



A Report Prepared for:

Univar USA Inc.
32131 Steven Way
Conifer, CO 80433

REMEDIAL INVESTIGATION REPORT

**UNIVAR USA INC.
KENT, WASHINGTON**

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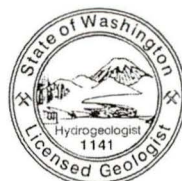
By:

A handwritten signature in black ink, appearing to read "Daniel A. Balbiani".

Daniel A. Balbiani, P.E.
Principal Engineer

A handwritten signature in black ink, appearing to read "William R. Haldeman".

William R. Haldeman, LHG
Senior Hydrogeologist



William R. Haldeman

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1.0 INTRODUCTION

This report presents the results of the remedial investigations (RI) conducted at the Univar USA Inc. (formerly Van Waters & Rogers Inc. [VW&R] and subsequently Vopak USA Inc.) Facility in Kent, Washington. The remedial investigation has been conducted under the Voluntary Cleanup Program administered by the Washington State Department of Ecology (Ecology).

1.1 Site Description

The Univar facility is an active chemical distribution facility located at 8201 South 212th Street in Kent, Washington (Township 22 North, Range 4 East, Section 12A). The 11-acre site is approximately 3 miles east of Interstate 5, and 2 miles north of downtown Kent. The site is located in an industrial/commercial part of the Kent Valley (Figure 1).

A one-story, concrete warehouse is located in the center of the site, with an attached office on the northwest corner (Figure 2). The warehouse is bounded by a covered loading dock on the north side, a rail line on the south side, a large, covered storage area on the east side, and a parking lot with a driveway for truck traffic on the west side. A second loading dock is located on the east side of the covered storage area, with a covered work area and two uncovered aboveground storage tank (AST) areas south of that. Additional ASTs are located south of the rail line. Two additional small, one-story buildings are located at the site, one near the south side of the covered storage area and one in the south AST area. Two hazardous waste storage areas are located in the southern portion of the covered storage area. Drums are stored on the eastern part of the site.

Except for the grass north of the office and planters surrounding the office, the entire Univar Kent site is paved with asphalt or concrete. All utilities are located underground, with storm drain and fire-suppression water lines surrounding the buildings and docks. Sanitary sewer lines run on the north and east sides of the site (Figure 2).

1.2 Adjacent Properties

The Univar facility is bounded to the north by South 212th Street and to the west by a Puget Sound Energy parking lot (Figure 2). An undeveloped field lies to the southwest of the Univar property, and warehouses and truck-trailer parking facilities are to the immediate south of Univar. On the east side of the Univar facility lie (from south to north) a Univar easement, a construction fasteners warehouse, an auto repair shop, a construction materials warehouse, an automatic transmission repair shop, and a Chevron station.

The Chevron service station is immediately east of the northern Univar parking lot (Figure 2). The service station has been an active Chevron station since 1996 and currently includes a station building with a mini-market, three pump islands, three underground storage tanks (USTs), and a car wash (Environmental Resolutions, Inc. [ERI], 2003). The station was operated as an Exxon service station before 1990, with three steel gasoline USTs, one steel fuel oil UST, and one steel waste oil UST. Environmental investigations conducted in the 1990's at the service station site identified soil and groundwater contamination above Model Toxics Control

Act (MTCA) Method A soil and groundwater cleanup levels and a groundwater flow direction to the northwest. Maximum on-site benzene, toluene, ethylbenzene, and total xylene (BTEX) concentrations in groundwater were 8,700, 28,000, 21,000, and 15,000 micrograms per liter ($\mu\text{g/L}$), respectively. Maximum BTEX concentrations in an off-site, downgradient well located on the south side of South 212th Street were 260, 5, 210, and 600 $\mu\text{g/L}$, respectively.

Remediation activities at the Exxon/Chevron site involved excavation of 250 cubic yards (cy) of soil from the former gasoline UST basin and 30 cy of soil from the eastern pump island in July 1996 (ERI, 2003) and operation of a soil vapor extraction and air sparging (SVE/AS) system between August 1995 and mid-1998 (EA Engineering, Science, and Technology [EA], 1996; ERI, 2003). BTEX concentrations have generally been near or below analytical reporting limits since the SVE/AS system ceased operating in 1998.

1.3 Background and Purpose

The Univar site has been in operation since 1974. The facility stores, packages, and distributes various chemicals. Historically, VW&R operated one 1,500 gallon and one 6,000 gallon aboveground dangerous waste storage tanks at the site. The former 1,500 gallon tank was located on top of the elevated dock immediately north of the existing barrel wash pit (Figure 2). This area is currently at ground level and is covered by a concrete pad constructed in approximately 1985. The former 6,000 gallon tank was located in Tank Farm #1, 100 feet south of the southeast corner of the main warehouse. Tank Farm #1 consists of a concrete pad surrounded by a 3 foot high concrete wall. The waste storage tanks were taken out of service in 1982 (1,500 gallon tank) and in 1985 (6,000 gallon tank). There were no known releases from either tank during their operating history.

In 1995 and 1996, VW&R formally closed the former aboveground dangerous waste storage tanks following the procedures specified in the Ecology-approved closure plan (VW&R, 1993). Subsurface investigations conducted during closure indicated that volatile organic compounds (VOCs) were present in the subsurface above the Model Toxics Control Act (MTCA) cleanup levels applicable at the time. Further investigations were conducted to determine the nature and extent of subsurface VOCs. A site characterization report was prepared in 1998 followed by a focused feasibility study (FS) report in 2000. Both reports were submitted to Ecology, with Ecology approving the approach. Based on the FS recommendations, a pilot study was performed in 2001. During the installation of the pilot study wells, additional VOC contamination was discovered, initiating a second round of investigations conducted in 2002, 2003, and 2004 to determine the nature and extent of subsurface VOCs to the base of the aquifer.

Periodic progress meetings were held with Ecology to discuss the site investigations, results, and project approach. Because of the site investigations conducted in 2002, 2003, and 2004, Ecology requested that Univar prepare a comprehensive site characterization report. The purpose of this site characterization report (RI report) is to (1) update the groundwater investigation report (EMCON, 1998) and the draft focused feasibility study report (IT Corporation, 2000) with data collected during additional site investigations and a remediation pilot study, (2) identify exposure pathways and receptors, and (3) identify cleanup levels for the site. The report presents a

description of the site investigations, results of testing and sampling performed at the site, a description of the site characteristics, and a summary of the nature and extent of contamination.

1.4 Report Organization

Section 1 – Introduction: Describes the background and purpose of this report, the site description, and the organization of the report.

Section 2 – Environmental Setting: Provides a summary of the physical setting, climate, surface water hydrology, regional geology and hydrogeology, and area water supply wells.

Section 3 – Site Investigations: Describes the subsurface explorations, pilot test installations, hydraulic and chemical testing, groundwater monitoring, and surveying conducted at the site.

Section 4 – Investigation Results: Describes the site geology, hydrostratigraphy, groundwater flow, and soil and groundwater chemistry results.

Section 5 – Conceptual Site Model and Media Cleanup Standards: Provides a summary of the indicator hazardous substances, contaminant sources, chemical fate and transport, exposure pathways and receptors, and cleanup standards for the site.

Section 6 – Nature and Extent of Contamination: Describes the nature and extent of soil and groundwater contamination above the site cleanup levels.

Section 7 – Summary: Provides a summary of the investigations, results, conceptual site model, cleanup standards, and nature and extent of contamination.

Section 8 – References: Lists the sources of information referenced in the document.

2.0 ENVIRONMENTAL SETTING

2.1 Physical Setting

The Univar site is located in the southeastern portion of the Puget Sound Lowland, a topographic low between the Cascade Range and the Olympic Mountains. Alluvial valleys and plains, and glacially formed or modified hills and ridges dominate the lowland. The site lies in the Duwamish Valley between the Covington Plain on the east and the Des Moines Plain on the west. The elevation of the valley ranges from about 25 to 100 feet above sea level, with the site at an elevation of approximately 35 feet.

2.2 Climate

Air masses originating over the Pacific Ocean strongly affect the climate of the Puget Sound Lowland, with generally overcast, cool, damp, and mild weather during the autumn, winter, and spring, and warm and dry weather during the summer. The annual precipitation ranges from about 30 to over 60 inches in the lowland. The average annual precipitation in the Kent area is about 38 inches, with 76 percent of it falling between October and March.

2.3 Surface Water Hydrology

The Duwamish Valley lies in the Duwamish-Green River Watershed, a northwest-southeast trending basin extending from the Cascade foothills to Puget Sound. Major surface water bodies in the Duwamish Valley include the Green River, the Black River, the Duwamish River, Mill Creek, and Springbrook Creek. The closest surface water body to the site is a reach of Mill Creek located 1,700 feet northwest of the site.

2.4 Regional Geology

The valley is thought to have been formed during the last glacial advance between 14,000 and 18,000 years ago (Mullineaux, 1970; Jones, 1999). The valley is filled with over 300 feet of Quaternary alluvium interbedded with marine sand deposited after the last glaciation. Beneath that lies approximately 500 feet of older unconsolidated, undifferentiated deposits (Woodward and others, 1995), and beneath that Tertiary bedrock consisting of sandstone, shale, and coal (Mullineaux, 1970).

According to the U.S. Geological Survey (Mullineaux, 1970), most of the upper 100 feet of deposits in the Duwamish Valley consist of sand, gravel, silt, clay, and peat deposited by the White River. In a series of borings drilled in the valley, the U.S. Geological Survey found finer-grained deposits (fine sand, silt, clay, and peat) up to 35 feet thick at the surface with underlying sand and gravel deposited by the White River. Environmental investigations and water well logs near Kent report that the finer-grained surficial deposits (interbedded sand, silty sand, sandy silt, and silt) extend to depths greater than 50 feet. The shallowest layers of sandy silt or silt are generally found within 30 feet below ground surface (bgs) and are generally continuous across a given site.

2.5 Regional Hydrogeology

Groundwater is found at shallow depths throughout the Duwamish Valley. Groundwater elevations in shallow wells near Kent are about 25 feet above mean sea level (Woodward and others, 1995). In general, groundwater elevations in deeper wells in the Duwamish Valley are higher than in shallower wells, indicating upward groundwater flow. Hydraulic conductivities measured in water wells in the valley vary from 10^{-4} to 3 cm/sec, with average or geometric mean values ranging from 3×10^{-3} to 1×10^{-1} cm/sec (Jones, 1999).

Groundwater flows regionally from topographic highs to topographic lows, with recharge in unpaved areas and discharge to streams, lakes, or saltwater bodies (Vaccaro and others, 1998). Shallow groundwater flow in the Kent area is generally toward the Green River, Mill Creek, or Springbrook Creek. Shallow groundwater flow in the vicinity of the Univar Kent site is to the northwest.

2.6 Water Supply Wells

Ecology's well log files were reviewed in 1998, and the Ecology well log database was accessed in 2004 to determine the number of water supply wells near the Univar Kent facility. Based on a review of the well logs in the database (Appendix A), 16 water wells may be located within a

1-mile radius of the site (Figure 3 and Table 1). None of the wells are located downgradient of the site.

Seven of these wells were installed before 1960, and six of the seven were reportedly located west of Highway 167. The four closest wells to the site were all installed before 1960, the closest being a 321-foot-deep well located approximately 1,100 feet south-southeast (upgradient). Most of these seven wells did not indicate a well use, though given the amount of the valley devoted to agricultural use at the time these seven wells were installed, it is likely that these wells were used for domestic or irrigation purposes. Based on the age of the wells, the changing land use and water supplies in the valley since 1960, and the presence of numerous abandonment logs in Ecology's database that could not be precisely matched to the well installation logs, it is likely that most of these wells have been abandoned.

Of the nine wells installed after 1960, two represent test wells installed by the city of Kent, six represent city of Kent municipal water supply wells, and one represents a domestic water supply well. The two test wells were installed in 1998 approximately 4,000 feet west-northwest and 3,600 feet west-southwest of the Univar site. According to city of Kent personnel, the wells were installed for an environmental restoration project; neither well is in use and neither has been abandoned. Six of the seven known water supply wells are located east of Highway 167, and all are at least 2,500 feet upgradient of the site. Six of the seven known water supply wells were installed at depths greater than 180 feet and have recorded artesian flow rates up to 550 gallons per minute (gpm).

3.0 SITE INVESTIGATIONS

Site soil and groundwater have been investigated since 1994 using direct-push and hollow-stem auger drilling techniques, monitoring well installation, soil and groundwater sampling, laboratory chemical analysis, groundwater level monitoring, and hydraulic conductivity testing. Following is a discussion of the subsurface investigations conducted at the site and a summary of the methods used. Figure 4 provides the locations of the site explorations. Appendix B provides the boring and monitoring well logs, including well completion diagrams. Appendix C provides the hydraulic conductivity testing data. A field pilot test of in-situ chemical oxidation was conducted in 2001. The injection and monitoring wells installed during the pilot test are described in this section; however, a complete discussion of the pilot test results will be included in the forthcoming feasibility study report.

3.1 Temporary Borings and Monitoring Wells

3.1.1 1994 and 1995 Site Investigations

In 1994, a temporary boring (SB-8) was drilled at the location of the former 1,500-gallon storage tank using a hollow-stem auger drilling rig. Soil samples were collected at 2.5-foot intervals; two samples were analyzed for VOCs, hexane, copper, and alcohols. The laboratory results indicated the presence of several VOCs and copper; however, the concentrations were below applicable Model Toxics Control Act (MTCA) Method A Soil Cleanup Levels (EMCON, 1994).

However, during collection of the soil sample at a depth of approximately 5- to 6.5-feet below ground surface (bgs), a solvent-like odor was noted.

Ecology subsequently requested that VW&R conduct an investigation of groundwater conditions near the former storage tank to evaluate the observation of the solvent-like odor. In 1995, EMCON investigated groundwater conditions using a temporary well point (SB-9) and three monitoring wells (MW-1, MW-2, and MW-3). The borings were drilled with a hollow-stem auger drilling rig equipped with nominal 6-inch inside diameter (i.d.) and nominal 9-inch outside diameter (o.d.) auger flights. SB-9 was advanced to a depth of 6 feet, with continuous soil sampling. The monitoring wells were advanced to 21 feet below grade; subsurface soil samples were collected continuously to a depth of about 6 feet and at 5-foot intervals thereafter. In all four borings, soil samples were collected in advance of the drill bit with an 18-inch-long, 3-inch o.d., split-barrel sampler lined with stainless steel tube inserts. Each soil sample was screened for VOCs with a photoionization detector (PID). Soil samples from 4.5 and 6 feet bgs in MW-1, MW-2, and MW-3 were submitted for laboratory analysis of VOCs using U.S. Environmental Protection Agency (USEPA) Method 8240 (USEPA, 1992). Groundwater samples from SB-9 and monitoring wells MW-1, MW-2, and MW-3 were also submitted for laboratory analysis using USEPA Method 8240. Monitoring wells MW-1, MW-2, and MW-3 were constructed using 2-inch-diameter, Schedule 40 polyvinyl chloride (PVC) screened between 4 and 19 feet bgs (Table 2). Boring SB-9 was abandoned with bentonite chips as the augers were extracted from the boring.

The results of the 1995 investigation indicated that groundwater beneath the location of the former hazardous waste storage tank contained VOCs at concentrations exceeding MTCA Method A and/or B groundwater cleanup levels (EMCON, 1995a). Based on the information provided in the closure plan, a number of the VOCs present in groundwater were not known to have been managed in the former hazardous waste storage tank. These VOCs included acetone, ethylbenzene, chloroform, total xylenes, benzene, trichlorotrifluoroethane, 4-methyl-2-pentanone (MIBK), and styrene. The detection of these compounds in groundwater indicated that multiple sources of VOCs might have been present near the former hazardous waste storage tank.

A review of VW&R's files indicated that historically VW&R operated 37 underground storage tanks (USTs) in the area of the former 1,500-gallon tank (Figure 2; EMCON, 1995b). The USTs, which were removed in 1985 and 1986, were used to store raw products not managed in the former 1,500-gallon tank (Table 3). Some of the chemical constituents stored in the USTs were detected in groundwater. This information indicated that the former USTs could have been a source of VOCs in groundwater near the former 1,500-gallon aboveground storage tank location. In a letter dated December 8, 1995, Ecology concurred with this assessment and requested additional groundwater investigation.

3.1.2 1996 MW-1 Area Groundwater Investigation

On August 13, 1996, SB-10 was drilled and sampled to assess the water quality southwest of MW-1. The boring was drilled and sampled with a hollow-stem auger drilling rig. Soil samples were collected at 1 foot bgs and immediately above the water table with an 18-inch-long, 3-inch o.d., split-barrel sampler lined with stainless steel tube inserts. Both soil samples were submitted

to the analytical laboratory for analysis of VOCs using USEPA Method 8260 (USEPA, 1992). A groundwater sample was also collected from a temporary well screen installed in SB-10 between 4 and 9.5 feet below grade. The groundwater sample was collected with a disposable polyethylene bailer after field parameters (pH, specific conductance, dissolved oxygen, and temperature) had stabilized within ± 10 percent. The groundwater sample was submitted for analysis of VOCs including acetone, hexane, MIBK, ethyl acetate, and 2-nitropropane by USEPA Method 8260; total petroleum hydrocarbons as gasoline (TPH-G), petroleum naphtha, and mineral spirits using Method WTPH-G (Ecology, 1992); TPH as diesel (TPH-D), oil (TPH-O), and kerosene using Method WTPH-D extended (Ecology, 1992); and ethylene glycol, propylene glycol, and alcohols (including ethanol, isopropanol, and 1-butanol) using USEPA Method 8015 Modified (USEPA, 1992). Boring SB-10 was abandoned with bentonite chips as the augers were extracted from the boring.

Three monitoring wells (MW-4, MW-5, and MW-6) were installed on August 13, 1996, to assess the northern, northeastern, and eastern extent of VOCs in shallow groundwater near MW-1. The wells were drilled with a hollow-stem auger drilling rig equipped with nominal 6-inch i.d. and nominal 9-inch o.d. auger flights. The monitoring wells were advanced to about 15 feet bgs. Subsurface soil samples were collected at 2.5-foot intervals in all five monitoring well borings. Soil samples were collected in advance of the drill bit with an 18-inch-long, 3-inch o.d., split-barrel sampler lined with stainless steel tube inserts. Each soil sample was screened for VOCs with a PID. Based on field screening results, two soil samples from MW-4, MW-5, and MW-6 were submitted for laboratory analysis of VOCs using USEPA Method 8260 (USEPA, 1992). All samples submitted for VOC analysis from this investigation onward were analyzed using USEPA Method 8260.

Monitoring wells MW-4, MW-5, and MW-6 were constructed using 2-inch-diameter, Schedule 40 PVC screened between 4.5 and 14.5 feet bgs (Table 2). MW-4, MW-5, and MW-6 were developed by the driller using surge block and pumping techniques. After well development, four quarterly rounds of groundwater samples were collected from MW-1 through MW-6 using the same techniques used in SB-10. The samples were submitted for laboratory analysis of VOCs including acetone, hexane, MIBK, ethyl acetate, and 2-nitropropane; TPH-G, petroleum naphtha, and mineral spirits using Method WTPH-G; and TPH-D, TPH-O, and kerosene using Method WTPH-D extended. The September 1996 samples were also analyzed for chloride and sulfate (USEPA Method 300.0), total manganese and iron (USEPA Method 6010A), and total dissolved solids (USEPA Method 160.1). The December 1996 samples were also analyzed for ethylene glycol, propylene glycol, and alcohols (including ethanol, isopropanol, and 1-butanol) using USEPA Method 8015 Modified.

3.1.3 1997 MW-5 Area Groundwater Investigation

Based on the elevated concentrations of tetrachloroethene (PCE) found in MW-5 during the 1996 and 1997 quarterly sampling events, GP-1 through GP-10 were drilled and sampled on October 10, 1997, to further define the extent of PCE in groundwater in the vicinity of MW-5. The direct-push borings were advanced to a maximum depth of 10.5 feet bgs. One soil sample was collected from each boring between depths of approximately 1 and 4 feet bgs. Groundwater was located in each boring at approximately 8 feet bgs. A groundwater sampling screen was

exposed at the water table in each boring by retracting the outer sleeve of the probe. Groundwater samples were obtained using a peristaltic pump and polyethylene tubing. Samples were collected after field parameters (pH, conductivity, dissolved oxygen, and temperature) stabilized within ± 10 percent. Based on PID readings or boring location, four soil samples were submitted for analysis of VOCs. One groundwater sample from each boring was analyzed for VOCs. Each direct-push boring was abandoned by pumping the boring full of bentonite grout from the bottom to the top as the tools were extracted from the hole.

Two monitoring wells (MW-7 and MW-8) were installed on December 12, 1997, to assess the northern and northeastern extent of PCE in shallow groundwater near MW-5. The wells were drilled and sampled as with MW-4 through MW-6. Monitoring wells MW-7 and MW-8 were constructed using 2-inch-diameter, Schedule 40 PVC screened between 4.5 and 14.5 feet bgs (Table 2). MW-7 and MW-8 were developed by surging and pumping each well.

3.1.4 1999 MW-5 Area Deep Investigation

To investigate the deeper hydrogeology and groundwater chemistry near MW-5, two direct-push borings (GP-11 and GP-12) were drilled and sampled adjacent to MW-8 in January 1999. Soil in GP-11 was continuously sampled for lithologic identification from ground surface to the bottom of the boring at 48 feet bgs. GP-12 was advanced to a depth of 40 feet, with groundwater samples collected at four depths (15 to 16 feet bgs, 23 to 24 feet bgs, 31 to 32 feet bgs, and 39 to 40 feet bgs). The groundwater samples were submitted for laboratory analysis of VOCs. Each direct-push boring was abandoned by pumping the boring full of bentonite grout from the bottom to the top as the tools were extracted from the hole.

In January 1999, a piezometer (P-1) was installed adjacent to GP-11 and GP-12 for groundwater level measurements. The piezometer boring was drilled with a hollow-stem auger drilling rig equipped with nominal 6-inch i.d. and nominal 9-inch o.d. auger flights. The piezometer boring was advanced to about 46.5 feet bgs. One soil sample was collected from the piezometer boring, a Shelby tube pushed in advance of the drill bit at the bottom of the boring (44.5 to 46.5 feet bgs) for laboratory analysis of vertical hydraulic conductivity. The piezometer was constructed of 2-inch-diameter, Schedule 40 PVC screened between 39 and 44 feet bgs (Table 2). P-1 was developed using surging and pumping techniques. GP-11 and GP-12 were abandoned by pumping the borings full of bentonite grout from the bottom to the top as the tools were extracted from the holes.

3.1.5 2001 Warehouse and Property Boundary Investigations

Seven direct-push borings (SB-11 through SB-14, and SB-16 through SB-18) were completed at the site in June 2001 to investigate the area near the warehouse west of MW-1 and MW-4, and at the property boundary east of MW-5. A planned eighth boring (SB-15) near SB-14 through SB-17 was not completed due to refusal at a depth of 4.5 feet. Two monitoring wells were also installed in June 2001 to facilitate on-going groundwater monitoring in these areas.

Three borings (SB-14, SB-16, and SB-17) were completed west of MW-1 and MW-4 within the covered outside storage area of the warehouse building. Soil samples were collected from

borings SB-14, SB-16, and SB-17 at a depth of 6 to 7 feet bgs and analyzed for VOCs; groundwater samples were collected from each boring. Boring SB-14 was advanced to a total depth of 16 feet bgs; a groundwater sample was collected from 12 to 16 feet bgs and analyzed for VOCs. Borings SB-16 and SB-17 were advanced to a total depth of 14 feet bgs; groundwater samples were collected from 10 to 14 feet bgs and analyzed for VOCs. One boring (SB-18) was completed west of the warehouse building to a depth of 10 feet bgs, and a groundwater sample was collected from 6 to 10 feet bgs. This boring was completed to confirm that the western extent of VOC contamination in groundwater was defined. No soil samples were submitted for laboratory analyses from this boring. All groundwater samples were collected by retracting the outer sleeve of the sampling probe and exposing the temporary screen at the desired sampling depth. Groundwater samples were obtained using a peristaltic pump and polyethylene tubing. Samples were collected after field parameters (pH, conductivity, dissolved oxygen, and temperature) stabilized within ± 10 percent. Each direct-push boring was abandoned by pumping the boring full of bentonite grout from the bottom to the top as the tools were extracted from the hole.

Three borings (SB-11 through SB-13) were completed along the eastern edge of the property east of MW-5. Groundwater samples from these borings were used to determine the placement of a monitoring well used to monitor this area. Boring SB-11 was completed to a total depth of 12 feet bgs, and a groundwater sample was collected from 8 to 12 feet bgs and analyzed for VOCs. Borings SB-12 and SB-13 were completed to a total depth of 10 feet bgs, and groundwater samples were collected from each boring at 8 to 10 feet bgs and analyzed for VOCs. No soil samples were submitted for laboratory analyses from these borings. Each direct-push boring was abandoned by pumping the boring full of bentonite grout from the bottom to the top as the tools were extracted from the hole.

Monitoring well MW-9 was installed east of the MW-5 plume adjacent to the property boundary to monitor groundwater elevations and chemistry. Monitoring well MW-9 was installed near the direct-push boring at the property boundary with the highest concentration of groundwater VOCs (SB-12). Monitoring well MW-10 was installed north of the MW-1 plume, near the northeast corner of the facility loading dock. The wells were drilled with a hollow-stem auger drilling rig equipped with nominal 6-inch i.d. and nominal 9-inch o.d. auger flights. Monitoring wells MW-9 and MW-10 were installed to a total depth of 15 feet bgs. The wells were constructed using 2-inch-diameter, Schedule 40 PVC screened between 5 and 15 feet bgs (Table 2). MW-9 and MW-10 were developed by surging and pumping each well.

3.1.6 2002 MW-1 and MW-5 Area Investigations

In September 2002, soil and groundwater samples were collected from seven locations (SB-21 through SB-27) to further characterize the extent of tetrachloroethene (PCE) in the MW-5 area. At each location, two direct-push borings were drilled, the first for continuous soil sample collection (from 5 feet bgs to the bottom of the boring at 19 feet bgs) and the second for groundwater sample collection (at depths of 10 to 12 feet bgs and 17 to 19 feet bgs). Each soil sample was screened for VOCs with a PID. Based on field screening results, two to four soil samples from each boring were submitted for laboratory analysis of VOCs. All groundwater samples were submitted for laboratory analysis of VOCs. Each direct-push boring was

abandoned by pumping the boring full of bentonite grout from the bottom to the top as the tools were extracted from the hole. The September 2002 MW-5 area results indicated that additional borings were required to the north of MW-5 to define the vertical extent of the VOC plume.

In September 2002, soil samples were also collected from two shallow temporary borings drilled in the MW-1 area (SB-28 and SB-29). The borings were not completed to their intended depth due to the presence of subsurface obstructions at the drilling locations. One soil sample was collected from each boring between 4 and 5.5 feet and submitted for laboratory analysis of VOCs.

In November 2002, soil and groundwater samples were collected from three direct-push boring locations (SB-32, SB-33, and SB-34) in MW-5 area. As in the September investigation, two borings were drilled, one for continuous soil sample collection and one for groundwater sample collection. SB-32 was located adjacent to MW-5, and SB-33 and SB-34 were drilled on the north side of the MW-5 area. Borings at all three locations were advanced to the base of the aquifer. Each soil sample was screened for VOCs with a PID. One soil sample each from SB-32 and SB-34 and two soil samples from SB-33 were submitted for laboratory analysis of VOCs. Groundwater samples were collected from 10 to 12 (except SB-32), 15 to 17, 20 to 22, 25 to 27, 30 to 32, 35 to 37, and 40 to 42 feet bgs. All groundwater samples were submitted for laboratory analysis of VOCs, and each direct-push boring was abandoned by pumping the boring full of bentonite grout from the bottom to the top as the tools were extracted from the hole. The SB-32 through SB-34 results indicated that additional investigation north of the SB-33 location was required to define the horizontal extent of the MW-5 area VOC plume.

In November 2002, soil samples were also collected from two direct-push boring locations in the MW-1 area (SB-30 and SB-31). Two borings were drilled at each location, one each for soil and groundwater sample collection. Soil samples were collected continuously to the base of the aquifer in each boring and screened for VOCs with a PID. Six soil samples from SB-30 and three samples from SB-31 were submitted for laboratory analysis of VOCs. At each location, groundwater samples were collected at 5-foot intervals and submitted for laboratory analysis of VOCs. Each direct-push boring was abandoned by pumping the boring full of bentonite grout from the bottom to the top as the tools were extracted from the hole. The SB-30 and SB-31 results indicated that additional borings were required to verify and delineate the horizontal extent of VOCs found at the base of the aquifer in the MW-1 area.

3.1.7 2003 MW-1 and MW-5 Area Investigations

Soil and groundwater samples were collected in March 2003 at one direct-push boring location (SB-35) to define the horizontal extent of VOCs on the north side of the MW-5 area. Two borings were drilled, one each for soil and groundwater sample collection. Soil samples were collected continuously from 2 feet bgs to the bottom of the boring at 26 feet bgs. Each soil sample was screened for VOCs with a PID; seven soil samples were submitted for laboratory analysis of VOCs. Groundwater samples were collected at 5-foot intervals and submitted for laboratory analysis of VOCs. The direct-push borings were abandoned by pumping the boring full of bentonite grout from the bottom to the top as the tools were extracted from the hole.

Deep monitoring well (MW-13) was installed in March 2003 adjacent to SB-30 to verify the existence of VOCs at the base of the aquifer. Soil samples were not collected during drilling. The well was installed with a hollow-stem auger drilling rig equipped with nominal 4-inch i.d. and nominal 8-inch o.d. auger flights. The well boring was drilled to a total depth of 45.3 feet bgs, and the well was constructed using 2-inch-diameter, Schedule 40 PVC, with a pre-pack screen between 39.6 and 44.1 feet bgs (Table 2). The well was developed by surging and pumping techniques.

Soil and groundwater samples were collected in May and June 2003 from seven direct-push borings (SB-36 through SB-42) to further characterize the deeper part of the aquifer in the MW-1 area. Each boring was drilled to the base of the aquifer, with alternating soil and groundwater samples collected. Each soil sample was screened for VOCs with a PID. Based on field screening results, eight soil samples from SB-38 and two soil samples from SB-41 were submitted for laboratory analysis of VOCs. Five to six groundwater samples were collected from each direct-push boring except SB-42. SB-42 was drilled at the end of the last day of an investigation, so no soil samples were collected from that location; one groundwater sample was collected from SB-42 between 44 and 46 feet below the dock surface. All groundwater samples were submitted for laboratory analysis of VOCs. Each direct-push boring was abandoned by pumping the boring full of bentonite grout from the bottom to the top as the tools were extracted from the hole. The results from SB-36 through SB-42 indicated that the additional data were needed to the northwest of the MW-1/MW-4 area to define the horizontal extent of VOCs at the base of the aquifer.

Based on the direct-push boring results, five deep monitoring wells (MW-14 through MW-18) were installed in October 2003 to define the horizontal extent of VOCs at the base of the aquifer. Soil samples were not collected during the drilling of MW-14 through MW-17, since these wells were installed adjacent to and after deep temporary borings in which soil samples were collected. While drilling MW-18, subsurface soil samples were collected at 5-foot intervals for lithologic logging; soil samples were collected in advance of the drill bit with an 18-inch-long, 2-inch o.d., split-barrel sampler. All five wells were installed with a hollow-stem auger drilling rig equipped with nominal 6-inch i.d. and nominal 9-inch o.d. auger flights. The well borings were drilled to total depths ranging from 43 to 44 feet bgs (MW-14, MW-15, MW-17, and MW-18) or 48 feet below the dock surface (MW-16). The wells were constructed using 2-inch-diameter, Schedule 40 PVC, with 10-foot-long, pre-pack screens located at the base of the aquifer (Table 2). The wells were developed using surging and pumping techniques.

3.1.8 2004 Property Boundary and Off-Site Investigations

One deep monitoring well (MW-19) was installed January 2004 to define the horizontal extent of VOCs at the base of the aquifer at the northern property boundary. Soil samples were collected at 5-foot intervals in advance of the drill bit with an 18-inch-long, 2-inch o.d., split-barrel sampler. Each soil sample was screened for VOCs with a PID. Based on field screening results, one sample (collected between 44.5 and 46 feet) was submitted for laboratory analysis of VOCs. MW-19 was installed with a hollow-stem auger drilling rig equipped with nominal 6-inch i.d. and nominal 9-inch o.d. auger flights. The well boring was drilled to total depth of 50.5 feet bgs. The well was constructed of 2-inch-diameter, Schedule 40 PVC, with a 10-foot-long, pre-pack

screen located at the base of the aquifer (Table 2). The well was developed using surging and pumping techniques.

Soil and groundwater samples were collected in February 2004 from one direct-push boring (SB-43) to verify the absence of VOCs to the east of the MW-5 area. SB-43 was selected to be closest to the highest concentrations of VOCs near the eastern property boundary; it was drilled to a depth of 34 feet bgs, with alternating soil and groundwater samples collected. Each soil sample was screened for VOCs with a PID. Based on field screening results, no soil samples were submitted for laboratory analysis. Groundwater samples were collected from 8 to 10, 18 to 20, and 28 to 30 feet bgs. All groundwater samples were submitted for laboratory analysis of VOCs. SB-43 was abandoned by pumping the boring full of bentonite grout from the bottom to the top as the tools were extracted from the hole.

3.2 Pilot Test Investigations

Three injection wells and two performance monitoring wells were installed within a portion of the MW-5 plume designated a pilot test (pilot test area) in June 2001. The injection wells (INJ-1 through INJ-3) were placed in a triangular pattern separated by approximately 30 feet. The injection wells were constructed to a depth of 20 feet bgs, with a screened interval from 10 to 20 feet bgs. During drilling, continuous soil sampling was performed within the screened section of injection wells to obtain detailed information on the lithology through the injection zone and to determine if zones of lower permeability (i.e., silt or clay layers) are present that could potentially inhibit the injection process.

Two performance monitoring wells were installed at between injection wells INJ-1 and INJ-2. The monitoring wells (MW-11 and MW-12) were to be used to monitor the groundwater quality during the pilot test, as well as, to confirm that the injection reagents were being delivered to the aquifer at various distances from the injection wells (radius of influence). Monitoring well MW-11 was located approximately 15 feet equidistant from both INJ-1 and INJ-2. Monitoring well MW-12 was located approximately 5 feet from INJ-2 and 25 feet from INJ-1. Monitoring wells MW-11 and MW-12 were constructed to a total depth of 20 feet bgs, with a screened interval from 10 to 20 feet bgs.

The injection and monitoring wells were installed with a hollow-stem auger drilling rig equipped with nominal 6-inch i.d. and nominal 9-inch o.d. auger flights. The wells were constructed using 2-inch-diameter, Schedule 40 PVC (Table 2). All wells were developed after installation using surging and pumping techniques.

3.3 Hydraulic Conductivity Testing

Slug tests were performed in monitoring wells MW-2, MW-3, and MW-5 to evaluate horizontal hydraulic properties of the aquifer near each tested well. The rising head slug test method was used, with a "slug" of water quickly removed from the well bore with a PVC bailer. The water level in the tested well was monitored with a pressure transducer and datalogger until the water level recovered. Additionally, a soil sample collected in the silt at the base of piezometer boring P-1 was submitted for laboratory vertical hydraulic conductivity testing.

3.4 Groundwater Level Monitoring

Groundwater levels have been measured periodically to evaluate the seasonal fluctuation of aquifer water levels and seasonal changes in groundwater flow direction. Water levels were measured periodically prior to August 1996 in three on-site monitoring wells (MW-1, MW-2, and MW-3) and seven off-site monitoring wells (EMW-1 through EMW-7) installed by Exxon. Water levels were also measured monthly in on-site monitoring wells MW-1 through MW-6 and off-site monitoring well EMW-7 for six months (September 1996 through February 1997). Water levels have been measured quarterly in all available wells since then. Water levels were measured from the surveyed top of PVC casing using an electric water level probe. For a given water level measurement event, water levels were measured within a few hours of each other to minimize the affects of seasonal, barometric, or pressure loading changes on water levels.

3.5 Routine Groundwater Sampling and Analysis

MW-1 through MW-6 were sampled quarterly beginning in September 1996. MW-7 through MW-19 were added to the quarterly sampling schedule after they were installed. Each groundwater sample collected before June 1999 was obtained by purging three pore volumes from the wells using a high-capacity peristaltic pump fitted with polyethylene tubing (with silicon tubing at the pump head) and measuring field parameters (temperature, pH, specific conductance, dissolved oxygen (DO), and turbidity) after removing every pore volume. After field parameter stabilization, the sample (for analysis of inorganic parameters) was collected from the pump discharge line and with a disposable polyethylene bailer (organic parameters). Samples were placed directly in laboratory-prepared bottles.

