher gasoline because of the higher

² “Composition of Petroleum Mixtures”, in Total Petroleum Hydrocarbon Criteria Working Group Series. Amherst Scientific Publishers, May, 1998, Volume 2, p.12

solubility of benzene near the source, or it could indicate higher downgradient concentrations of benzene because of high mobility and movement away from the source as a pumped aqueous-phase contaminant plume. The highest ratios occur from samples collected in Monitor Wells MW-1, MW-4, MW-5 and MW-7 from 1995 through 1999. A secondary grouping of relatively higher ratios appears to be associated with Monitor Well MW-1 from 1994 through 1998, although higher ratios shown for MW-4 may be indicative of benzene being drawn toward the nearby pumping well MW-8.

The relatively high ratio due to sample results collected from MW-1 appears to be associated with a pipeline leak at the nearest pump island. This is somewhat confirmed by a slight southeasterly bulge of high benzene concentrations ($>800\mu\text{g/l}$) contour in Figures 10C – “Benzene Concentration Contours (Groundwater)”.

2.7.4.3 MTBE Concentrations in Groundwater

MTBE (methyl tertiary butyl ether) has been regionally added to gasoline to enhance octane and to comply with the Clean Air Act mandates. It was approved by EPA for use in 1979 and was added to gasoline during the 1980's at approximately 2-5% by volume as an octane booster. In 1992, it was blended at 10-15% by volume for use in some regions in the wintertime oxygenated fuel program. In 1996, it began to be used year around at 11% by volume in many statewide reformulated gasoline programs (especially California and New York).

Oregon does not require MTBE to maintain reformulated gasoline compliance with ozone standards. Although some areas in Oregon maintain compliance with carbon monoxide standards during the winter months, ethanol rather than MTBE has been predominantly used to meet the requirements of the 1990 Clean Air Act.

The Oregon DEQ states that MTBE has entered the State as a residual component of gasoline from states such as California, although it admits that low levels of MTBE may have been added to maintain adequate octane levels by suppliers. In screening chemicals for risk assessment, DEQ uses a preliminary remediation goal concentration of $20\mu\text{g/l}$ (micrograms per liter) and uses this value as an acceptable cleanup level. Indications are that EPA will ban MTBE as a gasoline additive in the near future.

MTBE is more volatile than benzene and less volatile than xylene. MTBE was detected in groundwater samples from wells MW-1 and MW-2 on June 24, 1999 at $112\mu\text{g/l}$ and $113\mu\text{g/l}$, respectively. These two wells are located to the north and south of the remedial excavation (see Figure 2). As discussed below, MTBE was detected in soil samples collected near MW-2; however, MTBE was not detected in soil samples collected from the excavation near MW-1. Gasoline contaminated soil was encountered in the vicinity of the pump island near MW-2 during remedial excavation and could be the source of detected MTBE.

2.8. GEOLOGY AND HYDROGEOLOGY

2.8.1 General

The Site area is within Pleistocene fine-grained facies of coarse sand to silt deposited by catastrophic floods.³ The finer sediments are predominantly quartz and feldspar and also contain white mica. The coarser sediments are predominantly Columbia River Basalt fragments. Poorly defined beds of 1- to 3-feet thick have

³ “Geologic Map of the Lake Oswego Quadrangle, Clackamas, Multnomah, and Washington Counties, Oregon”, M.H. Beeson and Others, State of Oregon Department of Geology and Mineral Industries GMS-59, 1989, 1 Plate.

complex layering. Soil development commonly introduces significant clay in the upper 6- to 15-feet. The fine sediments are locally thick and extend upslope to elevation 300- to 350-feet. Local variations to shallow groundwater flow directions may occur due to changes in lithology and thickness of beds.

The northwest trending Oatfield Fault to the north, and the sub-parallel Concord Fault to the south, bound the Site. The faults are mapped (*ibid.*) as cutting through the youngest sediments, including the Pleistocene fine-grained facies.

The Site is generally at approximate elevation 100-feet mean sea level ("msl"). It is surrounded by gently sloping terrain toward the Willamette River, which flows northerly approximately one-half mile to the west. Wells within one-mile of the Site include two monitoring wells, one industrial well, ten domestic wells (about 42-feet average depth), and one unused well (U.S. Geological Survey Water Resource Division). Most wells develop from basalt aquifers.

2.8.2 Site Specific

Monitor well drilling logs describe the Site as underlain by medium to dark gray clay and clayey silt to approximately 12- to 15-feet depth where dark gray silty fine sand to medium sand was encountered. Remedial excavation to maximum depths below ground surface of approximately 14- to 15-feet in places encountered essentially backfill material to a continuous silty clay bed at about 8.5- to 9-feet (Figure 18). Sandy cobbly gravel and a fine-medium sand unit underlie the approximate four (4)-foot thick clay unit (Figure 20). The backfill material is predominantly uncompacted dark gray clayey silt to silty clay with medium to fine sand. Heterogeneous fill material included stumps, tires, concrete blocks up to six (6)-feet diameter, asphalt shingles, bricks, lumber, buckets, hay bales, and other material. An auto parts and building materials dump was uncovered in the northwest area of the excavation (Figure 21). All excavated soil and dump material was disposed off-site.

A typical cross-section of material encountered during remedial excavation is shown in Figure 12 – "Pre-Excavation Cross-Section A-A". The upper part of the silty clay layer is shown in Figure 18 – "Contact Fill and Upper Part of Silty Clay".

3. REMEDIAL EXCAVATION

3.1. EXCAVATION

3.1.1. Tanks And Sheet Piling

Four (4) underground steel storage tanks were excavated and disposed to Northwest Truck Parts Recycling on October 13, 1999 by OR UST Service Provider Licensee RE ID 774, ADDR ID 111589, Pacific Northern Environmental, Corp., 1081 Columbia Blvd., Longview, WA 98632, whose services and responsibilities included removing the previous Petroleum UST System and installing the new Petroleum UST System at the Site pursuant to appropriate regulations (see Appendix D - "UST Recycler Receipt"). The UST's were one (1) diesel with a nominal capacity of 8,000-gallons, and three (3) gasoline each with a nominal capacity of 12,000-gallons from a 'tank field' located in the north-central portion of the Site. An inspection of the tanks indicated no visible holes or other areas of potential rupture (see Figure 14 – "Excavated Underground Storage Tanks"). Petroleum hydrocarbon smear was visible near the bottom outside of the tanks due to the tanks being partly below groundwater levels.

The initial excavation began with removing the surface concrete above the UST's on September 23, 1999. As the uncovering of the diesel UST continued, soil collapse progressed northward toward the adjacent Ed's Muffler Building (see lower photograph, Figure 4 and upper photograph, Figure 13). Due to the potential of further erosion toward and under the building, and to avoid future liability, the Landowner decided to install a steel sheet pile retaining wall, approximately fifty-two (52)-inches from Ed's Muffler Building (see Figure 13 – "Steel Sheet Piling Retaining Wall"). The nominal depth of the sheet piling was thirty (30)-feet below surface. The sheet pile wall was completed on October 7, 1999.

3.1.2. Other Piping

Besides the gasoline pipelines, a water line, natural gas line, and electric lines for the cathodic protection system were excavated. The lines were within sand-filled trenches, which may have served as conduits for petroleum product migration (see Figure 15 – "Pipelines and Sand-Filled Trenches").

3.1.3. Extent of Excavation

After the underground storage tanks were removed, the excavation was extended vertically to a nominal depth of twelve (12)-feet, up to approximately fifteen (15)-feet in places, to remove petroleum contaminated soil in the vicinity of the previous tanks. The excavation proceeded generally to the east and then south toward the previous gasoline pump islands. Except for the area where the UST's were previously located, the nominal depth of the excavation was nine (9)- to ten (10)-feet below ground surface. The limits of excavation were guided by soil sample analytical results. Approximately 5,000-tons of petroleum contaminated soil was excavated and disposed at TPS Technologies, Portland, Oregon.

A map of the approximated excavation depths is shown in Figure 19 – "Excavation Map Final Depths". A cross section depicting the backfilled excavation is shown in Figure 20 – "Post-Excavation Cross-Section B-B".

Typical petroleum contaminated soil and groundwater encountered are shown in Figure 16 – "Typical Contaminated Soil and Groundwater". Groundwater recharge into the excavation was pumped into nearby holding tanks, aerated, and discharged into an on-site storm drain after water analysis results indicated the water was below existing NPDES Permit levels (see Figure 17 – "Groundwater Recharging Into Excavation"). Up to six (6) holding tanks were required during excavation, each holding a nominal 16,800-gallons, with each filled and emptied at least twice, depending upon the need to drawdown the groundwater level during excavation.

The excavation was extended westward following installation of the new UST's when access to the western area became available. Apparently, an unknown dump had been created following demolition of the previous station, approximated to be around 1962 by the Landowner. A grab sample collected and analyzed from water seeping through the dump area resulted in non-hazardous levels of detectable volatile organics. 152-tons of soil and 10 rubber truck tires were disposed at the Columbia Ridge Landfill, Arlington, Oregon, and, 80-tons of soil was disposed at the Hillsboro Landfill, Hillsboro, Oregon. from the auto parts-building materials dump (see Figure 21 – "Auto Parts and Building Materials Dump Area").

3.2. SOIL SAMPLING

3.2.1. Soil Sample Locations

Field screening was used as a general guideline to delineate areas of possible contamination. Screening results were used to aid in the selection of soil samples submitted to the laboratory for chemical analysis. Screening methods included: a) visual, b) water sheen, and c) PID headspace. The precision and accuracy of field screening were not quantified.

During visual screening, the soil was observed for petroleum residuals, anomalous color, and stains indicative of possible contamination. Periodically, a portion of the sample was placed in water and observed for signs of sheen. Changes to the surface of the water were noted including color, iridescence, how rapid the sheen flowed and dissipated. Headspace screening included placing a portion of the sample in plastic bags, gently shaking the bag, and allowing it to remain closed for about 5 minutes before headspace vapors were measured.

New disposable gloves were worn when collecting soil and water samples. Soil samples were collected from a trac-hoe bucket immediately after the bucket was raised from the excavation and sample location. Samples were transferred into new sample glass containers supplied by the laboratory. Sample container volumes and preservation methods were furnished by the laboratory and were compatible with the method QC analyses on a laboratory-batch basis. Sample labels were completed for each sample. Immediately following the collection of each sample, they were stored on a cooler with ice until delivered to the analytical laboratory. Chain of custody procedures were followed, including a form and sample request form inside each shipping container.

The cleanup goal was to excavate contaminated soil to below potential risk-assessment levels. Where practical, excavation reached non-detectable hydrocarbon levels, typically within the upper foot or so of the grayish-green silty clay underlying the backfill material (see Figure 20 – “Post-Excavation Cross-Section B-B”).

Soil samples were named using the daily excavation limits as a convention. Therefore, “east wall” samples, for example, may appear on the sample location map in the middle of the final extent of excavation (see Figure 22 – “Excavation Sample Location Map”), but were collected from the east side of the excavation as it progressed.

3.2.2. Soil Analyses

Soil samples were analyzed for gasoline (as NWTPH-Gx), diesel (as NWTPH-Dx), aromatics benzene, toluene, ethylbenzene, and xylenes, and octane enhancer MTBE (methyl tertiary butyl ether) as directed by Oregon DEQ. The laboratory reports are included in Appendix G – “Laboratory Reports”. The following is a summary of detections for all analyses (excluding non-detection and tar sample):

<u>Constituent</u>	<u>Mean (mg/kg)</u>	<u>Minimum (mg/kg)</u>	<u>Maximum (mg/kg)</u>
TPH Gasoline	488.7	0.229	11,700
TPH Diesel	257.2	0.83	1,220
Benzene	28.8	0.0286	1,700
Toluene	52.8	0.0676	1,260
Ethylbenzene	13.9	0.0025	188
Xylenes	84.2	0.0026	1,390
MTBE	1.91	0.003	12.4

A summary of all soil sample analyses is included in Table 5.

Table 5 – “EXCAVATION SOIL SAMPLE ANALYSES” following page

Notes to accompany Table 5 – “Excavation Soil Sample Analyses”:

(A) Reporting Limits raised due to dilution necessary for analysis. Sample contains high levels of reported analyte, non-target analyte, and/or matrix interference.

(B) Detected hydrocarbons in the diesel range do not have distinct diesel pattern and may be due to heavily weathered diesel or possibly biogenic interference.

(C) The detected hydrocarbons appear to be due to the overlap of weathered gas, the overlap of the heavy-oil range, as well as, weathered diesel.

(D) Detected hydrocarbons in the diesel range appear to be due to weathered gasoline.

(E) The detected hydrocarbons for this sample appear to be due to the overlap of the gas range as well as the heavy/oil range, but there is a trace of weathered diesel present.

(F) Detected hydrocarbons in the diesel range appear to be due primarily to the overlap of gas and heavy oil, but there is weathered diesel present.

(G) Detected hydrocarbons in the diesel range appear to be primarily due to the overlap of weathered gasoline, though chromatogram indicates the presence of diesel.

(H) Hydrocarbon pattern and range are consistent with a combination of weathered gasoline and heavily weathered diesel.

(I) The detected hydrocarbons appear to be due to the overlaps of the gas and heavy/oil range as well as diesel.

Table 5 - EXCAVATION SOIL SAMPLE ANALYSES

milligrams per kilogram ("mg/kg")									
SAMPLE	Depth BGS	Gasoline	Diesel	Heavy Oil	Benzene	Toluene	EthylBenzene	Xylenes	MTBE
NORTH WALL									
NW-13-12'	12.0	ND	ND	ND	ND	ND	ND	ND	ND
NW-17-9'	9.0	5.10	ND	ND	0.0531	ND	ND	ND	ND
NW-18-9'	9.0	38.5	ND	ND	0.209	0.182	1.03	1.20	ND
NW-19-9'	9.0	5.49	ND	ND	ND	ND	ND	ND	ND
NW-20-9'	9.0	6.22	ND	ND	ND	ND	ND	ND	0.402
NW-22-9'	9.0	15.1	ND	ND	0.247	ND	0.111	0.232	ND
NW-27-14'	14.0	ND	ND	ND	0.263	ND	ND	ND	ND
NW-28-14'	14.0	25.6	ND	ND	0.297	ND	0.163	0.764	ND
NW-29-15'	15.0	3.69	ND	ND	ND	ND	ND	ND	ND
NW-32-6'	6.0	8.82	ND	ND	ND	ND	ND	ND	ND
NW-73-4'	4.0	49.3	ND	453	1.78	3.03	1.70	7.13	3.97
NW-79-7'	7.0	35.5	ND	271 (A)	1.46	0.0883	0.267	1.70	ND
NW-84-7'	7.0	7.39	ND	ND	ND	ND	ND	ND	ND
WEST WALL									
WW-1-4'	4.0	105	ND	ND	0.210	0.147	1.70	0.827	ND
WW-2-12'	12.0	5.77	ND	ND	0.257	ND	ND	ND	ND
WW-3-4'	4.0	12.7	ND	62.5	0.390	ND	ND	0.476	ND
WW-4-12'	12.0	2.69	ND	ND	0.0849	ND	ND	ND	ND
WW-5-4'	4.0	101	ND	233	1.05	0.321	3.55	0.785	ND
WW-6-12'	12.0	9.32	ND	ND	0.181	ND	ND	ND	ND
WW-38-4'	4.0	32.6	ND	ND	0.123	0.0676	0.471	1.90	ND
WW-39-12'	12.0	4.67	ND	ND	0.0945	ND	ND	ND	ND
WW-40-4'	4.0	17.8	ND	81.4	0.327	ND	0.0768	0.239	ND
WW-41-12'	12.0	8.56	ND	ND	0.0979	ND	0.0504	ND	ND
WW-42-4'	4.0	717	ND	244	1.50	ND	14.9	0.791	ND
WW-43-12'	12.0	ND	ND	ND	ND	ND	ND	ND	ND
WW-44-4'	4.0	71.5	ND	296	1.51	0.321	2.58	6.26	ND
WW-45-12'	12.0	ND	ND	ND	0.0966	ND	ND	ND	ND
WW-82-7'	7.0	8.56	ND	ND	ND	ND	ND	ND	ND
WW-86-8'	8.0	7.55	90.2	305	ND	ND	ND	ND	ND
SOUTH WALL									
SW-7-4'	4.0	3,180	587	193 (G,I)	ND	6.3	50.7	189	ND
SW-8-12'	12.0	16.7	ND	ND	0.756	ND	0.123	0.552	ND
SW-9-4'	4.0	1,160	234	274 (G,I)	2.30	2.21	20.6	97.4	ND
SW-10-12'	12.0	1,110	424	88.3 (G)	2.94	ND	15.8	89.8	ND
SW-11-4'	4.0	420	289	114 (G)	1.58	5.85	6.80	45.0	ND
SW-12-11'	11.0	738	ND	ND	3.55	6.98	11.2	60.5	ND
SW-13-8'	8.0	2,870	593	234 (G,I)	12.8	68.6	52.9	314	ND
SW-23-4'	4.0	328	85.0	178 (E)	2.99	1.59	5.48	26.6	ND
SW-24-8'	8.0	1,290	167	71.6 (E)	6.27	11.9	18.7	111	ND
SW-25-4'	4.0	39.5	52.1	125 (E)	0.117	0.107	0.383	1.32	ND
SW-26-8'	8.0	1,390	259	72.5 (E)	5.39	37.4	20.9	123	ND
SW-58-5'	5.0	3.31	27.2	102	0.0933	ND	ND	ND	ND
SW-59-5.5'	5.5	60.0	ND	231	2.35	0.324	0.387	1.58	ND
SW-60-4.5'	4.5	ND	ND	67.1	ND	ND	ND	ND	ND
SW-61-4.5'	4.5	ND	ND	208	ND	ND	ND	ND	ND
SW-62-4'	4.0	ND	ND	ND	ND	ND	ND	ND	ND
SW-76-8'	8.0	237	ND	69.7	9.94	0.717	11.5	8.70	5.51
SW-80-7'	7.0	96.0	ND	ND	0.328	ND	0.513	0.135	ND
EAST WALL									
EW-1-6'	6.0	2.86	ND	82.1	ND	ND	ND	ND	ND
EW-2-4'	4.0	95.2	35.2 (D)	ND	1.62	0.312	2.80	2.19	1.67
EW-33-4'	4.0	3,290	ND	66.7	22.9	149	72.0	383	ND
EW-34-4'	4.0	11,700	ND	241	202	1,260	188	1,390	ND
EW-46-4'	4.0	2.55	ND	419	ND	ND	ND	ND	0.579
EW-52-4'	4.0	ND	ND	ND	ND	ND	ND	ND	0.225
EW-55-9'	9.0	51.2	ND	ND	0.442	ND	1.15	ND	ND
EW-74-5'	5.0	14.5	43.9	96.7 (B)	0.903	0.151	0.215	0.735	ND
BOTTOM									
B-1-15'	15.0	ND	ND	ND	0.730	ND	ND	ND	ND
B-2-8'	8.0	2,290	1,220	58.2 (H)	18.7	116	34.9	191	ND
B-3-14'	14.0	3.95	ND	ND	ND	ND	ND	ND	ND
B-4-8'	8.0	22.7	ND	ND	1.01	0.423	0.523	2.92	ND
B-4-12'	12.0	8.75	ND	ND	0.253	ND	0.280	0.865	ND
B-30-9'	9.0	1,350	224	73.4 (E)	5.04	26.1	20.7	117	ND
B-31-9'	9.0	44.2	ND	ND	2.88	0.193	1.33	3.56	0.264
B-32-6'	6.0	181	ND	ND	4.03	0.502	3.47	19.2	0.867
B-35-6'	6.0	12.4	ND	ND	0.0543	ND	ND	ND	12.4
B-36-6'	6.0	67.3	ND	ND	2.66	ND	0.567	0.723	1.73
B-37-9'	9.0	28.0	ND	ND	1.44	ND	1.19	1.36	0.819
B-47-8'	8.0	81.2	ND	ND	1.17	ND	2.00	4.35	0.220
B-48-5'	5.0	3.10	ND	53.3	ND	ND	ND	ND	ND
B-49-8'	8.0	247	ND	ND	0.626	1.15	3.49	13.7	ND
B-50-8'	8.0	37.0	ND	ND	4.05	0.0885	1.71	3.72	2.74
B-51-8'	8.0	128	ND	ND	2.08	0.607	2.80	9.78	ND
B-53-9'	9.0	230	ND	ND	2.78	2.33	3.98	20.2	2.23
B-54-9'	9.0	16.9	ND	ND	0.203	ND	0.0666	ND	0.264
B-56-9'	9.0	6.13	ND	ND	0.0554	ND	ND	ND	ND
B-57-9'	9.0	4.46	ND	ND	0.372	ND	0.220	ND	ND
B-63-10.5'	10.5	2.87	ND	ND	0.712	ND	0.232	ND	ND
B-64-9.5'	9.5	26	ND	ND	3.27	0.0789	1.19	3.57	0.968
B-65-9.5'	9.5	17	ND	ND	5.18	ND	0.697	2.15	ND
B-66-9.5'	9.5	8.3	ND	ND	2.15	0.39	0.21	1.23	0.447
B-67-9.5'	9.5	21.4	ND	ND	3.44	0.272	0.788	2.18	ND
B-68-14'	14.0	ND	ND	ND	ND	ND	ND	ND	ND
B-69-14'	14.0	ND	ND	ND	ND	ND	ND	ND	ND
B-70-14'	14.0	ND	ND	ND	ND	ND	ND	ND	ND
B-71-14'	14.0	34.6	41.7	92.6 (C)	0.0644	0.346	0.311	1.60	ND
B-72-12.5'	12.5	ND	ND	ND	ND	ND	ND	0.331	ND
B-75-9.5'	9.5	ND	ND	ND	0.266	ND	0.0805	ND	1.52
B-77-9'	9.0	4.24	ND	ND	ND	ND	ND	0.202	ND
B-78-12'	12.0	5.02	ND	ND	ND	ND	ND	ND	ND
B-81-7.5'	7.5	5.01	ND	ND	ND	ND	ND	ND	ND
B-83-9.5'	9.5	7.45	ND	ND	ND	ND	ND	ND	ND
B-85-9.5'	9.5	7.40	ND	ND	ND	ND	ND	ND	ND
ISLAND AREA									
IB-1-8'	8.0	147	ND	ND	3.07	ND	3.17	9.05	0.493
IB-2-8'	8.0	39.4	ND	ND	2.44	ND	0.921	4.07	3.36
IB-3-8'	8.0	82.8	ND	ND	2.58	ND	2.64	5.93	1.51
IB-4-8'	8.0	187	ND	ND	6.58	ND	2.78	3.93	ND
IB-5-8'	8.0	16.4	ND	ND	ND	ND	ND	ND	ND
IB-6-2.5' (tar)	2.5	2,920	5,400	14,700 (F)	60.8 (I)	ND	87.3	ND	ND
IB-7-2.5'	2.5	2,760	ND	ND	7.65	55.2	48.0	160	ND
IB-8-4'	4.0	36.8	ND	ND	0.157	ND	0.0701	ND	ND
IB-9-4.5'	4.5	4,460	ND	113	33.4	194	111	576	ND
DUMP									
D-1-5	5.0	NA	ND	2,010 (A)	1,700	ND	111	860	ND
D-2-SPOIL	0.0	NA	ND	16,100 (A)	13,200	613	1,120	5,178	ND

3.2.3. Soil Contamination Distribution

Each analyzed constituent result was contoured to evaluate distribution within the excavation. The contours are shown in Figures 23A through 23G. Certain analyses resulted in less definitive characterization of petroleum products. For example, Sample B-71-4', located approximately central to the excavation, apparently contained a mixture of weathered gasoline and diesel (see Figure 24 – "Chromatogram Soil Sample B-71-4"). Other samples containing apparent multiple interpretations of petroleum are listed above as "Notes to accompany Table 5". This would indicate that there was a possible mixture of diesel and gasoline beyond the highest diesel concentrations shown in Figure 23B.

