Interim Removal Action Measure Report
Former Springvilla Dry Cleaners
Mohawk Shopping Center
Springfield, Oregon

Prepared for
Oregon Department of Environmental Quality

April 20, 2006
15267-02/Task 2

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FORMER SPRINGVILLA DRY CLEANERS
MOHAWK SHOPPING CENTER
SPRINGFIELD, OREGON

1.0 INTRODUCTION

This report presents the results of additional Interim Removal Action Measure (IRAM) activities to address groundwater contaminated with chlorinated volatile organic compounds (VOCs), specifically tetrachloroethene (PCE) and its degradation product trichloroethene (TCE), at the former Springvilla Dry Cleaners (SDC) in Springfield, Oregon (Figures 1 and 2). This report was prepared for the Department of Environmental Quality (DEQ) under Task 3 of Task Order 73-03-42.

1.1 Objective

Groundwater beneath the SDC site is contaminated with PCE and TCE.
A second in a series of sodium permanganate/bromide tracer injections were performed to reduce contaminant concentrations. By reducing contaminant concentrations, potential risks for human exposure to groundwater (and associated volatilized vapors) by chlorinated VOCs will effectively be reduced. An aquifer test was also performed during IRAM activities to determine aquifer hydraulic conductivity and other hydrogeologic parameters to assist in evaluating additional remedial alternatives with the objective to expedite the cleanup of groundwater at the site.

Groundwater monitoring was performed to assess the performance of past IRAM actions and to help evaluate the effectiveness of the IRAM activities described herein.

1.2 Scope of Work

To expedite the cleanup of groundwater and further evaluate the site conditions, the scope of work performed at the site included the following activities:

- Groundwater sampling (baseline and post-injection sampling);
- Injection of sodium permanganate injection solution;
- Injection of a conservative tracer (sodium bromide);
- Completion of an aquifer slug and pump tests; and
- Preparation of this data summary report.

1.3 Report Organization

This report presents the following: a background summary (Section 2); IRAM activities (Section 3) including aquifer slug and pump testing, groundwater monitoring, and injection activities; the analytical program (Section 4); monitoring and analytical results (Section 5); data evaluation (Section 6); a summary, conclusions, and recommendations (Section 7); and references (Section 8).

Tables and figures are presented in the order referenced in the text. Tables include physical and chemical data, and figures show the site location and layout, groundwater elevations and contours, emulsified oil injection areas, and contaminant concentrations in groundwater. Appendices to this report include field methods and sampling procedures, quality assurance review and analytical laboratory reports, and data plots.

1.4 Limitations

Hart Crowser performed this work in accordance with generally accepted professional practices related to the nature of the work accomplished, in the same or similar localities, at the time the services were performed. This report is for the specific application to the referenced project and for the exclusive use of the DEQ.

2.0 BACKGROUND

This section presents a brief description of the site, its history, and available physical and chemical data.

2.1 Site Location and Description

The project site, SDC, was formerly located in the Mohawk Shopping Center property which is located immediately northeast of the intersection of Mohawk Boulevard and Centennial Boulevard in Springfield, Oregon (Figure 1). The site is located within the SE 1/4 of the SW 1/4 of Section 25 of Township 17 South, Range 3 West, Willamette Meridian. The shopping center occupies approximately 16 acres of commercially developed property. SDC was formerly located in the northeast corner of a retail space shared with Waremart Foods (Waremart) in the southern portion of the Mohawk Shopping Center. Waremart Foods has vacated the building. However, several small businesses west of the former SDC remain in the building. The facility address is 1459 Mohawk Boulevard. The site vicinity plan is shown on Figure 2.

2.2 Site History

The site was used as a self-service laundromat and dry cleaners from the 1960s to 2000. Up to eight self-service dry cleaning units reportedly operated at the facility prior. It was reported by the last operator that self-service dry cleaning was discontinued at the site upon recognition of abnormal replacement of the dry cleaner solvents. It is unknown how spent dry cleaner solvent was disposed of historically. It is suspected that spent solvent was disposed of in the sanitary sewer. It was also reported that the area to the rear of the dry cleaning facility was not paved until the 1970s. Prior to being paved, the area was graveled, and it was noted that spent solvent disposal might have occurred in this area.

2.3 Previous Work in the Vicinity of the Site

Previous Investigations. The property owner and the DEQ completed eight previous investigations at the site from June 1999 through August 2002. Work accomplished during these investigations includes the completion of 29 push probes and the installation of 21 groundwater monitoring wells (12 shallow and 9 intermediate depth wells). Detected concentrations of chlorinated volatile organic compounds (VOCs) (primarily PCE and its degradation products, such as TCE and *cis*-1,2-dichloroethene [c-DCE]) were encountered in soil and groundwater samples. The highest concentrations of chlorinated VOCs were encountered in samples collected beneath and around the northeast corner of the site building (the location of the former SDC facility), particularly around a drain line previously used to service the dry cleaning equipment. A beneficial use evaluation was also completed in the vicinity of the site, identifying 17 water wells within the study area (11 domestic water supply wells, three irrigation wells, one municipal water supply well, and two domestic/irrigation multi-use wells).

Additional information regarding the previous investigations can be found in the following documents:

- Initial Subsurface Investigation (BBA Letter Report, July 27, 1999);
- Groundwater Monitoring Well Installation (BBA Letter Report, October 15, 1999);
- Additional Investigative Activities (BBA Letter Report, December 1, 1999);
- Initial Source Area Investigation (BBA Letter Report, July 24, 2000);
- Expanded Source Area Investigation (BBA Letter Report, July 24, 2000), and Groundwater Monitoring (BBA Letter Report, April 23, 2001);
- Groundwater Assessment (MFA Report, November 21, 2001);

- Beneficial Use Evaluation (MFA Report, November 21, 2001); and
- Site Investigation Report (Hart Crowser, October 17, 2002).

Source Area Investigation. In July and August 2002, Hart Crowser completed six push probe explorations (HCGP-1 through HCGP-6) within the interior of the site building (in the vicinity of the drain line) to collect subsurface soil and groundwater samples (Hart Crowser, 2002). Selected soil samples were submitted for VOC analysis using EPA Method 8260B. Push probe groundwater samples were analyzed for VOCs by EPA Method 8260B and natural attenuation parameters.

The highest concentrations of PCE and its degradation products were encountered in HCGP-1 (130,000 micrograms per kilogram [μg/kg] PCE, 39 μg/kg TCE), near the drain line in the SDC portion of the site building. Soils impacted by chlorinated VOCs appeared to be limited to beneath the northeast corner of the site building, under both the former SDC and Waremart portions of the building. Total chlorinated VOC concentrations decreased laterally outward from the interior probe exploration HCGP-1, though VOCs tended to extend toward the southeast (in the vicinity of the presumed location of the building drain line).

Based on a comparison to the screening levels at that time, PCE was identified as the only soil COPC, with samples collected from beneath the floor of the former SDC and Waremart portions of the building exceeding the Residential and Occupational Risk-Based Concentrations (RBCs) for direct contact with soil, volatilization to indoor air, and leaching to groundwater.

Interim Vapor Collection System. In February 2003, a vapor collection and venting system was constructed to intercept vapors that may accumulate beneath the building floor, as part of the interim action activities (Hart Crowser, 2003). These activities also included the installation of vapor extraction/injection wells and initiation of a vapor sampling program. Results from the ambient air samples indicate that PCE concentrations exceed the DEQ Occupational Air Inhalation RBC in the former Waremart portion of the site building, though the operation of the system has consistently reduced concentrations.

Expanded Groundwater Beneficial Use Assessment. In November 2003, an expanded beneficial use assessment was completed in the vicinity of the dry cleaner, evaluating changes that may have occurred since the previous assessment was done and collecting water samples from accessible wells (Hart Crowser, 2004). During this work, no exposures to site contaminants above risk-based screening levels were identified (several wells had detected concentrations of contaminants, but no domestic use of groundwater was identified within the locality of the facility). A distinct groundwater contaminant plume originating from the site was not identified as part of this work, as the distribution of VOCs (both relative to the on-site concentrations and to other off-site concentrations) was not consistent. There is also the potential for the presence of more than one source of VOC contamination in the vicinity of the SDC site, further complicating the evaluation of the extent of contamination.

The available published information regarding the regional hydrogeology did not allow for the creation of a valid cross section through the site vicinity. The geology is heterogeneous and includes intermittent layers of silts, sands, and gravels. To fully characterize the geology and hydrogeology in the vicinity of the site would be difficult and costly.

IRAM activities. In October 2004, an IRAM excavation was completed with the removal of source soils impacted by contaminant concentrations indicative of residual non-aqueous phase liquids (NAPLs) (Hart Crowser, 2005). On-site treatment of excavated soils via *ex situ* soil vapor extraction was successfully completed achieving Contained-In Determination disposal criteria. The treated soil was disposed of at a licensed Subtitle D landfill as a non-hazardous waste.

The results of confirmation soil sample (C-4) collected at the excavation floor indicated that PCE concentrations (11 milligrams per kilogram [mg/kg]) exceeded the RBCs for occupational direct contact and vapor intrusion into buildings. To aggressively remediate the residual contamination, a sodium permanganate chemical oxidant was initially injected into the source area in October 2005.

Ambient air samples were collected in the northeast portion of the former Waremart building following IRAM activities. Results indicated PCE concentrations slightly exceeding the DEQ Occupational Air Inhalation RBC. The slight exceedence may be a result of contaminated groundwater outside the zone of the IRAM excavation. However, improvements in indoor air are anticipated particularly due to the source removal, the continued operation of the vapor recovery system, natural attenuation of groundwater, and the future installation of a modern building heating, ventilation and air conditioning (HVAC) system.

2.4 Geology and Hydrogeology

Site Geology. Based on observations during previous exploration activities, native soil underlying the site building consists of unconsolidated alluvial deposits occurring to at least 100 feet below the ground surface (bgs), the maximum depth of explorations completed at the Mohawk Shopping Center. The alluvial deposits consist of 9 to 11 feet of clayey silt/silty clay overlying gravel with varying amounts of sand and silt. The gravel extended to the maximum depth of the exploration at 100 feet.

Site Hydrogeology. Groundwater monitoring wells were installed at generally two depths within the gravel unit described in the previous section. Shallow-depth monitoring wells were completed at approximately 25 feet bgs. The intermediate-depth monitoring wells were completed at approximately 75 feet bgs. Comparison of data between "paired" shallow and intermediate wells indicates that the groundwater elevation in a given shallow monitoring well is consistently higher than the nearby intermediate monitoring well. Both the shallow and intermediate wells are installed in a water-bearing zone containing consolidated fine- and coarse-grained sediments. Pump test results discussed in Section 5.4, suggest a low permeable layer exists between the two zones that is creating confining conditions in the intermediate zone. However, VOC concentrations detected in the intermediate water-bearing zone suggest contaminated water is transmitted slowly from the shallow zone into the intermediate zone. The low permeable layer between the two water-bearing zones can be characterized as a leaky confining layer.

The typical depth to shallow and intermediate groundwater is about 5 to 10 feet bgs. The inferred groundwater gradient in the shallow and intermediate monitoring wells is toward the west at approximately 0.005 to 0.006 foot/foot, respectively.

