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Remedial Investigation and Feasibility Study
Ken's Auto Wash
1013 East University Way
Ellensburg, Washington

Prepared for
Ken's Auto Wash

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CONTENTS

CONTENTS (Continued)

TABLES

FIGURES

CONTENTS (Continued)

REMEDIAL INVESTIGATION AND FEASIBILITY STUDY
KEN'S AUTO WASH
1013 EAST UNIVERSITY WAY
ELLENSBURG, WASHINGTON

1.0 INTRODUCTION

This report presents the Remedial Investigation (RI) and Feasibility Study (FS) for the Ken's Auto Wash site in Ellensburg, Washington (Figure 1). Site soils and groundwater are affected by a previous release of petroleum hydrocarbons associated with a gasoline underground storage tank (UST) at the site. The petroleum hydrocarbon release was discovered during tank tightness testing in 1995.

The RI/FS incorporates information from several previous site investigations, initial soil removal/treatment efforts in 2000, UST removal in 2005, and on-going groundwater monitoring. These efforts were conducted by Hart Crowser and others on behalf of the site owner, Ken Peterson. Mr. Peterson has entered into an Agreed Order with the Washington State Department of Ecology (Ecology) pursuant to the Model Toxics Control Act (MTCA - RCW 70.105D.040(5)).

This RI/FS compiles and summarizes results of previous site investigations, soil cleanup, and monitoring efforts from 1995 to present. The RI/FS presents a chronology of the work completed and a conceptual model of current site conditions. Accordingly, this RI/FS has been formatted for consistency with elements listed in WAC 173-340-350 Remedial Investigation and Feasibility Study, WAC 173-340-360 Selection of Cleanup Actions, and other pertinent sections of MTCA. Note that laboratory analytical data for testing results summarized in this RI/FS report is provided with the source data reports referenced herein.

2.0 FACILITY BACKGROUND

2.1 Site Description and Use

The Ken's Auto Wash property is located at 1013 East University Way in Ellensburg, Washington (Figure 1), at the northwest corner of East University Way and Alder Street. The property covers a total area of approximately 15,000 square feet (0.35 acre). The site is a former gasoline service station. The current business (Ken's Auto Wash) is an active car wash. Site structures include a three-stall car wash and convenience store building, which is currently inactive.

The site is paved with concrete beneath the car wash and on the southern half of the site and with asphalt to the north and east of the car wash/convenience store.

2.2 Surrounding Properties

The Ken's Auto Wash property is bound to the west by a vacant lot (unpaved gravel), to the north by an alley, to the south by East University Way, and to the east by Alder Street. The property is zoned commercial/highway. In the surrounding area, there are a mixture of commercial, office, and residential properties.

The site is located within city limits, and surrounding businesses and residences receive their drinking water from the municipal water supply. Well inventories by Ecology (1996) and Hart Crowser (1999a) identified three municipal water supply wells located in the surrounding area: two wells located 1,200 and 1,600 feet south of the site, and one well located 4,000 feet northwest of the site. Locations and logs of these supply wells are included in Attachment A in Appendix A. As discussed in Section 4.2 and Appendix A, there is no identified connection between affected groundwater at the site and the hydrogeologic units tapped by the water supply wells.

2.3 Potential Sources of Environmental Contaminants

Gasoline USTs and associated piping and delivery systems have been located on the southern half of the site. Former UST and pump island locations associated with Ken's Auto Wash operations are shown on Figure 2. Four unleaded and regular (leaded) gasoline USTs were replaced in 1988 with three new USTs: one 6,000-gallon super unleaded UST (UST No. 1), one 10,000-gallon unleaded gasoline UST (UST No. 2), and one 10,000-gallon regular (unleaded) gasoline UST (UST No. 3). The new USTs were replaced in the same UST "nest" that held the previous USTs. In 1996, a leak was discovered during a tank tightness test in a product line from the super unleaded gasoline UST No. 1. After discovery and correction of the leak, gasoline odors were noted in two observation wells located adjacent to the USTs.

2.4 Regulatory History

Following the reported UST leak, a Site Hazard Assessment was conducted in 1996 (Ecology 1996). The site was ranked a "2." In 1999, the site was entered into Ecology's Voluntary Cleanup Program (VCP) (Hart Crowser 1999b). Groundwater monitoring, hot spot excavation of petroleum hydrocarbon-affected soils in 2000, UST removal, and related site investigations since 1999 were conducted under the VCP.

In January 2003, reranking of the site was requested because the original site ranking was based on an assumed connection between petroleum-affected groundwater at the site and the City of Ellensburg supply wells (see Appendix A). Ecology denied the request on the basis that reevaluating the site would not result in a significant change in rank (i.e., a new Site Hazard Assessment would likely change the rank from a "2" to a "3"). In August 2003, Mr. Peterson and Ecology entered into an Agreed Order to prepare an RI/FS for the site.

3.0 ENVIRONMENTAL INVESTIGATIONS AND REMEDIAL ACTIONS

Following the 1996 leak, Hart Crowser and others have conducted several environmental field investigations, remedial actions, and groundwater monitoring at the site. These activities are summarized below in chronological order. Exploration locations are shown on Figure 5 and Figure 6. A summary of investigation results is presented in Section 4. A list of available reports regarding environmental conditions at the site is provided in Section 8.0. Table 1 presents a summary of the site investigation, remediation, and monitoring activities, as discussed below.

3.1 1995 to 2000—Site Characterization and Groundwater Monitoring (Sage 1998a and 1998b; Hart Crowser 1999a, 2000a, 2000b, 2000c, and 2000e)

Between 1996 and 1998, Sage Earth Sciences (Sage) installed six monitoring wells (MW-1 through MW-6) at the site, measured groundwater elevations, and sampled and analyzed soil and groundwater at each location for gasoline-range petroleum hydrocarbons (TPH-G) and benzene, toluene, ethylbenzene, and xylenes (BTEX). Selected soil samples were analyzed for diesel- and oil-range petroleum hydrocarbons (TPH-D and TPH-O), and selected groundwater samples were analyzed for total and dissolved lead. In 1998, Sage continued monthly elevation measurements and quarterly monitoring of TPH-G, BTEX, and total lead in groundwater. In 1999, Hart Crowser completed a receptor analysis, a utility survey, analyzed soil and groundwater samples from five borings (HP-7 through HP-11) for TPH-G and BTEX, analyzed groundwater samples collected from the borings via hydropunch methods, and installed monitoring wells MW-12 and MW-13. Between December 1999 and September 2000, Hart Crowser analyzed groundwater samples from the eight wells for TPH-G and BTEX on a quarterly basis. In September 2000, Hart Crowser advanced five soil borings (HP-12 through HP-16) and collected and analyzed soil and groundwater samples for TPH-G and BTEX. Selected soil samples were analyzed for lead.

3.2 2000—Hot Spot Soil Excavation and In Situ Bioremediation (Hart Crowser 2001)

In October and November 2000, Hart Crowser conducted a hot spot removal of accessible petroleum-impacted materials at the location shown on Figure 5. Approximately 520 tons of TPH-affected soil and 5,500 gallons of TPH-affected groundwater, containing an estimated 2,700 pounds of TPH, were removed from the area between the existing USTs and East University Way. Excavation extent was spatially limited by the presence of the USTs to the north and the East University Way sidewalk to the south. Verification samples were collected from the side walls of the excavation and chemically analyzed. Verification sample results indicated soil containing TPH concentrations above applicable MTCA cleanup levels remained in place to the north (next to the UST area) and the south (beneath the sidewalk). Approximately 600 pounds of Oxygen-Releasing Compound (ORC) were added to the excavation backfill (below the seasonal high water table elevation) to promote biodegradation of petroleum hydrocarbons remaining in place.

3.3 Strataprobe Explorations and In Situ Bioremediation (Hart Crowser 2005a)

In February 2005, strataprobe (push-probe) explorations were advanced in eight locations at the Ken's Auto Wash site to collect soil and grab groundwater samples. These locations are identified as HCSP-04-01 through HCSP-04-08 on Figure 5. Soil and groundwater samples were submitted for laboratory analysis of TPH-G and BTEX. Soil samples were also analyzed for total lead, while groundwater samples were analyzed for methyl tertiary-butyl ether (MTBE).

While on site, approximately 120 pounds of ORC were injected at the six strataprobe locations as a relatively low cost, opportunistic measure to benefit the additional remediation alternatives considered. Five injection locations were in the westbound lane of East University Way near the sidewalk, which is near the apparent leading edge of the TPH source area in soil (Figure 5). Locations included strataprobes HCSP-04-01, HCSP-04-02, HCSP-04-03, and two (unnamed) locations for areal coverage between HCSP-04-01, HCSP-04-02, and HCSP-04-03. The sixth injection location was completed near the centerline of the westbound lanes where the highest MultiRae photoionization detector (PID) reading in soil was recorded during advancement of strataprobe HCSP-04-07. The depth of the injections was below and across the inferred water table, taking into account seasonal fluctuations in water table elevation.

3.4 UST Closure (Hart Crowser 2005b)

In April 2005 Clearcreek Contractors, with observation by Hart Crowser, completed closure activities to remove the three site USTs and the associated piping. Once the USTs were removed, Hart Crowser collected and analyzed verification soil samples of the excavation side walls and bottom. Laboratory analytical results were below applicable Washington State MTCA Method A cleanup levels, with the exception of the south UST side wall sample, which exceeded the applicable criteria for TPH-G and BTEX. The south side wall sample is located near the edge of the TPH "hot spot" excavation completed in 2000. During UST closure, approximately 8 cubic yards (cy) of TPH-affected soil were removed from the south side wall for off-site disposal. Excavation of additional TPH-affected soil was not possible because of stability concerns related to utility lines in the adjacent East University Way right of way. Soil sampling data and observations from the various site exploration, UST removal, and remediation activities indicate that soils remaining in this area with elevated TPH concentrations are limited to a localized area identified on Figure 6 and Figure 7.

Well MW-4 was removed during UST closure activities and was replaced with MW-4R in October 2005. In conjunction with removing the USTs, six "pothole" test pits were completed to delineate the extent of TPH-affected soils to the east and west of the UST excavation. Soil sample analytical results contained gasoline-range hydrocarbons and benzene at concentrations exceeding Method A cleanup levels. TPH concentrations are expected to be amenable to natural attenuation and these soils were left in place following discussions with Ecology.

3.5 2001 to Present—Groundwater Monitoring (Hart Crowser 2001, 2002a, 2002b, 2003, 2004a, 2004b, 2004c, 2005b, 2005c, 2006, and Data Provided in Draft RI/FS Report)

In January 2001, following the hot spot removal effort, Hart Crowser installed two additional monitoring wells at the site: MW-14 to replace MW-1, and MW-15 to define the southeastern plume boundary. The nine wells on site were monitored for TPH-G and BTEX on a quarterly basis in 2001. These wells, with the exception of MW-13, were monitored for TPH-G and BTEX in November 2002. They were monitored again in May 2003 for TPH-G, BTEX, total lead, and gasoline additives including MTBE, 1,2-dibromoethane (EDB), and 1,2-dichloroethane (EDC). Wells MW-2 through MW-6 and MW-12 through MW-15 were monitored on a quarterly basis from May 2003 to December 2004. Beginning in September 2003, the conventional parameters—nitrate, nitrite, and sulfate—were analyzed. One year later, in September 2004, the analysis of MTBE, EDB, and EDC was discontinued. In accordance with the schedule shown in Table 9, monitoring events were completed on a biannual basis in 2005. The most recent round of groundwater samples was collected in June 2006.

4.0 SITE PHYSICAL CHARACTERISTICS

The site is generally flat, with a slight downward slope (less than 5 percent) from the convenience store to the south toward East University Way. The entire Ken's Auto Wash facility is covered with concrete and asphalt pavement, but the neighboring property to the west is unpaved. A description of subsurface geology and hydrogeology is provided below.

4.1 Geology

A cross section showing generalized subsurface conditions at the site is provided on Figure 3. Soils typically encountered at the site are related to alluvial deposition, and consist primarily of silty, sandy gravel with occasional cobbles. In several borings and during the 2000 hot spot excavation, a surface layer of sandy silt, typically 4 to 6 feet thick, was encountered. The former UST area is backfilled with pea gravel to an approximate depth of 13 feet. A compendium of site boring logs by Hart Crowser and others is provided in Appendix C.

A description of regional geology, including regional cross sections, is included in Appendix A.

4.2 Hydrogeology

Groundwater is present beneath the site within the shallow silty, sandy gravel unit at depths between 6 and 10 feet below ground surface. Depth to water measurements and elevations obtained between 1996 and 2006 are summarized in Table 2.

A description of regional hydrogeology is included in Appendix A. Groundwater at the site appears to be a shallow perched zone above a clay aquitard that is typically encountered in the surrounding area at depths of less than 30 feet. Drilling logs of the municipal supply wells indicate that several aquitards separate shallow site groundwater from deeper water-bearing units, including zones used for water supply beyond the vicinity of the site.

Groundwater elevation contours for the latest monitoring event in June 2006 are illustrated on Figure 4. The groundwater flow direction is toward the southwest, consistent with historical data. Calculated gradients are typically between 0.015

and 0.025 and do not change significantly with season. Groundwater elevations at the site typically fluctuate 1 to 2 feet seasonally, reaching their peak in late spring and low point in late fall. Utilities on and downgradient of the site are located at depths above the seasonal high water table elevation, and thus do not appear to affect groundwater flow. A more detailed discussion concerning utilities is presented below.

Physical groundwater characteristics collected during groundwater monitoring events include temperature, pH, and conductivity. These characteristics are relatively consistent in groundwater on and downgradient of the site, with normal ranges of each parameter as follows:

- **Temperature.** Measured groundwater temperatures are typically between 10 and 18 degrees Celsius, with the slightly lower temperatures most often measured during the winter months.

- **pH.** The pH of shallow groundwater at the site is typically between 5.9 and 7.1.

- **Conductivity.** The electrical conductivity (which is an indicator of total dissolved solids) is typically between 180 and 360 uS in site groundwater. The higher measured conductivity values are generally measured in wells MW-5, MW-6, and MW-14, which are also affected by petroleum contamination (see Section 5.3).

4.3 Underground Utilities

A potential concern for contaminant migration at a typical site is the tendency for trench backfill to act as a preferential pathway for groundwater. However, utilities at the Ken's Auto site are not identified as a significant concern for the following reasons:

- Existing utilities within the Ken's Auto Wash property are located either upgradient of the source area.

- Off-property utilities include a City of Ellensburg storm sewer in the East University Way right of way with invert depths of approximately 4 feet below grade. Based on historical groundwater monitoring, the invert depths are above the depth to groundwater typically encountered on the site.

- The City's sanitary sewer is located along Alder Street to the east of the site, upgradient of the source area.

Historical groundwater monitoring data indicate that depth to groundwater is typically greater than 6 feet below ground surface along the East University Way right of way; therefore, migration of contaminants down the utility corridor is unlikely. Furthermore, any future utility maintenance is not expected to encounter contaminated soil and groundwater. Figure 5 illustrates the location of the City's storm sewer along East University Way.

5.0 NATURE AND EXTENT OF CONTAMINATION

This section summarizes the environmental conditions in soil and groundwater that currently exist at the site. Our understanding of site conditions is based on environmental data from the investigations and remedial actions summarized in Section 3.0, and described in greater detail in reports referenced herein.

5.1 Identifying Potential Chemicals of Concern

Based on historical site use as a gasoline fueling station, the chemicals of potential concern at the Ken's Auto Wash site are TPH-G, BTEX, lead, and related gasoline additives including MTBE, EDB, and EDC. Based on the timing of the leak and the history of gasoline additive use in Washington, it was determined to be unlikely that gasoline additives would be present. However, in accordance with recent MTCA guidance, these constituents were added to the groundwater monitoring program in 2003, and were analyzed for through 2004.

Occurrences of chemicals of potential concern are described below.

5.2 Soil Quality

Since 1996, twenty-three soil borings have been advanced, six "pothole" test pits were completed, and sixteen excavation verification soil samples have been collected and analyzed during site investigation and remediation activities. Soil samples were screened for the presence of volatile organics (including TPH-G and BTEX) with a photoionization detector (PID). Selected soil samples were analyzed for TPH-G, BTEX, and lead. Analytical results are provided in Table 3. Chemical concentrations detected in soil were screened against MTCA Method A cleanup levels for unrestricted use. Detected soil concentrations of the following constituents exceed screening levels:

- **TPH-G.** Site maps showing locations of soil samples where chemical concentrations exceed Method A cleanup levels are provided on Figures 5, 6, and 7. Soil containing elevated concentrations of TPH-G is present primarily on the south side of the UST area and underneath the East

University Way sidewalk. The occurrence of gasoline-range hydrocarbons is generally limited to soils at depths between 6 and 10 feet, in the groundwater "smear zone." The highest concentration of TPH-G detected was 11,000 mg/kg, in the northeast wall verification sample from the October 2000 hot spot excavation. A second sample was collected in that area during the April 2005 UST removal. Although the second sample was collected within 5 feet of the first, the concentration detected was only 2,400 mg/kg, indicating that TPH-G concentrations have been decreasing, or that higher concentration areas are very limited at the site.

- **BTEX.** Soil containing elevated concentrations of BTEX is collocated with those with elevated concentrations of gasoline-range petroleum hydrocarbons. The highest concentrations of BTEX detected in soil were also present in the October 2000 hot spot excavation northeast wall verification sample, with 10.6 mg/kg benzene, 73.9 mg/kg ethylbenzene, and 588 mg/kg xylenes. These concentrations were significantly lower in a second sample collected from that area during the UST removal in 2005, with 0.935 mg/kg benzene, 24.8 mg/kg ethylbenzene, and 43.0 mg/kg toluene. The highest detected concentration of toluene in soil at the site was 10 mg/kg at a depth of 7 to 9 feet at well MW-5. No subsequent samples have been collected near this location.

- **Additional Areas of TPH and BTEX in Soil.** Additional areas of relatively low concentration TPH and BTEX were encountered during attempts to excavate soils between the UST area and 2000 hot spot excavation to the south. Additional pothole test pit explorations were then completed at the locations shown on Figure 7 to evaluate the nature and extent of TPH-affected soils elsewhere. Gasoline-range TPH was detected up to concentrations of 705 mg/kg, and benzene was detected at concentrations up to 1.42 mg/kg at these locations. The TPH-affected soils are present between about 7 to 12 feet below ground surface, coincident with the approximate depth range of the shallow water table. TPH and benzene concentrations decreased rapidly with depth based on sample analytical results and/or field screening PID readings. As noted above, these soils were left in place following discussions with the Ecology and are expected to be amendable to natural attenuation.

Lead has not been detected in site soils above the MTCA Method A cleanup level of 250 mg/kg.

5.3 Groundwater Quality

Nine groundwater monitoring wells (Figure 2) have been installed on or downgradient of the site to characterize groundwater quality. Ten groundwater grab samples were collected using hydropunch sampling methods before the October 2000 hot spot excavation to define the potential extent of the groundwater plume. Seven additional samples were collected during the February 2005 strataprobe investigation. Both sets of samples were collected as assumed "worse case" indicators of groundwater quality conditions, and contained high concentrations of solids. For this reason sample analytical results are not representative of actual groundwater quality than samples collected from the site monitoring wells. Chemical concentrations in groundwater samples collected from monitoring wells are provided in Table 4 for TPH-G, BTEX, and lead, and in Table 5 for other detected compounds. Groundwater grab sample results are provided in Table 6. Below, we describe chemical occurrences in groundwater, identify contaminants of concern, and discuss long-term trends in groundwater quality at the site.

Occurrence of Contaminants of Potential Concern

TPH-G and benzene in groundwater are identified in an area south of the UST area to near MW-6 (Figures 8 and 9). This area is bound to the south by MW-13; to the southwest by MW-12; to the southeast by MW-15; to the east by MW-4R; and to the west by MW-5.

Chemical concentrations detected in groundwater were screened against MTCA Method A cleanup levels for unrestricted use. Concentrations of the following constituents exceed screening levels:

- **TPH-G.** A site map showing the extent of TPH-G occurrences in groundwater during the most recent monitoring event in June 2006 is provided on Figure 8. Groundwater containing elevated concentrations of TPH-G is present on the southwest corner of the Ken's Auto Wash property and extends underneath East University Way to well MW-6. During the most recent groundwater monitoring event in June 2006, after the completion of the remedial activities described above (2000 hot spot excavation, 2005 ORC injection, and 2005 UST removal), TPH-G was detected in well MW-14 at a concentration of 0.53 mg/L, below the MTCA Method A cleanup level of 0.8 mg/L and significantly decreased from previous sampling events. Although well MW-6 was not sampled during the June 2006 event, a TPH-G concentration of 1.38 mg/L (estimated) was detected at this location in October 2005. This well will be included with future sampling events.

  TPH-G was not detected in well MW-2 between April 1996 through December 2003. However, monitoring during 2004 identified TPH-G concentrations of 13.0, 1.48, and 1.29 mg/L, respectively. During sampling it was noted that the MW-2 well monument contained water with a notable TPH-like odor. Although the water was removed before opening of the well casing, we suspect that surface water previously entered the casing. Supported by the substantial TPH concentration decreases in more recent sampling events, we believe that these detections were not representative of site groundwater conditions, but resulted from introduction of minor amounts of TPH constituents from surface runoff through the well surface seal. We will continue to monitor MW-2 closely and make any necessary future recommendations.

- **Benzene.** A site map showing the extent of benzene occurrences in groundwater during the most recent monitoring event in June 2006 is provided on Figure 9. Groundwater containing elevated concentrations of benzene is generally collocated with elevated concentrations of TPH-G. In October 2005, after the completion of the remedial activities described above, benzene was detected in MW-6 at a concentration of 8.10 ug/L, marginally above the MTCA Method A cleanup level of 5 ug/L. This well was not sampled during the most recent groundwater monitoring event in June 2006, but is planned for inclusion in future sampling events.

- **Lead.** In early groundwater monitoring at the site, lead was detected above the MTCA Method A cleanup level of 15 ug/L at two wells during several sampling events—at a maximum concentration of 220 ug/L at MW-1 and 34 ug/L at MW-2. These samples were collected with a bailer, and the results may have been biased high due to suspended solids in the sample. Lead has not been detected in site groundwater above cleanup levels since March 2000.

Gasoline additives, including MTBE, EDB, and EDC, have not been detected above MTCA Method A cleanup levels at the site except for one anomalous hit in MW-4 during the March 2004 groundwater monitoring event. The exceedance is most likely associated with the detection of TPH-G at that location as discussed above.

Trends in Groundwater Quality for Contaminants of Potential Concern

Concentrations of TPH-G and benzene at wells where exceedances of cleanup levels have been recorded are shown on Figures 8 and 9, respectively. Concentrations of both of these chemicals have generally declined at well locations since monitoring began in 1996, indicating that the affected area of groundwater has decreased in terms of TPH-G concentrations. There is some variability in the data, with several spikes; however, long-term trends indicate an overall concentration decline site-wide. TPH-G concentrations exceeding the 0.8 mg/L MTCA Method A cleanup level are currently limited to well MW-6 (1.38J mg/L). During the latest sampling round TPH-G concentrations were non-detect in well MW-14 for the first time. The trends in xylene and lead concentrations mirror trends in TPH-G and benzene concentrations. Overall the results indicate marked decrease in TPH and benzene concentrations near the central source area of affected soil following ORC injection and UST removal in 2005.

5.4 Free Product

Free product has been observed intermittently at well MW-1/MW-14. Product thicknesses measured before and after the October 2000 hot spot excavation are summarized in Table 7. Free product has not been observed at other site wells. Note that the actual free product thickness in the formation is typically one-half to one-sixth the free product thickness measured in the well, due to capillary forces.

An overall decline in free product thickness has been observed since 1998. After the hot spot excavation, product was only been observed during the winter monitoring events, when the water table was low and free product was most likely to accumulate. No free product has been observed since the UST removal in 2005, indicating that ORC injection efforts and soil removal activities during UST closure have been effective in further reducing the mass of TPH.

5.5 Site Conceptual Model

Subsurface contamination at the Ken's Auto Wash site appears to have been caused by a fuel line leak reported and repaired in 1995. This leak occurred in the pea gravel backfill around the UST. Free product likely migrated down through the UST backfill to the top of the water table (within the pea gravel) and from there along the top of the water table to the downgradient edge of UST backfill, at the southwest corner of the property. Finer grained soils outside the UST area limit the extent of migration of free product farther downgradient.

Seasonally fluctuating water tables smear the gasoline product (which is less dense than water, and thus floats on top of the water table) in the soil at depths between 6 and 10 feet below ground surface. The highest dissolved phase contaminant concentrations are typically observed in the spring, at high water levels when groundwater is in contact with the greatest amount of soils containing TPH-impacted material.

After repair of the fuel leak, product occurrences and contaminant concentrations peaked between 1996 and 1998 and have since declined as the source was removed and natural attenuation processes continue to remove and degrade petroleum constituents. The hot spot excavation in 2000 removed approximately half the estimated mass of TPH-affected soil from the subsurface. ORC injection and additional soils excavation during UST removal also aided in further reducing this mass. As a result of these actions and continued natural attenuation of petroleum hydrocarbons, dissolved phase concentrations and free product occurrences continue to decrease.

The product released was unleaded gasoline and does not appear to have contained gasoline additives, based on groundwater chemistry data. Exceedances of the lead cleanup level in groundwater samples previously collected by Sage are likely due to suspended solids entrained in the samples as a result of collecting samples with bailers.

Dissolved oxygen concentrations have varied significantly in site wells since 2000 (Figure 12). Although distinct trends are difficult to discern from data, detected concentrations of dissolved oxygen (DO) may be attributable to a number of factors:

- The lowest DO concentrations have commonly been observed within the petroleum-affected area, as observed in wells MW-1/MW-14, MW-4/MW-4R, and MW-6. Concentrations in these wells rarely exceed 1 mg/L. Depressed DO concentrations are typical of groundwater containing petroleum hydrocarbons and may be indicative of aerobic petroleum-degrading microbial activity, although DO concentrations at the site have continued to vary significantly between sampling events.

- The highest DO concentrations have generally been observed outside the petroleum-affected area, as noted in wells MW-12, MW-13, and to lesser extent in MW-2, MW-3, and MW-15. Concentrations up to 6.05 mg/L were detected (well MW-2 during the December 2004 sampling event, the most recent event with complete DO data), as compared with a maximum concentration of 0.42 mg/L from wells located inside the plume (well MW-6) during the December 2004 sampling event. High DO concentrations are indicative of well oxygenated water beyond the petroleum-affected area.

- Infiltration events and seasonal recharge of relative oxygen-rich precipitation may promote sporadic increases in DO concentrations. Many of the wells, both inside and outside of the plume, exhibited increased concentrations during the December 2004 monitoring event that may be attributable to this effect.

- Instrument drift and accuracy may also contribute to observed variability in DO concentrations.

6.0 CLEANUP OBJECTIVES AND CRITERIA

6.1 Chemicals of Concern

We compared chemical occurrences to MTCA Method A cleanup levels to identify chemicals of concern for each medium at the site. These chemicals of concern are as follows:

- **Soil.** TPH-G, BTEX, and lead.

- **Groundwater.** TPH-G, BTEX, and lead.

6.2 Potential Exposure Pathways

Direct Contact with Soil

TPH-G and benzene occurrences in soil are in relatively deep 'smear zone' soils below depths of 6 feet. The potential for direct contact exposures is minimal due to the presence of concrete pavement above the affected area (beneath the subject property and adjacent sidewalk).

Direct Contact with Groundwater

The receptor analysis performed by Hart Crowser in 1999 (Hart Crowser 1999a) identified the following hypothetical receptors of contaminated groundwater from the site for evaluation:

- The west branch of Wilson Creek, located approximately 600 feet in the cross-gradient direction of the site; and
- Two City of Ellensburg water supply wells, located 1,200 and 1,600 feet in the downgradient direction of the site.

Site groundwater data indicate that the TPH-affected zone is limited to an area within about 100 feet of the site and is shrinking. Furthermore, an analysis of regional hydrogeology shows that the shallow water-bearing zone affected at the site is not hydraulically connected to the aquifers tapped by the water supply wells (see Appendix A). The upper water-bearing zone is isolated by several underlying aquitards between the shallow water-bearing zone and the water supply aquifers located at depths between 200 and 700 feet. In addition, the receptor analysis and well survey by Hart Crowser have not identified any consumptive use of shallow groundwater in the vicinity of the site.

Although a completed groundwater exposure pathway does not exist, affected groundwater has been detected both on and off the site, and represents a potential exposure risk in the event that excavations are performed in the affected area. Utilities along East University Way are located above the water table, so the likelihood of encountering affected groundwater in utility repair work is low.

6.3 Remedial Action Objectives (RAOs)

Cleanup actions to be implemented at the Ken's Auto Wash site are designed to address the following RAOs:

- **Prevent Direct Contact with Contaminated Soil.** Prevent direct contact with petroleum-impacted soils exhibiting concentrations above MTCA unrestricted cleanup levels.

- **Protect Groundwater.** Address petroleum-impacted soil and groundwater to reduce gasoline-range hydrocarbon and benzene concentrations in groundwater to concentrations below MTCA Method A criteria.

- **Remove Free Product.** Remove free product from the subsurface to the extent practicable.

Under current site conditions, contact with contaminated soil is prevented by a concrete cap over the affected area.

Achieving Method A cleanup levels in soil and groundwater on site may not be practicable because of the heterogeneous site soils containing both coarse- and fine-grained materials. Under this scenario, the downgradient property boundary (near well MW-14) could be used as a conditional point of compliance. Residual petroleum hydrocarbons exceeding MTCA Method A cleanup levels in soil and groundwater may be addressed by appropriate institutional controls, such as a deed restriction or maintenance of pavement areas.

6.4 ARARs and Applicable Regulations

Potential remedial technologies are evaluated in Section 7.0 based on their ability to meet Applicable or Relevant and Appropriate Requirements (ARARs) associated with federal, state, and regional regulations. The following ARARs have been identified:

- **Model Toxics Control Act (MTCA 70.105D RCW, Chapter 173-340 WAC).** MTCA contains detailed requirements and Washington State's expectations for cleanup of contaminated sites.

- **State Environmental Policy Act (SEPA – 43.21 RCW, Chapter 197-11 WAC).** An environmental checklist is necessary as part of any permitting activity within the City of Ellensburg and pursuant to MTCA.

- **Minimum Standards for Construction and Maintenance of Wells (Chapter 173-160 WAC).** This regulation contains requirements for abandonment and construction of resource protection wells.

- **Dangerous Waste Regulations (Chapter 173-303 WAC).** This regulation addresses requirements for identification and proper management of dangerous wastes. It is unlikely that petroleum-impacted soils or groundwater on the Ken's Auto Wash property would be designated as Dangerous or Extremely Hazardous Wastes.

- **State Clean Air Act (RCW 70.94), General Regulations for Air Pollution Sources (Chapter 173-403 WAC), and Toxic Air Contaminant New Source Review Guidelines.** Emissions during any on-site treatment operations may be subject to these regulations and may require a Notice of Construction Permit.

6.5 Cleanup Levels

The Ken's Auto Wash site is a routine cleanup action, as defined in WAC 173-340-200, and involves relatively few constituents. Therefore, in accordance with WAC 173-340-700(5)(a), MTCA Method A cleanup levels may be used. (i.e., for unrestricted site uses). Cleanup levels for chemicals of concern are summarized in Table 8.

6.6 Terrestrial Ecological Evaluation

Ecology's policy for protection of terrestrial ecological receptors (Terrestrial Ecological Evaluation Procedures) is described in WAC 173-340-7490 of MTCA. The site also qualifies for an exclusion from a terrestrial ecological evaluation, as described in WAC 173-340-7491(c). A portion of the site located immediately west of the Ken's Auto Wash property is an unpaved vacant lot, qualifying this area as contiguous undeveloped land based on the definition presented in WAC 173-340-7491(1)(c)(iii). The area of contiguous undeveloped land is less than 1.5 acres, and no further terrestrial ecological evaluation is therefore required based on the criteria listed in WAC 173-340-7491 9(c).

Further, there is no potential exposure pathway to terrestrial wildlife at the site:

- The site is entirely paved where TPH constituents in soil exceed applicable MTCA ecological indicator concentrations;
- Where present, depth to soils contamination is more than 7 feet below ground surface; and
- Where present, depth to groundwater is more than 5 feet below ground surface.

The depth and location of contamination, therefore, is beyond the range of reasonable exposure scenarios.

7.0 REMEDIAL ALTERNATIVE DEVELOPMENT AND EVALUATION

In the Focused Feasibility Study and Remedial Design (Hart Crowser 2000d), we screened potential remediation technologies and proposed two groundwater remediation technologies as potential supplements to the October 2000 excavation—oxygen infusion and ORC injection. These were identified based on the assumption that the majority of contaminated soil and free phase product would be removed by excavation, and that residual hydrocarbons left in-place could be removed using *in situ* bioremediation methods. Current site conditions require a broader evaluation of remedial alternatives. This section describes the development and screening of remedial alternatives.

7.1 Technology Screening

We identified the following remediation technologies to be potentially applicable for addressing petroleum contamination remaining in place:

- **Natural Attenuation.** Natural processes, including biodegradation by native bacteria, would remove petroleum hydrocarbons remaining in-place.
- **Enhanced *In Situ* Bioremediation.** Oxygen would be added to groundwater using biosparging, oxygen infusion, or ORC injection. The added oxygen helps to stimulate biodegradation of petroleum hydrocarbons by native bacteria.
- **Soil Vapor Extraction.** Soil vapor would be removed from the subsurface. Volatile contaminants in soil would evaporate into the vapor, and the vapor would be treated above ground. Increased flow of oxygen to the subsurface

would stimulate biodegradation of petroleum hydrocarbons. Because most of the contamination occurs in soil near the water table, this technology would only be implemented in conjunction with air sparging for effective treatment.

- **Air Sparging.** Air would be bubbled into the groundwater. Volatile contaminants in groundwater would evaporate into the air, which would then be collected and treated by a soil vapor extraction system. Oxygen in air would dissolve into the groundwater and stimulate biodegradation of petroleum hydrocarbons remaining in-place.

In this section we describe remedial action objectives and compare estimated project costs and preliminary remediation time frames for four remedial alternatives that could achieve these objectives:

- Alternative 1 - Monitored Natural Attenuation;
- Alternative 2 - Monitored Natural Attenuation with Passive Product Recovery;
- Alternative 3 - Enhanced Biodegradation by ORC Injection; and
- Alternative 4 - Air Sparging and Soil Vapor Extraction.

7.2 Remedial Alternative Descriptions

MTCA requires at a minimum that cleanup actions protect human health and the environment, comply with cleanup standards, comply with applicable state and federal laws, and provide for compliance monitoring. Using the technologies identified in Section 7.1, we developed four remedial alternatives that meet the above requirements. These alternatives are described below and compared in Table 9.

Cost estimate details are provided in Appendix D. The level of accuracy of these estimated costs is "order of magnitude," as defined by the American Association of Cost Engineers. The target accuracy of an order of magnitude estimate is plus 50 percent and minus 30 percent. Construction cost estimates at this level may be used to compare alternatives, but should not be used to plan, finance, or develop projects. Estimated alternative costs were calculated using a present worth analysis assuming a discount rate of 2.6 percent for 5-year returns or less, 2.8 percent for returns between 5 and 10 years, and 3.0 percent for returns greater than 10 years. These discount rates are based on rates from January 2006 listed in the Office of Management and Budget Circular A-94. Nominal estimated Ecology oversight costs are included for each alternative. In response to Ecology review comments on the previous draft version of the document, costs include a contingency for replacing up to three monitoring wells over the lifetime of each alternative.

Note that estimated costs are for comparing alternatives and do not include costs for preparation and review of deliverables associated with a second Agreed Order, if issued by Ecology to complete remediation. Tasks may include preparation of a Cleanup Action Plan, interaction with Ecology, and related project management. Costs are expected to be comparable for Alternatives 1 and 2 and are estimated in the $15,000 to $25,000 range. Costs for Alternatives 3 and 4 may also be comparable and are estimated to be in the $25,000 to $40,000. Costs exclude additional field work (other than on-going monitoring currently being conducted at the site), and we caution that significant uncertainty is associated with these estimates. Additional input from Ecology will be necessary to refine these preliminary estimates more accurately.

Alternative 1 - Monitored Natural Attenuation

Monitored natural attenuation consists of allowing naturally occurring processes, such as dilution, dispersion, adsorption, and biodegradation, to remove contaminants and reduce concentrations. This approach is potentially effective at the site based on the following observations:

- Chemical data indicate that the contaminant plume in groundwater is stable or shrinking.

- Depressed concentrations of DO in groundwater are typical of petroleum hydrocarbon plumes where significant biological activity is occurring. The depressed concentrations result from utilization of the petroleum contaminants as a growth substrate. As discussed above, low DO concentrations in many of the samples collected from the site plume area is one weight-of-evidence factor suggesting that biological degradation is continuing to occur.

- Conversely, relatively higher DO concentrations in groundwater samples outside of the plume area indicate that oxygen continues to be available to promote natural attenuation.

Continued periodic groundwater monitoring would be required to verify the removal of contaminants and that the contaminant plume in groundwater does not expand. Additional limited monitoring for constituents indicative of biodegradation (e.g., dissolved iron, nitrate, and sulfate) would be prudent. This approach provides minimal site or area impacts. Note that for comparative purposes with Alternative 2, Alternative 1 does not include removal of residual free product near the source area. As an MTCA requirement, removal of residual free product was included as part of Alternative 2, as discussed below. A free product monitoring program would ensure free product occurrences at well MW-14 diminish and that product does not migrate to downgradient wells. Free product was not detected in well MW-14 during the last three sampling rounds, which immediately followed the UST removal and ORC injection in 2005. There is no indication that free product is currently present or migrating in the subsurface.

If free product remains at the site and is detected during future sampling events, the projected remediation time frame could be more than 20 years. Therefore, the estimated cost of this alternative is based on a nominal monitoring period between 15 to 30 years. Estimated costs range from about $325,000 to $491,000. Cost estimate details are provided in Table D-1 of Appendix D.

Alternative 2 - Monitored Natural Attenuation with Passive Free Product Recovery

This alternative is the same as Alternative 1 except a sorbent sock or similar passive recovery device would be placed in well MW-14 if free product was observed. Although not recently observed in MW-14, free product may still be present near the southern border of the UST excavation, as described in Section 3.4. Active free product recovery is not viable, nor expected to be necessary because only a small amount of product has intermittently been observed in this well. Passive free product recovery would minimize the potential for free product migration and increase the speed of site cleanup. Based on current decreasing trends in constituent concentrations, the projected remediation time frame could be 5 to 10 years, but for costing purposes a time period of up to 30 years was used for reaching target groundwater cleanup levels at monitoring well MW-14. The longer time frame was also used for comparative purposes with Alternative 1. The estimated costs of this alternative range from about $333,000 to $505,000. Cost estimate details are provided in Table D-2 of Appendix D.