Based on the soil sample analytical results contours of gasoline (as TPH) and related constituents, BTEX, and MTBE, the highest concentration patterns are:

- 1) located east of Monitor Well MW-5 and north of the service station (distinctly south of the prior gasoline UST locations);
- 2) along the gasoline pipeline between the storm drain and the prior UST's; and at the area where the easternmost gasoline pipeline bends (elbows) southward to the easternmost pump island;
- 3) south along the pipelines to the prior pump islands, and, at the southwesternmost pump island, northeast of Monitor Well MW-1.

These three areas of probable sources of gasoline leakage are further indicated by the Total Xylenes contours (Figure 23F) since the xylenes would be the least rapidly depleted by groundwater dissolution or biodegradation and would have the higher concentrations over time. These patterns are also consistent with those found for groundwater contamination (see discussion Section 2.7.4).

The high concentrations of gasoline and related constituents north of the office may be related to leakage migration along the natural gas pipeline trench (see Figure 2 for alignment); and/or overspill from the gasoline tanks located immediately to the north; and/or leakage migration along the gasoline pipeline trench. The higher permeability of the prior UST backfill material may have allowed 'ponding' of the product that could not rapidly dissipate into the area of the dump where some interruption of groundwater flow (due to the partial envelopment in visqueen) may have consequently resulted in higher soil contamination north of the office. However, water and/or product migration around the dump area would have been possible. Higher concentrations south of the prior UST's could have also been due to reversals in groundwater gradient at some time in the past.

The TPH diesel concentration contour (Figure 23B) indicates that leakage may have been near the fill pipe of the UST. No visible holes or fractures were seen in the diesel UST that was excavated. The higher concentrations of diesel contaminated soil extends north of the location of the prior diesel tank and southward toward the service station office. This pattern, as well as the similar pattern for gasoline, may be related to the higher permeability of the UST backfill.

A linear regression fit of all detected gasoline and diesel in soil samples is shown in Figure 25 – "TPH Linear Regression and Sample Depth Plots". The plots indicate a decrease in concentration with depth. The slope of the line fit coincides with the approximate depth of the underlying grayish-green silty clay unit, considered to be a natural aquitard, although distinct monitoring above and below this unit has not been established. In general, the sample results reflect the annual vertical movement of the water table. The lowest concentrations of gasoline and diesel occur at the greatest depth of sampling (about fourteen (14)-feet).

3.2.3.1 Ratio Concentrations In Soil

The ratio of benzene to toluene concentration in soil samples is shown in Figure 26 – “Concentration Ratios (Soil)”. In general, the more water soluble and volatile compounds are lost most rapidly from contaminated soil. Benzene is depleted relatively rapidly from gasoline-saturated soil, while ethylbenzene and xylenes tend to increase in concentration. Benzene is ten times more soluble than ethylbenzene and xylenes and therefore is leached ten times faster, assuming dissolution rather than volatilization is the dominant weathering process. A lower ratio would tend to indicate older gasoline; for example, 50ppm benzene to 10 ppm toluene would be a ratio of 5:1; whereas 10 ppm benzene (depleted) to 50 ppm xylenes (increased concentration) would be a lower ratio of 1:5.

Based on Figure 26, the highest benzene to toluene ratios occur in soil samples B-67-9.5', SW-76-8', B-31-9', NW-79-7', B-64-9.5', and B-50-8'. The second highest grouping of ratios appears to include samples WW-44-4', EW-2-4', B-66-9.5', EW-74-5', SW-59-5.5', and B-32-6'. These two groups appear as breaks in the slope and could indicate separate leakage events.

A high ratio, approximately 10:1, of toluene to ethylbenzene appears to indicate fresh gasoline. As shown in the lower Figure 27 – “Toluene to Ethylbenzene Concentration Ratio (Soil)”, samples EW-33-4' and EW-34-4' have high ratios of toluene to ethylbenzene.

The highest ratios of benzene to xylenes (Figure 26) occur in samples SW-59-5.5', B-67-9.5', IB-4-8', B-66-9.5', WW-42-4', B-65-9.5', SW-80-7', and B-36-6'.

While not definitive, the ratios indicating fresher gasoline tend to cluster in samples collected near the bend in the easternmost gasoline pipeline where it turns south to the pump islands, and, northeast of the service station office.

3.3. DEQ REPORTS

3.3.1. Previous Groundwater Sampling

Previous groundwater sampling is summarized in a report submitted to the Oregon Department of Environmental Quality (“DEQ”) titled “Quarterly Report, July 1999, Groundwater Monitoring, Flying J-Milwaukie #2, DEQ Site No. 03-93-0008”, dated August 4, 1999 by GeoPro Geologic Services. Planned remedial excavation and upgrade of underground storage tanks was submitted as a “Work Plan” dated August 11, 1999 and subsequently approved by DEQ.

During excavation, Monitor Wells MW-2, MW-4, MW-7, and MW-8 were decommissioned by over-excavation. A decommissioning report was submitted to the Oregon Department of Water Resources.

3.3.2. New MW-14 and MW-15

Two (2) additional groundwater monitoring wells, MW-14 and MW-15 (see Figure 3), were installed at the direction of DEQ. The geologic and construction logs are included in Appendix F – “Monitor Well Logs MW-14 and MW-15 and Well Survey”.

3.3.3. Future Monitoring

Following quarterly groundwater sampling as directed by DEQ, an assessment of results will be made in quarterly reports, after which a Risk-Based Assessment Report could propose outlining steps for no further action.

4. INTERPRETATIONS AND CONCLUSIONS

4.1. CONTAMINANT SOURCES

4.1.1. Gasoline Pipeline

On February 18, 1993, an 'Initial Report Form For UST Cleanup Project' was prepared by Flying J Inc. for a reportedly unleaded gasoline pipeline release that apparently occurred on January 12, 1993. During remedial excavation in September 1999, an abandoned set of pipelines was found between the UST's and MW-2. Free product, apparently from the pipeline leak, was last reported in monitor wells in 1995.

It is concluded that, although most of the gasoline contamination from this initial 1993 pipeline spill could have partitioned or degraded since 1993, residual product may have been trapped in pockets within the backfill.

4.1.2. Gasoline Pipeline Elbow

Contours of gasoline constituents in groundwater indicate that a significant gasoline leakage source could have apparently continued after the gasoline pipeline was repaired and replaced in 1993. It appears that an elbow, or bending of the pipe toward the pump islands, may be the source of leakage near the prior location of Monitor Well MW-2.

It is concluded that leakage from near bends in gasoline pipelines could have occurred since 1993.

4.1.3. Pump Islands

Benzene to toluene groundwater concentration ratios from samples collected in 1995 through 1998 from Monitor Well MW-1 indicates an apparent gasoline pipeline leak near the southwesternmost pump island.

High concentrations of TPH as gasoline and xylenes were detected in soil samples collected during excavation northeast of MW-1.

It is concluded that leakage from near the southern pump islands could have occurred since 1993.

4.1.4. Diesel UST

On January 23, 1998, the diesel UST failed a leak detection test. In March 1999, diesel was not offered because water was discovered in the product during pumping.

It is concluded that most, if not all, of the diesel contamination occurred after the purchase of the property in February 1994.

4.2. CONTAMINATION EXTENT

Confirmation soil samples were collected at the extent of the excavation or limit of apparent contamination. The selected sample locations were based on visual and laboratory analyses. The southern extent of the excavation was limited by the need to allow vehicle traffic access to Jiffy Lube. The excavation was also limited south of monitor well MW-5, and east of the office building, to retain the safety integrity of the office building.

4.2.1. Diesel

Diesel apparently spilled from near the UST fill pipe and/or from breaks in the pipeline to the nearby diesel pump. Contours (Figure 23B) of diesel soil contamination indicate that diesel may have spread into soil surrounding the prior UST tank field and also spread easterly and southerly, possibly due to changes in groundwater flow, vertically and horizontally.

Minor diesel (27.2 mg/kg) was detected in soil sample SW-58-5' at the southern extent of the excavation, although laboratory notes indicate that the constituent may be weathered gasoline. Minor diesel (90.2 mg/kg) was also detected in soil sample WW-86-8' collected north of the auto part-building dump and northern extent of the excavation. However, analysis of soil sample NW-84-7', collected approximately five (5)-feet from sample WW-86-8', resulted in non-detection of diesel.

Minor diesel (43.9 mg/kg) was detected in soil sample EW-74-5', at the northeastern extent of the excavation, adjacent to the previous location of the storm drain (and property boundary). Diesel was detected at 41.7 mg/kg in soil sample B-71-14', collected at the central-bottom of the excavation.

These locations of diesel detection in soil samples collected from the excavation limits are not considered to be significant contamination and would be expected to continue degradation overtime. Apparently, some of the detected diesel in the soil may be weathered gasoline.

4.2.2. Gasoline

Benzene concentrations in groundwater contours appear to peak in late 1994 and early 1995 (Figures 10E and 10F). Benzene contours for January 24, 1995 (Figure 10E) indicate a large concentration increase along the gasoline pipeline, indicating that the replacement gasoline pipeline may have leaked, and/or the elbows (or pipeline bends) may have leaked. An area of high concentration of gasoline contaminated soil was excavated from around MW-2, as well as, around the gasoline pipeline elbows/bends as they turned southward toward the pump islands. Benzene to toluene groundwater concentration ratios from samples collected in 1995 through 1998 indicates an apparent gasoline pipeline leak near the southwesternmost pump island (Figure 11).

Gasoline was detected in soil samples NW-84-7' (7.39 mg/kg), NW-79-7' (35.5 mg/kg), WW-82-7' (8.56 mg/kg), and WW-86-8' (7.55 mg/kg) collected at the northwestern extent of the excavation. Minor gasoline was also detected in soil samples collected along the northern sheet-pile wall extent of excavation, at concentrations from 5.10 mg/kg (NW-17-9') to 25.6 mg/kg (NW-29-15'). Minor gasoline was detected in soil samples NW-73-4' (49.3 mg/kg) and SW-76-8' (237 mg/kg), at the north and eastern extents of the excavation within the area of the previous storm drain. Slightly higher concentrations of gasoline were detected in soil sample SW-59-5.5' (60.0 mg/kg) collected at the extent of the excavation along the east side of the office building. At the extent of the southern limit of the excavation, east of monitor well MW-1, analysis of soil sample IB-4-8' resulted in 187 mg/kg, however, the excavation was extended southerly based on visual observations.

Except for soil sample SW-76-8' in which benzene was detected at 9.94 mg/kg, the benzene concentrations in the above soil samples ranged from non-detect to less than 3 mg/kg. MTBE was not detected in any confirmation soil samples collected at the extent of the excavation except SW-76-8' (5.51 mg/kg) near the previous storm drain location.

4.2.3. Auto Parts-Building Dump

The auto parts-building material dump area was apparently created around 1962. Soil sample D-1-5' was collected from within the dump area, and soil sample D-2 was collected from a temporary stockpile of dump material. The auto parts-building material was disposed off-site.

Soil samples B-81-7.5', B-83-9.5', B-85-9.5', WW-82-7', WW-86-8', and NW-84-7' were collected from the northwesternmost area of the dump, near the property boundary. Except for soil sample WW-86-8', the results of analyzing the soil samples indicated low concentrations of gasoline below nine (9) mg/kg. Soil sample WW-86-8' (8-feet bgs) contained gasoline (7.55 mg/kg), diesel (90.2 mg/kg) and heavy oil (305 mg/kg) constituents.

Soil samples B-83-9.5', B-85-9.5', WW-82-7', WW-86-8', and NW-84-7', collected essentially downgradient from the dump, were also analyzed for total metals. The following Table 6 summarizes the results of metals analyses.

Table 6 – AUTO PARTS-BUILDING DUMP: SOIL METALS ANALYSES

SAMPLE	DEPTH, BGS	mg/kg					
		Barium	Cadmium	Chromium	Lead	Silver	Mercury
B-83-9.5'	9.5	160	0.573	26.6	18.8	ND	ND
B-85-9.5'	9.5	172	ND	24.7	18.2	ND	ND
WW-82-7'	7	186	ND	21.8	ND	ND	ND
WW-86-8	8	118	ND	21.9	17.7	ND	ND
NW-84-7'	7	231	0.797	28.4	19.8	ND	ND

Two soil samples, D-1-5' and D-2-SPOIL, were collected and analyzed to characterize constituents in the auto parts-building dump. These two soil samples were analyzed for diesel and heavy oil hydrocarbons, total metals, polychlorinated byphenyls, and volatile organic compounds. Sample D-2-SPOIL was also analyzed for TCLP lead and benzene.

The following Table 7 summarizes the detectable results of analyzing samples D-1-5' and D-2-SPOIL.

Table 7 – AUTO PARTS-BUILDING DUMP: DETECTED RESULTS (SOIL)

CONSTITUENT	mg/kg D-1-5'	D-2-SPOIL
Heavy Oil Range Hydrocarbons	2,010*	16,100*
Barium	182	186
Cadmium	1.25	1.38
Chromium	41.5	25.3
Lead	82.5	188 (TCLP=ND mg/l)
Arsenic	7.57	14.7
Aroclor 1260	0.0891*	ND
Benzene	1.7	13.2 (TCLP=0.0563 mg/l)
n-Butylbenzene	0.113	ND
Ethylbenzene	0.111*	1.120
Isopropylbenzene	0.116*	0.191
n-Propylbenzene	0.359	0.248
Toluene	ND	0.613
1,2,4-Trimethylbenzene	0.887	0.117*
1,3,5-Trimethylbenzene	0.860	0.160
0-Xylene	ND	0.398
m,p-Xylene	0.860	4.780

*see lab note

A water grab sample taken from the bottom of the auto parts dump excavation, at about 9.5-feet bgs, (sample WG-1-9.5') was analyzed for volatile organic compounds, gasoline hydrocarbons, total metals, and diesel and heavy range hydrocarbons. The following Table 8 summarizes the detectable results of analyzing water sample WG-1-9.5'.

Table 8 – AUTO PARTS-BUILDING DUMP: DETECTED RESULTS (WATER) - mg/l

CONSTITUENT	WG-1-9.5'
Gasoline Range Hydrocarbons	0.229
Diesel Range Organics	0.830
Arsenic	0.191
Barium	11.6
Cadmium	0.0140
Chromium	0.947
Lead	2.45
Silver	0.00790
Selenium	0.0125
Methyl tert-butyl ether	0.00305
Benzene	0.0286
Carbon disulfide	0.0125
cis-1,2-Dichloroethene	0.0998
Ethylbenzene	0.00250
Isopropylbenzene	0.00221
n-Propylbenzene	0.00152
Tetrachloroethene	0.00100
1,2,4-Trimethylbenzene	0.00122
Vinyl chloride	0.0112
m,p-Xylene	0.00266

-trichloroethene

0.0492

5. LIMITATIONS

This report is restricted to an investigation which has included the review of previous work involving underground storage tanks which contained known or suspected hazardous products identified either by the property owner(s), historical records, or previous reports. Such records and investigations have been relied upon in good faith, however, no responsibility is accepted for errors or omissions of previous work. Drilling and excavation and associated services were performed under separate agreement with the landowner and Consultant makes no claim of responsibility for services provided by others. This report is restricted to geologic services as requested by the Client.

It is possible that exploration or sampling by others failed to reveal the presence of hazardous materials at areas where hazardous materials were assumed, suspected or expected to exist. Client understands that third-party failures to discover contaminated or hazardous materials through appropriate and mutually agreed-upon sampling techniques does not guarantee that such materials do not exist at the Site. Similarly, a Site, or adjacent, or nearby property, which in fact is unaffected by contaminated or hazardous materials at the time of exploration or sampling, may later, due to natural causes including groundwater movement or human intervention, become contaminated. Consultant is not responsible for failing to locate groundwater monitoring wells which have not discovered hazardous materials at the time of this report or in the future.

This report should not be construed as presenting a value to neither the Site nor the condition as to construction capabilities. In the event of changes in future development plans as understood at the time of this report, the conclusions and recommendations made herein shall be invalid until given the opportunity to review and modify this report in writing.

Services were performed, findings obtained, and recommendations prepared in a manner generally exercised by members of the profession under similar conditions at the time services were rendered. This warranty is in lieu of all other warranties, either expressed or implied. Findings apply only to present conditions, and opinions expressed are subject to revision when additional or new information is submitted in writing. This report has been prepared for the landowner(s) or landowner's agents and Consultant shall not accept liability or responsibility for detachment, partial use or separation by third parties and such use shall be at user's sole risk.

Portions of an Agreement to perform professional services for the Client may or may not be disclosed in this report. Final approval of environmental investigations and remediation is authorized only by appropriate governmental agencies.

Respectfully submitted,

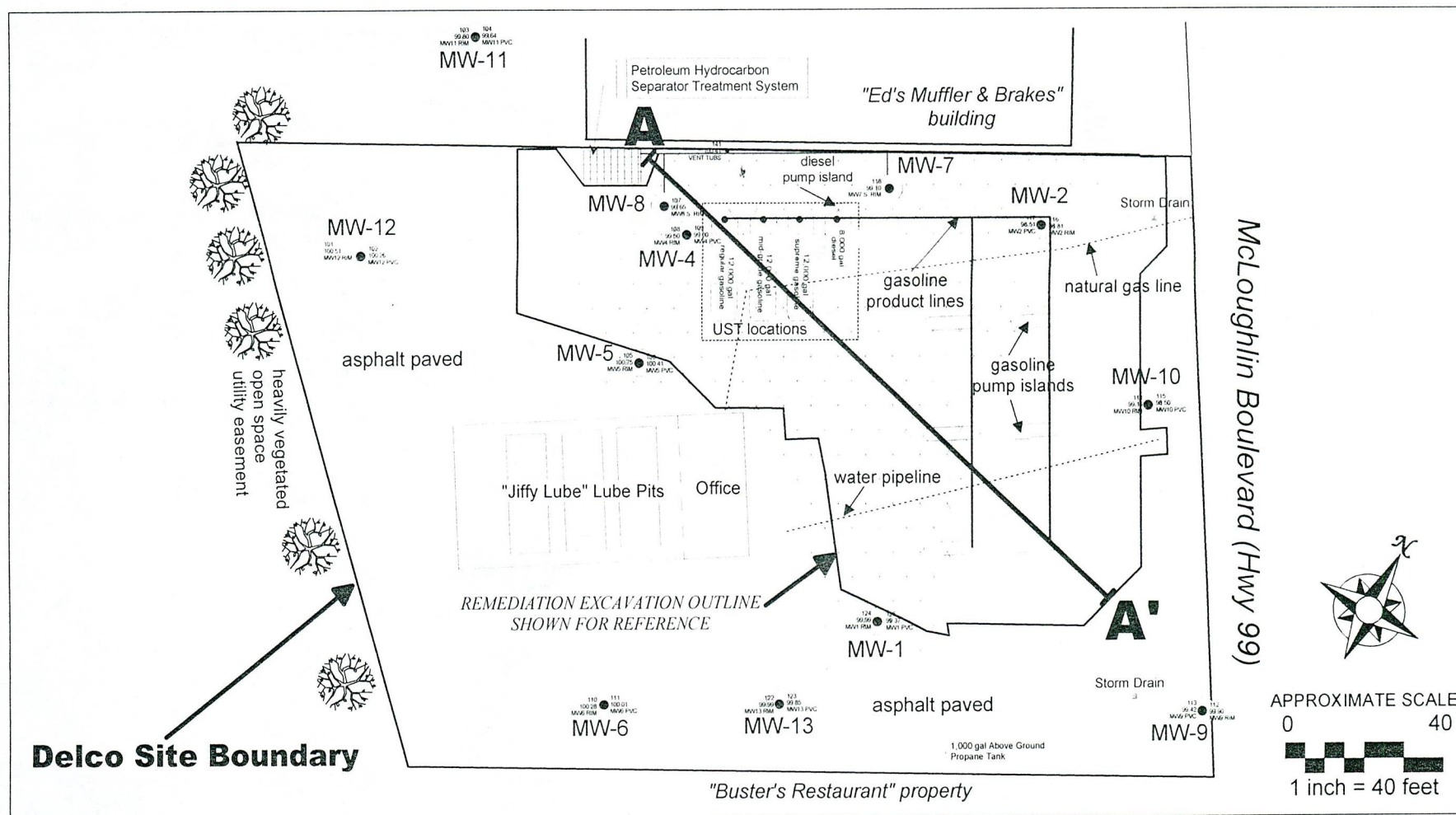


Richard C. Kent, R.G.
Professional Geologist

Figure 1 - LOCATION MAP

Source: U.S.G.S. Topographic Map, Gladstone Quadrangle, 1:24,000





Groundwater
MW-13 Monitor Well Location

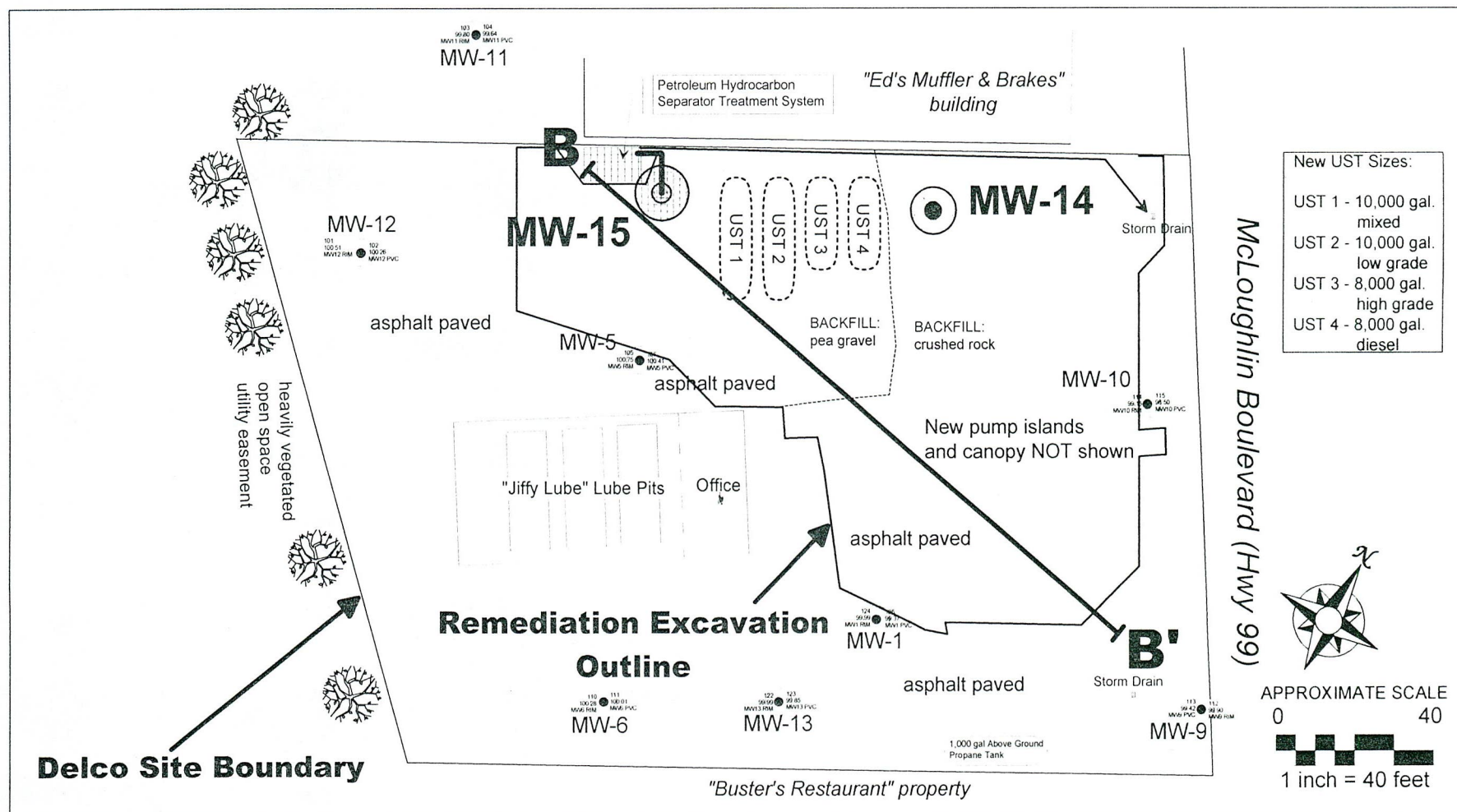
pre-excitation
estimated area
of groundwater
contamination