Although the apparent groundwater flow direction in the shallow and intermediate-depth hydrogeologic units is consistently to the west, shallow groundwater contamination also appears to have migrated in a southerly direction, towards Centennial Boulevard and monitoring well MW-16. This contamination may be a result of transport through a preferential conduit such as a buried utility. VOC results in the intermediate-depth groundwater wells suggest a more westerly transport of contamination, consistent with the apparent groundwater flow direction, and less of a migration component to the south.

3.0 INTERIM REMEDIAL ACTION MEASURE ACTIVITIES

In October and November 2005, IRAM activities were completed at the site that included preparatory tasks, baseline and post-injection groundwater monitoring, injection of the sodium permanganate injection solution and conservative bromide tracer solution, and performance of an aquifer slug/pump test. These activities are described briefly below. Field procedures are discussed in detail in Appendix A.

3.1 Preparatory Activities

Site Health and Safety Plan. Prior to beginning site activities, Hart Crowser updated the site-specific Health and Safety Plan (HSP) for the proposed IRAM activities. The HSP was prepared in general accordance with the Occupational Safety and Health Act (OSHA) and the Oregon Administrative Rules (OARs).

Permitting. An Underground Injection Control (UIC) permit (or permit waiver) was required for the injection activities. The DEQ registered with its UIC program to do this work. The permit number is UIC 12168-1.

3.2 Groundwater Monitoring

Groundwater monitoring events for the IRAM include a baseline groundwater monitoring event and one post-injection monitoring event. An overview of these events and the sampling methodologies employed at the site are discussed below. The groundwater monitoring analytical program and results are discussed in Sections 4 and 5, respectively.

3.2.1 October 2005 Groundwater Monitoring

On October 13 and 14, 2005, groundwater monitoring was performed to establish groundwater conditions at the site prior to the October 2005 sodium permanganate injection. Groundwater samples were collected from 16 of the 23 existing monitoring wells (MW-1 through MW-4, MW-9, MW-10, MW-14, MW-16, MW-17, MW-21, MW-22, and DEQ-1 through DEQ-5). The October 2005 groundwater monitoring event was completed approximately 12 months after the initial sodium permanganate injections completed on October 2004, and approximately 13 months following soil removal activities conducted in September 2004 (see the Interim Removal Action Measure Report, dated April 11, 2005).

3.2.2 November 2005 Groundwater Monitoring

The sodium permanganate and bromide tracer injections were conducted on October 20 and 21, 2005. Post-injection groundwater monitoring was performed on November 21, 2005, from four monitoring wells (MW-3, MW-4, MW-22, and DEQ-4) at the site.

3.2.3 Groundwater Monitoring Methodologies

Groundwater monitoring consisted of measuring water levels, purging and sampling groundwater, and measuring groundwater field parameters.

Groundwater Level Measurements. Water levels were measured in all 23 monitoring wells on October 13, 2005, and in four monitoring wells on November 21, 2005, for the purpose of determining groundwater elevations, gradients, and apparent groundwater flow direction. Groundwater level measurements were obtained using an electronic water-level indicator and recorded to the nearest 0.01 foot. Depth-to-groundwater data were converted to elevations referenced to NGVD 29 and are presented in Table 1.

Purging. Upon completion of groundwater level measurements, a peristaltic pump with dedicated tubing was used to purge each monitoring well. The tubing intake was positioned approximately at the middle of the well screen interval. Field parameters (temperature, pH, and electrical conductivity) were monitored continuously and recorded at 2-minute intervals. Groundwater field parameters are presented in Table 2. Purging was considered complete when the field parameters stabilized within 10 percent of previous measurements for three consecutive two-minute intervals or if the well purged dry (DEQ-5 only). Once the above-mentioned field parameters had stabilized, dissolved oxygen (DO) and oxidation-reduction potential (ORP) were also measured.

Sampling. Groundwater samples were collected from the wells immediately after purging using the same equipment. Samples were submitted for analysis in accordance with the analytical program discussed in Section 4.

3.3 Sodium Permanganate and Bromide Tracer Injections

Hart Crowser supervised Terra Hydr, Inc., in performing the sodium permanganate injection activities on October 20 and 21, 2005. This was the second sodium permanganate/bromide injection. The first injection was completed in October 2004 (1,100 gallons of 4 percent solution). During this second Injection, approximately 2,000 gallons of prepared 4 percent sodium permanganate solution was injected to the source area via the infiltration piping. The sodium permanganate injection was completed to aggressively remediate residual contamination in the former source area. Additionally, a bromide (Br^-) tracer of was added to the injection solution to further assess the movement of groundwater beneath the site. The sodium permanganate/Br^- solution was injected into the infiltration gallery shown on Figure 3.

Sodium Permanganate. The sodium permanganate solution was prepared by mixing 110 gallons of 40 percent stock sodium permanganate solution with approximately 2,000 gallons of water. Approximately 1,000 gallons municipal supplied water, approximately 1,000 gallons from MW-21, and 35 gallons from MW-1 and MW-22 were mixed in a batch tank (i.e., two 55-gallon drums of stock solution mixed to prepare 2,000 gallons of injection solution). Mixing of the solution was accomplished by simultaneously feeding the stock solution with the water feed. The prepared solution was gravity fed to the infiltration gallery piping at a maximum injection rate of 13 gallons per minute (gpm). The solution was followed with approximately 200 gallons of municipal water to flush the piping and clean the stock 55-gallon drums and batch tank.

Bromide Tracer. A bromide (Br^-) tracer in the form of sodium bromide (NaBr) was added to the sodium permanganate solution to further assess the movement of groundwater beneath the site. Bromide was selected as an effective tracer because it does not absorb to soil grains, biodegrade, or have toxic properties. The sodium permanganate migrates slower than the bromide through the subsurface, but evaluation of the bromide migration is intended to assist with estimating the extent (both laterally and vertically) of the injected solution. Approximately 35 pounds of sodium bromide was dissolved in a 300-gallon batch of the sodium permanganate solution on October 20, 2005, and gravity fed into the infiltration gallery.

3.4 Aquifer Slug/Pump Tests

On October 20 and 21, 2005, Hart Crowser performed aquifer slug and pump tests to assess the hydraulic conductivity of the gravel aquifer unit beneath the site. The pump tests were also designed provide for a water source during the sodium permanganate injections scheduled for the same mobilization. The slug tests (slug-in and slug-out) were completed in monitoring well MW-22, located 300 feet west of the injection area. The well was screened from approximately 10 to 25 feet below ground surface (bgs). Water levels were measured manually (using an electronic water-level indicator) and throughout the duration of the test. The slug was introduced (slug-in test) into the monitoring well, raising the water level within the well. Groundwater level measurements were recorded as the water flowed out of the well and back into the shallow water-bearing zone. The slug was then removed (slug-out test), and water level measurements were recorded as the level within the well increased over the test period. The results of the slug tests are discussed in Section 5.2.

Groundwater pump tests were conducted on shallow monitoring wells MW-1 and MW-22, both screened at approximately 10 to 25 feet bgs. Attempts at establishing a constant flow at MW-22 were not successful due to low yield or well construction. The maximum sustainable flow from MW-1 was 0.67 gallons per minute (gpm). Drawdown measurements were recorded by hand as the groundwater was extracted from each well. Approximately 35 gallons of groundwater was recovered from the pump tests and was used for the permanganate injection, eliminating the need to dispose of investigation-derived waste (IDW). The results of the pump tests are discussed in Section 5.2.

A third groundwater pump test was conducted at intermediate well MW-21 (screened from 50 to 70 feet bgs) that achieved a maximum sustainable flow rate of 4.3 gpm during the 4-hour pump test. Drawdown measurements were recorded by hand as the groundwater was extracted from the well. Approximately 1,000 gallons of groundwater was recovered from the pump test and was used for the permanganate injection, eliminating the need to dispose of IDW. The results of the pump test are discussed in Section 5.2

3.5 Investigation-Derived Waste Handling and Disposal

IDW consisted of decontamination water, purged groundwater, and personal protective equipment. Disposable and personal protective equipment was disposed of as a solid waste. Purge water generated during the October 13 and 14, 2005, baseline groundwater monitoring event was mixed in with the sodium permanganate injection solution. Approximately 4 gallons of IDW water were generated on November 21, 2005, post-injection groundwater monitoring event and placed in a properly labeled, Oregon Department of Transportation (ODOT)-approved drum. It is expected the IDW water will be disposed of into the local municipal sanitary sewer after permission is granted by the City of Springfield.

4.0 ANALYTICAL PROGRAM

Hart Crowser subcontracted Coffee Laboratory, Inc., an Oregon-licensed analytical laboratory in Portland, Oregon, to perform chemical analysis on groundwater samples for the project. All samples were collected in laboratory-supplied containers, marked with identifying information, and maintained under chain of custody protocols. Copies of the analytical laboratory reports are included with a data quality review in Attachment B. Chemical results are discussed in Section 5.

4.1 October 2005 Groundwater Monitoring

Groundwater samples were collected from monitoring wells MW-1 through MW-4, MW-9, MW-10, MW-14, MW-16, MW-17, MW-21, MW-22, and DEQ-1 through DEQ-5 and were analyzed for VOCs by EPA Method 8260B. In addition, groundwater samples from monitoring wells MW-1, MW-9, MW-22, DEQ-4, and DEQ-5 were analyzed for total iron, dissolved iron, and total and dissolved manganese by EPA Method 200.7, nitrate and sulfate by EPA Method 300.0, bromide by EPA Method 300.0B, and total alkalinity by EPA Method 310.1.

4.2 November 2005 Groundwater Monitoring

Groundwater samples were collected from shallow monitoring wells MW-3, MW-4, MW-22 and DEQ-4 during the November 21, 2005 monitoring event.

Groundwater samples were analyzed for VOCs by EPA Method 8260B and bromide by EPA Method 300.0B.

5.0 MONITORING AND ANALYTICAL RESULTS

This section presents a summary of the groundwater monitoring results conducted as part of the IRAM, including baseline and post injection events, slug tests and pump tests. Monitoring results include groundwater field parameters, groundwater elevation data and chemical analyses on groundwater samples.

5.1 Groundwater Monitoring

The following sections present a summary of the results of the baseline and post-injection groundwater monitoring events including water level measurements and elevations (relative to NGVD 29), and laboratory analyses. Field parameters (pH and ORP), total organic carbon, bromide, and competing electron acceptor (DO, nitrate, iron, manganese, and sulfate) results are presented in Tables 2 and 3.

5.1.1 General Groundwater Elevation Measurements, Flow Direction, and Gradient

Based on the groundwater data collected in October 2005, shallow groundwater elevations ranged from 450.16 feet above mean sea level (MSL) in MW-4 to 454.38 feet above MSL in MW-18. The inferred shallow groundwater gradient was 0.006 foot/foot with an apparent groundwater flow direction toward the west across the site, which is consistent with previous observations. Depth to groundwater measured from the top of casing (TOC) ranged from 8.28 feet in MW-12 to 10.38 feet in MW-14. Groundwater level measurements and calculated elevations from the TOC are listed in Table 1. Groundwater elevations and contours for baseline monitoring (October 2005) for on-site shallow groundwater wells are presented on Figure 3.