Alternative 3 - Enhanced Biodegradation

An enhanced biodegradation approach uses the same processes involved in natural attenuation but speeds up remediation by stimulating the biodegradation component. Because biodegradation of contaminants is oxygen-limited, oxygen can be added by several methods to increase the rate of biodegradation. In the Focused Feasibility Study (Hart Crowser 2000d), we evaluated two methods—oxygen infusion (e.g., via passive diffusion) and ORC injection—of introducing oxygen to groundwater in the subsurface that would incur limited site and area impacts. Implementing oxygen infusion would require installing two wells, storing a secured oxygen cylinder on site, and replacing the oxygen cylinder every month. ORC injection would require injection of ORC slurry into groundwater beneath the source area and downgradient plume twice a year. Injection would be performed with a direct-push drill rig and require limited concrete coring and temporary partial street closure for one day. This method was used to complete ORC injection at the locations previously noted along East University Way in 2005.

The Focused Feasibility Study considered implementing oxygen infusion to remove contaminants left after excavation but recognized that this technology had not yet been proven and that re-evaluation of this selection following excavation and groundwater monitoring was warranted. Since that time the oxygen infusion technology has not been clearly demonstrated to be more effective than other oxygen introduction technologies. Therefore, in this RI/FS, we discard the oxygen infusion alternative and further evaluate enhanced biodegradation using ORC injection as the most viable biodegradation alternative. Because of the uncertainties associated with the time frame needed for this alternative, enhanced biodegradation may need to be implemented on a relatively long-term basis to be effective and meet remedial action objectives. The estimated cost of this alternative, based on a nominal 10- to 15-year operating lifetime ranges from about $485,000 to $653,000. The operating lifetime is based on our preliminary projection, and assuming that additional free product may be present, as discussed above for Alternative 2. Cost estimate details are provided in Table D-3 of Appendix D.

Alternative 4 - Air Sparging and Soil Vapor Extraction

Two aggressive *in situ* technologies were identified in the Focused Feasibility Study as potentially applicable to the site--sparging and sparging combined with soil vapor extraction (SVE). Based on the estimated contaminated mass remaining in-place, sparging combined with SVE would likely be necessary to collect and treat hydrocarbon emissions.

In sparging with SVE, air would be injected into groundwater, stripping contaminants from the water and from soil. Air containing contaminant vapors would be collected using SVE and treated to remove contaminants and meet air discharge requirements. During the October 2000 soil removal, porous horizontal pipes for sparging were laid at the base of the excavation to facilitate implementation of these technologies, if necessary. Implementing this alternative would require installing four vapor extraction wells, five sparging wells, piping, and a secure equipment compound containing a sparging blower, SVE blower, knockout drum, 500-gallon condensate collection tank, and control panel. Sound enclosures would be placed around the blowers, but the blowers will still be audible when running.

A typical time to achieve site closure using sparging/SVE at sites with similar conditions (e.g., some free product and relatively heterogeneous soil) is approximately 5 years of system operation followed by 1 year of confirmation monitoring. The actual duration of remediation would be determined by evaluating system performance over time. The estimated cost for this alternative, based on an operating lifetime of 5 to 7 years for comparative purposes, including 1 year of monitoring, ranges between about $395,000 to $464,000. The estimated operating lifetime is based on our experience at similar sites with comparable conditions, and is intended for cost comparison and planning purposes only. Cost estimate details are provided in Table D-4 of Appendix D.

7.3 Evaluation of Alternatives

These four proposed alternatives would meet the threshold requirements for cleanup actions outlined in WAC 173-340-360 (2)(a): they protect human health and the environment, comply with cleanup standards, comply with applicable state and federal laws, and provide for compliance monitoring. In Table 9, we evaluate each of the four alternatives described in Section 7.2 based on their use of permanent solutions to the maximum extent practicable and on the ability of each alternative to provide for restoration in a reasonable timeframe following the criteria described in WAC 173-340-360.

Alternative 1 meets the criteria described in WAC 173-340-360, except if free product continues to be present in the future. Alternative 2 provides additional control and removal of free product for a relatively small increase in cost for comparable project lifetimes. Costs could conceivably be less for Alternative 2 if product removal further accelerates the natural attenuation process. Alternative 3 and 4 potentially provide faster source removal than Alternative 2, but have disproportionately higher costs and resource utilization. Further, even the most aggressive alternative (Alternative 4) will not provide for complete source removal during active remediation, as complete removal of petroleum hydrocarbons from fine-grained soils in the short term is unlikely. The capital costs for Alternative 4 (estimated $186,100) are also substantially greater than the other alternatives. Conversely, it should be noted that if Alternatives 3 or 4 achieved cleanup goals faster than the estimated time projections, they could be less expensive than Alternative 2. However, there is no assurance of this outcome, given uncertainties associated with duration for the *in situ* technologies considered. Therefore, Alternative 2—Monitored Natural Attenuation with Free Product Recovery was identified as the preferred remedial alternative. This alternative provides for a reasonable restoration time frame in accordance with WAC 173-340-360(4). Implementation of this alternative is described below.

7.4 Preferred Remedial Alternative Identification

Monitoring data indicate that previous remediation actions and ongoing natural attenuation of contaminants have been effective in removing contamination from the subsurface, and that the contaminant plume in groundwater is shrinking. It is our opinion that occurrences of residual petroleum hydrocarbons in soil and groundwater at this site do not represent a risk to human health or the environment.

Because some free product is still present at the site, we recommend adopting Alternative 2—Monitored Natural Attenuation with Passive Product Recovery as the remediation strategy. This alternative meets site RAOs: direct contact with contaminated soils on site is prevented by maintaining the existing concrete surface; removes free product to the extent practicable using passive recovery devices; and in the long term reduces soil and groundwater concentrations below cleanup levels by natural degradation of contaminants.

Alternative 2 would be sufficiently protective of human health and the environment and is the most cost-effective alternative. Passive product recovery would mitigate potential free product migration while adding a relatively small cost. Although this alternative has a long remediation time frame, contaminants will be completely destroyed *in situ* while using a minimum of energy and natural resources. Monitoring would be conducted to ensure that this alternative remains protective of human health and the environment.

A preliminary monitoring schedule is included in Table 10. This schedule includes the continuation of periodic monitoring for natural attenuation parameters to demonstrate contaminants are degraded *in situ.* Monitoring frequency will continue on a biannual basis and will be conducted during wet and dry season conditions. Every 5 years, in accordance with Ecology policy, we assume that the site data would be reviewed by Ecology to ensure the alternative is still protective of human health and the environment, that the contaminant plume is still contained, and that long-term trends show constituent concentrations are decreasing.

8.0 REFERENCES

Ecology 1996. Site Hazard Assessment, Ken's Auto Wash, 1013 East 10th, Ellensburg, Washington.

Sage 1998a. Limited Site Characterization Report, Ken's Auto Wash Facility, Ellensburg, Washington. Prepared by Sage Earth Sciences, Inc., March 1998.

Sage 1998b. Preliminary Fourth Quarter Groundwater Monitoring Report for the Ken's Auto Wash Facility, Ellensburg, Washington. Prepared by Sage Earth Sciences, Inc., November 1998.

Hart Crowser 1999a. Limited Phase II Environmental Assessment, Ken's Auto Wash Facility, Ellensburg, Washington. Prepared by Hart Crowser, Inc., November 29, 1999.

Hart Crowser 1999b. Request for Assistance, Ken's Auto Wash Facility. Letter to Ecology Prepared by Hart Crowser, Inc., December 3, 1999.

Hart Crowser 2000a. Fourth Quarter 1999 Groundwater Monitoring Report, Voluntary Cleanup Program, Ken's Auto Wash Facility, Ellensburg, Washington. Prepared by Hart Crowser, Inc., February 10, 2000.

Hart Crowser 2000b. First Quarter 2000 Groundwater Monitoring Report, Voluntary Cleanup Program, Ken's Auto Wash Facility, Ellensburg, Washington. Prepared by Hart Crowser, Inc., April 7, 2000.

Hart Crowser 2000c. Second Quarter 2000 Groundwater Monitoring Report, Voluntary Cleanup Program, Ken's Auto Wash Facility, Ellensburg, Washington. Prepared by Hart Crowser, Inc., July 25, 2000.

Hart Crowser 2000d. Focused Feasibility Study and Remedial Design, Ken's Auto Wash Facility, Ellensburg, Washington. Prepared by Hart Crowser, Inc., August 16, 2000.

Hart Crowser 2000e. Third Quarter 2000 Groundwater Monitoring and Soil Investigation Report (Draft), Voluntary Cleanup Program, Ken's Auto Wash Facility, Ellensburg, Washington. Prepared by Hart Crowser, Inc., October 18, 2000.

Hart Crowser 2001. Soil Excavation Report, Ken's Auto Wash, Ellensburg, Washington. Prepared by Hart Crowser, Inc., January 4, 2001.

Hart Crowser 2002a. 2001 Groundwater Monitoring and Remediation Status Report, Voluntary Cleanup Program, Ken's Auto Wash Facility, Ellensburg, Washington. Prepared by Hart Crowser, Inc., July 16, 2002.

Hart Crowser 2002b. Groundwater Monitoring Report and Evaluation of Remedial Alternatives, Ken's Auto Wash Facility, Ellensburg, Washington. Letter to Ecology prepared by Hart Crowser, Inc., December 16, 2002.

Hart Crowser 2003. Groundwater Monitoring Report, Ken's Auto Wash, September 2003. Prepared by Hart Crowser, Inc., November 17, 2003.

Hart Crowser 2004a. Groundwater Monitoring Report, Ken's Auto Wash, December 2003. Prepared by Hart Crowser, Inc., February 6, 2004

Hart Crowser 2004b. Groundwater Monitoring Report, Ken's Auto Wash, March 2004. Prepared by Hart Crowser, Inc., July 7, 2004.

Hart Crowser 2004c. Groundwater Monitoring Report, Ken's Auto Wash, June 2004. Prepared by Hart Crowser, Inc., August 31, 2004.

Hart Crowser 2005a. Supplemental Strataprobe Explorations, Ken's Auto Wash Site, February 2005. Prepared by Hart Crowser, Inc., April 6, 2005.

Hart Crowser 2005b. Gasoline Underground Storage Tank (UST) Closure Report, Ken's Auto Wash, April 2005. Prepared by Hart Crowser, Inc., June 7, 2005.

Hart Crowser 2005c. Hart Crowser 2005. Groundwater Monitoring Report, Ken's Auto Wash, April and October 2005. Prepared by Hart Crowser, Inc., November 9, 2005.

Hart Crowser 2006. Hart Crowser 2004. Groundwater Monitoring Report, Ken's Auto Wash, June 2006. Prepared by Hart Crowser, Inc., July 7, 2006.

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Table 1 - Summary of Site Investigation, Remediation, and Monitoring Activities

Dates	Activity				
	Soil and Groundwater Investigation	**Soil Sampling and Analysis**	**Groundwater Monitoring**	**Remediation**	**Consultant**
1995 to 1998	Monitoring Well Installation	X	X		Sage Earth Sciences
1998			X		
1999	Recepter Analysis Utility Survey Soil Boring Exploration Monitoring Well Installation	X	X		Hart Crowser
2000			X		
September 2000	Additional Soil Borings Hydropunch Groundwater Samples from Borings Monitoring Well Installation	X	X		
October and November 2000	Soil Sampling from Hot Spot Excavation	X		Hot Spot Excavation ORC Application to Excavation	
January 2001	Install MW-14 Replacement Well and MW-15		X		
2000 to 2005			X		
February 2005	Strataprobe (Push-Probe) Explorations	X	X	ORC Injection via Strataprobes	
April 2005	Soil Sampling from UST Explorations "Pothole" Test Pit Explorations	X		UST Removal	
October 2005	Install MW-4R Replacement Well		X		
2005-On-Going			X		

Table 2 - Groundwater Elevation Data

Measured Depth to Groundwater in Feet

Measured Depth to Groundwater in Feet | Measured Depth to Groundwater in Feet

Well No.	8-Apr-96	5-Jan-98	5-Feb-98	5-Mar-98	6-Apr-98	5-May-98	5-Jun-98	6-Jul-98	5-Aug-98	4-Sep-98	5-Oct-98	5-Nov-98	29-Dec-99	21-Mar-00	14-Jun-00	12-Sep-00	30-Jan-01	26-Apr-01	29-Jul-01
MW-1	6.85	na	7.67	8.01	8.38	6.88	6.94	7.50	7.69	7.82	7.85	8.33	9.65	8.51	7.08	7.85	—	—	—
MW-14 (b)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	8.55	8.35	7.01
MW-2	6.70	7.53	6.50	6.88	7.18	5.69	5.79	6.19	6.55	6.58	7.70	7.06	7.23	7.18	6.10	6.70	7.54	7.11	6.23
MW-3	8.08	8.42	7.65	8.01	8.17	6.71	7.50	7.42	7.51	7.66	7.80	8.28	8.41	8.29	7.42	7.92	8.70	7.67	7.28
MW-4	—	7.84	7.17	7.43	7.67	6.42	6.57	6.90	7.01	7.14	7.21	7.62	7.68	7.60	6.80	7.23	8.08	7.85	6.93
MW-4R (c)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
MW-5		8.23	7.15	7.45	7.96	6.24	6.34	6.65	7.16	7.29	7.41	7.94	7.52	7.32	6.25	6.87	na	7.98	6.29
MW-6	—	9.70	8.67	9.13	9.46	8.14	8.21	8.66	8.87	9.01	9.05	9.51	8.60	8.36	7.70	8.07	na	9.28	8.09
MW-12	—	—	—	—	—	—	—	—	—	—	—	—	6.91	6.64	6.05	6.36	na	7.30	6.38
MW-13	—	—	—	—	—	—	—	—	—	—	—	—	5.42	5.33	4.70	4.98	na	5.74	4.67
MW-15	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	9.23	8.83	7.59

Groundwater Elevation in Feet | Groundwater Elevation in Feet

Well No.	TOC Elev. (a)	8-Apr-96	5-Jan-98	5-Feb-98	5-Mar-98	6-Apr-98	5-May-98	5-Jun-98	6-Jul-98	5-Aug-98	4-Sep-98	5-Oct-98	5-Nov-98	29-Dec-99	21-Mar-00	14-Jun-00	12-Sep-00	30-Jan-01	26-Apr-01	29-Jul-01
MW-1	1588.38	1581.53	na	1580.71	1580.37	1580.00	1581.50	1581.44	1580.88	1580.69	1580.56	1580.53	1580.05	1578.73	1579.87	1581.30	1580.53	—	—	—
MW-14 (b)	1588.4	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1579.85	1580.05	1581.39
MW-2	1588.92	1582.22	1581.39	1582.42	1582.04	1581.74	1583.23	1583.13	1582.73	1582.37	1582.34	1581.22	1581.86	1581.69	1581.74	1582.82	1582.22	1581.38	1581.81	1582.69
MW-3	1591.43	1583.35	1583.01	1583.78	1583.42	1583.26	1584.72	1583.93	1584.01	1583.92	1583.77	1583.63	1583.15	1583.02	1583.14	1584.01	1583.51	1582.73	1583.76	1584.15
MW-4	1589.50	—	1581.66	1582.33	1582.07	1581.83	1583.08	1582.93	1582.60	1582.49	1582.36	1582.29	1581.88	1581.82	1581.90	1582.70	1582.27	1581.42	1581.65	1582.57
MW-4R (c)	1591.43	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
MW-5	1587.75	—	1579.52	1580.60	1580.30	1579.79	1581.51	1581.41	1581.10	1580.59	1580.46	1580.34	1579.81	1580.23	1580.43	1581.50	1580.88	na	1579.77	1581.46
MW-6	1587.72	—	1578.02	1579.05	1578.59	1578.26	1579.58	1579.51	1579.06	1578.85	1578.71	1578.67	1578.21	1579.12	1579.36	1580.02	1579.65	na	1578.44	1579.63
MW-12	1585.41	—	—	—	—	—	—	—	—	—	—	—	—	1578.50	1578.77	1579.36	1579.05	na	1578.11	1579.03
MW-13	1582.45	—	—	—	—	—	—	—	—	—	—	—	—	1577.03	1577.12	1577.75	1577.47	na	1576.71	1577.78
MW-15	1588.39	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1579.16	1579.56	1580.80

Table 2 - Groundwater Elevation Data

Measured Depth to Groundwater in Feet

Measured Depth to Groundwater in Feet

Well No.	27-Oct-01	15-Nov-02	9-May-03	30-Sep-03	11-Dec-03	31-Mar-04	2-Jun-04	30-Sep-04	14-Dec-04	4-Apr-05	6-Oct-05	28-Jun-06
MW-1	—	—	—	—	—	—	—	—	—	—		—
MW-14 (b)	9.02	8.90	6.23	8.05	8.58	8.32	6.28	7.79	8.45	8.63	7.83	6.15
MW-2	7.64	7.61	5.95	6.81	7.03	7.05	5.94	6.69	7.07	7.57	7.21	nm
MW-3	8.66	8.63	6.89	8.06	8.48	8.30	6.98	7.92	8.64	8.80	8.37	nm
MW-4	8.09	8.04	6.71	7.65	7.81	7.70	6.62	7.44	7.86	8.02	—	—
MW-4R (c)	—	—	—	—	—	—	—	—	—	—	7.78	6.01
MW-5	7.97	8.05	6.19	7.55	7.83	7.59	6.14	—	9.21	8.32	7.73	6.38
MW-6	9.44	9.37	7.91	8.90	9.19	9.00	7.82	8.88	9.49	9.78	9.14	nm
MW-12	7.13	7.52	6.50	7.25	7.38	7.18	6.40	7.31	7.81	7.89	7.51	6.90
MW-13	5.78	—	—	5.32	5.73	5.49	4.63	5.18	5.81	5.16	5.56	nm
MW-15	9.30	9.08	7.38	8.55	8.67	8.85	7.31	8.33	9.20	9.40	8.02	nm

Groundwater Elevation in Feet

Well No.	TOC Elev. (a)	27-Oct-01	15-Nov-02	9-May-03	30-Sep-03	11-Dec-03	31-Mar-04	2-Jun-04	30-Sep-04	14-Dec-04	4-Apr-05	6-Oct-05	28-Jun-06
MW-1	1588.38	—	—	—	—	—	—	—	—	—	—	—	
MW-14 (b)	1588.4	1579.38	1579.50	1582.17	1580.35	1579.82	1580.08	1582.12	1580.61	1579.95	1579.77	1580.57	1582.25
MW-2	1588.92	1581.28	1581.31	1582.97	1582.11	1581.89	1581.87	1582.98	1582.23	1581.85	1581.35	1581.71	nm
MW-3	1591.43	1582.77	1582.80	1584.54	1583.37	1582.95	1583.13	1584.45	1583.51	1582.79	1582.63	1583.06	nm
MW-4	1589.50	1581.41	1581.46	1582.79	1581.85	1581.69	1581.80	1582.88	1582.06	1581.64	1581.48	—	—
MW-4R (c)	1591.43	—	—	—	—	—	—	—	—	—	—	1583.65	1585.42
MW-5	1587.75	1579.78	1579.70	1581.56	1580.20	1579.92	1580.16	1581.61	—	1578.54	1579.43	1580.02	1581.37
MW-6	1587.72	1578.28	1578.35	1579.81	1578.82	1578.53	1578.72	1579.90	1578.84	1578.23	1577.94	1578.58	nm
MW-12	1585.41	1578.28	1577.89	1578.91	1578.16	1578.03	1578.23	1579.01	1578.10	1577.60	1577.52	1577.90	1578.51
MW-13	1582.45	1576.67	—	—	1577.13	1576.72	1576.96	1577.82	1577.27	1576.64	1577.29	1576.89	nm
MW-15	1588.39	1579.09	1579.31	1581.01	1579.84	1579.72	1579.54	1581.08	1580.06	1579.19	1578.99	1580.37	nm

Notes:

(a) TOC Elevation = top of casing elevations are surveyed relative to Mean Sea Level by Sage Environmental. MW-12 and MW-13 were surveyed relative to existing well MW-1, and existing wells MW-5 and MW-6 were re-surveyed and corrected slightly.

(b) Well MW-1 replaced as well MW-14 by Hart Crowser following remediation work in November 2000.

(c) Well MW-4 was replaced as well MW-4R by Hart Crowser in October 2005, following removal of the well during UST removal activities in April 2005.

— Well not installed or not available as of date indicated

nm Indicates well was not monitored

Table 3 - Summary of Soil Chemistry Data

				Concentration in mg/kg							
Location	Sample ID	Sample Depth in Feet	Date Sampled	TPH-G	TPH-D	TPP-O	Benzene	Toluene	Ethylbenzene	Xylenes	Lead
Soil Borings											
MW-1	BP-0296-S1	7.5	4/5/1996	**4,800**	–	–	**3**	**45**	**37**	**270**	–
MW-2	BP-0296-S5	7.5	4/5/1996	4	–	–	0.02 U	0.02 U	0.02 U	0.03	–
MW-3	BP-0296-S8	7.5	4/5/1996	20 U	50 U	100 U	–	–	–	–	–
MW-4	BP-0397-S1	cuttings	12/9/1997	3	–	–	0.02 U	0.02	0.02 U	0.03	–
MW-5	BP-0397-S2	7 to 9	12/9/1997	**870**	–	–	0.2 U	**10**	0.2 U	**12**	–
MW-5	BP-0397-S3	12.5 to 13	12/9/1997	**110**	–	–	0.02 U	1.6	0.27	1.6	–
MW-6	BP-0397-S4	12.5	12/9/1997	1 U	–	–	0.02 U	0.02 U	0.02 U	0.02 U	–
HP-8	HP-8	8.5	7/14/1999	8.12	–	–	0.05 U	0.06 U	0.05 U	0.1 U	–
HP-9	HP-9	10	7/14/1999	20.7	–	–	0.05 U	0.05 U	0.05 U	0.12 U	–
HP-12	HP-12 S-3	10 to 11.5	9/12/2000	11.3	–	–	0.05 U	0.05 U	0.05 U	0.1 U	2.37
HP-13	HP-13 S-3	10 to 11.5	9/12/2000	24.3	–	–	0.05 U	0.05 U	0.05 U	0.206	–
HP-14	HP-14 S-2	8 to 9.5	9/12/2000	**68.1**	–	–	**0.0686**	0.0701	0.062	0.474	–
HP-15	HP-15 S-2	8 to 9.5	9/12/2000	5 U	–	–	0.05 U	0.05 U	0.05 U	0.1 U	–
HP-16	HP-16 S-2	8 to 9.5	9/12/2000	**247**	–	–	**0.273**	0.408	1.41	3.27	3.76
MW-14	MW-14 S-1	8 to 9.5	1/26/2001	7.15	–	–	0.05 U	0.06 U	0.05 U	0.1 U	–
MW-14	MW-14 S-2	15 to 16.5	1/26/2001	5.47	–	–	0.05 U	0.06 U	0.05 U	0.103	–
MW-15	MW-15 S-1	8 to 9.5	1/26/2001	5 U	–	–	0.05 U	0.06 U	0.05 U	0.1 U	–
Hot Spot Excavation Verification Samples											
East Wall	11/3-E Wall	7 to 8	11/3/2000	32.8	–	–	0.05 U	0.05 U	0.05 U	0.1 U	–
Northeast Wall	11/3-NE Wall	7 to 8	11/3/2000	**11,000**	–	–	**10.6**	13.5 U	**73.9**	**588**	–
Southeast Wall	11/3-SE Wall	7 to 8	11/3/2000	**7,130**	–	–	2.5 U	7.75 U	**72.3**	**423**	–
West Wall	11/10-W Wall	7 to 8	11/10/2000	5 U	–	–	0.05 U	0.05 U	0.05 U	0.1 U	–
Northwest Wall	11/10-NW Wall	7 to 8	11/10/2000	**1,250**	–	–	1 U	1.7 U	6 U	**29.6**	–
Southwest Wall	11/10-SW Wall	7 to 8	11/10/2000	**126**	–	–	**0.134**	0.195 U	0.05 U	0.945 U	–
Strataprobe Investigation Samples											
HCSP-04-01	HCSP-04-01 S-4	6.0 to 8.0	2/24/2005	21.6	–	–	0.030 U	0.050 U	0.050 U	0.100 U	4.15
HCSP-04-01	HCSP-04-01 S-5	8.0 to 10.C	2/24/2005	**108**	–	–	0.030 U	0.136 J	0.158 J	0.305 J	5.09
HCSP-04-02	HCSP-04-02 S-2	4.0 to 8.0	2/24/2005	23.1	–	–	0.030 U	0.050 U	0.050 U	0.100 U	3.71
HCSP-04-02	HCSP-04-02 S-3	8.0 to 12.C	2/24/2005	9.4	–	–	0.030 U	0.050 U	0.050 U	0.100 U	5.32
HCSP-04-03	HCSP-04-03 S-4	8.0 to 10.C	2/24/2005	19.1	–	–	0.030 U	0.050 U	0.0717 J	0.132 J	10.5
HCSP-04-03	HCSP-04-03 S-5	10.0 to 12.	2/24/2005	5.0	–	–	0.030 U	0.050 U	0.050 U	0.100 U	3.54
HCSP-04-04	HCSP-04-04 S-4	8.0 to 10.C	2/24/2005	5.0 U	–	–	0.030 U	0.050 U	0.050 U	0.100 U	16.8
HCSP-04-04	HCSP-04-04 S-5	10.0 to 12.	2/24/2005	5.0 U	–	–	0.030 U	0.050 U	0.050 U	0.100 U	2.91
HCSP-04-05	HCSP-04-05 S-4	6.0 to 8.0	2/24/2005	**108** J	–	–	0.030 U	0.109 J	0.432 J	0.400 J	5.30
HCSP-04-05	HCSP-04-05 S-5	8.0 to 10.C	2/24/2005	**116** J	–	–	0.030 U	0.134 J	0.563 J	0.522 J	5.77
HCSP-04-06	HCSP-04-06 S-4	6.0 to 8.0	2/24/2005	5 U	–	–	0.030 U	0.050 U	0.050 U	0.100 U	5.07
HCSP-04-06	HCSP-04-06 S-5	8.0 to 10.C	2/24/2005	64.7	–	–	0.030 U	0.123 J	0.482 J	0.548 J	7.92
HCSP-04-07	HCSP-04-07 S-3	4.0 to 7.0	2/24/2005	5 U	–	–	0.030 U	0.050 U	0.050 U	0.100	8.76
HCSP-04-07	HCSP-04-07 S-4	8.0 to 11.C	2/24/2005	49.0	–	–	0.030 U	0.050 U	0.109 J	0.163	2.95
HCSP-04-08	HCSP-04-08 S-3	6.0 to 8.0	2/24/2005	5.0 U	–	–	0.030 U	0.050 U	0.050 U	0.100 U	2.85
HCSP-04-08	HCSP-04-08 S-4	8.0 to 10.C	2/24/2005	16.4	–	–	0.030 U	0.050 U	0.0696 J	0.102 J	2.91
UST Removal Verification Samples											
East Pump Island		2.5 to 3.0	4/6/2005	5.0 U	–	–	0.030 U	0.050 U	0.050 U	0.100 U	–
West Pump Island		3.0	4/6/2005	9.51 U	–	–	0.057 U	0.0951 U	0.0951 U	0.190 U	–
Fuel Line 1		3.0	4/6/2005	3.74 U	–	–	0.0225 U	0.0374 U	0.0374 U	0.0749 U	–
Fuel Line 2		3.0	4/6/2005	5.0 U	–	–	0.030 U	0.050 U	0.050 U	0.100 U	–
Fuel Line 3		14	4/6/2005	3.84 U	–	–	0.023 U	0.0384 U	0.0384 U	0.0768 U	–
Bottom Tank 1		12	4/6/2005	5.0 U	–	–	0.030 U	0.050 U	0.050 U	0.100 U	–
Bottom Tank 2		12	4/6/2005	16.5	–	–	0.0262 U	0.0437 U	0.0437 U	0.0874 U	–
Bottom Tank 3		12	4/6/2005	20.2	–	–	0.0264 U	0.0439 U	0.0439 U	0.148	–
West Wall center		8 to 10	4/6/2005	6.43	–	–	**0.0337**	0.039 U	0.039 U	0.0779 U	–
South Wall		8	4/7/2005	**2400**	–	–	**0.935**	0.436 U	**24.8**	**43.0**	–
Pothole A		9	4/7/2005	**162**	–	–	**0.180**	0.0433 U	0.423	1.00	–
Pothole B		7	4/7/2005	**490**	–	–	**0.697**	0.0952	1.77	3.28	–
Pothole D		10	4/7/2005	16	–	–	0.030 U	0.050 U	0.050 U	0.100 U	–
Pothole E-6'		6	4/8/2005	**705**	–	–	**1.42**	0.0435 U	1.21	1.59	–
Pothole E-10'		10	4/8/2005	**346**	–	–	**0.555**	0.0622	0.948	1.76	–
Pothole E-12'		12	4/8/2005	**65**	–	–	**0.0685**	0.050 U	0.158	0.326	–
Pothole F-6'		6	4/8/2005	**144**	–	–	**0.0358**	0.050 U	0.0961	1.86	–
Pothole F-10'		10	4/8/2005	36.7	–	–	0.030 U	0.050 U	0.050 U	0.242	–
MTCA Method A Cleanup Levels				100/30 [a]	2000	2000	0.03	7	6	9	250

TPH analyzed by EPA Method 8015 or WTPH-HCID for 1996 and 1997 samples and NWTPH-G for post-1997 samples.
BTEX (Benzene, Toluene, Ethylbenzene, Xylenes) analyzed by EPA Method 8021B.
U Not detected above specified reporting limit.
– Not analyzed.
[a] Cleanup level with/without benzene detected
Bolded concentrations exceed MTCA Method A cleanup levels.

Table 4 - Summary of Groundwater Chemistry Data - TPH-G, BTEX, and Lead

		Concentration in mg/L		Concentration in μg/L						
Well ID	Sampled	Oxygen	Ferrous Iron	TPH	Benzene	Toluene	Ethylbenzene	Xylenes	Total Lead	Diss. Lead
MW-1	4/8/1996	–	–	160,000	2,500	19,000	3,000	21,000	65	–
	1/5/1998	–	–	–	–	–	–	–	–	–
	4/6/1998	–	–	100,000	180	260	940	9,800	180	–
	7/6/1998	–	–	93,000	110	200	760	8,800	220	–
	10/5/1998	–	–	–	–	–	–	–	–	–
	12/29/1999	–	–	21,600	87.4	47.7	657	3,900	–	21.3
	3/21/2000	0.6	–	19,800	94.1	59.6	479	2,710	–	16.5
	6/14/2000	1	–	18,800	94.9	26.4	471	2,870	–	8
	9/12/2000	0.4	–	21,400	111	35.1	496	2,930	–	6.54
MW-14	1/30/2001	2.4	–	7,450	19.3	14	424	673	–	–
(Replaces MW-1)	4/26/2001	–	–	26,100	37.2	29.7	580	2,680	–	–
	7/29/2001	2.3	–	14,200	10.3	14.2	318	1,480	–	–
	10/27/2001	0.8	–	9,970	46.4	4.55	187	707	–	–
	11/15/2002	–	–	8,380	11	2.5 U	122	357	–	–
	5/9/2003	1.2	–	4,520	2.62	0.5 U	0.775	172	5.33	–
	9/30/2003	0.29	1.6	6,230 J	11.7 J	1.61 J	151 J	369 J	4.56	–
	12/11/2003	3.2	4	5,890	12.6	5.0 U	5.0 U	271	12.4	–
	3/31/2004	0.12	5.2	6,270	12.6	5 U	80.4	168.4	4.85	–
	6/2/2004	0.02	7.2	3,790 J	2.36 J	0.5 U	26.9 J	88.1 J	4.12	–
	9/30/2004	0.11	5.6	5,700 J	5.52	2.5 U	82.1	256	4.29	–
	12/14/2004	0.07	6.3	5,500 J	4.36	0.643	66.1	178	–	–
	4/4/2005	–	4.82 J	8,100 J	6.89	0.746	75.8	221	–	–
	10/6/2005	–	9.74	4,070 J	7.85	0.5 U	43.1	62.8	3.7	–
	6/28/2006	0.6	0.25 U	533	0.545	0.5 U	0.593	5.34	3.41	–
MW-2	4/8/1996	–	–	50 U	1 U	1 U	1 U	1 U	5 U	–
	1/5/1998	–	–	50 U	1 U	1 U	1 U	1 U	15	5 U
	4/6/1998	–	–	50 U	1 U	1 U	1 U	1 U	5 U	–
	7/6/1998	–	–	50 U	1 U	1 U	1 U	1 U	21	–
	10/5/1998	–	–	50 U	1 U	1 U	1 U	1 U	34	–
	12/29/1999	–	–	50 U	0.5 U	0.5 U	0.5 U	1 U	–	1 U
	3/21/2000	2.6	–	50 U	0.5 U	0.5 U	0.5 U	1 U	–	1 U
	6/14/2000	2.8	–	50 U	0.5 U	0.5 U	0.55	3.41	–	1 U
	9/12/2000	0.8	–	50 U	0.5 U	0.5 U	0.5 U	1 U	–	1 U
	1/30/2001	1.5	–	50 U	0.5 U	0.5 U	0.5 U	1 U	–	–
	4/26/2001	4.5	–	50 U	0.5 U	0.5 U	0.5 U	1 U	–	–
	7/29/2001	3.3	–	50 U	0.5 U	0.5 U	0.5 U	1 U	–	–
	10/27/2001	2	–	50 U	0.5 U	0.5 U	0.5 U	1 U	–	–
	11/15/2002	1.5	–	50 U	0.5 U	0.5 U	0.5 U	1 U	–	–
	5/9/2003	2.3	–	50 U	0.5 U	0.5 U	0.5 U	1 U	1 U	–
	9/30/2003	1.51	1.2	50 U	0.5 U	0.5 U	0.5 U	1 U	2.61	–
	12/11/2003	3.90	0.0	50 U	0.5 U	0.5 U	0.5 U	1 U	1 U	–
	3/31/2004	0.82	0.0	13,000	10 U	119	180	2,541 J	1 U	–
	6/2/2004	1.63	0.0	1,480	2.10	0.5 U	0.5 U	11.0	1 U	–
	9/30/2004	0.52	0.2	1,290 J	2.40	0.5 U	0.859	5.11	1 U	–
	12/14/2004	6.05	0.0	50 U	0.5 U	0.5 U	0.5 U	1 U	–	–
	4/4/2005	–	0.25 R	101	0.5 U	0.5 U	0.5 U	1 U	–	–
	10/6/2005	–	0.25 U	160	0.741	0.5 U	0.5 U	1 U	1 U	–
	6/28/2006	–	–	–	–	–	–	–	–	–
MTCA Method A Groundwater Cleanup Level				1,000/800 ^{a}	5	1000	700	1000	15	15

Table 4 - Summary of Groundwater Chemistry Data - TPH-G, BTEX, and Lead

		Concentration in mg/L		Concentration in µg/L						
Well ID	Sampled	Oxygen	Ferrous Iron	TPH	Benzene	Toluene	Ethylbenzene	Xylenes	Total Lead	Diss. Lead
MW-3	4/8/1996	–	–	50 U	1 U	1 U	1 U	1 U	5 U	–
	1/5/1998	–	–	50 U	1 U	1 U	1 U	1 U	5 U	–
	4/6/1998	–	–	50 U	1 U	1 U	1 U	1 U	5 U	–
	7/6/1998	–	–	50 U	1 U	1 U	1 U	1 U	5 U	–
	10/5/1998	–	–	50 U	1 U	1 U	1 U	1 U	3.8	–
	12/29/1999	–	–	50 U	0.5 U	0.5 U	0.5 U	1 U	–	1 U
	3/21/2000	2	–	50 U	0.5 U	0.5 U	0.5 U	1 U	–	1 U
	6/14/2000	2.1	–	50 U	0.5 U	0.85	0.5 U	1 U	–	1 U
	9/12/2000	1.4	–	50 U	0.5 U	0.5 U	0.5 U	1 U	–	1 U
	1/30/2001	2.7	–	50 U	0.5 U	0.5 U	0.5 U	1 U	–	–
	4/26/2001	1.8	–	50 U	0.5 U	0.5 U	0.5 U	1 U	–	–
	7/29/2001	4.4	–	50 U	0.5 U	0.5 U	0.5 U	1 U	–	–
	10/27/2001	2.3	–	50 U	0.5 U	0.5 U	0.5 U	1 U	–	–
	11/15/2002	2.1	–	50 U	0.5 U	0.5 U	0.5 U	1 U	–	–
	5/9/2003	2.7	–	50 U	0.5 U	0.5 U	0.5 U	1 U	1 U	–
	9/30/2003	0.44	0.0	50 U	0.5 U	0.5 U	0.5 U	1 U	1 U	–
	12/11/2003	3.20	0.0	50 U	0.5 U	0.5 U	0.5 U	1 U	1 U	–
	3/31/2004	1.59	0.0	50 U	0.2 U	0.2 U	0.2 U	0.5 U	1 U	–
	6/2/2004	0.89	0.0	50 U	0.5 U	0.5 U	0.5 U	1 U	1 U	–
	9/30/2004	0.54	0.0	50 UJ	0.5 U	0.5 U	0.5 U	1 U	1 U	–
	12/14/2004	2.10	0.0	50 U	0.5 U	0.5 U	0.5 U	1 U	–	–
	4/4/2005	–	0.25 R	50 U	0.5 U	0.5 U	0.5 U	1 U	–	–
	10/6/2005	–	0.25 U	50 U	0.5 U	0.5 U	0.5 U	1 U	1 U	–
	6/28/2006	–	–	–	–	–	–	–	–	–
MW-4	1/5/1998	–	–	200	1 U	27	1	3	10	5 U
	4/6/1998	–	–	400	3	14	1	6	5 U	–
	7/6/1998	–	–	50 U	1 U	3	1 U	1 U	5 U	–
	10/5/1998	–	–	150	1 U	7	1 U	1 U	2	–
begin data →	12/29/1999	–	–	301	**51.4**	32.5	0.5 U	6.08	–	1 U
	3/21/2000	0.6	–	414	**44.8**	28.2	1.92	3.2 U	–	1 U
	6/14/2000	1	–	439	**69.7**	4.91	2.01	6.8	–	1 U
	9/12/2000	0.4	–	101	4.49	0.5 U	0.5 U	0.5 U	–	1 U
	1/31/2001	2.4	–	182	2.22	1.17 U	0.5 U	1.33 U	–	–
	4/26/2001	–	–	673	**8.79**	4.73	4.28	28.6	–	–
	7/29/2001	2.3	–	402	**24.3**	16.3	2.84	14.8	–	–
	10/27/2001	0.8	–	200	**24.9**	2.62	1.15	6.57	–	–
	11/15/2002	–	–	75.6	0.858	0.5 U	0.5 U	1 U	–	–
	5/9/2003	1.2	–	61.8	0.5 U	0.5 U	0.5 U	1 U	1 U	–
	9/30/2003	0.12	1.4	161	0.730	0.5 U	2.59	2.59	1 U	–
	12/11/2003	1.40	0.5	50 U	0.5 U	0.5 U	0.5 U	1 U	3.22	–
	3/31/2004	0.11	5.4	267	**29.0**	1.43	1 U	2.94	1 U	–
	6/2/2004	0.03	5.2	140	**46.4**	4.2	0.5 U	1 U	1 U	–
	9/30/2004	0.06	3.8	88.7 J	0.5 U	0.5 U	1.83	1 U	1 U	–
	12/14/2004	0.12	2.0	50 U	0.5 U	0.5 U	0.5 U	1 U	–	–
MW-4R	4/4/2005	–	3.47 J	112	1.93	0.5 U	0.5 U	1 U	–	–
(Replaces MW-4)	10/6/2005	–	1.39	744	0.929	0.5 U	9.31	3.57	19	–
	6/28/2006	0.6	0.25 U	50 U	0.5 U	0.5 U	0.5 U	1 U	1 U	–
MTCA Method A Groundwater Cleanup Level				1,000/800 *	5	1000	700	1000	15	15