Figure 2
PRE-EXCAVATION SITE MAP AND
CROSS-SECTION A-A' INDEX

DELCO PETROLEUM CO. LLC
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Milwaukie, OR



GeoPro Geologic Services
Battle Ground, WA
Project No. 990621



GeoPro Geologic Services
Battle Ground, WA

Project No. 990621



MW-14 New 4" monitor well



MW-15 New 4" Production Well



New 4" PVC pipeline to treatment facility
and discharge to storm drain



MW-13

Existing Monitor Well Location

Figure 3
POST-EXCAVATION SITE MAP
AND CROSS-SECTION B-B' INDEX

DELCO PETROLEUM CO. LLC
17873 SE McLoughlin Blvd.
Milwaukie, OR

Figure 4 – EXPOSED DIESEL UST AND GASOLINE PIPELINES

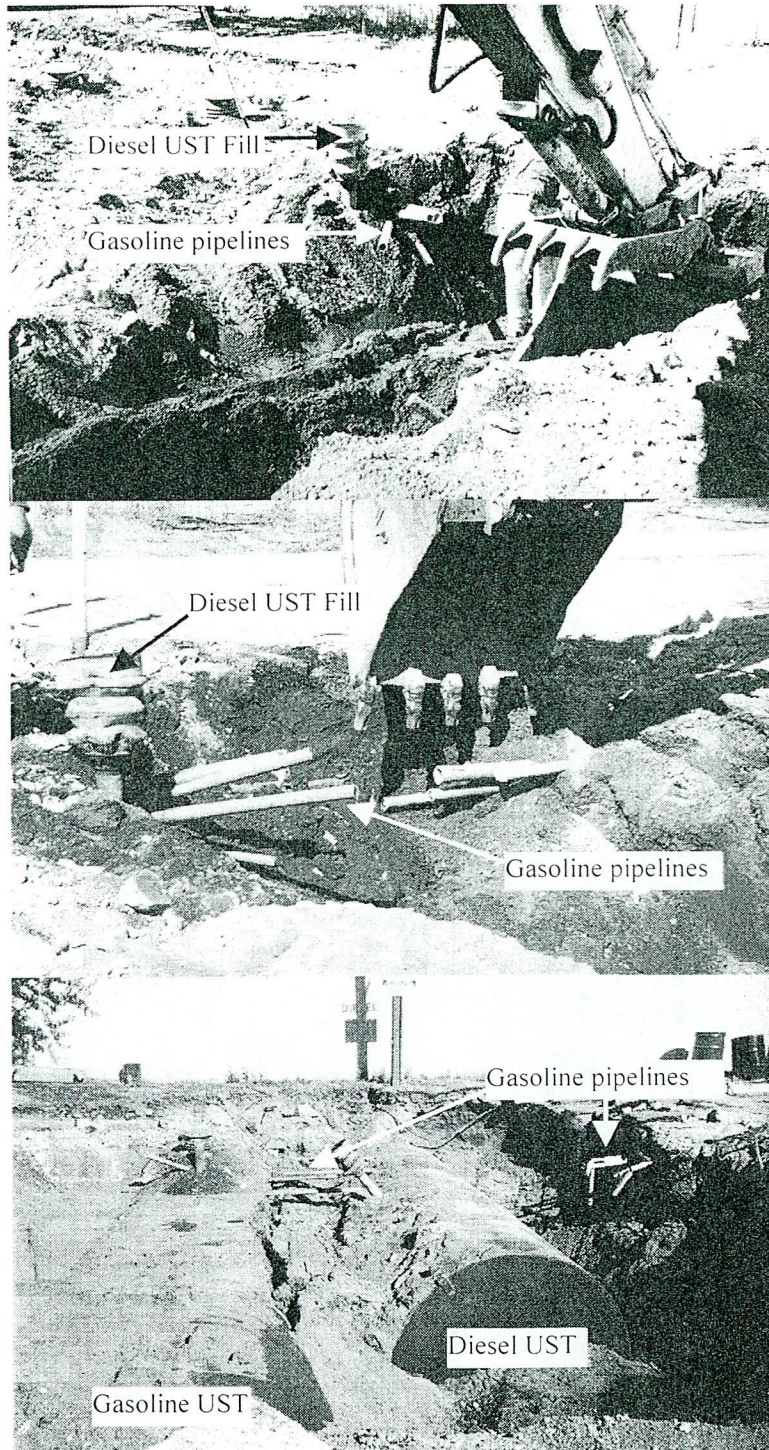


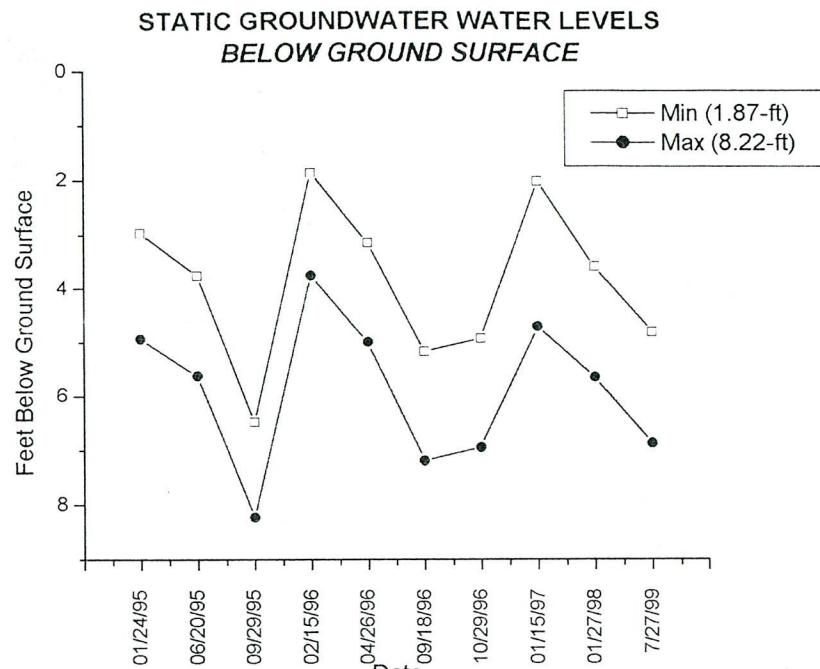
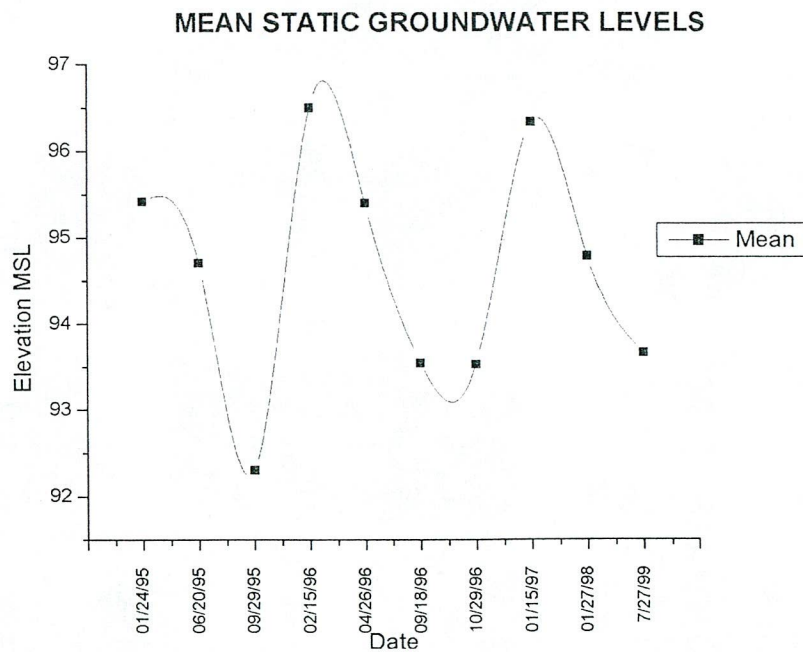
Figure 5 - STATIC GROUNDWATER LEVELS BELOW GROUND SURFACE**Figure 6 – MEAN GROUNDWATER STATIC LEVELS (RELATIVE ELEVATION)**

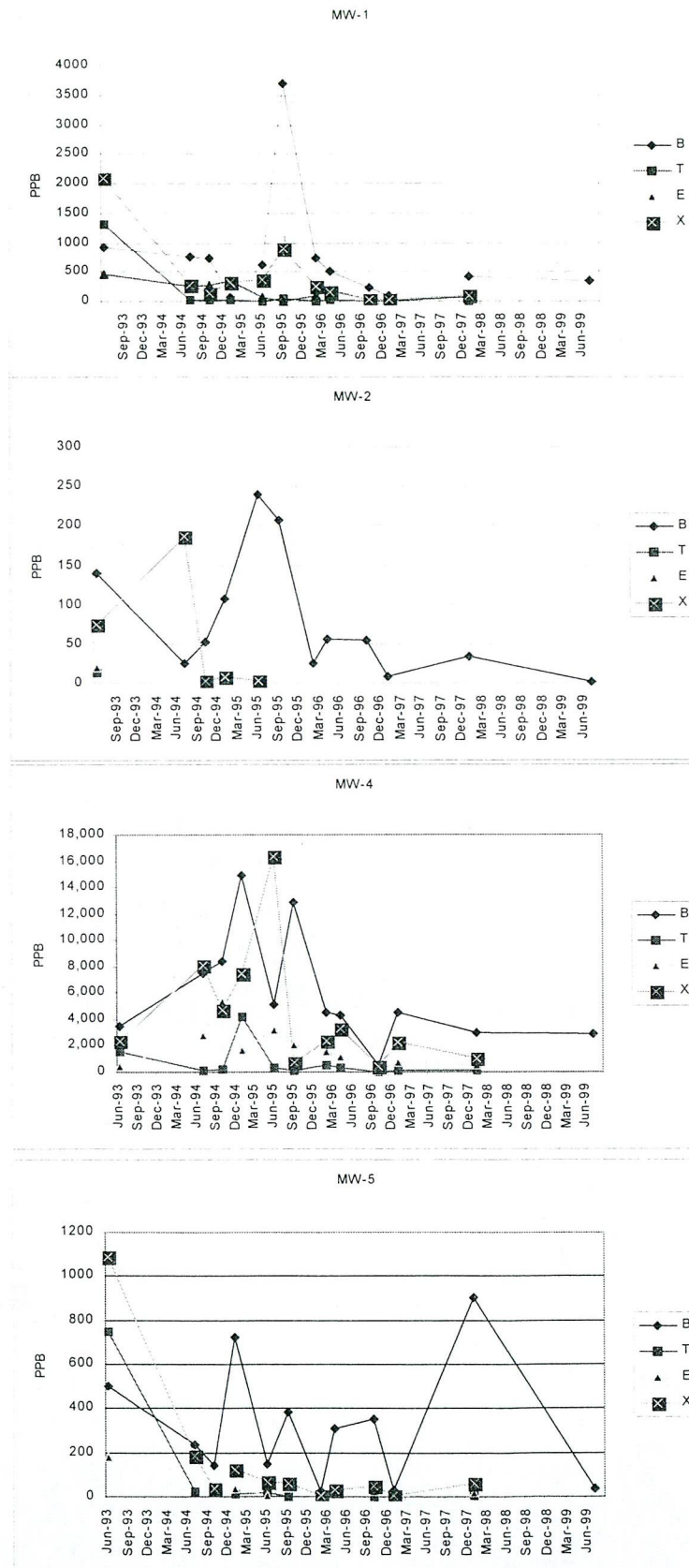
Figure 7 – GROUNDWATER ANALYSES (Selected Wells, ND not shown)

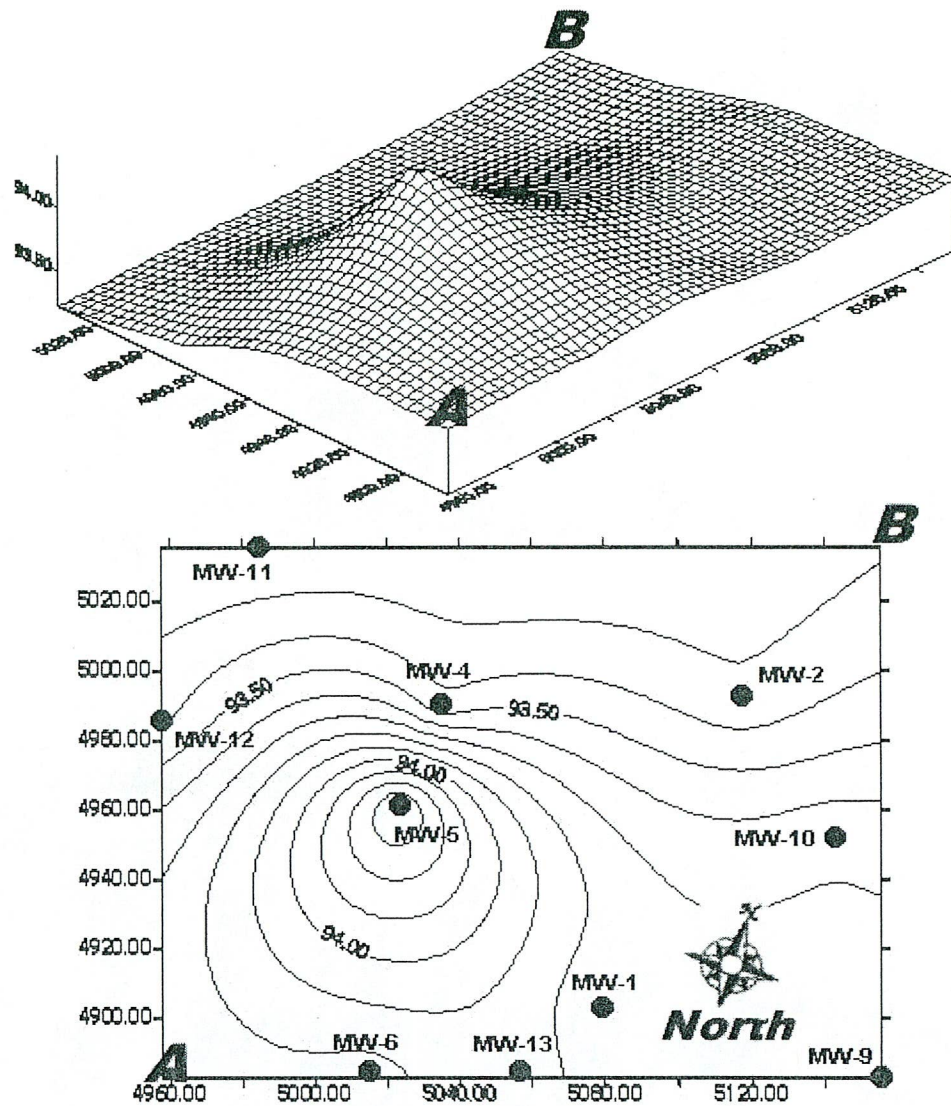
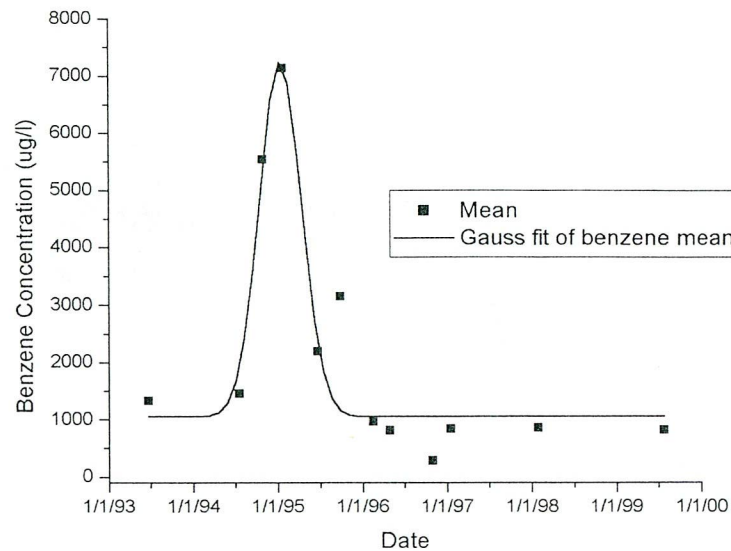
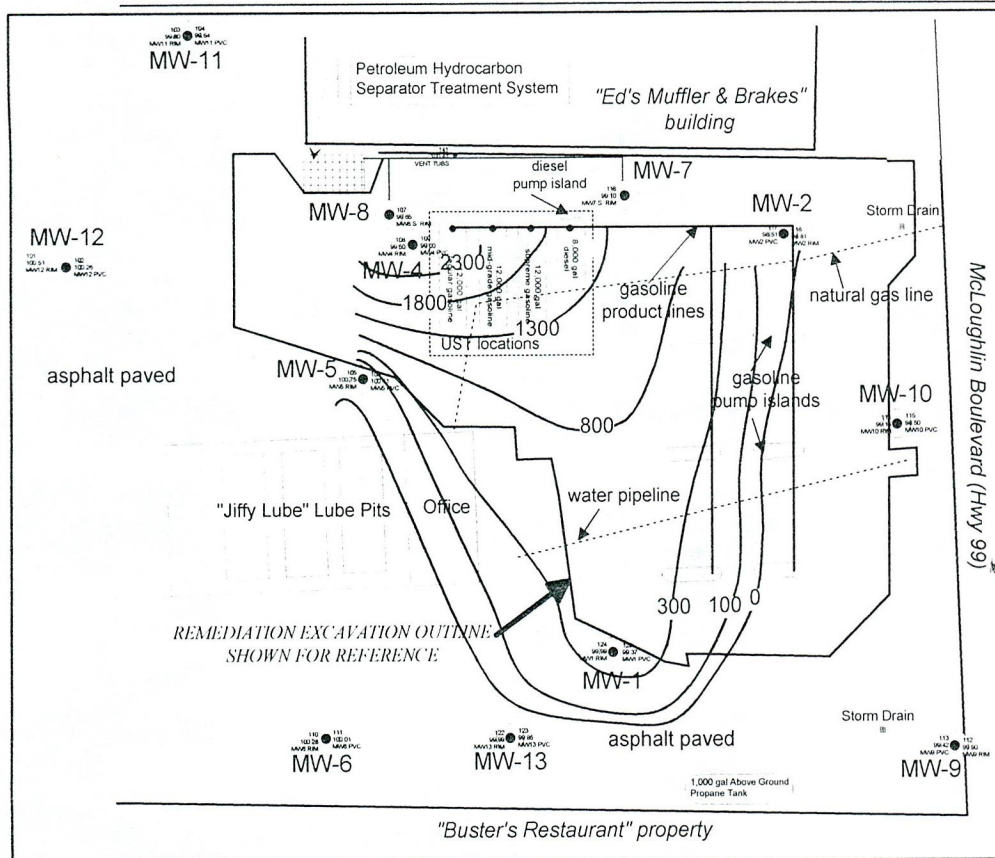
Figure 8 – JULY 1999 GROUNDWATER GRADIENT

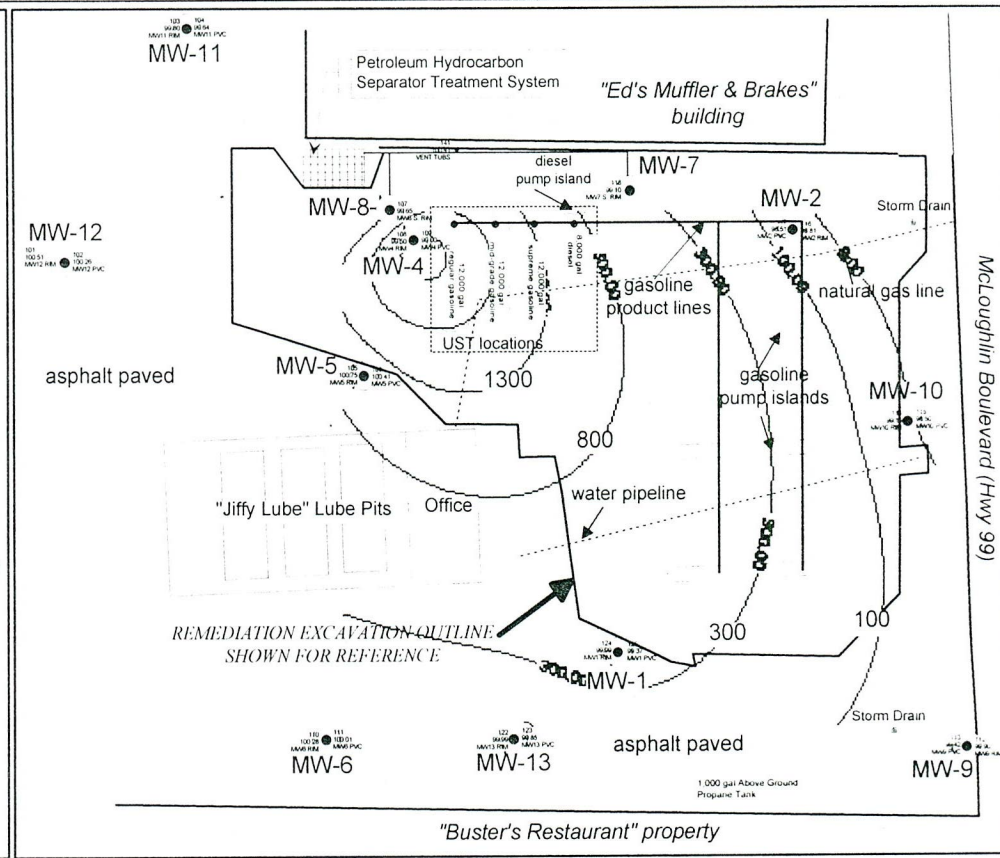
Figure 9 – BENZENE GROUNDWATER MEAN CONCENTRATIONS