Intermediate groundwater elevations ranged from 441.65 feet above MSL in DEQ-3 to 450.70 feet above MSL in MW-9 (Table 1). The inferred gradient is 0.005 foot/foot based on water levels measured in intermediate groundwater monitoring wells. The depth to groundwater as measured from the TOC ranged from 11.20 feet in MW-14 to 14.97 feet in MW-21. The apparent groundwater flow direction is toward the west across the site in the intermediate water-bearing zone. A westerly flow direction and gradient was also noted in the previous sampling event, although west-northwesterly trends have been recorded. Groundwater elevations and contours for on-site intermediate wells are presented on Figure 4, and off-site groundwater elevations on Figure 5.

Comparison of data between "paired" shallow and intermediate wells indicate that the groundwater elevation in a given shallow monitoring well (well depth of approximately 25 feet bgs) is consistently higher than the nearby intermediate monitoring well (well depths of approximately 75 feet bgs). Both the shallow and intermediate wells are installed in a water-bearing zone containing consolidated fine- and coarse-grained sediments. However, VOC concentrations detected in the intermediate water-bearing zone suggest contaminated water transmitted from the shallow zone into the intermediate zone suggest a leaky confining layer between the two zones.

The leaky confined layer model is also consistent with the vertical hydraulic gradient observed as water moving from a higher groundwater elevation (shallow water-bearing unit) to a lower elevation (intermediate water-bearing unit). The difference in hydraulic potential enables the contaminated groundwater to penetrate the less permeable layer into the intermediate zone. The average vertical gradient during this monitoring event was approximately 0.08 foot/foot downward. This gradient is higher than previous observations and likely reflects seasonal variations.

5.1.2 Summary of October 2005 Groundwater Analytical Results

VOCs. Chlorinated VOCs were detected in all nine of the shallow groundwater monitoring wells sampled. Detected chlorinated VOCs in shallow depth wells included PCE, TCE, and c-DCE. The highest PCE concentrations were detected in shallow-depth groundwater monitoring wells DEQ-4 and MW-16 (approximately 1,600 micrograms per liter (µg/L) total VOCs in each). PCE was detected in upgradient shallow monitoring well MW-1 at a concentration of 28 µg/L. The current and historical groundwater VOC chemical results for shallow groundwater monitoring wells are summarized in Table 3. The distribution of total chlorinated VOCs across the site (shallow wells) are shown on Figure 6. The PCE concentration trends for shallow groundwater monitoring events are graphically presented on Figure 7. The complete laboratory data reports are in Appendix B.

Chlorinated VOCs were detected in six of the seven intermediate groundwater monitoring wells sampled. Chlorinated VOCs detected in intermediate wells included PCE, TCE, and c-DCE. Chlorinated VOCs were not detected in intermediate well DEQ-3 (1,300 feet west-northwest of the site). PCE was detected in upgradient intermediate well MW-9 at a concentration of 13 µg/L. The extent of the intermediate-depth off-site plume is not known to the south. The southernmost groundwater monitoring well (DEQ-2) contains a total VOC concentration of 350 µg/L. VOC concentrations have decreased in monitoring well DEQ-2 from 1,112 µg/L to 350 µg/L, since the well was installed in August 2002. The current and historical groundwater VOC chemical results for intermediate-depth groundwater monitoring are summarized in Table 5. The distribution of total chlorinated VOCs across the site (intermediate wells) are presented on Figures 8 and 9. The PCE concentration trends for intermediate groundwater are graphically presented on Figure 10.

Bromide Tracer. Bromide was detected in samples collected from all five monitoring wells during the October 2005 monitoring event (Table 2). The highest concentrations of bromide were detected in wells DEQ-4 and MW-22 at 200 μg/L and 280 μg/L, respectively.

5.1.3 Summary of November 2005 Groundwater Analytical Results

VOCs. Chlorinated VOCs were detected in all four shallow groundwater monitoring wells sampled (no intermediate groundwater monitoring wells were sampled as part of the post-injection sampling). Concentrations of chlorinated VOCs detected in groundwater monitoring wells are shown on Table 3. Chlorinated VOCs results indicated concentrations ranging from 1.8 μg/L (MW-4) to 5,200 μg/L (DEQ-4).

Bromide Tracer. Bromide was detected in samples collected from all five monitoring wells during the November 2005 monitoring event (Table 2). The highest concentrations of bromide were detected in wells DEQ-4 and MW-22 at 314 μg/L and 358 μg/L, respectively.

5.2 Aquifer Slug/Pump Test Results

Slug test data from MW-22 (shallow water-bearing zone) were entered into the analysis software (Environmental Simulations AquiferWin32). The software allows for selecting several models to perform the calculations; the Bower and Rice method was selected as the most appropriate slug-in test model, and Black was as the best slug-out test method to estimate the hydraulic conductivity (K). The model estimated a K value for the slug-in and slug-out test of 9.68×10^{-7} and 4.65×10^{-7} feet per second (ft/sec), respectively. The average for the two tests would be 7.16×10^{-7} ft/sec (2.18×10^{-5} centimeters per second [cm/sec]) for the shallow water-bearing zone. The data evaluation will be discussed in Section 6.2 and the results of the aquifer slug test best-fit curves are provided in Appendix C.

Groundwater pumping tests were conducted on shallow monitoring wells MW-1 and MW-22. The data generated from the MW-22 pump test could not be used because of flow rate inconsistencies.

A sustainable flow of 0.67 gallons per minute (gpm) from MW-1 was adequate to analyze the data. The Cooper and Jacob log-log analytical method was selected by Hart Crowser to estimate the transmissivity (T) in square feet per sec (ft^2/sec).

The model produced an estimated transmissivity of 7.5×10^{-4} ft^2/sec. Since T=Kb (where b is the thickness of the aquifer) and our aquifer thickness is 4 feet, the estimated hydraulic conductivity is 5.36×10^{-5} ft/sec (1.63×10^{-3} cm/sec). The DEQ also analyzed the data using the Jacob and Cooper straight-line method that resulted in a K value of 2.4×10^{-4} cm/sec. These results will be discussed further in the data evaluation section (Section 6.2), and the best-fit graphs are provided in Appendix C.

The third groundwater pump test conducted at intermediate-depth well MW-21 achieved a maximum sustainable flow rate of 4.3 gpm during the 4-hour pump test. Pump tests conducted in intermediate well MW-21 resulted in 9 feet of drawdown over a 4-hour period. Water level measurements were also collected from MW-22 (shallow-depth well at a distance of 15 feet), MW-14 and MW-17 (intermediate-depth wells at a distance of 160 and 260 feet, respectively). Monitoring of these wells resulted in drawdowns of 0.10 feet in MW-22, 1.65 feet in downgradient monitoring well MW-14, and 0.52 feet in cross-gradient well MW-17. These results will be discussed further in the data evaluation section.

Hart Crowser analyzed the data using a Hantush 1964 model for leaky aquifers and estimated the value for T in the intermediate water-bearing zone at 9.38×10^{-5} ft^2/sec. Calculating K for an aquifer thickness of 20 feet (the screen length is not fully penetrating the intermediate zone) resulted in an estimated value of 4.69×10^{-6} ft/sec (1.43×10^{-4} cm/sec). The DEQ used the Jacob straight-line method resulting in a K value of 3×10^{-3} cm/sec. These results will be discussed further in the data evaluation section, and the best-fit graphs are provided in Appendix C.

5.3 Quality Assurance and Quality Control

The general quality assurance objectives for this project have been to develop and implement procedures for obtaining and evaluating data of a specified quality that can be used to evaluate the treatment effectiveness of sodium permanganate by means of chemical oxidation. To collect such information, analytical data must have an appropriate degree of accuracy and reproducibility, samples collected must be representative of actual field conditions, and samples must be collected and analyzed using unbroken chain of custody procedures. A more detailed discussion of the quality assurance and quality control procedures employed during the field activities is presented in Appendix B.

During field work, disposable and/or decontaminated sampling equipment was used to reduce the potential for cross contamination. All samples were placed into laboratory-supplied sample containers, including preservative, when required. Samples were labeled with sample-specific identifying information. Chain of custody was maintained at all times. The laboratory performed quality control analyses (e.g., matrix spikes and method blanks), per the requirements of the analytical method. Detection limits were consistent with industry standards and, when practicable, below or comparable to promulgated regulatory standards, unless raised due to high analyte concentrations in the sample or matrix effects.

6.0 DATA EVALUATION

A data evaluation was completed to determine the effectiveness of the permanganate injections on the VOC concentrations, establish general VOC trends, assess the groundwater flow based on Br^- tracer data and discuss the aquifer tests. The results of our evaluation are discussed below.

6.1 VOC Data Evaluation

Effect of Permanganate Injections on VOC Concentrations. The following observations are based on the baseline and post-injection sampling events conducted in October and November 2005.

- During baseline monitoring in October 2005, DEQ-4 (Figure 6) exhibited its lowest PCE concentration (1,600 µg/L) to date. However, following the permanganate injections, PCE concentrations increased in DEQ-4 to 5,200 µg/L, the highest PCE concentration detected at the site (Figure 7). The elevated PCE concentrations in DEQ-4 may be due to contaminant mass desorption from the source area soil matrix in response to the sodium permanganate injection.
- PCE concentrations in shallow monitoring well MW-22 (Figure 7) went from 250 µg/L during October 2005 sampling event, to 92 µg/L during the post-injection sampling conducted one month later. Although bromide tracer was detected in MW-22, it is likely this reduction in PCE concentrations was not due to the permanganate injection in October 2005, since bromide was injected into the source area in 2004 and the seepage velocity for the site does not support this conclusion.

General VOC Concentration Trends. The following general observations and trends were formulated through interpretation of data collected from October 1999 to the present.

- PCE was detected in shallow upgradient monitoring well MW-1 at a concentration slightly lower than historically detected.

- Figure 7 shows a downward trend in PCE concentrations for the shallow-depth groundwater monitoring wells, except for MW-16, which has remained fairly consistent, between 1,000 and 1,500 μg/L.

- PCE was detected at its lowest concentration to date in shallow-depth monitoring wells MW-1 and MW-22 at 28 and 92 μg/L, respectively.

- Low VOC concentrations in shallow-depth monitoring wells MW-4 and MW-10 and non-detect VOC concentrations in shallow-depth off-site monitoring well DEQ-3, suggest the plume has been delineated to the west, and further off site migration to the west is limited.

- VOC concentrations in shallow-depth monitoring wells MW-3 and MW-16 suggest that portions of the groundwater plume is continuing to migrate to the south due to possible utility corridor migration.

- PCE concentrations at intermediate-depth monitoring well MW-17 continue to slowly decline, but remain above 200 μg/L.

- Figure 10 shows downward PCE concentration trends in intermediate-depth monitoring wells MW-9, MW-17, MW-21, and DEQ-2, with a slightly increasing trend observed in MW-11 (since June 2002).

- VOC concentrations in intermediate-depth wells MW-14 and MW-21 suggest the contaminant migration pathway in the intermediate-depth portion of the aquifer is primarily to the west, with diffusion probably responsible for lower concentrations in DEQ-1.