Table 4 - Summary of Groundwater Chemistry Data - TPH-G, BTEX, and Lead

Well ID	Sampled	Concentration in mg/L		Concentration in µg/L						
		Oxygen	Ferrous Iron	TPH	Benzene	Toluene	Ethylbenzene	Xylenes	Total Lead	Diss. Lead
MW-5	1/5/1998	–	–	6200	1	57	3	160	5 U	–
	4/6/1998	–	–	2800	2	30	2	27	5 U	–
	7/6/1998	–	–	50 U	1 U	1 U	1 U	1 U	10	–
	10/5/1998	–	–	4700	2	39	16	94	7.4	–
	12/29/1999	–	–	779	2.96	0.69	9.03	27.4	–	1 U
	3/21/2000	0.6	–	519	0.5 U	13.9	4.95	3.6	–	1 U
	6/14/2000	0.7	–	708	3.45 U	1.17 U	1.08	1 U	–	1 U
	9/12/2000	0.6	–	50 U	0.5 U	0.5 U	0.5 U	1 U	–	1 U
	4/26/2001	0.8	–	831	7.35	0.516	15.3	1 U	–	–
	7/29/2001	3	–	53.8	0.5 U	0.5 U	0.5 U	1 U	–	–
	10/27/2001	0.9	–	552	3.29	0.5 U	1.28	1.58	–	–
	11/15/2002	0.7	–	108	0.5 U	0.5 U	0.5 U	0.5 U	–	–
	5/9/2003	1.2	–	78.7	0.5 U	0.5 U	0.5 U	1 U	1 U	–
	9/30/2003	0.30	1.8	229	0.5 U	0.5 U	0.5 U	1.61	1 U	–
	12/11/2003	1.30	0.0	50 U	0.5 U	0.5 U	0.5 U	1 U	1 U	–
	3/31/2004	0.42	0.0	53	0.2 U	0.2 U	0.2 U	0.5 U	1 U	–
	6/2/2004	0.20	0.0	92.8	0.5 U	0.5 U	0.5 U	1 U	1 U	–
	12/14/2004	0.49	2.95	308	0.5 U	0.5 U	0.5 U	1 U	–	–
	4/4/2005	–	3.06 J	620	1.45	0.5 U	0.5 U	1.07	–	–
	10/6/2005	–	0.25 U	114	0.5 U	0.5 U	0.5 U	1 U	1 U	–
	6/28/2006	2.4	0.25 U	50 U	0.5 U	0.5 U	0.5 U	1 U	1 U	–
MW-6	1/5/1998	–	–	2,200	53	17	9	93	5 U	–
	4/6/1998	–	–	4,200	51	16	25	110	5 U	–
	7/6/1998	–	–	6,900	11	19	1	510	11	–
	10/5/1998	–	–	5,800	43	22	48	240	12	–
	12/29/1999	–	–	2,090	11.5	2	35.1	65.1	–	1 U
	3/21/2000	1.8	–	1,580	0.75 U	14.3	28.7	61	–	1 U
	6/14/2000	0.5	–	2,170	9.78	1.03 U	33.1	101	–	1 U
	9/12/2000	0.5	–	1,630	12.8	1.2 U	27.9	75.7	–	1 U
	4/26/2001	–	–	1,320	11.3	0.906	1.41	3.37	–	–
	7/29/2001	2.6	–	5,050	8.71	4.99	189	536	–	–
	10/27/2001	0.7	–	1,910	15.3	0.786	1.67	5.49	–	–
	11/15/2002	0.6	–	1,270	9.01	0.5 U	0.594	1.85	–	–
	5/9/2003	1.8	–	1,710	1.79	0.5 U	1.29	21.2	1.29	–
	9/30/2003	0.12	2.2	1,610	16.7	2.50 U	2.91	7.96	1 U	–
	12/11/2003	1.50	3.8	624	5.67	0.50 U	0.737 J	2.19 J	1 U	–
	3/31/2004	0.15	3.4	1,160	0.520	0.2 U	0.350	0.5 U	1 U	–
	6/2/2004	0.09	5.2	2,300 J	4.78 J	0.5 U	54.0 J	75.5 J	1.29	–
	9/30/2004	0.12	6.4	1,150 J	8.34 J	0.5 J	0.553 J	2.92 J	1 U	–
	12/14/2004	0.42	3.2	672	3.57	0.5 U	0.5 U	1.42	–	–
	4/4/2005 ^{b}	–	9.33 J	1,010	5.91	0.5 U	0.5 U	1.86 ^{c}	–	–
	10/6/2005	–	14.4	1,380 J	8.10	0.5 U	0.632	1.94	1 U	–
	6/28/2006	–	–	–	–	–	–	–	–	–
MTCA Method A Groundwater Cleanup Level				1,000/800 ^{a}	5	1000	700	1000	15	15

Table 4 - Summary of Groundwater Chemistry Data - TPH-G, BTEX, and Lead

		Concentration in mg/L		Concentration in µg/L						
Well ID	Sampled	Oxygen	Ferrous Iron	TPH	Benzene	Toluene	Ethylbenzene	Xylenes	Total Lead	Diss. Lead
MW-12	12/29/1999	–	–	50 U	0.5 U	0.5 U	0.5 U	1 U	–	1 U
	3/21/2000	5	–	50 U	0.5 U	0.5 U	0.5 U	1 U	–	1 U
	6/14/2000	4.9	–	50 U	0.5 U	0.5 U	0.5 U	1 U	–	1 U
	9/12/2000	0.6	–	50 U	0.5 U	0.5 U	0.5 U	1 U	–	1 U
	4/26/2001	4	–	50 U	0.5 U	0.5 U	0.5 U	1 U	–	–
	7/29/2001	3	–	50 U	0.5 U	0.5 U	1.74	4.83	–	–
	10/27/2001	5.2	–	50 U	0.5 U	0.5 U	0.5 U	1 U	–	–
	11/15/2002	2.7	–	50 U	0.5 U	0.5 U	0.5 U	1 U	–	–
	5/9/2003	6	–	50 U	0.5 U	0.5 U	0.5 U	1 U	1 U	–
	9/30/2003	1.66	0.8	50 U	0.5 U	0.5 U	0.5 U	1 U	1 U	–
	12/11/2003	2.70	0.0	50 U	0.5 U	0.5 U	0.5 U	1 U	1.47	–
	3/31/2004	3.91	0.0	50 U	0.2 U	0.2 U	0.2 U	0.5 U	1 U	–
	6/2/2004	5.20	0.0	50 U	0.5 U	0.5 U	0.5 U	1 U	1 U	–
	9/30/2004	6	0.0	50 UJ	0.5 U	0.5 U	0.5 U	1 U	1 U	–
	12/14/2004	1.32	0.0	50 U	0.5 U	0.5 U	0.5 U	1 U	–	–
	4/4/2005	–	0.25 R	50 U	0.5 U	0.5 U	0.5 U	1 U	–	–
	10/12/2005	–	0.25 U	50 U	0.5 U	0.5 U	0.5 U	1 U	1 U	–
	6/28/2006	0.42	0.25 U	50 U	0.5 U	0.5 U	0.5 U	1 U	2.98	–
MW-13	12/29/99	–	–	50 U	0.5 U	0.5 U	0.5 U	1 U	–	1 U
	3/21/2000	4.6	–	50 U	0.5 U	0.5 U	0.5 U	1 U	–	1 U
	6/14/2000	1.5	–	50 U	0.5 U	0.5 U	0.5 U	1 U	–	1 U
	9/12/2000	3.3	–	50 U	0.5 U	0.5 U	0.5 U	1 U	–	1 U
	4/26/2001	5	–	50 U	0.5 U	0.5 U	0.5 U	1 U	–	–
	7/29/2001	3.8	–	50 U	0.5 U	0.5 U	0.5 U	1 U	–	–
	10/27/2001	3.4	–	50 U	0.5 U	0.5 U	0.5 U	1 U	–	–
	9/30/2003	3.04	2.2	50 U	0.5 U	0.5 U	0.5 U	1 U	1 U	–
	12/11/2003	6.70	0.0	50 U	0.5 U	0.5 U	0.5 U	1 U	1.56	–
	3/31/2004	4.87	0.0	50 U	0.2 U	0.2 U	0.2 U	0.5 U	1 U	–
	6/2/2004	1.85	0.0	50 U	0.5 U	0.5 U	0.5 U	1 U	1 U	–
	9/30/2004	2.69	0.0	50 UJ	0.5 U	0.5 U	0.5 U	1 U	1 U	–
	12/14/2004	5.57	0.0	50 U	0.5 U	0.5 U	0.5 U	1 U	–	–
	4/4/2005	–	0.547 J	50 U	0.5 U	0.5 U	0.5 U	1 U	–	–
	10/6/2005	–	0.25 U	50 U	0.5 U	0.5 U	0.5 U	1 U	1 U	–
	6/28/2006	–	–	–	–	–	–	–	–	–
MTCA Method A Groundwater Cleanup Level				1,000/800 [a]	5	1000	700	1000	15	15
MW-15	1/30/2001	1.3	–	161	1.53	0.5 U	0.5 U	1.18 U	–	–
	4/26/2001	–	–	50 U	0.5 U	0.5 U	0.5 U	1 U	–	–
	7/29/2001	2.6	–	50 U	0.5 U	0.5 U	0.5 U	1 U	–	–
	10/27/2001	1.4	–	50 U	0.5 U	0.5 U	0.5 U	1 U	–	–
	11/15/2002	0.8	–	50 U	0.5 U	0.5 U	0.5 U	1 U	–	–
	5/9/2003	1.5	–	50 U	0.5 U	0.5 U	0.5 U	1 U	1 U	–
	9/30/2003	0.56	2.6	50 U	0.5 U	0.5 U	0.5 U	1 U	1 U	–
	12/11/2003	2.80	0.0	50 U	0.5 U	0.5 U	0.5 U	1 U	1 U	–
	3/31/2004	0.88	0.0	50 U	0.2 U	0.2 U	0.2 U	0.5 U	1 U	–
	6/2/2004	0.40	0.0	50 U	0.5 U	0.5 U	0.5 U	1 U	1 U	–
	9/30/2004	0.33	0.0	50 UJ	0.5 U	0.5 U	0.5 U	1 U	1 U	–
	12/14/2004	1.40	0.0	50 U	0.5 U	0.5 U	0.5 U	1 U	–	–
	4/4/2005	–	0.254 J	50 U	0.5 U	0.5 U	0.5 U	1 U	–	–
	10/6/2005	–	0.25 U	50 U	0.5 U	0.5 U	0.5 U	1 U	1 U	–
	6/28/2006	–	–	–	–	–	–	–	–	–
MTCA Method A Groundwater Cleanup Level				1,000/800 [a]	5	1000	700	1000	15	15

Gasoline-range TPH analyzed by EPA Method 8015 prior to 1999-after that, analyzed by NWTPH-G; BTEX Analyzed by EPA Method 8021B
BTEX analyzed by EPA Method 8260B in March 2004.
Total and Dissolved Lead analyzed by EPA Method 6010 or 6020.
– Not analyzed.
U = Not detected at specified reporting limit.
J = Estimated concentration.
R = Rejected concentration.
Bolded concentrations exceed MTCA Method A cleanup levels.
Access to well MW-13 obstructed in November 2002 and May 2003.
Access to well MW-5 obstructed in September 2004.
Data from 1996 and 1998 collected by Sage Environmental.
Well MW-1 was removed during the October 2000 excavation. Wells MW-14 and MW-15 were installed in January 2001 after the excavation.
Well MW-4 was replaced as well MW-4R by Hart Crowser in October 2005, following removal of the well during UST removal activities in April 2005.
Dashed line indicates date of excavation.
a) Cleanup level for with/without detectable benzene
b) Values shown are the average of the results for the sample and its field duplicate.
c) The value is the result for the field duplicate. The result for the sample was ND (not detected at the detection limit of 1.0 µg/L).

Table 5 - Summary of Groundwater Chemistry Data - Other Detected Compounds

		Concentration in ug/L			Concentration in mg/L		
Exploration	Date Sampled	MTBE	EDB	EDC	Nitrate	Nitrite	Sulfate
MW-1/MW-14	5/9/2003	2 U	--	--	--	--	--
	9/30/2003	20 U	10 U	10 U	0.349	0.200 U	0.400 U
	12/11/2003	3.65	1.00 U	1.00 U	0.200 U	0.200 U	1.14
	3/31/2004	6.80	5.00 U	5.00 U	0.200 U	0.200 U	1.08
	6/2/2004	0.500 U	0.500 U	0.500 U	0.200 U	0.200 U	4.24
	9/30/2004	1 U	1 U	1 U	0.200 U	0.200 U	0.635
	12/14/2004	--	--	--	0.200 U	0.200 U	0.400 U
	4/4/2005	--	--	--	0.200 U	0.200 U	0.464
	10/6/2005	--	--	--	0.200 U	0.200 U	0.400 U
MW-2	5/9/2003	1 U	--	--	--	--	--
	9/30/2003	0.200 U	0.200 U	0.200 U	0.489	0.200 U	3.38
	12/11/2003	0.500 U	0.200 U	0.200 U	1.08	0.200 U	3.79
	3/31/2004	5.00 U	10.00 U	10.00 U	0.912	0.200 U	4.60
	6/2/2004	0.500 U	0.500 U	0.500 U	0.467	0.200 U	3.23
	9/30/2004	1 U	1 U	1 U	0.443	0.200 U	2.93
	12/14/2004	--	--	--	0.922	0.200 U	3.05
	4/4/2005	--	--	--	0.719	0.200 U	3.52
	10/6/2005	--	--	--	0.219	0.200 U	3.75
MW-3	5/9/2003	1 U	--	--	--	--	--
	9/30/2003	0.200 U	0.200 U	0.200 U	0.228	0.200 U	4.39
	12/11/2003	0.500 U	0.200 U	0.200 U	0.200 U	0.200 U	4.79
	3/31/2004	0.500 U	0.200 U	0.200 U	0.812	0.200 U	5.53
	6/2/2004	0.500 U	0.200 U	0.200 U	0.816	0.200 U	5.61
	9/30/2004	1 U	1 U	1 U	0.253	0.200 U	4.43
	12/14/2004	--	--	--	0.206	0.200 U	4.69
	4/4/2005	--	--	--	0.358	0.200 U	4.23
	10/6/2005	--	--	--	0.200 U	0.200 U	3.67
MW-4	5/9/2003	5.89 J	--	--	--	--	--
	9/30/2003	5.10	1.00 U	1.00 U	0.200 U	0.200 U	4.57
	12/11/2003	1.80	0.200 U	0.200 U	1.05	0.200 U	15.3
	3/31/2004	**31.60**	1.00 U	1.00 U	0.200 U	0.200 U	7.41
	6/2/2004	0.500 U	0.500 U	0.500 U	0.200 U	0.200 U	8.32
	9/30/2004	1 U	1 U	1 U	0.200 U	0.200 U	4.91
	12/14/2004	--	--	--	0.200 U	0.200 U	5.13
	4/4/2005	--	--	--	0.200 U	0.200 U	5.79
MW-4R	10/6/2005	--	--	--	0.200 U	0.200 U	8.07
MW-5	5/9/2003	1.47 J	--	--	--	--	--
	9/30/2003	0.200 U	0.200 U	0.200 U	0.200 U	0.200 U	8.61
	12/11/2003	0.500 U	0.200 U	0.200 U	0.200 U	0.200 U	6.85
	3/31/2004	0.500 U	0.200 U	0.200 U	1.32	0.200 U	16.1
	6/2/2004	0.500 U	0.200 U	0.200 U	1.36	0.200 U	11.7
	12/14/2004	--	--	--	0.200 U	0.200 U	7.57
	4/4/2005	--	--	--	0.200 U	0.200 U	9.92
	10/6/2005	--	--	--	0.200 U	0.200 U	9.50
MW-6	5/9/2003	10.6 J	--	--	--	--	--
	9/30/2003	13.2	1.00 U	1.00 U	0.200 U	0.200 U	0.400 U
	12/11/2003	0.500 U	0.200 U	0.200 U	0.200 U	0.200 U	0.685
	3/31/2004	1.88	0.200 U	0.200 U	0.200 U	0.200 U	3.02
	6/2/2004	1.15	0.500 U	0.500 U	0.200 U	0.200 U	0.557
	9/30/2004	1 U	1 U	1 U	0.200 U	0.200 U	0.400 U
	12/14/2004	--	--	--	0.200 U	0.200 U	0.400 U
	4/4/2005[b]	--	--	--	0.200 U	0.200 U	3.19
	10/6/2005	--	--	--	0.200 U	0.200 U	0.400 U
MW-12	5/9/2003	1 U	--	--	--	--	--
	9/30/2003	0.200 U	0.200 U	0.200 U	0.452	0.200 U	5.32
	12/11/2003	0.500 U	0.200 U	0.200 U	0.200 U	0.200 U	2.77
	3/31/2004	0.500 U	0.200 U	0.200 U	3.88	0.200 U	8.45
	6/2/2004	0.500 U	0.200 U	0.200 U	3.64	0.200 U	11.7
	9/30/2004	1 U	1 U	1 U	0.573	0.200 U	5.66
	12/14/2004	--	--	--	0.200 U	0.200 U	2.95
	4/4/2005	--	--	--	0.200 U	0.200 U	3.32
	10/12/2005	--	--	--	0.200 U	0.200 U	3.37
MW-13	9/30/2003	0.200 U	0.200 U	0.200 U	0.455	0.200 U	4.91
	12/11/2003	0.500 U	0.200 U	0.200 U	0.477	0.200 U	5.56
	3/31/2004	0.500 U	0.200 U	0.200 U	1.60	0.200 U	8.04
	6/2/2004	0.500 U	0.200 U	0.200 U	1.05	0.200 U	6.52
	9/30/2004	1 U	1 U	1 U	0.496	0.200 U	4.49
	12/14/2004	--	--	--	0.412	0.200 U	5.10
	4/4/2005	--	--	--	0.582	0.200 U	4.99
	10/6/2005	--	--	--	0.348	0.200 U	3.68
MW-15	5/9/2003	1 U	--	--	--	--	--
	9/30/2003	0.200 U	0.200 U	0.200 U	0.282	0.200 U	5.02
	12/11/2003	0.500 U	0.200 U	0.200 U	0.415	0.200 U	8.52
	3/31/2004	0.500 U	0.200 U	0.200 U	0.200 U	0.200 U	8.42
	6/2/2004	0.500 U	0.200 U	0.200 U	1.67	0.200 U	8.32
	9/30/2004	1 U	1 U	1 U	0.429	0.200 U	4.56
	12/14/2004	--	--	--	0.200 U	0.200 U	6.68
	4/4/2005	--	--	--	0.200 U	0.200 U	7.45
	10/6/2005	--	--	--	0.340	0.200 U	4.14
MTCA Method A Groundwater Cleanup Level		20	0.01	5	na	na	na

MTBE, EDB, and EDC analyzed by EPA Method 8260B.
Nitrate, nitrite, and sulfate analyzed by EPA Method 300.0.
-- Not analyzed.
U = Not detected above specified reporting limit.
J = Estimated concentration.
Bolded concentrations exceed MTCA Method A cleanup levels.
a) MTCA Method B Cleanup Level. No Method A value available.
b) Values shown are the average of the results for the sample and its field duplicate.
na No MTCA Method A or B value available.

Table 6 - Summary of Groundwater Chemistry Data - Groundwater Grab Samples

		Concentration in ug/L				
Exploration	Date Sampled	TPH-G	Benzene	Toluene	Ethylbenzene	Xylenes
Soil Borings						
HP-7	7/14/1999	167	0.5 U	49.7	2.73	11.7
HP-8	7/14/1999	**14,100**	**27.9**	50.8	458	804
HP-9	7/14/1999	**970**	1.28	91.8	16.1	40.9
HP-10	7/14/1999	232	0.968	9.48	0.5 U	2.54
HP-11	7/14/1999	420	1.06	71.6	10.6	31.6
HP-12	9/12/2000	**13,600**	**95.1**	12.2	404	**1150**
HP-13	9/12/2000	541	**34.2**	1.7	1.71	7.06
HP-14	9/12/2000	**1,770**	**22.6**	2.52	1.13	4.2
HP-15	9/12/2000	50 U	0.811	0.5 U	0.5 U	1 U
HP-16	9/12/2000	**31,100**	**255**	48.6	**1,170**	**4,830**
Strataprobe Explorations						
HCSP-04-01	2/24/05	**12500**	**25.6**	35.2	126	78.0
HCSP-04-02	2/24/05	**814** J	1.38	0.50 U	2.00	3.40 J
HCSP-04-03	2/24/05	**1220**	4.76	0.559	6.91	8.10
HCSP-04-04	2/24/05	257	1.81	0.50 U	0.924	6.15
HCSP-04-05	2/24/05	**1930** J	3.22	5.33 J	8.85	10.9 J
HCSP-04-06	2/24/05	**1630** J	**5.37**	0.618	15.9	22.4
HCSP-04-07	2/24/05	**1340** J	**7.05**	0.974	42.5	27.1
Trip Blank	2/24/05	50 U	0.50 U	0.50 U	0.50 U	1.00 U
MTCA Method A Cleanup Levels		800	5	1000	700	1000

TPH analyzed by Ecology Method NWTPH-G.

BTEX (Benzene, Toluene, Ethylbenzene, Xylenes) analyzed by EPA Method 8021B.

U Not detected above specified reporting limit.

Bolded values exceed MTCA Method A Cleanup Levels.

Table 7 - Measured Free Product Thickness in Well MW-1/MW-14

Date Measured	Product Thickness in Well in Inches	
4/8/1996	0	
4/6/1998	6	
10/5/1998	6	
12/29/1999	0.2	
3/21/2000	5	
6/14/2000	1	
9/12/2000	1	Hot Spot Excavation
1/30/2001	0	
4/26/2001	0	
7/29/2001	0	
10/27/2001	4	
11/15/2002	3	
5/9/2003	0	
9/30/2003	0	
12/12/2003	1	
3/31/2004	1.80	
6/2/2004	0	
9/30/2004	0	
12/14/2004	0.18	ORC Injection and UST Removal
4/4/2005	0	
10/6/2005	0	
6/28/2006	0	

Table 8 - Summary of Cleanup Levels for Chemicals of Concern

Constituent	MTCA Method A Cleanup Level for Unrestricted Use	
	Soil Cleanup Level in mg/kg	Groundwater Cleanup Level in ug/L
Gasoline-range Petroleum Hydrocarbons (TPH-G)	100/30 [a]	1,000/800 [a]
Benzene	0.03	5
Toluene	7	1,000
Ethylbenzene	6	700
Xylenes	9	1,000
Lead	250	15

[a] Upper concentration represents Method A cleanup level when benzene is not present, and total ethylbenzene, toluene, and xylenes are less than 1 percent of the total gasoline mixture.

Table 9 - Remedial Alternative Evaluation - Compliance with WAC 173-340-360

Evaluation Criterion	Alternative 1 Monitored Natural Attenuation	Alternative 2 Monitored Natural Attenuation and Passive Free Product Recovery	Alternative 3 Enhanced Bioremediation	Alternative 4 Air Sparging and Soil Vapor Extraction
Meets Definition of Permanent Cleanup Action	Yes	Yes	Yes	Yes
Protectiveness	Eliminates exposure pathways. Reduces soil and groundwater toxicity in the long term.	Eliminates exposure pathways. Reduces soil and groundwater toxicity in the long term.	Eliminates exposure pathways. Reduces soil and groundwater toxicity in the long term.	Eliminates exposure pathways. Reduces soil and groundwater toxicity in the long term.
Permanence	Natural attenuation will result in reduced soil and groundwater toxicity over the very long term.	Mobility and toxicity of contaminants will be reduced by collecting and properly disposing of free product. Natural attenuation will result in reduced soil and groundwater toxicity over the very long term.	Enhanced natural attenuation will result in reduced soil and groundwater toxicity over the long term.	Air sparging and soil vapor extraction will reduce contaminant mobility by removing and collecting or destroying contaminants from the subsurface. Natural attenuation will result in reduced soil and groundwater toxicity over the very long term for contaminants not removed by soil vapor extraction.
Estimated Cost[a]	$325,000 to $491,000	$333,000 to $505,000	$485,000 to $653,000	$365,000 to $420,000
Effectiveness over the Long Term and Restoration Time Frame	Will effectively remove contaminants over the long term. Estimated restoration time frame for groundwater, based on current trends, up to 25 years.	Will effectively remove contaminants over the long term. Estimated restoration time frame for groundwater, based on current trends, is 10 to 30 years.	Will effectively remove contaminants over the long term. Estimated restoration time frame for groundwater, based on current trends, is 10 to 15 years.	Will effectively remove contaminants over the long term. Estimated restoration time frame for groundwater, based on professional experience, is 5 to 7 years.
Management of Short-Term Risks	Protection monitoring will confirm protection of human health and the environment during site activities that may encounter contaminated materials.	Protection monitoring will confirm protection of human health and the environment during site activities that may encounter contaminated materials, such as free product removal.	Protection monitoring will confirm protection of human health and the environment during site activities that may encounter contaminated materials.	Protection monitoring will confirm protection of human health and the environment during site activities that may encounter contaminated materials, such as construction of wells. Air monitoring will be performed during soil vapor extraction.
Technical and Administrative Implementability	Easily implemented.	Easily implemented.	Moderately easily implemented; however, injection of ORC beneath sidewalk will require street use permit; may not be able to gain access to East 10th Avenue.	Moderately easy implemented if adjacent property is available to stage equipment and treatment compound.

[a] Cost estimate details provided in Appendix D.

Table 10 - Monitoring Schedule for Preferred Alternative

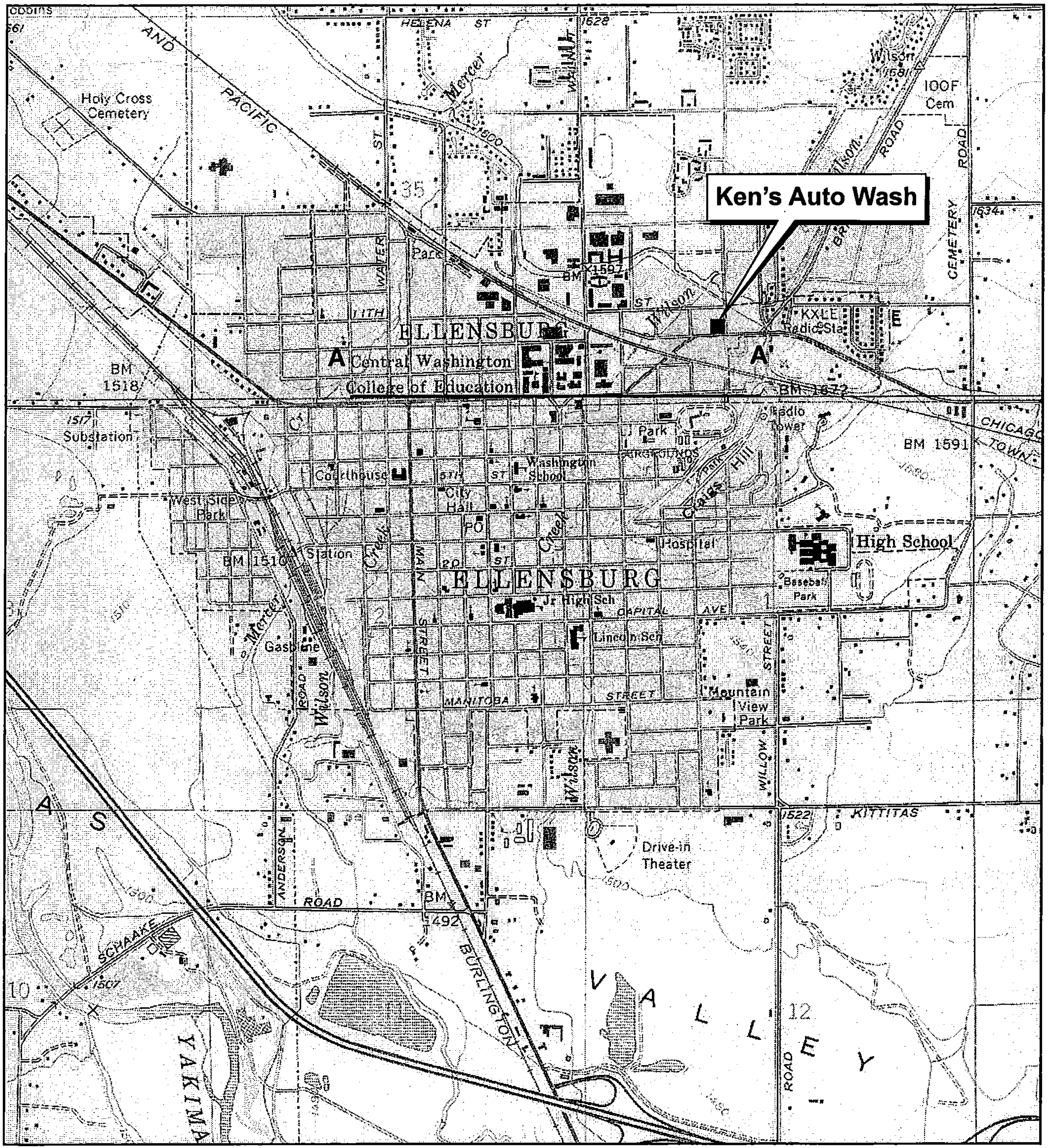
Well	Purpose	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
MW-2	Bound Plume - East	Quarterly ^{NA}	Quarterly	Biannual		Quarterly ^{NA}					Quarterly ^{NA}
MW-3	Background	Quarterly ^{NA}	Quarterly	Biannual		Quarterly ^{NA}					Quarterly ^{NA}
MW-4	Source Area (Upgradient Edge)	Quarterly ^{NA}	Quarterly	Biannual	Biannual	Quarterly ^{NA}	Annual	Annual	Annual	Annual	Quarterly ^{NA}
MW-5	Bound Plume - West	Quarterly ^{NA}	Quarterly	Biannual	Biannual	Quarterly ^{NA}	Annual	Annual	Annual	Annual	Quarterly ^{NA}
MW-6	Plume Extent	Quarterly ^{NA}	Quarterly	Biannual		Quarterly ^{NA}					Quarterly ^{NA}
MW-12	Bound Plume - Southwest	Quarterly ^{NA}	Quarterly	Biannual	Biannual	Quarterly ^{NA}	Annual	Annual	Annual	Annual	Quarterly ^{NA}
MW-13	Bound Plume - South	Quarterly ^{NA}	Quarterly	Biannual		Quarterly ^{NA}					Quarterly ^{NA}
MW-14	Source Area	Quarterly ^{NA}	Quarterly	Biannual	Biannual	Quarterly ^{NA}	Annual	Annual	Annual	Annual	Quarterly ^{NA}
MW-15	Bound Plume - Southeast	Quarterly ^{NA}	Quarterly	Biannual		Quarterly ^{NA}					Quarterly ^{NA}

Notes:

Biannual refers to twice per year. Biannual and annual monitoring schedules will be based on the dates of highest seasonal concentrations.
Monitoring will include measurement of groundwater elevation and dissolved oxygen and collection of a groundwater sample for analysis by NWTPH-Gx/BTEX.
First year of monitoring will include analysis for MTBE, EDB, and EDC by EPA Method 8260B and total Lead by EPA Method 6020.

^{NA} Monitoring will also include collection of a groundwater sample for analysis for nitrate/nitrite, sulfate, and ferrous iron.
Schedule assumes 5-year review by Ecology following 2007 sampling round.
Schedule after 2007 is tentative pending Ecology 5-year review.
Monitoring schedule after 2012, if necessary, will be based on review of previous data.
Blank entries indicate no monitoring planned in specific wells.

Vicinity Map



Note: Base map prepared from USGS 7.5 minute Quadangle of Ellensburg North and South, Washington; dated 1978.

0 2000 4000

Approximate Scale in Feet

N

716804BA.CDR JMK 11/14/06

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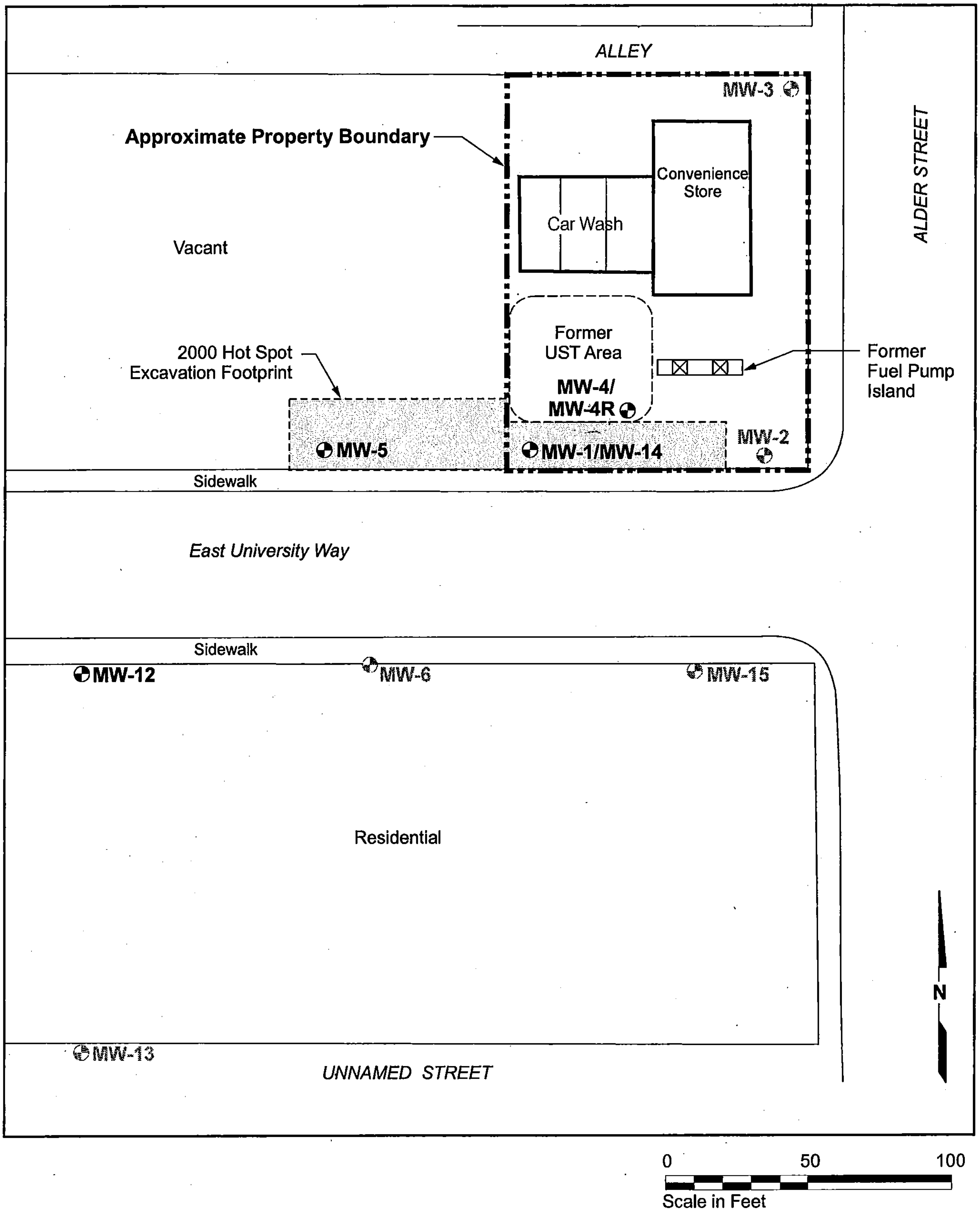
Figure 1

Site and Well Location Plan



7168048B.cdr JMK 11/14/06

MW-3 ◍ Monitoring Well Location and Number
Not Sampled in this Study

MW-12 ⊕ Monitoring Well Location and Number
Sampled on 6/06

Note: Base map prepared from drawing provided by Sage Earth Sciences titled "Proposed Additional Monitoring Well and ORC Injection Locations", dated January 1998.

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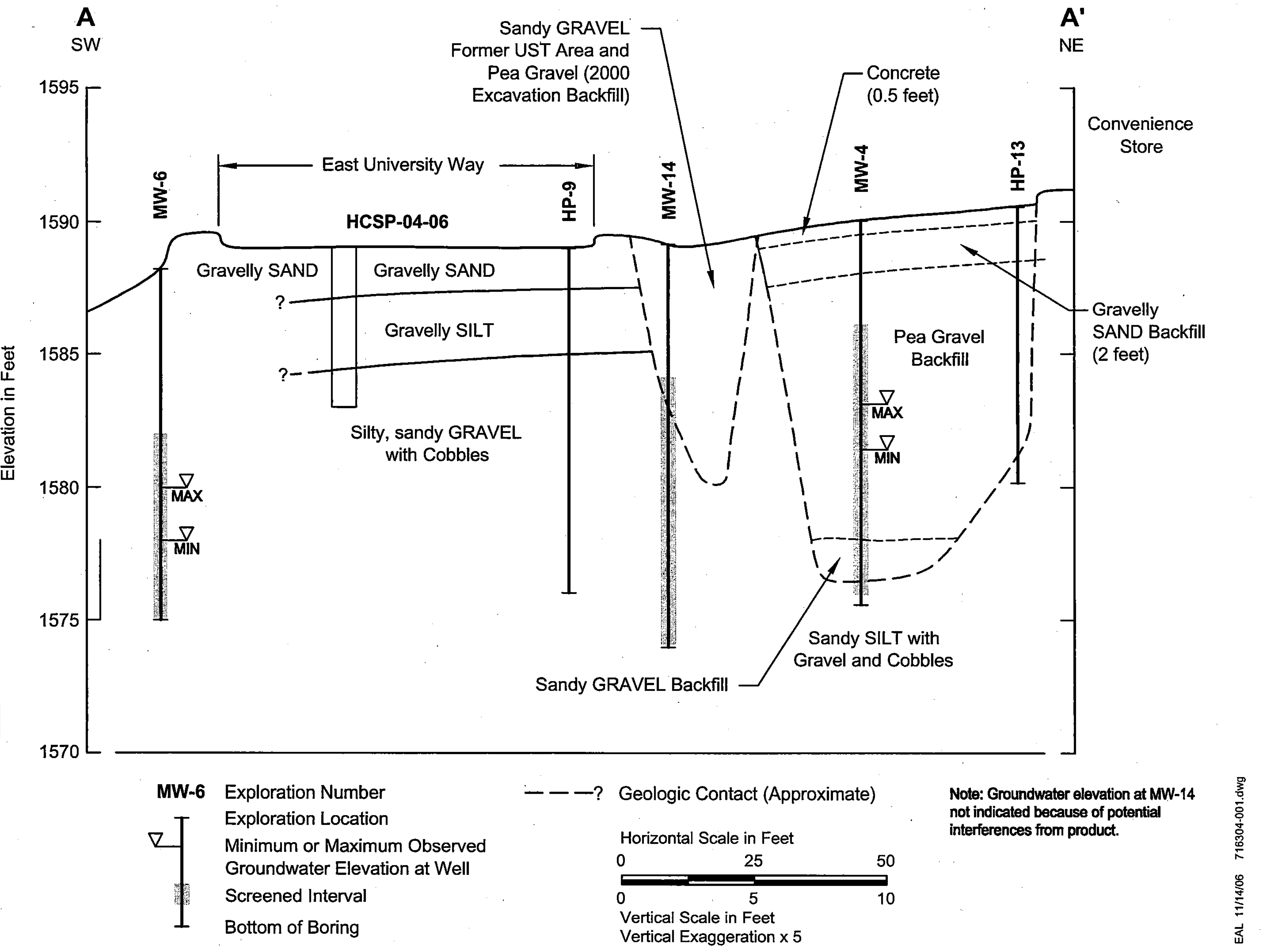
Figure 2

Generalized Geologic Cross Section A-A'



Note: Groundwater elevation at MW-14 not indicated because of potential interferences from product.