From June 1999 on, groundwater samples were collected using low-flow sampling techniques. The wells were purged and sampled with a low-capacity peristaltic pump fitted with polyethylene tubing and silicon tubing at the pump head. The intake of the polyethylene tubing was placed mid-screen, and the wells were purged at flow rates ranging from 120 to 250 mL/min until field parameters (pH, temperature, specific conductance, and dissolved oxygen) stabilized. Specific conductance and dissolved oxygen were given priority in determining when to sample. Samples were collected directly from the discharge line of the peristaltic pump in laboratory-prepared bottles.

Samples were analyzed for a comprehensive list of compounds based on the contents of the former aboveground storage tank and USTs listed in the closure plan. All groundwater samples were analyzed for VOCs including acetone, hexane, MIBK, ethyl acetate, and 2-nitropropane using USEPA Method 8240 (USEPA, 1986); TPH-G, petroleum naphtha, and mineral spirits using Method WTPH-G (Ecology, 1992); and TPH-D, TPH-O, and kerosene using Method WTPH-D extended (Ecology, 1992). In March 1996, the VOC analytical method was updated to USEPA Method 8260 (USEPA, 1992). In September 1997, the TPH-G and TPH-D methods were updated to the new NWTPH-Gx and NWTPH-Dx methods (Ecology, 1997).

Groundwater samples collected in September 1996 were also analyzed for chloride and sulfate using USEPA Method 300.0 (USEPA, 1983); iron, and manganese using USEPA Method 6010 (USEPA, 1986), and total dissolved solids (TDS) using USEPA Method 160.1 (USEPA, 1983).

Groundwater samples collected in December 1996 were also analyzed for ethylene glycol, propylene glycol, and alcohols (including ethanol, isopropanol, and 1-butanol) using USEPA Method 8015 Modified (USEPA, 1992).

3.6 Surveying

The horizontal and vertical locations of the existing and new on-site and off-site monitoring wells were surveyed by a registered surveyor. The horizontal datum was the Washington State Plane System North Zone (NAD 27), and the vertical datum was the North American Vertical Datum (NAVD 88). Survey results are provided in Table 2.

3.7 Data Validation

All soil and groundwater chemistry data were reviewed per the quality control criteria outlined by USEPA (USEPA, 1994 and once available 1999). Data completeness, holding times, laboratory instrument calibration, surrogate recoveries, matrix spike and matrix spike duplicates, laboratory control samples, quantitation limits, method blanks, field blanks, and trip blanks were reviewed. The usefulness of the data was determined based on the USEPA guidelines. Any data qualifiers assigned based on the review were added to the tabulated data.

4.0 INVESTIGATION RESULTS

4.1 Geology

Based on the subsurface investigations performed to date, the geologic materials at the site consist primarily of sand, silty sand, silt, and organic silt. Figures 5 and 6 present geologic cross sections that depict the distribution of these materials in the area east of the warehouse building. The upper 10 to 30 feet of soil consists of interbedded sand, silty sand, sandy silt, and silt. Locally this unit contains organic soil and peat layers. The interbeds are laterally discontinuous and range in thickness from approximately 1 to 12 feet. The soil is brown to gray, with local accumulations of wood debris. The sand is fine to medium, and the silt is of low to medium plasticity. The uppermost soil has likely been reworked during site construction and may include fill. The fill, however, is similar in composition to the underlying native soil, and the transition between fill and native soil is indistinct. In the area of the former underground storage tanks (Figure 2), debris that could not be penetrated (likely concrete) was encountered during the drilling of SB-28 and SB-29. Based on the explorations performed to date, this uppermost interbedded unit is thickest to the southwest and thinnest to the northeast.

The uppermost interbedded unit is underlain by gray to black, fine to medium sand. This unit ranges from approximately 14 to 35 feet thick, with the thickest accumulations of sand to the northeast. The sand contains trace to few silt and scattered wood fragments. Locally, the upper part of this unit contains 1-to 3-foot-thick lenses of silty sand, and elsewhere the unit contains laminations to thin lenses of silt, sandy silt, or silty sand. Under the north-central part of the covered storage area east of the warehouse (at SB-41), the upper portion of this unit is finer, consisting of silty sand.

The intermediate sand unit is underlain by silt. Brown to gray, low to medium plasticity, with scattered organic matter, this unit is first encountered at approximate depths ranging from 44 to 48 feet bgs. About 2 to 4 feet of the unit was encountered in each deep temporary boring. The entire thickness of this unit was not penetrated by any of the deep explorations.

The geologic materials encountered at the site are consistent with those encountered by the U.S. Geological Survey and by other environmental investigations in the valley.

4.2 Hydraulic Conductivity Testing Results

The slug test data from MW-2, MW-3, and MW-5 were analyzed using the Bouwer and Rice method (Kruseman and de Ridder, 1990). The horizontal hydraulic conductivities calculated from the slug tests were 3×10^{-2} and 1×10^{-2} cm/sec at MW-3 and MW-5, respectively. The data curve for MW-2 can be interpreted two different ways. Depending on which interpretation is used in the calculation, the calculated horizontal hydraulic conductivities at MW-2 are 1×10^{-4} and 3×10^{-3} cm/sec. The MW-3 and MW-5 slug test results are consistent with published hydraulic conductivity values for sand, while the MW-2 slug test results are consistent with silty sand to sand (Wolff, 1982). The slug test data and analyses are provided in Appendix C.

The vertical hydraulic conductivity of the P-1 sample submitted for laboratory analysis was 3.2×10^{-6} cm/sec, consistent with published hydraulic conductivity values for silt (Wolff, 1982).

4.3 Hydrostratigraphy

Two hydrostratigraphic units have been identified at the site: (1) the shallow water-table aquifer and (2) the underlying aquitard. The upper interbedded unit and the underlying sand unit represent the shallow aquifer. Although fine-grained soil that is likely less permeable to groundwater flow is encountered in the upper interbedded unit, the finer interbeds are laterally discontinuous and are less commonly encountered than the sand and silty sand that dominate the unit. The shallow monitoring wells (MW-1 through MW-12) are installed in the upper interbedded unit and at the top of the intermediate sand. Groundwater in these wells is encountered between approximately 4 and 8 feet bgs (Table 4). The deep piezometer and wells are installed at the base of the intermediate sand. Groundwater in these installations is also encountered between approximately 4 and 8 feet bgs.

The aquitard is continuous beneath the site and, based on the low hydraulic conductivity, represents a significant barrier to downward movement of groundwater.

4.4 Groundwater Flow

4.4.1 Groundwater Elevations

Table C-1 presents the measured groundwater levels and calculated groundwater elevations in all on-site wells and the available off-site wells. Between 1995 and September 2004, groundwater elevations in the shallow monitoring wells ranged from 24.57 to 29.85 feet (relative to NAVD 88). Between 1999 and September 2004, groundwater elevations in the deep piezometer (P-1) varied from 25.22 to 28.43 feet, and between March 2003 and September 2004, groundwater

elevations in the deep monitoring wells (MW-13 through MW-19) varied from 25.16 to 27.71 feet. Groundwater elevations vary up to approximately 3.5 feet seasonally and were highest in the spring and lowest in the fall.

4.4.2 Groundwater Flow Direction

4.4.2.1 Groundwater Contours

Figures 7 and 8 present groundwater contour maps in the shallow and deep monitoring wells, respectively, for data collected March 15, 2004. These groundwater contour maps are typical of those generated for data collected throughout the investigation. Groundwater flow in the shallow wells at the site is generally toward the northwest, with radial flow away from a groundwater high located near MW-1 and MW-4. Groundwater flow in the deep piezometer and wells is to the northwest, consistent with groundwater flow in the vicinity of the Univar Kent site.

4.4.2.2 Groundwater Mound

The shallow groundwater mound has been present during every groundwater level measurement event during the investigation. The height of the groundwater mound varies seasonally from less than 0.5 foot high to approximately 1.5 feet high and is most pronounced in the summer. Groundwater elevations at four pairs of wells in the shallow aquifer were compared to determine the vertical gradient within the aquifer. Table 4 presents the data for well pairs that are located near the center of the mound (MW-4 and MW-13), in the eastern edge of the area influenced by the mound (MW-6 and MW-14), and to the northeast (MW-8 and P-1) and north of the mound (MW-10 and MW-18). Based on the data collected to date, the vertical gradient in the shallow aquifer varies from 0.015 to 0.036 feet/foot downward near the center of the mound and is variable or slightly downward near or beyond the groundwater mound. The mound likely exists only in the shallow part of the shallow aquifer due to a surficial source of water and a higher horizontal hydraulic conductivity than vertical hydraulic conductivity in the aquifer.

Three potential sources of the groundwater mound near MW-1 and MW-4 have been investigated: (1) the barrel wash sump, which is located approximately 25 feet south of MW-1, (2) the discharge line from the barrel wash area to the sanitary sewer, which is located southeast of MW-1, and (3) the water line leading to the barrel wash area, which is located approximately 35 feet southwest of MW-1. To determine if the barrel wash sump (Figure 2) could have been the cause of the groundwater mound, monthly water levels were measured in the barrel wash sump for 10 months in 1996 and 1997 (Table C-1). Water levels in the sump were above the groundwater table in September 1996, October 1996, February 1997, June 1997, August 1997, and December 1997, and below the water table in November 1996, December 1996, January 1997, and March 1997. During 1997, workers at the facility noted changes in water levels in the sump unrelated to plant operations. Due to these observations, a plastic liner was installed in the sump during the week of December 1, 1997. The lack of a sump water level significantly above the water table before installation of the liner and the continued existence of the groundwater mound after installation of the liner indicate that the sump has not been the source of the groundwater mound.

The 6-inch-diameter PVC sewer discharge line that the barrel wash sump is pumped into was surveyed with a video camera on December 15, 1997, to determine if it could have been the cause of the groundwater mound. Filming began at the barrel wash pit and continued to a distance of approximately 100 feet due east. The camera could not proceed farther due to sludge in the piping. The video of the 6-inch-diameter PVC discharge line near the barrel wash sump showed no holes in the pipe. In the video, longitudinal cracks could be seen on the bottom of the pipe along most of the observed section of pipe. The cracks were most conspicuous beneath the highly trafficked area of the driveway. At the time the pipe was filmed, water was present in the last half of the pipe and was flowing near the end, indicating that the pipe leaked and that the leak was located below the water table. The 6-inch-diameter PVC discharge line did not appear to be the source of the groundwater mound based on (1) the fact that the pipe is only periodically used to discharge water to the sewer, (2) the location of the pipe at or below the water table, and (3) the lack of observable holes or gaps in the dry portion of the pipe. The pipe was removed and replaced in December 1998, with no subsequent influence on the groundwater mound.

To determine if the barrel wash area water line could have been the cause of the groundwater mound, the water meter recording water use within the Univar Kent facility was monitored on multiple weekends in 2003. The facility is closed on the weekend with only occasional restroom use by the small weekend crew. On each of the monitored weekends, only a few gallons water use were noted, consistent with infrequent restroom use.

In summary, the source of the groundwater mound consistently seen in the MW-1 and MW-4 area on the east side of the facility is not known. Based on the subsurface investigations conducted to date and the assessment of potential surficial sources, it appears that the source must be functioning year-round and be located in the area near MW-1. One potential source in the area is the subsurface fire suppression system piping. One section of the 10-inch-diameter steel, fire suppression pipe runs in a north-south line approximately 50 feet east of MW-1.

4.4.3 Groundwater Flow Velocity

Groundwater flow velocity is determined using the following equation:

$$v = \frac{ki}{n},$$

where v = groundwater flow velocity (cm/sec),
 k = hydraulic conductivity (cm/sec),
 i = hydraulic gradient (feet/foot), and
 n = effective porosity.

The average horizontal hydraulic gradient in the shallow part of the aquifer near MW-3 and MW-5 (as far away from the shallow groundwater mound as possible) on March 15, 2004, was about 0.004 feet/foot. The effective porosity of unconsolidated alluvium similar to that at the site is about 40 percent (Wolff, 1982). Using an effective porosity value of 40 percent, a conservative horizontal hydraulic conductivity range of 3×10^{-3} and 3×10^{-2} cm/sec, and a horizontal gradient of 0.004, the horizontal groundwater flow rate (average linear velocity) in the

shallow part of the aquifer ranges from approximately 30 to 300 feet per year. Higher shallow aquifer flow rates than those may be found near the groundwater mound.

The average horizontal hydraulic gradient in the deep part of the aquifer on March 15, 2004, was approximately 0.0014 feet/foot. Assuming the same range in horizontal hydraulic conductivity at the base of the aquifer as in the shallow part of the aquifer and using an effective porosity value of 40 percent, the horizontal groundwater flow rate (average linear velocity) at the base of the aquifer ranges from approximately 10 to 100 feet per year. Given the lack of influence of the groundwater mound at the base of the aquifer, the horizontal groundwater flow rate at the base of the aquifer may be a better estimate of the overall groundwater flow rate in the aquifer.

4.5 Soil Chemistry

Eighty-one soil samples collected during site investigations were analyzed for VOCs, 66 from direct-push and auger temporary borings and 15 from monitoring well and injection well borings. Table D-1 presents soil VOC detections and a statistical summary of the frequency of detection above the method reporting limit (MRL), the minimum and maximum concentrations, and the range in detection limits (MRLs or MDLs). A discussion of the data relative to cleanup levels and of areas of the site exceeding cleanup levels is provided in Section 6.

Of the 67 compounds quantitated in the VOC analyses, 35 were detected in at least one soil sample. The frequency of detection ranged from 1 percent (1,1,2-trichloroethane, bromodichloromethane, carbon disulfide, and dibromochloromethane) to 65 percent (acetone). Two frequently detected compounds, acetone and methylene chloride (detected in 43 percent of the analyzed soil samples), are common laboratory solvents that are often laboratory-introduced contaminants in VOC analyses; methylene chloride was a common blank contaminant during the project. Some of the low-level acetone and methylene chloride detections may represent laboratory contamination rather than soil contamination. Both acetone and methylene chloride were, however, stored in the former USTs located along the eastern side of the warehouse. Other compounds stored in the former USTs or the former aboveground hazardous waste storage tank that were detected in a significant percentage (i.e., greater than 10 percent) of the analyzed soil samples included:

- PCE, 45 percent;
- Trichloroethene (TCE), 36 percent;
- m- and p-xylenes, 33 percent;
- Toluene, 26 percent;
- o-xylene, 25 percent;
- Ethylbenzene, 25 percent;
- 1,1,1-trichloroethane (TCA), 15 percent; and
- Methyl ethyl ketone (2-butanone or MEK), 12 percent.

Other frequently detected VOCs included breakdown products of PCE, TCE, and TCA:

- cis-1,2-dichloroethene (cis-1,2-DCE), 31 percent;
- Chloroethane, 18 percent;

- 1,1-dichloroethane (1,1-DCA), 16 percent;
- Vinyl chloride, 9 percent; and
- trans-1,2-dichloroethene (trans-1,2-DCE), 8 percent.

Some potential constituents in the petroleum naphtha or mineral spirits that were stored in the former USTs were also detected in a significant percentage of the analyzed soil samples, including:

- 1,2,4-trimethylbenzene (1,2,4-TMB), 23 percent;
- n-propylbenzene, 15 percent;
- 1,3,5-trimethylbenzene (1,3,5-TMB), 14 percent; and
- Isopropylbenzene, 14 percent.

Of the 35 detected compounds, the maximum detected concentrations were in the following ranges:

- Less than 100 µg/kg: 1,1,2-TCA, 1,2-dichloroethane, 4-chlorotoluene, benzene, bromodichloromethane, carbon disulfide, chloroethane, chloroform, hexachlorobutadiene, naphthalene, n-hexane, styrene, and trans-1,2-DCE;
- Between 100 and 500 µg/kg: 1,1-DCA, 1,1-dichloroethene (1,1-DCE), 1,1,1-TCA, 2-butanone (MEK), 4-isopropyltoluene, cis-1,2-DCE, dibromochloromethane, isopropylbenzene, n-butylbenzene, o-xylene, sec-butylbenzene, and vinyl chloride;
- Between 500 and 1,000 µg/kg: ethylbenzene, n-propylbenzene, TCE, and toluene; and
- Greater than 1,000 µg/kg: 1,2,4-TMB, 1,3,5-TMB, acetone, m- and p-xylenes, methylene chloride, and PCE.

VOCs were primarily detected in soil samples collected from two areas of the site: in the area of the former USTs and near MW-5. In the former UST area, soil samples collected from SB-28, SB-29, SB-38, SB-41, and MW-1 had the greatest number of VOC detections. Soil samples collected from SB-8, SB-30, and MW-1 had the highest VOC detections. SB-38 had the most VOC detections in the former UST area, with at least 14 VOCs detected in all samples collected between 3 and 38 feet bgs. The highest VOC detection was 160,000 µg/kg PCE in a soil sample collected at a depth of 6 feet bgs in SB-29. VOCs were not detected in soil samples collected from SB-16 and SB-17. Other temporary borings with relatively few and low-concentration VOC detections included SB-10 and SB-14.

In the MW-5 area, soil samples collected from SB-22, SB-23, and SB-27 had the greatest number of VOC detections, and soil samples collected from SB-19, SB-20, SB-21, SB-24, SB-33, and MW-5 had the highest VOC detections. SB-23 had the most VOC detections in the MW-5 area, with at least eight VOCs detected in both samples collected from the boring. The highest VOC detection was 9,300 µg/kg PCE in a soil sample collected at a depth of 10 feet bgs in INJ-2. VOCs were not detected in soil samples collected from GP-4 and SB-34. Other temporary borings with relatively few and low-concentration VOC detections included GP-6, GP-10, and SB-35. The nature and extent of soil VOCs is discussed in Section 6.1.

Table D-2 presents the soil total organic carbon (TOC) results. TOC ranged from 0.02 to 0.43 percent in the five samples collected from SB-33 and SB-34.

4.6 Groundwater Quality

Four hundred and seventy-six groundwater samples were collected for chemical analysis during site investigations, 113 from temporary borings, and 363 from monitoring wells and injection wells.

4.6.1 **Groundwater Samples Collected From Temporary Borings**

4.6.1.1 VOCs

As discussed in Section 3.1, groundwater samples were collected from temporary borings advanced using either hollow-stem auger or direct-push techniques to investigate the nature and extent of contamination at the site. Samples collected in this manner were intended to give an indication of subsurface contamination at a single point in time and at specific depth intervals, and to provide information for subsequent siting of monitoring wells. Therefore, these results are not discussed in detail because the groundwater monitoring well sample results will be used to determine the extent of impacts at the site. The groundwater results from the temporary borings are used in evaluating the nature and extent of contamination and areas exceeding cleanup levels (Sections 6).

Table D-3 presents VOC detections for the 113 groundwater samples collected from the temporary borings. Of the 67 compounds quantitated in the VOC analyses (Table D-3), 33 were detected in at least one temporary boring groundwater sample. The most commonly detected VOCs in temporary boring groundwater samples were PCE, TCE, cis-1,2-DCE, trans-1,2-DCE, vinyl chloride, 1,1-DCA, chloroethane, methylene chloride, benzene, toluene, ethylbenzene, and total xylenes. Detected VOC concentrations in temporary boring groundwater samples ranged from less than 0.1 µg/L to 36,000 µg/L (cis-1,2-DCE in SB-38 between 30 and 32 feet bgs), with the highest VOC concentrations located in samples collected from SB-9, SB-30, SB-31, and SB-38.

4.6.1.2 TPH, Glycols, and Alcohols

Petroleum naphtha, mineral spirits, glycols, and alcohols were not detected in the groundwater sample collected from SB-10 (Table D-4). TPH-G was detected in SB-10 at the MRL of 0.05 mg/L, however, the laboratory identified the TPH-G detection as ethylbenzene and total xylenes, not petroleum product. TPH-D was detected in SB-10 at 0.42 mg/L, but the laboratory noted that the chromatogram did not match the typical diesel/kerosene fingerprint. It is likely that the TPH-D results represented the influence of the other detected VOCs at the site.

4.6.1.3 TOC

TOC in groundwater samples collected from SB-21, SB-22, and SB-25 ranged from 8.2 to 30.2 mg/L (Table D-5). The highest concentrations were in SB-22, and the lowest concentrations were in SB-21.

4.6.2 Groundwater Samples Collected From Monitoring Wells

Table D-6 provides VOC detections for groundwater samples collected from monitoring and injection wells. Table D-6 also includes a statistical summary of the frequency of detection above the MRL or method detection limit (MDL), the minimum and maximum concentrations, and the range in detection limits. Tables D-7 through D-11 present groundwater results, for samples collected from the monitoring wells, for TPH, glycols and alcohols, general chemistry parameters, dissolved organic gases, and field parameters.

4.6.2.1 VOCs

Of the 67 compounds quantitated in the VOC analyses, 40 were detected in at least one groundwater sample. Of the detected compounds, the frequency of detection ranged from 1 percent (styrene) to 80 percent (cis-1,2-DCE). Other compounds stored in the former USTs or former aboveground hazardous waste storage tank that were detected in a significant percentage of the analyzed groundwater samples included:

- TCE, 53 percent;
- PCE, 49 percent;
- Toluene, 49 percent;
- Benzene, 32 percent;
- Ethylbenzene, 28 percent;
- Total xylenes, 29 percent;
- Methylene chloride, 22 percent;
- Trichlorotrifluoroethane, 22 percent (only 9 samples, though);
- TCA, 15 percent;
- Hexane, 13 percent;
- Chloroform, 10 percent; and
- Acetone, 9 percent.

As stated in Section 4.5, some of the low-level acetone and methylene chloride detections may represent laboratory contamination rather than groundwater contamination. Other frequently detected VOCs included the breakdown products of PCE, TCE, and TCA:

- cis-1,2-DCE, 80 percent;
- 1,1-DCA, 57 percent;
- trans-1,2-DCE, 43 percent;
- Vinyl chloride, 43 percent;
- Chloroethane, 43 percent; and
- 1,1-DCE, 24 percent.

Some potential constituents in the petroleum naphtha or mineral spirits that were stored in the former USTs were also detected in a significant percentage of the analyzed groundwater samples, including:

- 1,2,4-TMB, 22 percent;
- 1,3,5-TMB, 22 percent;
- n-propylbenzene, 21 percent;
- Isopropylbenzene, 21 percent; and
- 4-isopropyltoluene, 12 percent.

Of the 40 detected VOCs, the maximum detected concentrations were in the following ranges:

- Less than 10 µg/L: 1,2-dichloroethane, 1,2-dichloropropane, 1,2,3-trichloropropane, 2-chlorotoluene, 4-chlorotoluene, 4-isopropyltoluene, chlorobenzene, dichlorodifluoromethane, hexachlorobutadiene, naphthalene, and sec-butylbenzene;
- Between 10 and 100 µg/L: 2-nitropropane, carbon disulfide, chloroform, hexane, methylene chloride, MIBK, n-butylbenzene, styrene, trans-1,2-DCE, and trichlorotrifluoroethane;
- Between 100 and 1,000 µg/L: 1,1-DCE, 1,2,4 trichlorobenzene, 1,2,4-TMB, 1,3,5-TMB, benzene, isopropylbenzene, n-propylbenzene, and MEK; and
- Greater than 1,000 µg/L: 1,1-DCA, cis-1,2-DCE, acetone, chloroethane, ethylbenzene, PCE, TCA, TCE, toluene, total xylenes, and vinyl chloride.

4.6.2.2 Total Petroleum Hydrocarbons

Petroleum naphtha and mineral spirits were not detected in any groundwater sample.

TPH-G was detected in MW-1, MW-4, MW-5, MW-6, MW-8, MW-9, MW-11, and MW-12; TPH-G detections ranged from 0.024 mg/L in MW-8 (July 2001) to 54 mg/L in MW-1 (April 1995). The highest and most consistent TPH-G detections were in MW-1 and MW-4, both of which are located in the vicinity of the former USTs. It was detected at low concentrations in MW-11 and MW-12 the only time it was analyzed (January 2002) and was detected in MW-5 between December 2000 and January 2002. Between June 2000 and January 2002, the TPH-G detections in MW-1, MW-4, MW-5, MW-11, and MW-12 were qualified by the laboratory as being atypical. The laboratory noted that the TPH-G chromatograms either did not resemble a petroleum product or did not match the calibration standard. Given that Univar did not store or handle gasoline at the facility and that the sample TPH-G chromatograms did not match a gasoline chromatogram, it is likely that other low-molecular-weight VOCs handled in the USTs and detected in the groundwater samples (e.g., toluene, ethylbenzene, and xylenes) could have yielded the positive TPH-G results. The infrequent detections of TPH-G below the MRL in MW-6, MW-8, and MW-9 were likely due to analytical noise and did not represent reliable detections.

TPH-D was detected infrequently in deep well MW-13 and every shallow well but INJ-2. The diesel detections ranged from 0.02 to 1.6 mg/L and sorted into two categories. Either the detections were qualified as estimates because they were below the MRL, or the laboratory noted that the diesel detections were atypical. It is likely that the low-level results (below the MRL) represented analytical noise rather than reliable detections. The laboratory explanations of the atypical results included that the diesel chromatogram did not resemble a petroleum product, the

chromatogram included a greater amount of lighter molecular weight constituents than expected for a diesel product, or the chromatogram did not match the calibration standard. It is possible that the data qualified by the laboratory as being atypical represented the influence of the other detected VOCs at the site rather than reliable petroleum hydrocarbon results.

TPH-O was only detected above the MRL in one sample, the September 1996 groundwater sample from MW-4. According to the laboratory, the MW-4 TPH-O chromatogram detection did not match the typical oil fingerprint; it likely represents overlap from the diesel-range petroleum hydrocarbons detected in the same sample. The other infrequent detections of TPH-O (in MW-1 through MW-4, MW-6 through MW-10, and MW-12) were likely due to analytical noise and did not represent reliable detections.

4.6.2.3 Glycols and Alcohols

The results of the December 1996 analysis for glycols and alcohols are presented in Table D-8. Ethylene glycol, propylene glycol, ethanol, and 1-butanol were not detected in any sample. Isopropanol was only detected in the MW-1 groundwater sample at 0.147 mg/L. Because the December 1996 glycol and alcohol results were so low, subsequent sampling events did not include these parameters.

4.6.2.4 General Chemistry Parameters

Groundwater inorganics data are presented in Table D-9. The data varied as follows:

- Chloride: 5.4 to 340 mg/L;
- Nitrate: less than 0.2 to 2.5 mg/L;
- Sulfate: less than 0.2 to 183 mg/L;
- Sulfide: less than 0.001 to 0.88 mg/L;
- Total alkalinity: 145 to 900 mg/L;
- Total organic carbon (TOC): 4.8 to 62.4 mg/L;
- Total iron: 0.1 to 222 mg/L;
- Ferrous iron: 0.008 to 125 mg/L;
- Total manganese: 0.34 to 9.89 mg/L; and
- Total dissolved solids: 332 to 1,260 mg/L.

A few observations are notable. The chloride concentrations were highest in samples collected from MW-1 and MW-4, and the TOC and iron concentrations were highest in samples collected from MW-1, MW-2, MW-3, and MW-6.

4.6.2.5 Dissolved Organic Gases

Dissolved methane ranged from less than 0.0005 mg/L to 18 mg/L, dissolved ethane varied from less than 0.0005 mg/L to 1.5 mg/L, and dissolved ethane ranged from less than 0.0005 mg/L to 0.13 mg/L. The highest concentrations of dissolved organic gases were found in MW-1, MW-4, and MW-6 (Table D-10), and the lowest concentrations of these gases were found in MW-5, MW-7, and MW-8.

4.6.2.6 Field Parameters

Groundwater field parameter data are presented in Table D-11. The data varied as follows:

- pH: 5.25 to 7.51 pH units, with a typical pH between 6.0 and 7.0 pH units;
- Specific conductance: 137 to 5000 $\mu\text{S}/\text{cm}$, with a typical value between 200 and 1,500 $\mu\text{S}/\text{cm}$;
- Temperature: 8.2 to 20.2 $^{\circ}\text{C}$;
- Turbidity: 0.7 to greater than 1,000 NTU, with typical values less than 20 NTU;
- Dissolved Oxygen: less than 0.1 to 8.9 mg/L; and
- Oxidation-reduction potential (ORP): -475 to 281 millivolts.

A few observations are notable. The specific conductance measurements were highest in wells in the MW-1/MW-4 area, although the specific conductance trends are downward in these wells. Temperature measurements were lowest in March and highest in September. ORP measurements were generally higher in wells in the MW-5 area than elsewhere on site.

4.6.2.7 VOC Time Trends

Time-trend plots for selected VOCs were prepared for MW-1, MW-4, and MW-5 covering 1995 through March 2004. Time-trend plots for BTEX in MW-1 and MW-4 are presented in Figures 9 and 10, respectively. Time-trend plots for PCE and TCA and their degradation products in MW-1 and MW-4 are presented in Figures 11 through 14, respectively. A time-trend plot for PCE and its degradation products in MW-5 is presented in Figure 15. Time trends were either not apparent for other wells and other constituents or not enough data are yet available to make a trend determination.

During the period of record, benzene, toluene, and ethylbenzene concentrations in MW-1 decreased. After an increase between 1995 and 1998, total xylene concentrations in MW-1 have also decreased. The concentrations of benzene, and toluene in MW-4 decreased during the period of record. The concentrations of ethylbenzene in MW-4, after an initial increase between 1996 and 1998, have remained relatively stable. Though the total xylene concentrations in MW-4 were quite variable, no discernable trend was observed.

PCE, TCE, and cis-1,2-DCE concentrations trended downward in MW-1 between 1995 and 1998 and have leveled off since then. During the period of record, the MW-1 vinyl chloride concentrations have been variable but with no discernable trend. MW-1 TCA and 1,1-DCA concentrations were, with some fluctuation, relatively stable during the period of record. The MW-1 1,1-DCE concentrations trended downward between 1995 and 1997 and have had no trend since then. The MW-1 chloroethane concentrations have trended downward during the period of record.

PCE was detected only once in MW-4 between 1994 and 1998. During the period of record, the MW-4 TCE frequency of detection was less than 50 percent, with a slight downward trend of the TCE concentrations, and the cis-1,2-DCE and vinyl chloride concentrations were low with a general downward trend. TCA was only detected in MW-4 in low concentrations in 1997 and

1998, and 1,1-DCE has never been detected in MW-4. Chloroethane and 1,1-DCA have been detected in MW-4 in every sampling event, but the concentrations of each have trended downward during the period of record.

PCE, TCE, and cis-1,2-DCE concentrations trended downward in MW-5 during the period of record. The number of vinyl chloride detections in MW-5 was insufficient for trend analysis.

4.6.3 Contaminant Distribution in Groundwater

4.6.3.1 VOCs

Figures 16 and 17 present the total VOCs concentrations in groundwater samples collected from both temporary borings and monitoring wells. Total VOCs in samples collected between 4 and 30 feet bgs are shown on Figure 16, and total VOCs in samples collected between 30 and 45 feet bgs are depicted on Figure 17. The June 2003 monitoring well data was used to match the most recent large set of temporary boring data. If multiple samples were collected from a temporary boring in a plotted depth range, the highest total VOC concentration was used. The nature and extent of specific groundwater VOCs are discussed in Section 6.2.

Shallow Groundwater (4 to 30 feet bgs). In the shallow borings and monitoring wells, the highest total VOC concentrations were located in the area immediately east of the eastern loading dock. The total VOC concentrations at 3 locations (SB-9, SB-31, and SB-38) were above 10,000 $\mu\text{g/L}$, and the total VOC concentrations at 15 locations were above 1,000 $\mu\text{g/L}$. The 1,000 $\mu\text{g/L}$ contour line encompasses both of these areas, giving the impression that one plume exists. Based on the VOCs detected in samples collected in the areas, it appears that two plumes exist, one centered in the former UST area near MW-1 and MW-4 and a second centered in the area near MW-5. The dominant VOCs in the MW-1/MW-4 area are toluene, ethylbenzene, total xylenes, TCA and its breakdown products, and the breakdown products of PCE and TCE. The primary VOCs in the MW-5 area are PCE and TCE. BTEX constituents and TCA (and breakdown products) are not detected or detected near the MRL in the MW-5 area. Temporary boring SB-27 represents a transitional boring between the two plumes, with moderate concentrations of PCE/TCE breakdown products and low concentrations of BTEX. The distribution of the two plumes displays the influence of the shallow groundwater mound and the radial flow from the MW-1/MW-4 area.

It should be noted that the elevated VOC concentrations (primarily BTEX) detected in GP-2 (northeast corner of the site) in 1997 were likely due to plume migration from the adjacent, upgradient service station. As discussed in Section 1.2, groundwater flow at the service station was documented to be to the northwest and groundwater BTEX concentrations at the service station in the mid-1990s were in the low mg/L range. The most recent available benzene concentrations (compliance monitoring data collected in 2001 and 2002) in nearby off-site monitoring well EMW-7 were below the laboratory MRL in 2001 and 2002, compared to a benzene concentration of 162 $\mu\text{g/L}$ as recently as July 1996. Based on these results, it is likely that benzene concentrations at the GP-2 location have also decreased below laboratory MRLs.

Deep Groundwater (30 to 45 feet bgs). In the deep borings and monitoring wells, the highest total VOC concentrations were located in the area under and immediately north of the eastern loading dock. The total VOC concentration at one location (SB-38) was above 100,000 µg/L, and the total VOC concentrations at four other locations (SB-30, SB-31, MW-13, and MW-18) were above 10,000 µg/L. The dominant VOCs in the plume at the base of the aquifer are toluene, ethylbenzene, total xylenes, TCA and its breakdown products, and the breakdown products of PCE and TCE. PCE and TCE were detected in the deepest SB-38 sample, but these detections have not been confirmed through subsequent monitoring of deep well MW-13. The distribution of the plume reflects the influence of the northwesterly deep groundwater flow and lack of influence of the shallow groundwater mound.

Potential Contaminant Sources. Since the VOC results in all of the samples collected in the vertical profile at SB-38 were relatively elevated, it is likely that SB-38 is closest to the primary MW-1/MW-4 area source. While groundwater samples at shallow and intermediate depths in SB-30 and SB-31 contained moderately elevated concentrations of VOCs, the highest VOC concentrations at these locations were at the base of the aquifer, indicating that the primary source is upgradient of these locations.

The relatively elevated VOC results from GP-7, SB-21 through SB-24, SB-27, SB-32, and SB-33 confirm that a VOC source lies in the MW-5 area. VOC detections in samples collected in vertical profiles in the MW-5 area show a significant decrease in VOC concentrations between depths of 15 and 25 feet bgs, indicating a shallow source in the area. Except for SB-33 and SB-34, located on the downgradient side of the MW-5 area, the highest VOC concentrations at a given location were in the shallowest samples collected.

4.6.3.2 Total Petroleum Hydrocarbons

As discussed in Section 4.6.2.2, the only potentially reliable TPH detections were in the diesel range. The highest and most consistent TPH-D detections were in the former UST area near MW-1 and MW-4.

5.0 CONCEPTUAL SITE MODEL AND MEDIA CLEANUP STANDARDS

This section describes contaminant sources, processes that affect contaminant fate and migration, potential receptors that may be impacted due to exposure to site-related contamination, site conceptual model, and media cleanup standards.

5.1 Contaminant Sources

Based on a review of historical information regarding site operations (Section 1.2) and the distribution of contaminants at the site (Section 4.0), it appears that the sources of contamination at the site were unknown releases in the area of the 37 former product storage USTs (MW-1/MW-4 plume) and near MW-5 (Figure 2). Possible release mechanisms for contamination at the MW-1/MW-4 plume include leaks from transfer piping, overfilling of USTs, minor surface spills of raw products, or possibly minor leakage from the USTs. The source of the

contamination at MW-5 is unknown, but based on adjacent soil probe data and plume chemistry, the source was likely adjacent to MW-5 and appears to be different from the MW-1 plume.

The primary contaminants (i.e., frequency of detection in either soil or groundwater greater than 20 percent) at the site appear to be PCE, TCE, BTEX, methylene chloride, 1,2,4-TMB, 1,3,5-TMB, n-propylbenzene, and isopropylbenzene. Other constituents present at significant concentrations included TCA and PCE, TCE, and TCA degradation products (cis-1,2-DCE, trans-1,2-DCE, 1,1-DCE, 1,1-DCA, vinyl chloride, and chloroethane).

5.2 Contaminant Fate and Transport

This section describes the physical, chemical, and biological processes that influence site-related contaminant migration through the subsurface.

5.2.1 Contaminant Fate Processes

Several physical, chemical, and biological processes affect the mobility and behavior of liquid- (or pure-) phase and vapor-phase contaminants in the unsaturated zone and dissolved- or pure-phase contaminants in the saturated zone. These processes can generally be classified into two categories: nondestructive and destructive. Nondestructive processes primarily affect contaminant mobility and behavior, but do not alter the chemical composition of the contaminant. Destructive processes either destroy the contaminant or change the chemical behavior. Both processes can result in effective decreases in contaminant concentration.