- PCE concentrations in MW-17 and DEQ-2 are likely related to the elevated concentration (1,600 μg/L) detected in shallow depth well MW-16. Contaminants to the south of the source area are not consistent with the groundwater gradient at the site and may have been transported to the south through a preferential pathway such as backfill in a utility corridor.

- For paired shallow- and intermediate-depth groundwater monitoring wells, PCE concentrations were approximately seven times greater in shallow-depth monitoring well MW-16 than intermediate-depth well MW-17.

- VOC concentrations could not be correlated to the bromide results, which are discussed in Section 6.3.

6.2 Aquifer Slug/Pump Test Evaluation

Available aquifer data consists of historical water level measurements, slug test data, and pump test data. Slug test data is limited to evaluating a small area immediately surrounding the test well. The hydraulic conductivity (7.18×10^{-7} ft/sec or 2.18×10^{-5} cm/sec) estimated from the slug tests in MW-22 is lower than a typical silty/gravel matrix containing some fine-grained (clayey) material (Freeze and Cherry, 1979). This suggests the slug test results were negatively affected by the sand pack or well screen (it is not efficiently conducting the groundwater), or the consolidation of fine- and coarse-grained materials has less permeability than unconsolidated sediments. In general, pump tests are more useful than slug test as the result of extracting water can be measured for several hundred feet beyond the well being tested. As such, the pump test will be the focus of this evaluation.

The pump test was conducted in the shallow-depth monitoring well MW-1 at a sustained flow of 0.67 gpm. Conducting pump tests and analyzing the data can be difficult at low flow rates. As the water level is lowered in the well, the increased head must be overcome to sustain a constant flow rate. The Cooper and Jacob Method was used by Hart Crowser and the DEQ to achieve K values of $1.6x10^{-3}$ cm/sec and $2.4x10^{-4}$ cm/sec, respectively. While the $2.4x10^{-4}$ appears to be a more reasonable value based on the relatively low well yield, the data points selected early (less than 8 minutes) into the test appears to represent the water within the well casing and sand pack surrounding the well rather than the aquifer conditions. The K value of $1.6x10^{-3}$ cm/sec value (which ignored the early data) is likely more representative of aquifer conditions and will be used to calculate the seepage velocity. Unfortunately, the limited pump duration (50 minutes), and the removal of 35 gallons under unconfined conditions, did not allow for measuring a response in adjacent wells.

A pump test was conducted in the intermediate-depth monitoring well MW-21 at a sustained flow of 4.3 gpm. Hart Crowser used the Hantush Method to analyze the leaky aquifer data. Although the Hantush curve selected by Hart Crowser matched the flat leaky aquifer scenario, the early data was limited, providing several potential curve matches, resulting in K values ranging from of $4.0x10^{-4}$ cm/sec to $1.4x10^{-5}$ cm/sec. The DEQ used the Cooper and Jacob straight-line method to analyze pumping well MW-21, and monitoring wells MW-14 and MW-17. This method resulted in good straight-line matches ranging from $3x10^{-3}$ cm/sec to $5x10^{-3}$ cm/sec. The average of these three tests are $3.9x10^{-3}$ cm/sec, and will be used to estimate the seepage velocity across the site for the intermediate water-bearing unit.

The pump test conducted at intermediate well MW-21 resulted in a drawdown of approximately 9 feet. Three additional wells monitored during the pump test resulted in drawdowns of 0.10 feet in MW-22 (shallow-depth well at a distance of 15 feet), 1.65 feet in MW-14 (intermediate well at a distance of 160 feet), and 0.52 feet in MW-17 (intermediate-depth well at a distance of 260 feet). It appears that the amount of influence on the potentiometric surface from pumping at MW-21 is the least at the shallow-depth well MW-22 at a distance of only 15 feet. In contrast, the intermediate wells at 160 and 260 feet from the pumping well (MW-21) are influenced much more. These observations suggest a less permeable layer (probably due to higher consolidation of silty gravels observed during the well installations) exists between the two zones.

Approximately 1,000 gallons of groundwater were removed during the 4-hour pump test reducing the potentiometric surface a minimum of 260 feet from the pumping well. These observations indicate that confining aquifer conditions in which the pressure inside the water-bearing unit was reduced. The radius of influence for unconfined aquifers is based on the drainage of pore space to reduce the potentiometric surface. If an unconfined continuous aquifer existed between all four wells, more drawdown would have been observed in MW-22 (15 feet from MW-21) than in MW-14 and MW-17 at a distance 160 and 260 feet, respectively. These results are consistent with a leaky confined layer between the shallow monitoring well (MW-22) and the three intermediate monitor wells (MW-14, MW-17 and MW-21).

The water levels in the shallow water-bearing zone are consistently higher than those in the intermediate water-bearing zone regardless of seasonal variation. If the two sets of wells were screened within the same continuous water-bearing zone, water levels should achieve an equal potentiometric surface.

Groundwater pumped from the intermediate-depth well increased the vertical hydraulic gradient between the two zones. This creates a more favorable gradient for water from the shallow zone to travel through the leaky confining layer, resulting in a lower the potentiometric surface (0.10 feet in this test) in the shallow water-bearing zone.

Groundwater seepage velocity for the shallow water-bearing unit can be estimated across the site using the hydraulic conductivity ($1.63x10^{-3}$ cm/sec) established during the MW-1 pump test. We have assumed a porosity of 30 percent (0.30) based on the silty/gravels at the site, and the gradient (0.006 foot/foot) across the site as measured from MW-8 to MW-4. The formula for seepage velocity is v=K/n (dh/dl) where n is the porosity, and dh/dl is the gradient across the site. The inferred groundwater seepage across the site is estimated to be 0.09 feet per day.

Groundwater seepage velocity for the intermediate zone can be calculated using the established an average K value of $3.9x10^{-3}$ cm/sec, a porosity of 30 percent (0.30), and a hydraulic gradient of 0.004 foot/foot across the site (MW-9 to MW-14). The inferred groundwater seepage across the site is estimate to be 0.15 feet per day.

6.3 Bromide Tracer Evaluation

Bromide (Br^-) was included as a tracer with the sodium permanganate during the previous injection activities (2004) and the recent permanganate injection conducting in October 2005. A total of four monitoring wells (MW-4, MW-9, MW-22 and DEQ-4) were sampled for Br^- during the November 2005 monitoring event. Br^- was detected in all four wells both to the west and east of the injection points and will be discussed in order from upgradient to downgradient locations.

Br^- concentrations in monitoring well MW-9 suggest diffusion is occurring upgradient of the injection location. An increase from 200 µg/L to 314 µg/L in Br^- was observed in DEQ-4 (approximately 15 feet downgradient of the injection location) and should increase during the next sampling event, based on the close proximity to the infiltration gallery in which the bromide was injected. Br^- concentrations detected in MW-22 (located approximately 380 feet downgradient) during the November 2005 were within the range of July and October 2005 results, and therefore, likely related to the 2004 injection event. The estimated travel time from October 2004 to July 2005 suggest a minimum groundwater seepage velocity of 1.5 ft/day. Bromide concentrations of 70 mg/L were reported in MW-4 (approximately 600 feet downgradient of the injection location) in November 2005, but had not been previously sampled. This concentration is likely related to the 2004 injection suggesting a minimum groundwater velocity of approximately 1.5 ft/day. In general, the bromide concentrations going forward will be difficult distinguish the 2004 injection event from the 2005 event, but have provided valuable results for apparent groundwater seepage velocity in the shallow water-bearing unit.

7.0 CONCLUSIONS AND RECOMMENDATIONS

In October and November 2005, Hart Crowser completed IRAM activities to address groundwater contaminated with chlorinated VOCs at the site. Conclusions are summarized below and followed by recommendations for potential future work.

7.1 Conclusions

The objective of the IRAM activities is to expedite the reduction of chlorinated VOCs concentrations in groundwater to a level that is protective of human health and the environment. The IRAM activities included an aquifer slug and pump tests, baseline groundwater monitoring, injection of a sodium permanganate solution/ bromide tracer solution, and post-injection monitoring as summarized below.

Aquifer Slug/Pump Tests. Aquifer slug and pump tests (slug-in and slug-out) were performed at MW-22 to assess the hydraulic conductivity of the silty/gravel aquifer unit beneath the site. The slug tests resulted in very low hydraulic conductivity ($7.16 x 10^{-7}$) that is not reasonable based on well logs. These results were not included as part of our analysis. The pump test at MW-22 could not maintain constant flow at 0.50 gpm, suggesting the well completion or well development was not allowing proper analysis of the aquifer conditions. A pump test was completed in monitoring well MW-1 and was also screened from approximately 10 to 25 feet bgs. Analysis of the pump test data resulted in an estimated hydraulic conductivity in the shallow water-bearing zone of $5.3x10^{-5}$ ft/sec ($1.6X10^{-3}$ cm/sec). This produced an estimated seepage velocity of 0.09 ft/day, which is not consistent with the minimum bromide travel times of approximately 1.5 ft/day.

A pump test was conducted in the intermediate-depth well MW-21 and screened at a depth of 50 to 70 feet bgs. Analysis of the pump test data resulted in an estimated hydraulic conductivity in the intermediate water-bearing zone of $3.9x\ 10^{-3}$ cm/sec. The slightly lower hydraulic conductivity suggests the silty clays may be more consolidated (as observed during drilling) than the shallower sediments. This produced an estimated seepage velocity of 0.14 ft/day. Bromide tracing has not been conducted in the intermediate zone.

Water level responses observed in MW-14, MW-17 and MW-22 during the pump test in MW-21 suggest that a leaky confined layer exists between the shallow and intermediate water-bearing zones, creating semi-confined aquifer conditions in the intermediate water-bearing zone.

The empirical data collected during the IRAM has provided valuable information about the aquifer conditions. Sustainable pump rates of 0.67 gpm and 4.3 gpm were established for the shallow and intermediate water-bearing units, respectively. Drawdown tests in the intermediate zone established that the radius of influence is at least 260 feet from the pumping well. This allows capturing and controlling the migration of on-site contaminants within the intermediate zone. This data also provides valuable information for designing and estimating costs of remedial alternatives.

Sodium Permanganate/Bromide Injections. In October 2005, a sodium permanganate/bromide tracer injection was completed in source area via the infiltration piping. The sodium permanganate solution consisted of 100 gallons of 40 percent stock sodium permanganate solution mixed with approximately 1000 gallons of municipal supplied water and approximately 1000 gallons from MW-22 (plus approximately 35 gallons from MW-1) in a batch tank. Approximately 35 lbs of sodium bromide was dissolved in a 300-gallon batch of sodium permanganate solution. The prepared solution was gravity fed to the infiltration gallery piping at a maximum injection rate of 13 gallons per minute gpm. No problems were encountered during injection activities.

October 2005 Groundwater Monitoring. Prior to the sodium permanganate injections, a groundwater monitoring event was conducted to assess baseline groundwater conditions. The baseline event was conducted in October 2005 and included monitoring wells MW-1 through MW-4, MW-9, MW-10, MW-14, MW-16, MW-17, MW-21, MW-22, and DEQ-1 through DEQ-5. Based on comparison of 2004 post-IRAM and 2005 baseline groundwater monitoring data, VOC contaminant concentrations appear to be decreasing at the site.