EAL 11/14/06 716304-001.dwg

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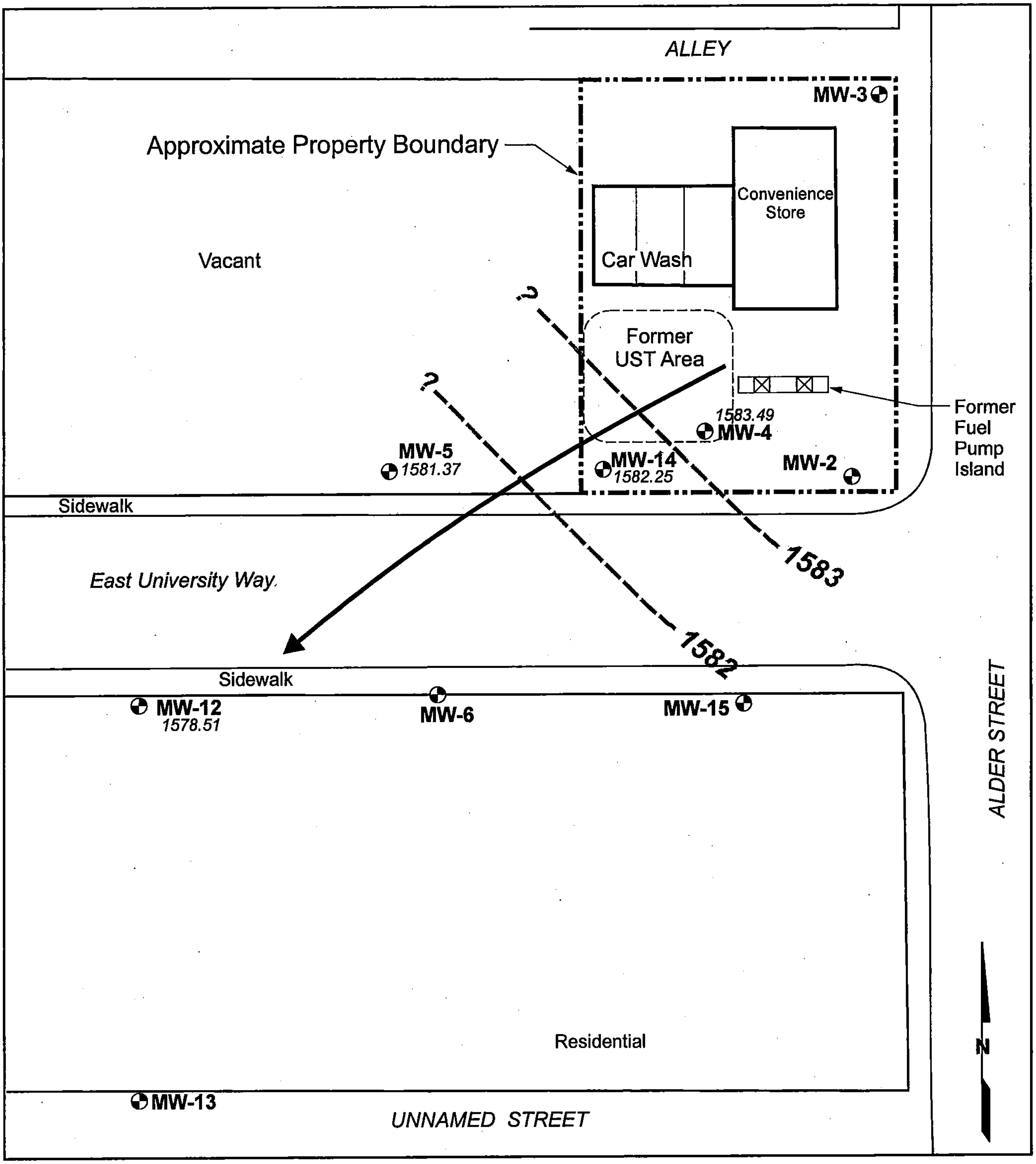
Figure 3

Groundwater Elevation Contour Map
June 2006



0 50 100
Scale in Feet

MW-2 ⊕	Monitoring Well Location and Number
1578.28	Groundwater Elevation in Feet (June 2006)
1582 - - -	Groundwater Elevation Contour in Feet
←	Inferred Groundwater Flow Direction

Note: Elevations shown are in feet above Mean Sea Level.

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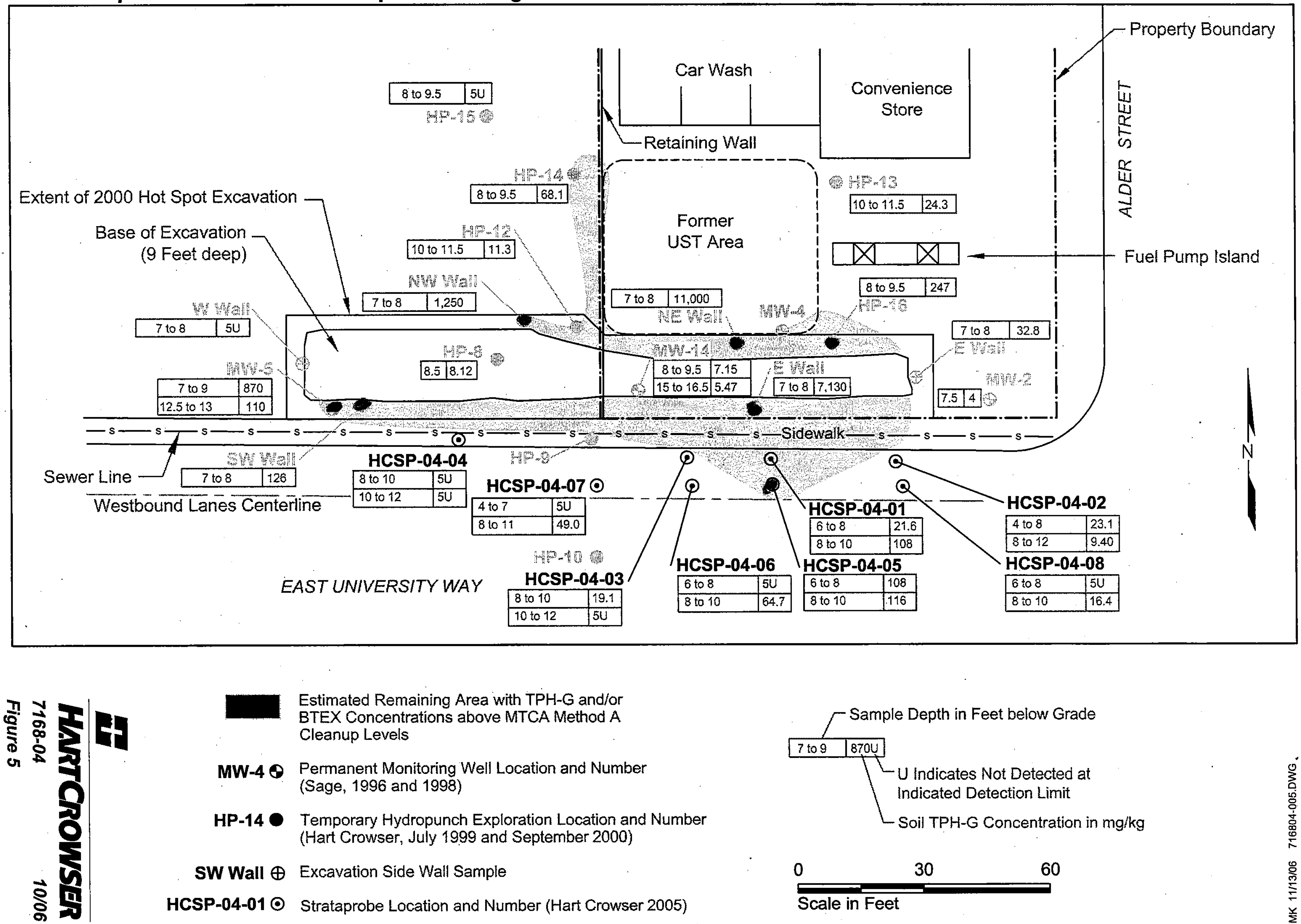
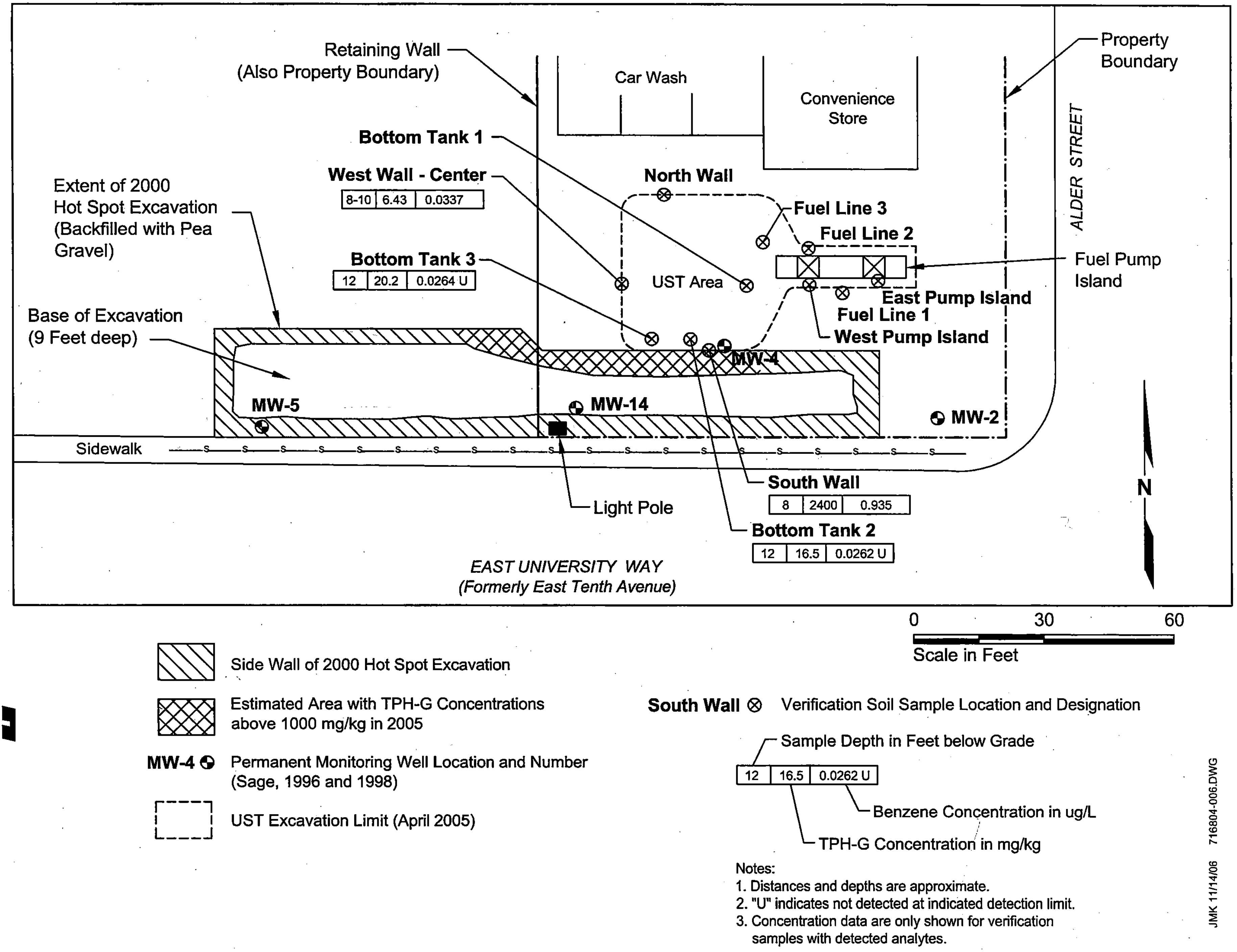
Figure 4

TPH Occurrences in Soil Samples
2000 Hot Spot Excavation and Strataprobe Investigation



UST Excavation Verification Sample Locations and Detected Analytical Results



Notes:
1. Distances and depths are approximate.
2. "U" indicates not detected at indicated detection limit.
3. Concentration data are only shown for verification samples with detected analytes.

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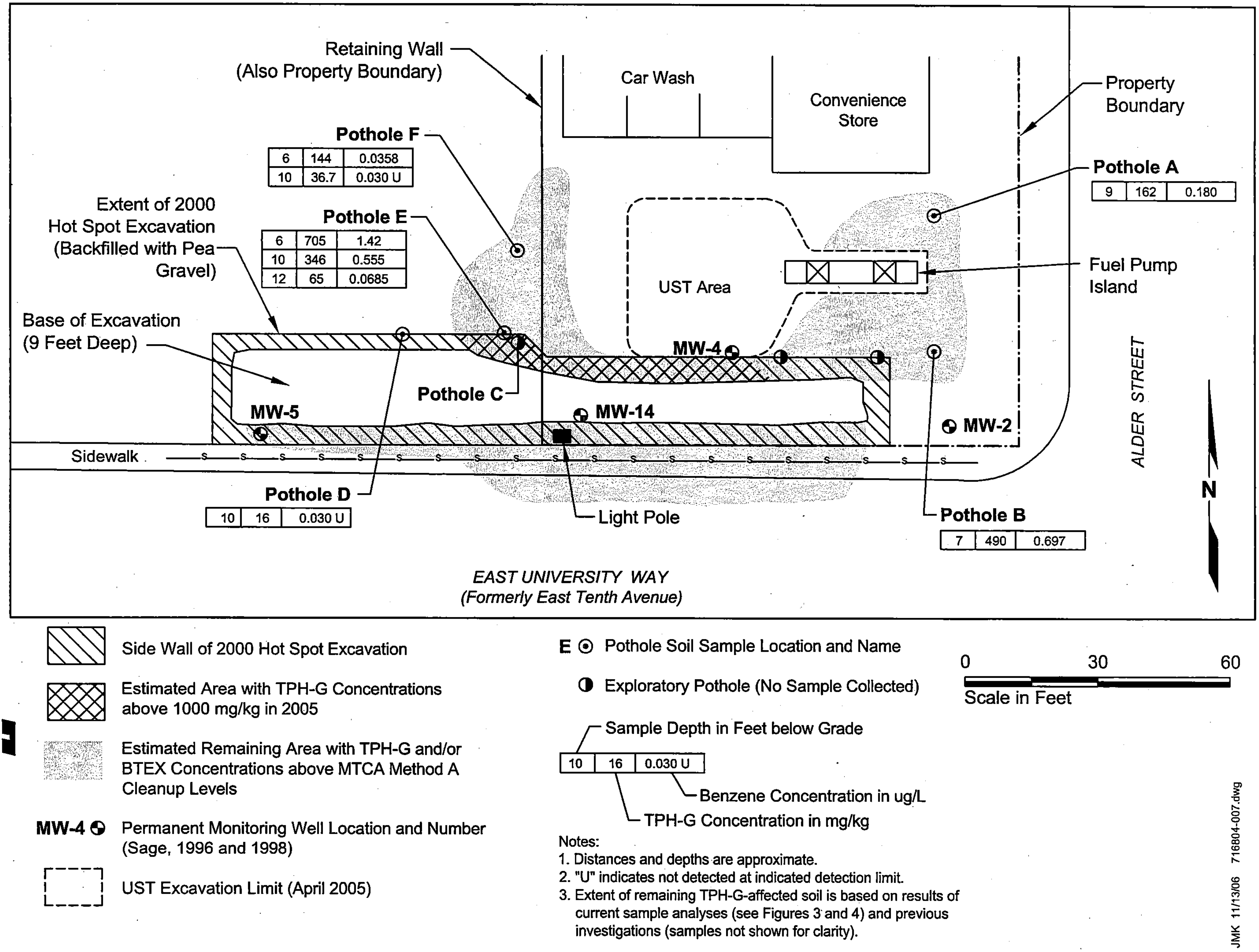
Figure 6

"Pothole" Test Pit and Sample Locations and Detected Analytical Results



Notes:
1. Distances and depths are approximate.
2. "U" indicates not detected at indicated detection limit.
3. Extent of remaining TPH-G-affected soil is based on results of current sample analyses (see Figures 3 and 4) and previous investigations (samples not shown for clarity).

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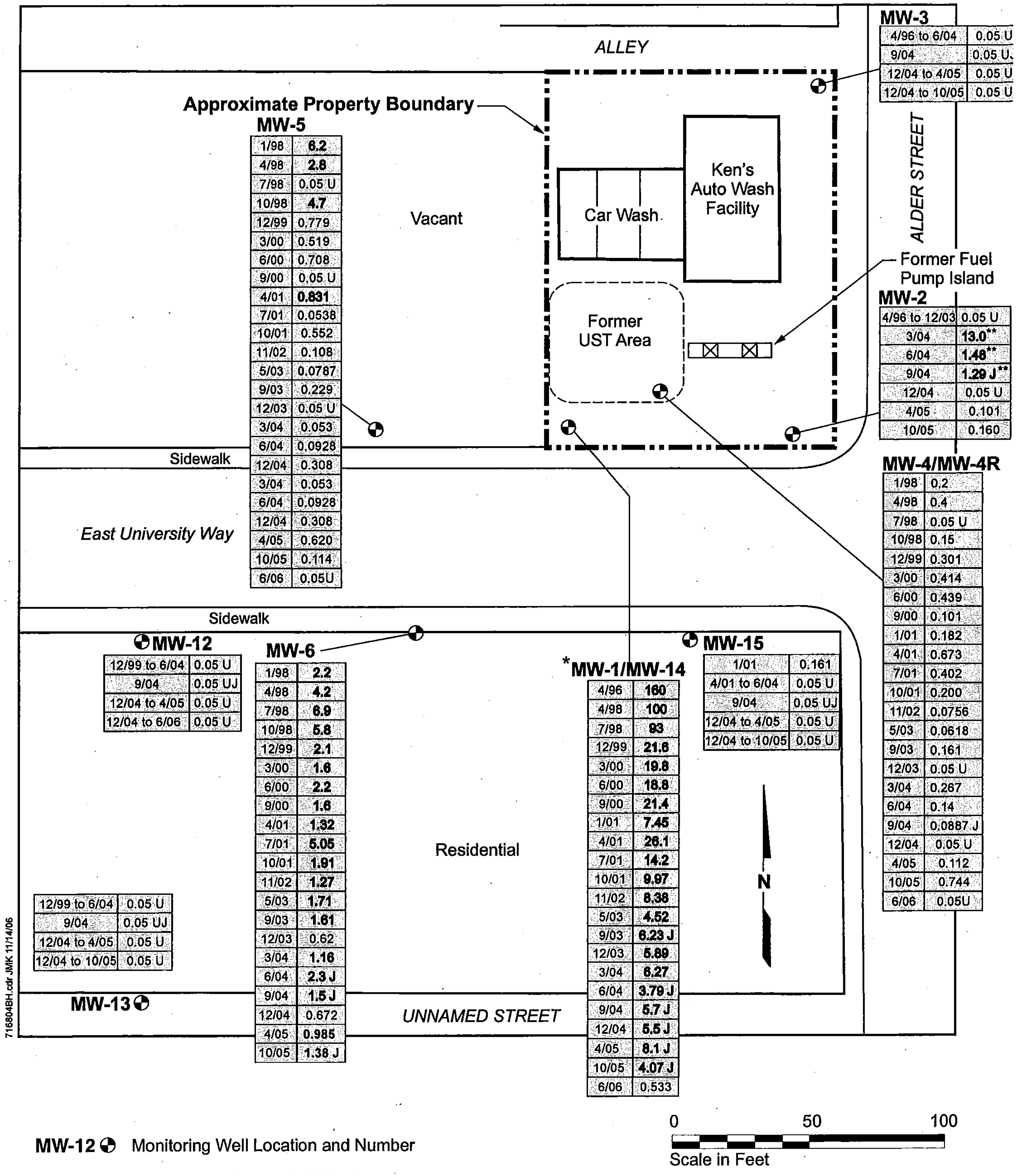
Figure 7

TPH-G Occurrences in Groundwater



MW-3

4/96 to 6/04	0.05 U
9/04	0.05 U
12/04 to 4/05	0.05 U
12/04 to 10/05	0.05 U

MW-5

1/98	**6.2**
4/98	**2.8**
7/98	0.05 U
10/98	**4.7**
12/99	0.779
3/00	0.519
6/00	0.708
9/00	0.05 U
4/01	**0.831**
7/01	0.0538
10/01	0.552
11/02	0.108
5/03	0.0787
9/03	0.229
12/03	0.05 U
3/04	0.053
6/04	0.0928
12/04	0.308
3/04	0.053
6/04	0.0928
12/04	0.308
4/05	0.620
10/05	0.114
6/06	0.05U

MW-2

4/96 to 12/03	0.05 U
3/04	**13.0****
6/04	**1.48****
9/04	**1.29 J****
12/04	0.05 U
4/05	0.101
10/05	0.160

MW-4/MW-4R

1/98	0.2
4/98	0.4
7/98	0.05 U
10/98	0.15
12/99	0.301
3/00	0.414
6/00	0.439
9/00	0.101
1/01	0.182
4/01	0.673
7/01	0.402
10/01	0.200
11/02	0.0756
5/03	0.0618
9/03	0.161
12/03	0.05 U
3/04	0.267
6/04	0.14
9/04	0.0887 J
12/04	0.05 U
4/05	0.112
10/05	0.744
6/06	0.05U

MW-12

12/99 to 6/04	0.05 U
9/04	0.05 UJ
12/04 to 4/05	0.05 U
12/04 to 6/06	0.05 U

MW-6

1/98	**2.2**
4/98	**4.2**
7/98	**6.9**
10/98	**5.8**
12/99	**2.1**
3/00	**1.6**
6/00	**2.2**
9/00	**1.6**
4/01	**1.32**
7/01	**5.05**
10/01	**1.91**
11/02	**1.27**
5/03	**1.71**
9/03	**1.61**
12/03	0.62
3/04	**1.16**
6/04	**2.3 J**
9/04	**1.5 J**
12/04	0.672
4/05	**0.985**
10/05	**1.38 J**

***MW-1/MW-14**

4/96	**160**
4/98	**100**
7/98	**93**
12/99	**21.6**
3/00	**19.8**
6/00	**18.8**
9/00	**21.4**
1/01	**7.45**
4/01	**26.1**
7/01	**14.2**
10/01	**9.97**
11/02	**8.38**
5/03	**4.52**
9/03	**6.23 J**
12/03	**5.89**
3/04	**6.27**
6/04	**3.79 J**
9/04	**5.7 J**
12/04	**5.5 J**
4/05	**8.1 J**
10/05	**4.07 J**
6/06	0.533

MW-15

1/01	0.161
4/01 to 6/04	0.05 U
9/04	0.05 UJ
12/04 to 4/05	0.05 U
12/04 to 10/05	0.05 U

MW-13

12/99 to 6/04	0.05 U
9/04	0.05 UJ
12/04 to 4/05	0.05 U
12/04 to 10/05	0.05 U

MW-12 ⊕ Monitoring Well Location and Number

3/04	0.05 U

Month/Year of Sample Collection

Groundwater TPH-G Concentration in mg/L

Notes: Concentrations exceeding the cleanup level are shown in bold.
U = Not detected at specified detection limit.
J = Estimated concentration.
* = Product has been observed periodically in MW-1/MW-14.
** = Previous inflow of minor TPH-contaminated water through the top of well casing suspected.

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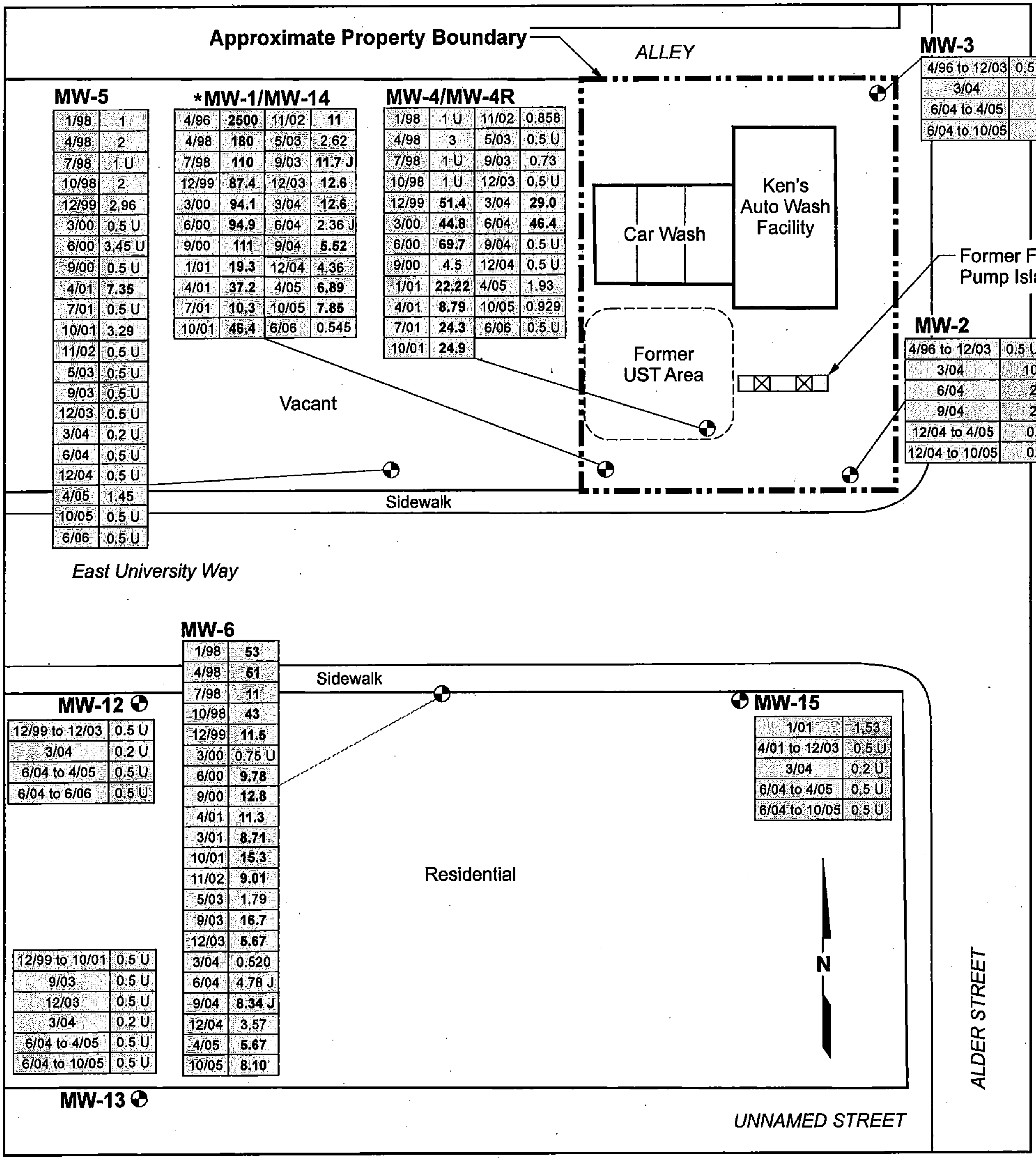
7168-04 ***10/06***
Figure 8

Benzene Occurrences in Groundwater



MW-5

1/98	1
4/98	2
7/98	1 U
10/98	2
12/99	2.96
3/00	0.5 U
6/00	3.45 U
9/00	0.5 U
4/01	**7.35**
7/01	0.5 U
10/01	3.29
11/02	0.5 U
5/03	0.5 U
9/03	0.5 U
12/03	0.5 U
3/04	0.2 U
6/04	0.5 U
12/04	0.5 U
4/05	1.45
10/05	0.5 U
6/06	0.5 U

***MW-1/MW-14**

4/96	**2500**	11/02	**11**
4/98	**180**	5/03	2.62
7/98	**110**	9/03	**11.7 J**
12/99	**87.4**	12/03	**12.6**
3/00	**94.1**	3/04	**12.6**
6/00	**94.9**	6/04	2.36 J
9/00	**111**	9/04	**5.52**
1/01	**19.3**	12/04	4.36
4/01	**37.2**	4/05	**6.89**
7/01	**10.3**	10/05	**7.85**
10/01	**46.4**	6/06	0.545

MW-4/MW-4R

1/98	1 U	11/02	0.858
4/98	3	5/03	0.5 U
7/98	1 U	9/03	0.73
10/98	1 U	12/03	0.5 U
12/99	**51.4**	3/04	**29.0**
3/00	**44.8**	6/04	**46.4**
6/00	**69.7**	9/04	0.5 U
9/00	4.5	12/04	0.5 U
1/01	**22.22**	4/05	1.93
4/01	**8.79**	10/05	0.929
7/01	**24.3**	6/06	0.5 U
10/01	**24.9**		

MW-3

4/96 to 12/03	0.5 U to 1 U
3/04	0.2 U
6/04 to 4/05	0.5 U
6/04 to 10/05	0.5 U

MW-2

4/96 to 12/03	0.5 U to 1 U
3/04	10.0 U
6/04	2.10
9/04	2.40
12/04 to 4/05	0.5 U
12/04 to 10/05	0.741

MW-6

1/98	**53**
4/98	**51**
7/98	**11**
10/98	**43**
12/99	**11.5**
3/00	0.75 U
6/00	**9.78**
9/00	**12.8**
4/01	**11.3**
3/01	**8.71**
10/01	**15.3**
11/02	**9.01**
5/03	1.79
9/03	**16.7**
12/03	**5.67**
3/04	0.520
6/04	4.78 J
9/04	**8.34 J**
12/04	3.57
4/05	**5.67**
10/05	**8.10**

MW-12

12/99 to 12/03	0.5 U
3/04	0.2 U
6/04 to 4/05	0.5 U
6/04 to 6/06	0.5 U

MW-15

1/01	1.53
4/01 to 12/03	0.5 U
3/04	0.2 U
6/04 to 4/05	0.5 U
6/04 to 10/05	0.5 U

MW-13

12/99 to 10/01	0.5 U
9/03	0.5 U
12/03	0.5 U
3/04	0.2 U
6/04 to 4/05	0.5 U
6/04 to 10/05	0.5 U

716804BJcdr JMK 11/14/06

0 50 100
Scale in Feet

MW-12 ⊕ Monitoring Well Location and Number

12/99	0.5 U

Month/Year of Sample Collection

Groundwater Benzene Concentration in μg/L

Notes: Concentrations exceeding the cleanup level are shown in bold.
U = Not detected at specified detection limit.
J = Estimated concentration.
* = Product has been observed periodically in MW-1/MW-14.

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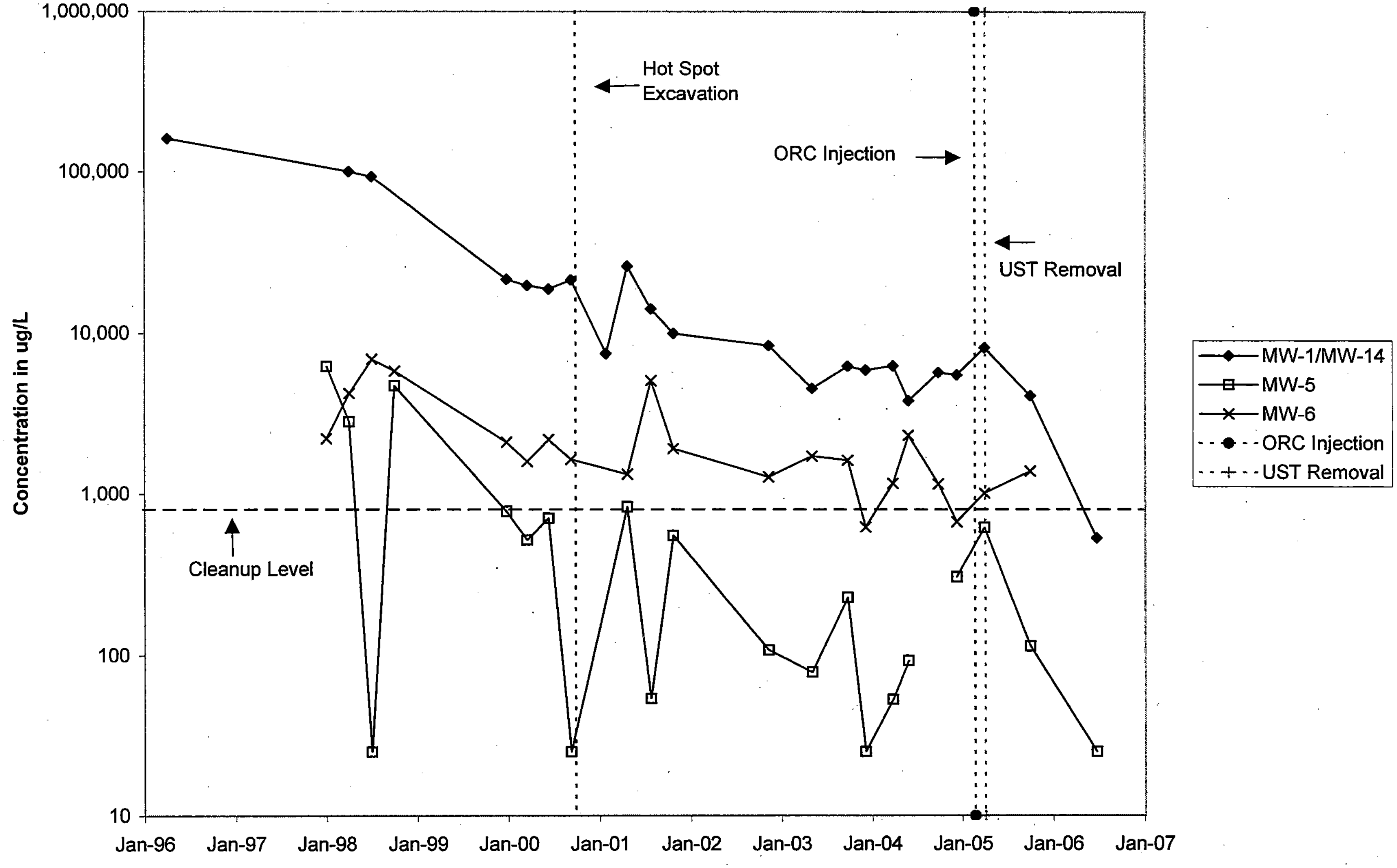
Figure 9

Long-Term Trends in TPH-G Concentration in Groundwater

Ken's Auto Wash



EAL 11/14/06 716304-003.DWG

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7163-04 ***10/06***

Figure 10

Long-Term Trends in Benzene Concentration in Groundwater
Ken's Auto Wash

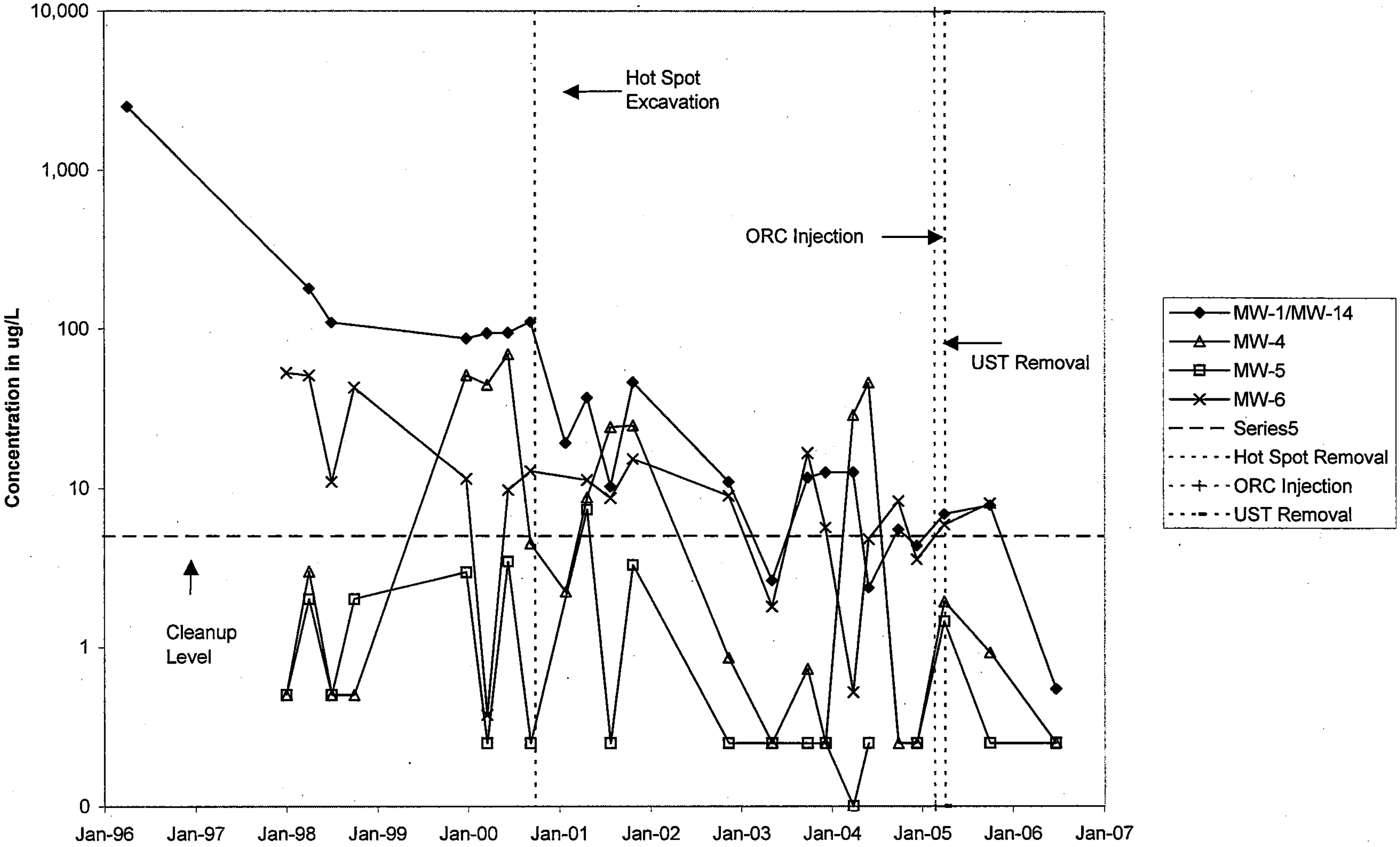

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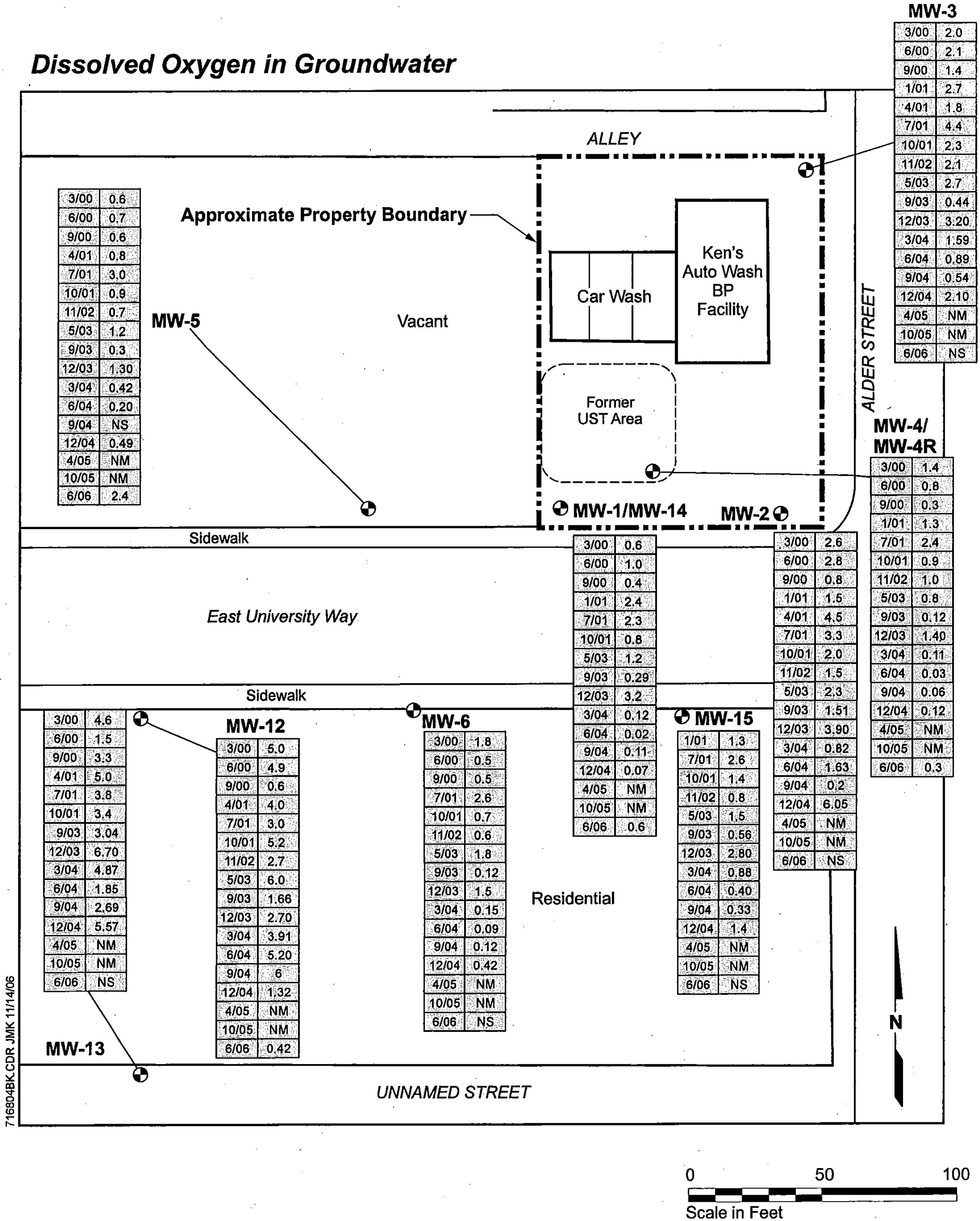
Figure 11