5.2.1.1 Nondestructive Processes

The nondestructive processes controlling the contaminant migration rate at the site are sorption, dispersion, volatilization, dissolution, and dilution. These are defined as follows:

- Sorption is the chemical bonding of contaminants to soil particles, which slows the rate of soil vapor and pure-phase contaminant migration in the unsaturated zone and the rate of dissolved- and pure-phase contaminant migration in the saturated zone. Sorption effects are directly related to soil organic carbon content. Based on the amount of silt and organic matter in the aquifer, sorption may slow the rate of contaminant transport at the site.
- Dispersion is the longitudinal and transverse spreading of contaminants as they move through a porous media. Dispersion spreads out the contaminant plume, which slows the migration rate and decreases the contaminant concentration of the plume boundary. Dispersion occurs when variations in soil pore size, pore "roughness", and particle flow path length results in different advective transport rates for different solute molecules. Dispersion is most significant in stratified soil zones. Its effects increase with flow path length. A narrow, high concentration plume near the source area will become a broad, low concentration plume several hundred feet from the source area. Dispersion may be significant in siltier portions of the aquifer.

- Volatilization occurs when pure-phase contaminants in the unsaturated soil or dissolved-phase contaminants in groundwater transfer into the vapor-phase in unsaturated soil. Volatilization from groundwater occurs only at the water table. Volatilization rates depend on the relative volatility of the contaminant (PCE is moderately volatile, while benzene and vinyl chloride are highly volatile). Volatilization may be significant at the site if high soil and groundwater contaminant concentrations detected during site investigations are located beneath occupied buildings.
- Dissolution occurs when pure-phase contaminants transfer into the dissolved-phase in soil pore water above the water table or into groundwater below the water table, and when vapor-phase contaminants transfer into groundwater at the water table. This process depends on the relative solubility of the contaminant (PCE is moderately soluble, and benzene and vinyl chloride are highly soluble).
- Dilution occurs when relatively cleaner water from natural or artificial sources infiltrates through the unsaturated soil and mixes with contaminated groundwater resulting in lower contaminant concentrations. Because the Univar Kent facility is completely paved, significant natural dilution is likely limited.

The nondestructive processes described above are generally active at the site. They do not appear to significantly retard or attenuate contaminants at the site except in siltier parts of the aquifer. Dissolution of adsorbed VOCs likely generates most of the dissolved VOCs in the subsurface.

5.2.1.2 Destructive Processes

Destructive processes are either biotic (biodegradation) or abiotic. Biodegradation includes all microbial activity occurring in the subsurface that permanently destroys contaminants. Abiotic processes include various chemical reactions, primarily hydrolysis, that destroy contaminants. Biodegradation processes are generally much more significant than abiotic processes; thus, only the biodegradation processes are discussed.

Microbial metabolic degradation of chlorinated VOCs (CVOCs) PCE, TCE, and TCA occurs under both aerobic and anaerobic conditions. Aerobic metabolism includes direct oxidation of CVOCs as an energy source, and fortuitous degradation of CVOCs (co-metabolism) during metabolism of other organic compounds. Under anaerobic conditions, CVOCs are degraded by reductive dechlorination (the sequential removal of chlorine atoms from an CVOc molecule), which is primarily a co-metabolic process (De Bruin et al., 1992; Freedman and Gossett, 1989; McCarty, 1994). Figure 18 shows the sequential dechlorination steps from primary CVOcs to secondary CVOcs to organic gases (e.g., ethene) and other breakdown products.

Anaerobic reductive dechlorination is defined as the degradation of a compound in the absence of oxygen; thus, only in the presence of other organic material that serves as the primary energy source (McCarty, 1987). Bacterial metabolism under anaerobic conditions requires both electron acceptor and electron donor compounds. Electron donors (primary energy sources or substrates) include organic compounds such as readily degradable sugars, volatile fatty acids (e.g., acetate,

lactate), naturally occurring organic matter, and alcohols, or longer chain aliphatic and aromatic hydrocarbons (petroleum fuels). Under anaerobic conditions, electron acceptors include (in order of decreasing metabolic energy yield) nitrate, manganese (V), iron (III), sulfate, and carbon dioxide. During anaerobic reductive dechlorination, CVOCs (i.e., PCE, TCE, DCE, and vinyl chloride) may increasingly serve as an electron acceptor, particularly as the naturally occurring electron acceptors are consumed by microbial metabolism. Degradation of both petroleum hydrocarbons and CVOCs may occur simultaneously during reductive dechlorination. Anaerobic reductive dechlorination is most favorable under methanogenic conditions (high methane concentrations). Anaerobic reductive dechlorination efficiency decreases as chlorine atoms are removed, PCE is most readily degraded, and vinyl chloride is the most recalcitrant. Vinyl chloride, however, may be degraded aerobically with oxygen as an electron acceptor, or co-metabolically under aerobic conditions in the presence of methane and the Fe^{3+} ion.

Table 5 summarizes the results of a previous evaluation (IT Corporation, 2000) of the biodegradation potential for CVOCs in both VOC plumes using to the Air Force Center for Environmental Excellence protocol (Wiedemeier et al., 1998). Based on geochemical conditions of the shallow MW-1/MW-4 plume, there is strong evidence for biodegradation occurring in this area. This evidence includes low dissolved oxygen, nitrate, sulfate, ferric iron, and carbon dioxide concentrations, and high TOC, ammonia, sulfide, ferrous iron, methane, and degradation daughter product concentrations (DCE, vinyl chloride, and ethene). Based on the MW-5 data; however, there is insufficient evidence for biodegradation occurring in the second plume. The net result of this natural attenuation (along with the other factors discussed) is that the high contaminant concentrations in groundwater in the MW-1/MW-4 source area decrease by one to four orders of magnitude in downgradient wells MW-2, MW-3 and MW-6 (Table D-6, Appendix D). For example, total DCE concentrations are approximately 400 $\mu\text{g/L}$ at MW-1 and less than 1.5 $\mu\text{g/L}$ in MW-2, MW-3, and MW-6, which are located from 150 to 330 feet downgradient.

5.2.2 Migration Mechanisms and Pathways

Residual contaminants residing in saturated and unsaturated soil may be further mobilized by flow of water or air in the subsurface. Several migration processes are likely to occur, and are described below.

5.2.2.1 Unsaturated Soil

Contaminants occur in unsaturated soil primarily in and around the source area. All of this soil lies beneath existing buildings or pavement. The following migration mechanisms have been identified:

- **Leaching to Groundwater.** The process includes infiltration of natural precipitation through unsaturated soil, dissolution of pure-phase contaminants or flushing of soil pore water contaminants into the water, and transport of the contaminants to the saturated zone. This process is not considered a significant migration pathway at the site because all unsaturated soil in the source areas is located beneath loading docks or pavement.

- **Pure Phase Flow.** Pure-phase chemical product released at the surface, from USTs, piping, or surface spills would have migrated downward due to gravity through unsaturated soil. This pathway was probably the primary contaminant migration route at the MW-1/MW-4 plume during active chemical storage in USTs at the site. Because the USTs were removed 15 years ago, it is likely that all pure-phase VOCs originally released into the unsaturated zone have migrated into the saturated zone, adsorbed onto unsaturated soil, or volatilized. The one exception is PCE, which was detected in a single soil sample (SB-29 at 6 feet bgs) at a concentration of 160 mg/kg, which exceeds the soil saturation limit of 110 mg/kg. The soil data around boring SB-29 indicates that this PCE concentration has a limited vertical and horizontal extent. At the MW-5 plume, it is also likely based on the low to moderate concentrations of PCE detected in soil (less than 3.5 mg/kg), that pure-phase VOCs originally released into the unsaturated zone have either migrated into the saturated zone, adsorbed onto unsaturated soil, or volatilized. Therefore, pure-phase migration in the unsaturated soil is not considered an active migration pathway.
- **Diffusion.** Diffusion is driven by chemical concentration gradients, and is the primary mechanism for vapor transport in unsaturated soil where soil vapor is usually stagnant. Diffusion is not considered an active migration pathway due to the low PID readings observed in the unsaturated zone during drilling.

5.2.2.2 Groundwater and Saturated Soil

Volatile organic compounds were originally released into the subsurface either during UST operations or from near-surface spills of pure-phase VOCs that subsequently migrated downward to the water table. VOCs may be currently adsorbed to soil surfaces or contained within the saturated soil matrix in the form of isolated or interconnected, residual droplets (ganglia). Based on the moderate concentrations of VOCs detected in saturated soil (i.e., PCE concentrations less than 10 mg/kg), low concentrations of dissolved VOCs in groundwater relative to their solubility limits, and no visual or PID evidence of VOC residual droplets detected during drilling, it is likely that VOCs are primarily found adsorbed to soil surfaces in the saturated zone and little to no VOCs as residual droplets are present. Volatile organic compounds in the saturated soil matrix slowly dissolve into the groundwater at rates depending on the VOC solubility and composition. Dissolved contaminants then migrate by advection with groundwater. Advective flow rates and pathways are influenced by seasonal changes in hydraulic gradient. During the drilling and sampling of soil borings, piezometers, and monitoring wells at the site, no evidence of pure-phase VOCs was documented.

5.3 Exposure Pathways and Receptors

This section evaluates the potential exposure pathways and receptors that may be impacted by contaminants present at the site. Figure 19 presents the conceptual site model (CSM), which is based on the current and future industrial land use, the results of the water supply well search (Section 2.6), the soil and groundwater sampling results described in Section 4, and the active and potentially active fate and transport mechanisms described previously.

5.3.1 Soil

Currently, buildings, covered docks, or asphalt pavement covers the vast majority of the site. Site characterization data indicates that contaminants are present in unsaturated and saturated soil to depths of 10 feet bgs beneath the east loading dock/pavement area where the former USTs were located (MW-1/MW-4) and beneath the paved area near MW-5. Current and potential future exposure pathways and receptors for contaminants in soil include the following:

- Exposure to site workers through direct contact with contaminated soil during site maintenance activities that disturb the existing structures or pavement (i.e., soil excavation). This is a current pathway;
- Exposure to site office workers through inhalation of vapors originating from contaminated soil and migrating up through the building floor. This is an incomplete pathway as there is currently no contaminated soil beneath the office occupied portions of the site structures; and
- Exposure to site workers or off-site residents/workers through consumption of groundwater that is impacted by leaching of contaminants in site soil. This is currently an incomplete pathway because there are currently no groundwater supply wells on the site or within 1-mile downgradient of the site, and contaminated groundwater is primarily contained within the site boundaries. This is a potential future pathway of concern.

Because the contaminated soil is located entirely beneath the covered dock and pavement areas of the site, there is no potential for exposure to terrestrial ecological receptors. Furthermore, the site qualifies for an exclusion from a terrestrial ecological evaluation in accordance with the requirements of WAC 173-340-7491(c). Specifically, there is no area of contiguous undeveloped land on the site or within 500 feet of the contaminated soil (requirement is less than 1.5 acres) and the site does not contain any of the hazardous substances of concern listed in WAC 173-340-7491(1)(c)(ii).

5.3.2 Groundwater

As described in Section 2.6, 16 water supply wells may be located within a 1-mile radius of the Univar Kent site. None of the wells are located downgradient of the site and all are deeper wells (ranging in depth from 55 to 522 feet). The closest well (321 feet deep) to the site is located 1,100 feet to the south-southeast (upgradient). A number of the wells are used for domestic water supply. Groundwater flow eventually discharges into Mill Creek, approximately 2,000 feet downgradient to the northwest. However, based on the low VOC concentrations in MW-3 and the distance to the creek, Mill Creek is not a likely potential receptor. Although the closest groundwater wells are located nearly ½ mile either cross gradient or upgradient of the site and likely in a deeper aquifer than the shallow aquifer beneath the site, a drinking water scenario was identified as the reasonable maximum exposure (RME) scenario for groundwater. Current and potential future exposure pathways and receptors for contaminants in groundwater include the following:

- Exposure to site workers or off-site residents/workers through consumption of contaminated groundwater originating from the site. This is currently an incomplete pathway because there are currently no groundwater supply wells on the site or within 1-mile downgradient of the site, and contaminated groundwater is primarily contained within the site boundaries. This is a potential future pathway of concern; and
- Exposure to site office workers through inhalation of vapors originating from contaminated shallow groundwater and migrating up through the building floor. This is an incomplete pathway as there is currently no contaminated groundwater beneath the office occupied portions of the site structures, including the small office located in the northeast corner of the warehouse.

5.4 Media Cleanup Standards

MTCA defined cleanup standards (WAC 173-340-700(2)) are composed of three separate components: cleanup levels, points of compliance, and additional regulatory requirements. Cleanup levels and points of compliance are the two primary components and are described in the following sections. The additional regulatory requirements that may apply to specific cleanup actions are addressed when cleanup action alternatives are selected.

5.4.1 Selection of Indicator Hazardous Substances

The investigation results indicate that over 40 individual VOCs, TPH-G, TPH-D, and TPH-O have been detected in soil and/or groundwater samples collected from the site. As discussed in Section 4.6, the detection of petroleum hydrocarbons appears to be related to the presence of other lighter weight VOCs detected in the same samples and likely does not represent reliable detections. Therefore, further evaluation of cleanup levels for petroleum hydrocarbons is not warranted.

The list of individual VOCs detected in soil and groundwater was screened to identify potential indicator hazardous substances (IHSs) and to eliminate those constituents that do not contribute significantly to the risk associated with the site from further consideration in the FS. The potential IHSs were identified in several steps consistent with the requirements provided in WAC 173-340-703. The frequency of detection (FOD) was used initially to identify those compounds that were consistently detected in soil and groundwater at the site; constituents with a FOD of 10 percent or greater in either soil or groundwater were retained as potential IHSs. The remaining compounds (FOD < 10 percent) were evaluated for selection as IHSs based on their geographic distribution, toxicity, mobility (i.e., persistence or ability to migrate in the environment), and, co-location and relative concentration with other IHSs. For example, a low toxicity compound that was detected infrequently and co-located with another IHS at relatively high concentration was eliminated as a potential IHS.

Tables D-1 and D-6 (Appendix D) provide the FOD, number of samples in which the analyte was detected, and the maximum and minimum detected concentrations. Tables 6 and 7 summarize the IHS screening for VOCs detected in soil samples and monitoring well groundwater samples from the site including the FOD and the rationale for either selecting or

eliminating the compound as a potential IHS. The potential IHSs retained for cleanup level evaluation are listed in Table 8.

5.4.2 Calculation of Cleanup Levels

Soil and groundwater cleanup levels were calculated for each of the VOCs listed in Table 8 based on the current or future complete pathways identified in the CSM (Figure 19). The basis for the soil and groundwater cleanup levels is presented below.

5.4.2.1 Groundwater Cleanup Levels

Because active water wells exist within a 1-mile radius of the site, the highest beneficial use of groundwater in the vicinity of the site is as drinking water. Therefore, groundwater cleanup levels were calculated using the Method B risk assessment equations in WAC 173-340-720(4) and Ecology's "*Workbook for Calculating Cleanup Levels for Individual Hazardous Substances*" (version MTCASGL10). The toxicological, physical, and chemical input parameters used in the workbook were updated from those provided in Ecology's CLARC Version 3.1 (Publication No 94-145, updated November 2001) by reviewing the current information source cited in CLARC as of August 2004. In addition, the USEPA's Region 9 2002 table of preliminary remediation goals was used to obtain toxicological data that was not available in the other sources. Table E-1 (Appendix E) summarizes the workbook input parameters for each VOC in groundwater identified as a potential IHS (Table 7), and Table 8 provides the Method B groundwater cleanup levels. Table 8 does not provide a cleanup level for 4-isopropyltoluene (FOD of 12 percent) because no toxicological parameters were available.

The Method B groundwater cleanup levels were compared to the available Federal Maximum Contaminant Levels (MCL; 40 Code of Federal Regulation 141) in Table 8. The lower of the Method B cleanup level and the MCL was selected as the final groundwater cleanup level (Table 8) unless the cleanup level was lower than the lowest MRL (i.e., PQL) reported by the analytical laboratory. The MRL for one constituent (vinyl chloride) was higher than the cleanup level. Per WAC 173-340-707(2):

"...the cleanup level shall be considered to have been attained, subject to subsection (4) of this section, only when the more stringent of the following conditions are met: (a) the practical quantitation limit is no greater than ten times the method detection limit; or (b) the practical quantitation limit for the particular hazardous substance, medium, and analytical procedure is no greater than the practical quantitation limit established by the United States Environmental Protection Agency and used to establish requirements in 40 CFR 136, 40 CFR 141 through 143, or 40 CFR 260 through 270."

Since the Method B cleanup level for vinyl chloride (0.0291 µg/L; see Table 8) is well below the lowest MRL reported by the laboratory (0.5 µg/L; see Table D-6), the final cleanup level for vinyl chloride has been set at a PQL of 0.5 µg/L (Table 8). This PQL is approximately two times the MDL and well below the USEPA PQL of 5 µg/L, consistent with the requirements of WAC 173-340-707(2).

Groundwater cleanup levels protective of indoor air were not calculated because this pathway is not complete at the site. The extent of VOCs in groundwater at the site extends beneath paved parking areas and open concrete dock areas where there are typically no indoor workers. There is an office located in the northeast corner of the warehouse, however, the VOC plume does not appear to extend beneath this area to any significant degree.

5.4.2.2 Soil Cleanup Levels

The current asphalt pavement and concrete docks prevent site workers from contact with contaminated soil. In addition, vapors originating from contaminated soil are unlikely to migrate to indoor air because of their location generally beneath the dock and pavement areas that are distant from the occupied buildings at the site. However, there is a potential that future excavation activities could result in direct contact with contaminated soil and infiltration of rainfall could cause soil contamination to migrate to groundwater. Soil cleanup levels were calculated to protect site workers based on direct contact (ingestion and dermal contact) and to protect groundwater. The direct contact cleanup levels were calculated using the Method C risk assessment equations in WAC 173-340-745, the input parameters summarized in Table E-1, and Ecology's workbook for calculating cleanup levels (MTCASGL10). Soil cleanup protective of groundwater were calculated using the procedures identified in WAC 173-345-747, the MTCASGL10 workbook, the physical and chemical properties provided in either Table E-1 or the default parameters in the workbook, and final groundwater cleanup levels identified in Table 8. The soil saturation limit was also calculated using Ecology's MTCASGL10 workbook.

The soil cleanup levels are summarized in Table 8 for each VOC in soil identified as a potential IHS (Table 6). The lowest concentration for the Method C (direct contact), soil leaching, and soil saturation limits was selected as the final soil cleanup level, unless the cleanup level was lower than the lowest MRL reported by the analytical laboratory. Except for four compounds, the final cleanup level was based on the soil-leaching pathway. The final soil cleanup levels for 1,2-dichloropropane (1,2-DCP), 1,2-DCA, benzene, and vinyl chloride are based on the lowest MRL (PQL) reported by the analytical laboratory.

5.4.3 **Points of Compliance**

The point of compliance refers to the point or points where cleanup levels will be attained. For soil, the point of compliance is throughout the site at depths of 0 to 15 feet bgs. For groundwater, the point of compliance is generally the affected portion of the aquifer throughout the site.

5.5 Constituents Detected Above Cleanup Levels

Table 9 compares the final cleanup levels to the maximum concentrations of VOCs detected in soil and groundwater (2003 monitoring well data) at the site. Of the 25 compounds with cleanup levels, 6 VOCs exceeded their cleanup levels in soil, and 17 VOCs exceeded their cleanup levels in groundwater. The VOCs that exceeded soil cleanup levels also exceeded their groundwater cleanup levels. It is also interesting to note that with one exception, the maximum soil VOC concentrations in Table 9 were below the Method C (direct contact) and soil saturation limits.

The exception was PCE, where the maximum concentration detected (in a single sample) exceeded the soil saturation limit of 110 mg/kg.

6.0 NATURE AND EXTENT OF CONTAMINATION

This section describes the nature and extent of soil and groundwater contamination relative to the site cleanup levels.

6.1 Soil

As outlined in Table 9, the final soil IHSs for the Univar Kent site are PCE, TCE, vinyl chloride, 1,1-DCE, methylene chloride, and benzene. Figures 20 and 21 present the areas of the site above the soil cleanup levels for the vadose zone (0 to 8 feet bgs) and saturated zone (>8 feet bgs), respectively. Included on the figures are tables of soil data for the six soil IHSs; on the tables, detections above the site soil cleanup levels are shown in bold numbers. To be conservative, the maximum thickness of the vadose zone was used. The noted areas above the site soil cleanup levels encompass temporary borings and monitoring wells with at least one detection above a cleanup level for one of the six soil IHSs. As shown on Figures 20 and 21, three areas of the site were above the site soil cleanup levels.

6.1.1 MW-1/MW-4 Area

IHSs detected above the site soil cleanup levels were limited to the vadose zone and the saturated zone below a depth of 25 feet bgs. In the vadose zone, VOCs were detected above soil cleanup levels in:

- SB-8 (methylene chloride at 6 feet bgs);
- SB-28 (PCE and methylene chloride at 5 feet bgs);
- SB-29 (PCE, TCE, and methylene chloride at 6 feet bgs);
- SB-38 (vinyl chloride, 1,1-DCE, and benzene at 3 feet bgs); and
- MW-1 (PCE and TCE at 4.5 feet and 6 feet bgs).

In the saturated zone, VOCs were detected above soil cleanup levels only in SB-38:

- Vinyl chloride and 1,1-DCE at 25 feet bgs;
- Vinyl chloride at 27.8 and 32.8 feet bgs; and
- PCE and vinyl chloride at 37.8 feet bgs.

At least one of the soil cleanup levels was exceeded by an order of magnitude or more in SB-8, SB-29, and SB-38. The boundary of the vadose zone VOC plume above the cleanup levels in the MW-1/MW-4 area is likely limited to the area around the former USTs and former aboveground dangerous waste storage tanks based on (1) the historical UST storage of pure or blended products containing the IHSs or parent products of the IHSs or (2) the likelihood that the IHSs or parent products of the IHSs were components of the waste stored in the aboveground dangerous waste storage tanks. In the borings and monitoring wells around the MW-1/MW-4

area (SB-14, SB-36, SB-37, SB-39, and SB-41), the PID readings were low and the IHSs were not detected above the site soil cleanup levels.

6.1.2 MW-5 Area

IHSs detected above the site soil cleanup levels were limited to the vadose zone and the saturated zone above a depth of 19 feet bgs. In the vadose zone, VOCs were detected above soil cleanup levels in:

- GP-7 and GP-10 (PCE at 2 feet bgs);
- SB-21 (PCE and methylene chloride at 7 feet bgs); and
- MW-5 (PCE at 1.5 feet and 3 feet bgs).

In the saturated zone, VOCs were detected above soil cleanup levels in:

- SB-21 (PCE and methylene chloride at 11 feet bgs and PCE at 16 feet and 17.7 feet bgs);
- SB-22 (PCE and vinyl chloride at 11.3 feet bgs);
- SB-24 (PCE, TCE, and methylene chloride at 10 feet bgs and PCE at 14.8 feet bgs);
- SB-25 (TCE at 11 and 15.5 feet bgs);
- SB-27 (benzene at 11.5 feet bgs);
- SB-33 (PCE and TCE at 10 feet bgs and PCE at 14.1 feet bgs);
- MW-11 (PCE 10 feet bgs); and
- INJ-2 (PCE and TCE at 10 feet bgs).

At least one of the soil cleanup levels was exceeded by an order of magnitude or more in GP-7, GP-10, SB-21, SB-23, SB-24, SB-25, SB-33, MW-5, MW-11, and INJ-2. Benzene was barely detected in SB-27 above the soil cleanup level, and 1,1-DCE was not detected above the soil cleanup level in the MW-5 area. The boundary of the MW-5 soil VOC plume is limited to the area shown on Figures 20 and 21 based on the low PID readings and lack of detections in the borings and monitoring wells surrounding the MW-5 area.

6.1.3 SB-10

Only one VOC was detected above a soil cleanup level in SB-10. PCE was detected at 23 µg/kg in a sample collected 1 foot bgs. Given that (1) the PCE cleanup level was not exceeded by a great amount in SB-10, (2) none of the six soil IHSs were detected in the SB-10 sample collected at a depth of 3.5 feet bgs, (3) PID readings in SB-10 and the adjacent SB-39 boring were low, and (4) groundwater VOC concentrations in SB-10 and in multiple samples collected in SB-39 were low, the cleanup level exceedance in SB-10 is likely very localized.

6.2 Groundwater

There are 17 groundwater IHSs for the Univar Kent site: PCE, TCE, cis-1,2-DCE, vinyl chloride, TCA, 1,1-DCE, 1,1-DCA, 1,2-DCA, 1,2-DCP, chloroethane, chloroform, methylene chloride, benzene, toluene, ethylbenzene, total xylenes, and 1,2,4-TMB. Most of the VOCs were detected multiple times above their respective cleanup levels in groundwater samples collected

from monitoring wells in 2003. Vinyl chloride was detected most often above its cleanup level in 2003, and chloroform and 1,2,4-TMB were detected the least above their respective cleanup levels (once each) in 2003.

Figures 22 through 29 present isoconcentration contours for PCE, TCE, vinyl chloride, TCA, chloroethane, benzene, toluene, and total xylenes in shallow monitoring wells. The maximum concentrations detected in 2003 were used in the plots. The constituents plotted were chosen to represent source constituents (e.g., PCE and TCA) and daughter products (e.g., vinyl chloride and chloroethane) for the chlorinated VOCs and representative aromatic VOCs. Figures 30 through 35 present isoconcentration contours for vinyl chloride, TCA, chloroethane, benzene, toluene, and total xylenes in deep monitoring wells. The maximum concentrations detected in 2003 were used in the plots. The constituents plotted were chosen as in the shallow well plots, except that PCE and TCE were not plotted due to lack of detections. Figures 36 and 37 show areas of the site above the groundwater cleanup levels. As shown on Figures 36 and 37, two areas of the site were above the site groundwater cleanup levels.

6.2.1 MW-1/MW-4 Area

Sixteen IHSs were detected at least once above their respective cleanup levels in 2003, 13 IHSs in MW-1 and 7 IHSs in MW-4. The PCE and TCE cleanup levels were moderately exceeded in MW-1. Cis-1,2-DCE and vinyl chloride cleanup levels were also exceeded in MW-1 and MW-13, and vinyl chloride cleanup levels were exceeded in MW-4. Similarly, the TCA, 1,1-DCE, 1,2-DCA, 1,1-DCA, and chloroethane cleanup levels were exceeded in MW-1 and MW-13, and the 1,2-DCA and chloroethane cleanup levels were exceeded in MW-4. These results are consistent with a shallow release of parent chlorinated solvents (PCE, TCE, and TCA), vertical movement downward of the relatively heavy parent and daughter (DCE, DCA, vinyl chloride, and chloroethane) products, and horizontal transport of daughter products with groundwater flow. Although PCE and TCE were not detected in deep well MW-13, the detection of these compounds at depth in groundwater samples from temporary borings SB-30 and SB-38 suggest the presence of PCE and TCE at the base of the aquifer in these areas. The distribution of cis-1,2-DCE at elevated concentrations to the northwest of the MW-1/MW-4 area indicates that the mass of parent chlorinated ethenes is greater at the base of the aquifer than at the top of the aquifer. Detections of vinyl chloride above the very low vinyl chloride cleanup level in MW-2 reflect the influence of the shallow groundwater mound.

The aromatic VOCs (BTEX) were detected above cleanup levels in MW-1 and/or MW-4 and in MW-13. Although the BTEX constituents are lighter than water, it is likely that their presence in significant concentrations at the base of the aquifer is a result of co-solvent transport with the relatively dense chlorinated VOCs to the base of the aquifer.

6.2.2 MW-5 Area

Seven IHSs (PCE, TCE, cis-1,2-DCE, vinyl chloride, chloroethane, 1,2-DCP, and benzene) were detected at least once above their respective cleanup levels in 2003, four in MW-1, MW-12, and INJ-3, three in MW-9 and INJ-2, and two in MW-5, MW-7, and MW-8. The PCE cleanup level was exceeded by two to three orders of magnitude in MW-5, MW-11, MW-12, INJ-2, and INJ-3.

The TCE cleanup level was exceeded by three orders of magnitude in MW-12, two orders of magnitude in INJ-2 and INJ-3, and one order of magnitude in MW-5, MW-8, and MW-11. The cis-1,2-DCE cleanup level was exceeded by two orders of magnitude in MW-12 and INJ-2, and by one order of magnitude in INJ-3. The highest vinyl chloride cleanup level exceedances were in MW-12 and INJ-3. The chloroethane and benzene cleanup levels were only exceeded moderately in MW-9 and likely reflect groundwater flow from the MW-1/MW-4 area. The 1,2-DCP cleanup level was only exceeded at MW-7. As discussed in Section 4.6.3, VOC detections in samples collected in vertical profiles in the MW-5 area show a significant decrease in VOC concentrations between depths of 15 and 25 feet bgs.

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LIMITATIONS

The services described in this report were performed consistent with generally accepted professional consulting principles and practices. No other warranty, express or implied, is made. These services were performed consistent with our agreement with our client. This report is solely for the use and information of our client unless otherwise noted. Any reliance on this report by a third party is at such party's sole risk.

Opinions and recommendations contained in this report apply to conditions existing when services were performed and are intended only for the client, purposes, locations, time frames, and project parameters indicated. We are not responsible for the impacts of any changes in environmental standards, practices, or regulations subsequent to performance of services. We do not warrant the accuracy of information supplied by others, nor the use of segregated portions of this report.

TABLES

Table 1
Water Wells Within a 1-Mile Radius
Univar USA Inc. Facility, Kent, Washington

Map Well Number	Listed Owner	Year Installed	Township (North)	Range (East)	Section	Drilled Depth	Open Interval	Use	Notes
1	Kent Nursery	1914	22	5	7L	NA	NA	D, I	Located 1047 feet west and 200 feet south of the center of Section 7
2	Sainati	1934	22	4	1R	NA	NA	NA	Located at 20444 84th Ave S, flowed at 100 gpm, no record of use/abandonment
3	Lewis	1941	22	5	7P	149	149	NA	Flowed at unmeasured rate, no record of use or abandonment
4	O'Brien	1951	22	5	7P	170	150 - 170	NA	Flowed at 60 gpm, water association well
5	Wilson	1955	22	5	6N	212	202	NA	Flowed, yielded 1730 gpm, may be well referenced in 1986 abandonment log
6	Komoto	1956	22	4	12H	321	313 - 321	NA	Flowed at 75 gpm, possible agricultural well, given area use may now be abandoned
7	Reiter	1959	22	5	7M	180	170 - 180	NA	Flowed at 30 gpm
8	City of Kent	1980	22	5	7J	500	422 - 432	M	Located near center of subsection J, yield of 400 gpm
9	City of Kent	1982	22	5	7F	367	336 - 367	M	Located at SE corner of 212th and Hwy 167, flows at 450 gpm, "Well #1"
10	City of Kent	1983	22	5	6P	395	184 - 221	M	S 208th Street well, flows at 450 gpm
11	City of Kent	1983	22	5	7F	463	331 - 356	M	Located at SE corner of 212th and Hwy 167, flows at 550 gpm, "Well #2"
12	Koopmans	1984	22	5	7C	55	50 - 55	D	Yields 16 gpm
13	City of Kent	1998	22	4	1P	100	85 - 95	T	Located at 72nd Ave S next to fire station, not currently in use
14	City of Kent	1998	22	4	12J	85	65 - 80	T	Located at 72nd Ave S and S 216th St, not currently in use
15	City of Kent	1999	22	5	7L	262	192 - 246	M	"O'Brien well", flowing well, yields 1050 gpm
16	City of Kent	2001	22	5	7F	522	290 - 480	M	Located at SE corner of 212th and Hwy 167, flows at greater than 200 gpm, "Well #3"
17	City of Kent	2004	22	5	7G	690	413 - 630	M	Located at Garrison Creek Park, 9615 S 218th Street
18	Jolly	NA	22	5	6K	NA	NA	NA	Reported address = 9455 South 202nd Street
19	K-T Supply	NA	22	5	6G	NA	NA	NA	Reported address = 19903 92nd Avenue South
20	Sloan	NA	22	5	6K	NA	NA	NA	Reported address = 9206 South 200th Street
21	Crutchfield	NA	22	5	7K	NA	NA	NA	Reported address = 21602 94th Place South

- Notes:
1. Well locations shown on Figure 3.
 2. Well logs provided in Appendix A.
 3. Information about wells 1 through 17 from the Washington State Department of Ecology's well log database.
 4. Information about wells 18 and 21 from the Washington State Department of Health's public water system databases.
 5. Drilled depths and open interval depths in feet below grade.
 6. NA = not available.
 7. Well uses: D = domestic well
 I = Irrigation well
 M = municipal well
 T = test well

Table 2

**Well Completion Data
Univar USA Inc. Facility
Kent, Washington**

Well	Northing	Easting	Monitoring Point Elevation	Surface Casing Rim Elevation	Boring Depth	Well Diameter	Screen Depth	Filter Pack Depth	Seal Depth
Shallow Monitoring Wells									
MW-1	153,067.16	1,654,570.34	33.15	33.42	21	2	4 - 19	3 - 21	0 - 3
MW-2	152,856.32	1,654,684.28	33.79	34.12	21	2	4 - 19	3 - 21	0 - 3
MW-3	153,315.66	1,654,344.26	32.94	33.23	21	2	4 - 19	3 - 21	0 - 3
MW-4	153,142.72	1,654,552.77	32.86	33.45	15	2	4.5 - 14.5	3 - 15	0 - 3
MW-5	153,239.21	1,654,654.19	32.60	33.06	15	2	4.5 - 14.5	3 - 15	0 - 3
MW-6	153,087.14	1,654,718.33	33.05	33.94	15	2	4.5 - 14.5	3 - 15	0 - 3
MW-7	153,300.59	1,654,656.24	32.96	33.34	15	2	4.5 - 14.5	3 - 15	0 - 3
MW-8	153,264.46	1,654,715.62	33.57	34.02	15	2	4.5 - 14.5	3 - 15	0 - 3
MW-9	153,229.88	1,654,722.90	33.77	34.18	15	2	5 - 15	4 - 15	0 - 4
MW-10	153,287.96	1,654,538.92	32.89	33.23	15	2	5 - 15	4 - 15	0 - 4
MW-11	153,234.78	1,654,648.47	32.79	33.03	20	2	5 - 20	4 - 20	0 - 4
MW-12	153,231.74	1,654,637.88	32.81	33.06	20	2	5 - 20	4 - 20	0 - 4
EMW-7	153,440.13	1,654,695.01	33.10	33.65	20	4	5 - 19.5	3.5 - 20	0 - 3.5
Deep Monitoring Wells and Piezometer									
MW-13	153,109.13	1,654,571.51	32.81	33.17	45.3	2	39.6 - 44.1	37 - 44.6	0 - 37
MW-14	153,086.60	1,654,671.42	32.60	33.11	43	2	32.7 - 42.2	30 - 43	0 - 30
W-15	152,979.86	1,654,652.03	32.57	32.90	44	2	33.7 - 43.5	31 - 44	0 - 31
W-16	153,133.76	1,654,408.04	36.92	37.35	48	2	37.2 - 47.2	35 - 48	0 - 35
MW-17	153,293.66	1,654,405.47	32.60	33.17	44.3	2	34.3 - 43.8	32 - 44.3	0 - 32
MW-18	153,291.64	1,654,531.24	32.73	33.21	44	2	34.0 - 43.5	31 - 44	0 - 31
MW-19	153,414.15	1,654,432.23	33.52	33.83	50	2	39.4 - 49.4	37 - 50	0 - 37
P-1	153,262.87	1,654,705.45	33.62	33.99	46.5	2	39.0 - 44.0	37 - 44.5	0 - 37
Pilot Test Injection Wells									
INJ-1	153,242.89	1,654,659.98	32.77	33.09	20.5	2	10 - 20	9 - 20.5	0 - 9
INJ-2	153,229.56	1,654,633.50	32.81	33.03	20.5	2	10 - 20	9 - 20.5	0 - 9
INJ-3A	153,259.06	1,654,632.92	33.01	33.25	20	2	9 - 19	8 - 20	0 - 8
<p>Notes: Northing/Easting in feet relative to the Washington State Plane System North Zone (NAD 27). Monitoring point (top of well casing) in feet relative to the North American Vertical Datum (NAVD 88). All wells but EMW-7 located on Univar property; EMW-7 located on city of Kent right-of-way. All depths shown in feet below ground surface. All wells completed with Schedule 40 PVC.</p>									