November 2005 Groundwater Monitoring Results. Upon completion of sodium permanganate and bromide tracer injections, post-injection groundwater monitoring (November 2005) was performed on the four on-site monitoring wells (MW-3, MW-4, MW-22, and DEQ-4). Bromide results were inconclusive after one month and appear to be masked by the 2004 bromide injection. The effectiveness of the sodium permanganate in reducing VOC concentrations was not conclusive since concentrations in DEQ-4 went up, MW-3 and MW-4 were within the range of previous results, and MW-22 showed reduced concentrations.

7.2 Recommendations

Based on the current understanding of site conditions including the IRAM activities and the conclusions discussed above, the groundwater monitoring program should be continued and will be designed to determine the following: (1) magnitude and extent of groundwater contamination; (2) assess the effectiveness of previously completed IRAM activities; and (3) evaluation of potential future remedial actions to be conducted at the site. Potential future remedial actions include, but not limited to biostimulation (with a possible recirculation component) and additional chemical oxidation. Future groundwater monitoring events should consist of the collection of groundwater samples from the existing monitoring well network (MW-1 through MW-4, MW-9, MW-10, MW-14, MW-16, MW-17, MW-21, MW-22, and DEQ-1 through DEQ-5) and nearby domestic wells (1460 G Street, 1441 M Street, and 1350 N Street). Bromide analysis should expand to include monitoring wells MW-3, MW-4, MW-14, MW-16, MW-17, MW-21, MW-22, DEQ-1 and DEQ-2. Concurrent with and based on results of the monitoring program, we recommend that remedial alternatives be reevaluated to reduce VOC concentrations.

8.0 REFERENCES

Freeze, R. A. and F.T. Cherry, 1979. Groundwater. Prentice-Hall, Inc., Englewood Cliffs, New Jersey.

Hart Crowser, 2002. *Site Investigation Report, Springvilla Dry Cleaners, Mohawk Shopping Center, Springfield, Oregon*. October 17, 2002.

Hart Crowser, 2003. *Interim Removal Measures Report, Springvilla Dry Cleaners, Mohawk Shopping Center, Springfield, Oregon*. April 15, 2003.

Hart Crowser, 2004. *Expanded Beneficial Use Evaluation Report, Springvilla Dry Cleaners, Mohawk Shopping Center, Springvilla, Oregon*. January 13, 2004.

Hart Crowser, 2005. *Interim Removal Action Measure Report, Springvilla Dry Cleaners, Springfield, Oregon.* April 11, 2005.

Oregon Department of Environmental Quality, (DEQ), 2003. Risk-Based *Decision Making for the Remediation of Petroleum- Contaminated Sites*. September 22, 2003.

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Table 1 - Groundwater Elevations
Former Springvilla Dry Cleaners
Mohawk Shopping Center, Springfield, Oregon

Well	TOC	Date Measured	Depth to Water (Feet below TOC)	Groundwater Surface Elevation (Feet, MSL)
Shallow-Depth Monitoring Wells				
MW-1	462.73	21-Aug-02	10.67	452.06
(27.7)		24-Jun-03	9.88	452.85
		5-Jan-04	4.82	457.91
		12-Apr-04	7.45	455.28
		12-Oct-04	8.05	454.68
		14-Jan-05	6.73	456.00
		20-Apr-05	5.60	457.13
		18-Jul-05	8.71	454.02
		13-Oct-05	9.03	453.70
		20-Oct-05	8.98	453.75
		21-Oct-05	8.93	453.80
MW-2	462.95	21-Aug-02	11.30	451.65
(24.73)		24-Jun-03	10.58	452.37
		5-Jan-04	5.50	457.45
		12-Apr-04	8.03	454.92
		12-Oct-04	8.65	454.30
		14-Jan-05	7.35	455.60
		20-Apr-05	6.21	456.74
		13-Oct-05	9.75	453.20
		20-Oct-05	9.72	453.23
		21-Oct-05	9.67	453.28
MW-3	463.03	21-Aug-02	12.22	450.81
(24.47)		24-Jun-03	11.50	451.53
		5-Jan-04	6.47	456.56
		12-Apr-04	8.67	454.36
		12-Oct-04	9.27	453.76
		14-Jan-05	8.02	455.01
		20-Apr-05	7.38	455.65
		13-Oct-05	10.53	452.50
		20-Oct-05	10.22	452.81
		21-Oct-05	10.34	452.69
		21-Nov-05	9.08	453.95
MW-4	459.54	21-Aug-02	10.46	449.08
(24.45)		24-Jun-03	9.68	449.86
		5-Jan-04	4.48	455.06
		12-Apr-04	7.00	452.54
		12-Oct-04	8.00	451.54
		13-Jan-05	6.19	453.35
		25-Feb-05	6.14	453.40
		20-Apr-05	5.78	453.76
		13-Oct-05	9.38	450.16
		20-Oct-05	8.83	450.71
		21-Oct-05	9.34	450.20
		21-Nov-05	7.35	452.19
MW-5	460.06	21-Aug-02	9.54	450.52
(24.23)		24-Jun-03	9.01	451.05
		5-Jan-04	4.26	455.80
		12-Apr-04	6.36	453.70
		12-Oct-04	7.36	452.70
		13-Jan-05	5.58	454.48
		25-Feb-05	5.73	454.33
		20-Apr-05	5.31	454.75
		13-Oct-05	8.49	451.57
MW-6	463.64	21-Aug-02	12.01	451.63
(24.57)		24-Jun-03	11.19	452.45
		5-Jan-04	6.33	457.31
		12-Apr-04	8.88	454.76
		12-Oct-04	8.80	454.84
		14-Jan-05	7.49	456.15
		20-Apr-05	6.95	456.69
		13-Oct-05	10.64	453.00

Please refer to notes on last page of table.

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Mohawk Shopping Center, Springfield, Oregon

Well	TOC	Date Measured	Depth to Water (Feet below TOC)	Groundwater Surface Elevation (Feet, MSL)
Shallow-Depth Monitoring Wells (cont.)				
MW-8	463.39	21-Aug-02	11.44	451.95
(26.77)		24-Jun-03	10.75	452.64
		5-Jan-04	5.61	457.78
		12-Apr-04	8.28	455.11
		12-Oct-04	8.88	454.51
		14-Jan-05	7.55	455.84
		20-Apr-05	6.40	456.99
		13-Oct-05	9.92	453.47
		20-Oct-05	9.90	453.49
		21-Oct-05	9.83	453.56
MW-10	461.01	21-Aug-02	10.57	450.44
(24.86)		25-Jun-03	9.92	451.09
		6-Jan-04	4.89	456.12
		12-Apr-04	7.60	453.41
		12-Oct-04	8.52	452.49
		14-Jan-05	6.88	454.13
		25-Feb-05	6.76	454.25
		20-Apr-05	5.83	455.18
		18-Jul-05	9.29	451.72
		13-Oct-05	9.63	451.38
		20-Oct-05	9.46	451.55
		21-Oct-05	9.63	451.38
MW-12	462.36	21-Aug-02	9.91	452.45
(24.38)		25-Jun-03	9.28	453.08
		6-Jan-04	4.17	458.19
		12-Apr-04	6.87	455.49
		12-Oct-04	7.25	455.11
		14-Jan-05	6.00	456.36
		20-Apr-05	4.96	457.40
		13-Oct-05	8.38	453.98
		20-Oct-05	8.39	453.97
		21-Oct-05	8.28	454.08
MW-16	461.36	21-Aug-02	10.61	450.75
(29.62)		24-Jun-03	10.03	451.33
		5-Jan-04	4.18	457.18
		12-Apr-04	7.09	454.27
		12-Oct-04	7.56	453.80
		14-Jan-05	6.30	455.06
		20-Apr-05	5.86	455.50
		18-Jul-05	9.06	452.30
		13-Oct-05	9.20	452.16
MW-18	462.71	21-Aug-02	10.30	452.41
(24.58)		24-Jun-03	9.63	453.08
		5-Jan-04	4.32	458.39
		12-Apr-04	7.01	455.70
		12-Oct-04	7.38	455.33
		14-Jan-05	6.15	456.56
		20-Apr-05	5.28	457.43
		13-Oct-05	8.35	454.36
		20-Oct-05	8.29	454.42
		21-Oct-05	8.27	454.44
MW-22	462.88	21-Aug-02	14.73	448.15
(24.86)		24-Jun-03	11.36	451.52
		5-Jan-04	7.30	455.58
		12-Apr-04	8.83	454.05
		12-Oct-04	9.51	453.37
		13-Jan-05	8.30	454.58
		20-Apr-05	7.49	455.39
		18-Jul-05	10.42	452.46
		13-Oct-05	10.77	452.11
		20-Oct-05	10.64	452.24
		21-Oct-05	10.53	452.35
		21-Nov-05	9.27	453.61

Please refer to notes on last page of table.

Table 1 - Groundwater Elevations
Former Springvilla Dry Cleaners
Mohawk Shopping Center, Springfield, Oregon

Well	TOC	Date Measured	Depth to Water (Feet below TOC)	Groundwater Surface Elevation (Feet, MSL)
Shallow-Depth Monitoring Wells (cont.)				
DEQ-4	463.81	28-Oct-04	9.00	454.81
(19.0)		13-Jan-05	7.87	455.94
		20-Apr-05	7.12	456.69
		18-Jul-05	10.4	453.41
		13-Oct-05	10.57	453.24
		21-Nov-05	9.13	454.68
DEQ-5	463.73	28-Oct-04	8.46	455.27
(14.0)		13-Jan-05	7.80	455.93
		20-Apr-05	7.49	456.24
		18-Jul-05	9.60	454.13
		13-Oct-05	10.38	453.35
Intermediate-Depth Monitoring Wells (cont.)				
MW-7	463.90	21-Aug-02	15.30	448.60
(68.66)		24-Jun-03	14.59	449.31
		5-Jan-04	8.58	455.32
		12-Apr-04	11.67	452.23
		12-Oct-04	12.89	451.01
		14-Jan-05	10.37	453.53
		20-Apr-05	10.13	453.77
		13-Oct-05	14.23	449.67
MW-9	463.73	21-Aug-02	14.28	449.45
(71.33)		24-Jun-03	13.66	450.07
		5-Jan-04	7.66	456.07
		12-Apr-04	10.72	453.01
		12-Oct-04	12.00	451.73
		14-Jan-05	9.67	454.06
		20-Apr-05	9.10	454.63
		18-Jul-05	13.06	450.67
		13-Oct-05	13.03	450.70
MW-11	460.56	21-Aug-02	12.80	447.76
(70.37)		25-Jun-03	12.09	448.47
		6-Jan-04	6.17	454.39
		12-Apr-04	9.15	451.41
		12-Oct-04	10.50	450.06
		14-Jan-05	8.10	452.46
		25-Feb-05	8.10	452.46
		20-Apr-05	7.74	452.82
		18-Jul-05	11.83	448.73
		13-Oct-05	11.78	448.78
MW-14	459.53	21-Aug-02	12.36	447.17
(59.07)		24-Jun-03	11.35	448.18
		5-Jan-04	5.13	454.40
		12-Apr-04	8.09	451.44
		12-Oct-04	9.72	449.81
		14-Jan-05	6.97	452.56
		25-Feb-05	7.05	452.48
		20-Apr-05	6.83	452.70
		13-Oct-05	11.17	448.36
		21-Oct-05	11.20	448.33
MW-17	461.38	21-Aug-02	14.08	447.30
(69.67)		24-Jun-03	12.77	448.61
		5-Jan-04	6.16	455.22
		12-Apr-04	9.71	451.67
		12-Oct-04	11.24	450.14
		14-Jan-05	8.15	453.23
		25-Feb-05	8.19	453.19
		20-Apr-05	8.21	453.17
		18-Jul-05	12.99	448.39
		13-Oct-05	12.89	448.49
		21-Oct-05	12.91	448.47

Please refer to notes on last page of table.