Concentration shown below in µg/l

Date	Mean	Minimum	Maximum
7/23/99	821	1.54	2910
1/27/98	856	34	2960
1/15/97	846	9	4540
10/29/96	285	54	490
4/26/96	815	56	4330
2/15/96	961	23	4490
9/29/95	3150	208	12900
6/20/95	2200	150	5130
1/24/95	7139	62	19900
10/28/94	5545	53	18400
7/18/94	1455	14	7460
6/22/93	1330	140	3500
<i>AVE</i>	<i>2117</i>	<i>67</i>	<i>7250</i>



7/23/99



1/27/98

Benzene groundwater concentration contour (ppb)
Contour Interval (CI) = 500 ppb except 0, 100 and 300 contours

Groundwater
MW-13 Monitor Well Location

Well	Install Date
MW-1	6/18/93
MW-2	6/18/93
MW-3	6/18/93 Replaced by MW-7 2/20/95
MW-4	6/18/93
MW-5	6/19/93
MW-6	6/19/93
MW-7	1/27/95 Production (intermittent)
MW-8	1/27/95 Production
MW-9	1/27/95
MW-10	8/12/96
MW-11	8/12/96
MW-12	8/12/96
MW-13	8/12/96



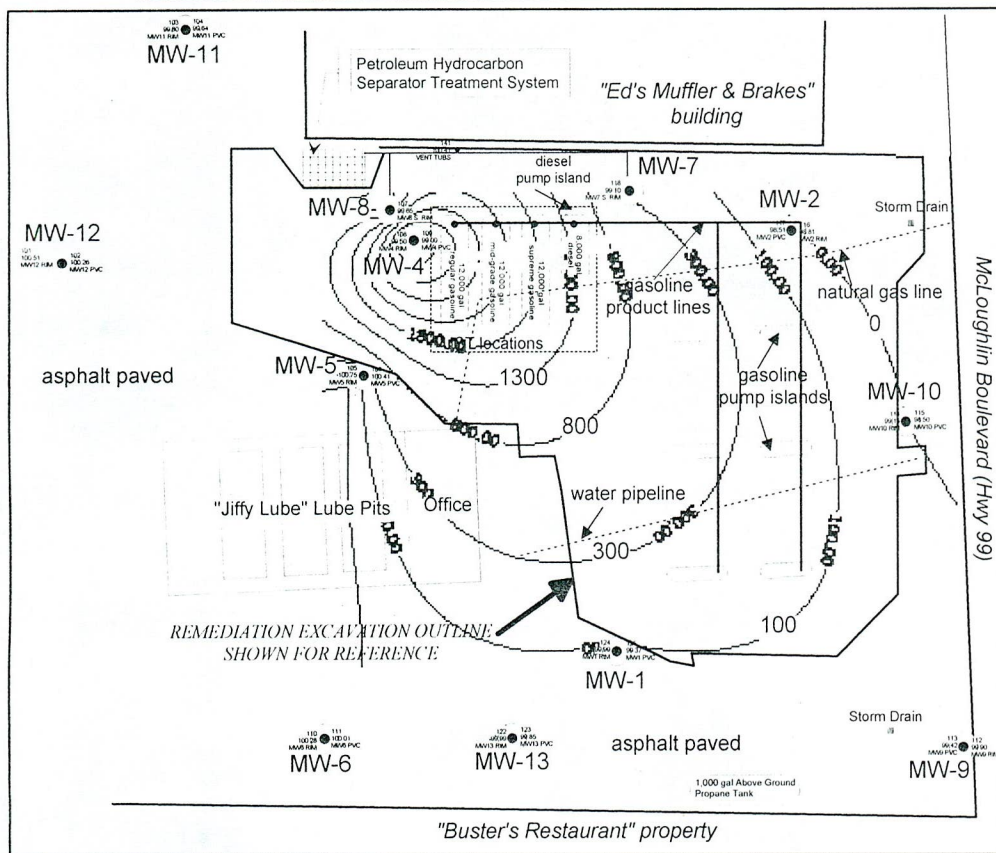
GeoPro Geologic Services
Battle Ground, WA
Project No. 990621

Figure 10A



BENZENE CONCENTRATION CONTOURS (GROUNDWATER)

DELCO PETROLEUM CO. LLC
17873 SE McLoughlin Blvd.
Milwaukie, OR



1/15/97

Benzene groundwater concentration contour (ppb)
Contour Interval (CI) = 500 ppb except 0, 100 and 300 contours

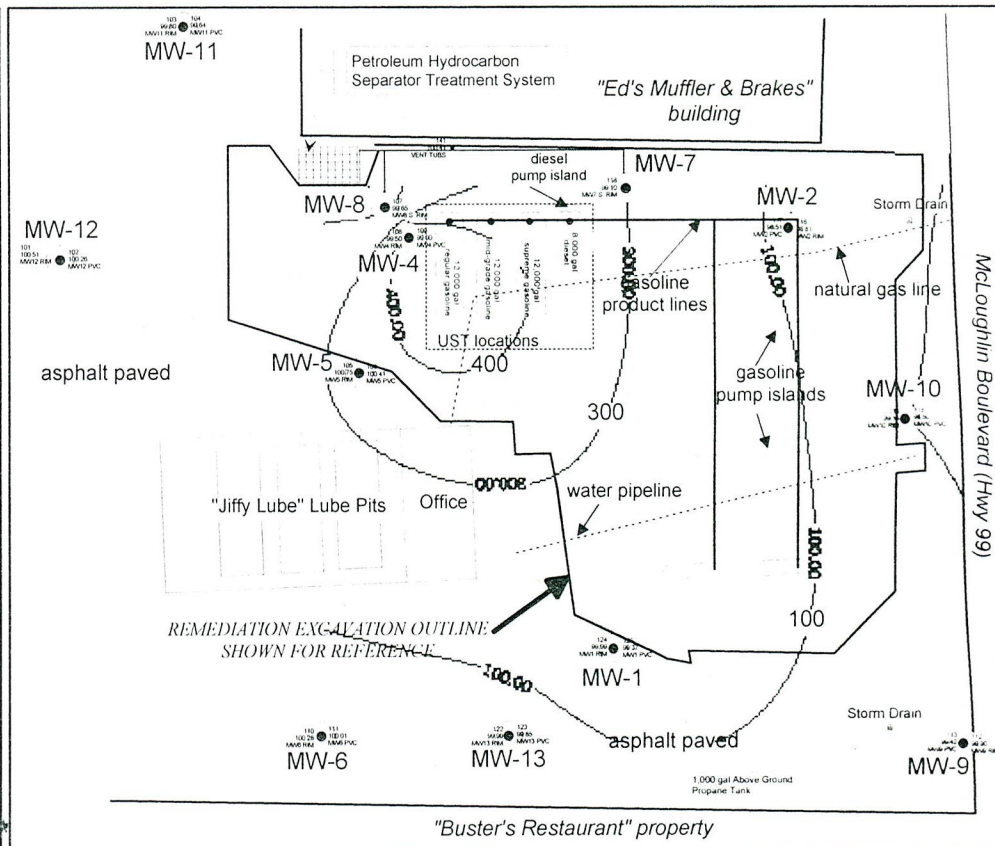
Groundwater
MW-13 Monitor Well Location



GeoPro Geologic Services
Battle Ground, WA

Project No. 990621

Well	Install Date
MW-1	6/18/93
MW-2	6/18/93
MW-3	6/18/93 Replaced by MW-7 2/20/95
MW-4	6/18/93
MW-5	6/19/93
MW-6	6/19/93
MW-7	1/27/95 Production (intermittent)
MW-8	1/27/95 Production
MW-9	1/27/95
MW-10	8/12/96
MW-11	8/12/96
MW-12	8/12/96
MW-13	8/12/96



10/29/96

NOTE: Contour Interval 100 ppb

Figure 10B



BENZENE CONCENTRATION CONTOURS (GROUNDWATER)

DELCO PETROLEUM CO. LLC
17873 SE McLoughlin Blvd.
Milwaukie, OR

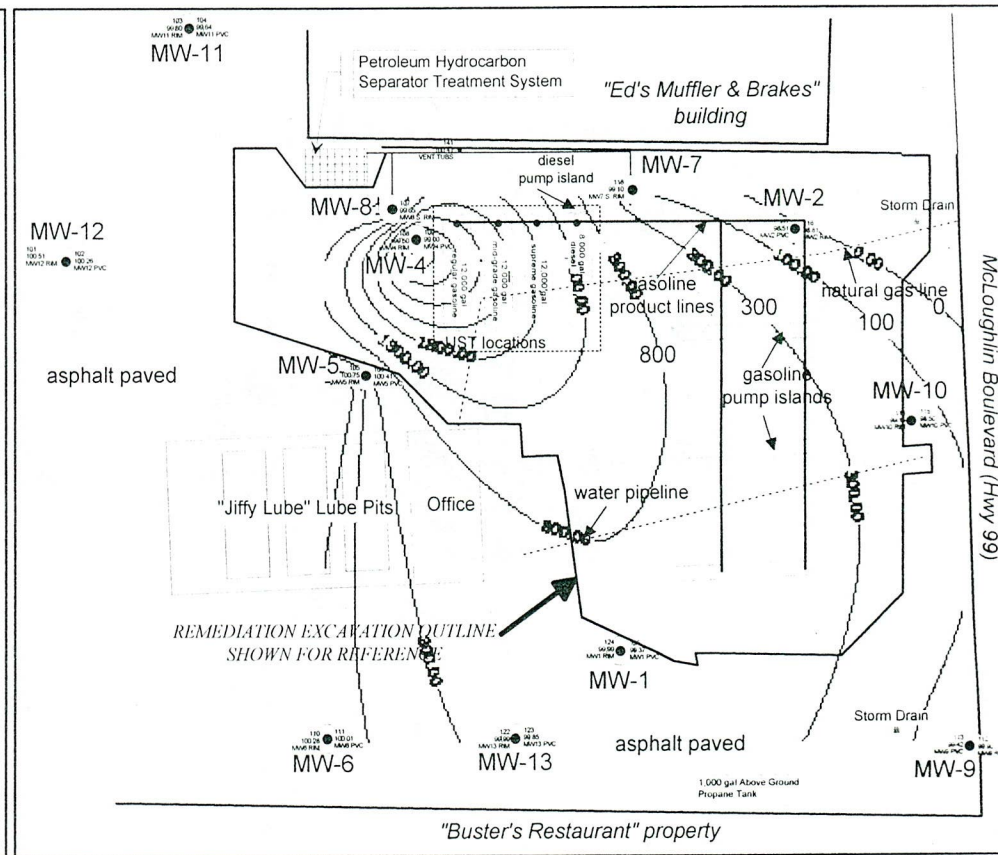
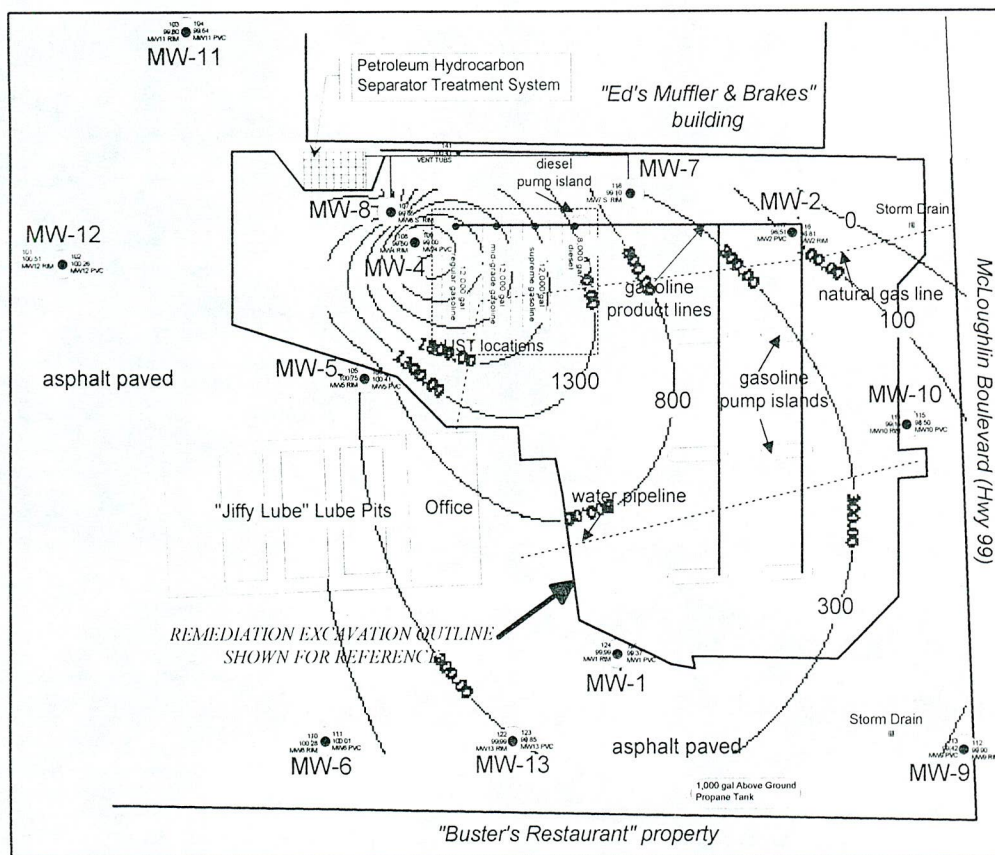
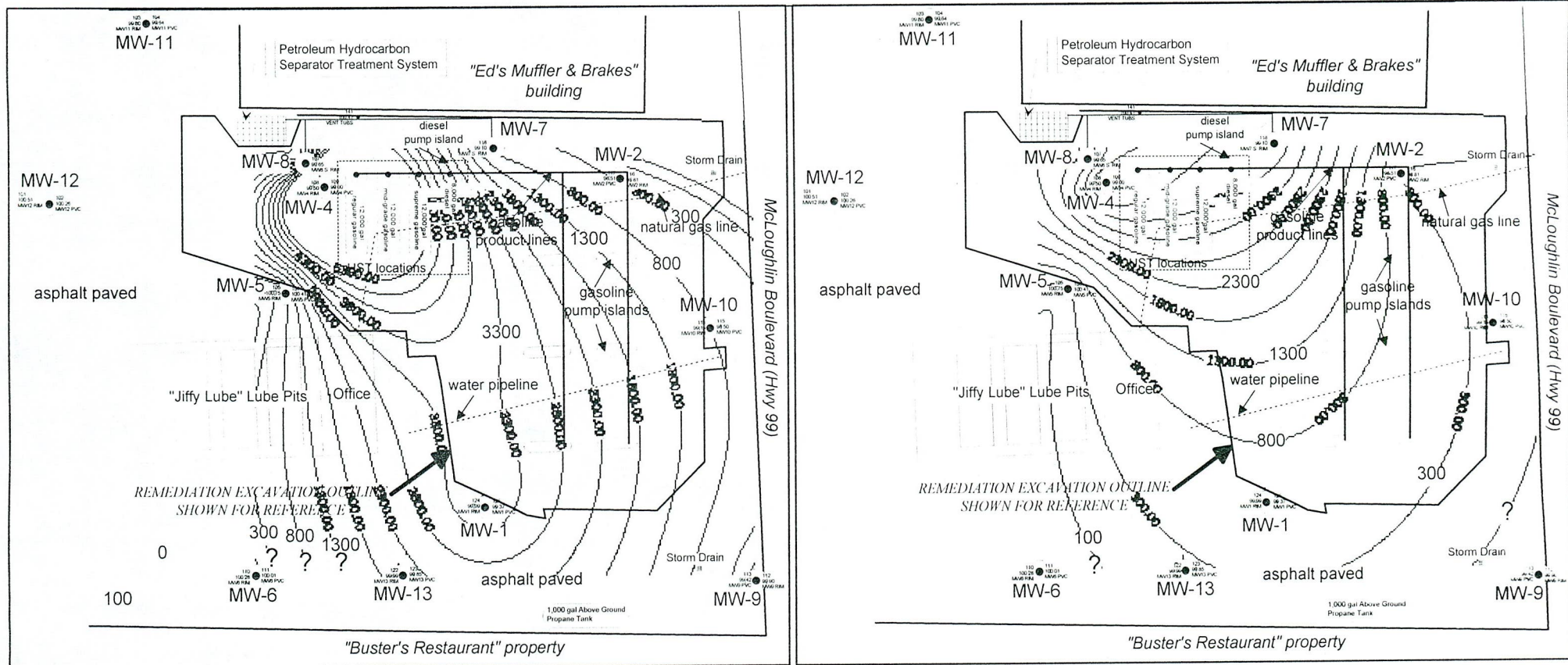


Figure 10C



BENZENE CONCENTRATION CONTOURS (GROUNDWATER)

DELCO PETROLEUM CO. LLC
17873 SE McLoughlin Blvd.
Milwaukie, OR



9/29/95

6/20/95

Benzene groundwater concentration contour (ppb)
Contour Interval (CI) = 500 ppb except 0, 100 and 300 contours

Groundwater
MW-13 Monitor Well Location



GeoPro Geologic Services
Battle Ground, WA
Project No. 990621

Well	Install Date
MW-1	6/18/93
MW-2	6/18/93
MW-3	6/18/93 Replaced by MW-7 2/20/95
MW-4	6/18/93
MW-5	6/19/93
MW-6	6/19/93
MW-7	1/27/95 Production (intermittent)
MW-8	1/27/95 Production
MW-9	1/27/95
MW-10	8/12/96
MW-11	8/12/96
MW-12	8/12/96
MW-13	8/12/96

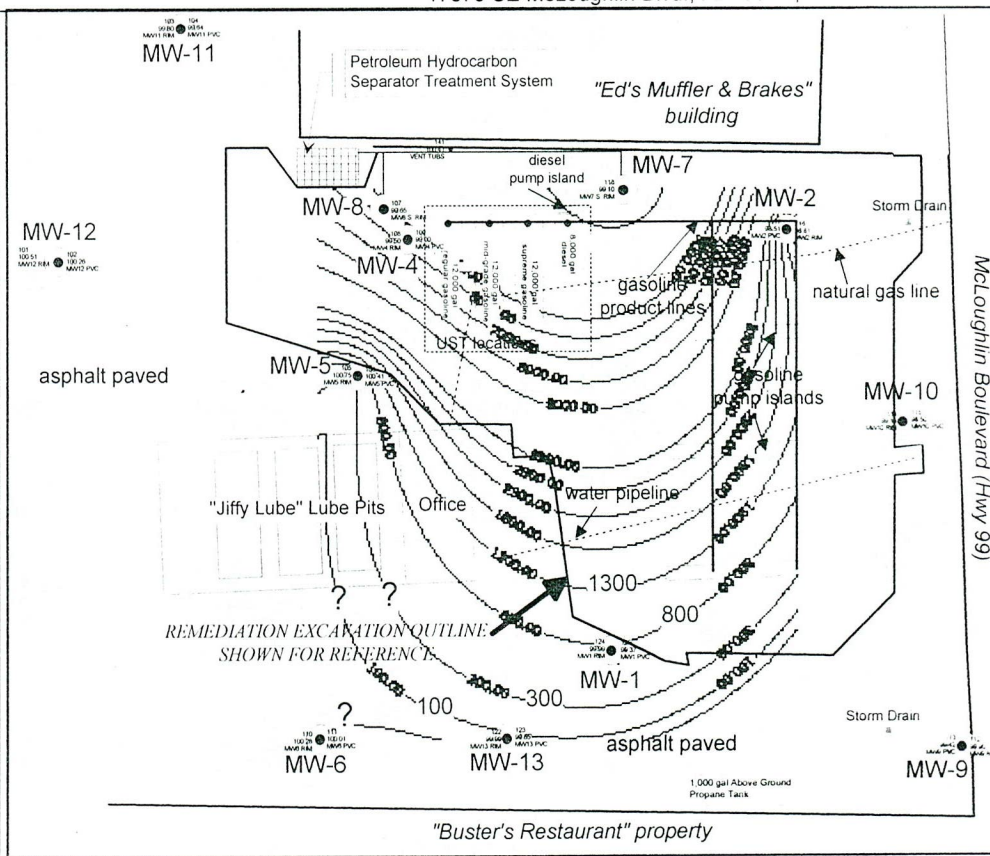
NOTE: Pump and treatment system installed February 1995.