Dissolved Oxygen in Groundwater



MW-3

3/00	2.0
6/00	2.1
9/00	1.4
1/01	2.7
4/01	1.8
7/01	4.4
10/01	2.3
11/02	2.1
5/03	2.7
9/03	0.44
12/03	3.20
3/04	1.59
6/04	0.89
9/04	0.54
12/04	2.10
4/05	NM
10/05	NM
6/06	NS

MW-5

3/00	0.6
6/00	0.7
9/00	0.6
4/01	0.8
7/01	3.0
10/01	0.9
11/02	0.7
5/03	1.2
9/03	0.3
12/03	1.30
3/04	0.42
6/04	0.20
9/04	NS
12/04	0.49
4/05	NM
10/05	NM
6/06	2.4

MW-4/ MW-4R

3/00	1.4
6/00	0.8
9/00	0.3
1/01	1.3
7/01	2.4
10/01	0.9
11/02	1.0
5/03	0.8
9/03	0.12
12/03	1.40
3/04	0.11
6/04	0.03
9/04	0.06
12/04	0.12
4/05	NM
10/05	NM
6/06	0.3

MW-1/MW-14

3/00	0.6
6/00	1.0
9/00	0.4
1/01	2.4
7/01	2.3
10/01	0.8
5/03	1.2
9/03	0.29
12/03	3.2
3/04	0.12
6/04	0.02
9/04	0.11
12/04	0.07
4/05	NM
10/05	NM
6/06	0.6

MW-2

3/00	2.6
6/00	2.8
9/00	0.8
1/01	1.5
4/01	4.5
7/01	3.3
10/01	2.0
11/02	1.5
5/03	2.3
9/03	1.51
12/03	3.90
3/04	0.82
6/04	1.63
9/04	0.2
12/04	6.05
4/05	NM
10/05	NM
6/06	NS

MW-13

3/00	4.6
6/00	1.5
9/00	3.3
4/01	5.0
7/01	3.8
10/01	3.4
9/03	3.04
12/03	6.70
3/04	4.87
6/04	1.85
9/04	2.69
12/04	5.57
4/05	NM
10/05	NM
6/06	NS

MW-12

3/00	5.0
6/00	4.9
9/00	0.6
4/01	4.0
7/01	3.0
10/01	5.2
11/02	2.7
5/03	6.0
9/03	1.66
12/03	2.70
3/04	3.91
6/04	5.20
9/04	6
12/04	1.32
4/05	NM
10/05	NM
6/06	0.42

MW-6

3/00	1.8
6/00	0.5
9/00	0.5
7/01	2.6
10/01	0.7
11/02	0.6
5/03	1.8
9/03	0.12
12/03	1.5
3/04	0.15
6/04	0.09
9/04	0.12
12/04	0.42
4/05	NM
10/05	NM
6/06	NS

MW-15

1/01	1.3
7/01	2.6
10/01	1.4
11/02	0.8
5/03	1.5
9/03	0.56
12/03	2.80
3/04	0.88
6/04	0.40
9/04	0.33
12/04	1.4
4/05	NM
10/05	NM
6/06	NS

MW-12 ⊕ Monitoring Well Location and Number

Month/Year of Measurement

3/00 5.0 Groundwater Dissolved Oxygen Concentration in mg/L

NS = Well Not Sampled

NM = Not Monitored

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Figure 12

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February 24, 2003

Ms. Krystal Rodriguez
Washington State Department of Ecology
15 West Yakima Ave, Suite 200
Yakima, Washington 98902

Re: Request for Site Hazard Assessment Reranking
Ken's Auto Wash
Ellensburg, Washington
7168-03

Dear Krystal:

On the behalf of our client, Ken Peterson, we are requesting that the Washington State Department of Ecology (Ecology) rerank the Ken's Auto Wash site located at 1013 10th Avenue East in Ellensburg, Washington. This request is based on conversations with Michael Spencer of Ecology and data obtained by Hart Crowser since the original Site Hazard Assessment was performed in 1996. The collected information indicates that the original Site Hazard Ranking of "2" was based on an erroneous assumption (described below). We ask that the site be reranked using updated information in accordance with WAC 173-340-330.

Shallow groundwater at the Ken's Auto Wash site is affected by petroleum hydrocarbons related to a historical release from an underground storage tank, as described in previous reports (Sage 1998; Hart Crowser 1999 and 2002). According to Mr. Spencer, the original Site Hazard Assessment assumed that shallow site groundwater was hydraulically connected to the regional aquifer serving the City of Ellensburg drinking water supply. Two City of Ellensburg water supply wells are located approximately 1,200 and 1,600 feet south of the site. However, these wells are screened at depths greater than 230 and 480 feet below ground surface, respectively, whereas site wells exhibit contaminated groundwater at depths of 15 feet. Our research indicates that the shallow water-bearing zone at the Ken's Auto Wash site is not directly connected with the deeper water-bearing zones that supply the City of Ellensburg. Below we discuss the regional geology setting and hydrogeology, and the location of municipal wells relative to the Ken's Auto Wash site.

REGIONAL GEOLOGIC SETTING

Ellensburg is located at the northwestern extent of the Columbia Basin physiographic region just east of the Cascade Range. The upper 1,000 feet of stratigraphy in the area consist of fluvial deposits grading upward from coarser deposits at depth to shallower finer-grained deposits. We obtained well logs from Ecology for the Ellensburg area to provide a more focused look at the regional geology units in the vicinity of the site and the city wells. Based on these logs, we identified two primary stratigraphic units as follows:

- **The Ellensburg Formation.** The deepest unit recorded in the well logs is the Ellensburg Formation consisting mainly of sands and sandstones with interbedded gravel and clay (Bentley and Campbell 1985). These deposits, derived from the Cascade Range, are best characterized as alluvial fan deposits built out eastward from the Cascades and stream deposits (Orr and Orr 1996). On the west side of town, a cemented layer is recorded at approximately 300 feet below ground surface. Similar strata are deeper on the east side of town and are referred to as sandstones in the drillers' logs. We have interpreted these strata to be the Ellensburg Formation.

- **Yakima River Deposits.** Deposits overlying the Ellensburg Formation are typically finer-grained, consisting of clays and clay-bound gravels with interbedded sand and gravel layers. These deposits represent alluvial deposits from the Yakima River and associated side streams (Bentley and Campbell 1985).

LOCAL HYDROGEOLOGY

Water-bearing units occur in both the Ellensburg Formation and Yakima River Deposits discussed above. The sandstones and gravels in the Ellensburg Formation have been developed as a water resource for the City of Ellensburg. In the overlying Yakima River Deposits, the interbedded gravel and sand layers have some potential for water development but on a very localized scale. A more detailed discussion of the hydrogeology of Ellensburg is provided below with focus on the Ellensburg water supply wells and the Ken's Auto Wash property.

Ellensburg Water Supply Wells

The municipal water supply wells for the City of Ellensburg are deep wells ranging in total depth from 700 to 1,200 feet. Wells locations are illustrated on Figure 1, and well logs are provided in Attachment A. Two of the wells are located approximately 1,200 and 1,600 feet south of Ken's Auto Wash. These wells were installed in 1946 and 1988. An east-west cross section along 8th Street is presented on Figure 2 to illustrate the municipal water levels relative to the site. A third municipal well installed in 1987 is located 4,000 feet west northwest of the site. Note that this well does not affect the Site Hazard Ranking because of its distance from the site, but it has been included in this discussion to provide a more complete understanding of the hydrogeology of the area.

The 1988 City well, located 1,200 feet south of the site, is screened from a depth of 488 to 757 feet, in the upper part of the Ellensburg Formation in intervals of sand and sandstone with some clay and gravel. Layers of clay and clay-bound gravels make up over 200 feet of the upper 400 feet overlying the screened interval. These fine-grained layers would act as a barrier to downward migration of contaminants. The final standing water level just after drilling was encountered at a depth of 29 feet.

The 1946 City well, located 1,600 feet to the south of the site, is screened at various intervals with the shallowest being at depths of 232 to 250 feet. Three clay units, 9, 25, and 10 feet in thickness, as well as more than 100 feet of clay-bound gravel, overlie this first screened interval. During drilling, the depth to water decreased with increasing depth, and flowing water was observed at a depth of 232 feet when the shallowest screen section was placed. Similar depth-to-water patterns were observed in deeper strata during drilling. This indicates that the water-bearing units served by the 1946 City well are confined and that a strong upward hydraulic gradient was present at the time of drilling.

The 1987 City well, located 4,000 feet to the northwest of the site, is also screened in the Ellensburg Formation from a depth of 410 to 595 feet. Layers of clay and clay-bound gravel make up over 280 feet of the upper 400 feet overlying the screened interval. The water level after drilling was at a depth of 39 feet.

GEOLOGY AND HYDROGEOLOGY OF THE KEN'S AUTO WASH SITE

Site soils are typically alluvially deposited silty, sandy gravels with cobbles (Hart Crowser 1999). These soils are consistent with those observed in the upper 32 feet of the 1988 City well. In addition, areas of silty sand and sandy silt fill have been observed at shallow depths typically less than 6 feet. The greatest depth at which soil affected by the petroleum release has been observed is 13 feet.

Site monitoring wells are screened above a depth of 16 feet with associated water levels ranging between depths of 6.5 and 9.5 feet. These wells are screened in a shallow unconfined sand and gravel unit. Groundwater elevations at the site have been shown to fluctuate nearly 2 feet seasonally (Hart Crowser 2002). The fact that these minor fluctuations correlate with seasonal precipitation, combined with knowledge of the local stratigraphy, suggests that the shallow groundwater unit is a perched on the underlying clay and clay-bound gravel unit. The depth to the uppermost confining unit at the site is not known but has been observed at a depth of 11 feet at the 1947 City well and a depth of 32 feet at the 1988 City well.

CONCLUSIONS

Evaluation of the water level data and the geology demonstrates that shallow groundwater at the Ken's Auto Wash site is not in direct connection with the water-bearing zones tapped by the City of Ellensburg for the following reasons:

- Substantial confining layers of clay and clay-bound gravels exist between the confined, deep water-bearing zones in the City wells, and the shallow, unconfined groundwater unit affected by releases at the site; and

- Upward hydraulic gradients prevent transport of contaminants from the shallower zone to the deeper zones.

Based on these data, the assumption made during the 1997 hazard assessment that affected groundwater at the site could potentially migrate or otherwise affect the City of Ellensburg drinking water supply is erroneous. Therefore, we request that Ecology update the Site Hazard Ranking to reflect this information.

Sincerely,

HART CROWSER, INC.

Dana Cannon

DANA CANNON
Senior Staff Geologist

Jeremy Porter

JEREMY PORTER
Remediation Engineer

RICHARD F. MOORE, L. HYD.
Senior Associate Environmental Specialist

Attachments:
Figure 1 – Vicinity Map
Figure 2 – Generalized Geologic Cross Section A-A'
Attachment A – Well Logs
City of Ellensburg and Ken's Auto Wash

cc: Ken Peterson, Ken's Auto Wash
Steven Lathrop, Lathrop, Winbauer, Harrel, Slothower & Denison, LLP
Larry Daniels, AIG

F:\docs\jobs\716803\sha(ltr).doc

REFERENCES

Bentley, R.D. and N.D. Campbell 1983. Geologic Map of the Ellensburg Quadrangle, Washington: Geologic Map GM-28. State of Washington, Department of Natural Resources.

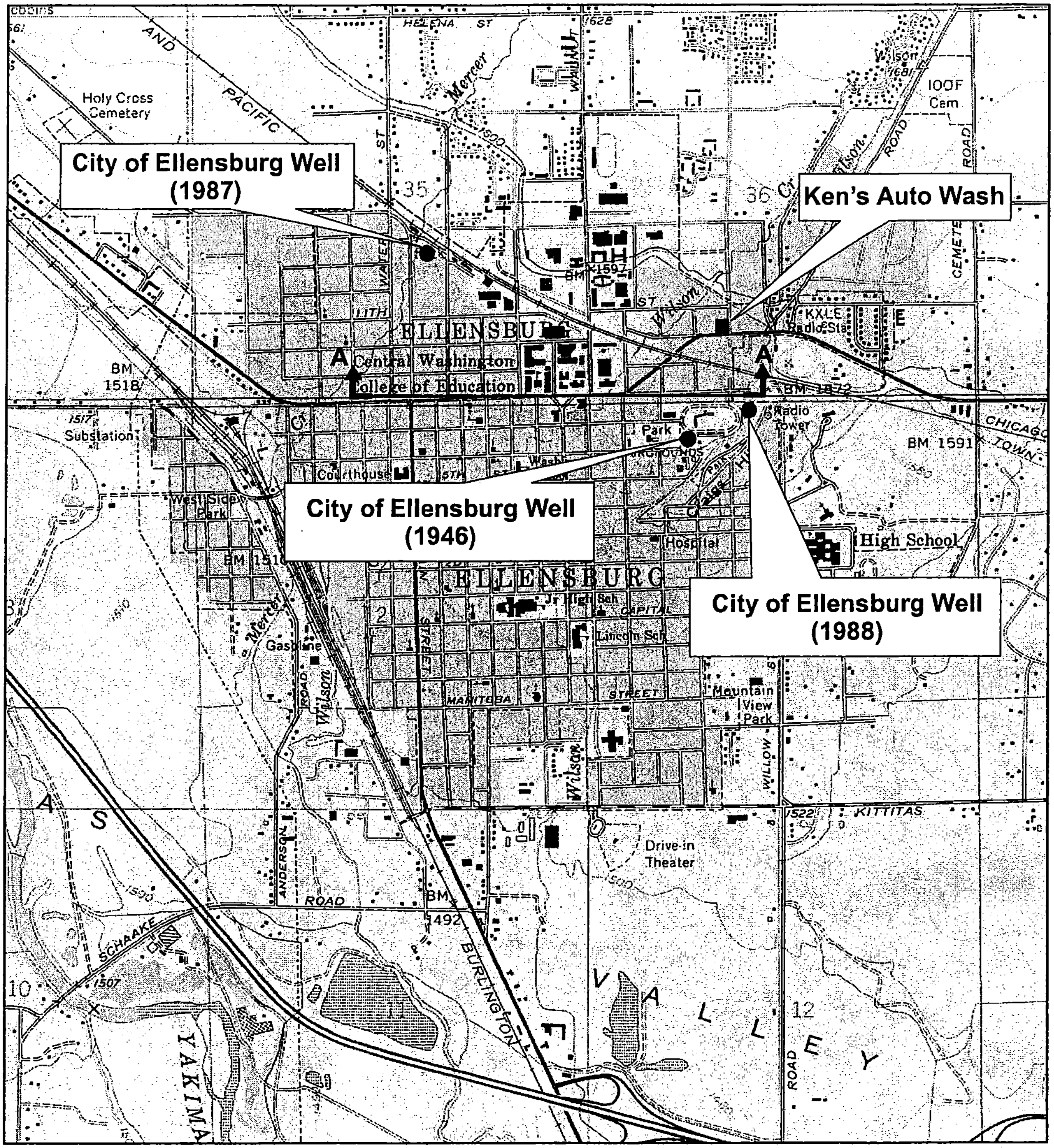
Hart Crowser 1999. Limited Phase II Environmental Assessment, Ken's Auto Wash Facility, Ellensburg, Washington. Prepared by Hart Crowser, Inc., November 29, 1999.

Hart Crowser 2002. Groundwater Monitoring Report and Evaluation of Remedial Alternatives. Ken's Auto Wash Facility, Ellensburg, Washington. Prepared by Hart Crowser, Inc., December 16, 2002.

Orr, E.L. and W.N. Orr 1996. Geology of the Pacific Northwest. McGraw - Hill Companies, Inc.

Sage 1998. Limited Site Characterization Report, Ken's Auto Wash Facility, Ellensburg, Washington. Prepared by Sage Earth Sciences, Inc., March 1998.

Vicinity Map



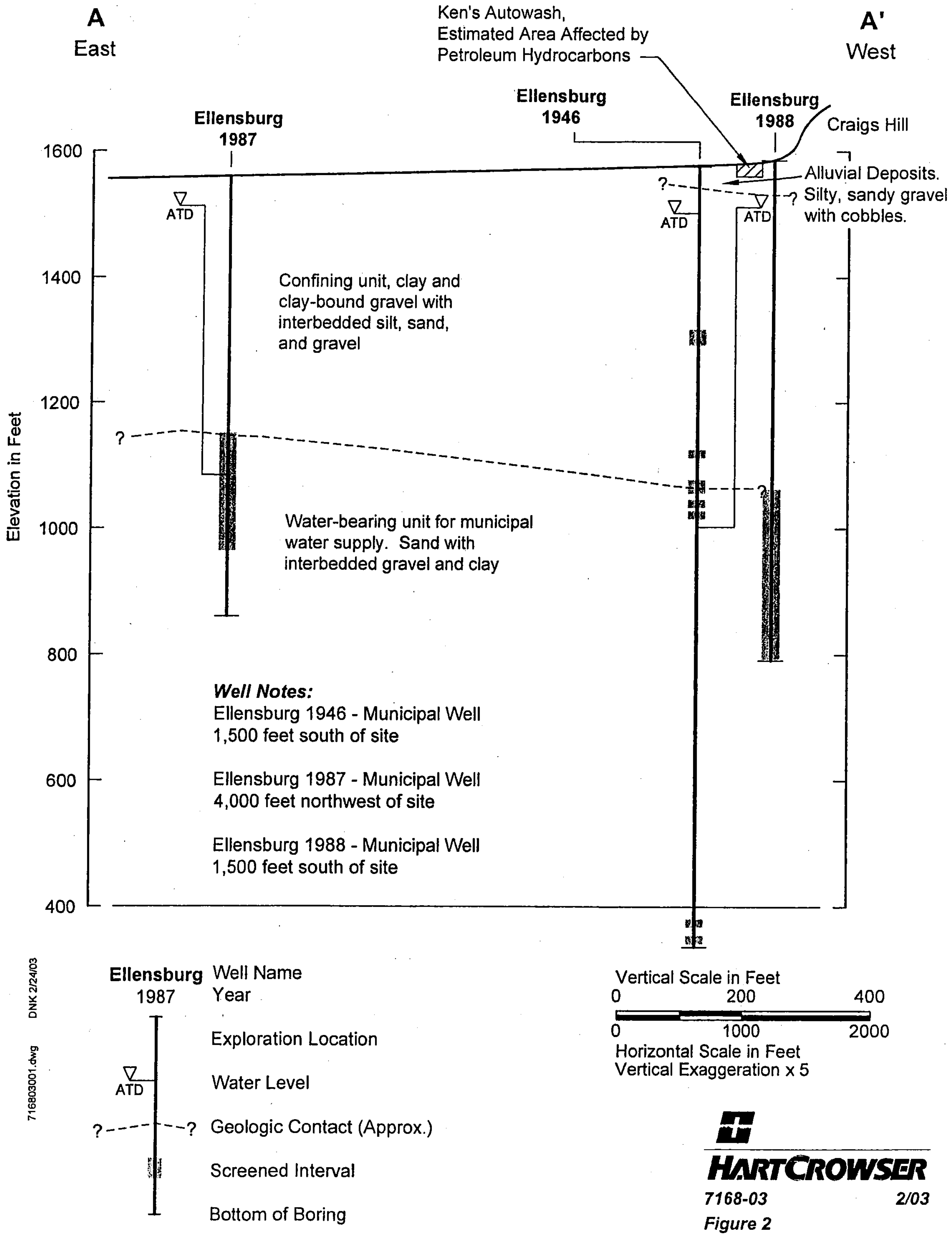
DNK 2/21/03 716803vicinity.cdr

Note: Base map prepared from USGS 7.5 minute Qudrangle of Ellensburg North and South, Washington; dated 1978.

Approximate Scale in Feet

HARTCROWSER
7168-03 2/03
Figure 1

Generalized Geologic Cross Section A-A'
8th Street



Well Notes:

Ellensburg 1946 - Municipal Well
1,500 feet south of site

Ellensburg 1987 - Municipal Well
4,000 feet northwest of site

Ellensburg 1988 - Municipal Well
1,500 feet south of site

716803001.dwg DNK 2/24/03

HARTCROWSER

7168-03 *2/03*

Figure 2

ATTACHMENT A
WELL LOGS
CITY OF ELLENSBURG AND KEN'S AUTO WASH

Well #4

C

STATE OF WASHINGTON
DEPARTMENT OF CONSERVATION
AND DEVELOPMENT

WELL LOG

No. Appli. #693
Cert. #816A

Date ____________, 19 46

Record by Gerald C. Hoff

Source Driller report

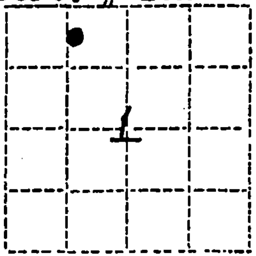


DIAGRAM OF SECTION

Location: State of WASHINGTON

County Kittitas

Area ____________

Map ____________

NE ¼ NW ¼ sec. 1 T. 17 N., R. 18 E. ~~W.~~

Drilling Co. ____________

Address ____________

Method of Drilling ____________ Date ____________ 19____

Owner City of Ellensburg Water Dept.

Address 420 N. Pearl St.; Ellensburg

Land surface, datum ____________ ft. above / below ____________

(Transcribe driller's terminology literally but paraphrase as necessary, in parentheses. If material water-bearing, so state and record static level if reported. Give depths in feet below land-surface datum unless otherwise indicated. Correlate with stratigraphic column, if feasible. Following log of materials, list all casings, perforations, screens, etc.)

CORRELATION	MATERIAL	THICKNESS (feet)	DEPTH (feet)
	See attached sheets		

Turn up

Sheet ______ of ______ sheets

17N-18E-1C

LOG OF ELLENSBURG WELL #4

Depth	Description	Comments
0 - 2'	Loam	
8 - 10'	Gravel and round rock	
1 - 11'	Coarse sand and gravel	
9 - 20'	Yellow clay	S.W.L. 12
7 - 27'	Fine gravel	" 7'6"
41 - 68'	Clay, sand and fine gravel	
25 - 93'	Clay	
5 - 5'	Clay and fine gravel	
22 - 120'	Gravel, rock and clay	
50 - 170'	Sand, gravel, rocks and clay	
13 - 183'	Clay and some sand	
39 - 222'	Gravel and clay	" 4' -
10 - 232'	Clay	
35 - 267'	Gravel, sand, and cement gravel	
24 - 291'	Clay and gravel	" 30'6" - 94'
7 - 298'	Gravel	" 60'
26 - 324'	Sand and clay	
13 - 337'	Sand, gravel and clay	" 30'
10 - 347'	Clay and gravel	" 26'
1 - 348'	Fine gravel and sand	
21 - 369'	Fine gravel, course sand, and clay	
24 - 393'	Clay, fine gravel, and sand stone	" 15'-43'
10 - 403'	Sandy clay, pea gravel, gravel & sand	
21 - 424'	Clay and sand stone	" 90'
7 - 431'	Gravel and fine sand	" 40'-43'
34 - 465'	Clay, fine gravel, sand	" 48'-85'
17 - 482'	Sand, gravel and clay	" 65'
21 - 503'	Clay	
8 - 511'	Clay, fine sand, and gravel	" 40'9"-60'
13 - 524'	Clay and sand	" 43'
26 - 550'	Gravel, sand, and clay	" 52'-33'
44 - 594'	Clay and sand	" 40'
6 - 600'	Gravel	
45 - 645'	Clay and sandy clay	" 85'-81'
29 - 674'	Sand and fine sand	" 72'-80'
16 - 690'	Sand, gravel, and clay	" 80'
24 - 714'	Sandy clay	" 84'
2 - 716'	Sand	
38 - 754'	Sandy clay	" 83'
3 - 757'	Gravel and sand	" 85'-100'
12 - 769'	Sand and clay	
1 - 770'	Sand and gravel	
10 - 780'	Sand and heaving sand	" 107'-100'
14 - 794'	Sand and gravel	" 88'-94'
55 - 849'	Clay, sand and gravel	" 83'-105'
6 - 855'	Heaving sand	
6 - 861'	Sandy clay	" 105'9"
4 - 865'	Red sand	" 105'
71 - 936'	Clay and sand and gravel clay mix	" 98'
5 - 941'	Clay	

Depth	Description	Comments
941 - 942'	Quick sand heaving badly	
27 - 969'	Clay, sand, and gumbo	
7 - 976'	Sand -- heaving	
41 - 1017'	Clay, blue mud, and gumbo	S.W.L. 90'-130'
7 - 1024'	Fine sand, D.O.I.	" 100'
16 - 1040'	Blue clay	" 97'
6 - 1046'	Coarse gravel	
18 - 1064'	Blue clay	" 105'-112'
4 - 1068'	Fine sand	
32 - 1100'	Blue clay and blue mud	" 110'-98'
53 - 1153'	Clay	" 98'-102'
3 - 1156'	Sand	" 98'
14 - 1170'	Clay and blue clay	" 96'. Shut down from Aug. 14th to Sept. 15th. Showed S.W.L. 35'8" on Sept. 15th.
3 - 1173'	Sand and gravel	S.W.L. 31'5"
4 - 1177'	Sand	" 31'5"-28'
1 - 1178'	Blue shale	
17 - 1195'	Green and greenish gray mud	" 25'-35'
10 - 1205'	Sand and gravel	" 41'-45'. On Oct. 10th, after fishing out tools S.W.L. 29'6"
5"-1209' ' 6"	Shale and greenish gray mud	S.W.L. 29'6"-31'

ELLENSBURG WELL NO. 4

PERFORATIONS

4 rows of 3/8" x 1-1/8" perforations

Depth	Depth	REMARKS
* 232	250	Very good water flow
424	431	Fair water flow
470	475	Poor to fair
477	482	Poor to fair
507	509	No good
524	529	Fair
1170	1177	Light flow
1195	1205	Very little water

*Well flowed when perforated here but quit flowing when perforating was continued.

37' of 20" conductor pipe left in hole.

15 yards of gravel were fed between the 16" and 20" casing
Level of gravel was left at 175'.

Pumped 1000 g.p.m. for 24 hrs. Would break suction at 1100 g.p.m. with 195' pump setting. Pumped 3 to 4 yds. of sand. Temperature of water 54½ degrees.

Gerald C. Hoff

10U

File Original and First Copy with
Department of Ecology
Second Copy — Owner's Copy
Third Copy — Driller's Copy

WATER WELL REPORT
STATE OF WASHINGTON

C

Application No
Permit No.

1) **OWNER:** Name CITY OF EllENSBURG Address EllENS BURG WA.

(2) **LOCATION OF WELL:** County KITTITAS — NE ¼ NW ¼ Sec. 1 T.17 N., R.18 W.M

ring and distance from section or subdivision corner

(3) **PROPOSED USE:** Domestic ☐ Industrial ☐ Municipal ☒
Irrigation ☐ Test Well ☐ Other ☐

(4) **TYPE OF WORK:** Owner's number of well (if more than one)
New well ☒ Method: Dug ☐ Bored ☐
Deepened ☐ Cable ☒ Driven ☐
Reconditioned ☐ Rotary ☐ Jetted ☐

(5) **DIMENSIONS:** Diameter of well 20 inches.
Drilled 761 ft. Depth of completed well 761 ft.

(6) **CONSTRUCTION DETAILS:**

Casing installed: 20 " Diam. from +1.5 ft. to 573 ft.
Threaded ☐ 12 " Diam. from 468 ft. to 757 ft.
Welded ☒ " Diam. from ft. to ft.

Perforations: Yes ☒ No ☐
Type of perforator used TORCH
SIZE of perforations ¼ in. by 6 in.
5/ft. perforations from 488 ft. to 757 ft.
perforations from ft. to ft.
perforations from ft. to ft.

Screens: Yes ☐ No ☐
Manufacturer's Name
Type Model No.
Diam. Slot size from ft. to ft.
Diam. Slot size from ft. to ft.

Gravel packed: Yes ☒ No ☐ Size of gravel ¼ MINUS
Gravel placed from 470 ft. to 760 ft.

Surface seal: Yes ☒ No ☐ To what depth? ~20 ft.
Material used in seal CONCRETE
Did any strata contain unusable water? Yes ☒ No ☐
Type of water? SURFACE Depth of strata 13
Method of sealing strata off CONCRETE

(7) **PUMP:** Manufacturer's Name NA
Type: H.P.

(8) **WATER LEVELS:** Land-surface elevation above mean sea level 1550 ft.
Static level 28.75 ft. below top of well Date 4-26-88
Artesian pressure lbs. per square inch Date
Artesian water is controlled by (Cap, valve, etc.)

(9) **WELL TESTS:** Drawdown is amount water level is lowered below static level
Was a pump test made? Yes ☒ No ☐ If yes, by whom? BACH
Yield: 1200 gal./min. with 116 ft. drawdown after 10 min ~~hrs.~~
" 1200 " 149 " 1 HR
" 1200 " 165 " 6 "

Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)

Time	Water Level	Time	Water Level	Time	Water Level
5MIN	71	1DAY	35		
10MIN	65				
21MIN	50				

Date of test
Bailer test gal./min. with ft. drawdown after hrs.
Artesian flow g.p.m. Date
Temperature of water 62°F Was a chemical analysis made? Yes ☒ No ☐

(10) **WELL LOG:**

Formation: Describe by color, character, size of material and structure, and show thickness of aquifers and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of formation.

MATERIAL	FROM	TO
SAND, GRAVEL, AND BOULDERS	0	16
SAND, GRAVEL, AND COBBLES	16	32
TAN SANDY CLAY	32	42
GRAVEL TO 1½", WATER BEARING	42	47
BROWN CLAY BOUND GRAVEL	47	89
BROWN SILTY SAND	89	91
GRAVEL	91	93
BROWN CLAY-BOUND GRAVEL	93	127
BROWN SAND AND GRAVEL WITH CLAY	127	170
BROWN CLAY AND GRAVEL	170	228
CREAM BROWN CLAY	228	243
BROWN CEMENTED SAND	243	247
BROWN SAND AND GRAVEL WITH CLAY	247	314
BROWN CLAY	314	316
BROWN CLAY-BOUND GRAVEL	316	367
BROWN CLAY	367	379
GRAVEL WITH SOME CLAY AND SAND	379	385
BROWN CLAY	385	387
BROWN CLAY BOUND GRAVEL	387	415
BROWN SAND WITH SOME GRAVEL	415	424
BROWN CLAY WITH SOME SAND	424	445
BROWN SAND AND GRAVEL TO 1"	445	449
BROWN CLAY-BOUND GRAVEL	449	482
BROWN SILTY SAND	482	490
BROWN CLAY WITH SAND SOME GVL	490	520
BROWN CLAY	520	545
BROWN CLAY-BOUND GRAVEL	545	573
WEATHERED GRANITE AND CLAY	573	587
BROWN SILTY SANDSTONE	587	636
GRAY SANDY CLAY WITH BLACK ORGANICS	636	645
BROWN SILTY SANDSTONE WITH CLAY + GVL	645	663
BROWN SANDSTONE WITH VOLCANIC ASH	663	665
BROWN SILTY SANDSTONE SOME GVL	665	733
BROWN SILTY SANDSTONE AND GRAVEL	733	747
GRAY SILTY SAND WITH GRAVEL	747	759
PINK BROWN SANDY CLAY	759	761+

Work started 10/30, 1987 Completed 5/11/, 1988

WELL DRILLER'S STATEMENT:

This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

ENTERED

NAME BACH WELL DRILLING
(Person, firm, or corporation) (Type or print)

Address Rt. 5 BOX 1010, ELLENSBURG

[Signed] Buck S
(Well Driller)

License No. 0555 Date 5/ , 1988

RECEIVED
DEPARTMENT OF ECOLOGY
CENTRAL REGION OFFICE

(USE ADDITIONAL SHEETS IF NECESSARY)

ECY 050

File Original and First Copy with
Department of Ecology
Second Copy — Owner's Copy
Third Copy — Driller's Copy

WATER WELL REPORT
STATE OF WASHINGTON

Application No. G4-29206
Permit No

(1) OWNER: Name CITY OF Ellens BURG Address ELLENSBURG, WA. 98926

(2) LOCATION OF WELL: County KITTITAS — NW ¼ SE ¼ Sec 35 T 18 N., R 18E W.M.

Bearing and distance from section or subdivision corner

(3) PROPOSED USE: Domestic ☐ Industrial ☐ Municipal ☒ Irrigation ☐ Test Well ☐ Other ☐

(4) TYPE OF WORK: Owner's number of well (if more than one)
New well ☒ Method: Dug ☐ Bored ☐
Deepened ☐ Cable ☐ Driven ☐
Reconditioned ☐ Rotary ☐ Jetted ☐

(5) DIMENSIONS: Diameter of well 20 inches.
Drilled 700 ft. Depth of completed well 617 ft.

(6) CONSTRUCTION DETAILS:

Casing installed: 20 " Diam. from +2 ft. to 575 ft.
Threaded ☐ 12 " Diam. from 398 ft. to 595 ft.
Welded ☒ " Diam. from ft. to ft.

Perforations: Yes ☒ No ☐
Type of perforator used TORCH
SIZE of perforations 1/8 in. by 12 in.
5 per Foot perforations from 410 ft. to 595 ft.
perforations from ft. to ft.
perforations from ft. to ft.

Screens: Yes ☒ No ☐
Manufacturer's Name UOP JOHNSON
Type 304 S.S. Model No
Diam. Slot size from ft. to ft.
Diam. Slot size from ft. to ft.

Gravel packed: Yes ☒ No ☐ Size of gravel 1/4"
Gravel placed from 610 ft. to 420 ft.

Surface seal: Yes ☒ No ☐ To what depth? 18 ft.
Material used in seal CONCRETE
Did any strata contain unusable water? Yes ☐ No ☒
Type of water? Depth of strata
Method of sealing strata off

(7) PUMP: Manufacturer's Name NA
Type H.P.

(8) WATER LEVELS: Land-surface elevation above mean sea level 1580 ft.
Static level 39 ft. below top of well Date 10/11/87
Artesian pressure — lbs. per square inch Date
Artesian water is controlled by (Cap, valve, etc.)

(9) WELL TESTS: Drawdown is amount water level is lowered below static level
Was a pump test made? Yes ☒ No ☐ If yes, by whom? R+N, BWD
Yield 1200 gal./min. with 139 ft. drawdown after 24 hrs.

Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)

Time	Water Level	Time	Water Level	Time	Water Level
5 MIN	69				
60 MIN	54				
	41.5				

Date of test 10/20/87
Bailer test gal./min. with ft. drawdown after hrs.
Artesian flow g.p.m. Date
Temperature of water 64°F Was a chemical analysis made? Yes ☒ No ☐

(10) WELL LOG:

Formation: *Describe by color, character, size of material and structure, and show thickness of aquifers and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of formation.*

MATERIAL	FROM	TO
SILTY GRAY CLAY	0	13
TAN CLAYBOUND GRAVEL.	13	126
TAN CLAY	126	128
TAN SANDY CLAY WITH SMALL GRAVEL	128	148
BROWN SAND AND GRAVEL WITH CLAY LAYERS	148	164
BROWN CLAY WITH VOLCANIC ASH, GRANULES + PUMICE	164	184
BROWN SAND WITH GRANULES	184	194
BROWN CLAYBOUND GRAVEL	194	212
DENSE BROWN CLAYBOUND GRAVEL	212	215
BROWN CLAYBOUND GRAVEL WITH LAYERS OF CLAY	215	232
BROWN CLAY AND GRAVEL TO 1/4"	232	237
BROWN CLAYBOUND GRAVEL AND CLAY LAYERS	237	247
PINK BROWN MED SAND AND DARK GVL	247	260
BROWN CLAY AND GRAVEL	280	280
TAN CLAY	280	282
TAN CLAYBOUND GRAVEL	282	288
TAN CLAY	288	297
BROWN CEMENTED SAND	297	307
BROWN CEMENTED SAND WITH GRAVEL TO 3/4" AND SOME CLAY	307	323
BROWN CLAY	323	340
BROWN CEMENTED GRAVEL AND SAND	340	351
BROWN CEMENTED GRAVEL	351	358
CHOCOLATE BROWN CLAY	358	380
CHOCOLATE BROWN CLAY WITH GRAVEL	380	395
BROWN SILTY SAND WITH SOME GRAVEL	395	464
BROWN MED SAND, GRAVEL WITH CLAY	464	489
BROWN SANDSTONE WITH OCCASIONAL GVL	489	560
BROWN SANDSTONE	560	683
BROWN SAND	683	686
BROWN CLAYBOUND GRAVEL	686	700

Work started 6/2, 1987 Completed 10/29, 1987

WELL DRILLER'S STATEMENT:

This well was drilled under my jurisdiction and this report is true to the best of my knowledge ~~and belief.~~

NAME BACH DRilling Co.
(Person, firm, or corporation) (Type or print)

Address Rt. 5 Box 1010, ELLENSBURG 98926

[Signed] Darrel H. "Buck" Smith
(Well Driller)

License No. 0555 Date 11/18, 1987

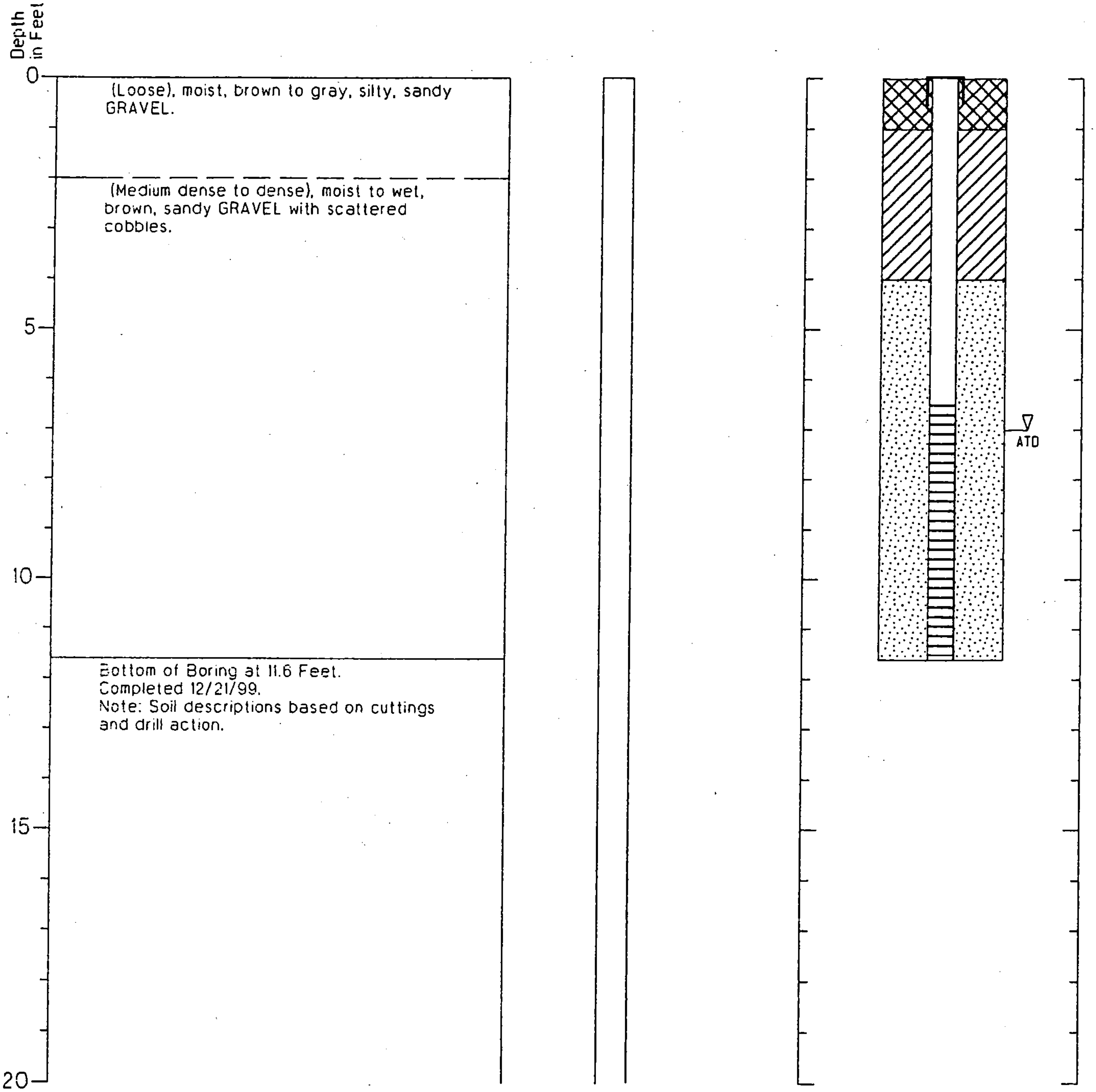
(USE ADDITIONAL SHEETS IF NECESSARY)

Boring Log and Construction Data for Monitoring Well MW-13

Geologic Log

Monitoring
Well Design

Top of Casing in Feet: 1582.45



(Loose), moist, brown to gray, silty, sandy GRAVEL.

(Medium dense to dense), moist to wet, brown, sandy GRAVEL with scattered cobbles.

Bottom of Boring at 11.6 Feet.
Completed 12/21/99.
Note: Soil descriptions based on cuttings and drill action.

1. Refer to Figure C-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Ground water level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.

HARTCROWSER

J-7188 **12/99**

Figure A-3

DRILLING REPORT

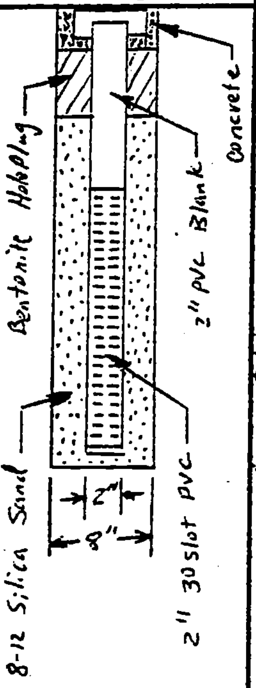
SAGE
Earth Sciences, Inc.
602 Cherryhill Lane
P.O. Box 1644
Zillah, WA 98953
Phone (509) 829-6400

F ld Crew Dave Green & Radney Heit
P oject Name Ken's Auto Wash Project # BP-0296
A ess 1013 E. 10th Ave. Ellensburg, WA Date 4-5-96
L ation SE 1/4 SW 1/4 Sec. 36 T. 18 N. R. 18 E., W.M. Elevation Top of Casing 1588.38 Datum M.S.L.
Drilling Firm Environmental Drilling, Inc Driller Bruce McCall License # 1712
Drilling Firm Address 10918 159th Ave. SE, Snohomish, WA 98920
D lling Method 8" Rotary Auger Sampling Method 2" Split Spoon
Casing Type 2" PVC threaded Screened Interval 7' of 30 slot PVC Finish Depth 12.5' BGS
P king Material 8-12 Silica Sand Surface Sealant Bentonite "Hole Plug"
rotector Cap Flush Mount Monument Well Identification Number BP-0296-MW1

	Start	Finish	Water Level Measurements			Development	
						7 gal.	gal.
Date	4/5/96	4/5/96	4/8/96			4/8/96	
Time	9:00 Am	10:45 Am	7.08 ft			12:00 pm	

MW #1

Well Diagram



Matrix	Blows	Depth (ft)	Unified Soil Classification	Soils Description
				Concrete surface
Soil	3/4/4	2	ML	Sandy silt, brown & moist
		4		
		6		encountered water @ ~7' BGS.
	5/50-5"	8	GM	River gravels up to approximately 6" in diameter Sandy silt matrix, petroleum odors observed
		10		
Soil	50-4"	12		Encountered small boulder @ 12.5' BGS. Drilling terminated.
		14		

Bruce D McCall

Driller Signature Date

SAGE Representative Date 4-5-96

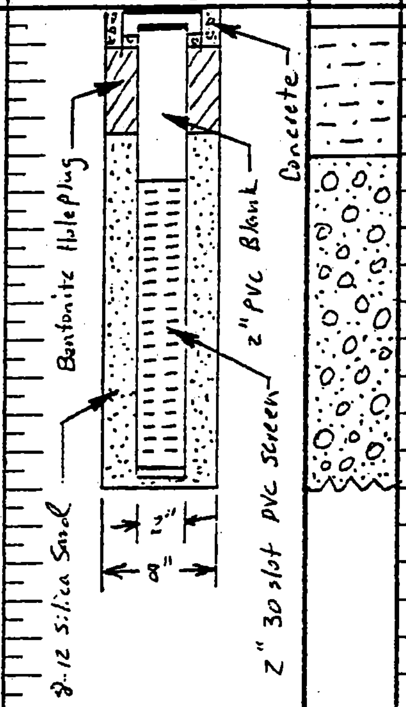
DRILLING REPORT

SAGE
Earth Sciences, Inc.
602 Cherryhill Lane
P.O. Box 1644
Zillah, WA 98953
Phone (509) 829-6400

F eld Crew Dave Green & Rodney Heit
P oject Name Ken's Auto Wash Project # BP-0296
A ess 1013 E. 10th Ave. Ellensburg, WA Date 4-5-96
L cation SE 1/4 SW 1/4 Sec. 36 T. 18 N. R. 18 E., W.M. Elevation Top of casing 1588.92 Datum M.S.L
Drilling Firm Environmental Drilling, Inc. Driller Bruce McCall License # 1712
D illing Firm Address 10918 159th Avenue S.E., Snohomish, WA 98920
D illing Method 8" Rotary Auger Sampling Method 2" Split Spoon
Casing Type 2" Threaded PVC Screened Interval 8' of 30 slot PVC Finish Depth 13' BGS
P cking Material 8-12 Silica Sand Surface Sealant Bentonite "Hole Plug"
Protector Cap Flush mount Monnment w/ J Plug Well Identification Number BP-0296-MW2

	Start	Finish	Water Level Measurements		Development	
					12 gal.	gal.
Date	4-5-96	4-5-96	4-8-96		4-8-96	
Time	11:00Am	12:15Pm	7.04Ft		2:10Pm	

MW #2



Sample #	Matrix	Blows	Depth (ft)	Unified Soil Classification	Soils Description
					Concrete Surface
			2		Sandy silt, brown & moist. A little water @ 2' BGS.
r	Soil	2/2/1		ML	
			4		
			6		Poorly sorted Cobbles & small boulders up to ~6" in diameter. Matrix consists of sandy silt.
		24/50-5"			
			8	GM	No petroleum odors observed.
			10		
			12		
	il	50-6"			
			14		

Bruce D. McCall
Driller Signature Date

SAGE Representative 4-5-96 Date

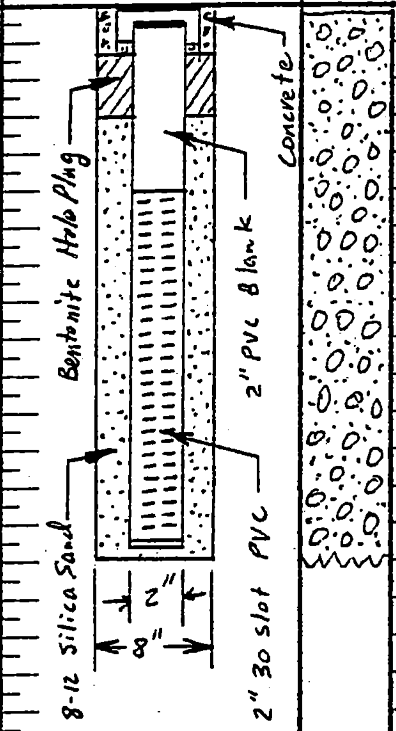
DRILLING REPORT

SAGE
Earth Sciences, Inc.
602 Cherryhill Lane
P.O. Box 1644
Zillah, WA 98953
Phone (509) 829-6400

eld Crew Dave Green & Rodney Heit
oject Name Ken's Auto Wash Project # BP-0296
ess 1013 E. 10th Ave., Ellensburg, WA Date 4-5-96
cation SE 1/4 SW 1/4 Sec. 36 T. 18 N. R. 18 E., W.M. Elevation Top of casing 1591.43 Datum MSL
Drilling Firm Environmental Drilling, Inc. Driller Bruce McCall License # 1712
Drilling Firm Address 10918 159th Ave. SE, Snohomish, WA 98920
illing Method 8" Rotary Auger Sampling Method 2" Split Spoon
Casing Type 2" Threaded PVC Screened Interval 10' 30 Slot PVC Finish Depth 15' BGS
cking Material 8-12 Silica Sand Surface Sealant Bentonite Hole Plug
Protector Cap Flush Mount Monument w/ J-Plug Well Identification Number BP-0296-MW3

	Start	Finish	Water Level Measurements			Development	
						15 gal.	gal.
Date	4-5-96	4-5-96	4-8-96			4-8-96	
Time	1:30 PM	3:15 PM	8.08 ft.			3:15 PM	

MW #3



Well Diagram

Sample #	Matrix	Blows	Depth (ft)	Graphic Log	Unified Soil Classification	Soils Description
						Asphalt Surface upper 2".
			2			
7	501	11/16/7				
			4			
			6		GM	Poorly Sorted cobbles & Small boulders up to ~6" in diameter. Matrix consists of Sandy silt.
8		50/6"	8			
			10			
						No petroleum odors observed
9	501	40/501	12			
			14			
			16			

Driller Signature Date

SAGE Representative 4-5-96 Date

DRILLING REPORT

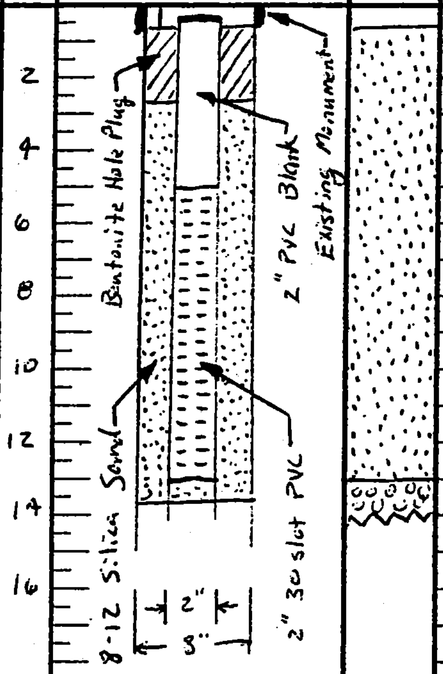
SAGE
Earth Sciences, Inc.
602 Cherryhill Lane
P.O. Box 1644
Zillah, WA 98953
Phone (509) 829-6400

Field Crew Dave Green & Rodney Heit
Project Name Ken's Auto Wash Project # BP-0397
ress 1013 E. 10th Ave, Ellensburg, WA Date 12-9-97
ocation SE 1/4 SW 1/4 Sec. 36 T. 18 N. R. 18 E., W.M. Elevation ______ Datum MSL
Drilling Firm Environmental Drilling, Inc. Driller Bruce McCall License # 1712
Drilling Firm Address 10918 159th Ave. SE, Snohomish, WA 98920
Drilling Method 8" Rotary Auger Sampling Method 2" Split Spoon
Casing Type 2" Threaded PVC Screened Interval ~~1~~8' 30 slot PVC Finish Depth 13.5' BGS
Packing Material 8-12 Silica Sand Surface Sealant Bentonite Hole Plug
Protector Cap Flush Mount Monument w/J Plug Well Identification Number BP-0397-MW4

	Start	Finish	Water Level Measurements			Development gal.	gal.
Date	12-9-97	12-9-97					
Time	8:45am	10:00AM					

Sa e # | Matrix | Blows | Depth (ft) | Well Diagram | Graphic Log | Unified Soil Classification | Soils Description

MW #4



Unified Soil Classification	Soils Description
	Pulled existing observation well and replaced it within the existing monument. No soil samples collected from sluff of previous annulus
GW	1/2" minus pea gravel used for UST backfill.
GM	Poorly sorted cobbles and small boulders.

Bruce D. McCall
Driller Signature Date

SAGE Representative 12-9-97 Date

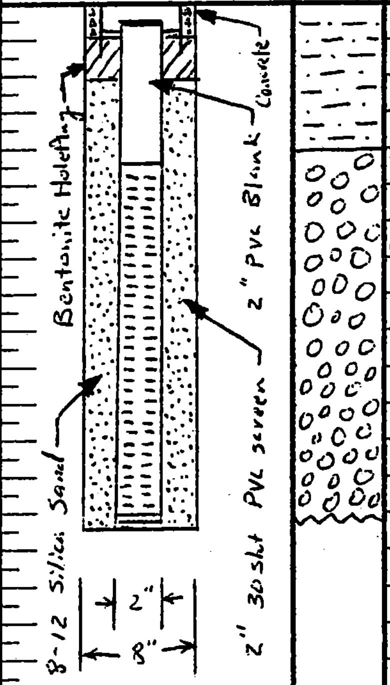
DRILLING REPORT

SAGE
Earth Sciences, Inc.
602 Cherryhill Lane
P.O. Box 1644
Zillah, WA 98953
Phone (509) 829-6400

Field Crew Dave Green & Rodney Heit
Project Name Ken's Auto Wash Project # BP-0397
Address 1011 E. 10th Ave. Ellensburg, WA Date 12-9-97
Location SE 1/4 SW 1/4 Sec. 36 T. 18 N. R. 18 E., W.M. Elevation ______ Datum MSL
Drilling Firm Environmental Drilling, Inc. Driller Bruce McCall License # 1712
Drilling Firm Address 10918 159th Ave. SE, Snohomish, WA 98920
Drilling Method 8" Rotary Auger Sampling Method 2" Split Spoon
Casing Type 2" Threaded PVC Screened Interval 10' 30 slot PVC Finish Depth 14'-4"
Packing Material 8-12 Silica Sand Surface Sealant Bentonite Hole Plug
Protector Cap Flush Mount Monument w/J Plug Well Identification Number BP-0397-MW5

	Start	Finish	Water Level Measurements			Development gal.	gal.
Date	12-9-97	12-9-97					
Time	10:35AM	12:00pm					

MW#5



Sample #	Matrix	Blows	Depth (ft.)	Unified Soil Classification	Soils Description
[illegible]	—	[illegible]	2	ML	Brown, sandy, clayey silt (topsoil). No sample retrieved.
			4		
			6	GM	Poorly sorted cobbles and small boulders up to ~6" in diameter. Matrix consists of sandy silt.
2		[illegible]	8		
			10		
3	Soil	[illegible]	12		
			14		
			16		

Bruce D McCall
Driller Signature Date

12-9-97
SAGE Representative Date

Key to Exploration Logs

Sample Description

Classification of soils in this report is based on visual field and laboratory observations which include density/consistency, moisture condition, grain size, and plasticity estimates and should not be construed to imply field nor laboratory testing unless presented herein. Visual-manual classification methods of ASTM D 2488 were used as an identification guide.

Soil descriptions consist of the following:
Density/consistency, moisture, color, minor constituents, MAJOR CONSTITUENT, additional remarks.

Density/Consistency

Soil density/consistency in borings is related primarily to the Standard Penetration Resistance.
Soil density/consistency in test pits is estimated based on visual observation and is presented parenthetically on the test pit logs.

SAND or GRAVEL Density	Standard Penetration Resistance (N) in Blows/Foot	SILT or CLAY Consistency	Standard Penetration Resistance (N) in Blows/Foot	Approximate Shear Strength in TSF
Very loose	0 - 4	Very soft	0 - 2	<0.125
Loose	4 - 10	Soft	2 - 4	0.125 - 0.25
Medium dense	10 - 30	Medium stiff	4 - 8	0.25 - 0.5
Dense	30 - 50	Stiff	8 - 15	0.5 - 1.0
Very dense	>50	Very stiff	15 - 30	1.0 - 2.0
		Hard	>30	>2.0

Moisture

Dry	Little perceptible moisture
Damp	Some perceptible moisture, probably below optimum
Moist	Probably near optimum moisture content
Wet	Much perceptible moisture, probably above optimum

Minor Constituents

	Estimated Percentage
Not identified in description	0 - 5
Slightly (clayey, silty, etc.)	5 - 12
Clayey, silty, sandy, gravelly	12 - 30
Very (clayey, silty, etc.)	30 - 50

Legends

Sampling Test Symbols

BORING SAMPLES

☒	Split Spoon
⧅	Shelby Tube
▥	Cuttings
◫	Core Run
*	No Sample Recovery
P	Tube Pushed, Not Driven

TEST PIT SAMPLES

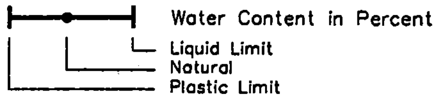
☒	Grab (Jar)
⧄	Bag
⧅	Shelby Tube

Groundwater Observations

▽	Groundwater Level on Date (ATD) At Time of Drilling

Test Symbols

GS	Grain Size Classification
CN	Consolidation
TUU	Triaxial Unconsolidated Undrained
TCU	Triaxial Consolidated Undrained
TCD	Triaxial Consolidated Drained
QU	Unconfined Compression
DS	Direct Shear
K	Permeability
PP	Pocket Penetrometer Approximate Compressive Strength in TSF
TV	Torvane Approximate Shear Strength in TSF
CBR	California Bearing Ratio
MD	Moisture Density Relationship
AL	Atterberg Limits



PID	Photoionization Detector Reading
CA	Chemical Analysis

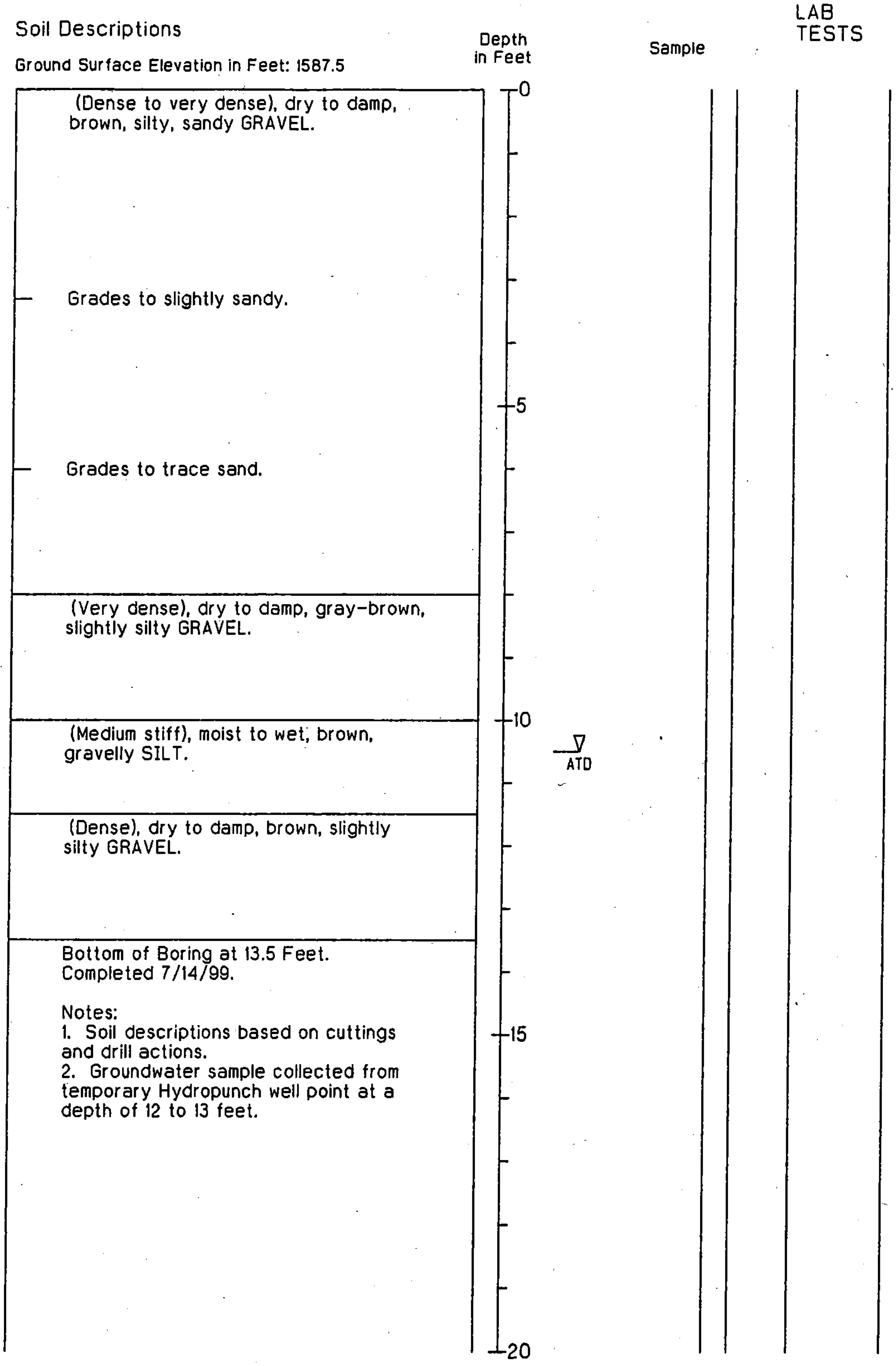
1=1 BORING.DWG

HARTCROWSER

J-7168 11/99

Figure A-1

Boring Log HP-7



(Dense to very dense), dry to damp, brown, silty, sandy GRAVEL.

Grades to slightly sandy.

Grades to trace sand.

(Very dense), dry to damp, gray-brown, slightly silty GRAVEL.

(Medium stiff), moist to wet, brown, gravelly SILT.

(Dense), dry to damp, brown, slightly silty GRAVEL.

Bottom of Boring at 13.5 Feet.
Completed 7/14/99.

Notes:
1. Soil descriptions based on cuttings and drill actions.
2. Groundwater sample collected from temporary Hydropunch well point at a depth of 12 to 13 feet.

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Ground water level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.

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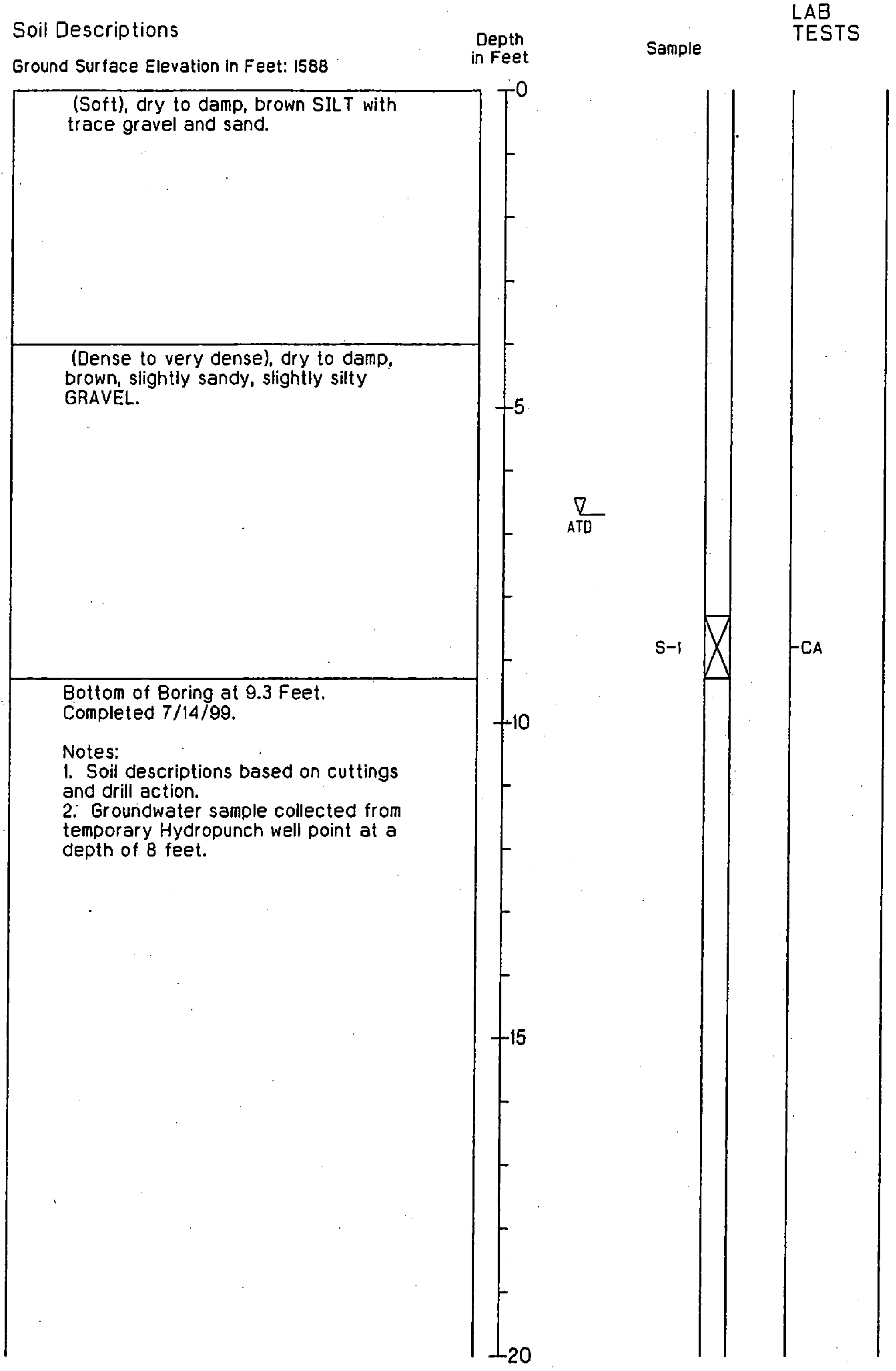
J-7168 **7/99**

Figure A-2

Boring Log HP-8



Soil Descriptions

Ground Surface Elevation in Feet: 1588

(Soft), dry to damp, brown SILT with trace gravel and sand.

(Dense to very dense), dry to damp, brown, slightly sandy, slightly silty GRAVEL.

Bottom of Boring at 9.3 Feet.
Completed 7/14/99.

Notes:
1. Soil descriptions based on cuttings and drill action.
2. Groundwater sample collected from temporary Hydropunch well point at a depth of 8 feet.

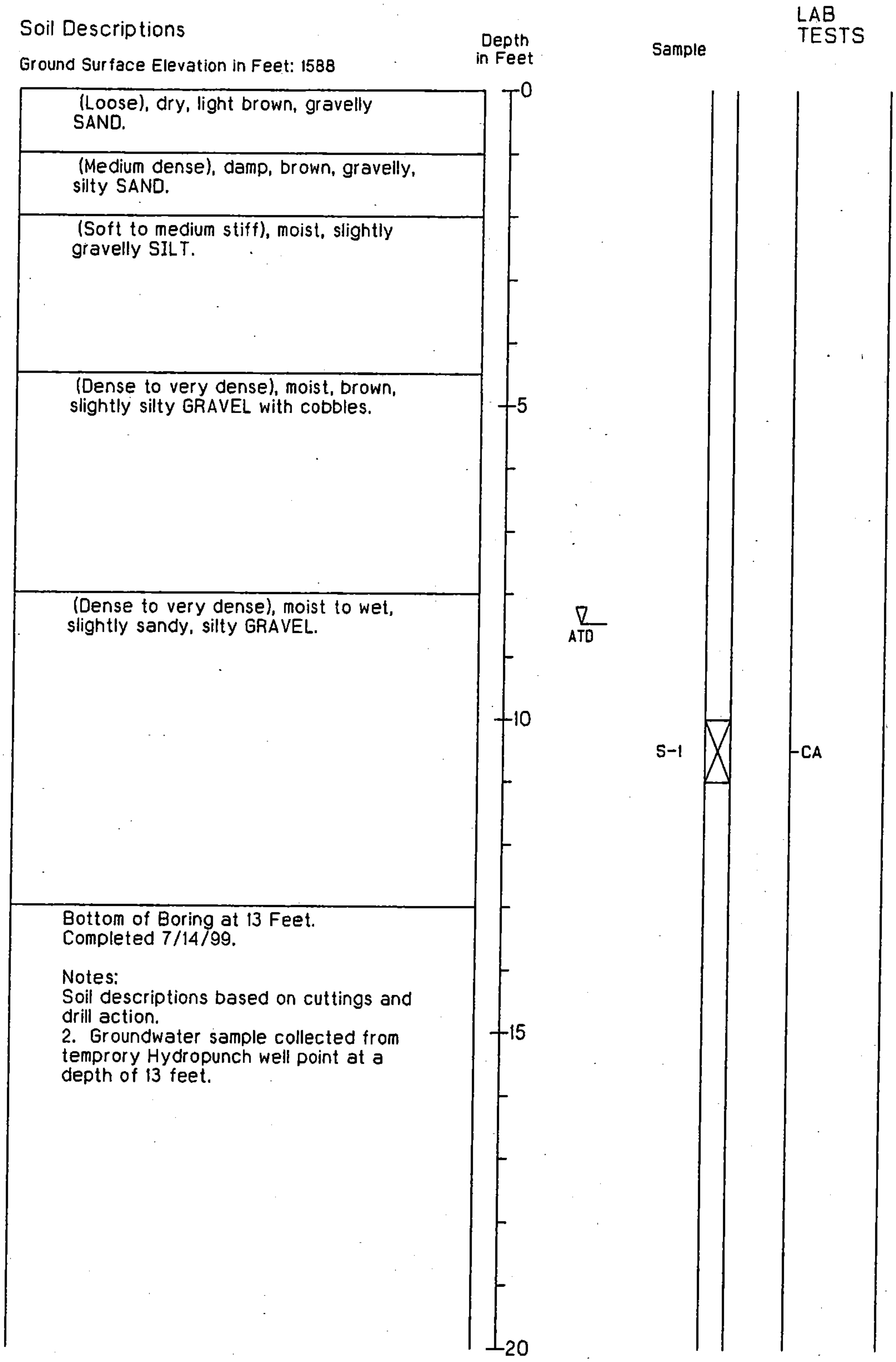
1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Ground water level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.

HARTCROWSER

J-7188 **8/99**

Figure A-3

Boring Log HP-9



Soil Descriptions

Ground Surface Elevation in Feet: 1588

(Loose), dry, light brown, gravelly SAND.

(Medium dense), damp, brown, gravelly, silty SAND.

(Soft to medium stiff), moist, slightly gravelly SILT.

(Dense to very dense), moist, brown, slightly silty GRAVEL with cobbles.

(Dense to very dense), moist to wet, slightly sandy, silty GRAVEL.

Bottom of Boring at 13 Feet.
Completed 7/14/99.

Notes:
Soil descriptions based on cuttings and drill action.
2. Groundwater sample collected from temprory Hydropunch well point at a depth of 13 feet.

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Ground water level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.

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J-7168 **7/99**

Figure A-4

Boring Log HP-10

LAB TESTS

Soil Descriptions

Ground Surface Elevation in Feet: 1587

Depth in Feet

Sample

0

4 inches of Asphalt over 6 inches of Concrete over (medium stiff), moist to wet, gravelly, sandy SILT.

(Dense), damp, brown, silty GRAVEL.

5

(Soft), moist, sandy SILT.

(Dense), damp, brown, silty GRAVEL.

(Dense to very dense), dry to damp, slightly silty GRAVEL with cobbles.

▽ ATD

10

(Dense), damp to moist, silty, sandy GRAVEL.

15

Bottom of Boring at 16 Feet.
Completed 7/14/99.

Notes:
1. Soil descriptions based on cuttings and drill action.
2. Groundwater sample collected from temporary Hydropunch well point at a depth of 14 feet.

20

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Ground water level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.

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J-7168 **7/99**

Figure A-5

Boring Log HP-11

Soil Descriptions

Ground Surface Elevation in Feet: 1508

Depth in Feet

Sample

LAB TESTS

0

3 inches of Concrete over (stiff), moist, brown, very gravelly SILT.

(Dense), damp, brown, slightly silty, slighty sandy GRAVEL.

5

(Stiff), moist, brown, gravelly SILT.

(Dense), dry to damp, brown, silty GRAVEL.

(Dense), damp, brown, slightly silty, slightly sandy GRAVEL.

▽ ATD

10

(Dense), wet, brown, very silty GRAVEL.

(Dense), dry, brown, slightly silty GRAVEL with cobbles.

15

Bottom of Boring at 16 Feet.
Completed 7/14/99.

Notes:
1. Soil descriptions based on cuttings and drill action.
2. Groundwater sample collected from temporary Hydropunch well point at a depth of 15 feet.

20

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Ground water level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.

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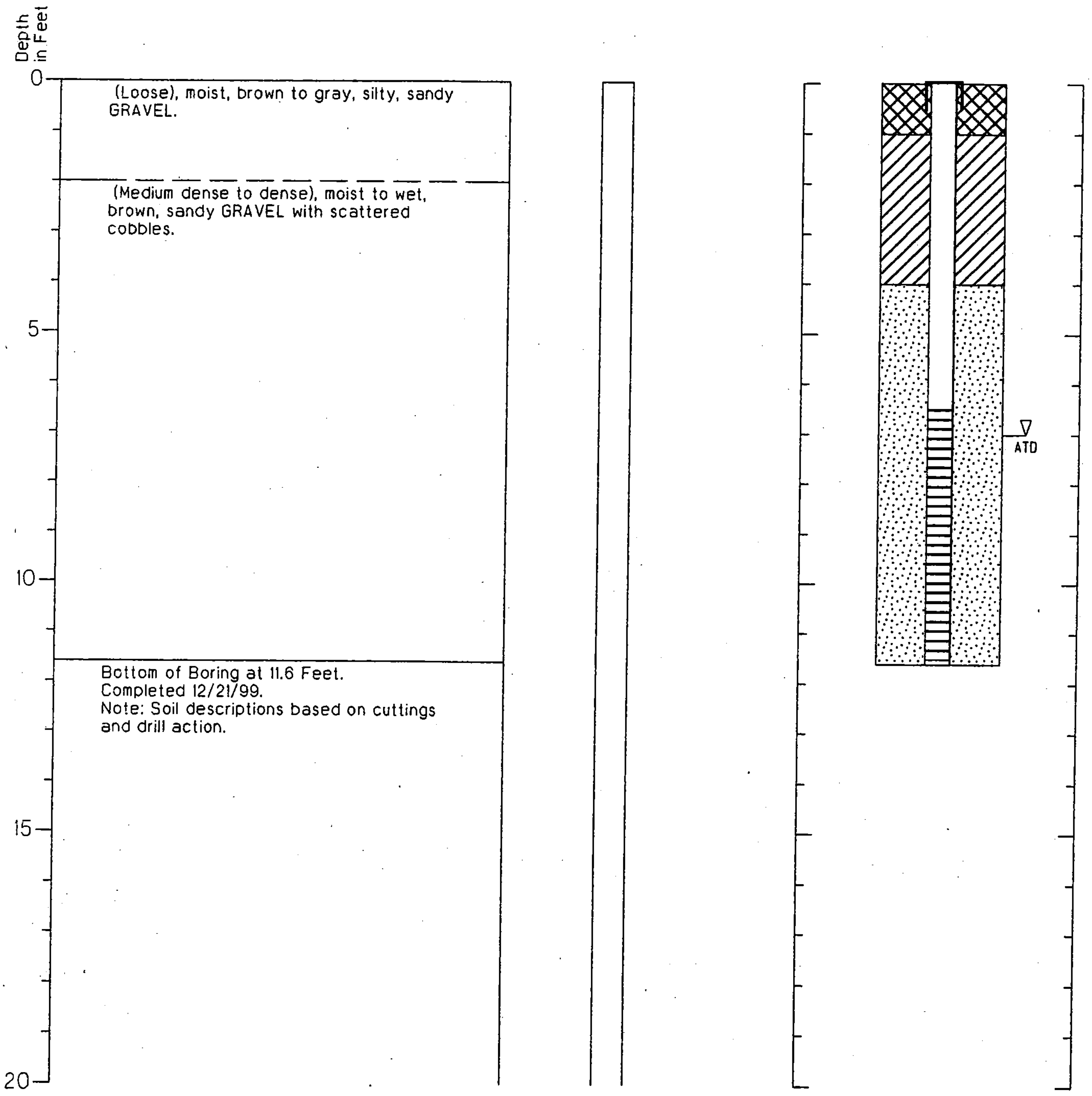
J-7168 7/99

Figure A-6

Boring Log and Construction Data for Monitoring Well MW-13

Geologic Log

Monitoring
Well Design
Top of Casing in Feet: 1582.45



(Loose), moist, brown to gray, silty, sandy GRAVEL.