Table 3

**Contents of Former Underground Storage Tanks
Univar USA Inc. Facility, Kent, Washington**

Tank #	Capacity (gallons)	Contents	Chemical Constituents
1	10,000	Hexane	Hexane
2	10,000	Red Band Alcohol Thinner	Ethyl Alcohol (90-95%); Methyl Alcohol (3-4%); Ethyl Acetate, Methyl Isobutyl Ketone, and Hydrocarbon Solvent (<2% each)
3	10,000	Deicing Fluid	Propylene Glycol (88%); Water (9%); Proprietary Compounds (3%)
4	10,000	Chlorothene	1,1,1-Trichloroethane
5	10,000	Solvent 1	Toluene (44%); Xylene (30%); Solvent Naphtha - Petroleum (21%); Ethylbenzene (5%)
6	10,000	Trichloroethylene	Trichloroethylene
7	10,000	Toluol	Toluene
8	10,000	Methyl Isobutyl Ketone	Methyl Isobutyl Ketone (4-methyl- 2-pentanone)
9	10,000	Isobutyl Acetate	Isobutyl Acetate
0	10,000	Ethyl Acetate	Ethyl Acetate
11	10,000	Chlorothene	1,1,1-Trichloroethane
12	10,000	Thinner 225	Solvent Naphtha - Petroleum (94%); Toluene (6%)
13	10,000	Xylene	Xylene
14	10,000	Vanzol	Ethyl Alcohol (86%); Methyl Alcohol (4%); Isopropyl Alcohol (9%); n-Propyl Acetate (1%)
15	10,000	Toluene	Toluene
16	10,000	Nipar S-20	2-Nitropropane
17	10,000	Dowanol EB	Ethylene Glycol n-Butyl Ether (2-Butoxyethanol)
18	10,000	Thinner 250	Not Available
19	6,000	VWR 3139	Mineral Spirits
20	6,000	Thinner 350B	Mineral Spirits
21	6,000	Thinner 182	Mineral Spirits
22	6,000	Iosol 1028	Not Available
23	6,000	Methylene Chloride	Methylene Chloride
24	6,000	Ethylene Glycol	Ethylene Glycol
25	6,000	Toluene	Toluene
6	6,000	N-Propyl Alcohol	N-Propyl Alcohol

Tank #	Capacity (gallons)	Contents	Chemical Constituents
7	6,000	Vanfuel	Kerosene
28	6,000	Acetone	Acetone
29	6,000	Isopropyl Alcohol	Isopropyl Alcohol
30	6,000	Red Band Alcohol Thinner	Ethyl alcohol (90-95%); Methyl Alcohol (3-4%); Ethyl Acetate, Methyl Isobutyl Ketone, and Hydrocarbon Solvent (<2% each)
31	6,000	Methanol	Methanol
32	6,000	Methyl Isobutyl Ketone	Methyl Isobutyl Ketone (4-methyl- 2-pentanone)
33	6,000	Glycol Ether EB	Not Available
34	6,000	Methyl Ethyl Ketone	Methyl Ethyl Ketone (2-Butanone)
35	6,000	VWR 7521	Methyl Ethyl Ketone (75%); Ethyl Acetate (25%)
36	6,000	VWR 3139	Mineral Spirits
37	4,000	Diesel	Diesel

Table 4

**Shallow Aquifer Vertical Gradients
Univar USA Inc. Facility
Kent, Washington**

Date	Groundwater Elevation (feet)	Date	Groundwater Elevation (feet)	ΔH	ΔL	Vertical Gradient (ft/ft)
	MW-4		MW-13			MW-4 → MW-13
03/17/03	28.12	03/31/03	27.38	0.74	32.35	0.0229
06/10/03	27.69	06/10/03	26.72	0.97	32.35	0.0300
09/10/03	25.84	09/10/03	25.16	0.68	32.35	0.0210
12/04/03	27.37	12/03/03	26.90	0.47	32.35	0.0145
01/12/04	27.98	01/12/04	27.44	0.54	32.35	0.0167
03/15/04	28.03	03/15/04	27.26	0.77	32.35	0.0238
06/10/04	27.53	06/10/04	26.37	1.16	32.35	0.0359
	MW-6		MW-14			MW-6 → MW-14
12/04/03	27.14	12/03/03	26.95	0.19	27.95	0.0068
01/12/04	27.43	01/12/04	27.53	-0.10	27.95	-0.0036
03/15/04	27.72	03/16/04	27.39	0.33	27.95	0.0118
06/10/04	26.65	06/10/04	26.92	-0.27	27.95	-0.0097
	MW-8		P-1			MW-8 → P-1
01/13/99	27.61	01/13/99	27.60	0.01	32	0.0003
03/02/99	28.45	03/02/99	28.43	0.02	32	0.0006
06/16/99	26.95	06/16/99	27.03	-0.08	32	-0.0025
09/16/99	26.18	09/16/99	26.28	-0.10	32	-0.0031
12/08/99	27.41	12/08/99	27.36	0.05	32	0.0016
03/07/00	27.86	03/07/00	27.70	0.16	32	0.0050
06/21/00	27.06	06/21/00	26.89	0.17	32	0.0053
09/12/00	25.93	09/12/00	25.94	-0.01	32	-0.0003
12/07/00	26.37	12/07/00	26.35	0.02	32	0.0006
03/15/01	26.88	03/15/01	27.75	-0.87	32	-0.0272
01/02/02	27.50	01/02/02	27.50	0.00	32	0.0000
09/17/02	25.63	09/17/02	25.68	-0.05	32	-0.0016
12/16/02	26.28	12/16/02	26.34	-0.06	32	-0.0019
03/17/03	26.99	03/17/03	27.34	-0.35	32	-0.0109
09/10/03	25.19	09/10/03	25.22	-0.03	32	-0.0009
12/03/03	26.87	12/03/03	26.59	0.28	32	0.0088
01/12/04	27.38	01/12/04	27.42	-0.04	32	-0.0013
03/15/04	27.25	03/15/04	27.27	-0.02	32	-0.0006
06/10/04	26.79	06/10/04	26.81	-0.02	32	-0.0006
	MW-10		MW-18			MW-10 → MW-18
12/03/03	26.82	12/03/03	26.79	0.03	28.75	0.0010
01/12/04	27.31	01/12/04	27.30	0.01	28.75	0.0003
03/15/04	27.16	03/15/04	27.13	0.03	28.75	0.0010
06/10/04	26.76	06/10/04	26.73	0.03	28.75	0.0010
<p>Note: H = groundwater elevation relative to NAVD 88. ΔH = difference in groundwater elevations (feet); a positive number represents a higher shallow elevation. ΔL = distance between the middle of the well pair screens (feet). Vertical gradient = $\Delta H/\Delta L$; a positive number represents a downward gradient.</p>						

Table 5

**Natural Attenuation Evaluation
Univar USA Inc. Facility, Kent, Washington**

Well	Analyte	Concentration in Most Contaminated Zone	Points Awarded
MW-1	Dissolved Oxygen	1.5 milligrams per liter (mg/L)	-3
	Nitrate	0.2 mg/L	2
	Ferrous Iron (Fe ²⁺ or iron II)	21 mg/L	3
	Sulfate	5.6 mg/L	2
	Sulfide	0.15 mg/L	0
	Methane	14 mg/L	3
	Oxidation Reduction Potential	-157 mv	2
	pH	6.5 SU	0
	Total Organic Carbon	42 mg/L	2
	Temperature	15 degrees Celsius (°C)	0
	Carbon Dioxide	NM	0
	Alkalinity	500 mg/L (bkd = 300 mg/L)	0
	Chloride	61 mg/L (bkd = 15 mg/L)	2
	Benzene, Toluene, Ethylbenzene, and Xylenes	8.5 mg/L	2
	Tetrachloroethene (released)	0.01 mg/L	0
	Trichloroethene (none released)	0.01 mg/L	0
	1,2-dichloroethene (none released)	0.4 mg/L	2
	Vinyl Chloride (none released)	0.07 mg/L	2
	Ethene/Ethane	0.29 mg/L	3
	Chloroethane	0.3 mg/L	2
	1,1,1-trichloroethane	0.2 mg/L	0
	1,2-dichlorobenzene	Non detect (ND)	0
	1,3-dichlorobenzene	ND	0
	1,4-dichlorobenzene	ND	0
	Chlorobenzene	ND	0
	1,1-dichloroethene	0.01 mg/L	0
Total Points:			24

Table 5

**Natural Attenuation Evaluation
Univar USA Inc. Facility, Kent, Washington**

Well	Analyte	Concentration in Most Contaminated Zone	Points Awarded
MW-5	Dissolved Oxygen	1.5 mg/L	-3
	Nitrate	2.4 mg/L	0
	Ferrous Iron (Fe ²⁺ or iron II)	0.04 mg/L	0
	Sulfate	19 mg/L	2
	Sulfide	0.002 mg/L	0
	Methane	0.025 mg/L	0
	Oxidation Reduction Potential	170 mv	0
	pH	6.2 SU	0
	Total Organic Carbon	6.2 mg/L	0
	Temperature	14 °C	0
	Carbon Dioxide	NM	0
	Alkalinity	175 mg/L (bkd = 300 mg/L)	0
	Chloride	12 mg/L (bkd = 15 mg/L)	0
	Benzene, Toluene, Ethylbenzene, and Xylenes	< 0.02 mg/L	0
	Tetrachloroethene (released)	4 mg/L	0
	Trichloroethylene (none released)	0.13 mg/L	2
	1,2-dichloroethene (none released)	0.025 mg/L	2
	Vinyl Chloride (none released)	0.002 mg/L	0
	Ethene/Ethane	ND	0
	Chloroethane	ND	0
	1,1,1-trichloroethane	ND	0
	1,2-dichlorobenzene	ND	0
	1,3-dichlorobenzene	ND	0
1,4-dichlorobenzene	ND	0	
Chlorobenzene	ND	0	
1,1-dichloroethene	ND	0	
Total Points			3

1 Screening method from Wiedemeier, T., M. Swanson, D. Moutoux, E. Gordon, J. Wilson, B. Wilson, D. Kampbell, J. Hansen, P. Haas, and F. Chapelle, 1996, *Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Groundwater*, Air Force Center for Environmental Excellence, Technology Transfer Division, Brooks AFB, Draft, Revision 1, San Antonio, TX.

2 Interpretation of total points: 1 to 5 points: inadequate evidence for biodegradation of chlorinated organics. 6 to 14 points: limited evidence for biodegradation of chlorinated organics. 15 to 20 points: adequate evidence for biodegradation of chlorinated organics. > 20 points: strong evidence for biodegradation of chlorinated organics.

Table 6

**Selection of Potential Indicator Hazardous Substances in Soil
Univar USA Inc. Facility, Kent, Washington**

Constituent	Frequency of Detection	Retained as Potential IHS	Rational for Selection or Elimination as Potential IHS
1,1-Dichloroethane	16%	Y	FOD > 10%
1,1-Dichloroethene	5%	Y	potential groundwater IHS, mobility, degradation compound
1,1,2,2-Tetrachloroethane	1%	N	found in only 1 sample at very low concentration
1,2-Dichloroethane	4%	N	low toxicity, single location, and low concentration
1,1,2-Trichloroethane	1%	N	found in only 1 sample at a concentration below MRL
1,3,5-Trimethylbenzene	14%	Y	FOD > 10%
1,2,4-Trimethylbenzene	23%	Y	FOD > 10%
2-Butanone (MEK)	12%	Y	FOD > 10%
4-Chlorotoluene	2%	N	no toxicity data, found in 1 sample at very low concentration
4-Isopropyltoluene	6%	N	no toxicity data, found at 2 locations, very low concentration
Acetone	65%	Y	FOD > 10%
Benzene	8%	Y	potential groundwater IHS, mobility, toxicity
Bromodichloromethane	1%	N	found in only 1 sample at very low concentration
Carbon Disulfide	1%	N	found in only 1 sample at very low concentration
Chloroethane	18%	Y	FOD > 10%
Chloroform	3%	N	found at only 1 location at very low concentrations
1,1,2-Dichloroethene	31%	Y	FOD > 10%
Dibromochloromethane	1%	N	found in 1 sample at very low concentration
Ethylbenzene	25%	Y	FOD > 10%
Hexachlorobutadiene	2%	N	found in only 1 sample, low concentration
Hexane	3%	N	found in 2 samples, attributed to lab contamination
Isopropylbenzene	14%	Y	FOD > 10%
Methylene Chloride	43%	Y	FOD > 10%
Naphthalene	5%	N	found in 3 samples from 1 location, very low concentrations
n-butylbenzene	3%	N	found in 2 samples, co-located with other IHS at high concen
n-propylbenzene	15%	Y	FOD > 10%
Tetrachloroethene (PCE)	45%	Y	FOD > 10%
sec-butyl-benzene	3%	N	found in 2 samples at low concentrations, co-located
Styrene	3%	N	found in 2 samples at low concentrations less than MRL
1,1,1-Trichloroethane (TCA)	15%	Y	FOD > 10%
Trichloroethene (TCE)	36%	Y	FOD > 10%
Toluene	26%	Y	FOD > 10%
Total Xylenes	33%	Y	FOD > 10%
trans-1,2-Dichloroethene	8%	N	found at 1 location, very low concentrations below MRL
Vinyl Chloride	9%	Y	potential groundwater IHS, mobility, degradation compound

- Notes:
1. Only detected compounds shown in table
 2. FOD = frequency of detection
 3. IHS = indicator hazardous substance
 4. MRL = method reporting limit

Table 7

**Identification of Potential Indicator Hazardous Substances in Groundwater
Univar USA Inc. Facility, Kent, Washington**

Constituent	Frequency of Detection	Retained as Potential IHS	Rational for Selection or Elimination as Potential IHS
1,1-Dichloroethane	57%	Y	FOD > 10%
1,1-Dichloroethene	24%	Y	FOD > 10%
1,2-Dichloroethane	12%	Y	FOD > 10%
1,2-Dichloropropane	7%	Y	toxicity, related to PCE
1,2,4-Trichlorobenzene	1%	N	moderate toxicity, found at only 1 location, co-located with other IHS
1,2,3-Trichloropropane	< 1%	N	detected in only 1 sample, co-located with other IHS
1,3,5-Trimethylbenzene	22%	Y	FOD > 10%
1,2,4-Trimethylbenzene	22%	Y	FOD > 10%
1,4-Dichlorobenzene	1%	N	detected in only 1 sample at low concentrations < MRL
2-Butanone (MEK)	1%	N	low FOD, low toxicity, and limited distribution
2-Nitropropane	< 1%	N	detected in only sample, co-located with other IHS
2-Chlorotoluene	< 1%	N	detected at very low concentrations, limited distribution
4-Chlorotoluene	< 1%	N	detected at very low concentrations, limited distribution
4-Isopropyltoluene	12%	N	no toxicity data available
Acetone	9%	Y	detected at high concentrations, geographically clustered
Benzene	32%	Y	FOD > 10%
Carbon Disulfide	8%	N	low toxicity, very low concentrations, limited distribution
CFC-12	< 1%	N	detected in 1 sample at very low concentrations < MRL
CFC-113	22%	Y	FOD > 10%
Chlorobenzene	2%	N	detected at very low concentrations < MRL
Chloroethane	43%	Y	FOD > 10%
Chloroform	10%	Y	FOD > 10%
cis-1,2-Dichloroethene	80%	Y	FOD > 10%
Ethylbenzene	28%	Y	FOD > 10%
Hexachlorobutadiene	< 1%	N	detected in 1 sample, co-located with other IHS
Hexane	13%	Y	FOD > 10%
Isopropylbenzene	21%	Y	FOD > 10%
Methyl isobutyl ketone	< 1%	N	detected in 2 samples, limited distribution, co-located with other IHS
Methylene Chloride	22%	Y	FOD > 10%
Naphthalene	6%	N	detected at very low concentrations, limited distribution, co-located
n-butylbenzene	< 1%	N	detected in 2 samples at very low concentrations
n-propylbenzene	21%	Y	FOD > 10%
Tetrachloroethene (PCE)	49%	Y	FOD > 10%
sec-butyl-benzene	6%	N	detected at very low concentrations < MRL
Styrene	1%	N	low/moderate concentrations, limited distribution, co-located
1,1,1-Trichloroethane (TCA)	15%	Y	FOD > 10%
Trichloroethene (TCE)	53%	Y	FOD > 10%
Toluene	49%	Y	FOD > 10%
Total Xylenes	29%	Y	FOD > 10%
trans-1,2-DCE	43%	Y	FOD > 10%
Vinyl Chloride	43%	Y	FOD > 10%

- Notes: 1. Only detected compounds shown in table
2. FOD = frequency of detection
3. IHS = indicator hazardous substance
4. MRL = method reporting limit

**Soil and Groundwater Cleanup Levels
Univar USA Inc. Facility, Kent, Washington**

Constituent	Potential IHS		Groundwater Cleanup Level ($\mu\text{g/L}$)				Soil Cleanup Level ^a (mg/kg)				
	Groundwater	Soil	Method B	MCL	Lowest MRL	Final CUL	Method C ^b	Soil Leaching ^c	Soil Saturation ^d	Lowest MRL	Final CUL
1,1-DCA	Y	Y	8.0E+02	–	5.0E-01	8.0E+02	1.99E+05	4.4E+00	1.4E+03	5.5E-03	4.4E+00
1,1-DCE	Y	Y	4.0E+02	7.0E+00	5.0E-01	7.0E+00	9.41E+04	5.0E-02	8.1E+02	5.5E-03	5.0E-02
1,2-DCA	Y	N	5.0E-01	5.0E+00	5.0E-01	5.0E-01	5.99E+02	2.0E-03	2.1E+03	5.5E-03	5.5E-03 ^e
1,2-DCP	Y	N	6.4E-01	5.0E+00	5.0E-01	6.4E-01	8.00E+02	3.3E-03	7.2E+02	5.0E-03	5.0E-03 ^e
1,3,5-TMB	Y	Y	4.0E+02	–	2.0E+00	4.0E+02	7.27E+04	8.4E+00	5.0E+01	2.2E-02	8.4E+00
1,2,4-TMB	Y	Y	4.0E+02	–	2.0E+00	4.0E+02	7.27E+04	3.1E+01	2.2E+02	2.2E-02	3.1E+01
2-butanone (MEK)	N	Y	4.8E+03	–	2.0E+01	4.8E+03	8.73E+05	2.0E+01	5.5E+02	2.2E-02	2.0E+01
Acetone	Y	Y	7.2E+03	–	2.0E+01	7.2E+03	1.79E+06	2.9E+01	2.0E+05	5.5E-02	2.9E+01
Benzene	Y	Y	8.0E-01	5.0E+00	5.0E-01	8.0E-01	1.36E+03	4.5E-03	4.9E+02	5.5E-03	5.5E-03 ^e
CFC-113 (Freon 113)	Y	N	2.4E+04	–	5.0E-01	2.4E+04	5.96E+07	1.0E+04	2.4E+03	1.0E-02	1.0E+04
Chloroethane	Y	Y	1.5E+01	–	5.0E-01	1.5E+01	2.57E+04	7.6E-02	1.4E+03	5.5E-03	7.6E-02
Chloroform	Y	N	7.2E+00	–	5.0E-01	7.2E+00	1.22E+04	4.1E-02	2.1E+03	5.5E-03	4.1E-02
cis-1,2-DCE	Y	Y	8.0E+01	7.0E+01	5.0E-01	7.0E+01	1.99E+04	3.5E-01	8.7E+02	5.5E-03	3.5E-01
Ethylbenzene	Y	Y	8.0E+02	7.0E+02	5.0E-01	7.0E+02	1.46E+05	6.0E+00	7.3E+01	5.5E-03	6.0E+00
Hexane	Y	N	4.8E+02	–	1.0E+00	4.8E+02	1.19E+05	9.6E+01	9.5E+01	1.1E-02	9.6E+01
Isopropylbenzene	Y	Y	8.0E+02	–	2.0E+00	8.0E+02	1.46E+05	7.4E+00	2.8E+01	2.2E-02	7.4E+00
Methylene Chloride	Y	Y	5.8E+00	5.0E+00	2.0E+00	5.0E+00	9.94E+03	2.2E-02	2.8E+03	1.1E-02	2.2E-02
n-propylbenzene	Y	Y	3.2E+02	–	2.0E+00	3.2E+02	5.82E+04	2.0E+01	4.3E+01	2.2E-02	2.0E+01
PCE	Y	Y	8.6E-01	5.0E+00	5.0E-01	8.6E-01	1.07E+03	9.0E-03	1.1E+02	5.5E-03	9.0E-03
TCA	Y	Y	7.2E+02	2.0E+02	5.0E-01	2.0E+02	1.79E+05	1.6E+00	5.3E+02	5.5E-03	1.6E+00
TCE	Y	Y	4.0E+00	5.0E+00	5.0E-01	4.0E+00	4.96E+03	2.6E-02	3.6E+02	5.5E-03	2.6E-02
Toluene	Y	Y	1.6E+03	1.0E+03	5.0E-01	1.0E+03	2.91E+05	7.3E+00	1.9E+02	5.5E-03	7.3E+00
Total Xylenes	Y	Y	1.6E+03	1.0E+04	5.0E-01	1.6E+03	2.91E+05	1.5E+01	7.8E+01	5.5E-03	1.5E+01
trans-1,2-DCE	Y	N	1.6E+02	1.0E+02	5.0E-01	1.0E+02	3.98E+04	5.4E-01	1.7E+03	5.5E-03	5.4E-01
Vinyl Chloride	Y	Y	2.9E-02	2.0E+00	5.0E-01	5.0E-01 ^e	4.97E+01	1.8E-04	8.7E+01	5.5E-03	5.5E-03 ^e

Notes: CUL = cleanup level MCL = maximum contaminant level – = MCL not available

^a Cleanup levels calculated using Ecology's Workbook for Calculating Cleanup Levels for Individual Hazardous Substances (Version No: MTCASGL10).

^b Soil cleanup level protective of human health based on ingestion and dermal contact exposure pathways.

^c Soil cleanup level protective of groundwater calculated using proposed final groundwater cleanup level.

^d Soil saturation limits calculated using Ecology's Workbook.

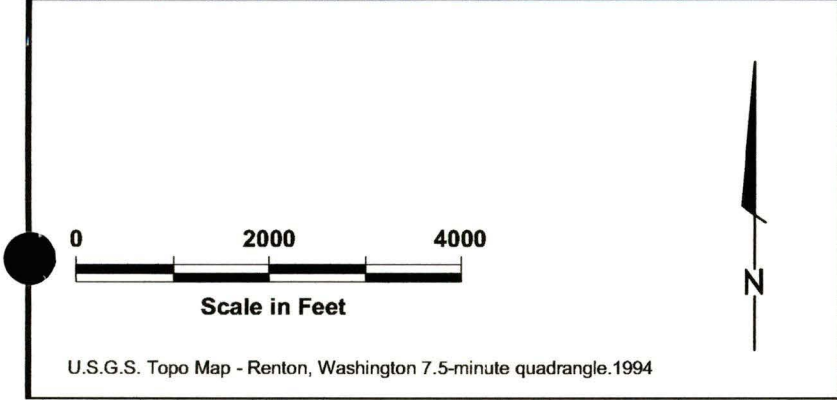
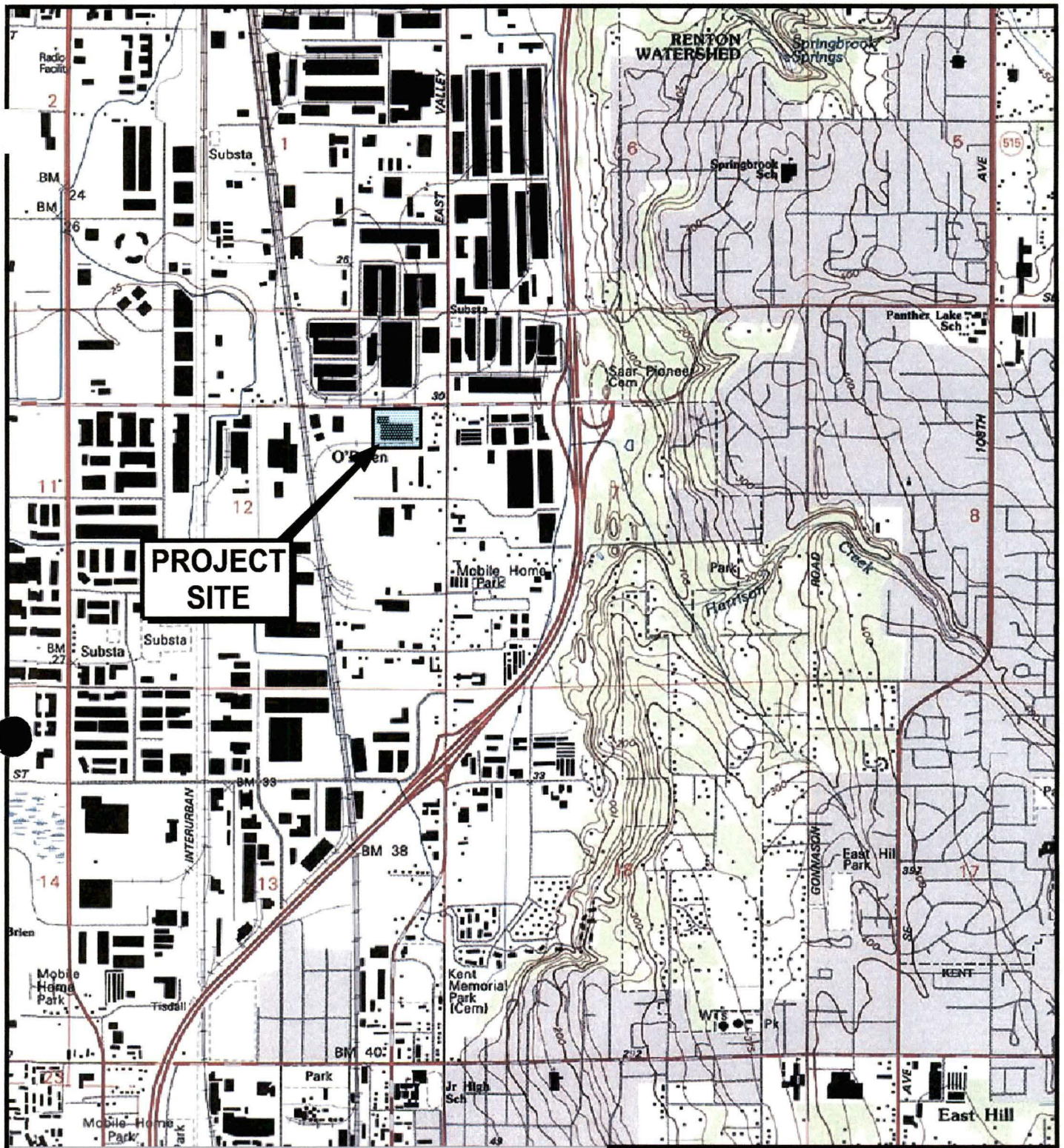
^e Per WAC 173-340-707(2), cleanup level based on PQL (lowest laboratory MRL).

Table 9

**Soil and Groundwater Indicator Hazardous Substances
Univar USA Inc. Facility, Kent, Washington**

Potential IHS	Groundwater (ug/L)		Soil (mg/kg)		Final IHS	
	Maximum 2003 Detection	Final CUL	Maximum Detection	Final CUL	Groundwater	Soil
1,1-DCA	5.6E+03	8.0E+02	4.2E-01	4.4E+00	Y	N
1,1-DCE	4.9E+02	7.0E+00	1.6E-01	5.0E-02	Y	Y
1,2-DCA	2.1E+00	5.0E-01	1.5E-03	5.5E-03	Y	N
1,2-DCP	1.7E+00	6.4E-01	ND	5.0E-03	Y	N
1,3,5-TMB	2.8E+02	4.0E+02	1.6E+00	8.4E+00	N	N
1,2,4-TMB	5.1E+02	4.0E+02	2.8E+00	3.1E+01	Y	N
2-butanone (MEK)	3.3E+01	4.8E+03	2.0E-01	2.0E+01	N	N
Acetone	8.2E+01	7.2E+03	3.1E+00	2.9E+01	N	N
Benzene	2.7E+01	8.0E-01	8.6E-03	5.5E-03	Y	Y
CFC-113 (Freon 113)	NA	2.4E+04	NA	1.0E+04	N	N
Chloroethane	5.3E+02	1.5E+01	6.9E-02	7.6E-02	Y	N
Chloroform	9.0E+00	7.2E+00	1.5E-02	4.1E-02	Y	N
cis-1,2-DCE	3.3E+04	7.0E+01	2.1E-01	3.5E-01	Y	N
Ethylbenzene	2.9E+03	7.0E+02	6.0E-01	6.0E+00	Y	N
Hexane	5.3E+01	4.8E+02	9.9E-02	9.6E+01	N	N
Isopropylbenzene	1.0E+02	8.0E+02	2.7E-01	7.4E+00	N	N
Methylene Chloride	2.5E+01	5.0E+00	1.4E+00	2.2E-02	Y	Y
n-propylbenzene	1.6E+02	3.2E+02	7.3E-01	2.0E+01	N	N
PCE	2.7E+03	8.6E-01	1.6E+02	9.0E-03	Y	Y
TCA	4.1E+03	2.0E+02	4.5E-01	1.6E+00	Y	N
TCE	3.5E+03	4.0E+00	6.3E-01	2.6E-02	Y	Y
Toluene	2.9E+04	1.0E+03	1.0E+00	7.3E+00	Y	N
Total Xylenes	1.2E+04	1.6E+03	4.2E+00	1.5E+01	Y	N
trans-1,2-DCE	6.6E+01	1.0E+02	5.7E-03	5.4E-01	N	N
Vinyl Chloride	7.9E+03	5.0E-01	1.9E-01	5.5E-03	Y	Y
Notes: IHS = indicator hazardous substance CUL = cleanup level ND = not detected NA = not analyzed						

ILLUSTRATIONS



PES Environmental, Inc.
Engineering & Environmental Services

SITE LOCATION MAP
UNIVAR USA INC.
8201 SOUTH 212TH STREET
KENT, WASHINGTON

FIGURE

1

U.S.G.S. Topo Map - Renton, Washington 7.5-minute quadrangle.1994

816.003.01.127 81600301127_RI-0704_Fig1_3

7/04

JOB NUMBER

DRAWING NUMBER

REVIEWED BY

DATE

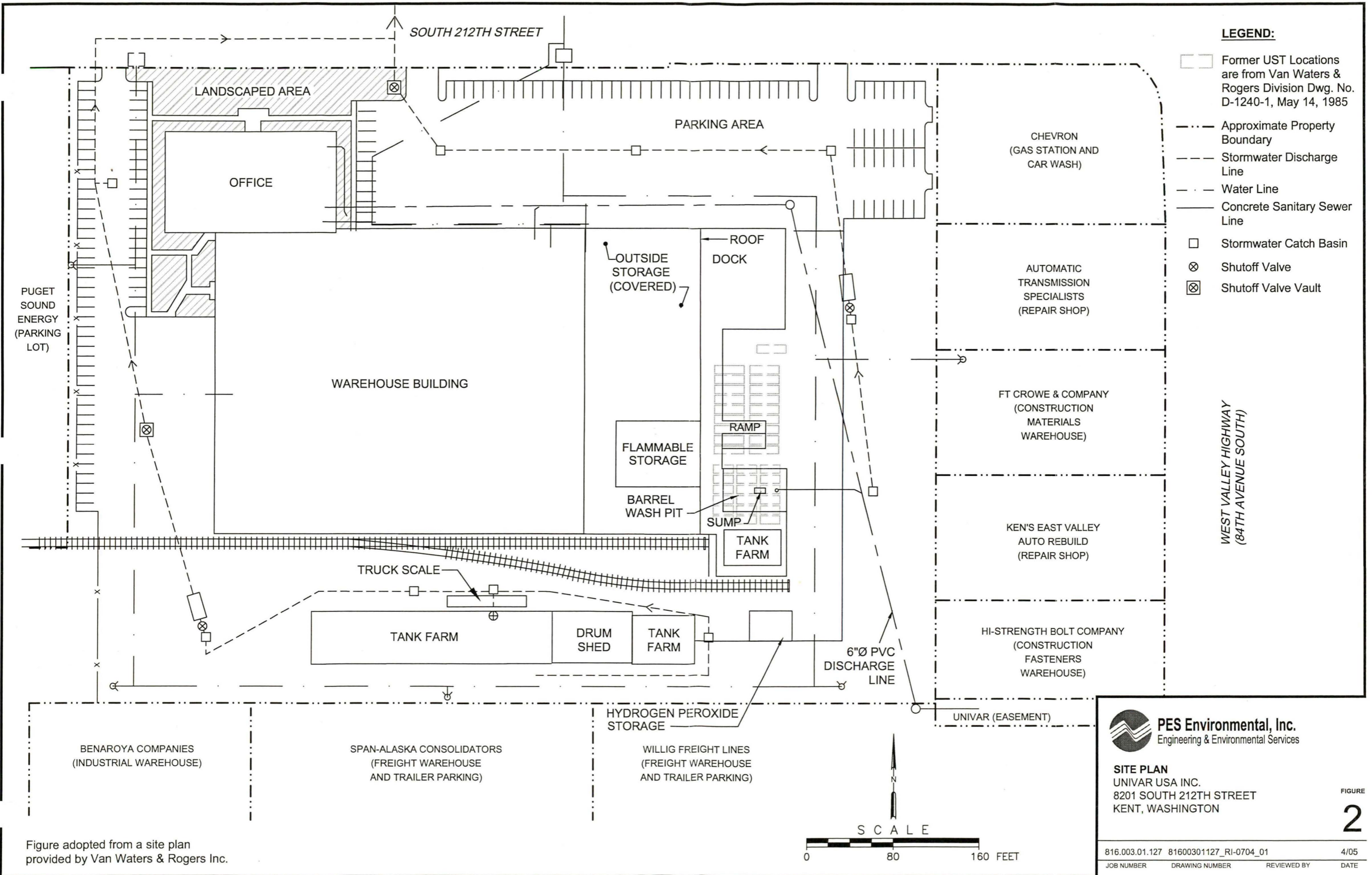


Figure adopted from a site plan provided by Van Waters & Rogers Inc.

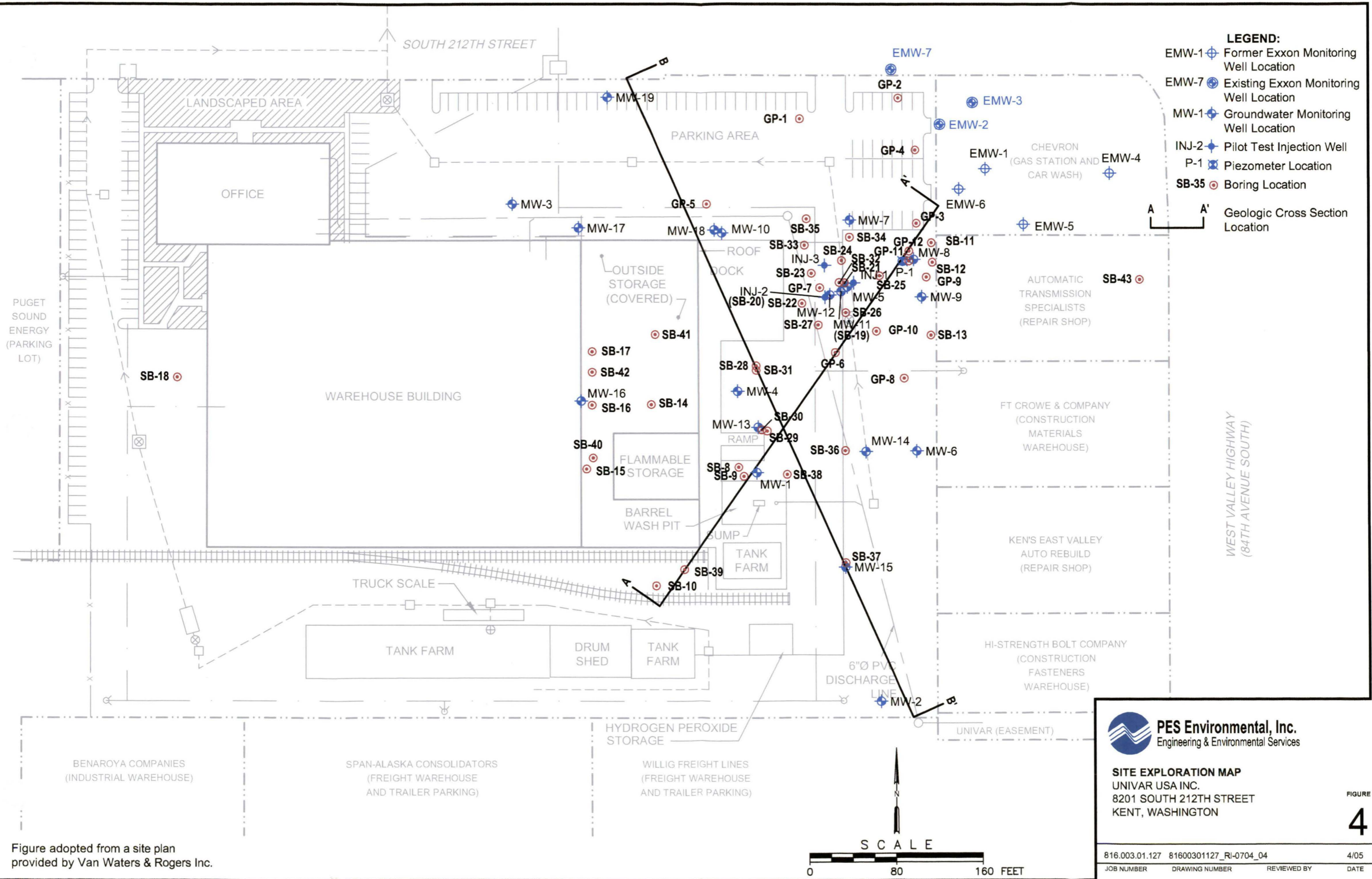


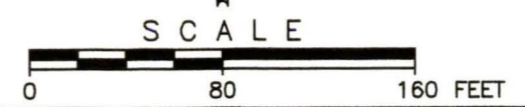
Figure adopted from a site plan provided by Van Waters & Rogers Inc.