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Former Springvilla Dry Cleaners
Mohawk Shopping Center, Springfield, Oregon

Well	TOC	Date Measured	Depth to Water (Feet below TOC)	Groundwater Surface Elevation (Feet, MSL)
Intermediate-Depth Monitoring Wells (cont.)				
MW-21	463.25	21-Aug-02	15.98	447.27
(70.64)		24-Jun-03	15.04	448.21
		5-Jan-04	8.72	454.53
		12-Apr-04	11.87	451.38
		12-Oct-04	13.26	449.99
		14-Jan-05	10.68	452.57
		25-Feb-05	10.69	452.56
		20-Apr-05	10.49	452.76
		18-Jul-05	15.03	448.22
		13-Oct-05	14.90	448.35
		21-Oct-05	14.97	448.28
DEQ-1	462.02	21-Aug-02	15.36	446.66
(89.49)		25-Jun-03	13.94	448.08
		6-Jan-04	7.74	454.28
		12-Apr-04	10.82	451.20
		12-Oct-04	12.30	449.72
		13-Jan-05	9.80	452.22
		25-Feb-05	9.70	452.32
		20-Apr-05	9.46	452.56
		13-Oct-05	13.68	448.34
DEQ-2	460.89	21-Aug-02	13.68	447.21
(69.84)		24-Jun-03	12.90	447.99
		5-Jan-04	5.78	455.11
		12-Apr-04	9.73	451.16
		12-Oct-04	11.49	449.40
		13-Jan-05	8.45	452.44
		20-Apr-05	8.77	452.12
		18-Jul-05	13.60	447.29
		13-Oct-05	13.52	447.37
DEQ-3	455.01	21-Aug-02	20.61	434.40
(118.5)		24-Jun-03	14.85	440.16
		5-Jan-04	6.51	448.50
		12-Apr-04	9.00	446.01
		12-Oct-04	10.79	444.22
		13-Jan-05	8.33	446.68
		20-Apr-05	8.36	446.65
		18-Jul-05	17.54	437.47
		13-Oct-05	13.36	441.65

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Notes:
TOC = Top of casing elevation (in feet above mean sea level [MSL]).
(27.7) = Well depth (in feet below ground surface [BGS]).

Table 2 - Summary of Groundwater Field Parameters
Former Springvilla Dry Cleaners
Mohawk Shopping Center, Springfield, Oregon

Well	Sample Date	Temperature (°C)	pH	Electrical Conductivity (μMHOs)	Oxygen Reduction Potential (mV)	Dissolved Oxygen (mg/L)
Shallow-Depth Monitoring Wells						
MW-1	12-Oct-04	--	--	--	--	--
	14-Jan-05	12.62	7.38	187	166	3.81
	21-Apr-05	16.83	6.82	202	121	0.38
	18-Jul-05	18.64	6.32	202	204	0.51
	13-Oct-05	18.31	6.87	218	77	1.05
MW-3	24-Jun-03	18.34	6.47	313	335	0.74
	5-Jan-04	17.33	6.68	313	2.39	0.95
	12-Apr-04	17.32	6.46	300	210	0.79
	12-Oct-04	17.29	6.40	300	189	0.86
	14-Jan-05	12.45	6.90	235	183.5	3.70
	21-Apr-05	16.70	6.57	312	120	0.57
	14-Oct-05	19.29	6.64	338	97	2.40
	21-Nov-05	18.19	6.79	350	172	9.85
MW-4	24-Jun-03	18.34	6.47	313	335	0.74
	5-Jan-04	15.99	6.82	243	212	1.50
	12-Apr-04	16.75	6.80	254	169	0.97
	12-Oct-04	17.01	7.01	256	160	0.99
	13-Jan-05	14.05	6.97	242	137.8	3.49
	25-Feb-05	16.93	6.74	260	139	1.74
	20-Apr-05	17.07	6.73	267	107	0.71
	14-Oct-05	17.71	7.08	243	92	2.98
	21-Nov-05	16.75	6.40	265	184	9.85
MW-5	24-Jun-03	17.14	6.07	204	394	0.92
	5-Jan-04	15.98	6.36	198	252	2.22
	12-Apr-04	15.98	6.43	184	210	0.35
	12-Oct-04	15.90	7.11	174	180	0.70
	13-Jan-05	14.34	7.43	190	183.9	3.11
	25-Feb-05	16.30	6.71	246	154	0.52
	20-Apr-05	16.44	6.55	248	99	0.46
MW-10	25-Jun-03	16.17	7.01	310	96	0.21
	6-Jan-04	15.48	6.99	319	141	1.17
	13-Apr-04	16.03	7.11	284	175	0.39
	12-Oct-04	15.83	7.29	300	181	0.81
	14-Jan-05	14.05	7.21	316	142	4.01
	25-Feb-05	16.45	6.95	337	135	0.98
	21-Apr-05	16.11	7.00	342	55	0.23
	14-Oct-05	16.46	7.13	344	86	2.10
MW-16	24-Jun-03	18.52	7.20	314	340	0.48
	5-Jan-04	16.89	7.44	276	219	1.25
	12-Apr-04	17.70	7.23	298	174	0.32
	12-Oct-04	17.70	6.99	310	151	0.59
	14-Jan-05	11.88	7.35	246	181.9	4.20
	21-Apr-05	17.80	7.90	296	118	0.33
	18-Jul-05	18.74	6.96	327	212	0.45
	14-Oct-05	18.25	7.28	305	81	1.38
MW-22	24-Jun-03	17.07	6.60	384	274	2.36
	5-Jan-04	15.45	6.90	299	210	2.29
	12-Apr-04	16.77	6.86	315	153	0.80
	12-Oct-04	16.69	6.95	307	140	0.77
	13-Jan-05	12.29	6.96	366	175.6	2.92
	21-Apr-05	16.14	6.62	424	105	0.69
	18-Jul-05	16.85	6.53	476	142	0.47
	13-Oct-05	17.10	6.63	433	108	3.98
	21-Nov-05	16.35	6.12	514	181	10.61
DEQ-4	28-Oct-04	14.80	7.10	355	136.6	2.99
	13-Jan-05	13.78	8.64	180	-270.3	3.39
	21-Apr-05	14.44	8.02	279	111	1.14
	19-Jul-05	15.86	8.38	290	166	0.52
	13-Oct-05	16.00	6.72	320	70	0.52
	21-Nov-05	14.40	8.01	435	147	11.83
DEQ-5	28-Oct-04	15.20	6.90	370	99.5	2.01
	13-Jan-05	13.81	7.65	160	68.8	5.56
	21-Apr-05	14.46	7.81	140	120	1.56
	19-Jul-05	15.19	7.89	149	149	3.19
	13-Oct-05	16.00	7.16	151	74	2.63

Please refer to notes on last page of table.

Table 2 - Summary of Groundwater Field Parameters
Former Springvilla Dry Cleaners
Mohawk Shopping Center, Springfield, Oregon

Well	Sample Date	Temperature (°C)	pH	Electrical Conductivity (μMHOs)	Oxygen Reduction Potential (mV)	Dissolved Oxygen (mg/L)
Intermediate-Depth Monitoring Wells						
MW-9	18-Jul-05	18.67	6.96	261	228	0.68
	13-Oct-05	17.14	6.92	244	101	1.84
MW-11	25-Jun-03	15.97	7.44	339	178	0.18
	6-Jan-04	14.54	7.43	332	145	0.84
	13-Apr-04	15.48	7.28	343	169	0.40
	12-Oct-04	15.69	7.10	333	143	0.88
	14-Jan-05	13.45	7.66	275	149.7	8.01
	25-Feb-05	15.60	7.31	355	154	1.16
	21-Apr-05	15.62	7.27	360	66	0.26
	18-Jul-05	16.55	7.08	381	160	0.52
MW-14	24-Jun-03	17.4	7.31	207	270	1.39
	5-Jan-04	15.02	7.54	192	183	0.61
	12-Apr-04	17.02	7.18	201	147	0.51
	12-Oct-04	16.88	6.98	258	166	0.61
	14-Jan-05	11.90	7.45	171	171.9	6.61
	25-Feb-05	16.57	7.46	206	142	1.49
	20-Apr-05	17.34	7.42	213	77	0.31
	14-Oct-05	16.92	7.58	227	92	1.26
MW-17	24-Jun-03	18.07	7.25	297	349	0.25
	5-Jan-04	15.45	7.50	206	212	0.69
	12-Apr-04	17.31	7.03	266	187	0.45
	12-Oct-04	17.50	7.18	305	175	0.64
	14-Jan-05	11.50	7.40	168	188.8	4.96
	25-Feb-05	16.85	7.42	244	167	1.02
	20-Apr-05	17.60	7.24	277	67	0.31
	18-Jul-05	19.08	7.09	298	208	0.52
	14-Oct-05	18.02	7.16	303	88	1.13
MW-21	24-Jun-03	17.76	7.23	246	257	2.75
	5-Jan-04	15.35	7.54	258	205	1.13
	12-Apr-04	17.06	7.31	252	163	0.39
	12-Oct-04	17.36	7.39	280	166	0.50
	14-Jan-05	11.25	7.59	149	179.3	4.60
	25-Feb-05	16.46	7.44	267	118	0.93
	20-Apr-05	17.45	7.42	277	57	0.31
	18-Jul-05	17.34	7.42	281	146	0.44
	14-Oct-05	16.55	7.36	279	94	1.34
DEQ-1	25-Jun-03	16.08	7.08	329	142	0.20
	6-Jan-04	14.34	7.01	285	93	2.66
	13-Apr-04	15.52	6.94	298	164	0.70
	12-Oct-04	16.86	7.15	237	151	0.90
	13-Jan-05	13.54	7.52	204	140.9	5.79
	25-Feb-05	16.00	6.79	323	55	1.42
	20-Apr-05	16.43	6.70	331	7.8	0.43
	14-Oct-05	16.15	7.00	330	95	2.20
DEQ-2	24-Jun-03	17.92	7.14	224	366	0.39
	5-Jan-04	15.84	7.26	218	205	2.57
	12-Apr-04	16.75	7.07	242	195	1.35
	12-Oct-04	16.49	7.06	241	190	1.06
	13-Jan-05	12.19	7.08	146	176.7	4.93
	20-Apr-05	16.96	7.26	215	2.5	1.72
	18-Jul-05	18.39	6.94	264	190	1.19
	14-Oct-05	18.50	7.26	251	85	1.63
DEQ-3	24-Jun-03	15.9	7.67	143	303	6.68
	5-Jan-04	13.68	8.03	134	182	3.38
	12-Apr-04	14.9	7.04	137	190	0.46
	12-Oct-04	15.39	6.91	135	200	0.86
	13-Jan-05	14.69	7.05	146	204.5	1.70
	20-Apr-05	15.27	7.77	139	-16	0.41
	18-Jul-05	17.25	7.47	155	209	0.52
	14-Oct-05	15.39	7.37	148	69	0.87

Notes:
Field parameters measured by hand held meters in the field.