(Medium dense to dense), moist to wet, brown, sandy GRAVEL with scattered cobbles.

Bottom of Boring at 11.6 Feet.
Completed 12/21/99.
Note: Soil descriptions based on cuttings and drill action.

1. Refer to Figure C-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Ground water level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.

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J-7188 **12/99**
Figure A-3

Key to Exploration Logs

Sample Description

Classification of soils in this report is based on visual field and laboratory observations which include density/consistency, moisture condition, grain size, and plasticity estimates and should not be construed to imply field nor laboratory testing unless presented herein. Visual-manual classification methods of ASTM D 2488 were used as an identification guide.

Soil descriptions consist of the following:
Density/consistency, moisture, color, minor constituents, MAJOR CONSTITUENT, additional remarks.

Density/Consistency

Soil density/consistency in borings is related primarily to the Standard Penetration Resistance.
Soil density/consistency in test pits is estimated based on visual observation and is presented parenthetically on the test pit logs.

SAND or GRAVEL Density	Standard Penetration Resistance (N) in Blows/Foot	SILT or CLAY Consistency	Standard Penetration Resistance (N) in Blows/Foot	Approximate Shear Strength in TSF
Very loose	0 - 4	Very soft	0 - 2	<0.125
Loose	4 - 10	Soft	2 - 4	0.125 - 0.25
Medium dense	10 - 30	Medium stiff	4 - 8	0.25 - 0.5
Dense	30 - 50	Stiff	8 - 15	0.5 - 1.0
Very dense	>50	Very stiff	15 - 30	1.0 - 2.0
		Hard	>30	>2.0

Moisture

Dry	Little perceptible moisture
Damp	Some perceptible moisture, probably below optimum
Moist	Probably near optimum moisture content
Wet	Much perceptible moisture, probably above optimum

Minor Constituents

	Estimated Percentage
Not identified in description	0 - 5
Slightly (clayey, silty, etc.)	5 - 12
Clayey, silty, sandy, gravelly	12 - 30
Very (clayey, silty, etc.)	30 - 50

Legends

Sampling Test Symbols

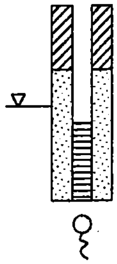
BORING SAMPLES

☒	Split Spoon
⧅	Shelby Tube
▥	Cuttings
◫	Core Run
*	No Sample Recovery
P	Tube Pushed, Not Driven

TEST PIT SAMPLES

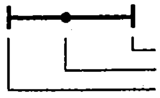
☒	Grab (Jar)
⧄	Bag
⧅	Shelby Tube

Groundwater Observations



Test Symbols

GS	Grain Size Classification
CN	Consolidation
UU	Unconsolidated Undrained Triaxial
CU	Consolidated Undrained Triaxial
CD	Consolidated Drained Triaxial
QU	Unconfined Compression
DS	Direct Shear
K	Permeability
PP	Pocket Penetrometer Approximate Compressive Strength in TSF
TV	Torvane Approximate Shear Strength in TSF
CBR	California Bearing Ratio
MD	Moisture Density Relationship
AL	Atterberg Limits



PID	Photoionization Detector Reading
CA	Chemical Analysis
DT	*In Situ* Density Test

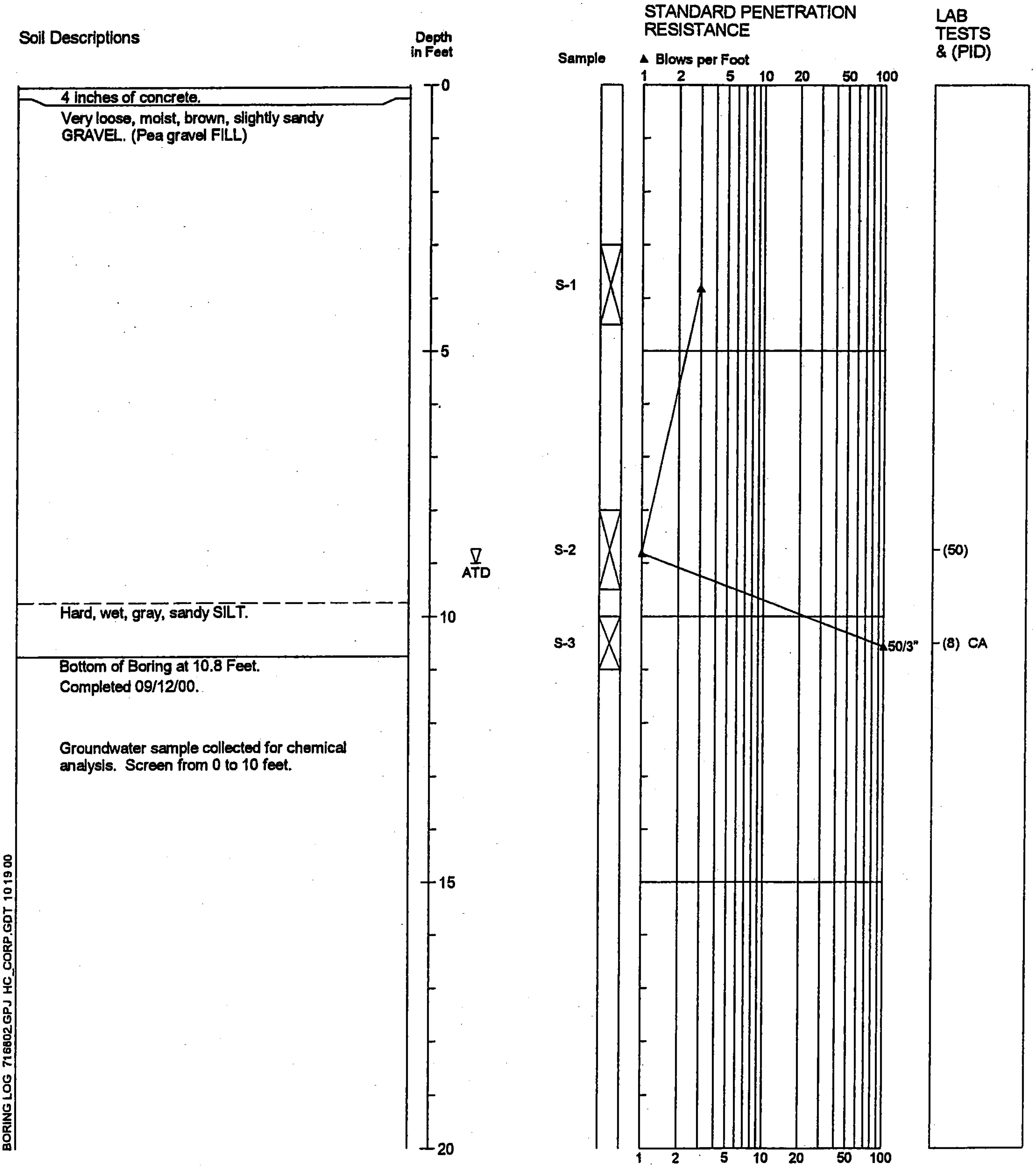
1=1 BORING1.DWG

HARTCROWSER

J-7168-02 **10/00**

Figure A-1 **1/2**

Boring Log HP-13



4 inches of concrete.

Very loose, moist, brown, slightly sandy GRAVEL. (Pea gravel FILL)

Hard, wet, gray, sandy SILT.

Bottom of Boring at 10.8 Feet.
Completed 09/12/00.

Groundwater sample collected for chemical analysis. Screen from 0 to 10 feet.

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Groundwater level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.

HARTCROWSER

J-7168-02 *09/00*

Figure A-3

Boring Log HP-14

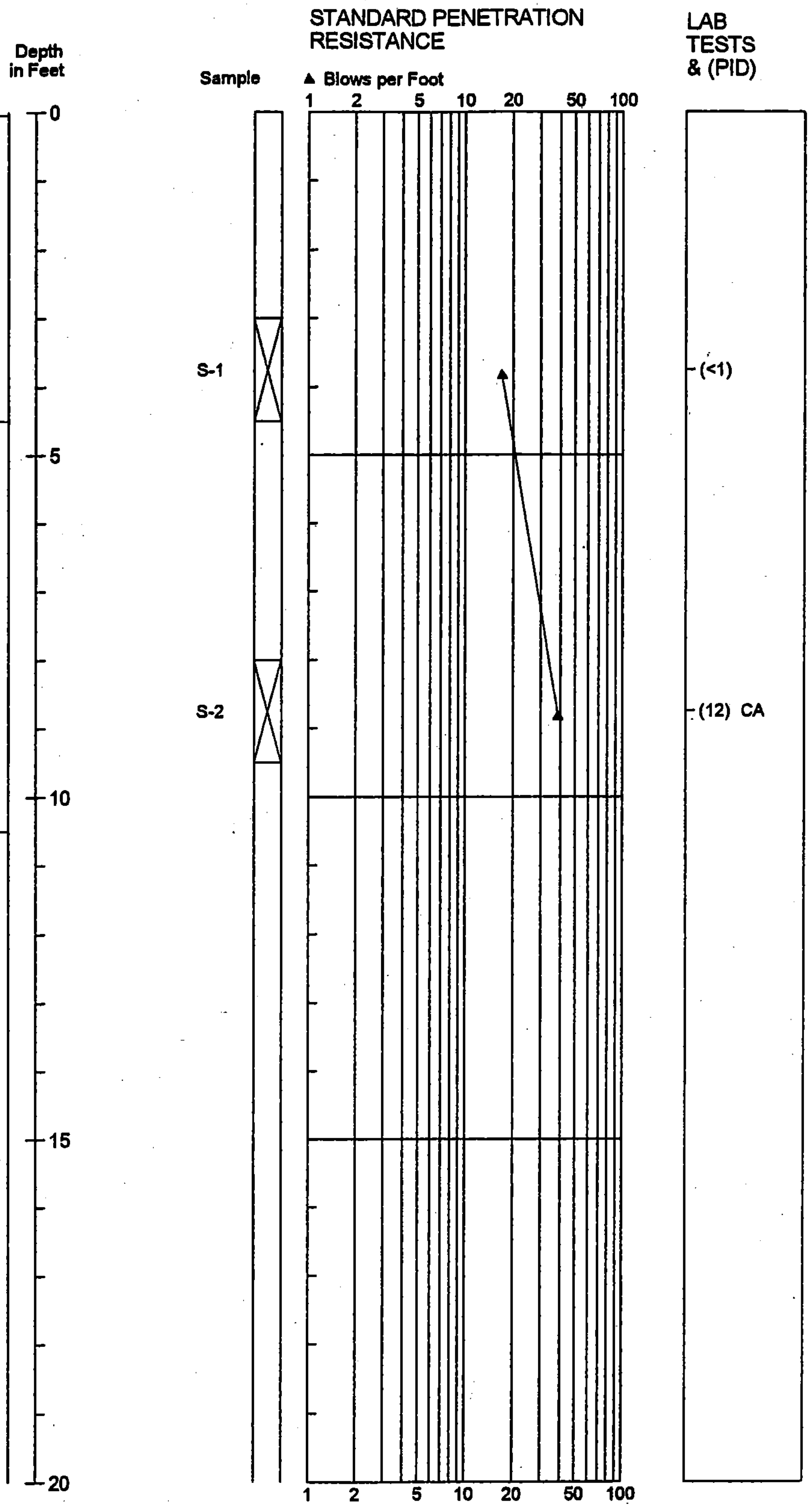
Soil Descriptions

Medium stiff, moist, brown, slightly sandy SILT.

Medium dense, wet, gray-brown, silty, gravelly SAND. Slight petroleum hydrocarbon-like odor.

Bottom of Boring at 10.5 Feet.
Completed 09/12/00.

Groundwater sample collected for chemical analysis. Screen from 0.5 to 10.5 feet.



BORING LOG 716802.GPJ HC_CORP.GDT 10 19 00

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Groundwater level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.

HARTCROWSER

J-7168-02 *09/00*

Figure A-4

Boring Log HP-15

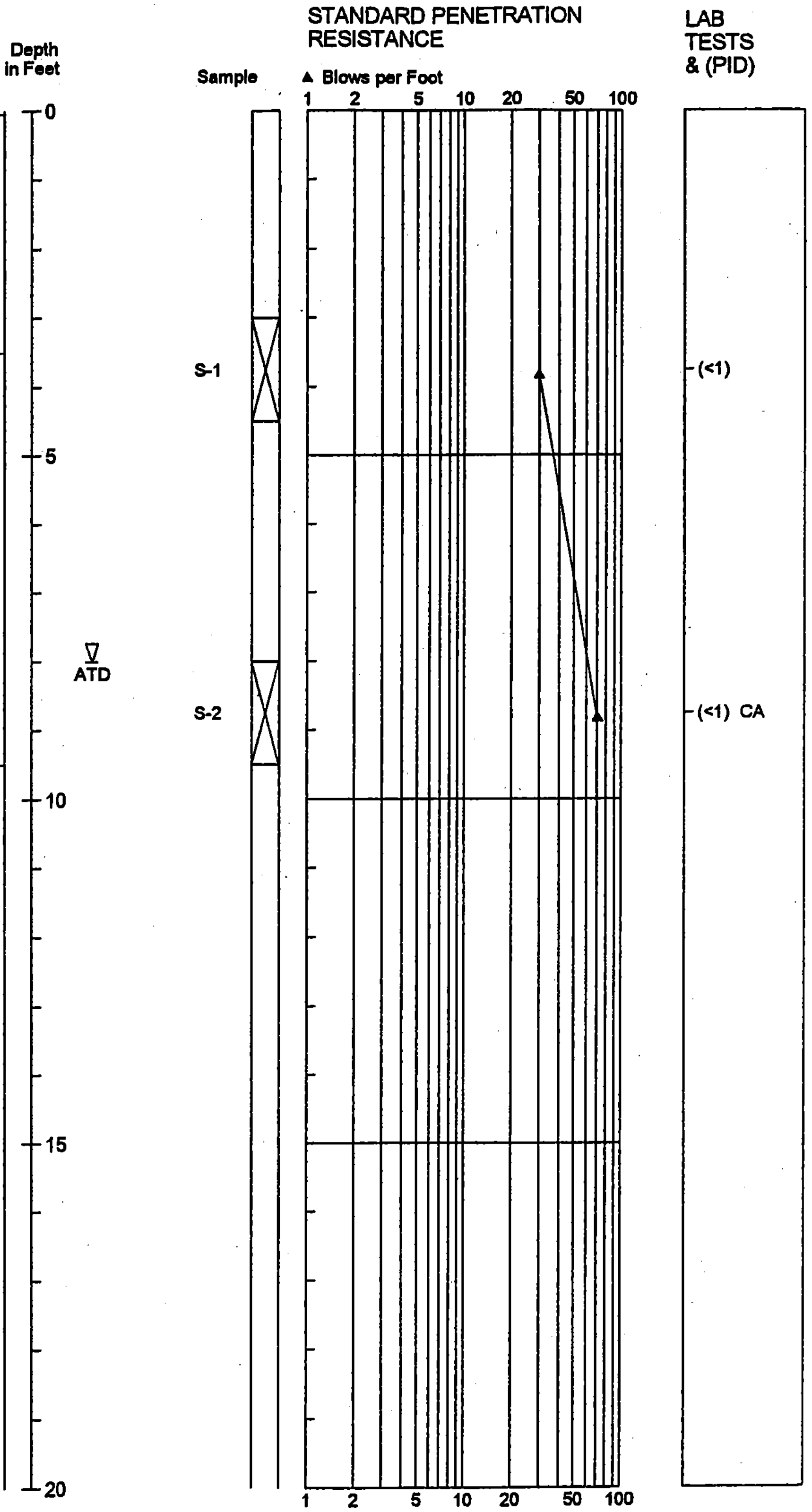
Soil Descriptions

Very stiff, moist, brown, slightly sandy SILT. (FILL)

Medium dense, moist to wet, gray-brown, silty, sandy GRAVEL.

Bottom of Boring at 9.5 Feet.
Completed 09/12/00.

Groundwater sample collected for chemical analysis. Screen from 0 to 9.5 feet.



1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Groundwater level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.

HARTCROWSER

J-7168-02 09/00

Figure A-5

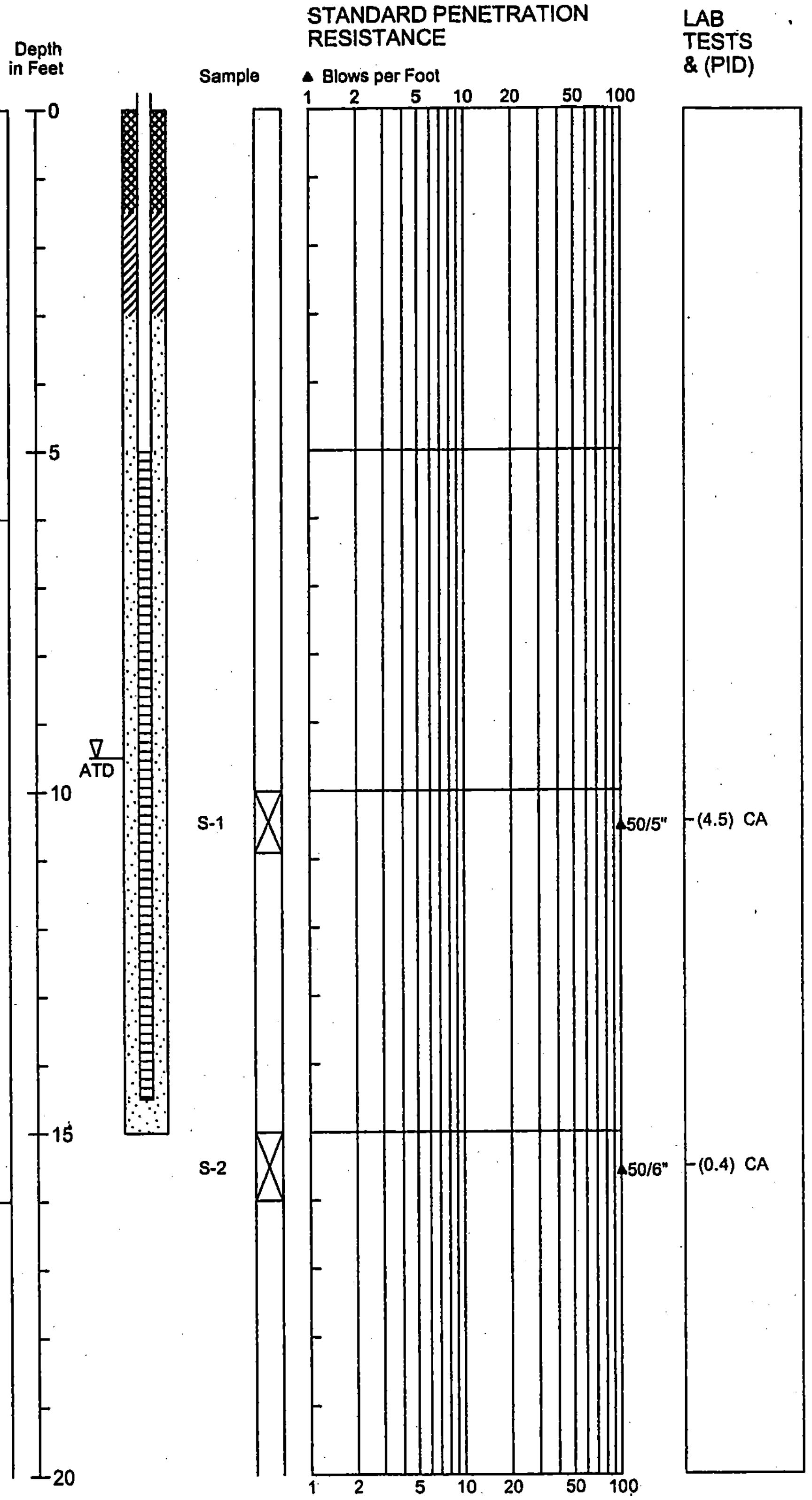
Monitoring Well Log MW-14

Soil Descriptions

Moist, brown, sandy GRAVEL. (FILL)
Observed from cuttings.

Very dense, wet, brown, silty, very gravelly SAND.

Bottom of Boring at 16.0 Feet.
Completed 01/26/01.



BORING LOG 716802MW.GPJ HC_CORP.GDT 3/4/02

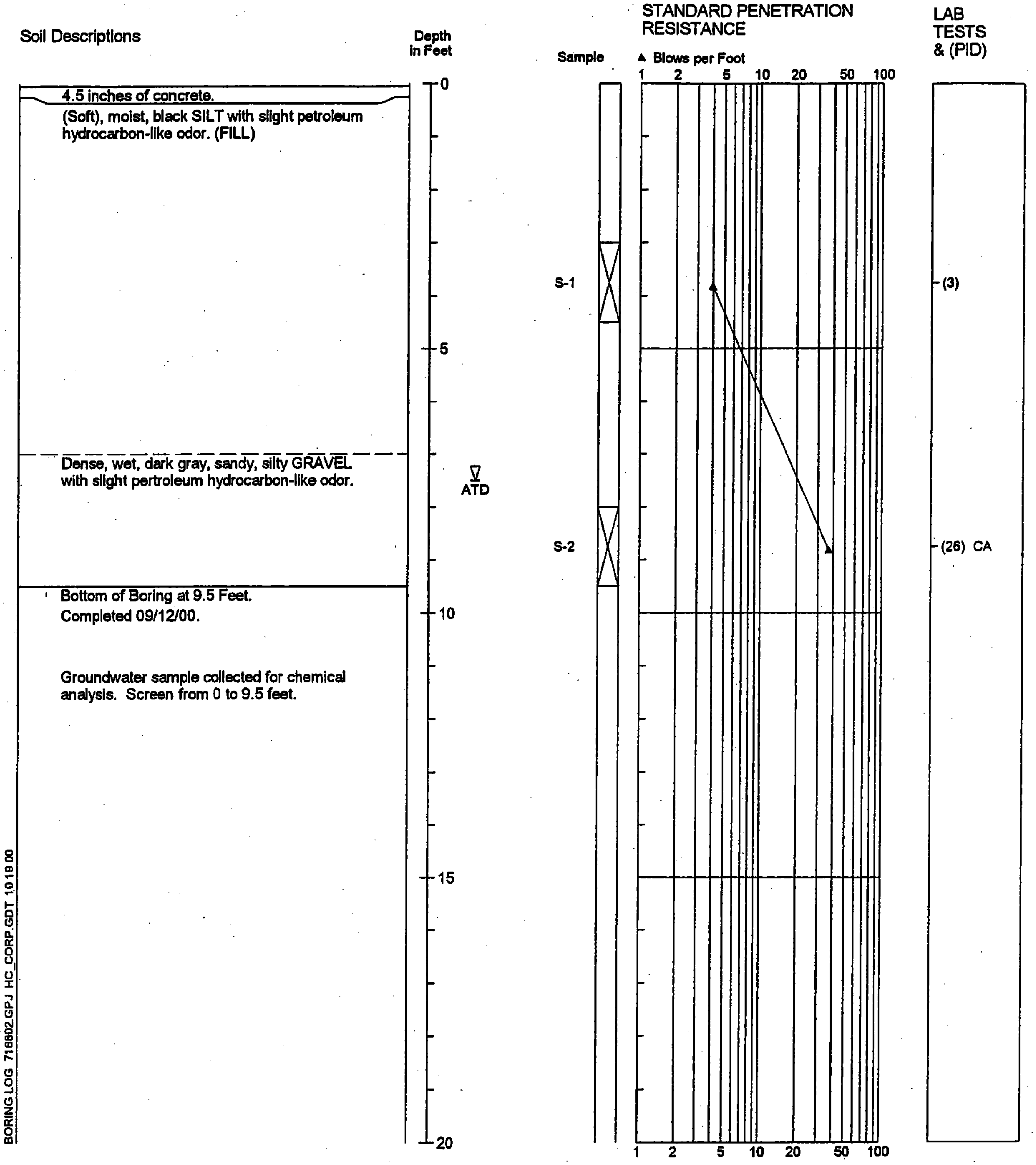
1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Groundwater level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.

HARTCROWSER

7168-02 01/01

Figure A-2

Boring Log HP-16



4.5 inches of concrete.

(Soft), moist, black SILT with slight petroleum hydrocarbon-like odor. (FILL)

Dense, wet, dark gray, sandy, silty GRAVEL with slight petroleum hydrocarbon-like odor.

Bottom of Boring at 9.5 Feet.
Completed 09/12/00.

Groundwater sample collected for chemical analysis. Screen from 0 to 9.5 feet.

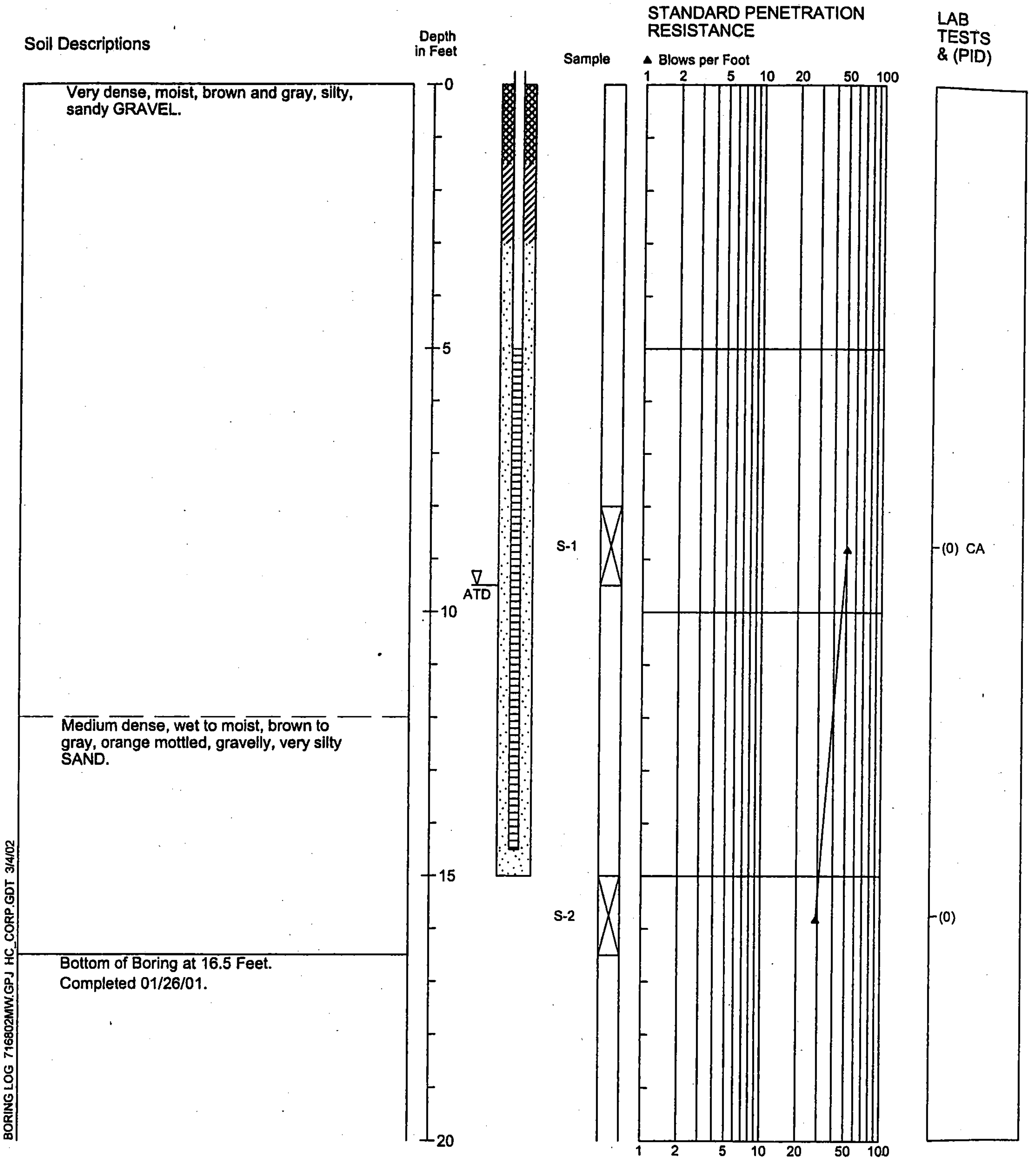
BORING LOG 716802.GPJ HC_CORP.GDT 10/19/00

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Groundwater level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.

HARTCROWSER

J-7168-02 *09/00*
Figure A-6

Monitoring Well Log MW-15



Very dense, moist, brown and gray, silty, sandy GRAVEL.

Medium dense, wet to moist, brown to gray, orange mottled, gravelly, very silty SAND.

Bottom of Boring at 16.5 Feet.
Completed 01/26/01.

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Groundwater level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.

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7168-02 01/01

Figure A-3

Key to Exploration Logs

Sample Description

Classification of soils in this report is based on visual field and laboratory observations which include density/consistency, moisture condition, grain size, and plasticity estimates and should not be construed to imply field nor laboratory testing unless presented herein. Visual-manual classification methods of ASTM D 2488 were used as an identification guide.

Soil descriptions consist of the following:
Density/consistency, moisture, color, minor constituents, MAJOR CONSTITUENT, additional remarks.

Density/Consistency

Soil density/consistency in borings is related primarily to the Standard Penetration Resistance. Soil density/consistency in test pits is estimated based on visual observation and is presented parenthetically on the test pit logs.

SAND or GRAVEL Density	Standard Penetration Resistance (N) in Blows/Foot	SILT or CLAY Consistency	Standard Penetration Resistance(N) in Blows/Foot	Approximate Shear Strength in TSF
Very loose	0 - 4	Very soft	0 - 2	<0.125
Loose	4 - 10	Soft	2 - 4	0.125 - 0.25
Medium dense	10 - 30	Medium stiff	4 - 8	0.25 - 0.5
Dense	30 - 50	Stiff	8 - 15	0.5 - 1.0
Very dense	>50	Very stiff	15 - 30	1.0 - 2.0
		Hard	>30	>2.0

Moisture

Dry	Little perceptible moisture
Damp	Some perceptible moisture, probably below optimum
Moist	Probably near optimum moisture content
Wet	Much perceptible moisture, probably above optimum

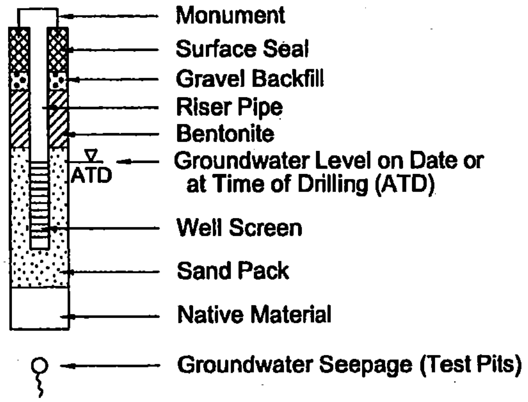
Minor Constituents	Estimated Percentage
Not identified in description	0 - 5
Slightly (clayey, silty, etc.)	5 - 12
Clayey, silty, sandy, gravelly	12 - 30
Very (clayey, silty, etc.)	30 - 50

Legends

Sampling Test Symbols

Boring Samples		Test Pit Samples	
☒	Split Spoon	☒	Grab (Jar)
⧅	Shelby Tube	⧄	Bag
▥	Cuttings	⧅	Shelby Tube
◫	Core Run		
*	No Sample Recovery		
P	Tube Pushed, Not Driven		

Groundwater Observation Wells



Test Symbols

GS	Grain Size Classification
CN	Consolidation
UU	Unconsolidated Undrained Triaxial
CU	Consolidated Undrained Triaxial
CD	Consolidated Drained Triaxial
QU	Unconfined Compression
DS	Direct Shear
K	Permeability
PP	Pocket Penetrometer Approximate Compressive Strength in TSF
TV	Torvane Approximate Shear Strength in TSF
CBR	California Bearing Ratio
MD	Moisture Density Relationship
AL	Atterberg Limits

PID	Photoionization Detector Reading
CA	Chemical Analysis

716804-002.DWG (SRF A-1 STANDARD (2005).DWG) ABJ 4/06/05

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7168-04 *4/05*

Figure A-1

Strataprobe Log HCSP-04-01

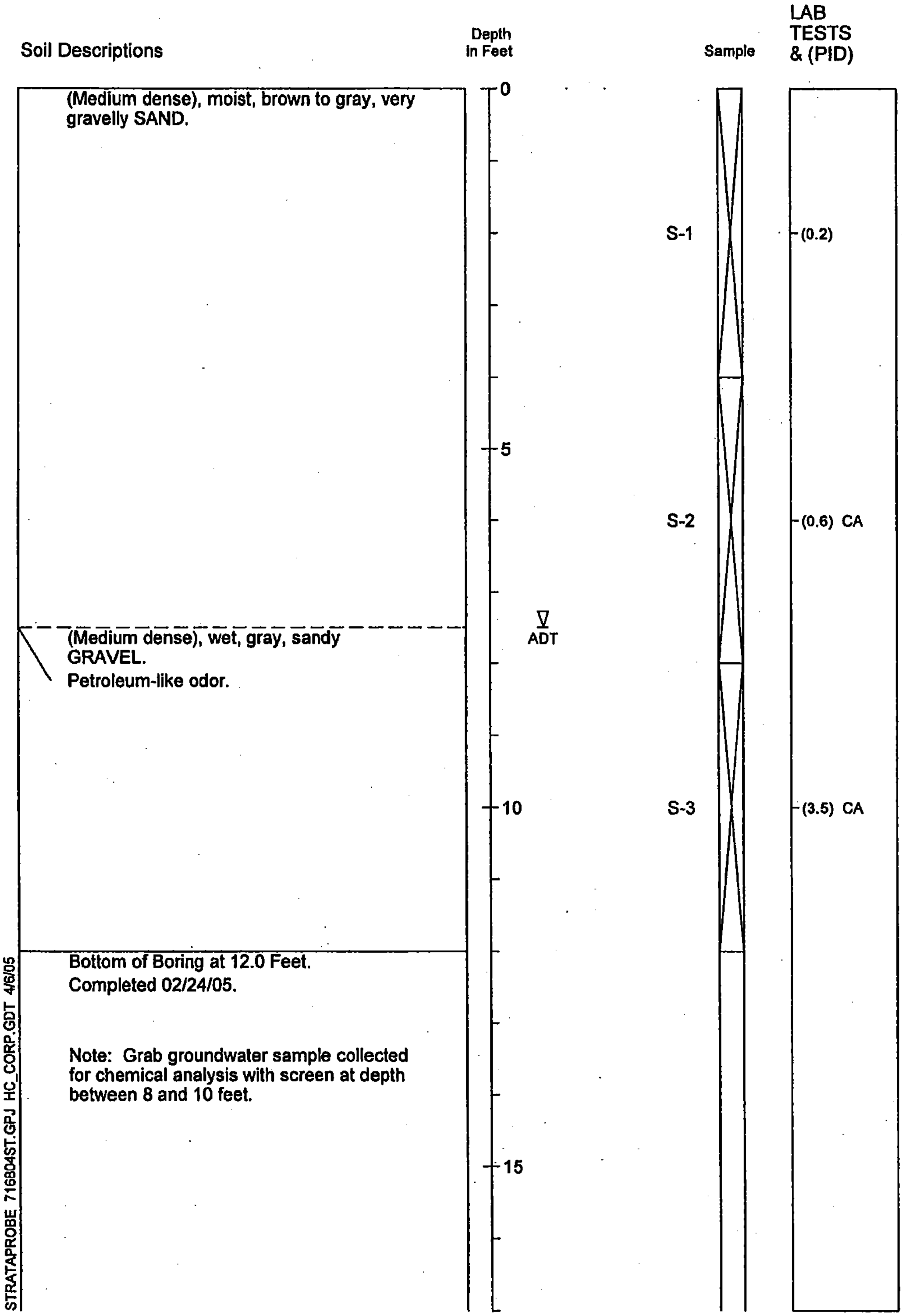
Soil Descriptions	Depth in Feet	Sample	LAB TESTS & (PID)
(Medium dense), dry, brown, slightly silty, gravelly SAND.	0		
		S-1	(1.9)
(Medium stiff to very stiff), moist, gray, sandy SILT.			
		S-2	(2.6)
	5	S-3	(1.4)
(Medium dense to very dense), dry to moist, gray, very gravelly SAND.			
		S-4	(9.5) CA
Petroleum-like odor.	∇ ATD		
		S-5	(150) CA
	10		
		S-6	(<0.1)
Bottom of Boring at 12.0 Feet. Completed 02/24/05.			
	15		

Note: Grab groundwater sample collected for chemical analysis with screen at depth between 6 and 10 feet.

STRATAPROBE 716804ST.GPJ HC_CORP.GDT 4/6/05

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Groundwater level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.

Strataprobe Log HCSP-04-02



(Medium dense), moist, brown to gray, very gravelly SAND.

(Medium dense), wet, gray, sandy GRAVEL.
Petroleum-like odor.

Bottom of Boring at 12.0 Feet.
Completed 02/24/05.

Note: Grab groundwater sample collected for chemical analysis with screen at depth between 8 and 10 feet.