Figure 10D



**BENZENE CONCENTRATION
CONTOURS (GROUNDWATER)**

DELCO PETROLEUM CO. LLC
17873 SE McLoughlin Blvd.
Milwaukie, OR



10/28/94

Benzene groundwater
concentration contour (ppb)
Contour Interval (CI) = 500 ppb except 0, 100 and 300 contours

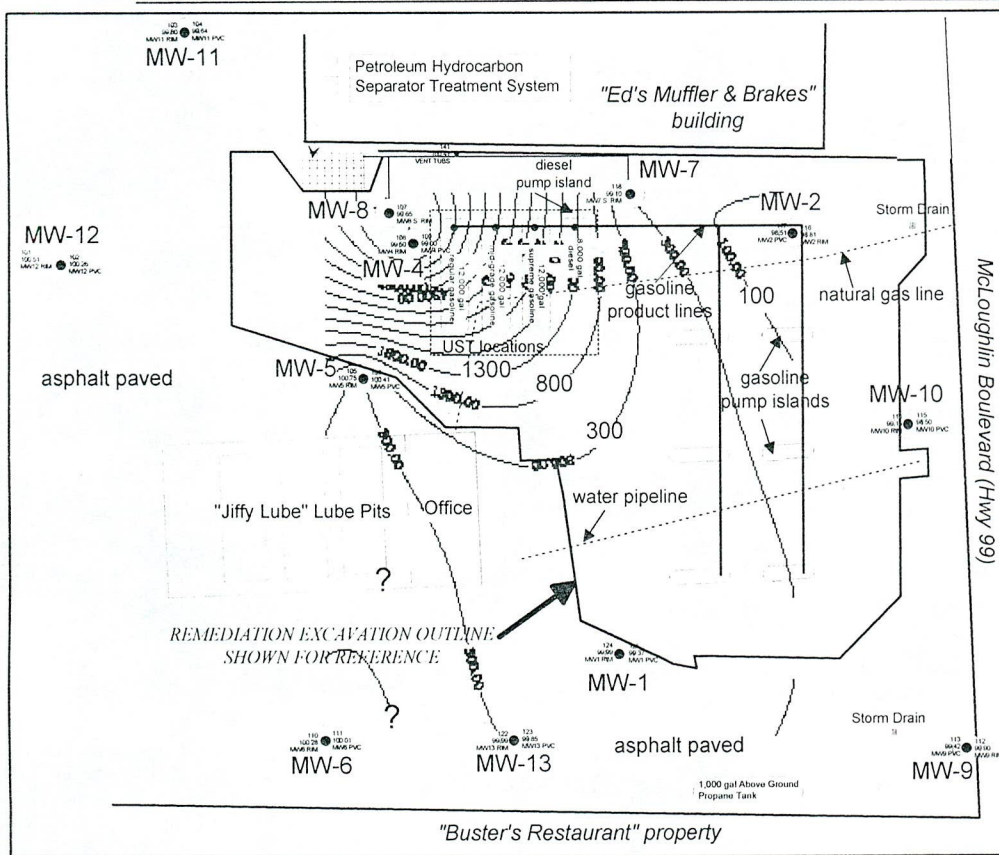
 GeoPro Geologic Services
Battle Ground, WA
Project No. 990621

<u>Well</u>	<u>Install Date</u>
MW-1	6/18/93
MW-2	6/18/93
MW-3	6/18/93 Replaced by MW-7 2/20/95
MW-4	6/18/93
MW-5	6/19/93
MW-6	6/19/93
MW-7	1/27/95 Production (intermittent)
MW-8	1/27/95 Production
MW-9	1/27/95
MW-10	8/12/96
MW-11	8/12/96
MW-12	8/12/96
MW-13	8/12/96

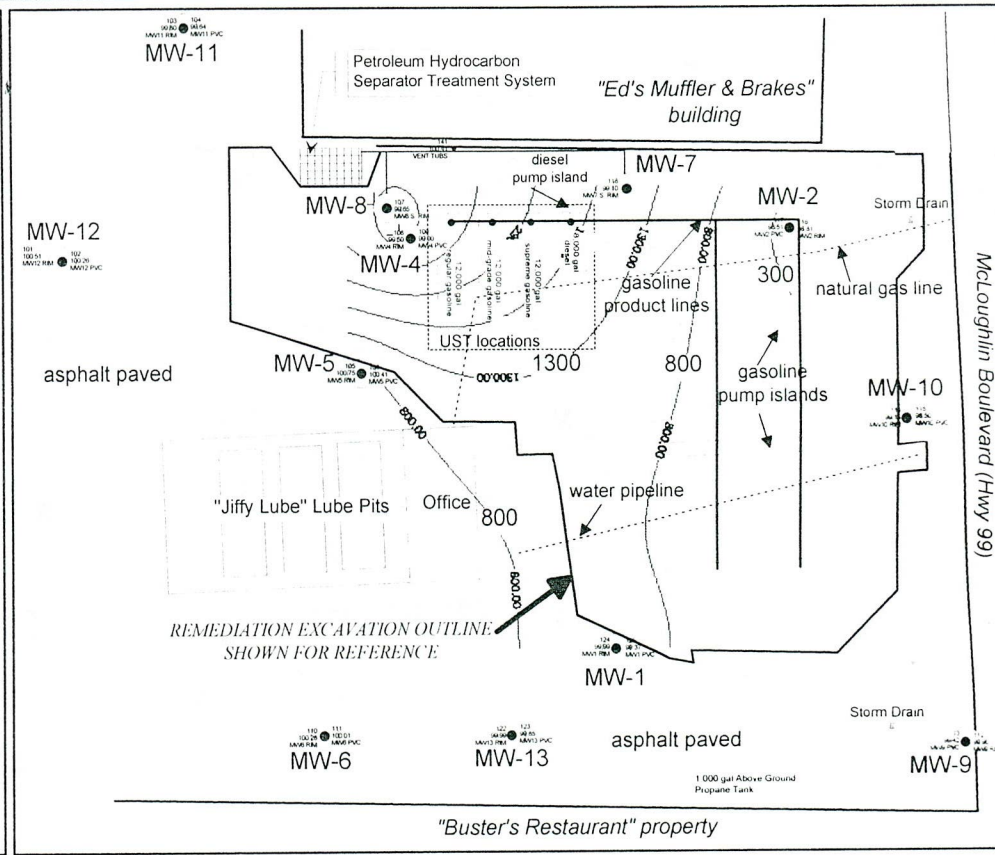
Figure 10E

BENZENE CONCENTRATION CONTOURS (GROUNDWATER)

DELCO PETROLEUM CO. LLC
17873 SE McLoughlin Blvd.
Milwaukie, OR



7/18/94



6/22/93

Benzene groundwater concentration contour (ppb)
Contour Interval (CI) = 500 ppb except 0, 100 and 300 contours

Groundwater
MW-13 Monitor Well Location



GeoPro Geologic Services
Battle Ground, WA
Project No. 990621

Well	Install Date
MW-1	6/18/93
MW-2	6/18/93
MW-3	6/18/93 Replaced by MW-7 2/20/95
MW-4	6/18/93
MW-5	6/19/93
MW-6	6/19/93
MW-7	1/27/95 Production (intermittent)
MW-8	1/27/95 Production
MW-9	1/27/95
MW-10	8/12/96
MW-11	8/12/96
MW-12	8/12/96
MW-13	8/12/96

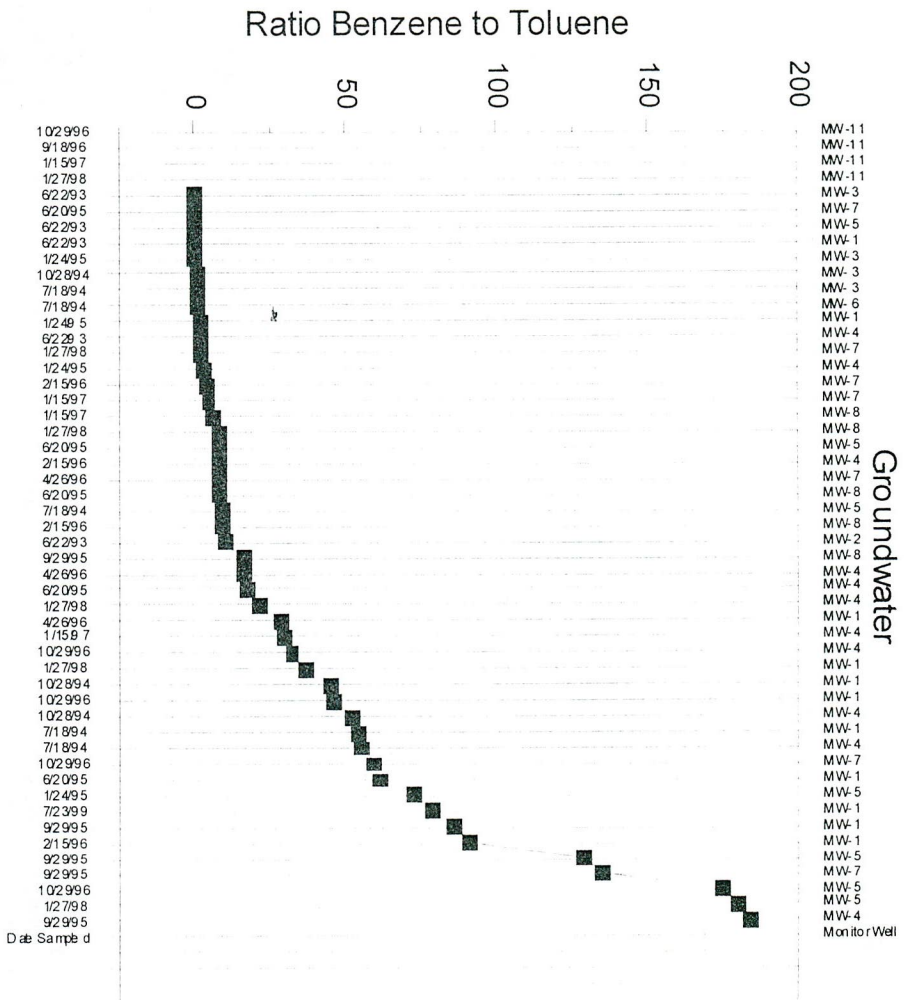
Figure 10F

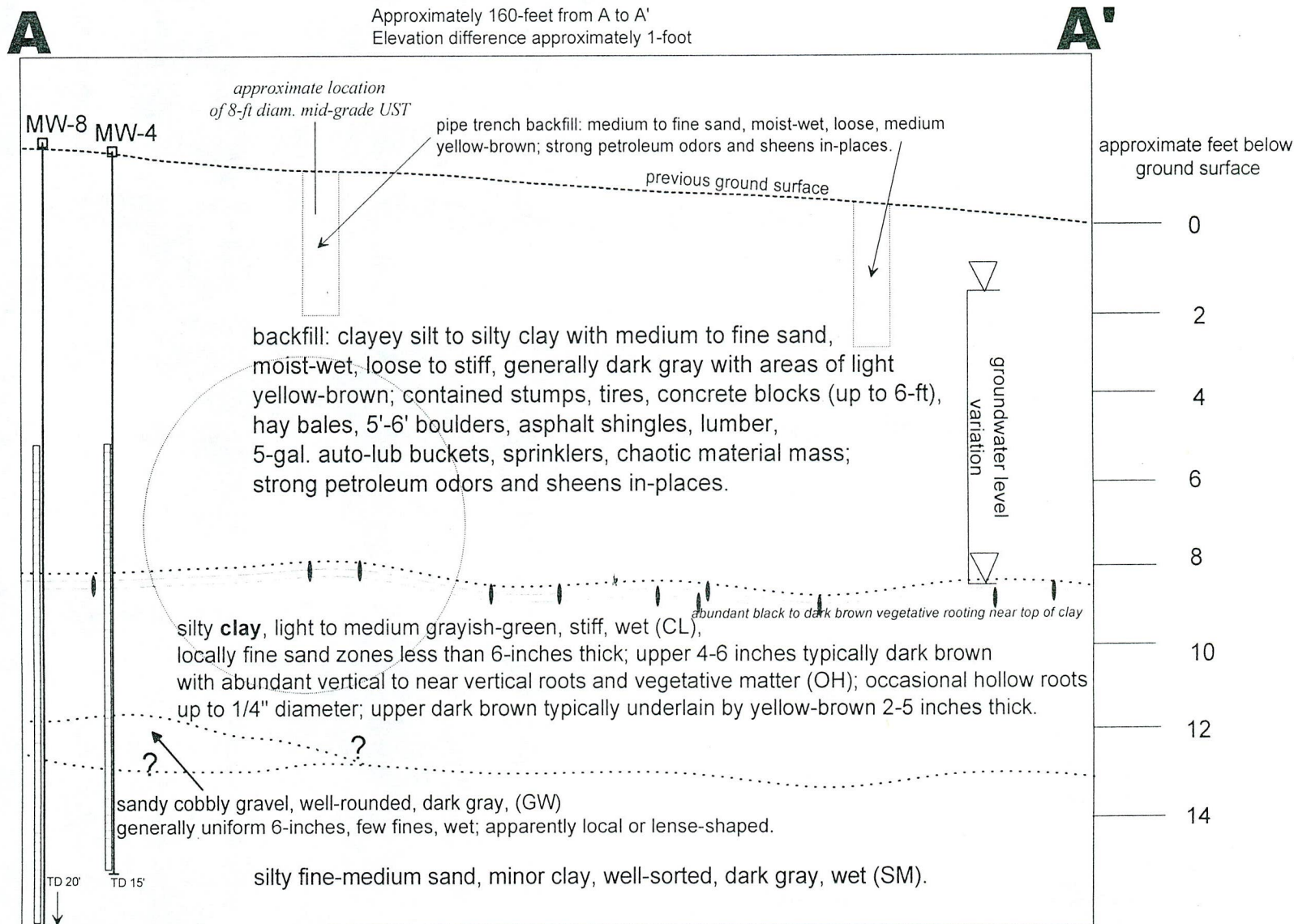


BENZENE CONCENTRATION CONTOURS (GROUNDWATER)

DELCO PETROLEUM CO. LLC
17873 SE McLoughlin Blvd.
Milwaukie, OR

Figure 11 – RATIO BENZENE TO TOLUENE (GROUNDWATER)





4"-MW-8 and 2"-MW-4 screened from
TD (total depth) to 5-feet bgs



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No Scale

Figure 12
PRE-EXCAVATION
CROSS-SECTION A-A'

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Figure 13 – STEEL SHEET PILING RETAINING WALL

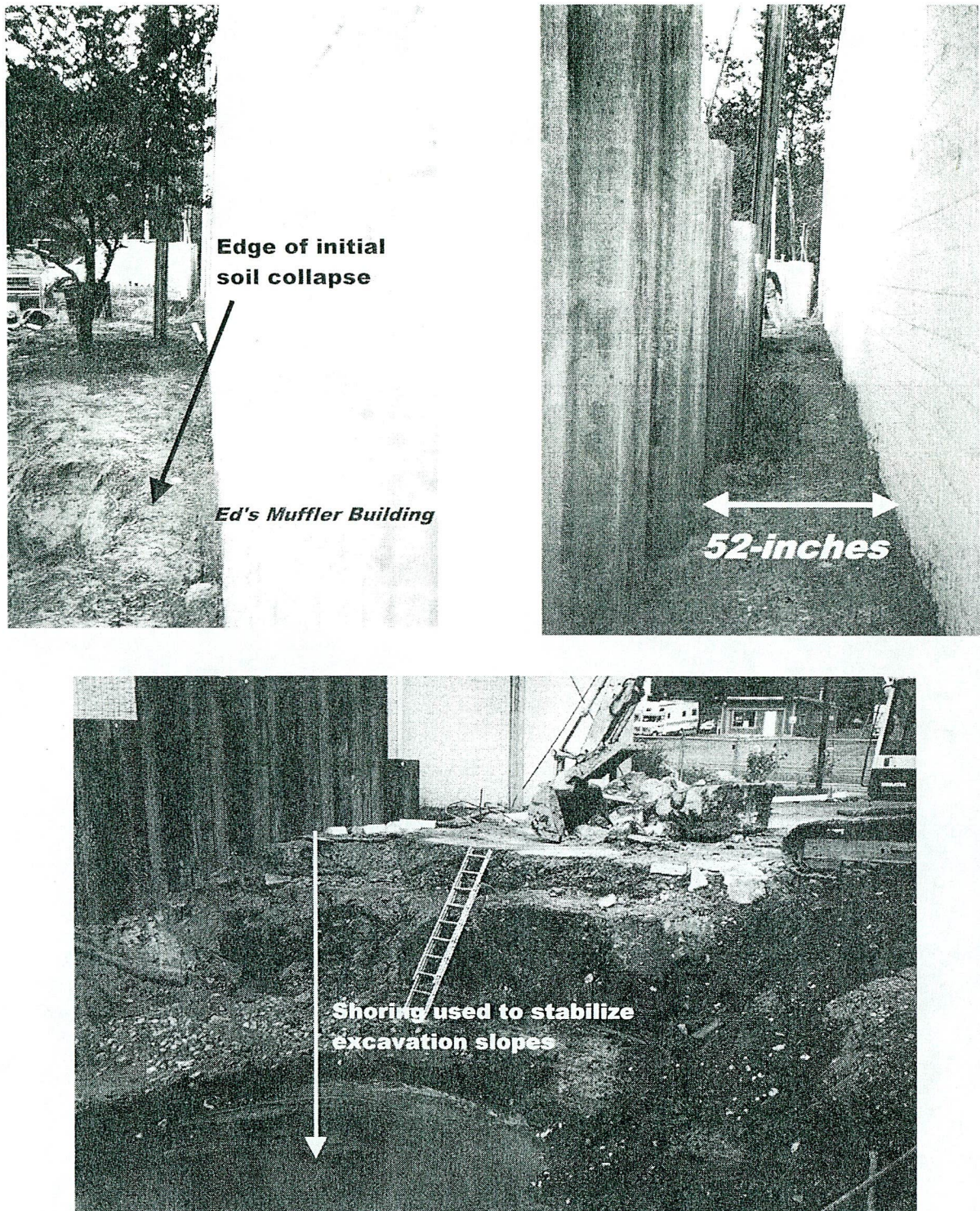


Figure 14 – EXCAVATED UNDERGROUND STORAGE TANKS

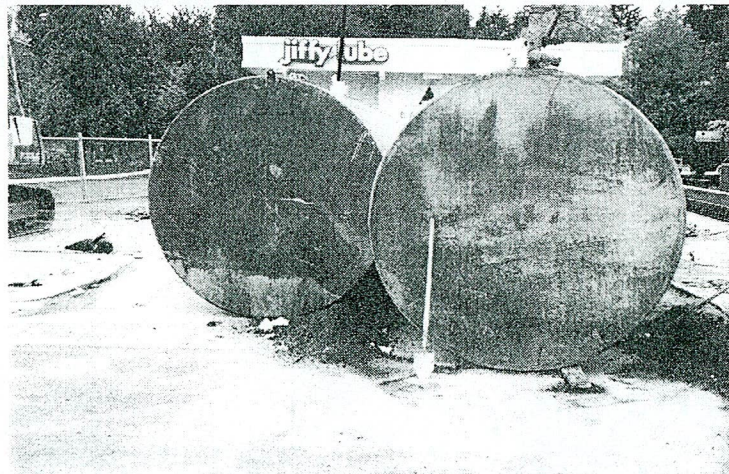
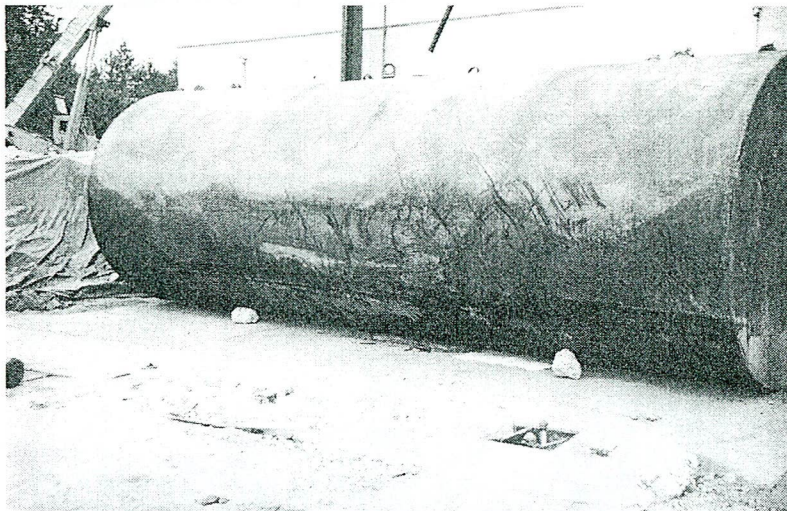
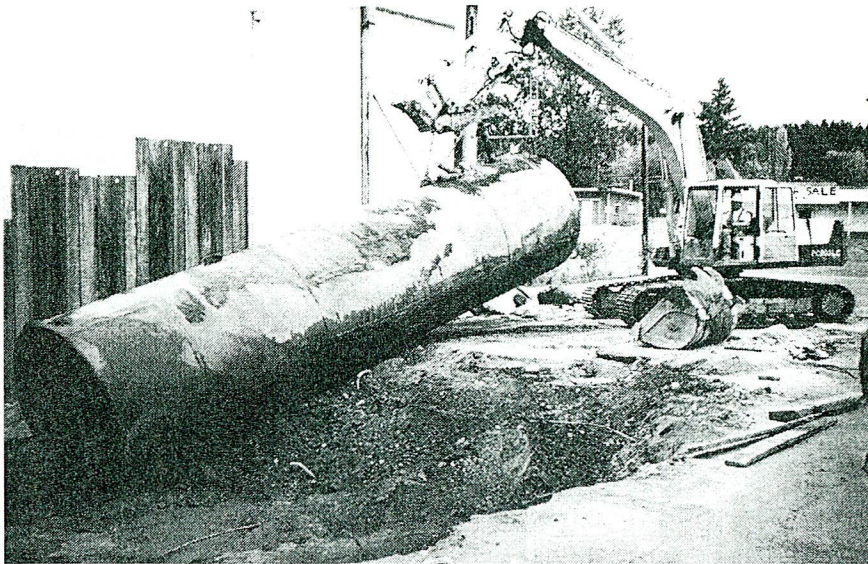