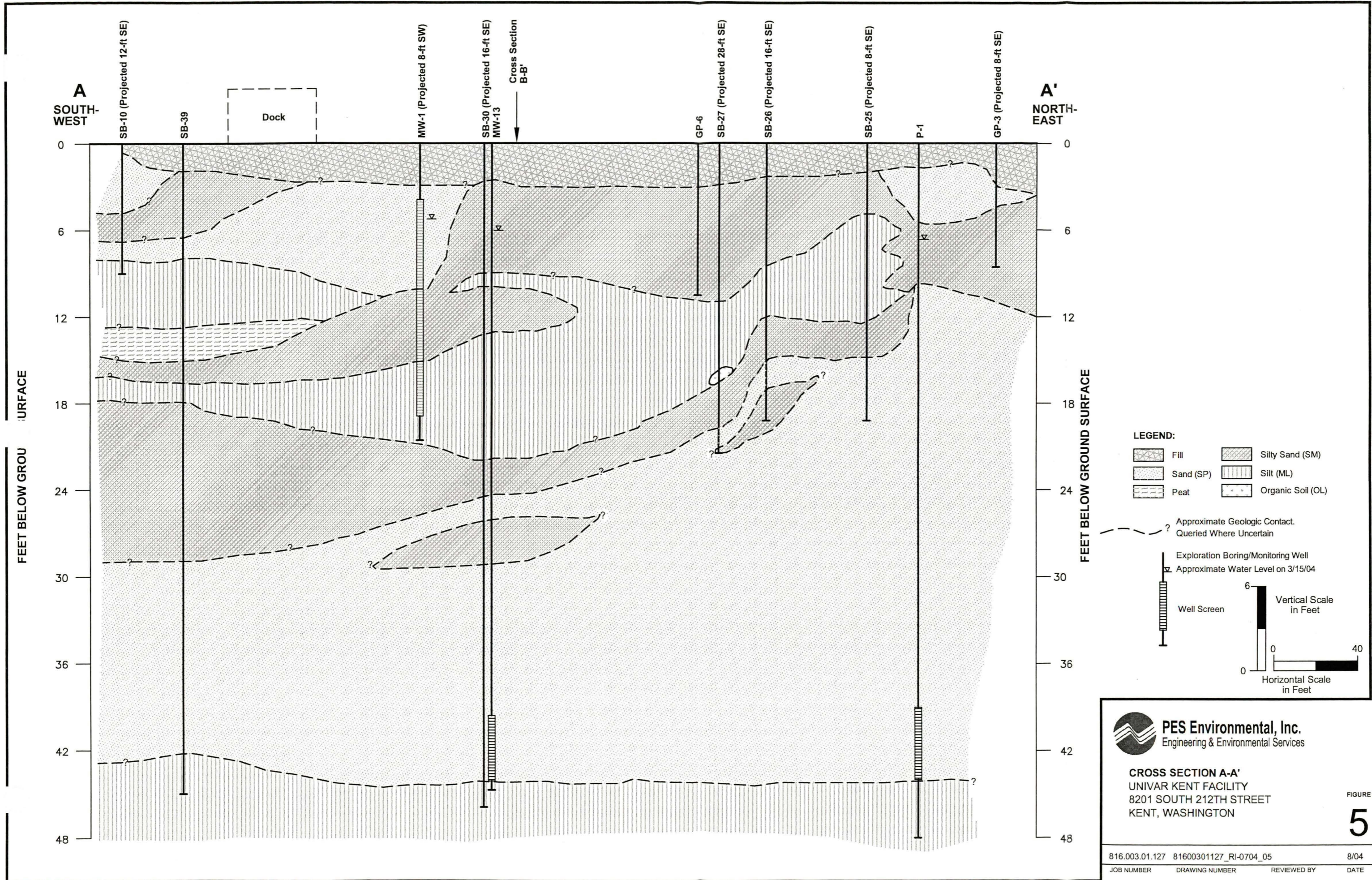
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SITE EXPLORATION MAP
UNIVAR USA INC.
8201 SOUTH 212TH STREET
KENT, WASHINGTON

FIGURE 4

816.003.01.127 81600301127_RI-0704_04 4/05
JOB NUMBER DRAWING NUMBER REVIEWED BY DATE

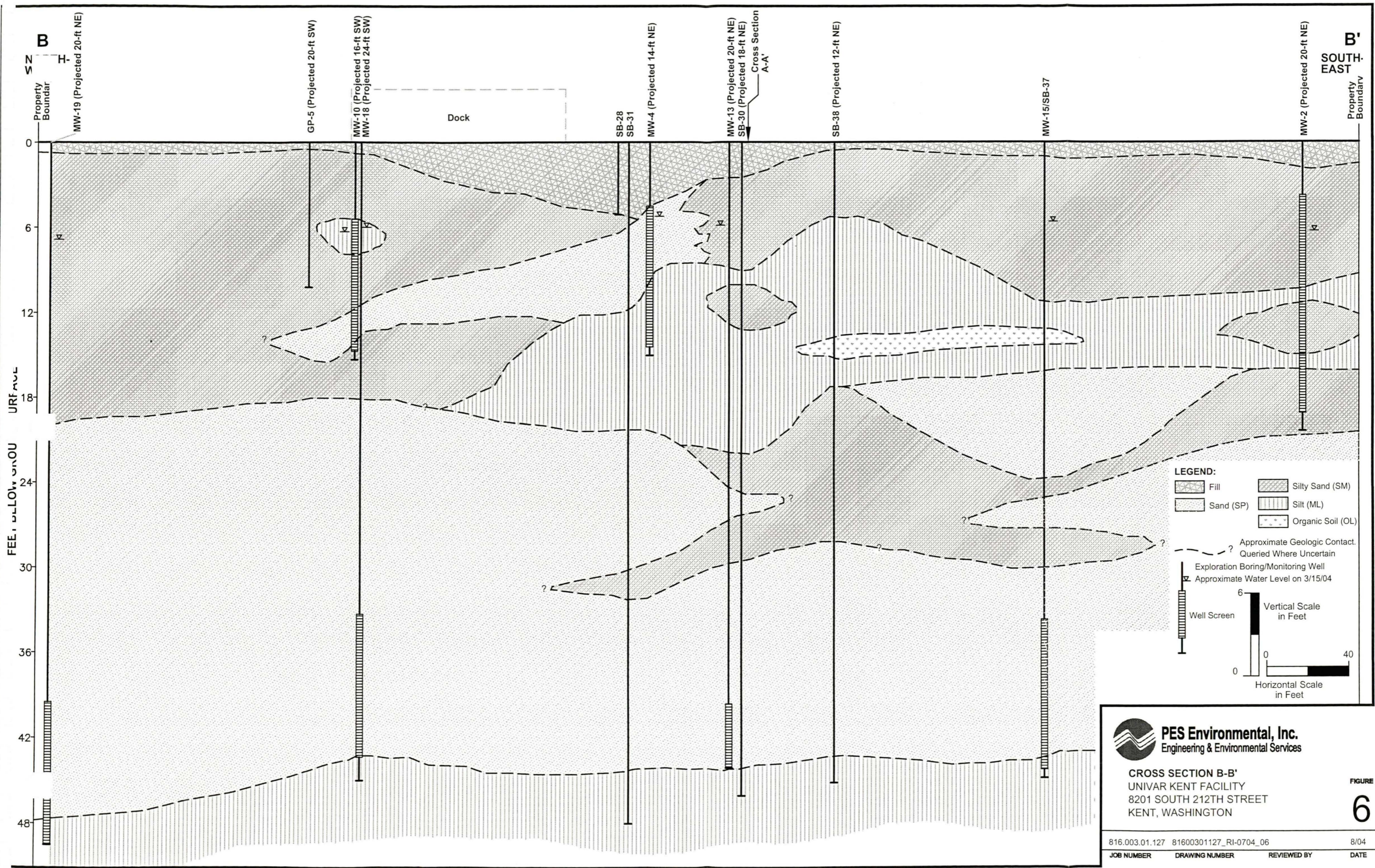




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CROSS SECTION A-A'
UNIVAR KENT FACILITY
8201 SOUTH 212TH STREET
KENT, WASHINGTON

FIGURE
5



PES Environmental, Inc.
Engineering & Environmental Services

CROSS SECTION B-B'
UNIVAR KENT FACILITY
8201 SOUTH 212TH STREET
KENT, WASHINGTON

FIGURE
6

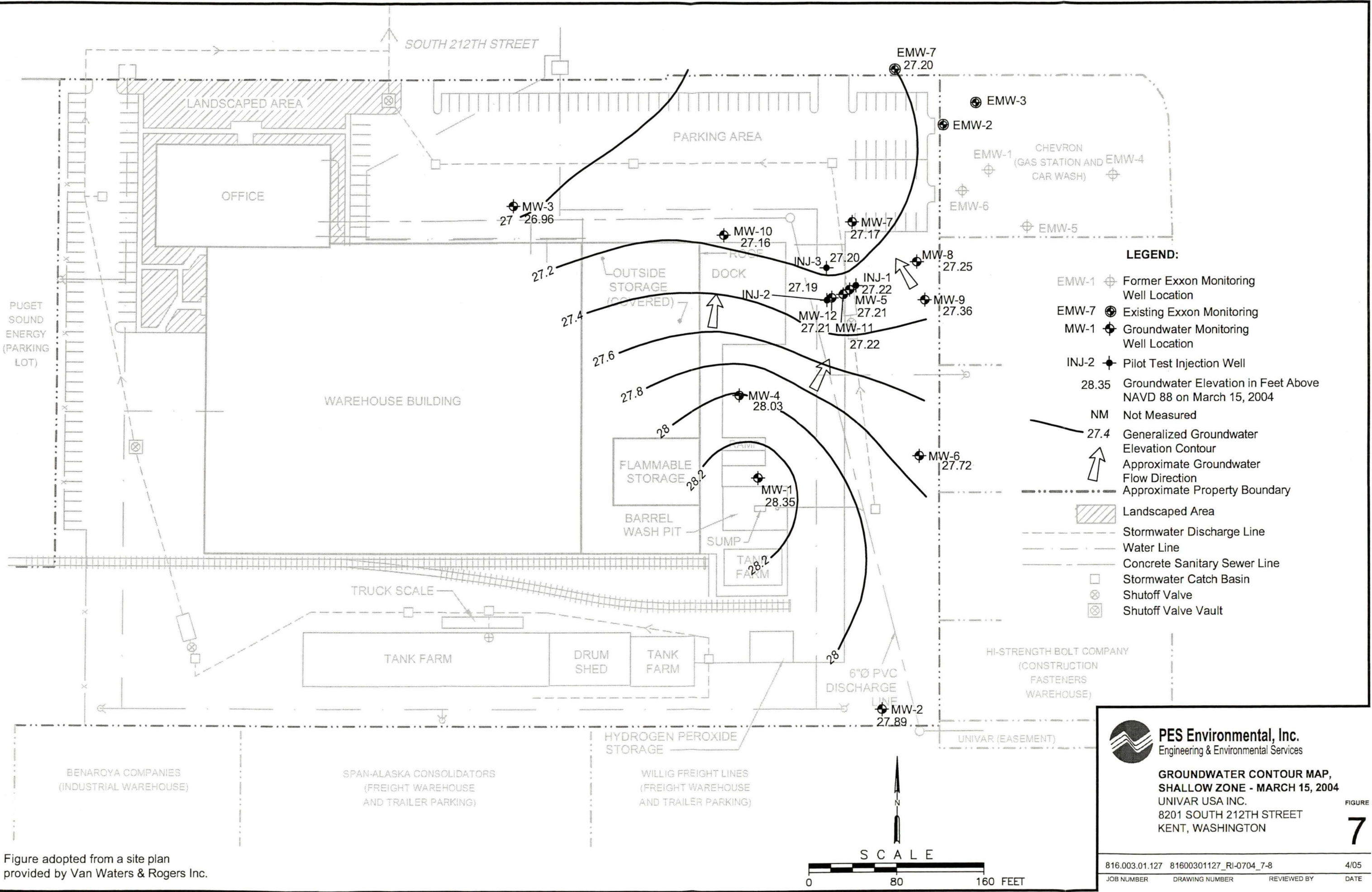
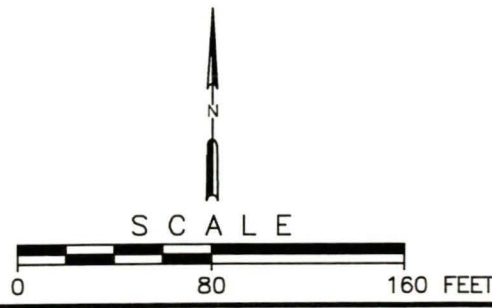


Figure adopted from a site plan provided by Van Waters & Rogers Inc.

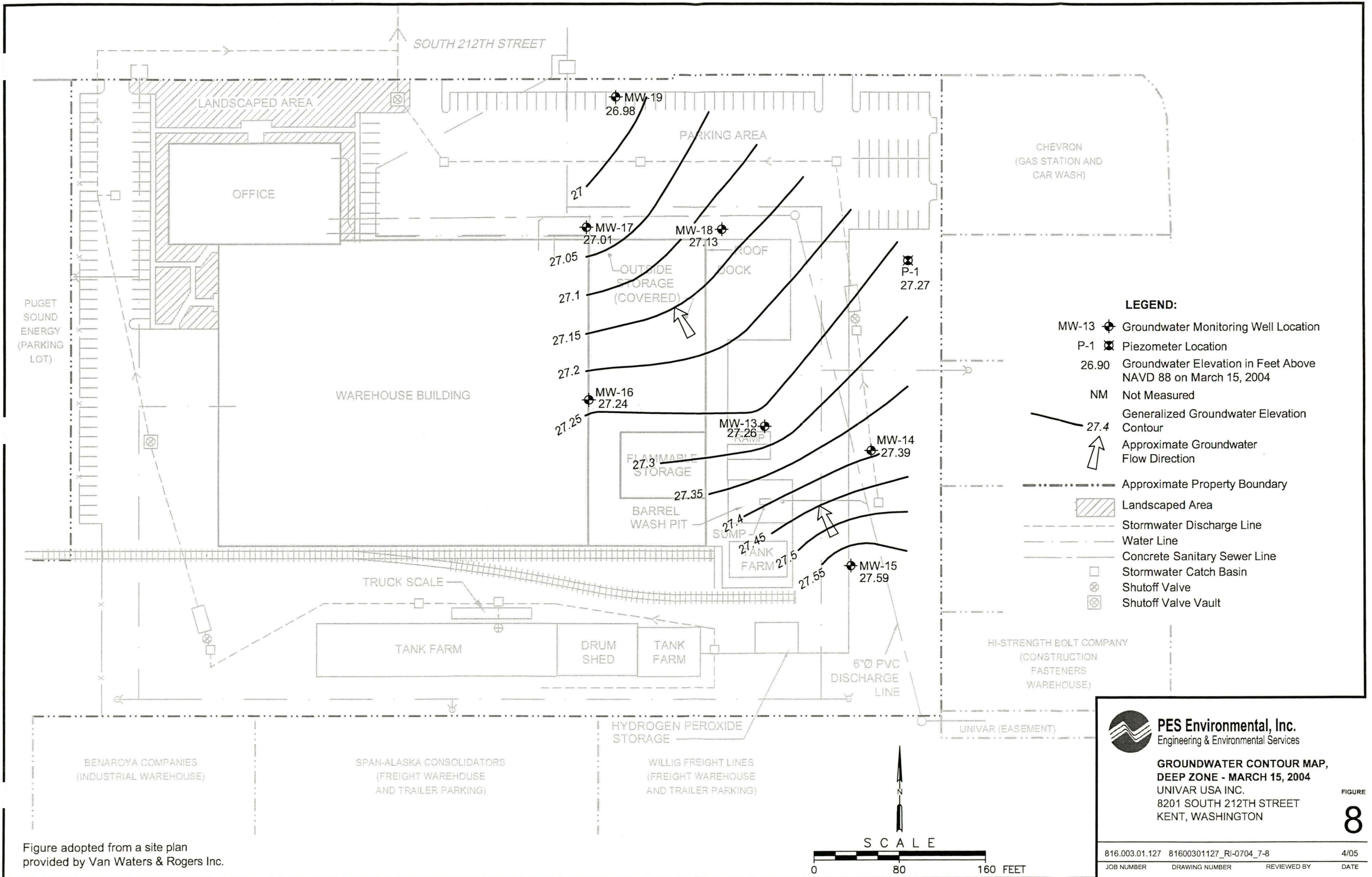


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**GROUNDWATER CONTOUR MAP,
SHALLOW ZONE - MARCH 15, 2004**
UNIVAR USA INC.
8201 SOUTH 212TH STREET
KENT, WASHINGTON

FIGURE **7**

816.003.01.127 81600301127_RI-0704_7-8 4/05
JOB NUMBER DRAWING NUMBER REVIEWED BY DATE



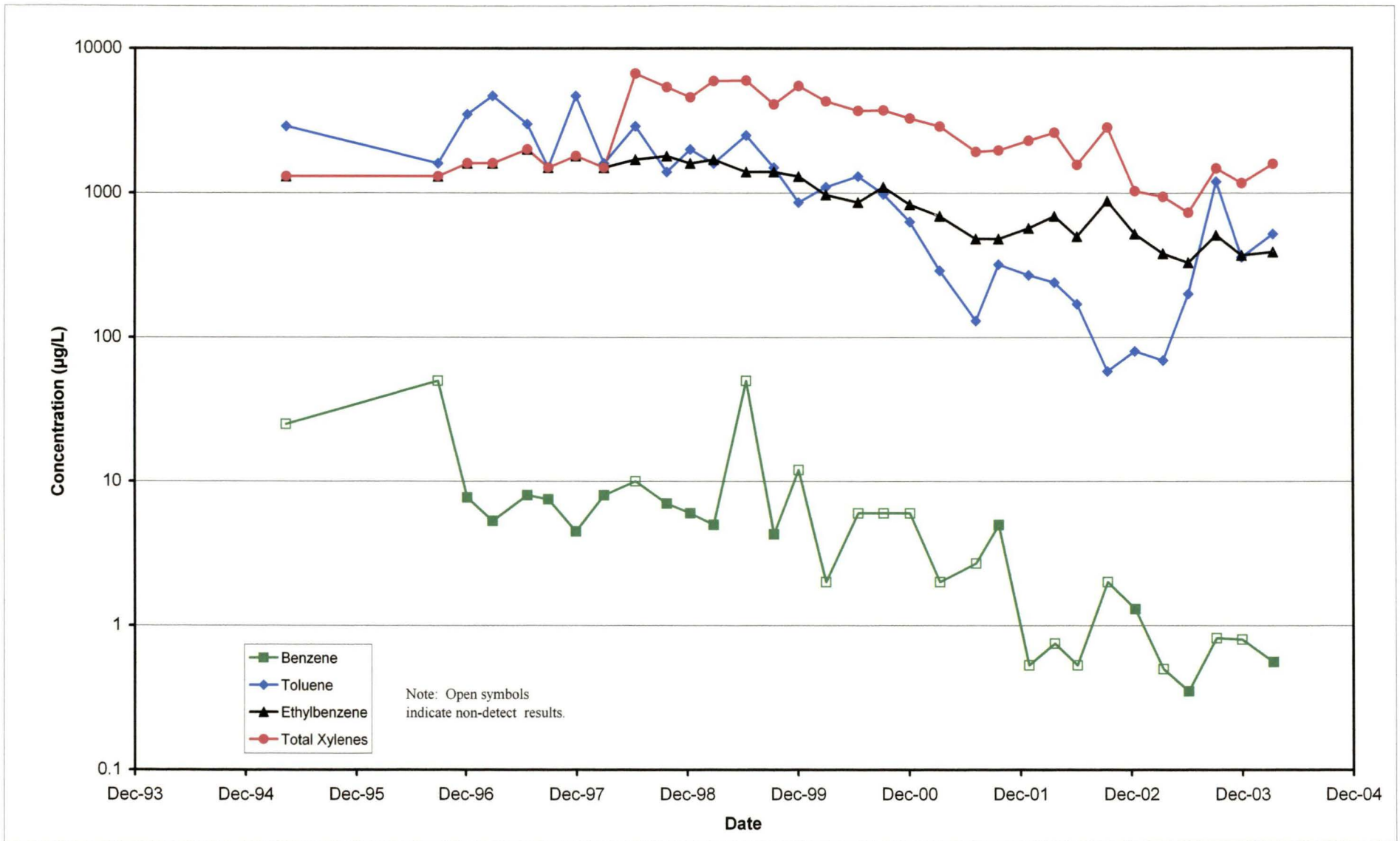
PES Environmental, Inc.
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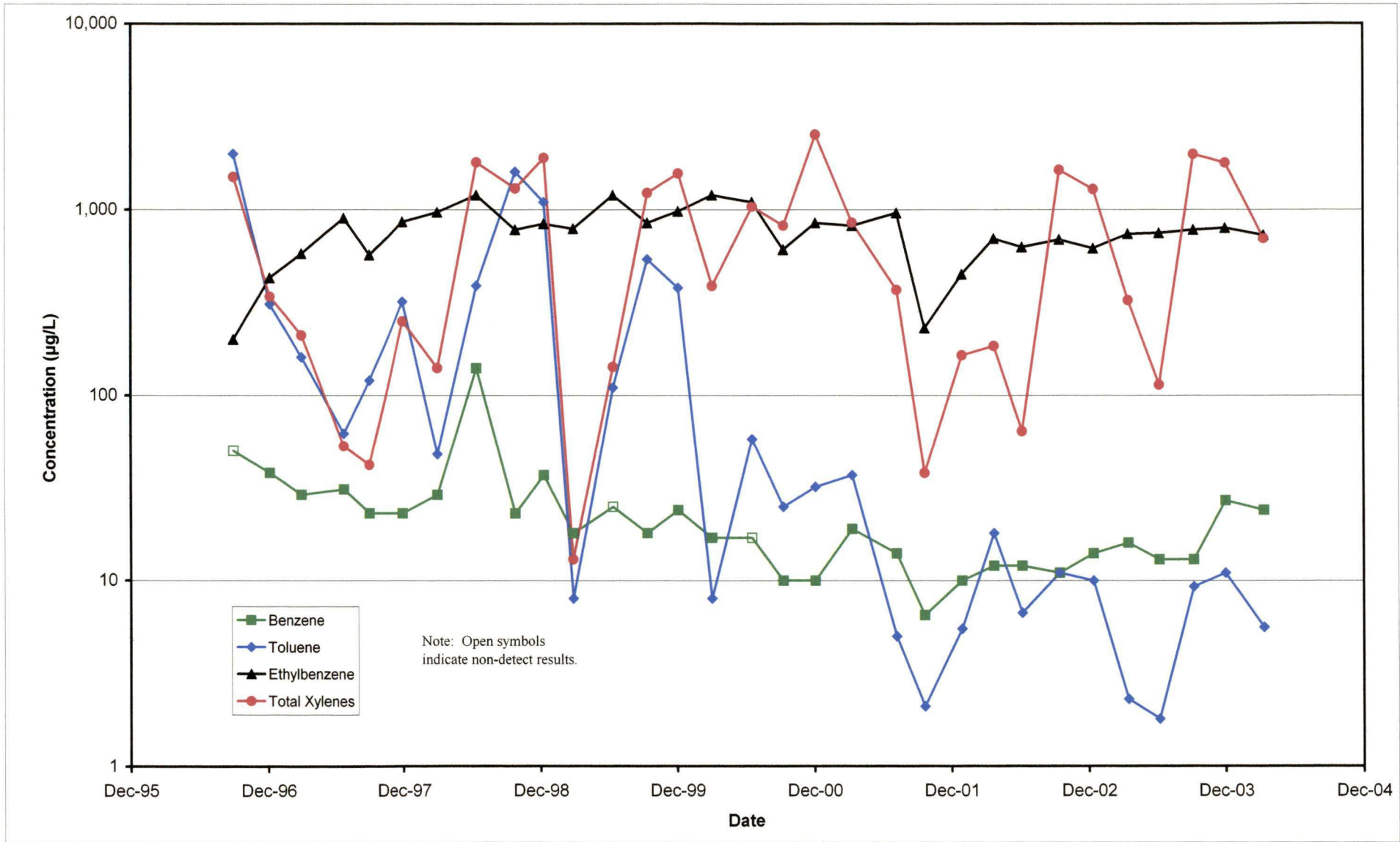
**GROUNDWATER CONTOUR MAP,
DEEP ZONE - MARCH 15, 2004**

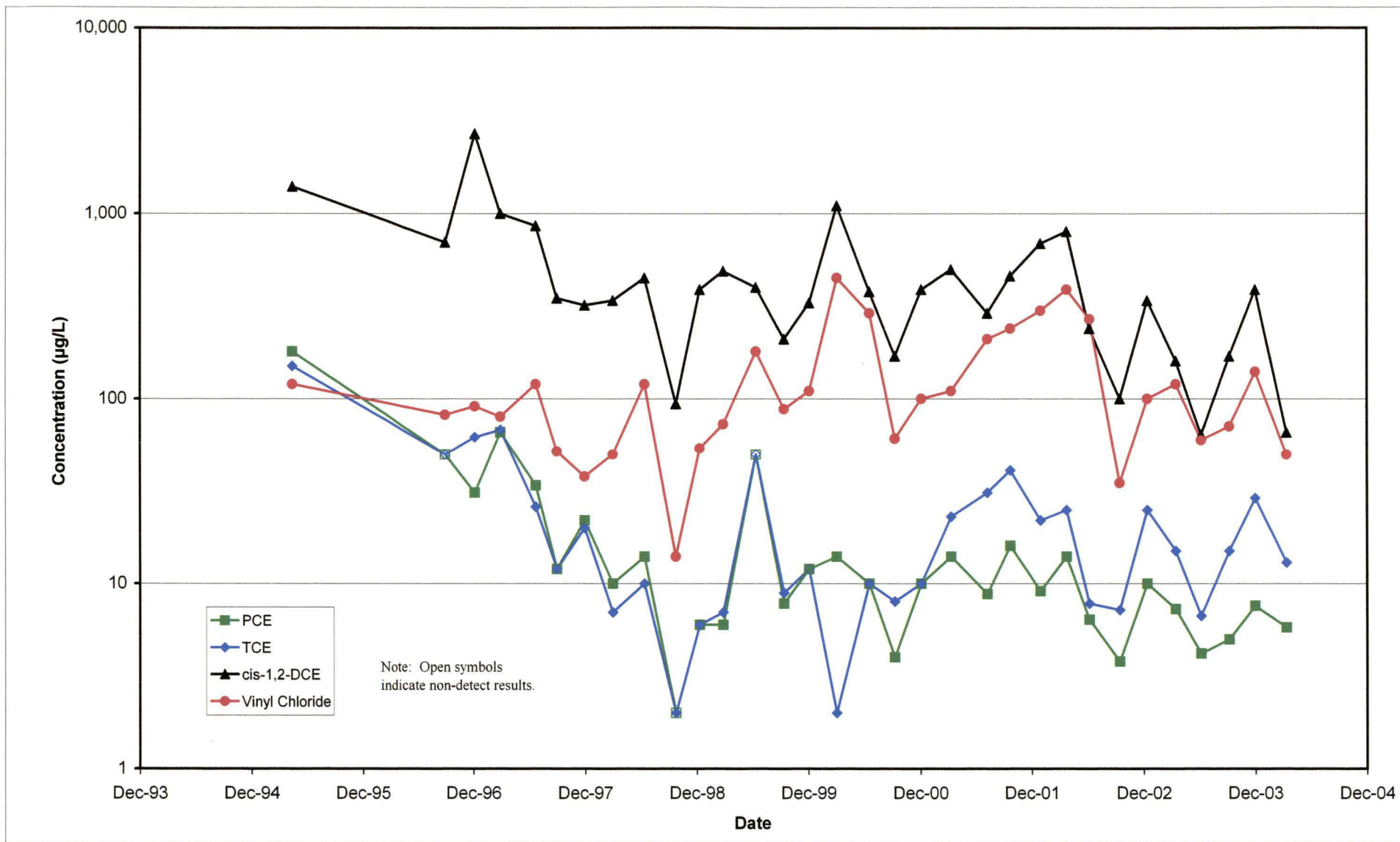
UNIVAR USA INC.
8201 SOUTH 212TH STREET
KENT, WASHINGTON

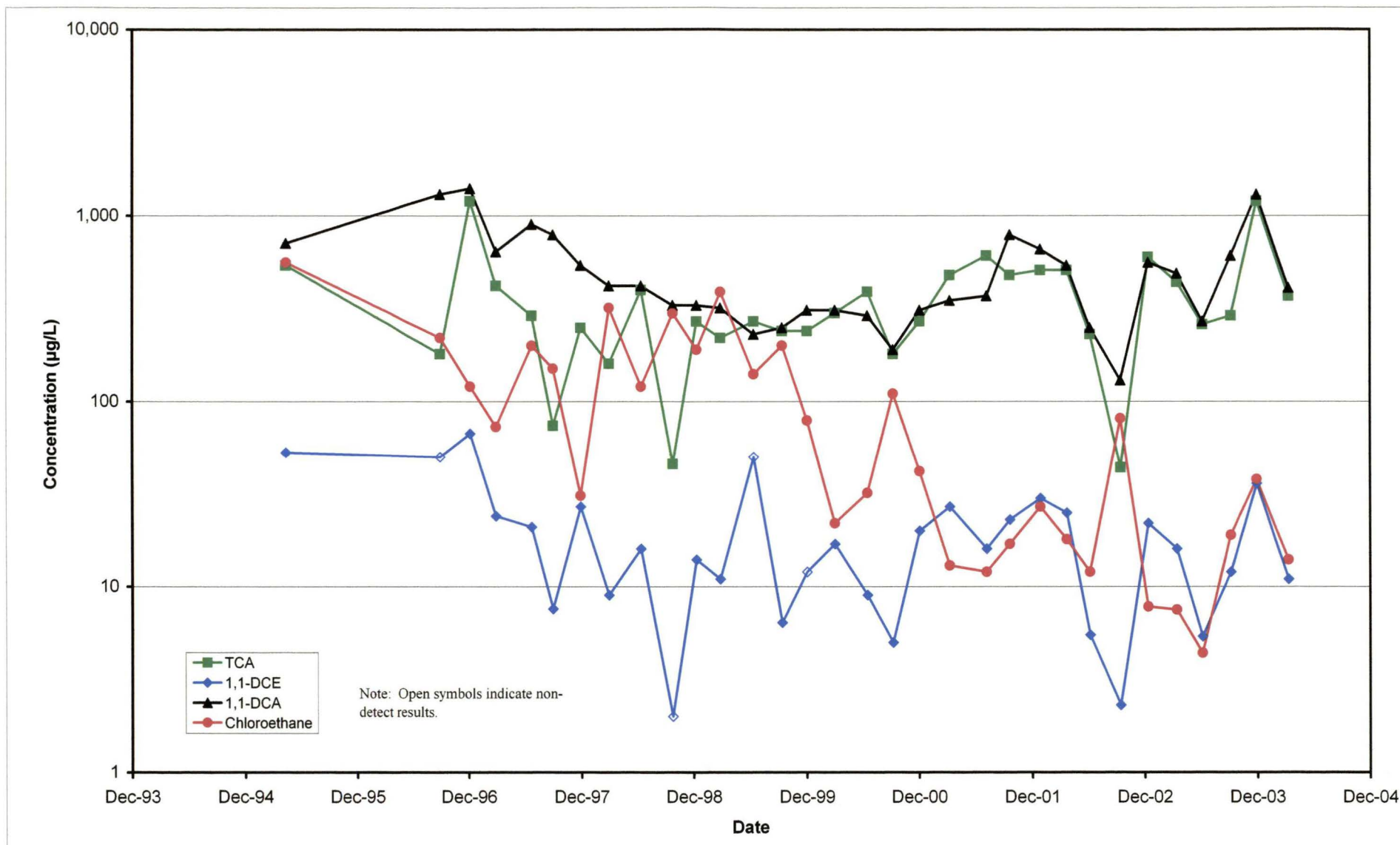
FIGURE 8

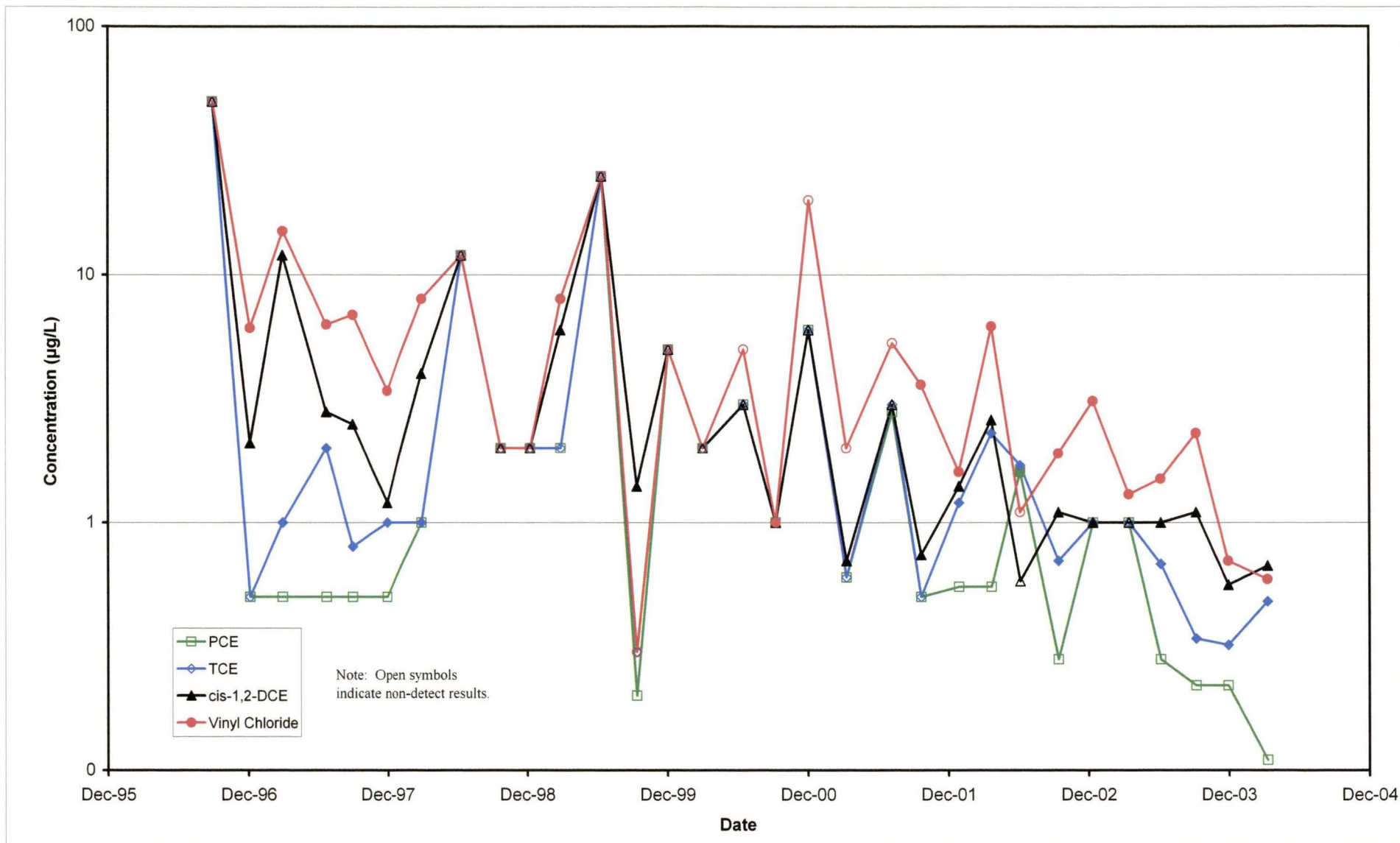
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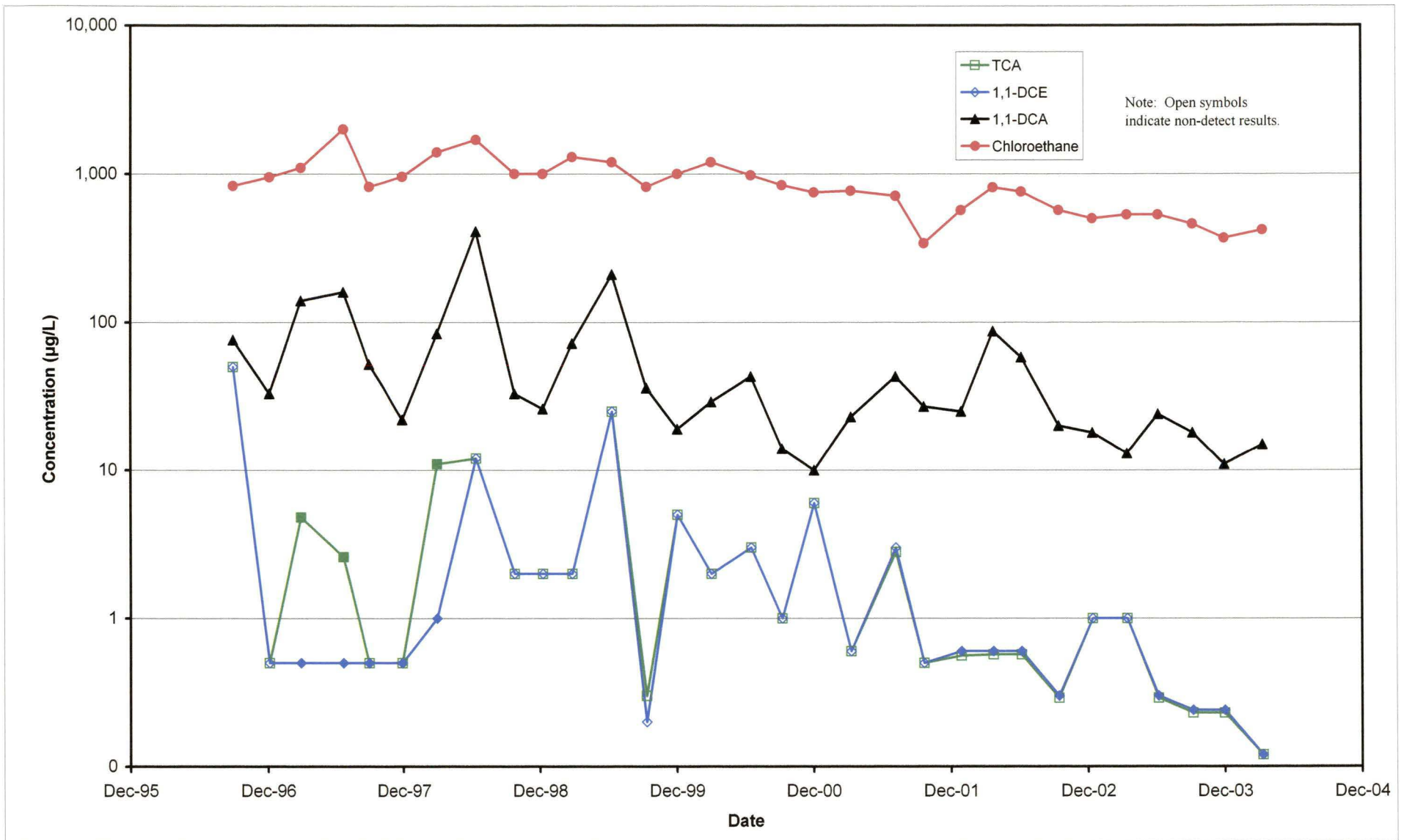