Table 3 - Summary of Groundwater Analytical Results (Other Data)
Former Springvilla Dry Cleaners
Mohawk Shopping Center, Springfield, Oregon

Well	Sample Date	Alkalinity[1] as CaCO3	Bromide [2]	Total Organic Carbon [3]	Competing Electron Acceptors: Total Manganese [4]	Dissolved Manganese [4]	Total Iron [4]	Dissolved Iron [4]	Nitrate [5]	Sulfate [5]
		Concentrations in mg/L (ppm)								
Shallow-Depth Monitoring Wells										
MW-1	14-Jan-05	--	--	< 0.8	0.52	0.60	1.6	0.62	2.51	8.04
	21-Apr-05	110	--	< 0.8	0.39	0.0068	0.3	< 0.028	2.5	--
	18-Jul-05	100	0.080	--	0.10	0.0220	0.084	1.2	2.4	8
	13-Oct-05	100	0.048	--	--	0.0080	<0.1	--	2.1	9.8
MW-3	14-Jan-05	--	--	< 0.8	0.32	0.030	0.050	0.068	6.22	5.12
	21-Apr-05	180	--	< 0.8	2.0	0.016	1.0	< 0.028	8	--
MW-4	21-Nov-05	--	0.0702	--	--	--	--	--	--	--
MW-16	14-Jan-05	--	--	0.8	4.0	0.27	0.94	0.15	0.361	7.57
	21-Apr-05	190	--	< 0.8	2.0	0.12	0.086	< 0.028	0.5	--
MW-22	13-Jan-05	--	--	< 0.8	6.6	0.35	2.0	0.11	4.35	16.9
	21-Apr-05	220	--	< 0.8	6.3	0.12	0.6	< 0.028	8	--
	18-Jul-05	230	0.44	--	4.9	0.68	0.19	< 0.033	8	20
	13-Oct-05	220	0.28	--	--	0.43	<0.1	--	7	14
	21-Nov-05	--	0.358	--	--	--	--	--	--	--
DEQ-4	28-Oct-04	--	--	2.5	0.24	--	--	--	--	--
	13-Jan-05	--	--	3.9	0.13	0.046	0.15	< 0.028	0.267	< 2.00
	21-Apr-05	140	--	1.8	0.092	0.35	0.092	0.036	0.7	--
	19-Jul-05	110	0.2	--	0.29	0.13	0.13	< 0.033	1.5	22
	13-Oct-05	160	0.207	--	--	0.12	<0.1	--	1	22
	21-Nov-05	--	0.314	--	--	--	--	--	--	--
DEQ-5	28-Oct-04	--	--	2.9	0.26	--	--	--	--	--
	13-Jan-05	--	--	1.0	0.24	0.11	0.78	0.48	< 0.0400	19.0
	21-Apr-05	95	--	1.0	0.48	0.37	6.7	0.53	0.5	--
	19-Jul-05	68	0.1	--	0.061	0.028	0.83	0.033	2	7.2
	13-Oct-05	80	0.018	--	--	0.0050	0.8	--	0.6	5.2
Intermediate-Depth Monitoring Wells										
MW-9	18-Jul-05	150	0.09	--	15.0	0.15	7.9	< 0.033	0.4	8.3
	13-Oct-05	150	0.066	--	--	0.16	0.9	--	0.3	8.1

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Notes:
[1] Total Alkalinity per EPA Method 310.1.
[2] Bromide per EPA Method 300.0B.
[3] Total Organic Carbon per EPA Method 415.1.
[4] Metals per EPA Method 6010B.
[5] Anions per EPA Method 300.0.
Shaded values represent detected concentrations of listed analyte.
-- = Not analyzed.

Table 4 - Summary of Shallow Groundwater Chemical Analyses Results (VOCs)
Former Springvilla Dry Cleaners
Mohawk Shopping Center, Springfield, Oregon

		VOC Concentrations in µg/L (ppb)[1]				
Well	**Sample Date**	**PCE**	**TCE**	**c-DCE**	**1,1-DCE**	**Total VOCs**
Shallow-Depth Groundwater Monitoring Wells						
MW-1	4-Oct-99	140	6.4	2.8	< 2.0	149
	7-Feb-00	120	2.8	1.1	< 1.0	124
	2-May-00	160	4.8	2.1	< 1.0	167
	19-Apr-01	140	3.5	1.2	< 1.0	145
	18-Jul-01	79	3.3	1.4	< 0.5	84
	21-Aug-02	40	2.0	< 1.0	< 1.0	42
	14-Jan-05	36	1.1	< 1.0	< 1.0	37
	21-Apr-05	30	< 1.0	< 1.0	< 1.2	30
	18-Jul-05	31	< 1.0	< 1.0	< 1.0	31
	13-Oct-05	28	1.1	< 1.0	< 1.0	29
MW-2	13-Oct-05	16	< 1.0	< 1.0	< 1.0	16
MW-3	4-Oct-99	620	11	< 1.0	< 2.0	631
	7-Feb-00	420	1.9	< 1.0	< 1.0	422
	2-May-00	570	3.4	< 1.0	< 1.0	573
	19-Apr-01	420	2.5	< 1.0	< 1.0	423
	18-Jul-01	610	< 10	< 10	< 10	610
	22-Aug-02	690	9.0	< 1.0	< 1.0	699
	24-Jun-03	380	2.9	< 1.0	< 1.0	383
	5-Jan-04	330	2.6	< 1.0	< 1.0	333
	12-Apr-04	302	2.34	< 2.0	< 2.0	304
	12-Oct-04	310	2.3	< 1.0	< 1.0	312
	14-Jan-05	290	2.3	< 1.0	< 1.0	292
	21-Apr-05	320	2.8	< 1.0	< 1.2	323
	13-Oct-05	380	< 1.0	< 1.0	< 1.0	380
	21-Nov-05	300	2.7	<1.0	<1.1	303
MW-4	7-Feb-00	19	< 1.0	< 1.0	< 1.0	19
	2-May-00	19	< 1.0	< 1.0	< 1.0	19
	19-Apr-01	8.5	< 1.0	< 1.0	< 1.0	8.5
	18-Jul-01	15	< 0.5	< 0.5	< 0.5	15
	24-Jun-03	10	< 1.0	< 1.0	< 1.0	10
	5-Jan-04	3.9	< 1.0	< 1.0	< 1.0	3.9
	12-Apr-04	9.01	< 1.0	< 1.0	< 1.0	9.0
	12-Oct-04	3.7	< 1.0	< 1.0	< 1.0	3.7
	25-Feb-05	8.4	< 1.0	< 1.0	< 1.0	8.4
	20-Apr-05	7.7	< 1.0	< 1.0	< 1.2	7.7
	13-Oct-05	< 5.0	< 1.0	< 1.0	< 1.0	< 5.0
	21-Nov-05	1.8	< 1.0	< 1.0	< 1.0	1.8
MW-5	7-Feb-00	3.0	< 1.0	< 1.0	< 1.0	3.0
	2-May-00	3.2	< 1.0	< 1.0	< 1.0	3.2
	19-Apr-01	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
	18-Jul-01	8.6	< 0.5	< 0.5	< 0.5	8.6
	21-Aug-02	< 1.0	9.4	< 1.0	< 1.0	9.4
	24-Jun-03	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
	5-Jan-04	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
	12-Apr-04	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
	12-Oct-04	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
	25-Feb-05	2.2	< 1.0	< 1.0	< 1.0	2.2
	20-Apr-05	1.6	< 1.0	< 1.0	< 1.2	1.6
MW-6	18-Jul-01	9.9	< 0.5	< 0.5	< 0.5	9.9
	21-Aug-02	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
MW-10	18-Jul-01	65	2.0	< 1.0	< 1.0	67
	21-Aug-02	16	3.5	1.2	< 1.0	21
	24-Jun-03	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
	6-Jan-04	2.7	< 1.0	< 1.0	< 1.0	2.7
	12-Apr-04	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
	12-Oct-04	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
	25-Feb-05	2.5	1.2	< 1.0	< 1.0	3.7
	21-Apr-05	2.2	1.1	< 1.0	< 1.2	3.3
	13-Oct-05	2.2	1.2	< 1.0	< 1.0	3.4
MW-12	18-Jul-01	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
	21-Aug-02	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0

Please refer to notes on last page of table.

Table 4 - Summary of Shallow Groundwater Chemical Analyses Results (VOCs)
Former Springvilla Dry Cleaners
Mohawk Shopping Center, Springfield, Oregon

		VOC Concentrations in (µg/L) (ppb)[1]				
Well	**Sample Date**	**PCE**	**TCE**	**c-DCE**	**1,1-DCE**	**Total VOCs**
Shallow-Depth Groundwater Monitoring Wells						
MW-16	18-Jul-01	1,500	31	< 25	< 25	1,531
	24-Jun-03	1,100	38	8.1	< 1.0	1,146
	5-Jan-04	1,800	42	10	< 1.0	1,852
	12-Apr-04	1,250	39.7	< 10	< 10	1,290
	12-Oct-04	1,200	48	5.9	< 1.0	1,254
	14-Jan-05	1,500	47	6.8	< 1.0	1,554
	21-Apr-05	1,300	44	< 10.0	< 12.0	1,344
	18-Jul-05	1,100	49	< 10.0	< 10.0	1,149
	13-Oct-05	1,500 E	71	8.1	< 1.0	79
MW-22	18-Jul-01	1,300	< 25	< 25	< 25	1,300
	24-Jun-03	300	1.2	< 1.0	< 1.0	301
	5-Jan-04	420	2.1	< 1.0	< 1.0	422
	12-Apr-04	364	< 5.0	< 5.0	< 5.0	364
	12-Oct-04	240	< 1.0	< 1.0	< 1.0	240
	13-Jan-05	260	1.2	< 1.0	< 1.0	261
	21-Apr-05	230	1.0	< 1.0	< 1.0	231
	18-Jul-05	160	< 5.0	< 5.0	< 5.0	160
	13-Oct-05	250	1.1	<1.0	<1.0	251
	21-Nov-05	92	<1.0	<1.0	<1.0	92
DEQ-4	28-Oct-04 *	7,800	43.0	< 1.0	< 1.0	7,843
	13-Jan-05 *	4,500	26.0	< 1.0	< 1.0	4,526
	21-Apr-05	3,300	< 25.0	< 25.0	< 30.0	3,300
	19-Jul-05	3,100	< 20.0	< 20.0	< 20.0	3,100
	13-Oct-05 *	1,600 E	13.0	< 1.0	< 1.0	1,615
	11/21/2005 *	5,200	10.0	<1.0	<1.0	5,213
DEQ-5	28-Oct-04 *	170	1.0	< 1.0	< 1.0	171
	13-Jan-05	190	1.2	< 1.0	< 1.0	191
	21-Apr-05	100	1.9	1.5	< 1.0	103
	19-Jul-05	140	< 1.0	< 1.0	< 1.0	140
	13-Oct-05 **	150	1.0	< 1.0	< 1.0	154

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Notes:
[1] Volatile Organic Compound (VOC) per EPA Method 8260B.
PCE = Tetrachloroethene.
TCE = Trichloroethene.
c-DCE = *cis*-1,2-Dichloroethene.
1,1-DCE = 1,1-Dichloroethene.
E = Value above quantitation range.
Shaded values represent detected concentrations of listed analyte.
* = Chloroform detected in sample.
** = Chloroform and 4-Isopropyltoluene detected in sample.