Figure 15 – PIPELINES AND SAND-FILLED TRENCHES

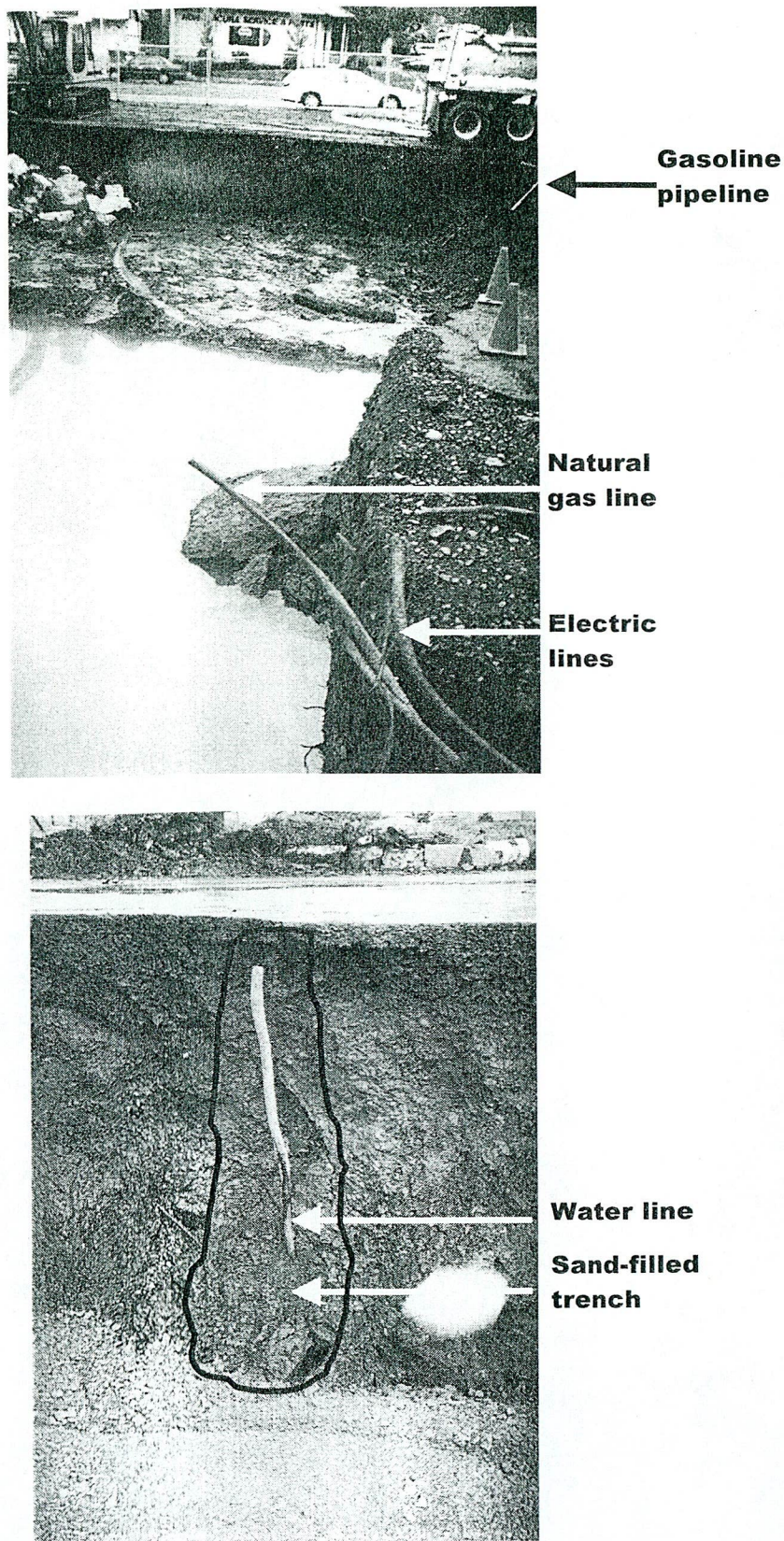


Figure 16 – TYPICAL CONTAMINATED SOIL AND GROUNDWATER

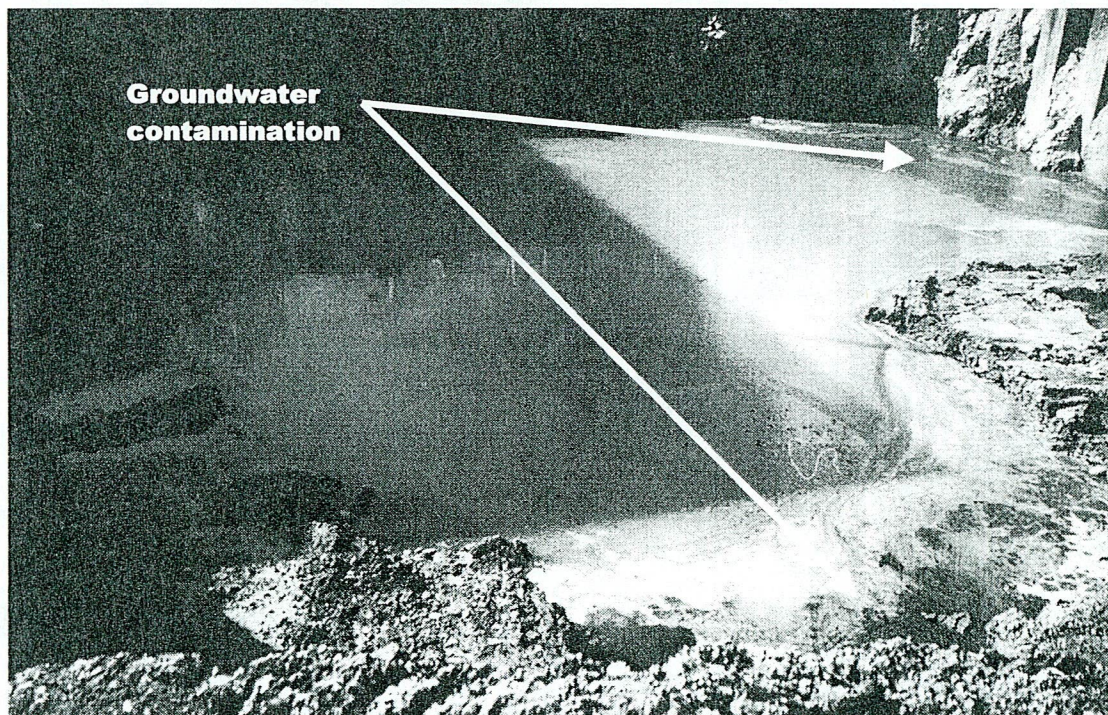
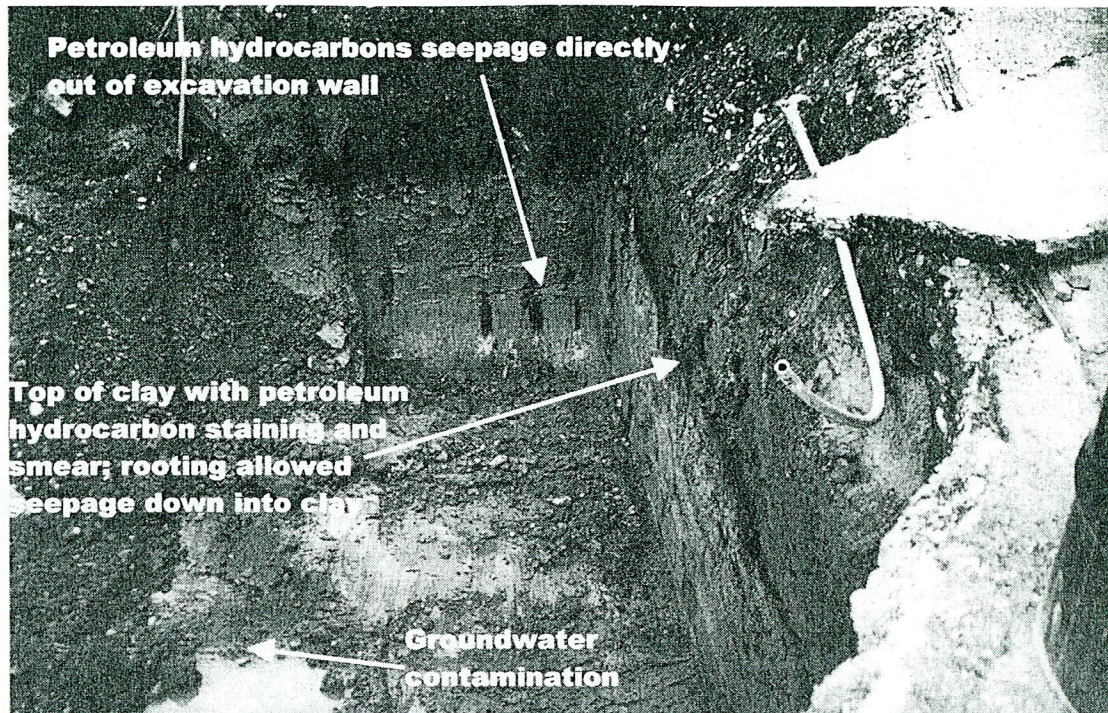


Figure 17 – GROUNDWATER RECHARGING INTO EXCAVATION

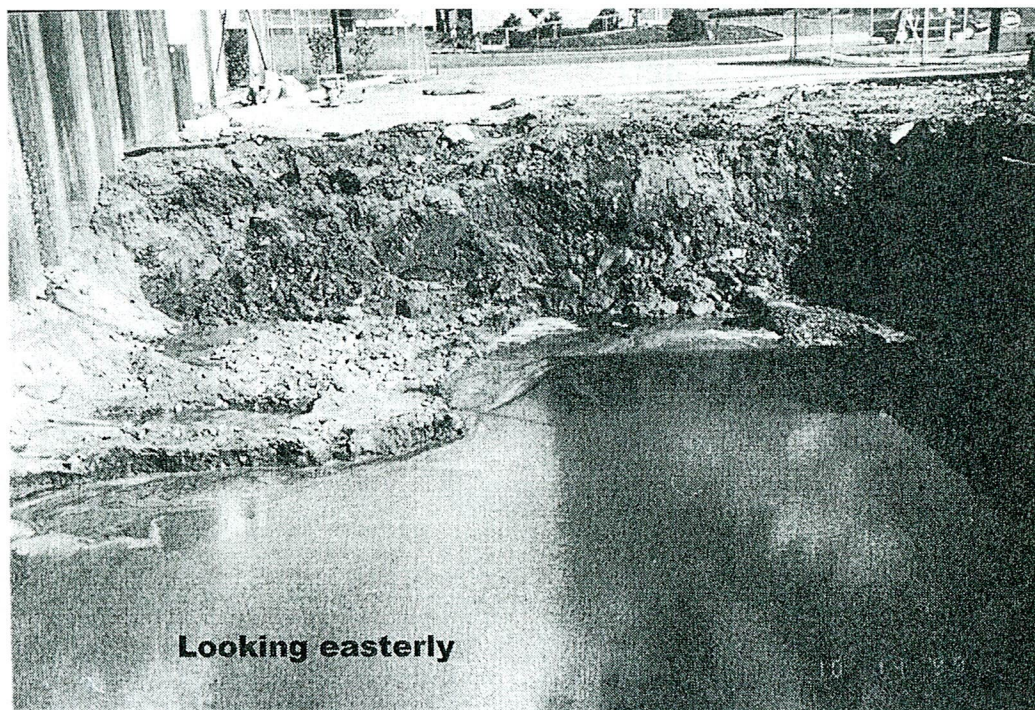
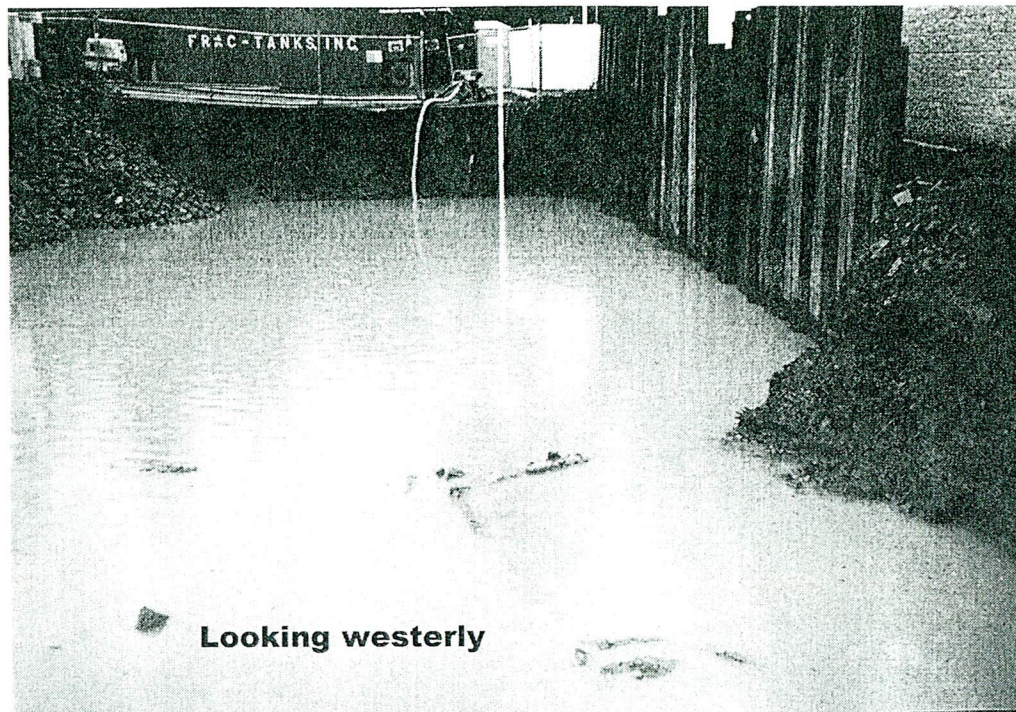
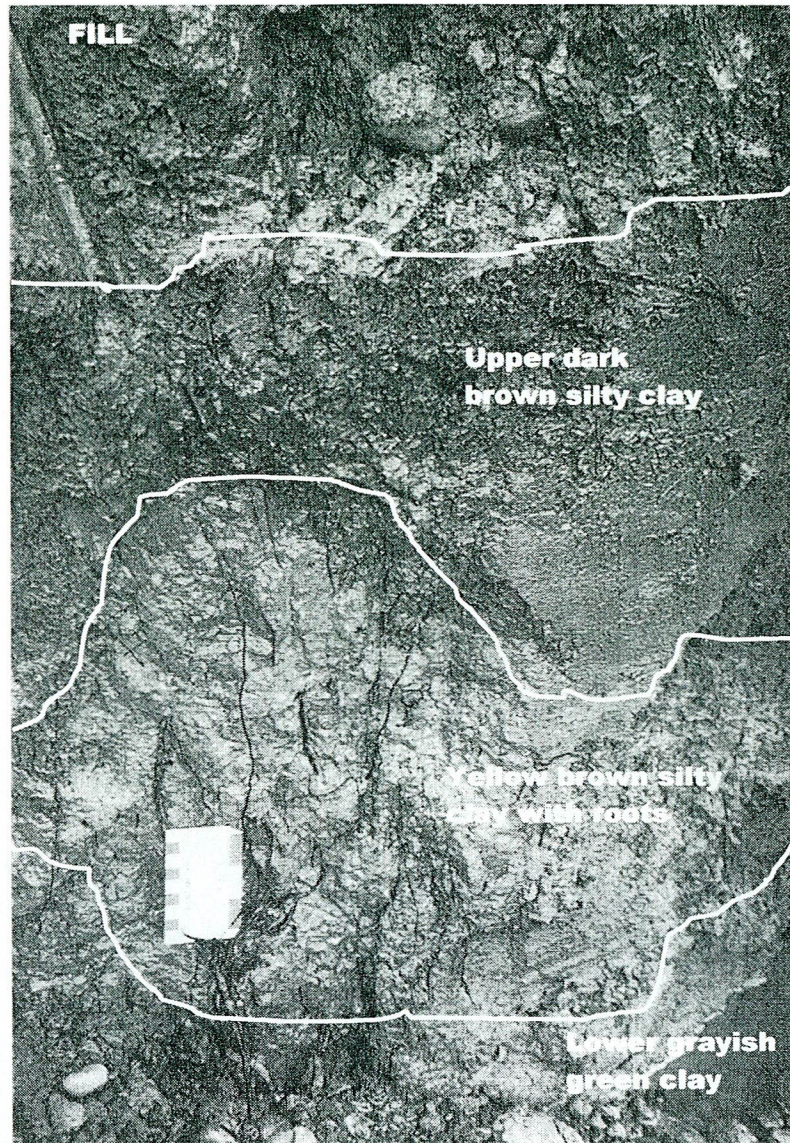
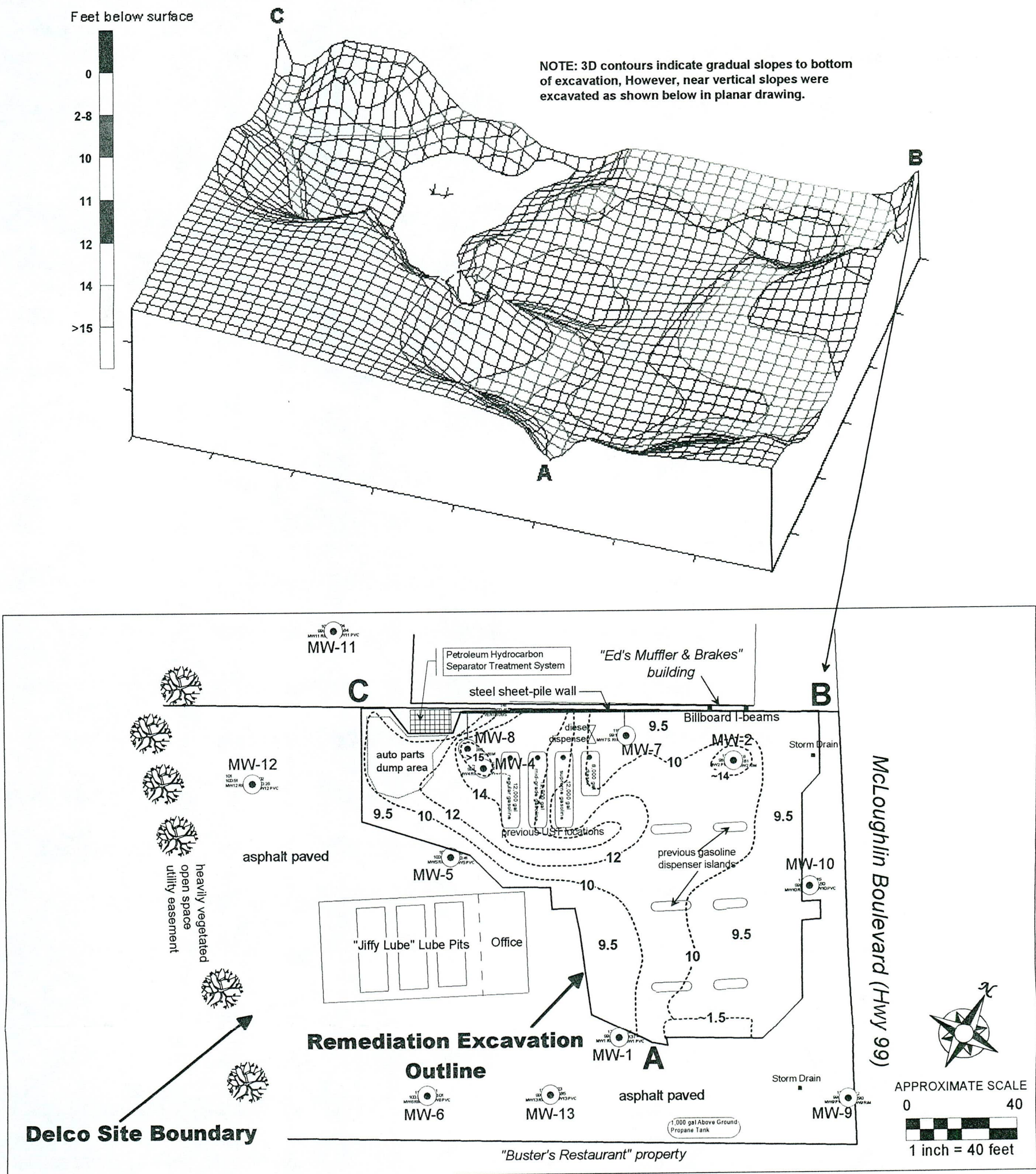


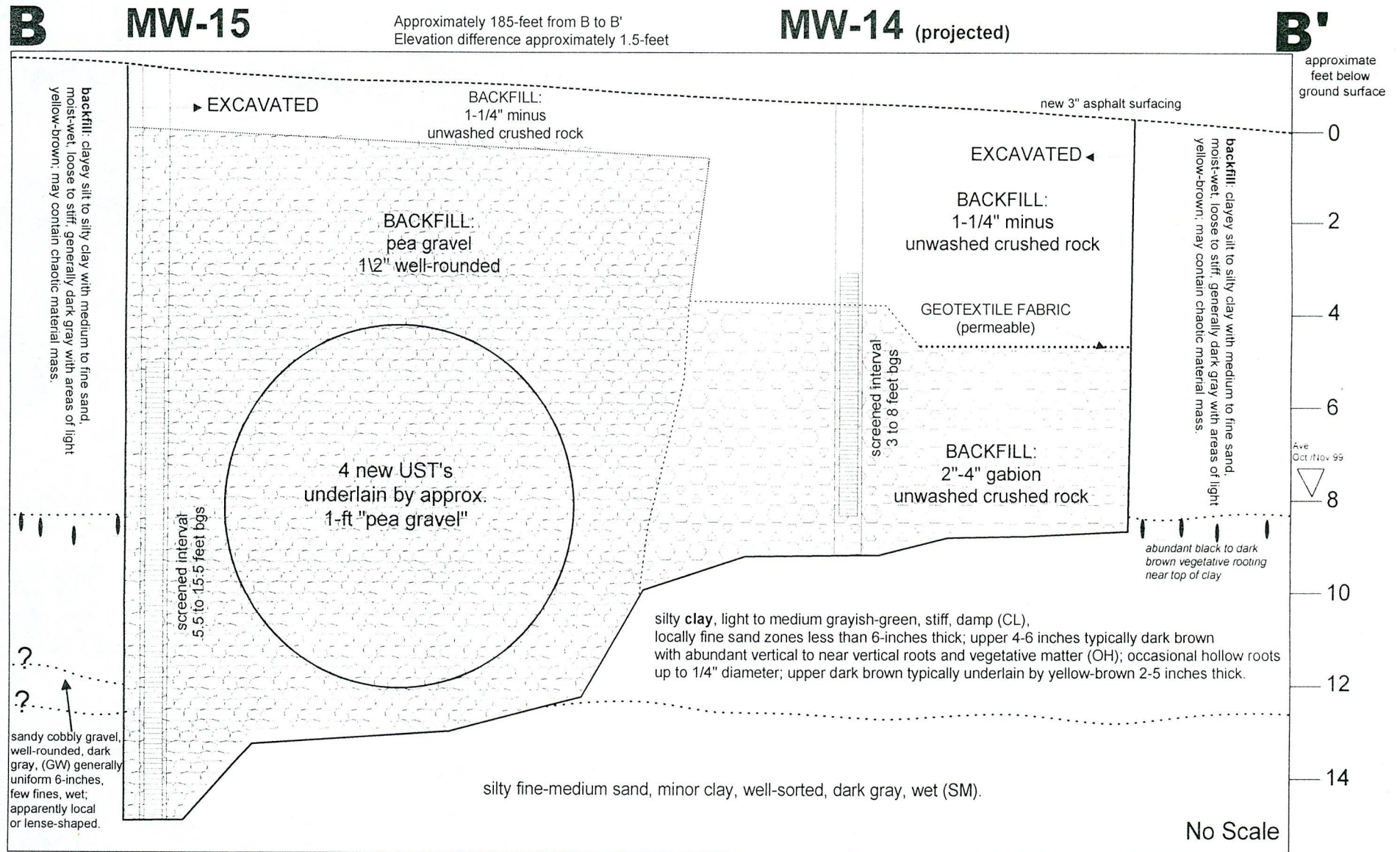
Figure 18 – CONTACT FILL AND UPPER PART OF SILTY CLAY



Note: Approximately 5,006 tons were excavated and disposed at TPS Technologies, Portland, OR, excluding the auto parts dump area (near "C"). Based on the following drawings, it is estimated that approximately 10,700 cubic yards were excavated, including the auto parts dump area.



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NOTES:

MW-14: between previous monitor wells MW-2 and MW-7.
MW-15: production of downgradient groundwater to treatment facility installed near previous monitor well MW-8 location.