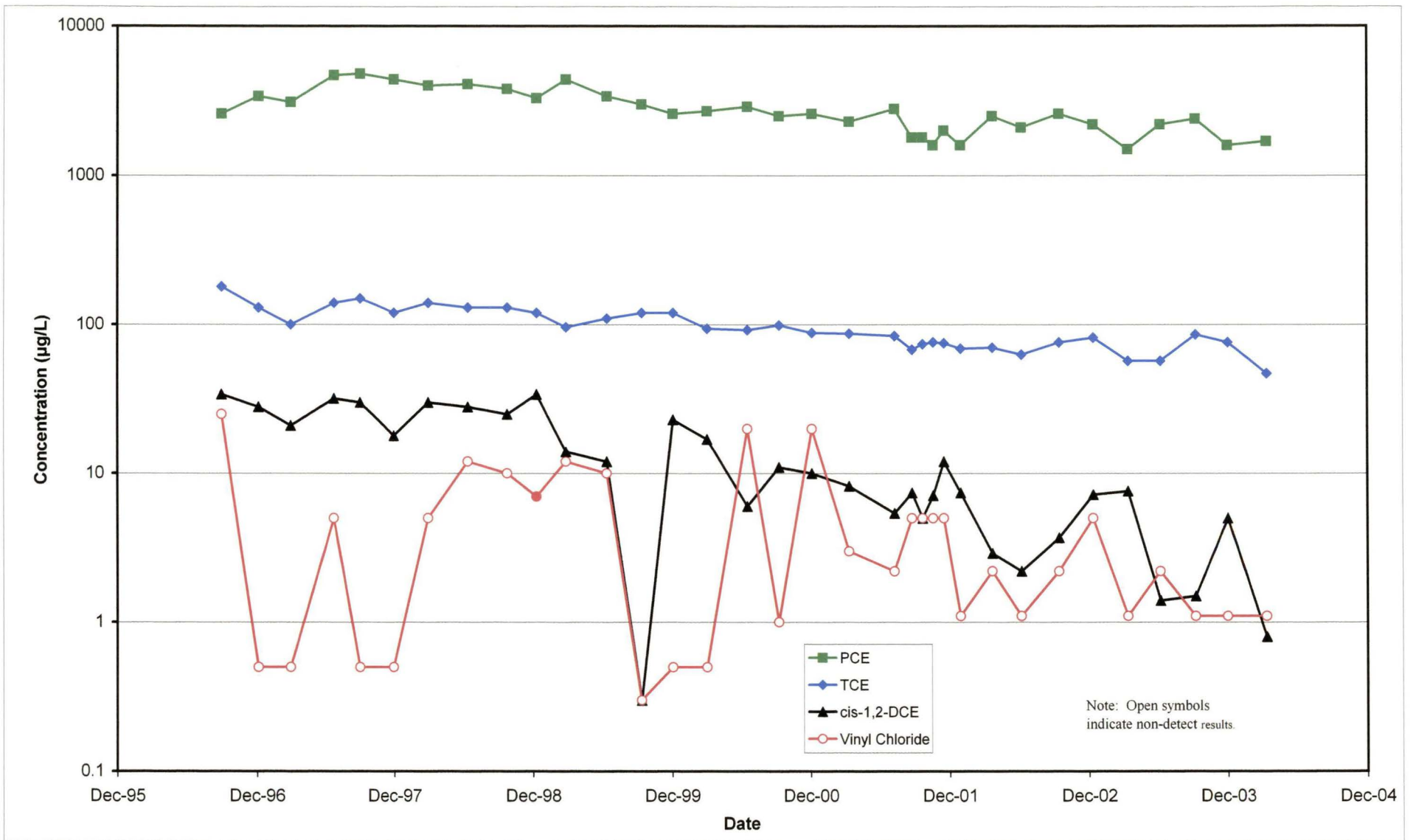


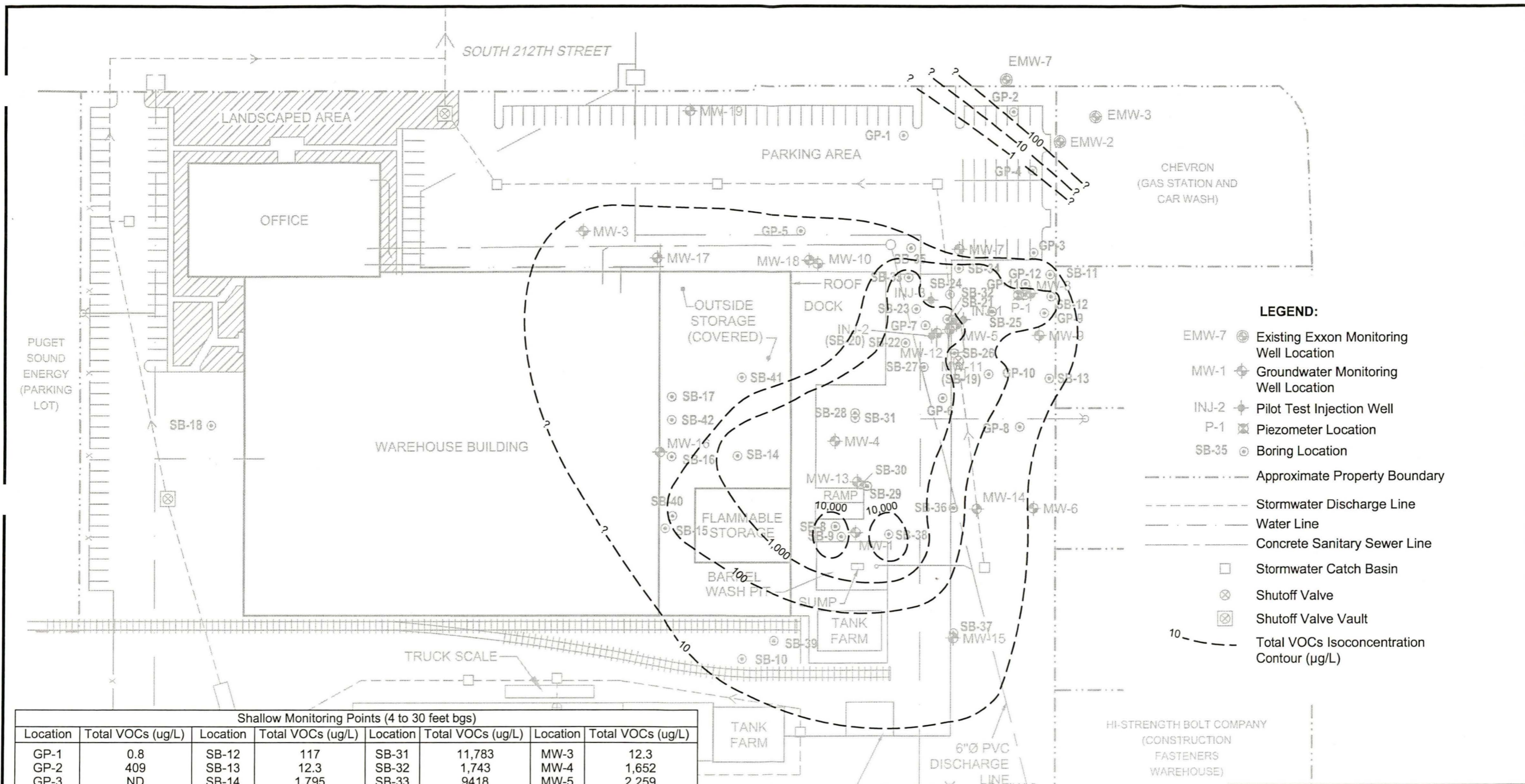












LEGEND:

- EMW-7 Existing Exxon Monitoring Well Location
- MW-1 Groundwater Monitoring Well Location
- INJ-2 Pilot Test Injection Well
- P-1 Piezometer Location
- SB-35 Boring Location
- Approximate Property Boundary
- Stormwater Discharge Line
- Water Line
- Concrete Sanitary Sewer Line
- Stormwater Catch Basin
- Shutoff Valve
- Shutoff Valve Vault
- Total VOCs Isoconcentration Contour (ug/L)

Shallow Monitoring Points (4 to 30 feet bgs)							
Location	Total VOCs (ug/L)	Location	Total VOCs (ug/L)	Location	Total VOCs (ug/L)	Location	Total VOCs (ug/L)
GP-1	0.8	SB-12	117	SB-31	11,783	MW-3	12.3
GP-2	409	SB-13	12.3	SB-32	1,743	MW-4	1,652
GP-3	ND	SB-14	1,795	SB-33	9418	MW-5	2,259
GP-4	ND	SB-16	89.0	SB-34	579	MW-6	4.4
GP-5	13.5	SB-17	18.8	SB-35	77.2	MW-7	9.0
GP-6	1,090	SB-18	1.3	SB-36	102	MW-8	20.1
GP-7	6,452	SB-21	1,865	SB-37	59.5	MW-9	47.3
GP-8	43.9	SB-22	1,967	SB-38	36,525	MW-10	0.8
GP-9	329	SB-23	7,312	SB-39	19.8	MW-11	1,771
GP-10	588	SB-24	3,967	SB-40	116	MW-12	4,825
GP-12	113	SB-25	548	SB-41	78.4	INJ-1	559
SB-9	36,313	SB-26	173	SB-43	0.2	INJ-2	5,436
SB-10	37.4	SB-27	2,075	MW-1	2,393	INJ-3	968
SB-11	ND	SB-30	17,574	MW-2	4.2		

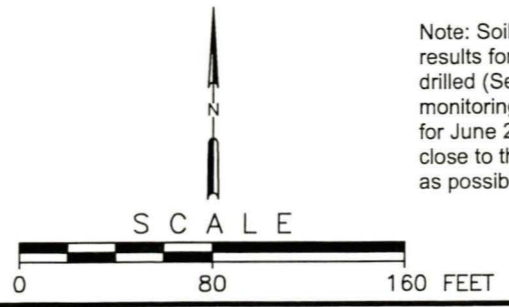
Note: Soil Boring results for date drilled (See Table 7), monitoring well data for June 2003 or as close to that date as possible



TOTAL VOCs IN GROUNDWATER (4 TO 30 FEET)
 UNIVAR USA INC.
 8201 SOUTH 212TH STREET
 KENT, WASHINGTON

FIGURE
16

Figure adopted from a site plan provided by Van Waters & Rogers Inc.



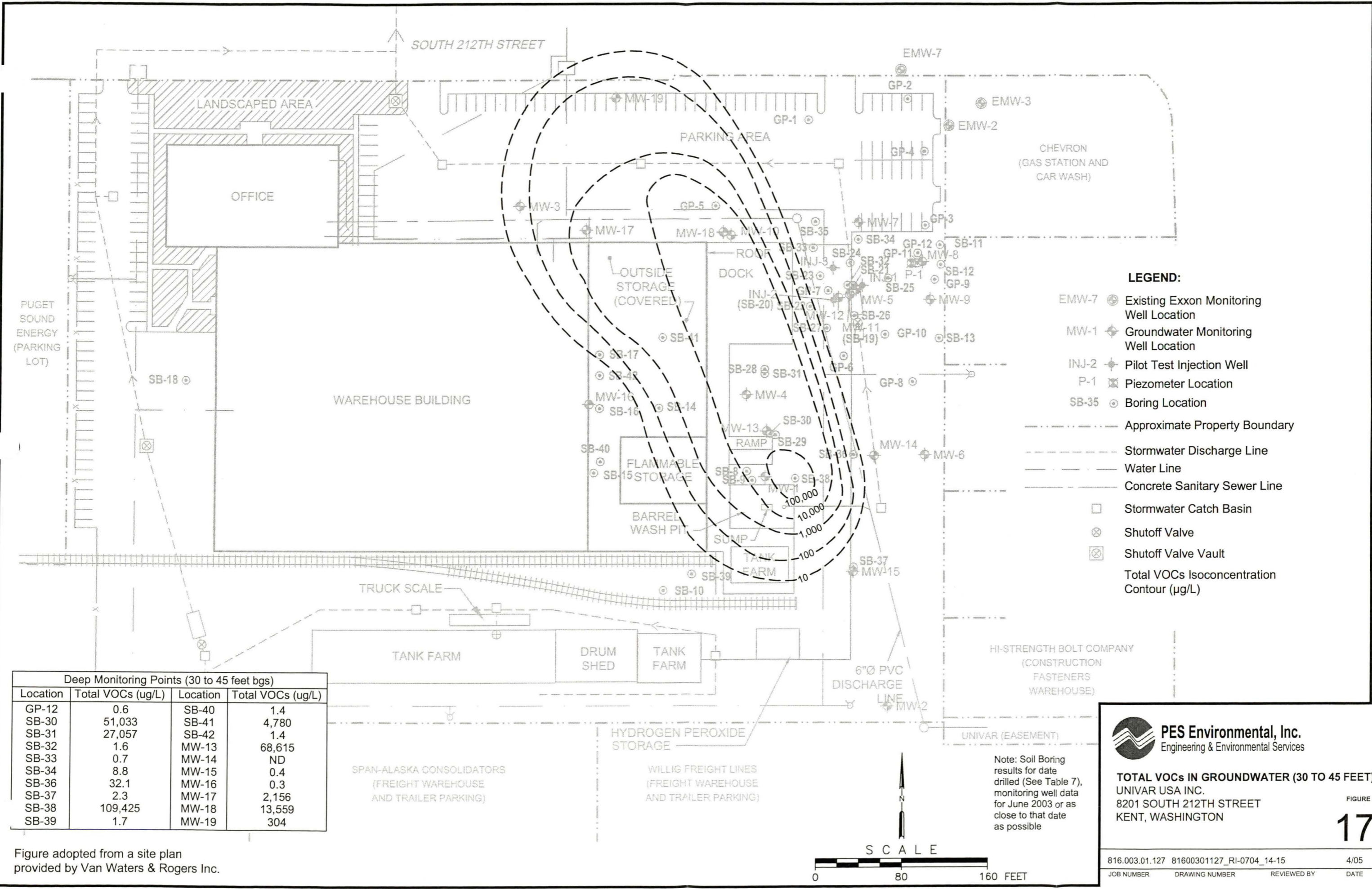
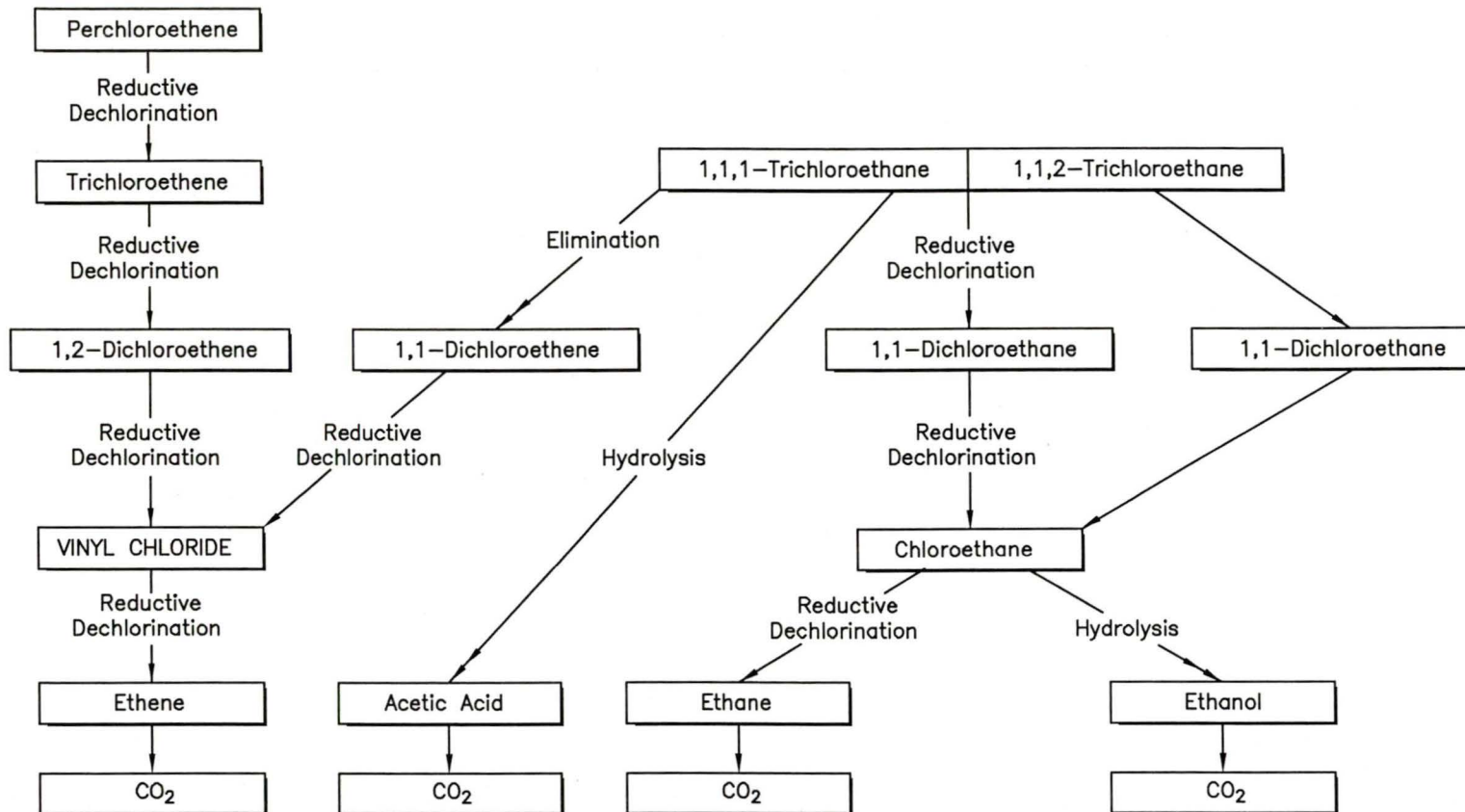


Figure adopted from a site plan provided by Van Waters & Rogers Inc.



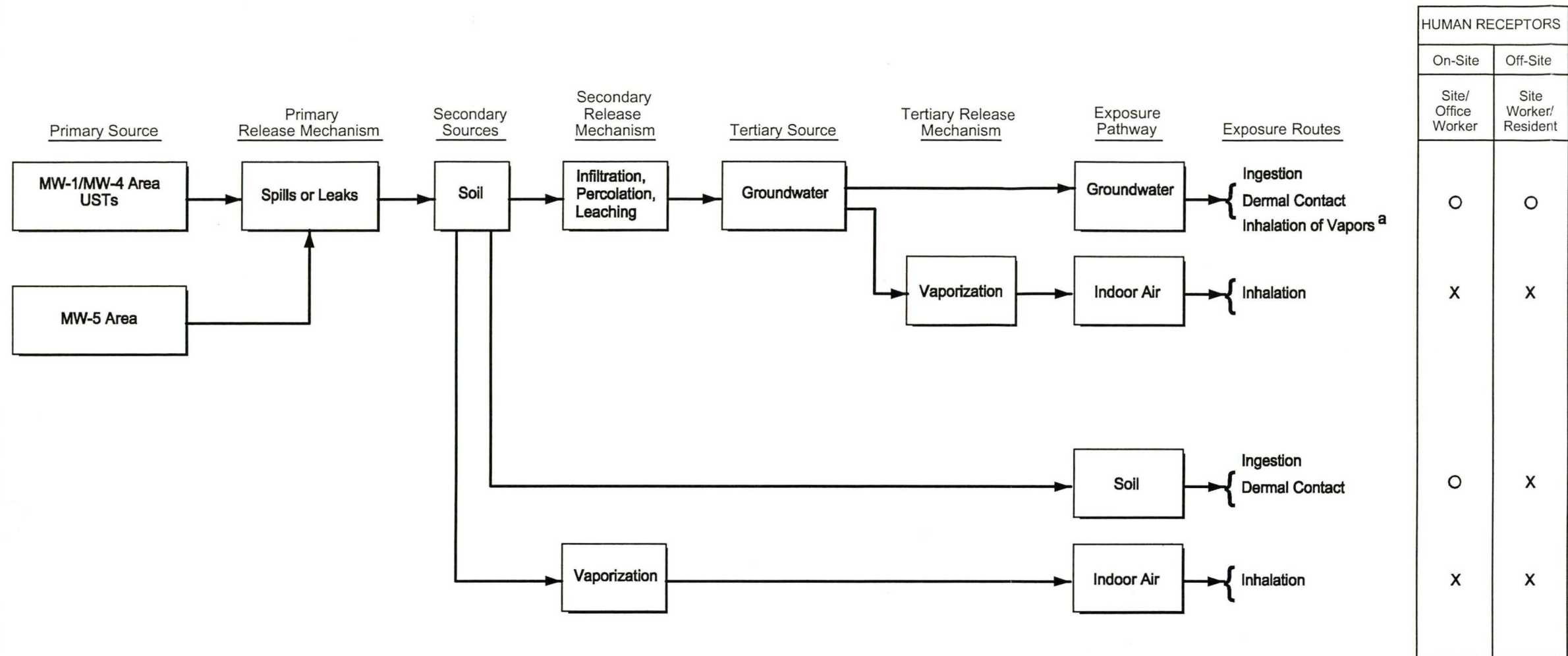
TOTAL VOCs IN GROUNDWATER (30 TO 45 FEET)
UNIVAR USA INC.
8201 SOUTH 212TH STREET
KENT, WASHINGTON

FIGURE
17



LEGEND:

- Biotic Reactions (Anaerobic Conditions)
- Abiotic Reactions (Anaerobic or Aerobic Conditions)



HUMAN RECEPTORS	
On-Site	Off-Site
Site/ Office Worker	Site Worker/ Resident
○	○
X	X
○	X
X	X

LEGEND:

- Current Complete Pathway
- Potential Future Pathway
- X Incomplete Pathway

FOOTNOTE:

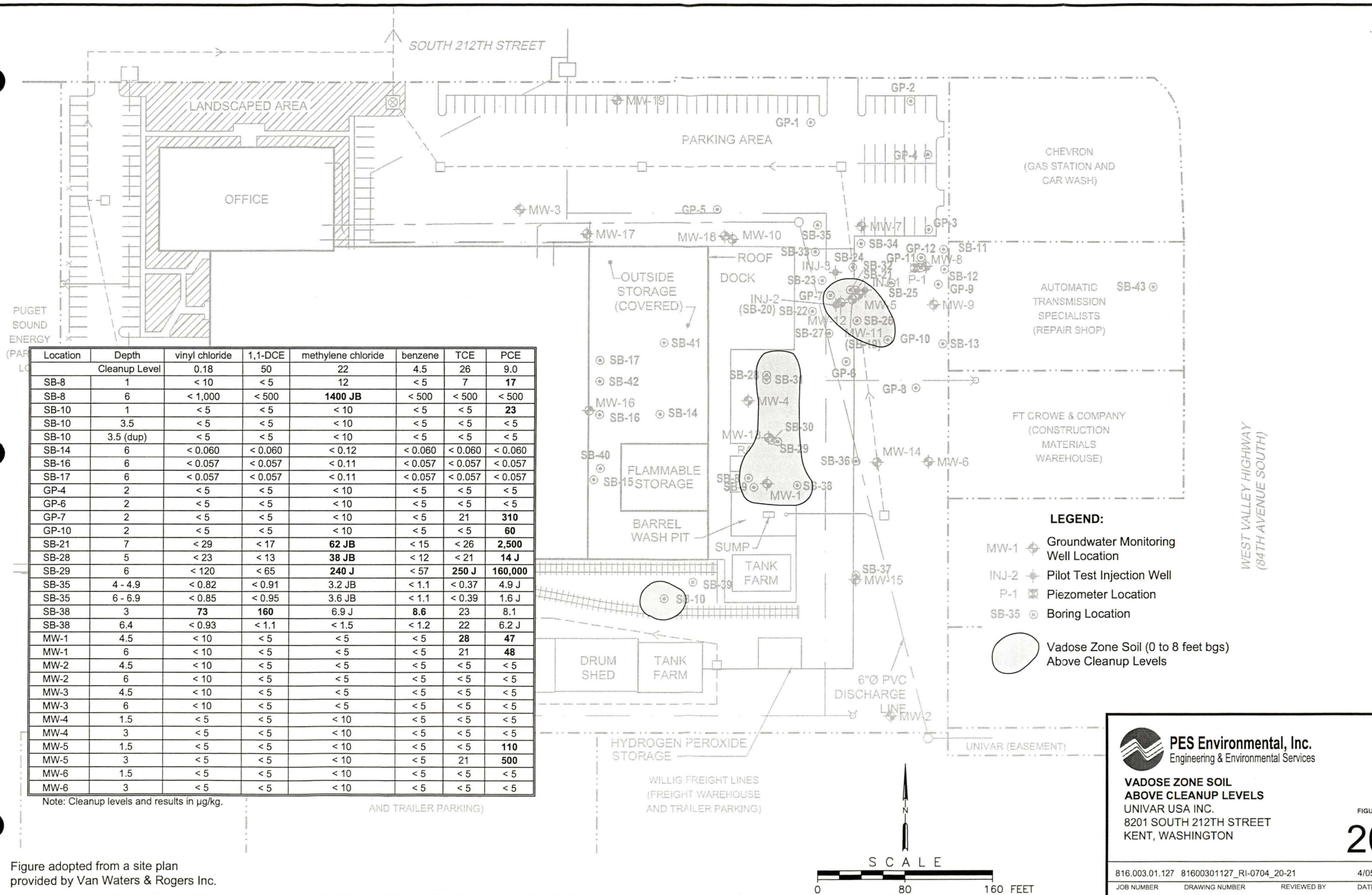
^a From Household use , such as showering.



Conceptual Site Model
Univar USA Inc.
Kent, Washington

FIGURE
19

SOUTH 212TH STREET



Location	Depth	vinyl chloride	1,1-DCE	methylene chloride	benzene	TCE	PCE
	Cleanup Level	0.18	50	22	4.5	26	9.0
SB-8	1	< 10	< 5	12	< 5	7	17
SB-8	6	< 1,000	< 500	1400 JB	< 500	< 500	< 500
SB-10	1	< 5	< 5	< 10	< 5	< 5	23
SB-10	3.5	< 5	< 5	< 10	< 5	< 5	< 5
SB-10	3.5 (dup)	< 5	< 5	< 10	< 5	< 5	< 5
SB-14	6	< 0.060	< 0.060	< 0.12	< 0.060	< 0.060	< 0.060
SB-16	6	< 0.057	< 0.057	< 0.11	< 0.057	< 0.057	< 0.057
SB-17	6	< 0.057	< 0.057	< 0.11	< 0.057	< 0.057	< 0.057
GP-4	2	< 5	< 5	< 10	< 5	< 5	< 5
GP-6	2	< 5	< 5	< 10	< 5	< 5	< 5
GP-7	2	< 5	< 5	< 10	< 5	21	310
GP-10	2	< 5	< 5	< 10	< 5	< 5	60
SB-21	7	< 29	< 17	62 JB	< 15	< 26	2,500
SB-28	5	< 23	< 13	38 JB	< 12	< 21	14 J
SB-29	6	< 120	< 65	240 J	< 57	250 J	160,000
SB-35	4 - 4.9	< 0.82	< 0.91	3.2 JB	< 1.1	< 0.37	4.9 J
SB-35	6 - 6.9	< 0.85	< 0.95	3.6 JB	< 1.1	< 0.39	1.6 J
SB-38	3	73	160	6.9 J	8.6	23	8.1
SB-38	6.4	< 0.93	< 1.1	< 1.5	< 1.2	22	6.2 J
MW-1	4.5	< 10	< 5	< 5	< 5	28	47
MW-1	6	< 10	< 5	< 5	< 5	21	48
MW-2	4.5	< 10	< 5	< 5	< 5	< 5	< 5
MW-2	6	< 10	< 5	< 5	< 5	< 5	< 5
MW-3	4.5	< 10	< 5	< 5	< 5	< 5	< 5
MW-3	6	< 10	< 5	< 5	< 5	< 5	< 5
MW-4	1.5	< 5	< 5	< 10	< 5	< 5	< 5
MW-4	3	< 5	< 5	< 10	< 5	< 5	< 5
MW-5	1.5	< 5	< 5	< 10	< 5	< 5	110
MW-5	3	< 5	< 5	< 10	< 5	21	500
MW-6	1.5	< 5	< 5	< 10	< 5	< 5	< 5
MW-6	3	< 5	< 5	< 10	< 5	< 5	< 5

Note: Cleanup levels and results in µg/kg.

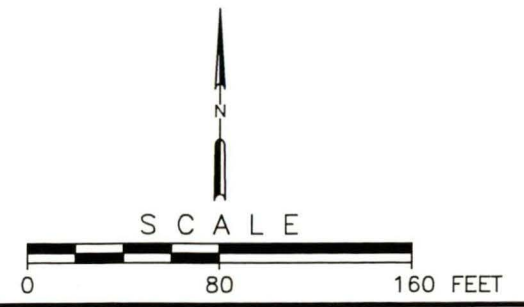
LEGEND:
 MW-1 ◈ Groundwater Monitoring Well Location
 INJ-2 ◈ Pilot Test Injection Well
 P-1 ◈ Piezometer Location
 SB-35 ◉ Boring Location
 ◉ Vadoso Zone Soil (0 to 8 feet bgs) Above Cleanup Levels

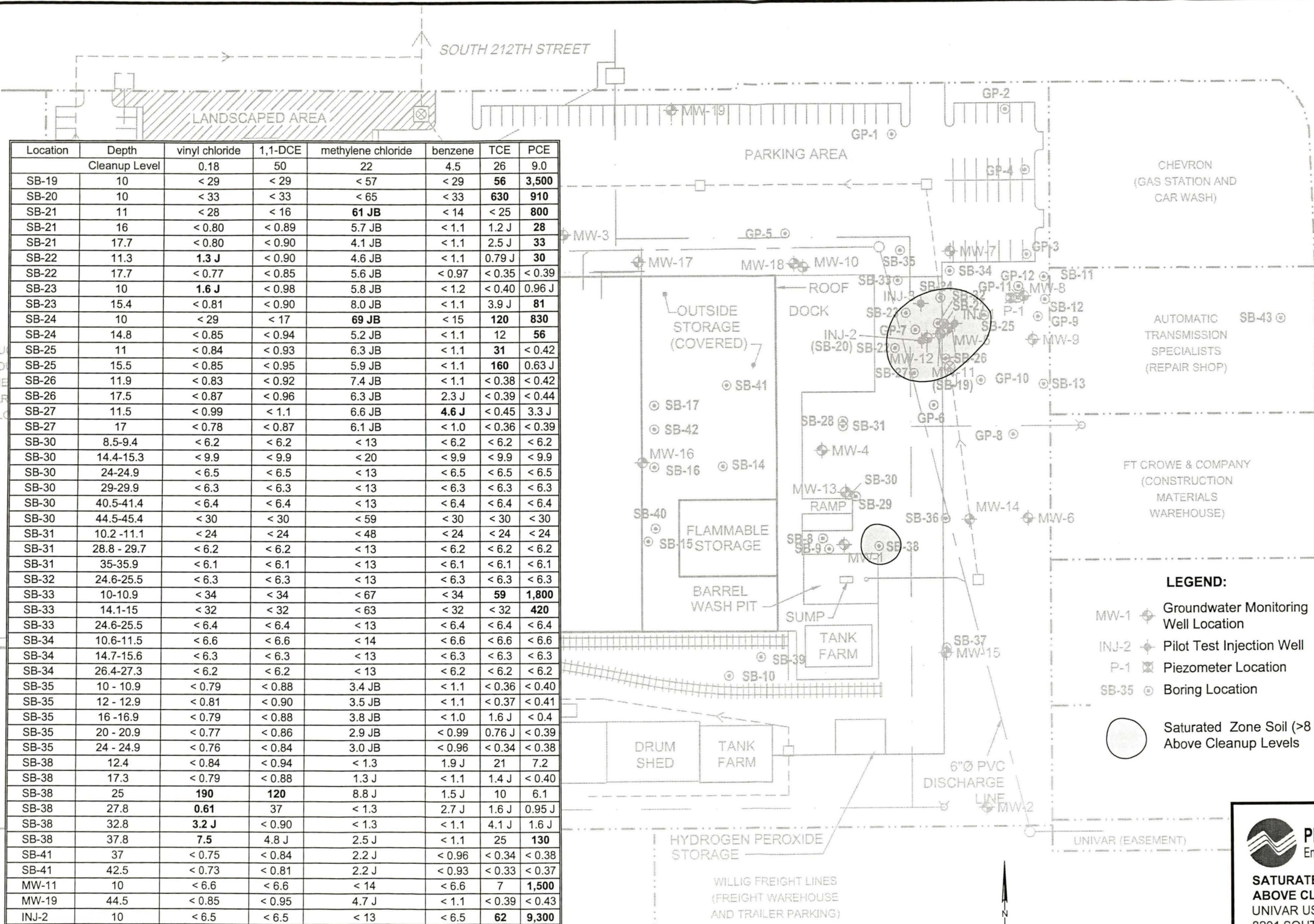


VADOSE ZONE SOIL ABOVE CLEANUP LEVELS
 UNIVAR USA INC.
 8201 SOUTH 212TH STREET
 KENT, WASHINGTON

FIGURE
20

Figure adopted from a site plan provided by Van Waters & Rogers Inc.