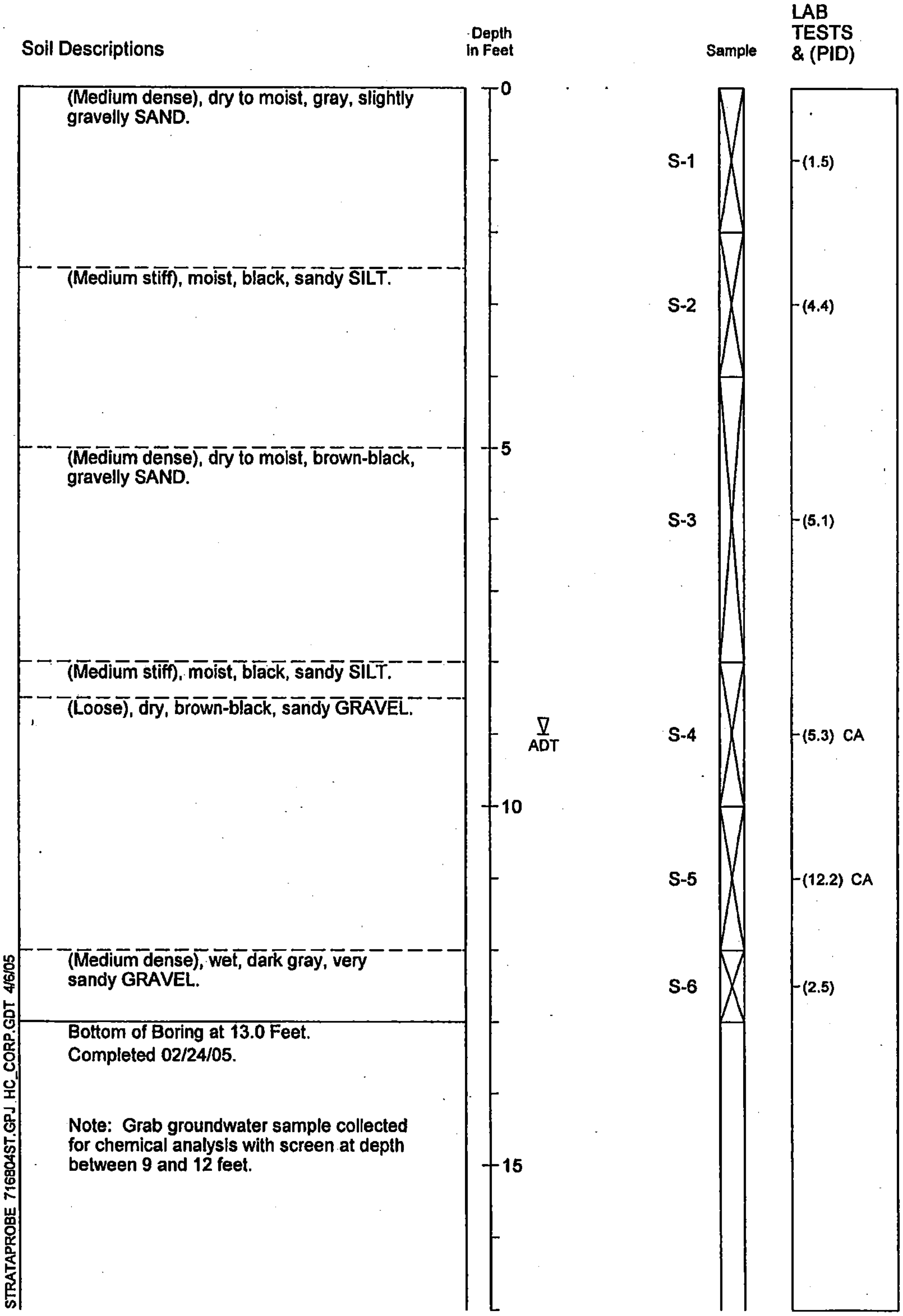
1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Groundwater level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.

HARTCROWSER

7168-04 *02/05*

Figure A-3

Strataprobe Log HCSP-04-03



(Medium dense), dry to moist, gray, slightly gravelly SAND.

(Medium stiff), moist, black, sandy SILT.

(Medium dense), dry to moist, brown-black, gravelly SAND.

(Medium stiff), moist, black, sandy SILT.

(Loose), dry, brown-black, sandy GRAVEL.

(Medium dense), wet, dark gray, very sandy GRAVEL.

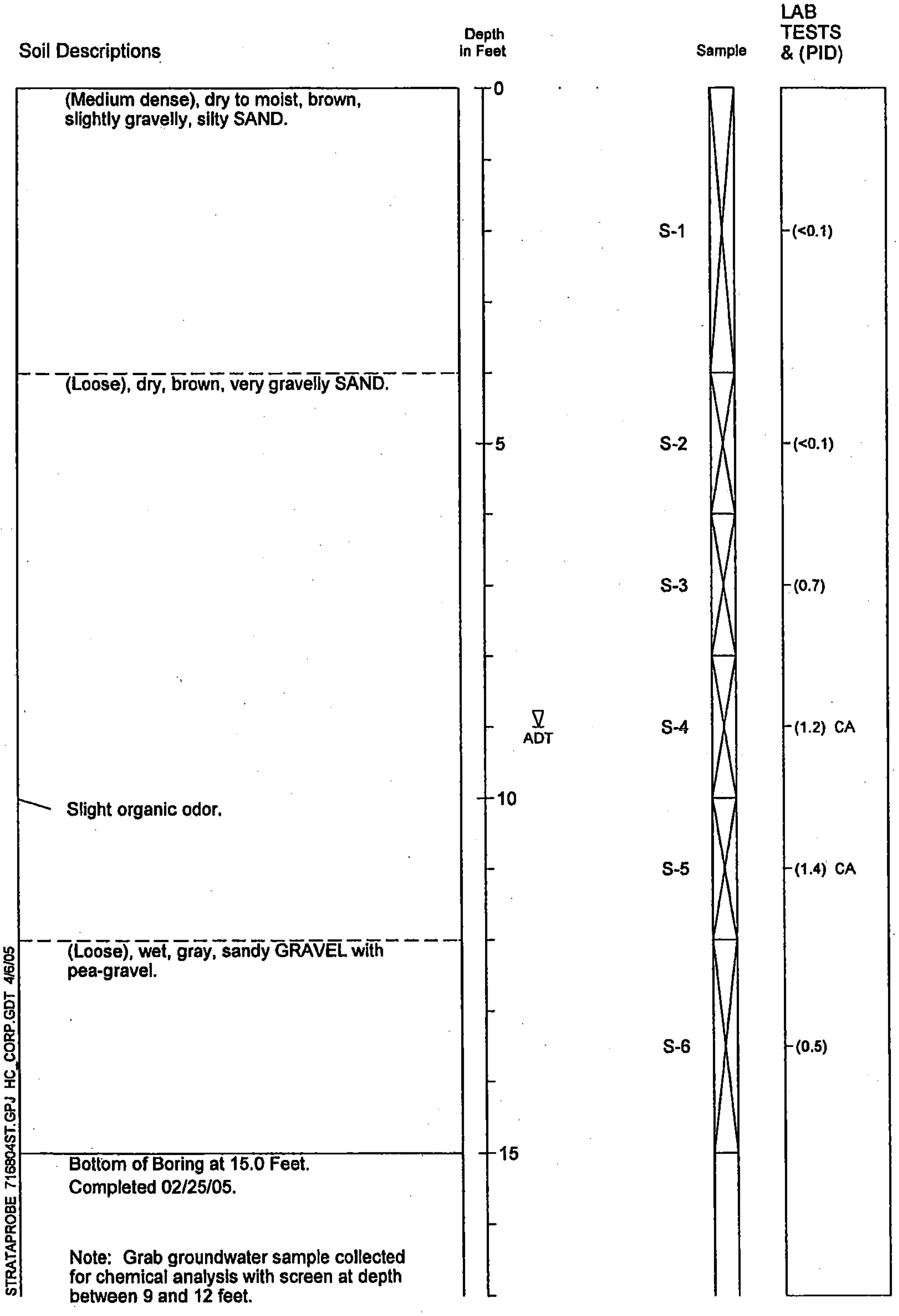
Bottom of Boring at 13.0 Feet.
Completed 02/24/05.

Note: Grab groundwater sample collected for chemical analysis with screen at depth between 9 and 12 feet.

Sample	LAB TESTS & (PID)
S-1	(1.5)
S-2	(4.4)
S-3	(5.1)
S-4	(5.3) CA
S-5	(12.2) CA
S-6	(2.5)

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Groundwater level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.

Strataprobe Log HCSP-04-04



Soil Descriptions

(Medium dense), dry to moist, brown, slightly gravelly, silty SAND.

(Loose), dry, brown, very gravelly SAND.

Slight organic odor.

(Loose), wet, gray, sandy GRAVEL with pea-gravel.

Bottom of Boring at 15.0 Feet.
Completed 02/25/05.

Note: Grab groundwater sample collected for chemical analysis with screen at depth between 9 and 12 feet.

Sample	LAB TESTS & (PID)
S-1	(<0.1)
S-2	(<0.1)
S-3	(0.7)
S-4	(1.2) CA
S-5	(1.4) CA
S-6	(0.5)

STRATAPROBE 716804ST.GPJ HC_CORP.GDT 4/6/05

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Groundwater level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.

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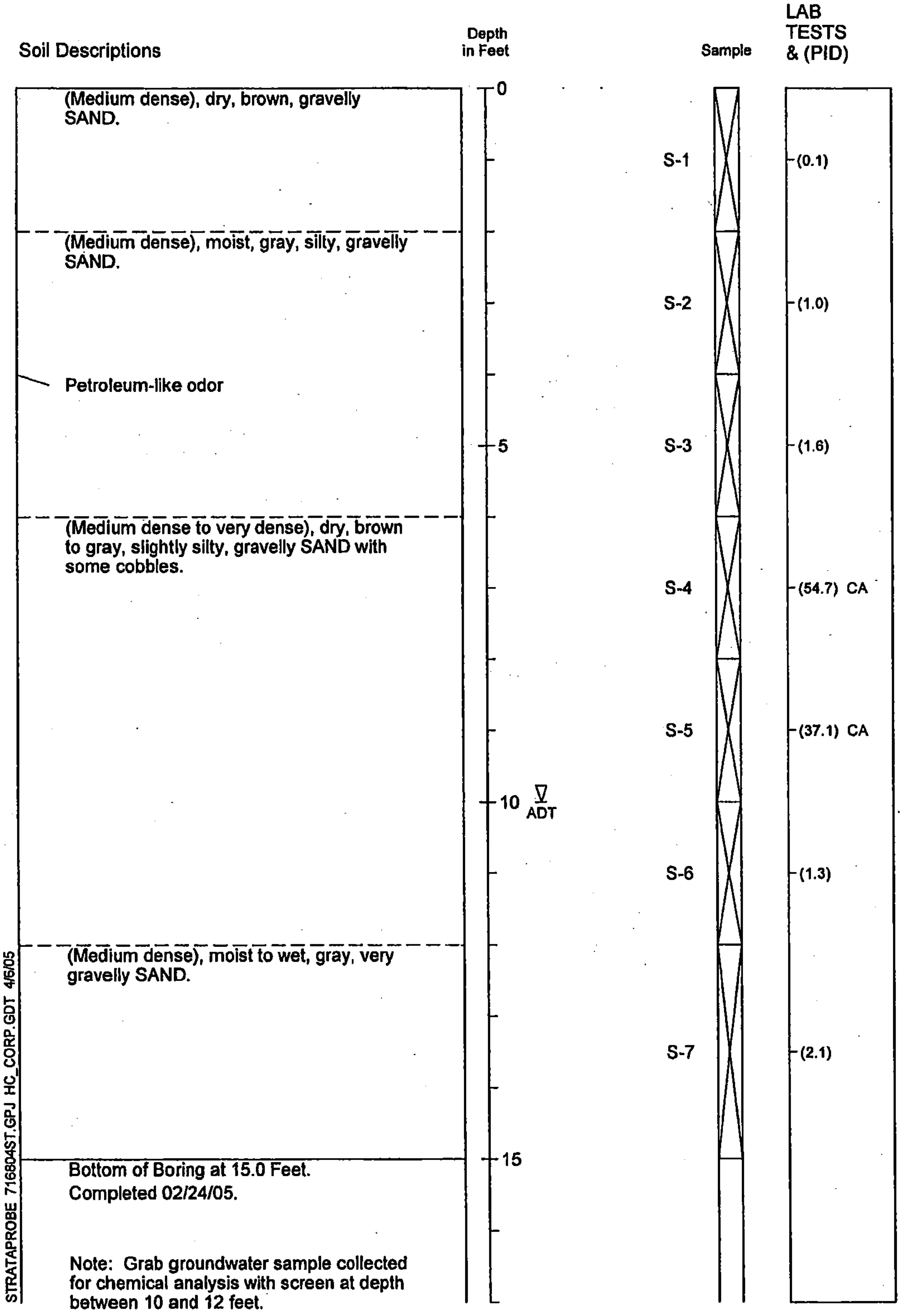
7168-04 02/05

Figure A-5

Strataprobe Log HCSP-04-05



(Medium dense), dry, brown, gravelly SAND.

(Medium dense), moist, gray, silty, gravelly SAND.

Petroleum-like odor

(Medium dense to very dense), dry, brown to gray, slightly silty, gravelly SAND with some cobbles.

(Medium dense), moist to wet, gray, very gravelly SAND.

Bottom of Boring at 15.0 Feet.
Completed 02/24/05.

Note: Grab groundwater sample collected for chemical analysis with screen at depth between 10 and 12 feet.

STRATAPROBE 716804ST.GPJ HC_CORP.GDT 4/6/05

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Groundwater level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.

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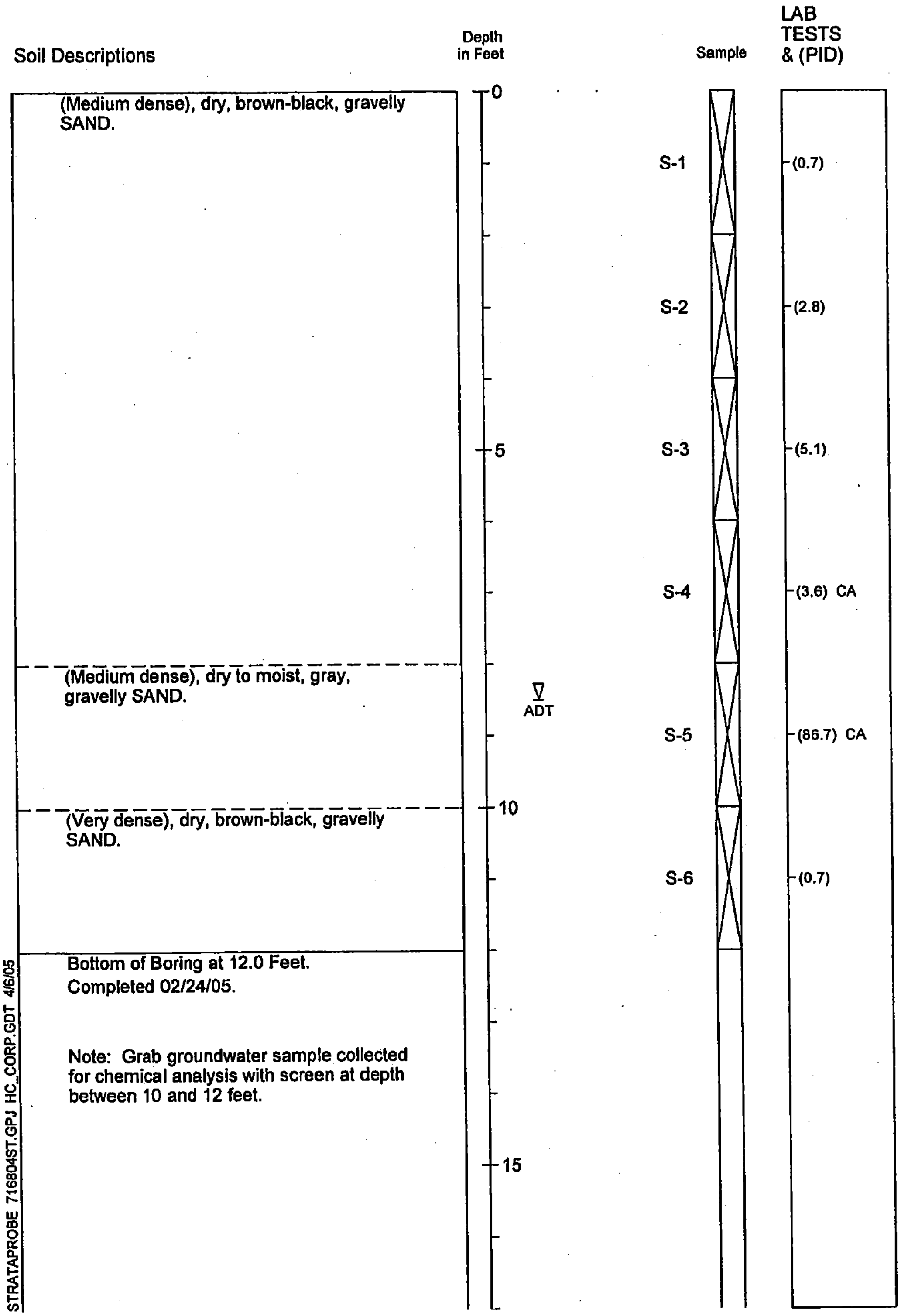
7168-04 *02/05*

Figure A-6

Strataprobe Log HCSP-04-06



(Medium dense), dry, brown-black, gravelly SAND.

(Medium dense), dry to moist, gray, gravelly SAND.

(Very dense), dry, brown-black, gravelly SAND.

Bottom of Boring at 12.0 Feet.
Completed 02/24/05.

Note: Grab groundwater sample collected for chemical analysis with screen at depth between 10 and 12 feet.

STRATAPROBE 716804ST.GPJ HC_CORP.GDT 4/6/05

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Groundwater level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.

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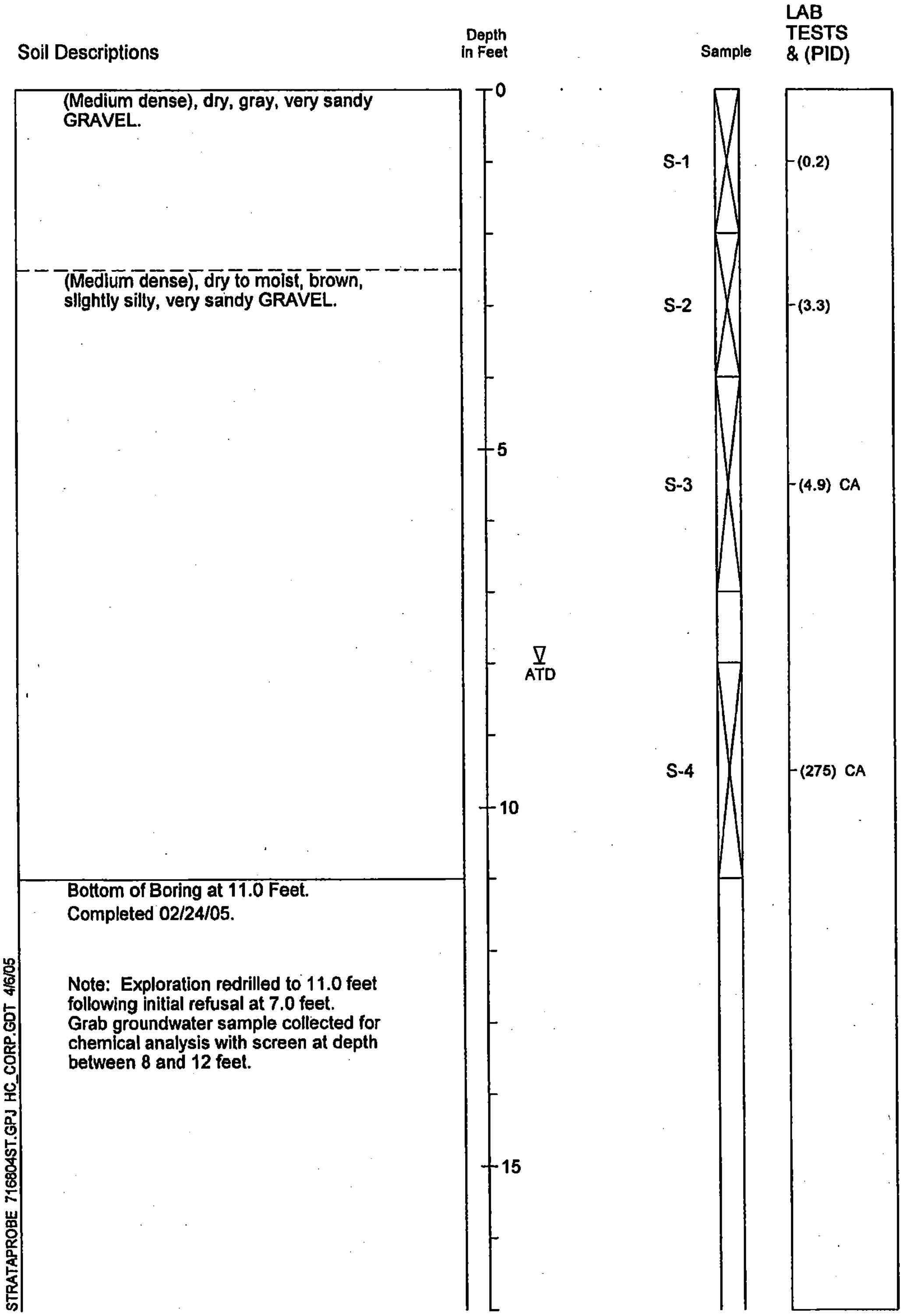
7168-04 *02/05*

Figure A-7

Strataprobe Log HCSP-04-07



(Medium dense), dry, gray, very sandy GRAVEL.

(Medium dense), dry to moist, brown, slightly silty, very sandy GRAVEL.

Bottom of Boring at 11.0 Feet.
Completed 02/24/05.

Note: Exploration redrilled to 11.0 feet following initial refusal at 7.0 feet. Grab groundwater sample collected for chemical analysis with screen at depth between 8 and 12 feet.

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Groundwater level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.

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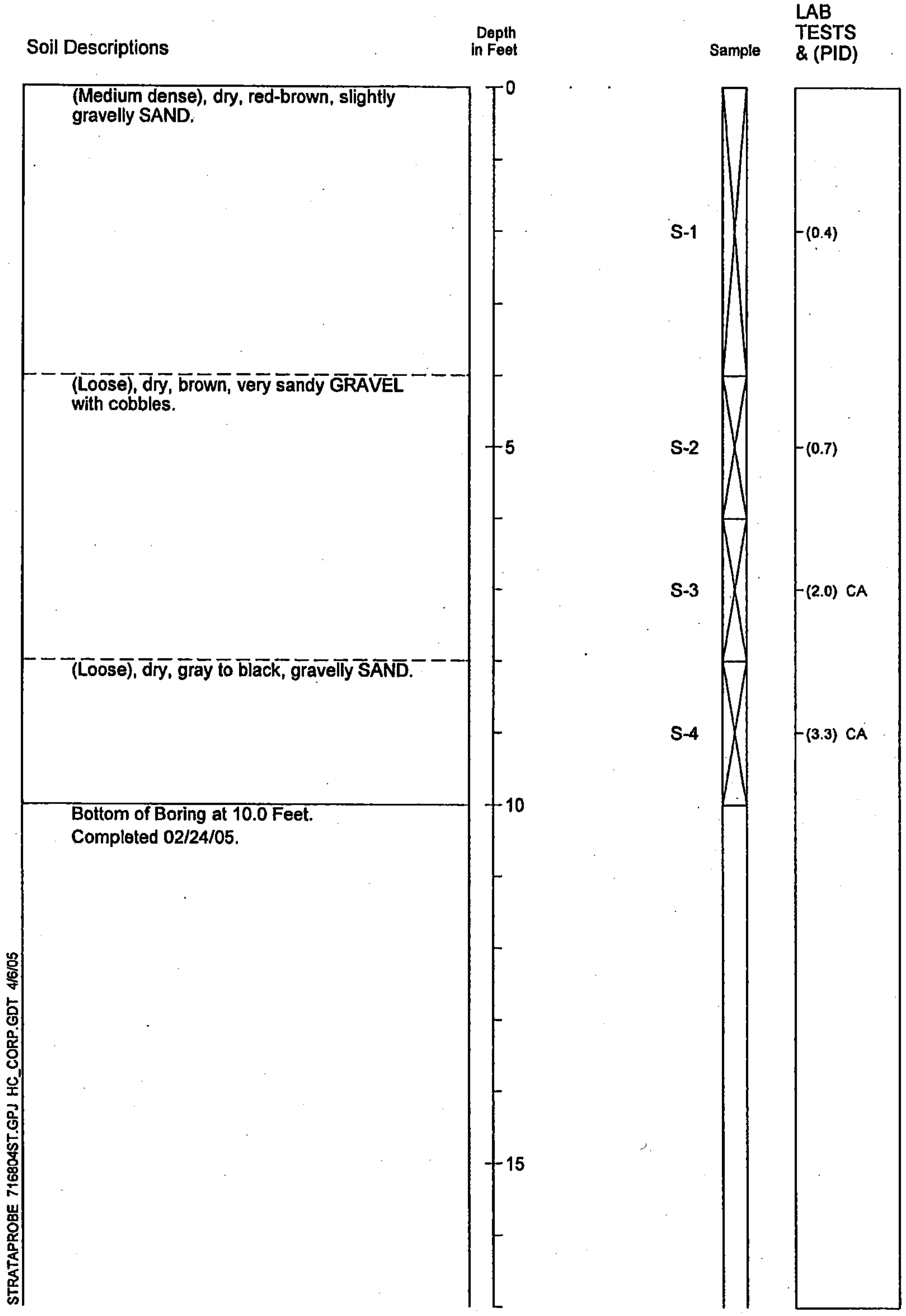
7168-04 02/05
Figure A-8

Strataprobe Log HCSP-04-08



(Medium dense), dry, red-brown, slightly gravelly SAND.

(Loose), dry, brown, very sandy GRAVEL with cobbles.

(Loose), dry, gray to black, gravelly SAND.

Bottom of Boring at 10.0 Feet.
Completed 02/24/05.

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Groundwater level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.

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7168-04 02/05

Figure A-9

Table C-1 - Cost Estimate for Alternative 1 - Monitored Natural Attenuation

Site: Ken's Auto Wash
Location: Ellensburg, Washington
Phase: Feasibility Study (-30% to +50%)
Base Year: 2007

Description: Monitoring of groundwater contaminated with gasoline-range petroleum and BTEX for up to 30-years. Monitoring program assumes twice yearly events (wet season and dry season) at all well locations, or a portion thereof. Also includes monitoring of natural attenuation (NA) parameters every other year.

ANNUAL MONITORING COSTS - ALL WELLS BIANNUALLY

DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL	SOURCE	NOTES
Project management and reporting	1	LS	7,500	$ 7,500	Estimate	
Waste disposal	1	LS	1,000	$ 1,000	Estimate	purge water
Groundwater monitoring	2	Ea	4,500	$ 9,000	Cost File	up to 9 wells, include NA parameters every other year
Estimated Ecology Oversight Costs	1	LS	3,000	$ 3,000	Estimate	Subject to revision by Ecology
Additional Contingency	15%			$ 2,625		10% scope + 5% bid
TOTAL ANNUAL MONITORING COST				$ 23,125		

NFA/ REGULATORY CLOSURE COSTS:

DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL	SOURCE	NOTES
Ecology interaction at 5-year review periods	3	EA	3,000	$ 9,000	Estimate	Ecology requirement
Confirmational groundwater monitoring	4	EA	4,400	$ 17,600	Cost File	confirmational montitoring at 9 wells
Report and Ecology interaction for closure	1	LS	15,000	$ 15,000	Estimate	
Estimated Ecology Oversight Costs	1	LS	3,000	$ 3,000	Estimate	Subject to revision by Ecology
Contingency	15%			$ 4,890		10% scope + 5% bid
TOTALCLOSURE COST				$ 49,490		

PRESENT VALUE ANALYSIS:

COST TYPE	YEAR	TOTAL COST	DISCOUNT RATE	PRESENT VALUE	
Contingency Well Replacement	-	$ 15,000	0%	$ 15,000	Up to 3 wells over project lifetime. Not Discounted.
Annual Operating Cost	1 to 5	$ 115,625	2.6%	$ 107,126	
Annual Operating Cost	6 to10	$ 115,625	2.8%	$ 92,776	
Annual Operating Cost	11 to 15	$ 115,625	3.0%	$ 78,804	
Closure Cost	16	$ 49,490	3.0%	$ 30,841	
		$ 396,365		$ 324,547	
TOTAL PRESENT VALUE OF ALTERNATIVE (15-Year Duration)				$ 324,500	

COST TYPE	YEAR	TOTAL COST	DISCOUNT RATE	PRESENT VALUE	
Contingency Well Replacement	-	$ 15,000	0%	$ 15,000	Up to 3 wells over project lifetime. Not Discounted.
Annual Operating Cost	1 to 5	$ 115,625	2.6%	$ 107,126	
Annual Operating Cost	6 to10	$ 115,625	2.8%	$ 92,776	
Annual Operating Cost	11 to 20	$ 231,250	3.0%	$ 146,781	
Closure Cost	21	$ 49,490	3.0%	$ 26,603	
		$ 511,990		$ 388,287	
TOTAL PRESENT VALUE OF ALTERNATIVE (20-Year Duration)				$ 388,300	

COST TYPE	YEAR	TOTAL COST	DISCOUNT RATE	PRESENT VALUE	
Contingency Well Replacement	-	$ 15,000	0%	$ 15,000	Up to 3 wells over project lifetime. Not Discounted.
Annual Operating Cost	1 to 5	$ 115,625	2.6%	$ 107,126	
Annual Operating Cost	6 to10	$ 115,625	2.8%	$ 92,776	
Annual Operating Cost	11 to 25	$ 346,875	3.0%	$ 205,418	
Closure Cost	26	$ 49,490	3.0%	$ 22,948	
		$ 627,615		$ 443,269	
TOTAL PRESENT VALUE OF ALTERNATIVE (25-Year Duration)				$ 443,300	

COST TYPE	YEAR	TOTAL COST	DISCOUNT RATE	PRESENT VALUE	
Contingency Well Replacement	-	$ 15,000	0%	$ 15,000	Up to 3 wells over project lifetime. Not Discounted.
Annual Operating Cost	1 to 5	$ 115,625	2.6%	$ 107,126	
Annual Operating Cost	6 to10	$ 115,625	2.8%	$ 92,776	
Annual Operating Cost	11 to 30	$ 462,500	3.0%	$ 255,999	
Closure Cost	31	$ 49,490	3.0%	$ 19,795	
		$ 743,240		$ 490,697	
TOTAL PRESENT VALUE OF ALTERNATIVE (30-Year Duration)				$ 490,700	

Notes

Costs are +50/-30% FS-level estimates. They do not represent a bid to do the work.

Table C-3 - Cost Estimate for Alternative 3 - Enhanced Bioremediation

Site: Ken's Auto Wash
Location: Ellensburg, Washington
Phase: Feasibility Study (-30% to +50%)
Base Year: 2007

Description: Active remediation of soil and groundwater contaminated with gasoline-range petroleum and BTEX. ORC injections every 6 months in source area and plume, for nominal 10-year period. Contingency cost provided for 15-year period.

CAPTITAL COSTS

DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL	SOURCE	NOTES
Site Preparation						
Ecology interaction	1	LS	1,500	$ 1,500	Estimate	Review through Voluntary Cleanup Program
Permits, utility check, revised health and safety plan	1	LS	6,000	$ 6,000	Estimate	Interaction with city
Core injection ports in concrete surface	1	LS	2,000	$ 2,000	Cost File plus Additional Estimate	Up to 8 12-inch holes
Install monuments	8	Ea	300	$ 2,400	Estimate	includes labor
Estimated Ecology Oversight Costs	1	LS	3,000	$ 3,000	Estimate	Subject to revision by Ecology
Contingency	15%			$ 660		10% scope + 5% bid
TOTAL CAPITAL COST				$ 15,560		

ANNUAL OPERATING AND MONITORING COSTS

DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL	SOURCE	NOTES
Project management and reporting	1	LS	10,000	$ 10,000	Estimate	Includes monthly monitoring performed by site worker
Groundwater monitoring	2	Ea	4,500	$ 9,000	Cost File	performance monitoring at up to 9 well locations
ORC	750	lbs	10	$ 7,500	Cost File	
Injections and field oversight	2	Ea	7,000	$ 14,000	Cost File	1 field day; includes traffic control
Estimated Ecology Oversight Costs	1	LS	5,000	$ 5,000	Estimate	Subject to revision by Ecology
Contingency	15%			$ 3,975		10% scope + 5% bid
TOTAL ANNUAL OPERATING AND MONITORING COST				$ 49,475		

CLOSURE COSTS:

DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL	SOURCE	NOTES
Ecology interaction at 5-year review periods	1	EA	3,000	$ 3,000	Estimate	Ecology requirement
Groundwater monitoring	4	EA	4,400	$ 17,600	Cost File	9 wells
Report and Ecology interaction	1	LS	15,000	$ 15,000	Estimate	
Estimated Ecology Oversight Costs	1	LS	5,000	$ 5,000	Estimate	Subject to revision by Ecology
Contingency	15%			$ 4,890		10% scope + 5% bid
TOTAL CLOSURE COST				$ 42,490		

PRESENT VALUE ANALYSIS:

COST TYPE	YEAR	TOTAL COST	DISCOUNT RATE	PRESENT VALUE	
Contingency Well Replacement	-	$ 15,000	0%	$ 15,000	Up to 3 wells over project lifetime. Not Discounted.
Capital Cost	0	$ 15,560	0.0%	$ 15,560	Not discounted
Annual Operating and Monitoring Cost	1 to 5	$ 247,375	2.6%	$ 229,192	
Annual Operating and Monitoring Cost	6 to 10	$ 247,375	2.8%	$ 198,492	
Closure Cost	11	$ 42,490	3.0%	$ 26,968	
		$ 552,800		$ 485,212	
TOTAL PRESENT VALUE OF ALTERNATIVE(10-Year Duration)				$ 485,200	

COST TYPE	YEAR	TOTAL COST	DISCOUNT RATE	PRESENT VALUE	
Contingency Well Replacement	-	$ 15,000	0%	$ 15,000	Up to 3 wells over project lifetime. Not Discounted.
Capital Cost	0	$ 15,560	0.0%	15,560	Not discounted
Annual Operating and Monitoring Cost	1 to 5	$ 247,375	2.6%	$ 229,192	
Annual Operating and Monitoring Cost	6 to 10	$ 247,375	2.8%	$ 198,492	
Annual Operating and Monitoring Cost	11 to 15	$ 247,375	3.0%	$ 168,598	
Closure Cost	16	$ 42,490	3.0%	$ 26,478	
		$ 800,175		$ 653,320	
TOTAL PRESENT VALUE OF ALTERNATIVE(15-Year Duration)				$ 653,300	

Notes
- Costs are +50/-30% FS-level estimates. They do not represent a bid to do the work.

Assumptions
- ORC effective for 6 months following injection
- Injection close to source area only

Table C-4 - Cost Estimate for Alternative 4 - Air Sparging and Soil Vapor Extraction

Site:	Ken's Auto Wash
Location:	Ellensburg, Washington
Phase:	Feasibility Study (-30% to +50%)
Base Year:	2007

Description: Active remediation of soil and groundwater contaminated with gasoline-range petroleum and BTEX. Uses horizontal sparging pipe already installed supplemented with 3 deeper sparging wells and 4 vapor extraction wells. Nominal 4-year remediation plus 1 year monitoring with contingency costs for 7-year total duration.

CAPITAL COSTS:

DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL	SOURCE	NOTES
Site Preparation						
Permits	1	LS	5000	$ 5,000	Estimate	air permit, street use permit
Mobilization	1	LS	5000	$ 5,000	Estimate	Drill rig, SVE/sparge equipment, etc.
Utilities	1	LS	1500	$ 1,500	Estimate	utility locate
Security	1	LS	1500	$ 1,500	Estimate	Security fencing for equipment compound
SUBTOTAL				$ 13,000		
SVE Installation						
Extraction well installation	4	EA	2,000	$ 8,000	Cost File	To 10-foot depth
Deep sparging well installation	5	EA	1,000	$ 5,000	Cost File	To 16 feet using direct-push
Disposal of contaminated drill cuttings	1	LS	2,500	$ 2,500	Cost File	12 drums of non-haz waste
SVE equipment	1	LS	9,000	$ 9,000	Cost File	Blower and accessories
Sparging equipment	1	LS	8,000	$ 8,000	Cost File	Blower and accessories
Blower sound enclosure	1	LS	3,500	$ 3,500	Cost File	Contains both blowers
Condensate removal and collection	1	LS	2,000	$ 2,000	Cost File	Knockout pot, pump, level switches, and tank
Treatment equipment - Cat Ox	1	LS	50,000	$ 50,000	Cost File	150 SCFM includes control panel with autodialer
Mechanical, electrical, and control work	1	LS	15,000	$ 15,000	Estimate	Installation and hookup
SVE and air sparging piping	1	LS	4,000	$ 4,000	Estimate	Piping, fittings, gauges, etc.
Installing SVE and air sparging piping	1	LS	6,000	$ 6,000	Estimate	Below ground but already installed under slab
SUBTOTAL				$ 113,000		
Project management and design	15%			$ 18,900		Includes Health and Safety Plan
Construction oversight	10%			$ 12,600		Includes startup labor
Estimated Ecology Oversight Costs	1	LS	5,000	$ 5,000	Estimate	Subject to revision by Ecology
Contingency	15%			$ 23,625		10% Scope + 5% bid
TOTAL CAPITAL COST				$ 186,100		

ANNUAL OPERATING AND MONITORING COSTS

DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL	SOURCE	NOTES
Project management, reporting, and O&M	1	LS	10,000	$ 10,000		Monthly monitoring performed by site worker
Groundwater monitoring	2	Ea	4,500	$ 9,000	Cost File	performance monitoring
Energy	12	Month	500	$ 6,000	Cost File	150 SCFM air flow, gas fired catox, blower electricity
Estimated Ecology Oversight Costs	1	LS	5,000	$ 5,000	Estimate	Subject to revision by Ecology
Contingency	15%			$ 3,750		10% scope + 5% bid
TOTAL OPERATING AND MONITORING COST				$ 33,750		

CLOSURE COSTS:

DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL	SOURCE	NOTES
Groundwater monitoring	4	EA	4,400	$ 17,600	Cost File	9 wells
Project Management, Report, and Ecology Interaction	1	LS	15,000	$ 15,000	Estimate	
Estimated Ecology Oversight Costs	1	LS	5,000	$ 5,000	Estimate	Subject to revision by Ecology
Contingency	15%			$ 4,890		10% scope + 5% bid
TOTAL CLOSURE COST				$ 42,490		

PRESENT VALUE ANALYSIS:

COST TYPE	YEAR	TOTAL COST	DISCOUNT RATE	PRESENT VALUE	
Contingency Well Replacement	-	$ 15,000	0%	$ 15,000	Up to 3 wells over project lifetime. Not Discounted.
Capital Cost	0	$ 186,100	0%	$ 186,100	Not Discounted
Annual Operating and Monitoring Cost	1 to 4	$ 135,000	2.6%	$ 126,661	
Closure Cost	5	$ 42,490	2.6%	$ 37,372	
		$ 363,590		$ 365,134	
TOTAL PRESENT VALUE OF ALTERNATIVE (5-Year Duration)				$ 365,100	

COST TYPE	YEAR	TOTAL COST	DISCOUNT RATE	PRESENT VALUE	
Contingency Well Replacement	-	$ 15,000	0%	$ 15,000	Up to 3 wells over project lifetime. Not Discounted.
Capital Cost	0	$ 186,100	0%	$ 186,100	Not Discounted
Annual Operating and Monitoring Cost	1 to 5	$ 168,750	2.6%	$ 156,346	
Annual Operating and Monitoring Cost	6	$ 33,750	2.8%	$ 27,702	
Closure Cost	7	$ 42,490	2.8%	$ 35,022	
		$ 431,090		$ 420,170	
TOTAL PRESENT VALUE OF ALTERNATIVE (7-Year Duration)				$ 420,200	

Notes

Costs are +50/-30% FS-level estimates. They do not represent a bid to do the work.

Assumptions

- Ecology will require 4 quarters of confirmational monitoring
- 150 SCFM SVE air flow
- 20-foot SVE radius of influence
- Gas available on site
- Room for system on adjacent vacant lot