Figure 20
POST-EXCAVATION
CROSS-SECTION B-B'

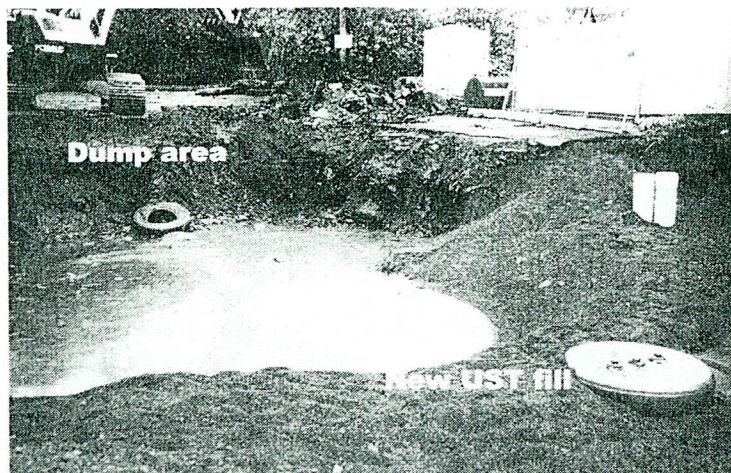
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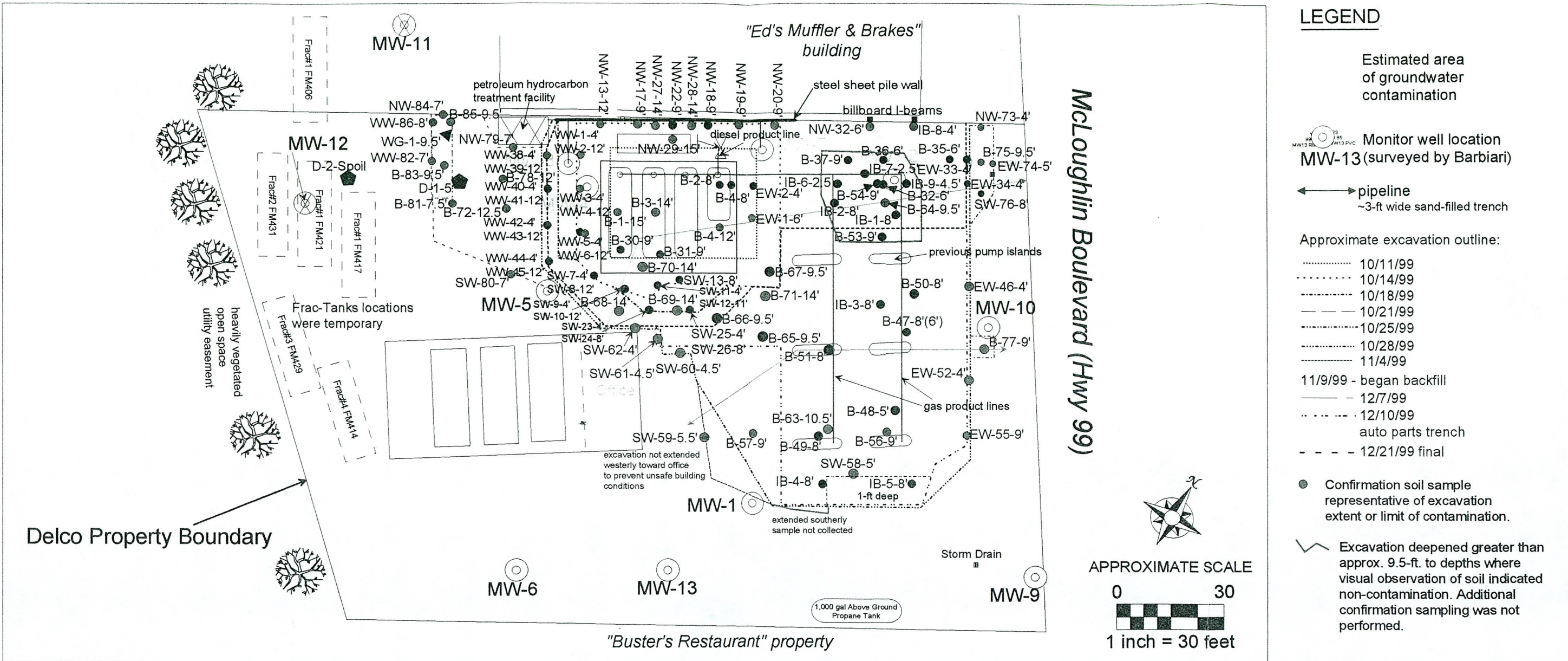


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Project No. 990621

Figure 21 – AUTO PARTS AND BUILDING MATERIALS DUMP AREA

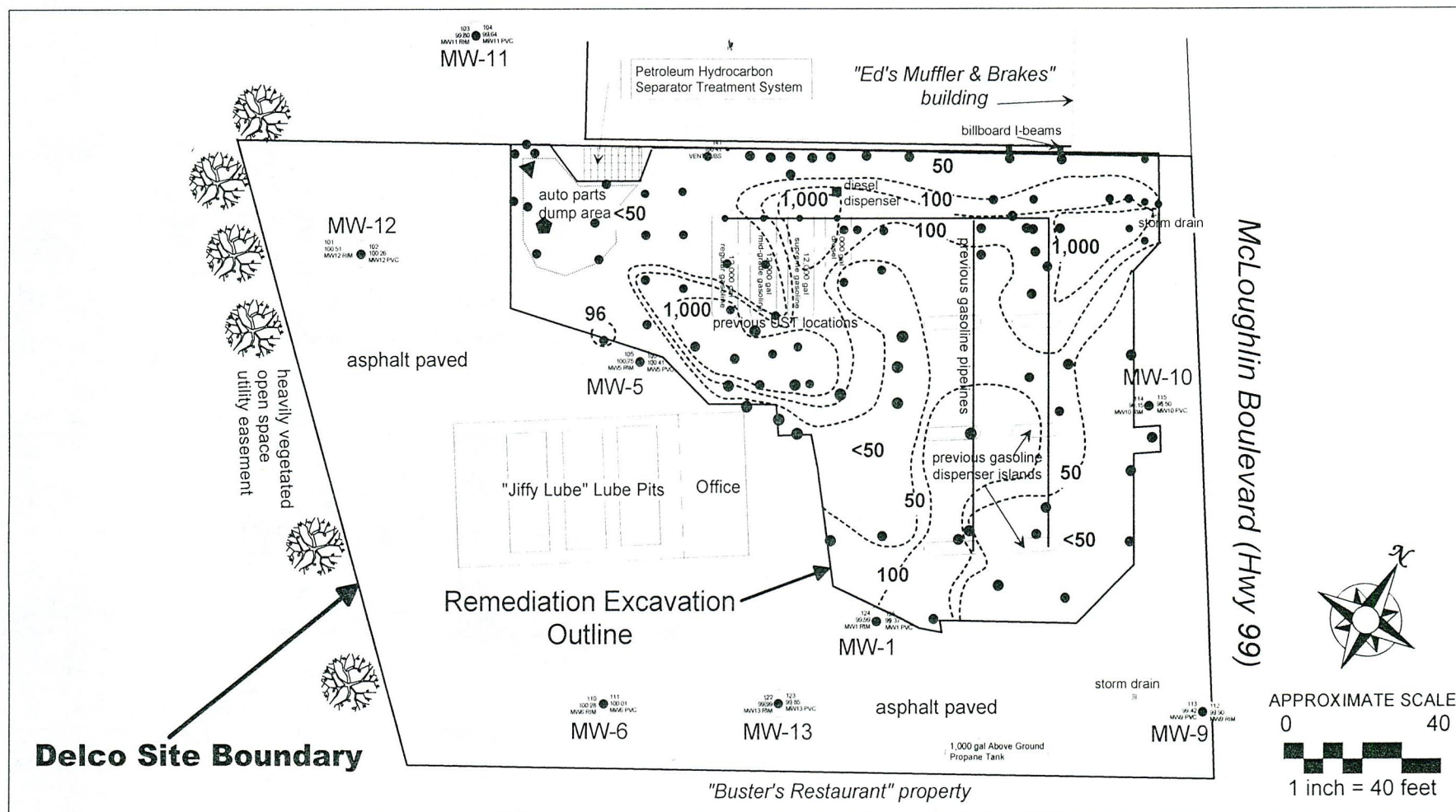




NOTES:

- 1) Excavated monitor wells, UST locations, groundwater contamination, dispenser islands, and pipelines shown for reference.
- 2) Samples IB-1-8', IB-2-8', IB-3-8', IB-4-8', and IB-5-8' collected from bottom of a trackhoe pit before excavation.
- 3) Samples collected during excavation labeled according to area: B-bottom; NW-north wall; EW-east wall; SW-south wall; WW-west wall; IB-pump islands; D-auto-dump; and WG-water grab.

Figure 23A – TPH GASOLINE CONTOUR MAP



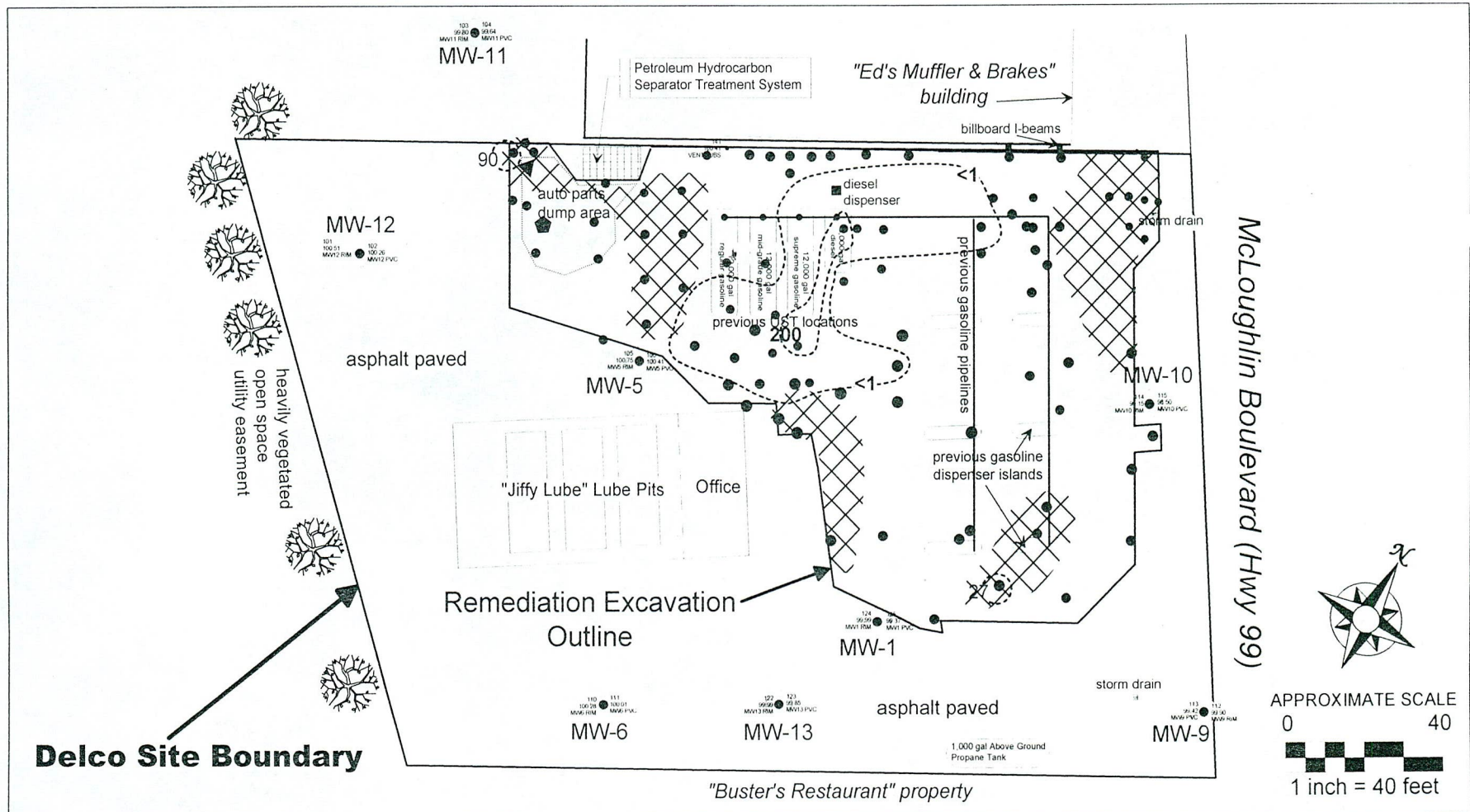
TPH-gasoline contours in mg/kg based on soil sample concentrations. Areas shown as "<50" were excavated because sample analysis, PID field measurements or visual observations of strong petroleum odors, colors, and sheen indicated high concentrations of TPH.

Soil sample location

Monitor Well Location

Figure 23A
TPH GASOLINE
CONTOUR MAP

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Figure 23B – TPH DIESEL CONTOUR MAP

- Soil sample location
 - Monitor Well Location
- MW-13



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Project No. 990621

100

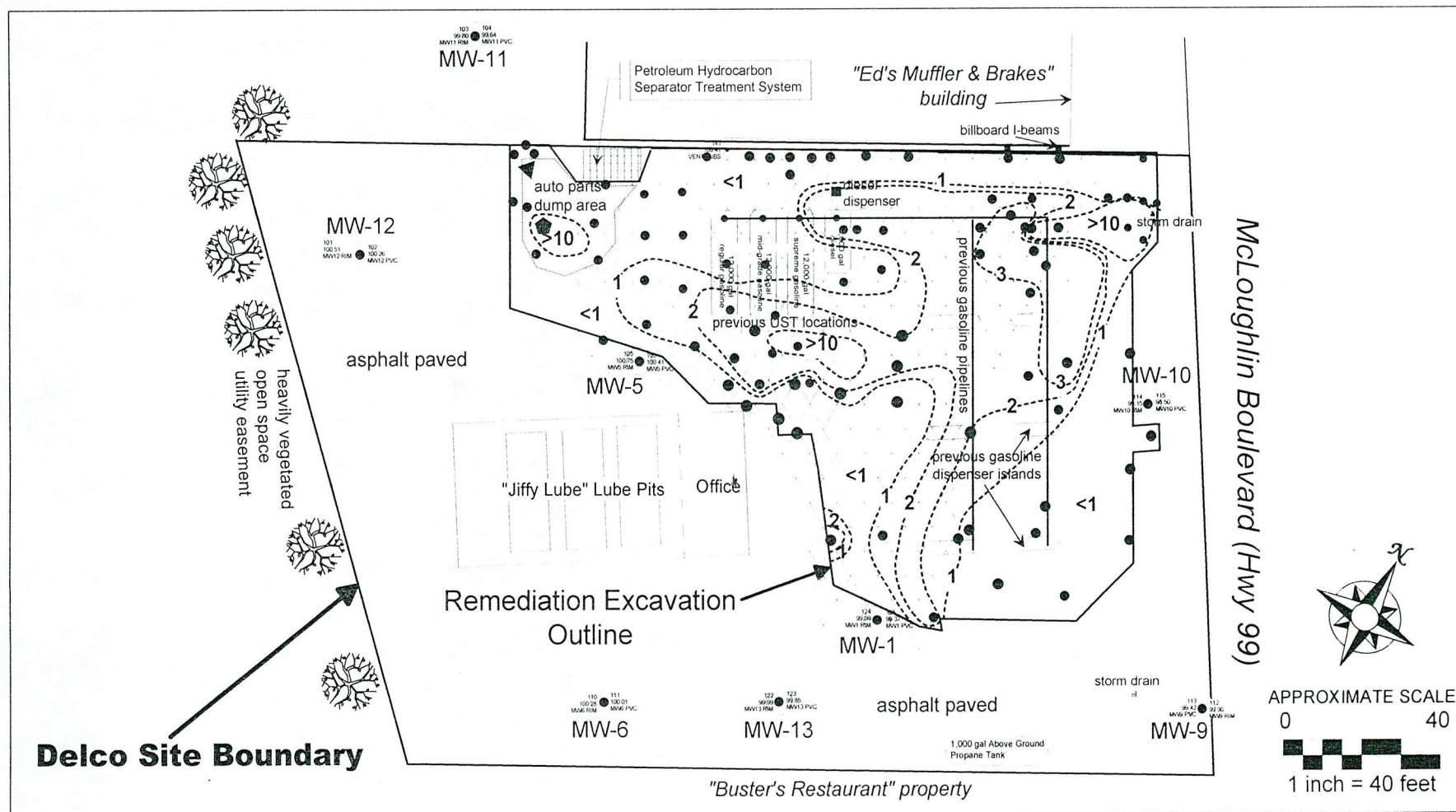
TPH-diesel contours in mg/kg based on soil sample concentrations. Areas shown as "ND" were excavated because sample analysis, PID field measurements or visual observations of strong petroleum odors, colors, and sheen indicated high concentrations of TPH.



Areas where detected hydrocarbons (TPH) appear to be primarily due to overlap of gasoline and heavy oil, but weathered diesel is present. Contours in mg/kg based on soil sample concentrations.

Figure 23B TPH DIESEL CONTOUR MAP

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Milwaukie, OR

Figure 23C – BENZENE CONTOUR MAP

2 Benzene contours in mg/kg based on soil sample concentrations. Areas shown as "<1" were excavated because sample analysis, PID field measurements or visual observations of strong petroleum odors, colors, and sheen indicated high concentrations of TPH.

Figure 23C BENZENE CONTOUR MAP

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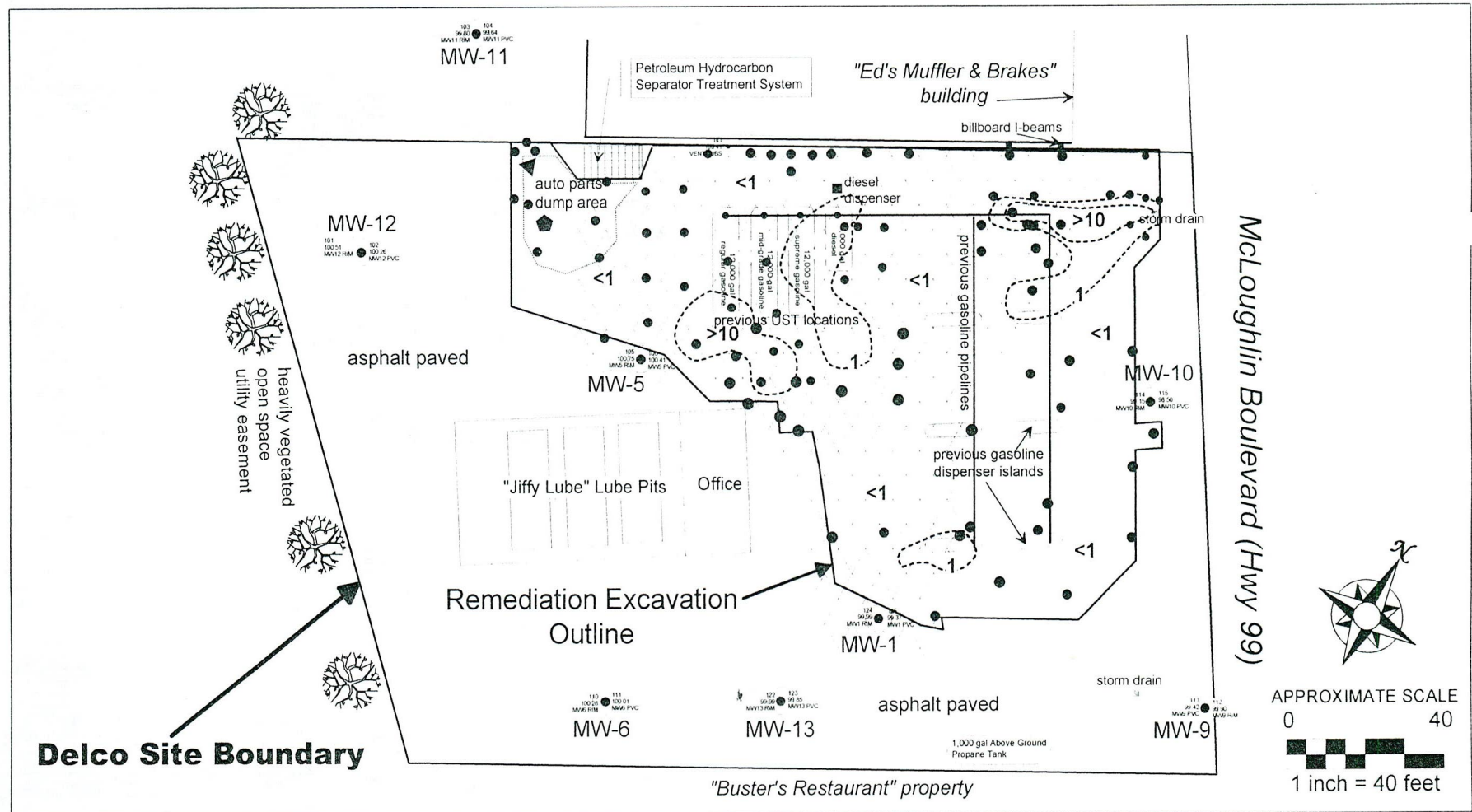


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Soil sample location
Monitor Well Location

Pre-excavation
estimated area
of groundwater
contamination

Figure 23D – TOLUENE CONTOUR MAP

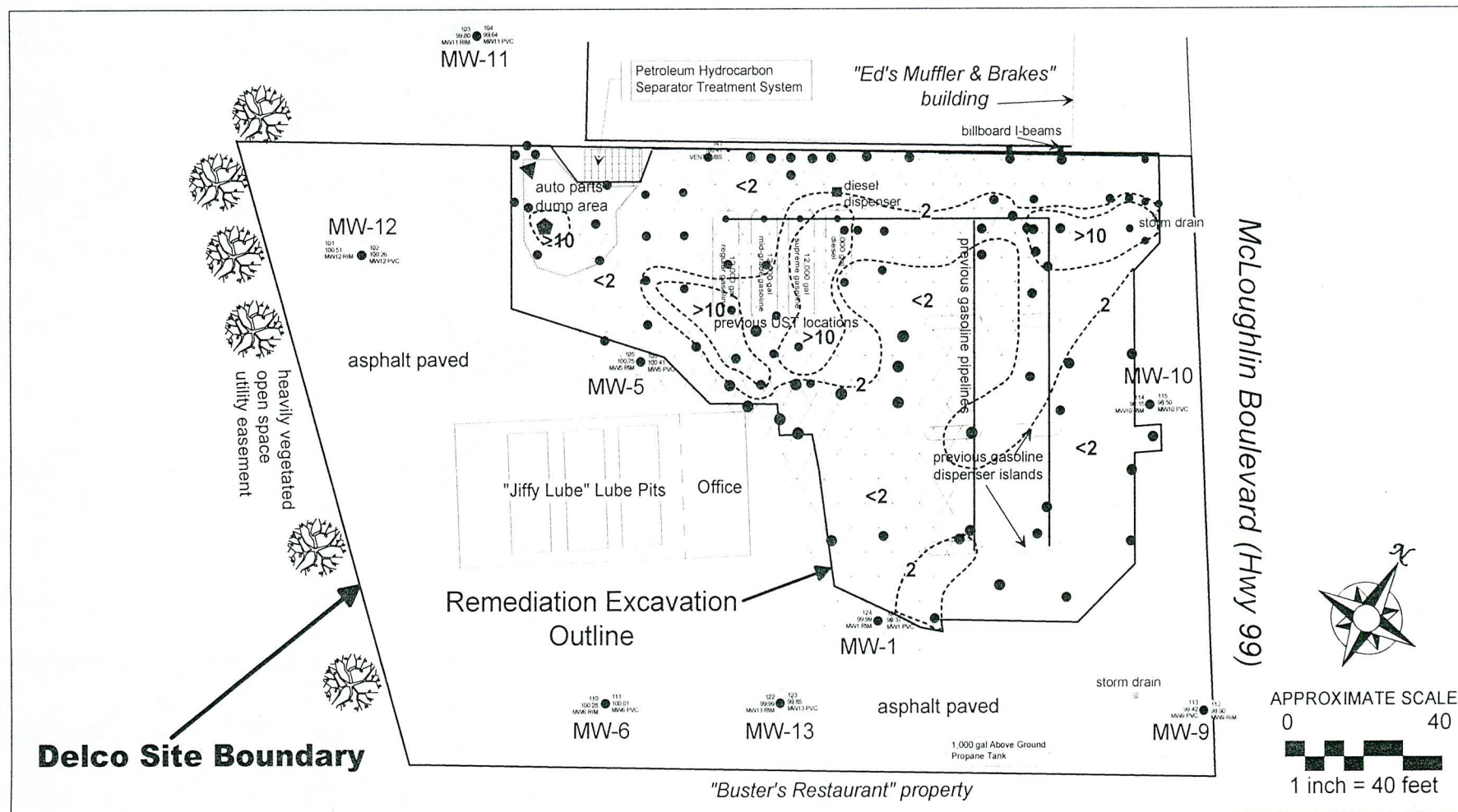
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Project No. 990621

127 99.25 MW13 RM
123 98.55 MW13 PVC

Soil sample location
Monitor Well Location

Pre-excavation
estimated area
of groundwater
contamination

April 3, 2000

Figure 23E – ETHYLBENZENE CONTOUR MAP

2 Ethylbenzene contours in mg/kg based on soil sample concentrations. Areas shown as "<2" were excavated because sample analysis, PID field measurements or visual observations of strong petroleum odors, colors, and sheen indicated high concentrations of TPH.