Location	Depth	vinyl chloride	1,1-DCE	methylene chloride	benzene	TCE	PCE
	Cleanup Level	0.18	50	22	4.5	26	9.0
SB-19	10	< 29	< 29	< 57	< 29	56	3,500
SB-20	10	< 33	< 33	< 65	< 33	630	910
SB-21	11	< 28	< 16	61 JB	< 14	< 25	800
SB-21	16	< 0.80	< 0.89	5.7 JB	< 1.1	1.2 J	28
SB-21	17.7	< 0.80	< 0.90	4.1 JB	< 1.1	2.5 J	33
SB-22	11.3	1.3 J	< 0.90	4.6 JB	< 1.1	0.79 J	30
SB-22	17.7	< 0.77	< 0.85	5.6 JB	< 0.97	< 0.35	< 0.39
SB-23	10	1.6 J	< 0.98	5.8 JB	< 1.2	< 0.40	0.96 J
SB-23	15.4	< 0.81	< 0.90	8.0 JB	< 1.1	3.9 J	81
SB-24	10	< 29	< 17	69 JB	< 15	120	830
SB-24	14.8	< 0.85	< 0.94	5.2 JB	< 1.1	12	56
SB-25	11	< 0.84	< 0.93	6.3 JB	< 1.1	31	< 0.42
SB-25	15.5	< 0.85	< 0.95	5.9 JB	< 1.1	160	0.63 J
SB-26	11.9	< 0.83	< 0.92	7.4 JB	< 1.1	< 0.38	< 0.42
SB-26	17.5	< 0.87	< 0.96	6.3 JB	2.3 J	< 0.39	< 0.44
SB-27	11.5	< 0.99	< 1.1	6.6 JB	4.6 J	< 0.45	3.3 J
SB-27	17	< 0.78	< 0.87	6.1 JB	< 1.0	< 0.36	< 0.39
SB-30	8.5-9.4	< 6.2	< 6.2	< 13	< 6.2	< 6.2	< 6.2
SB-30	14.4-15.3	< 9.9	< 9.9	< 20	< 9.9	< 9.9	< 9.9
SB-30	24-24.9	< 6.5	< 6.5	< 13	< 6.5	< 6.5	< 6.5
SB-30	29-29.9	< 6.3	< 6.3	< 13	< 6.3	< 6.3	< 6.3
SB-30	40.5-41.4	< 6.4	< 6.4	< 13	< 6.4	< 6.4	< 6.4
SB-30	44.5-45.4	< 30	< 30	< 59	< 30	< 30	< 30
SB-31	10.2-11.1	< 24	< 24	< 48	< 24	< 24	< 24
SB-31	28.8 - 29.7	< 6.2	< 6.2	< 13	< 6.2	< 6.2	< 6.2
SB-31	35-35.9	< 6.1	< 6.1	< 13	< 6.1	< 6.1	< 6.1
SB-32	24.6-25.5	< 6.3	< 6.3	< 13	< 6.3	< 6.3	< 6.3
SB-33	10-10.9	< 34	< 34	< 67	< 34	59	1,800
SB-33	14.1-15	< 32	< 32	< 63	< 32	< 32	420
SB-33	24.6-25.5	< 6.4	< 6.4	< 13	< 6.4	< 6.4	< 6.4
SB-34	10.6-11.5	< 6.6	< 6.6	< 14	< 6.6	< 6.6	< 6.6
SB-34	14.7-15.6	< 6.3	< 6.3	< 13	< 6.3	< 6.3	< 6.3
SB-34	26.4-27.3	< 6.2	< 6.2	< 13	< 6.2	< 6.2	< 6.2
SB-35	10 - 10.9	< 0.79	< 0.88	3.4 JB	< 1.1	< 0.36	< 0.40
SB-35	12 - 12.9	< 0.81	< 0.90	3.5 JB	< 1.1	< 0.37	< 0.41
SB-35	16 - 16.9	< 0.79	< 0.88	3.8 JB	< 1.0	1.6 J	< 0.4
SB-35	20 - 20.9	< 0.77	< 0.86	2.9 JB	< 0.99	0.76 J	< 0.39
SB-35	24 - 24.9	< 0.76	< 0.84	3.0 JB	< 0.96	< 0.34	< 0.38
SB-38	12.4	< 0.84	< 0.94	< 1.3	1.9 J	21	7.2
SB-38	17.3	< 0.79	< 0.88	1.3 J	< 1.1	1.4 J	< 0.40
SB-38	25	190	120	8.8 J	1.5 J	10	6.1
SB-38	27.8	0.61	37	< 1.3	2.7 J	1.6 J	0.95 J
SB-38	32.8	3.2 J	< 0.90	< 1.3	< 1.1	4.1 J	1.6 J
SB-38	37.8	7.5	4.8 J	2.5 J	< 1.1	25	130
SB-41	37	< 0.75	< 0.84	2.2 J	< 0.96	< 0.34	< 0.38
SB-41	42.5	< 0.73	< 0.81	2.2 J	< 0.93	< 0.33	< 0.37
MW-11	10	< 6.6	< 6.6	< 14	< 6.6	7	1,500
MW-19	44.5	< 0.85	< 0.95	4.7 J	< 1.1	< 0.39	< 0.43
INJ-2	10	< 6.5	< 6.5	< 13	< 6.5	62	9,300

Note: Cleanup levels and results in µg/kg.

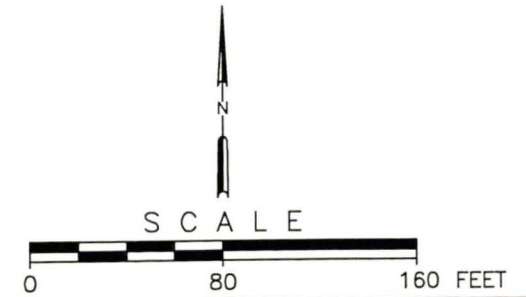
- LEGEND:**
- MW-1 Groundwater Monitoring Well Location
 - INJ-2 Pilot Test Injection Well
 - P-1 Piezometer Location
 - SB-35 Boring Location
 - Saturated Zone Soil (>8 feet bgs) Above Cleanup Levels

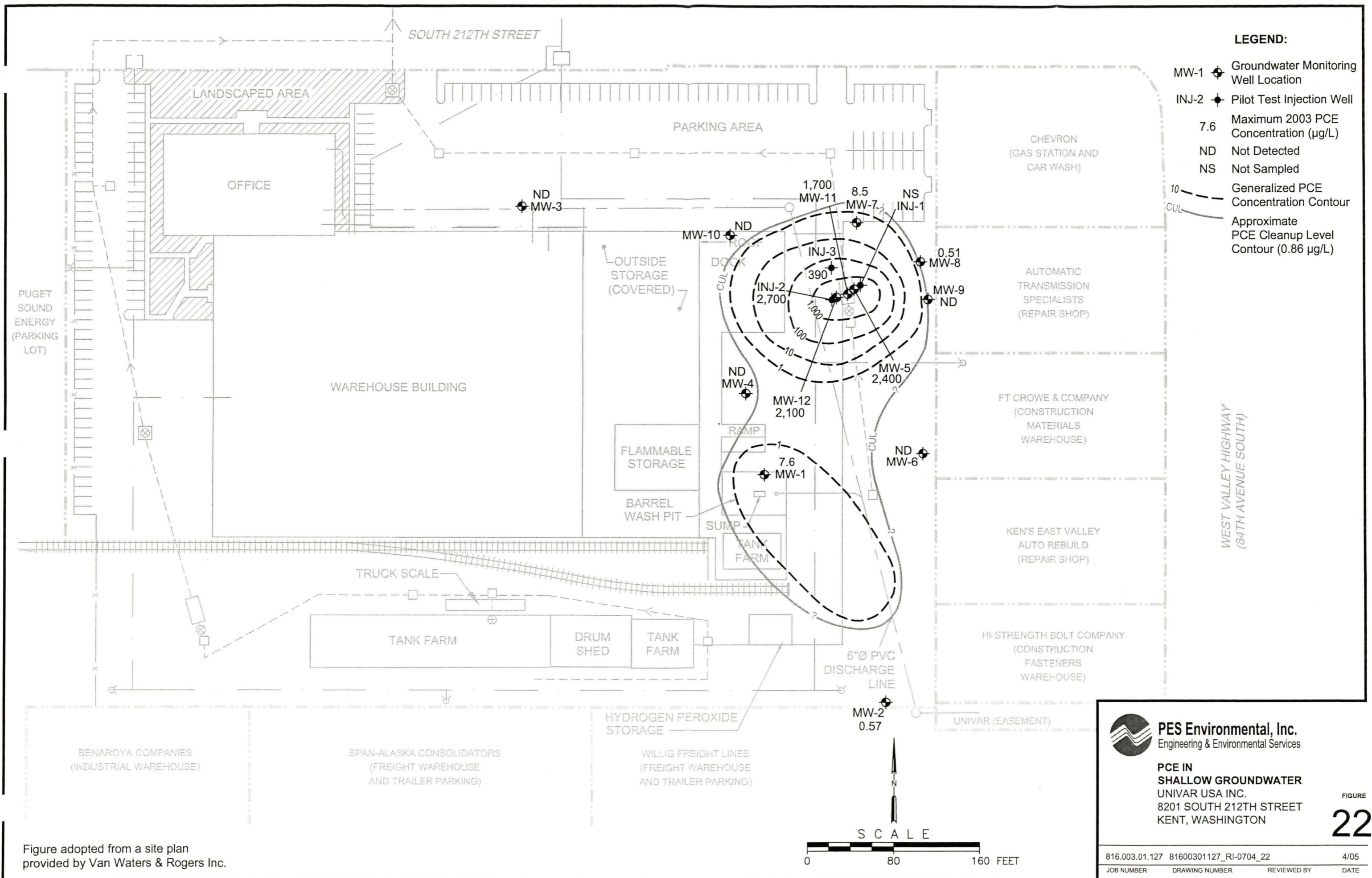


SATURATED ZONE SOIL ABOVE CLEANUP LEVELS
 UNIVAR USA INC.
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 KENT, WASHINGTON

FIGURE
21

Figure adopted from a site plan provided by Van Waters & Rogers Inc.





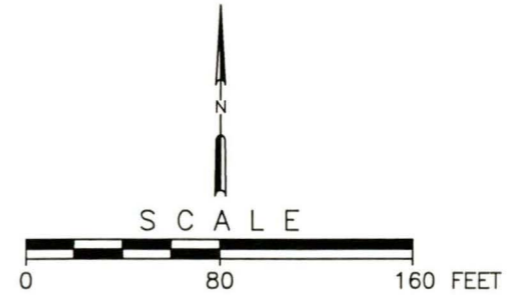
- LEGEND:**
- MW-1 Groundwater Monitoring Well Location
 - INJ-2 Pilot Test Injection Well
 - 7.6 Maximum 2003 PCE Concentration (µg/L)
 - ND Not Detected
 - NS Not Sampled
 - 10 Generalized PCE Concentration Contour
 - CUL Approximate PCE Cleanup Level Contour (0.86 µg/L)

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PCE IN SHALLOW GROUNDWATER
UNIVAR USA INC.
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KENT, WASHINGTON

FIGURE
22

Figure adopted from a site plan provided by Van Waters & Rogers Inc.



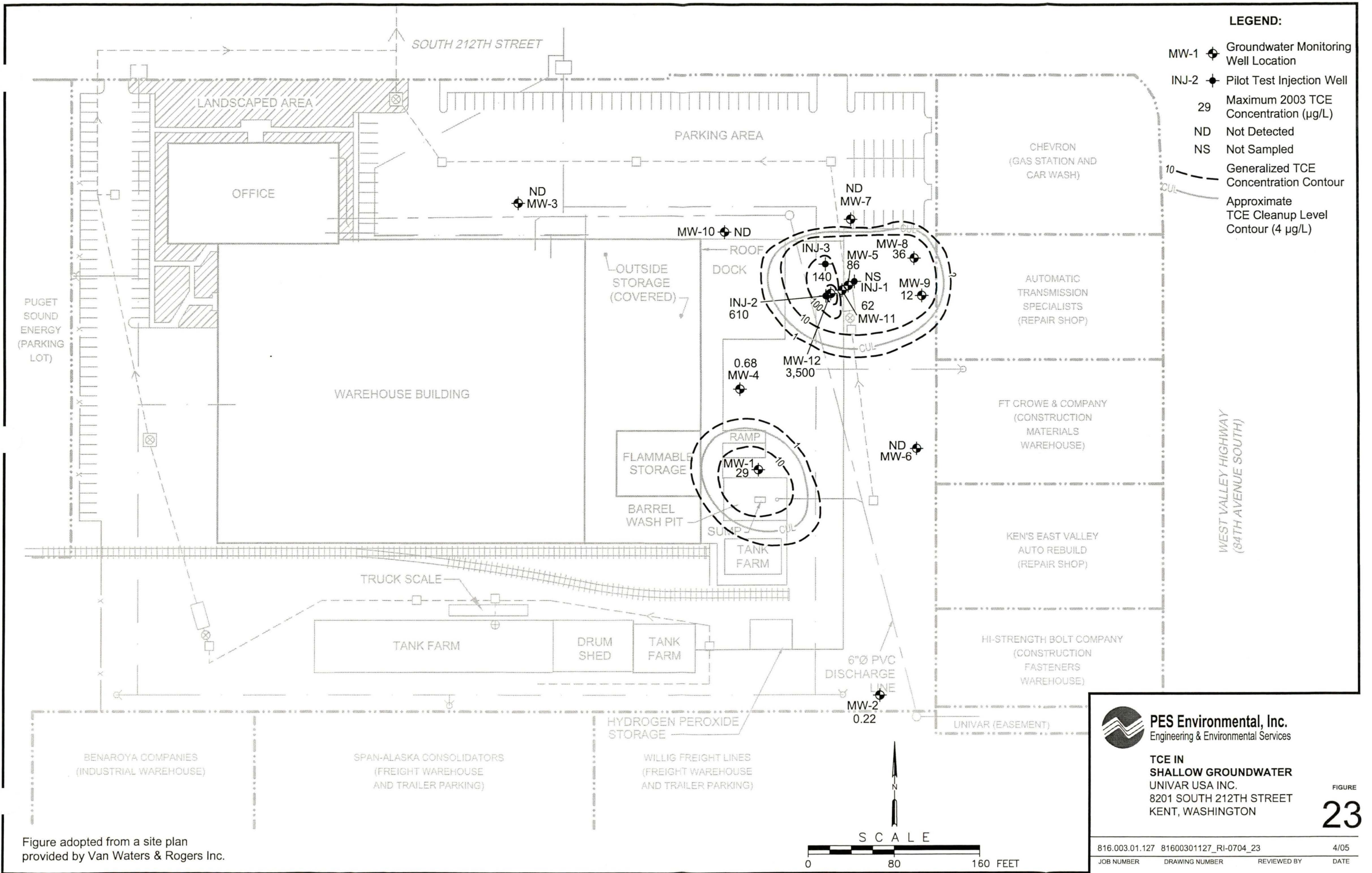


Figure adopted from a site plan provided by Van Waters & Rogers Inc.

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TCE IN SHALLOW GROUNDWATER
UNIVAR USA INC.
8201 SOUTH 212TH STREET
KENT, WASHINGTON

FIGURE
23

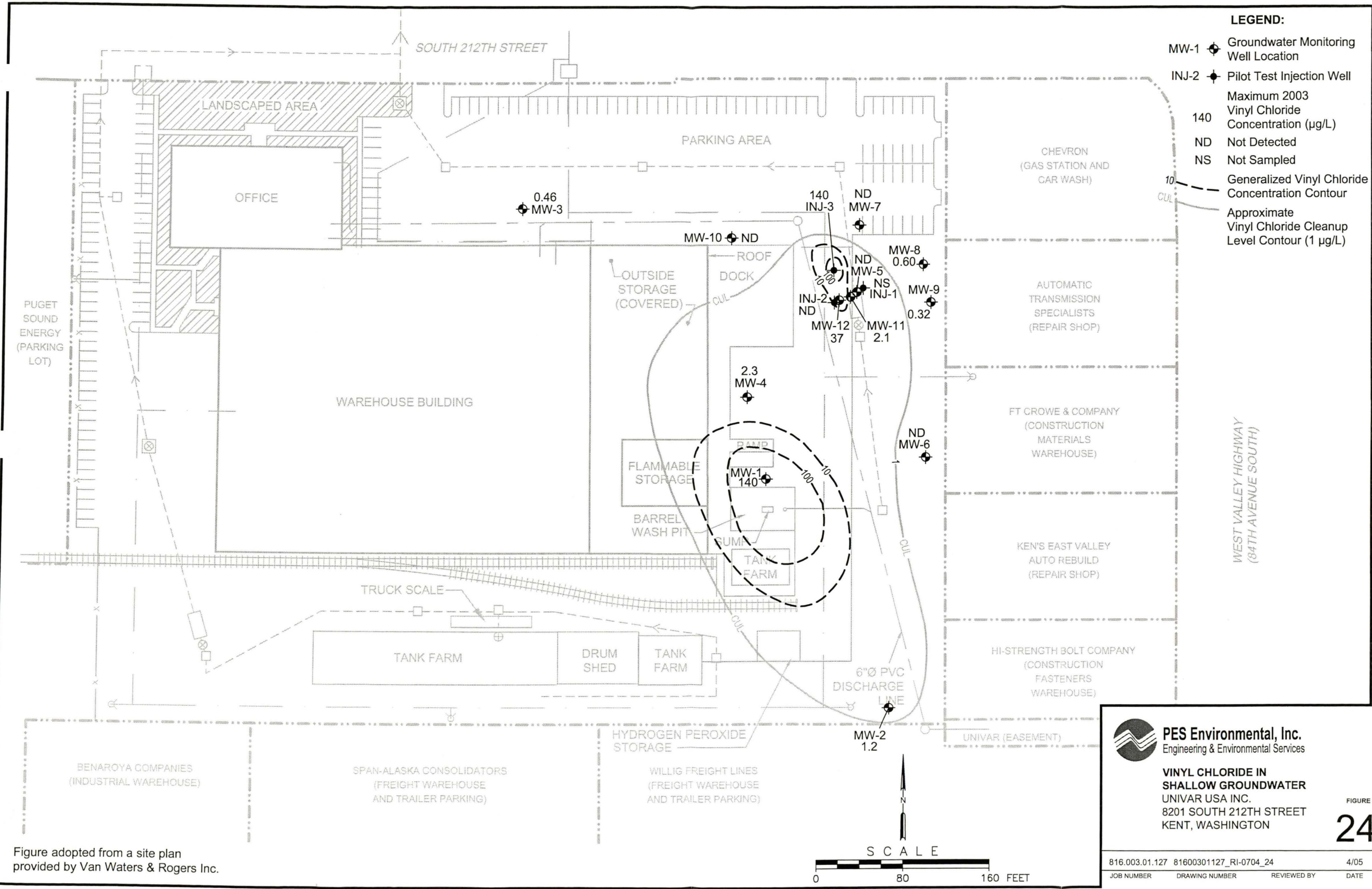
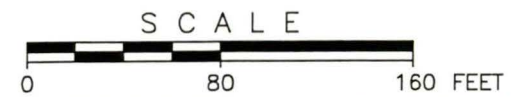


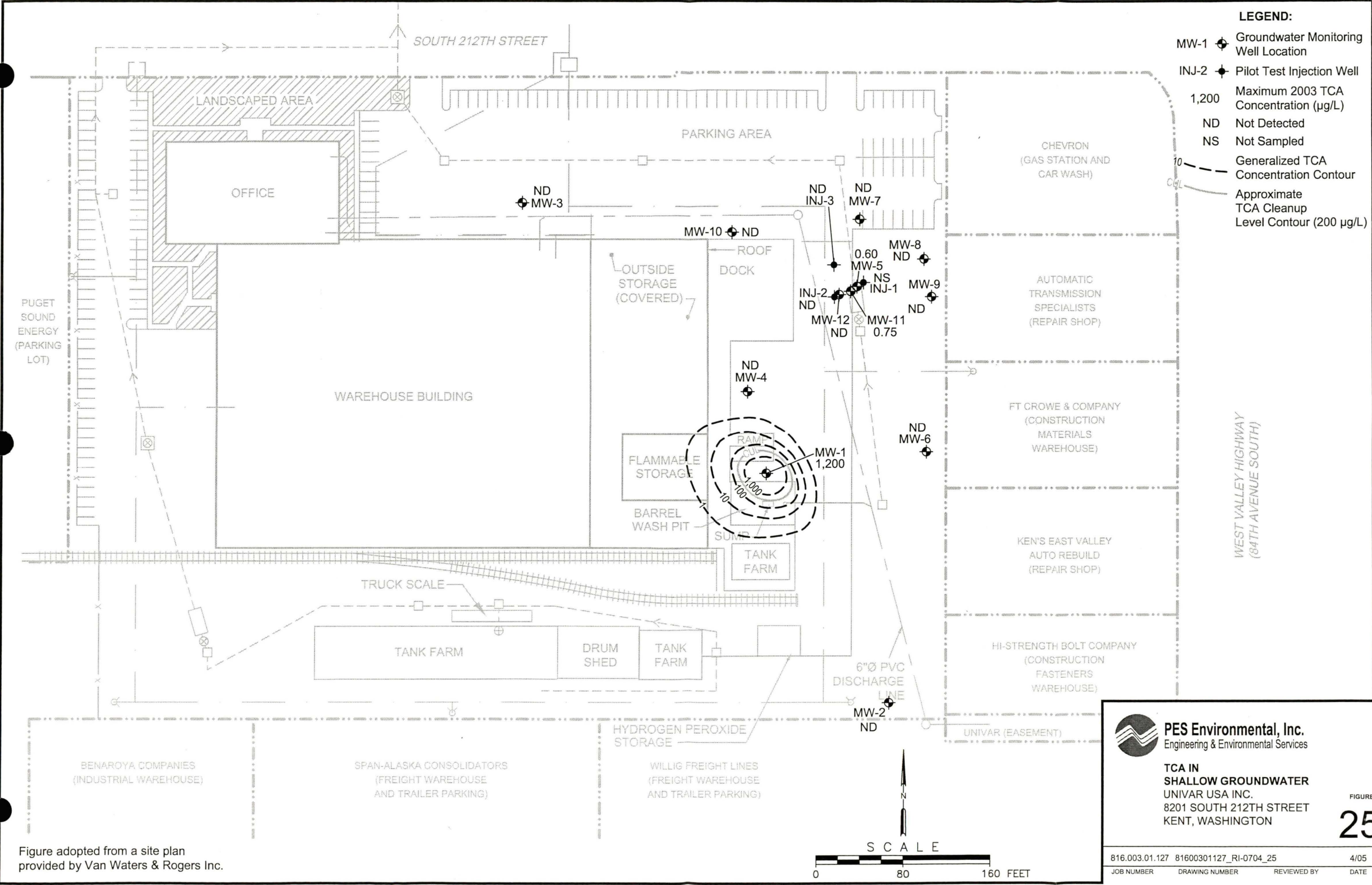
Figure adopted from a site plan provided by Van Waters & Rogers Inc.

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VINYL CHLORIDE IN SHALLOW GROUNDWATER
UNIVAR USA INC.
8201 SOUTH 212TH STREET
KENT, WASHINGTON

FIGURE
24





LEGEND:

- MW-1 Groundwater Monitoring Well Location
- INJ-2 Pilot Test Injection Well
- 1,200 Maximum 2003 TCA Concentration (µg/L)
- ND Not Detected
- NS Not Sampled
- 10 Generalized TCA Concentration Contour
- CGL Approximate TCA Cleanup Level Contour (200 µg/L)

Figure adopted from a site plan provided by Van Waters & Rogers Inc.

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TCA IN SHALLOW GROUNDWATER
UNIVAR USA INC.
8201 SOUTH 212TH STREET
KENT, WASHINGTON

FIGURE
25



SCALE



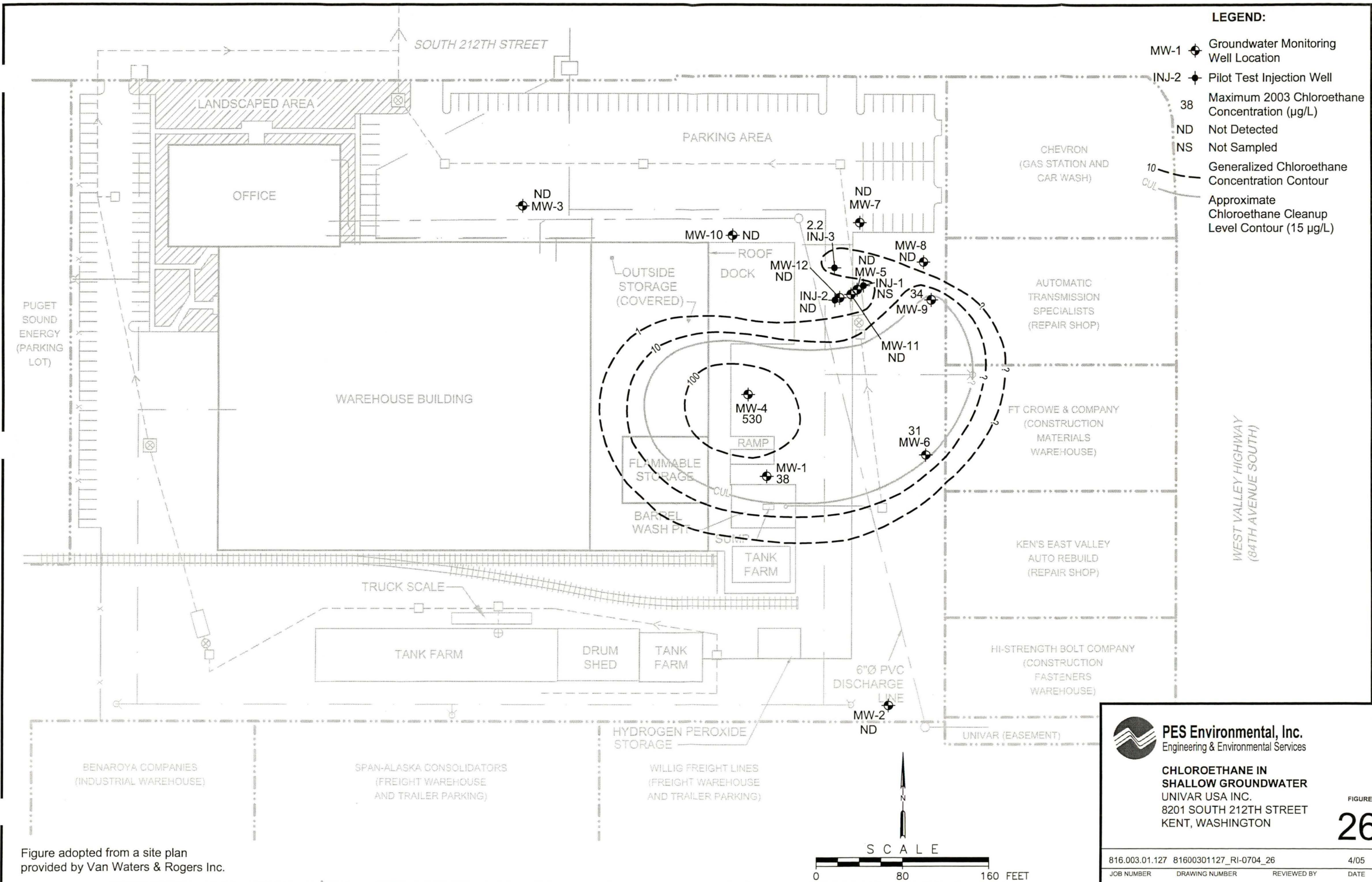


Figure adopted from a site plan provided by Van Waters & Rogers Inc.

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CHLOROETHANE IN SHALLOW GROUNDWATER
UNIVAR USA INC.
8201 SOUTH 212TH STREET
KENT, WASHINGTON

FIGURE
26

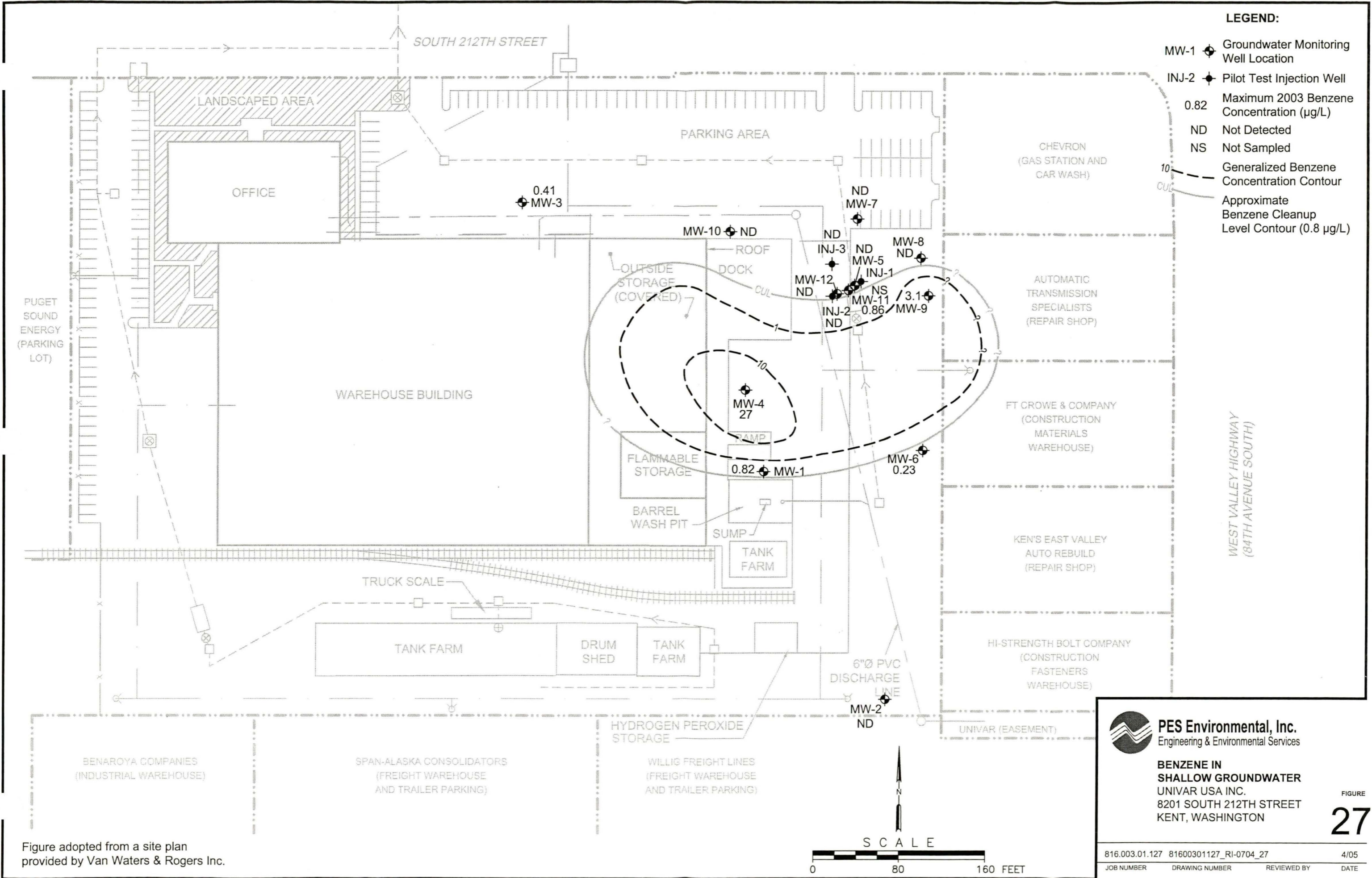


Figure adopted from a site plan provided by Van Waters & Rogers Inc.

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BENZENE IN SHALLOW GROUNDWATER
UNIVAR USA INC.
8201 SOUTH 212TH STREET
KENT, WASHINGTON

FIGURE
27

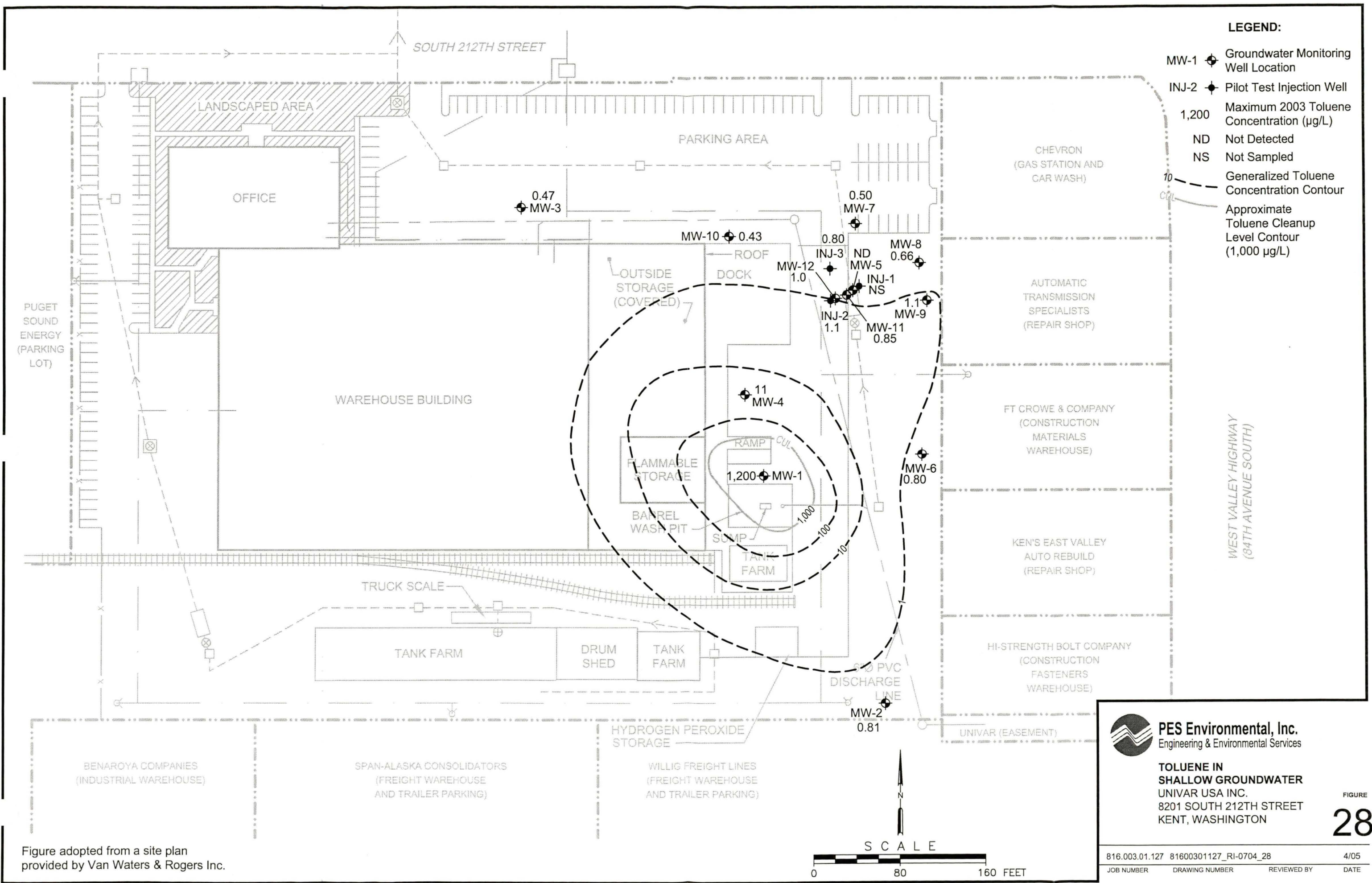
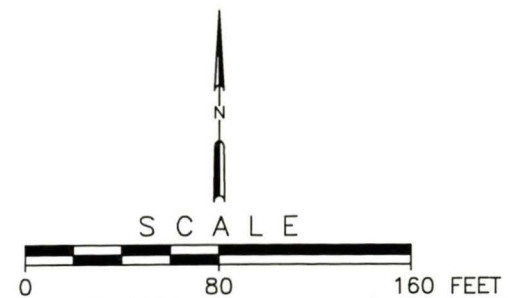


Figure adopted from a site plan provided by Van Waters & Rogers Inc.