Figure 23E ETHYLBENZENE CONTOUR MAP

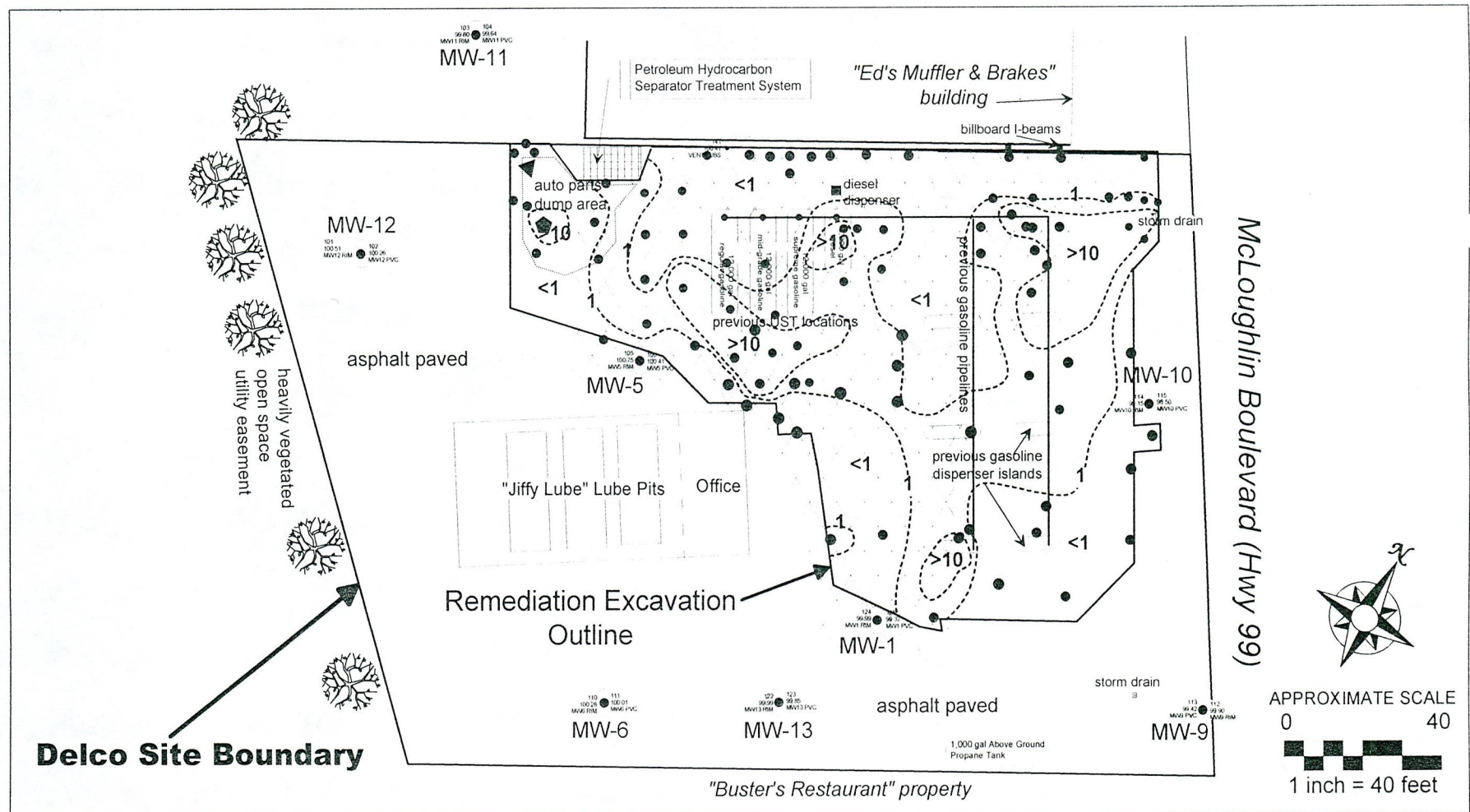
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Project No. 990621

• Soil sample location
• Monitor Well Location
MW-13

Pre-excavation
estimated area
of groundwater
contamination

Figure 23F – TOTAL XYLENES CONTOUR MAP

1. Total xylenes contours in mg/kg based on soil sample concentrations. Areas shown as "<1" were excavated because sample analysis, PID field measurements or visual observations of strong petroleum odors, colors, and sheen indicated high concentrations of TPH.

Figure 23F TOTAL XYLENES CONTOUR MAP

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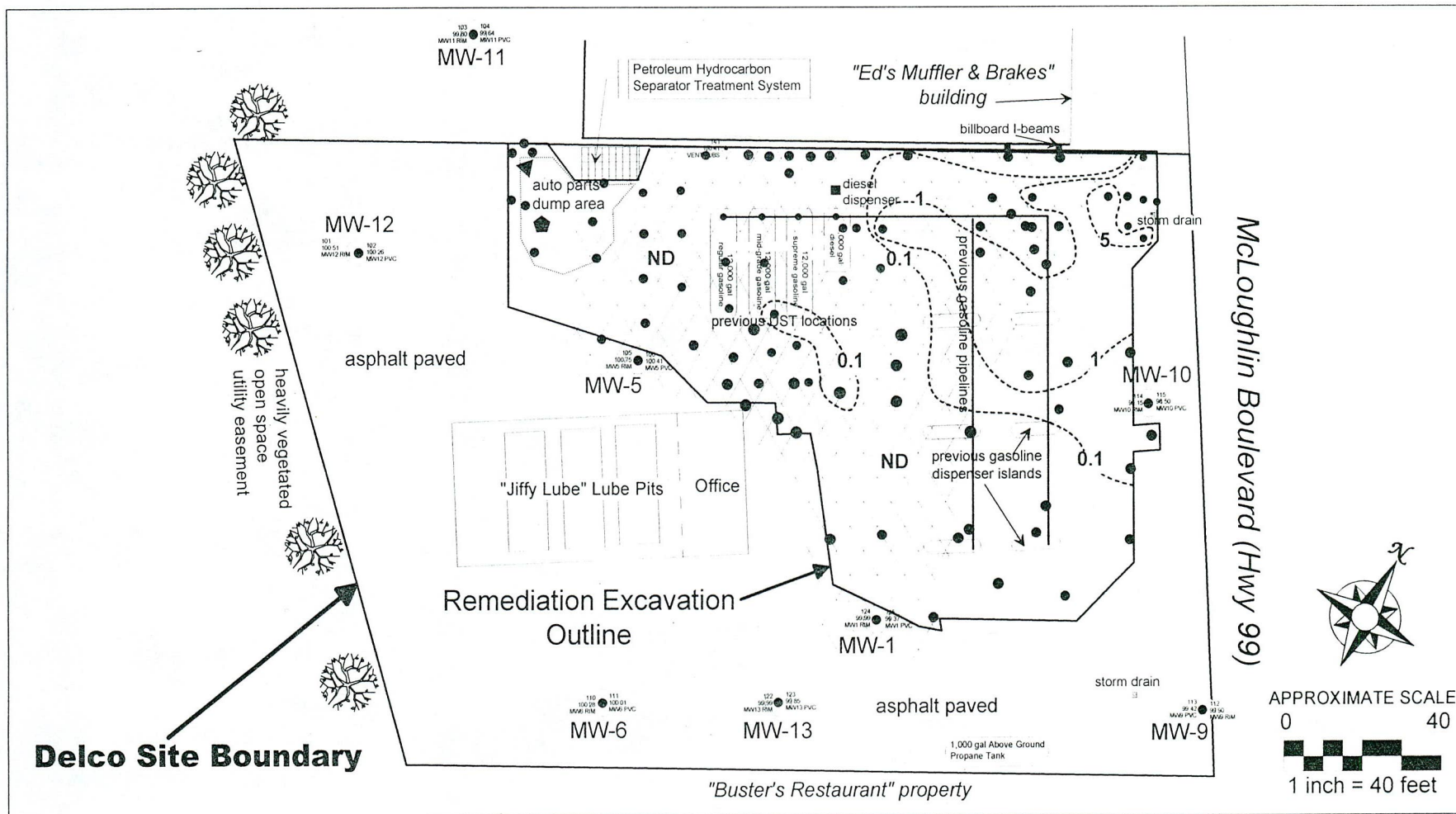


GeoPro Geologic Services
Battle Ground, WA
Project No. 990621

• Soil sample location
● Monitor Well Location
MW-13

Pre-excavation
estimated area
of groundwater
contamination

Figure 23G – MTBE CONTOUR MAP



1. MTBE contours in mg/kg based on soil sample concentrations. Areas shown as "ND" were excavated because sample analysis, PID field measurements or visual observations of strong petroleum odors, colors, and sheen indicated high concentrations of TPH.



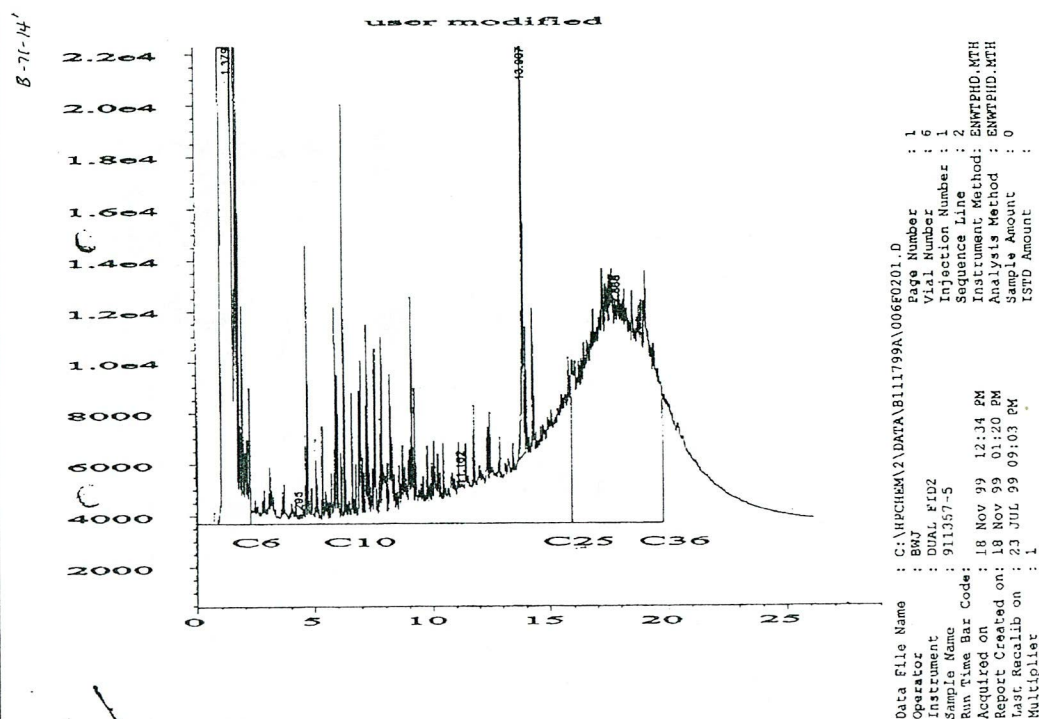
GeoPro Geologic Services
Battle Ground, WA
Project No. 990621

• Soil sample location
• Monitor Well Location
MW-13

Pre-excavation
estimated area
of groundwater
contamination

**Figure 23G
MTBE
CONTOUR MAP**

DELCO PETROLEUM CO. LLC
17873 SE McLoughlin Blvd.
Milwaukie, OR

Figure 24 – CHROMATOGRAM SOIL SAMPLE B-71-4'

Below: GC "Fingerprint" Chromatograms of Soil Contamination from Total Petroleum Hydrocarbon Criteria Working Group Series, Volume 1, March 1998, "Analysis of Petroleum Hydrocarbons in Environmental Media, p.26.

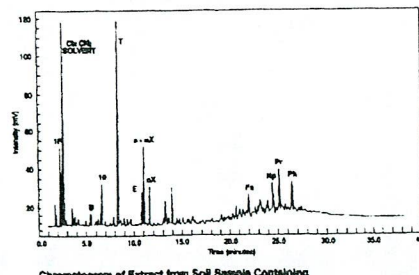
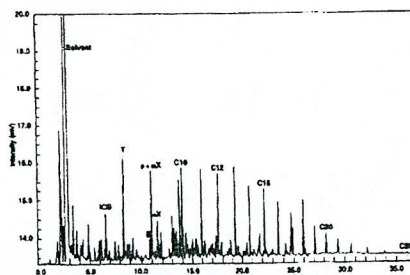
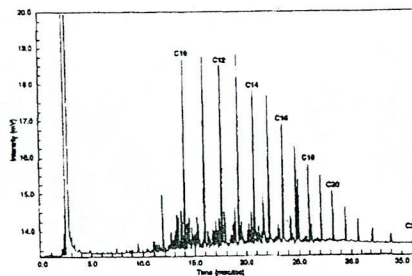
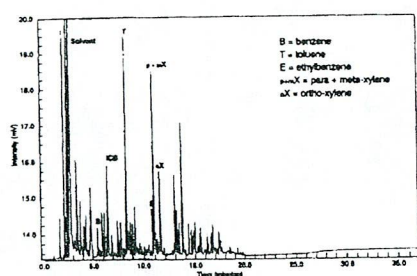


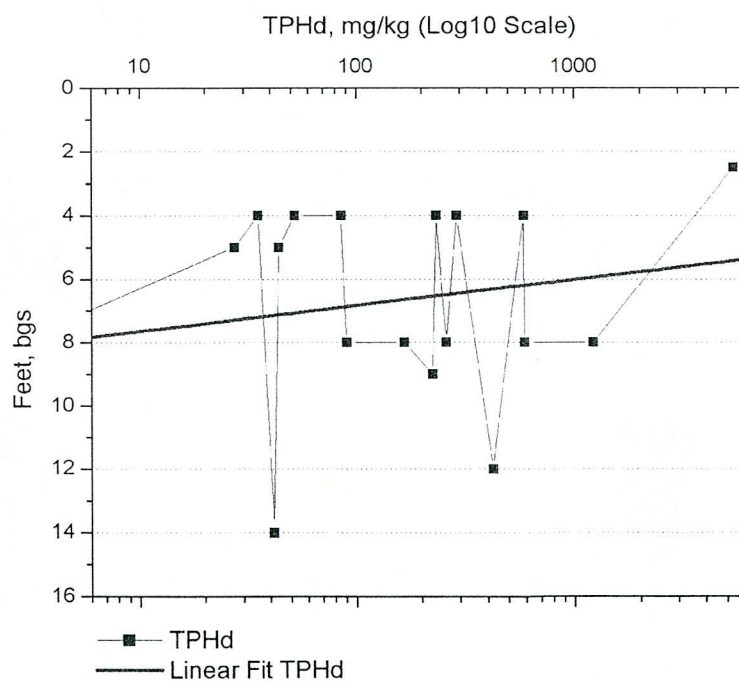
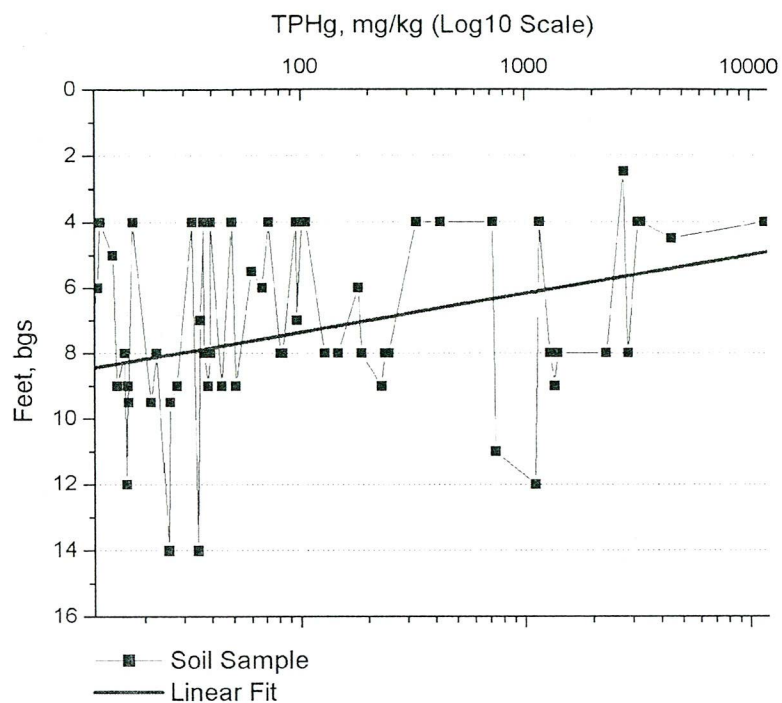
Figure 25 – TPH LINEAR REGRESSION AND SAMPLE DEPTH PLOTS

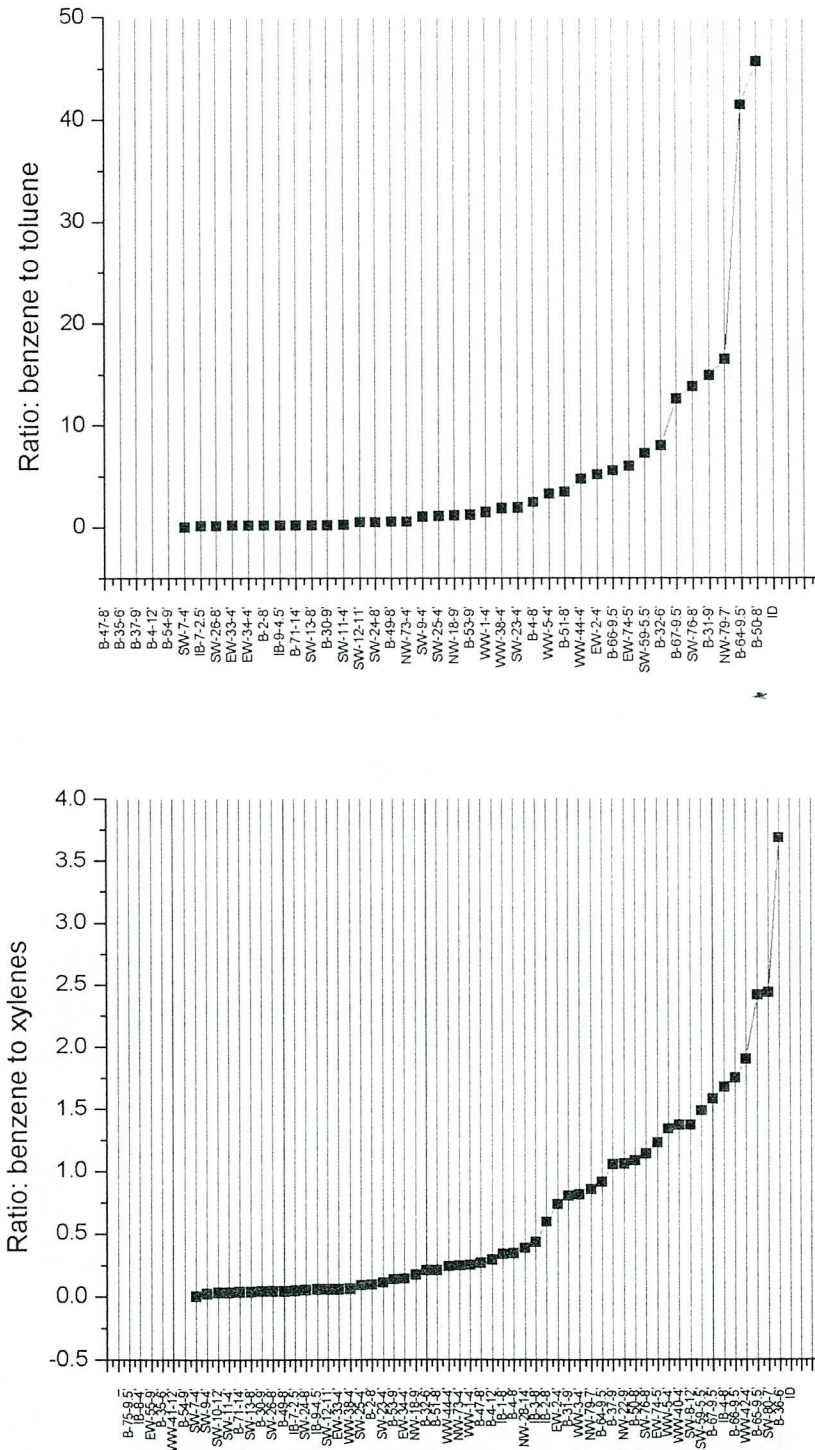
Figure 26 – CONCENTRATION RATIOS (SOIL)

Figure 27 – TOLUENE TO ETHYLBENZENE CONCENTRATION RATIO (SOIL)