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TOLUENE IN SHALLOW GROUNDWATER
UNIVAR USA INC.
8201 SOUTH 212TH STREET
KENT, WASHINGTON

FIGURE
28

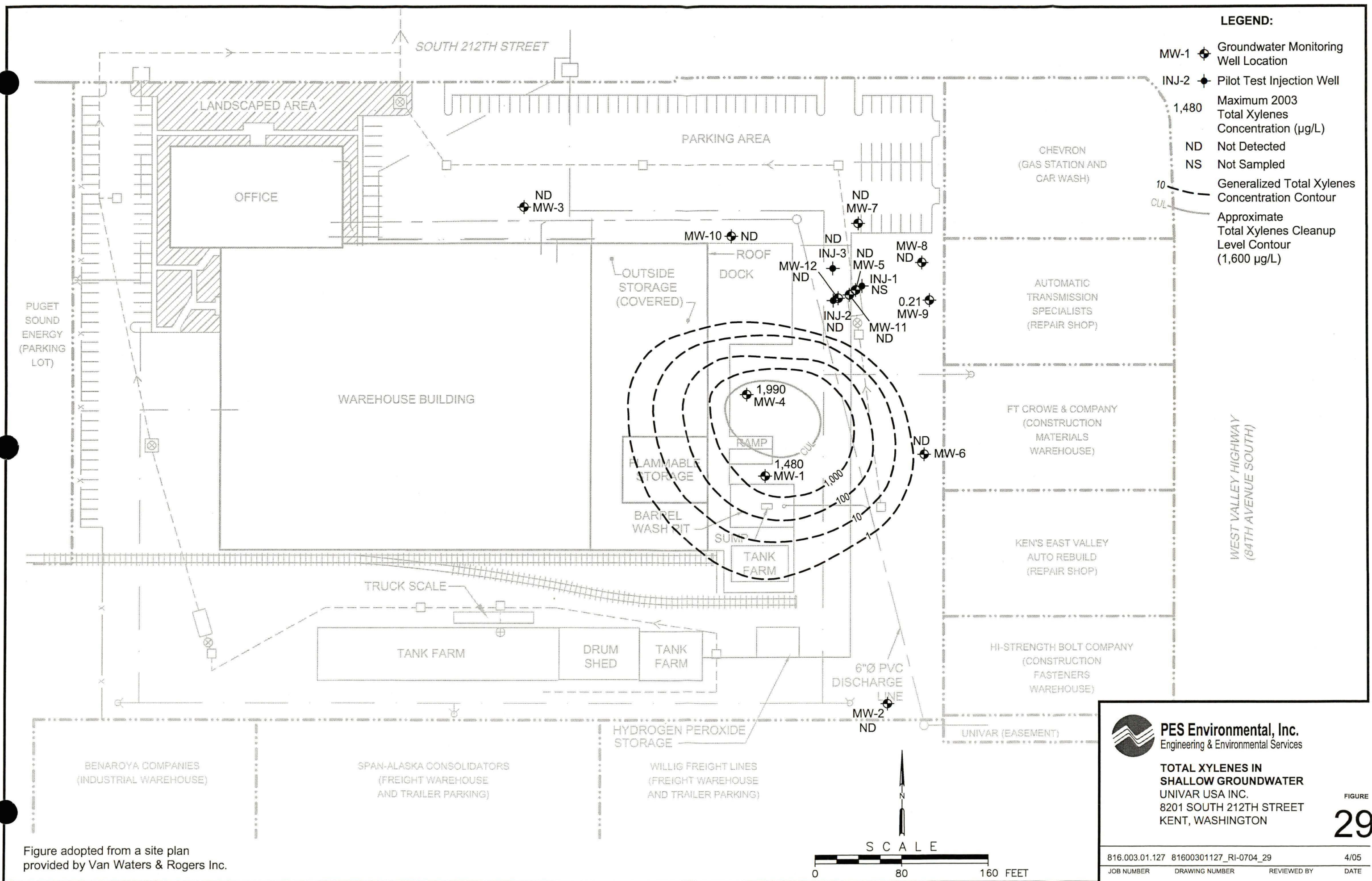


Figure adopted from a site plan provided by Van Waters & Rogers Inc.

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TOTAL XYLENES IN SHALLOW GROUNDWATER
UNIVAR USA INC.
8201 SOUTH 212TH STREET
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FIGURE 29

816.003.01.127 81600301127_RI-0704_29 4/05
JOB NUMBER DRAWING NUMBER REVIEWED BY DATE

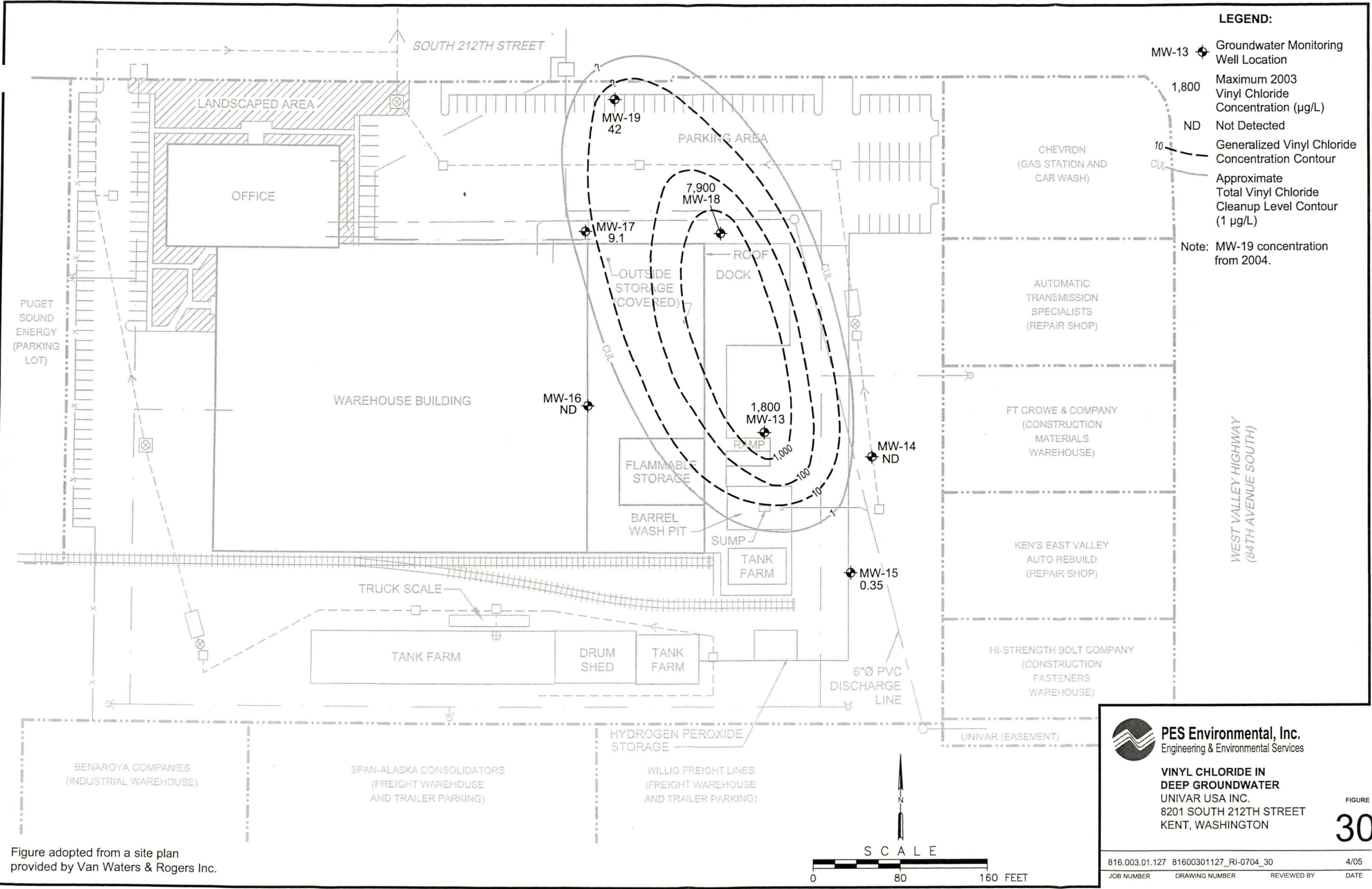
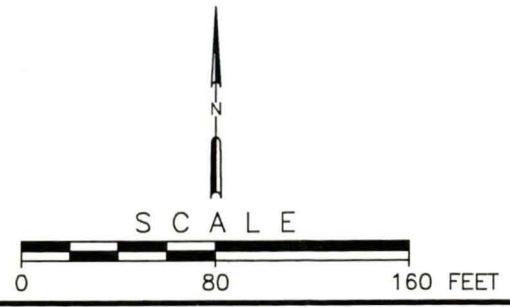


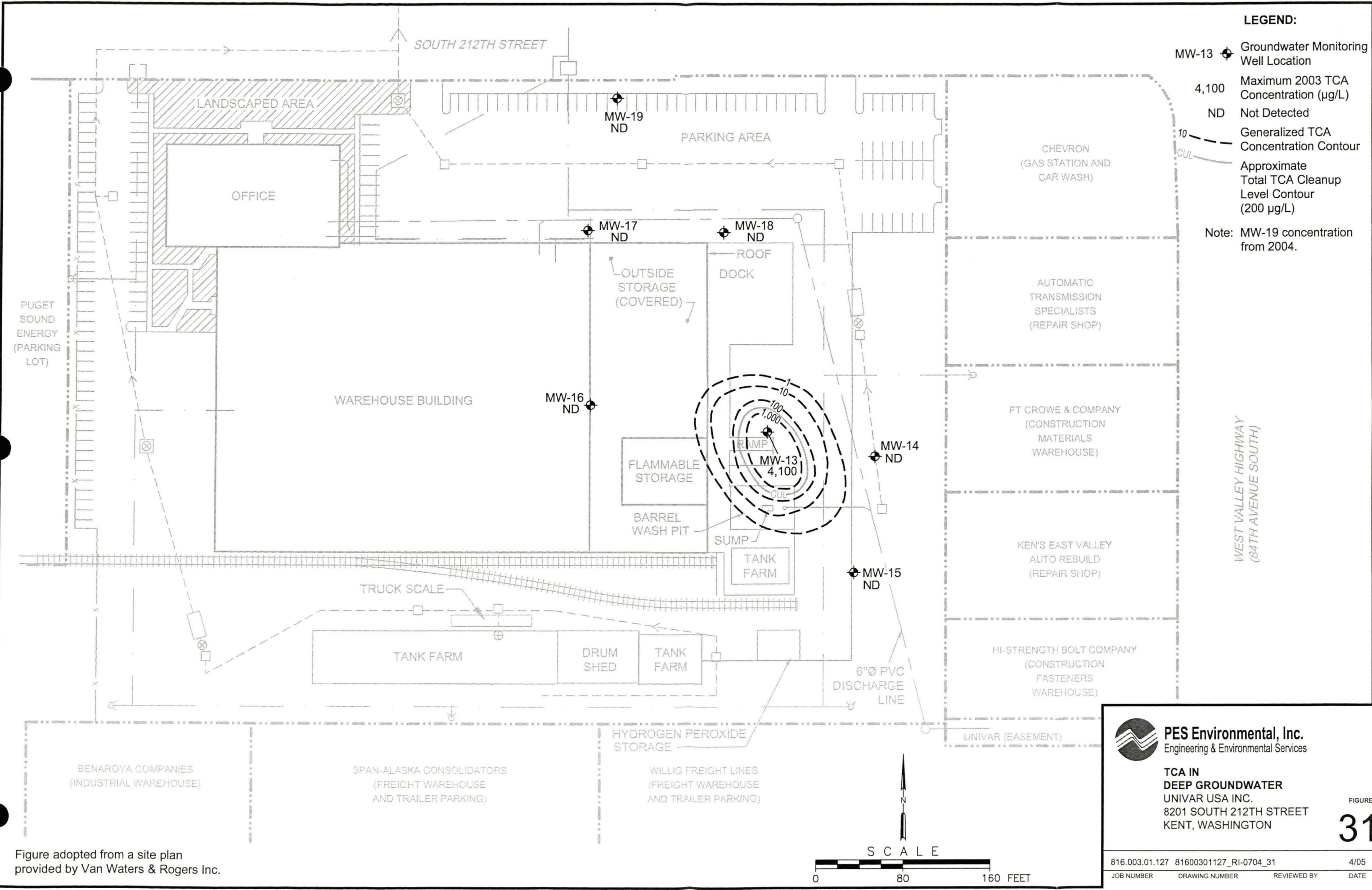
Figure adopted from a site plan provided by Van Waters & Rogers Inc.



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VINYL CHLORIDE IN DEEP GROUNDWATER
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FIGURE
30



LEGEND:

- MW-13 Groundwater Monitoring Well Location
- 4,100 Maximum 2003 TCA Concentration (µg/L)
- ND Not Detected
- 10 Generalized TCA Concentration Contour
- Approximate Total TCA Cleanup Level Contour (200 µg/L)

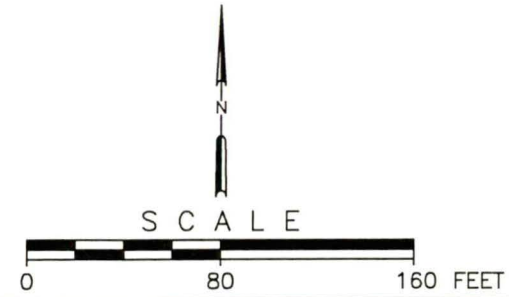
Note: MW-19 concentration from 2004.

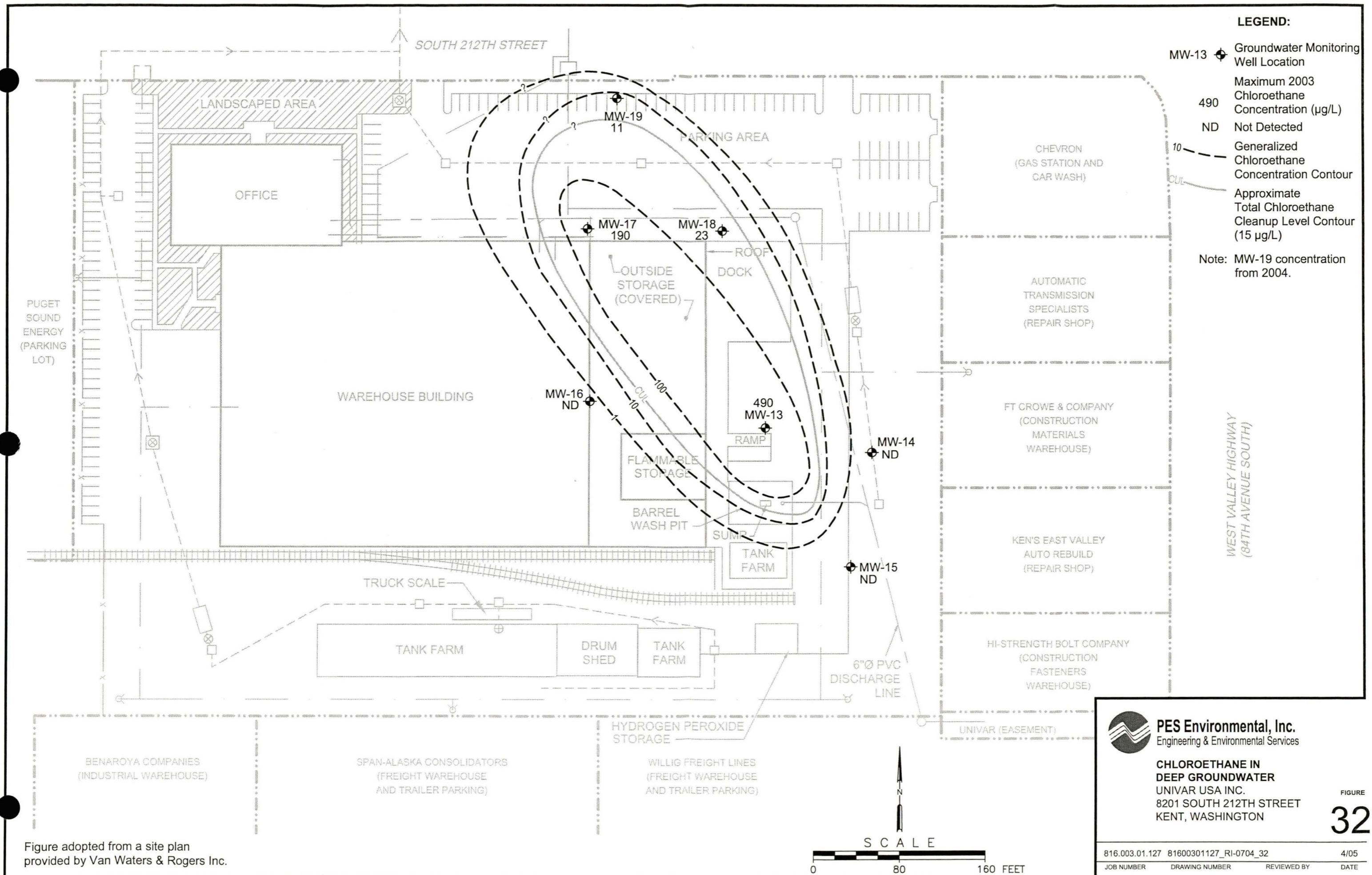
Figure adopted from a site plan provided by Van Waters & Rogers Inc.

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TCA IN DEEP GROUNDWATER
UNIVAR USA INC.
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FIGURE
31



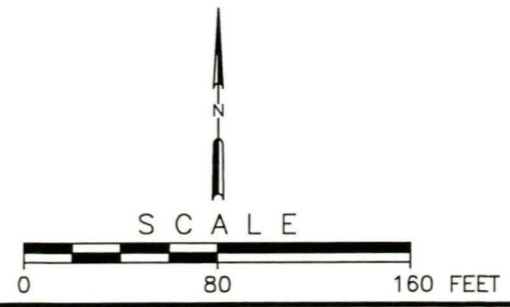


LEGEND:

- MW-13 Groundwater Monitoring Well Location
- 490 Maximum 2003 Chloroethane Concentration (µg/L)
- ND Not Detected
- 10 Generalized Chloroethane Concentration Contour
- CUL Approximate Total Chloroethane Cleanup Level Contour (15 µg/L)

Note: MW-19 concentration from 2004.

Figure adopted from a site plan provided by Van Waters & Rogers Inc.



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CHLOROETHANE IN DEEP GROUNDWATER
UNIVAR USA INC.
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KENT, WASHINGTON

FIGURE
32

816.003.01.127	81600301127_RI-0704_32	4/05
JOB NUMBER	DRAWING NUMBER	REVIEWED BY DATE

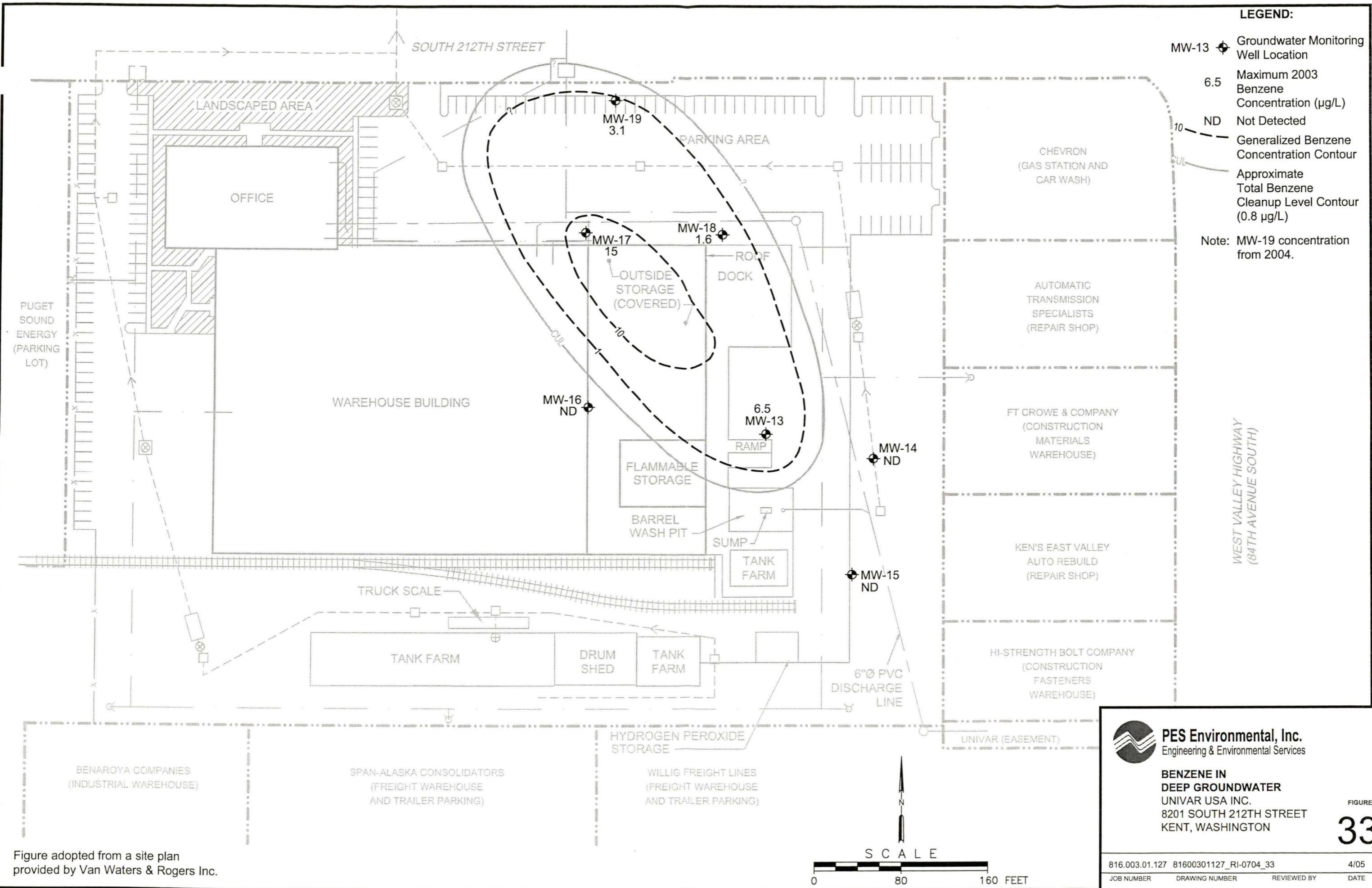
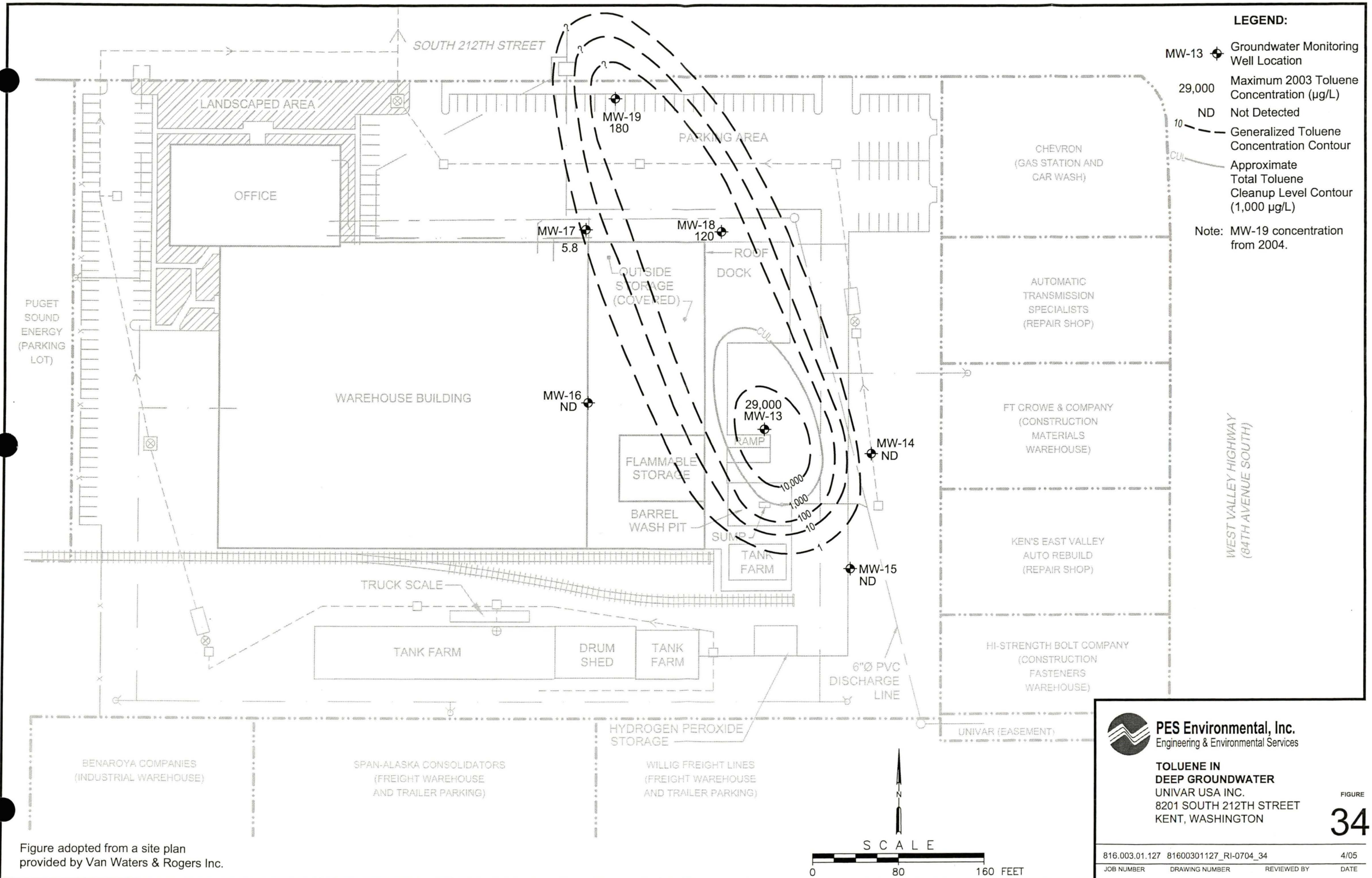


Figure adopted from a site plan provided by Van Waters & Rogers Inc.

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BENZENE IN DEEP GROUNDWATER
UNIVAR USA INC.
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KENT, WASHINGTON

FIGURE
33



LEGEND:

- MW-13 Groundwater Monitoring Well Location
- 29,000 Maximum 2003 Toluene Concentration (µg/L)
- ND Not Detected
- 10 Generalized Toluene Concentration Contour
- CUL Approximate Total Toluene Cleanup Level Contour (1,000 µg/L)

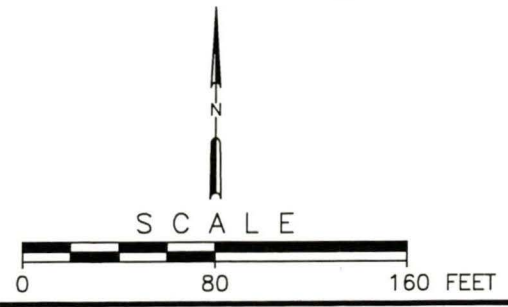
Note: MW-19 concentration from 2004.

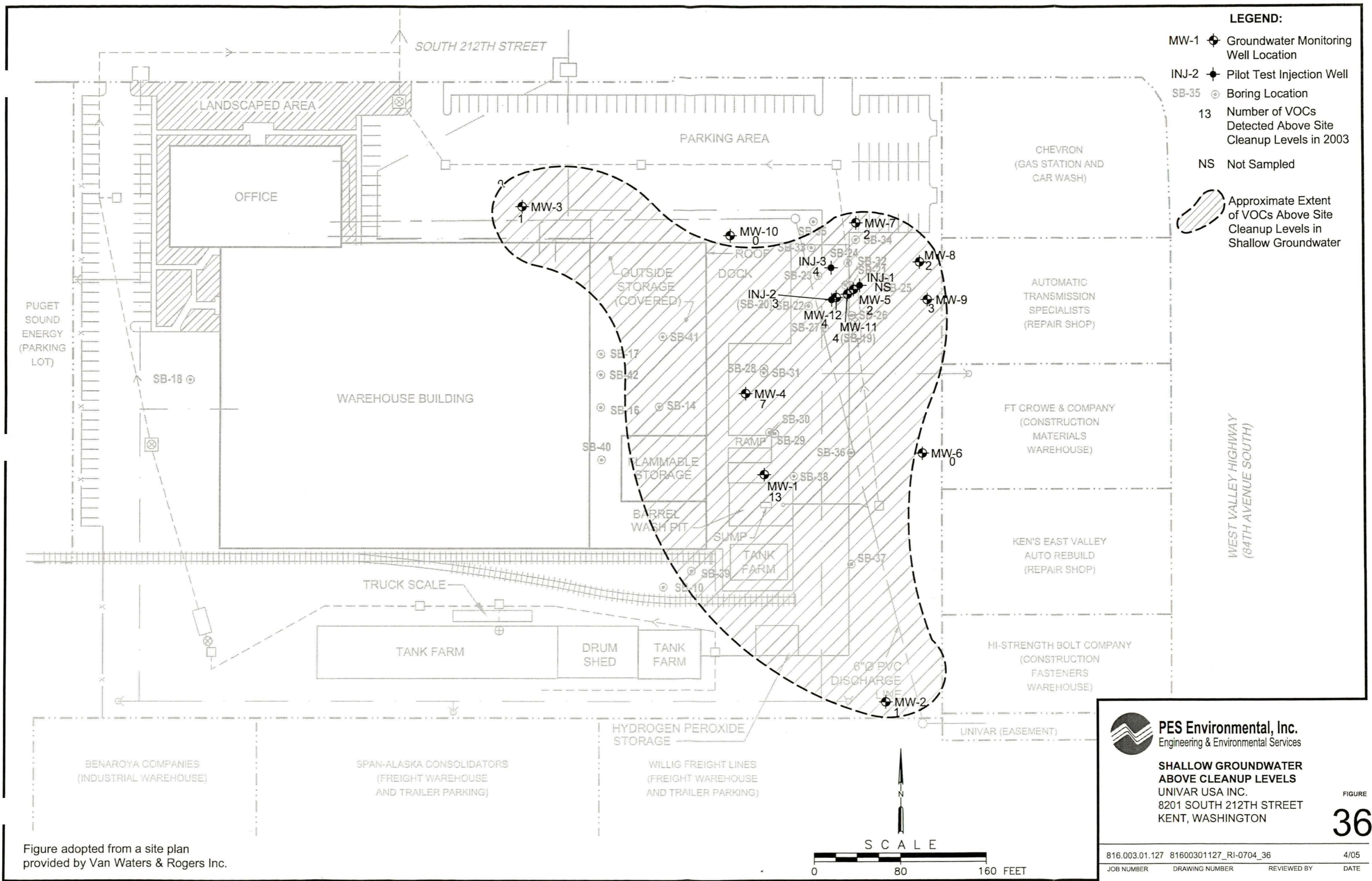
Figure adopted from a site plan provided by Van Waters & Rogers Inc.

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TOLUENE IN DEEP GROUNDWATER
UNIVAR USA INC.
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KENT, WASHINGTON

FIGURE
34





- LEGEND:**
- MW-1 Groundwater Monitoring Well Location
 - INJ-2 Pilot Test Injection Well
 - SB-35 Boring Location
 - 13 Number of VOCs Detected Above Site Cleanup Levels in 2003
 - NS Not Sampled

Approximate Extent of VOCs Above Site Cleanup Levels in Shallow Groundwater

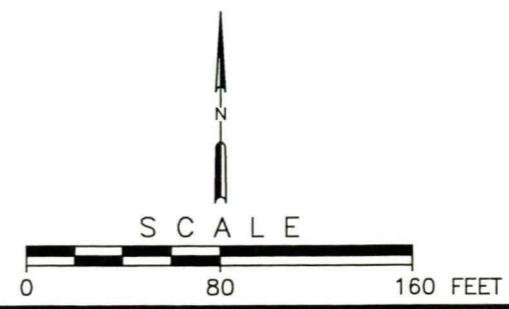
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SHALLOW GROUNDWATER ABOVE CLEANUP LEVELS
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KENT, WASHINGTON

FIGURE
36

816.003.01.127 81600301127_RI-0704_36 4/05
JOB NUMBER DRAWING NUMBER REVIEWED BY DATE

Figure adopted from a site plan provided by Van Waters & Rogers Inc.




SOUTH 212TH STREET

LEGEND:

MW-13  Groundwater Monitoring Well Location

SB-35  Boring Location

12  Number of VOCs Detected Above Site Cleanup Levels in 2003

 Approximate Extent of VOCs Above Site Cleanup Levels in Deep Groundwater

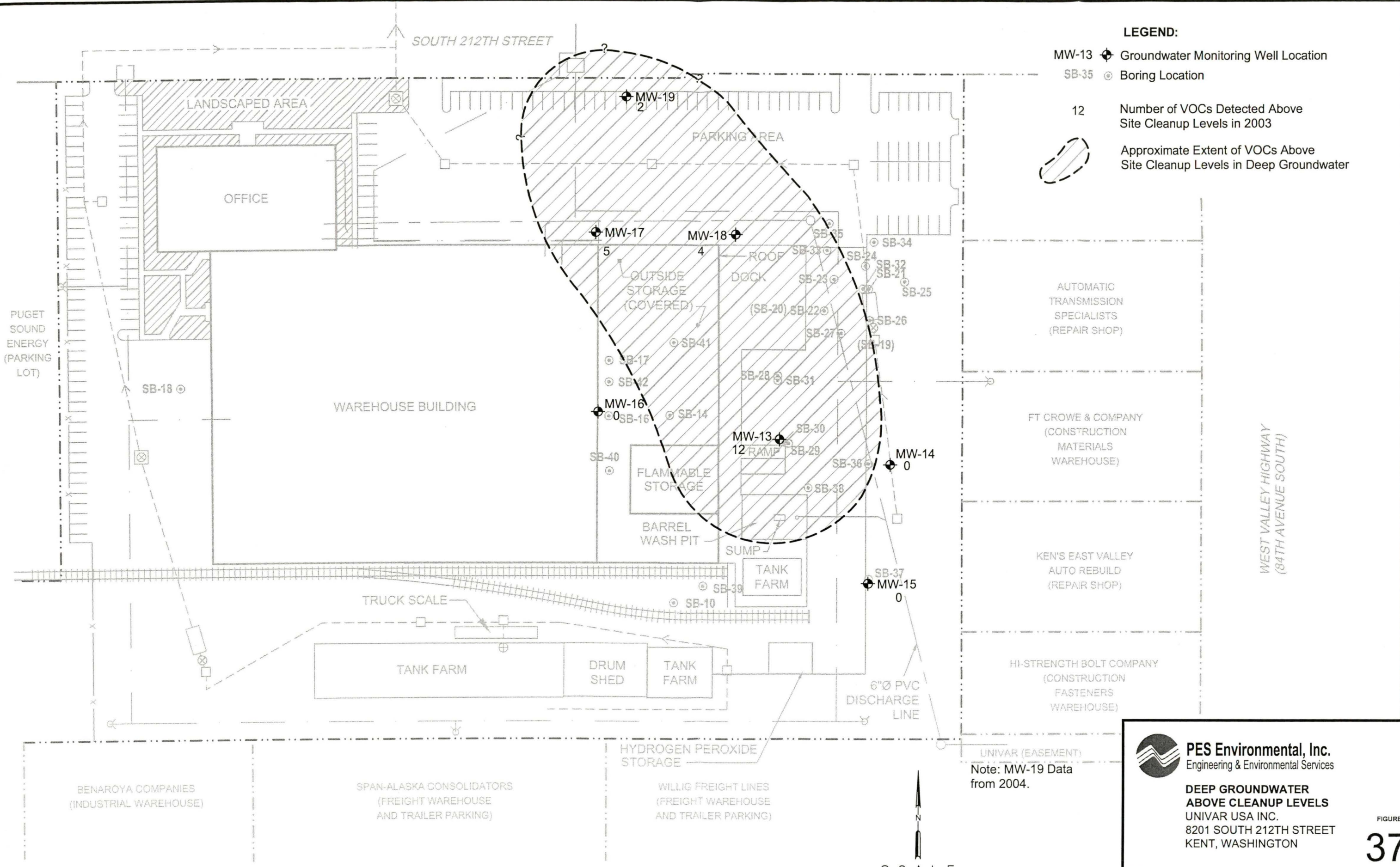
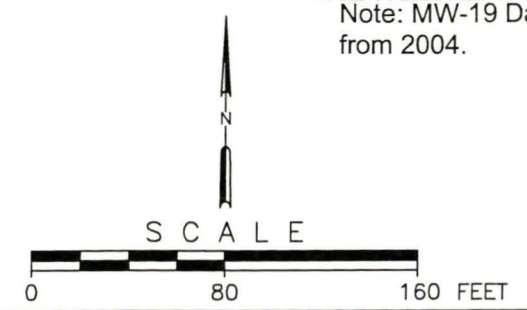


Figure adopted from a site plan provided by Van Waters & Rogers Inc.



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DEEP GROUNDWATER ABOVE CLEANUP LEVELS
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FIGURE
37