Table 5 - Summary of Intermediate Groundwater Chemical Analyses Results (VOCs)
Former Springvilla Dry Cleaners
Mohawk Shopping Center, Springfield, Oregon

		VOC Concentrations in µg/L (ppb)[1]				
Well	**Sample Date**	**PCE**	**TCE**	**c-DCE**	**1,1-DCE**	**Total VOCs**
Intermediate-Depth Monitoring Wells						
MW-7	18-Jul-01	83	2.9	1.7	< 0.5	88
	21-Aug-02	63	2.3	1.2	< 1.0	67
MW-9	18-Jul-01	49	2.1	1.1	< 0.5	52
	22-Aug-02	24	1.9	1.0	< 1.0	27
	18-Jul-05	12	< 1.0	< 1.0	< 1.0	12
	13-Oct-05	13	100	< 1.0	< 1.0	113
MW-11	18-Jul-01	77	2.5	< 0.5	< 0.5	80
	21-Aug-02	66	2.2	< 1.0	< 1.0	68
	24-Jun-03	100	2.1	< 1.0	< 1.0	102
	6-Jan-04	110	1.9	< 1.0	< 1.0	112
	12-Apr-04	125	1.88	< 1.0	< 1.0	127
	12-Oct-04	32	1.1	< 1.0	< 1.0	33
	25-Feb-05	150	2.2	< 1.0	< 1.0	152
	21-Apr-05	140	1.9	< 1.0	< 1.2	142
	18-Jul-05	120	1.8	< 1.0	< 1.0	122
MW-14	18-Jul-01	1,200	9.5	< 2.5	< 2.5	1,210
	22-Aug-02	800	7.2	1.0	< 1.0	808
	24-Jun-03	720	2.1	1.0	< 1.0	723
	5-Jan-04	760	9.4	1.1	< 1.0	771
	12-Apr-04	781	7.45	< 5.0	< 5.0	788
	12-Oct-04	690	7.4	< 1.0	< 1.0	697
	25-Feb-05	930	7.6	< 1.0	< 1.0	938
	20-Apr-05	770	< 10.0	< 10.0	< 12.0	770
	13-Oct-05	780 E	7.8	< 1.0	< 1.0	8
MW-17	18-Jul-01	1,200	11	< 0.5	< 0.5	1,211
	22-Aug-02	490	7.7	2.1	< 1.0	500
	24-Jun-03	350	6.2	2.4	< 1.0	359
	5-Jan-04	660	12	4.1	< 1.0	676
	12-Apr-04	335	6.68	2.58	< 2.0	344
	12-Oct-04	680	12	4.0	< 1.0	696
	25-Feb-05	470	7.8	2.8	< 1.0	481
	20-Apr-05	270	< 10.0	< 10.0	< 12.0	270
	18-Jul-05	260	5.5	< 5.0	< 5.0	266
	13-Oct-05	230	4.9	1.6	< 1.0	237
MW-21	18-Jul-01	2,000	17.0	1.1	0.64	2,019
	22-Aug-02	1,100	11.0	1.1	< 1.0	1,112
	24-Jun-03	860	9.0	1.0	< 1.0	870
	5-Jan-04	680	7.9	1.0	< 1.0	689
	12-Apr-04	701	7.70	< 5.0	< 5.0	709
	12-Oct-04	1,600	15	1.3	< 1.0	1,616
	25-Feb-05	890	8.7	< 1.0	< 1.0	899
	20-Apr-05	790	< 10.0	< 10.0	< 12.0	790
	18-Jul-05	770	< 10.0	< 10.0	< 10.0	770
	13-Oct-05	870 E	9.6	< 1.0	< 1.0	10
DEQ-1	22-Aug-02	150	2.1	< 1.0	< 1.0	152
	24-Jun-03	140	1.6	< 1.0	< 1.0	142
	6-Jan-04	85	1.1	< 1.0	< 1.0	86
	12-Apr-04	119	1.23	< 1.0	< 1.0	120
	12-Oct-04	25	< 1.0	< 1.0	< 1.0	25
	25-Feb-05	150	1.4	< 1.0	< 1.0	151
	20-Apr-05	110	1.2	< 1.0	< 1.2	111
	13-Oct-05	130	1.5	< 1.0	< 1.0	132
DEQ-2	22-Aug-02	1,100	10.0	1.6	< 1.0	1,112
	24-Jun-03	690	8.0	1.6	< 1.0	700
	5-Jan-04	520	7.6	1.3	< 1.0	529
	12-Apr-04	478	6.25	< 5.0	< 5.0	484
	12-Oct-04	420	< 1.0	< 1.0	< 1.0	420
	13-Jan-05	190	2.6	< 1.0	< 1.0	193
	20-Apr-05	380	5.3	1.1	< 1.2	386
	18-Jul-05	350	< 10	< 10	< 10	350
	13-Oct-05	350	6.5	1.2	< 1.0	358
DEQ-3	22-Aug-02	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
	24-Jun-03	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
	5-Jan-04	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
	12-Apr-04	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
	12-Oct-04	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
	13-Jan-05	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
	20-Apr-05	< 1.0	< 1.0	< 1.0	< 1.2	< 1.0
	18-Jul-05	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
	13-Oct-05	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0

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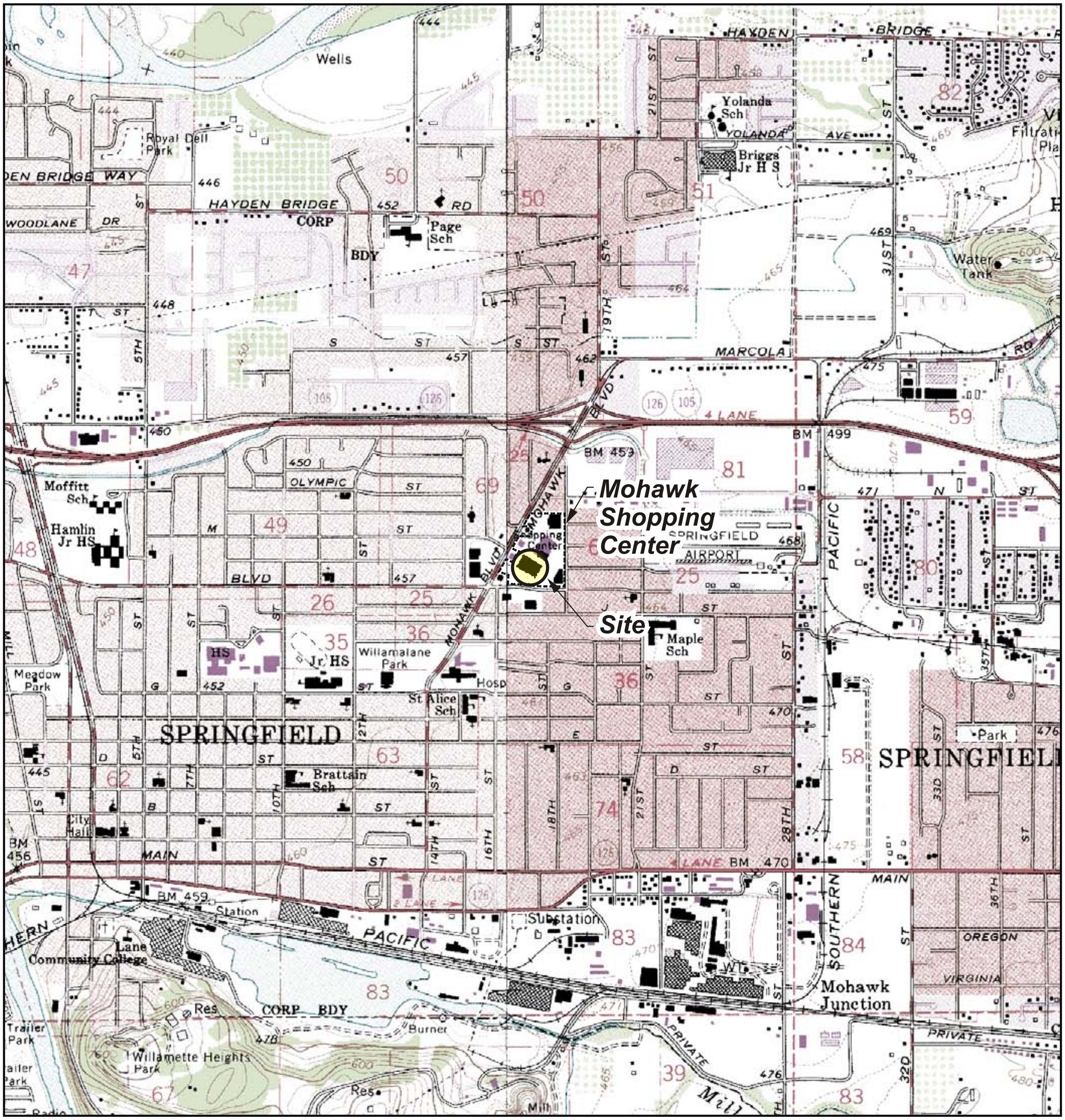
Notes:
[1] Volatile Organic Compound (VOC) per EPA Method 8260B.
PCE = Tetrachloroethene.
TCE = Trichloroethene.
c-DCE = *cis*-1,2-Dichloroethene.
1,1-DCE = 1,1-Dichloroethene.
E = Value above quantitation range.
Shaded values represent detected concentrations of listed analyte.

Site Location Map

Former Springvilla Dry Cleaners
Mohawk Shopping Center, Springfield, Oregon



Note: Base map prepared from the USGS 7.5-minute quadrangles of Eugene East and Springfield, OR, photorevised 1986.

0 2,000 4,000

Scale in Feet

Contour Interval 20 Feet

N

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15267-02/Task 2 *4/06*

Figure 1

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Site Vicinity Plan

Former Springvilla Dry Cleaners
Mohawk Shopping Center, Springfield, Oregon

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Note: Base map prepared from the USGS 7.5-minute quadrangles of Eugene East and Springfield, OR, photorevised 1986.

0 1,000 2,000

Scale in Feet
Contour Interval 20 Feet

Q Street Well ⊕ SUB Production Well Location and Identification

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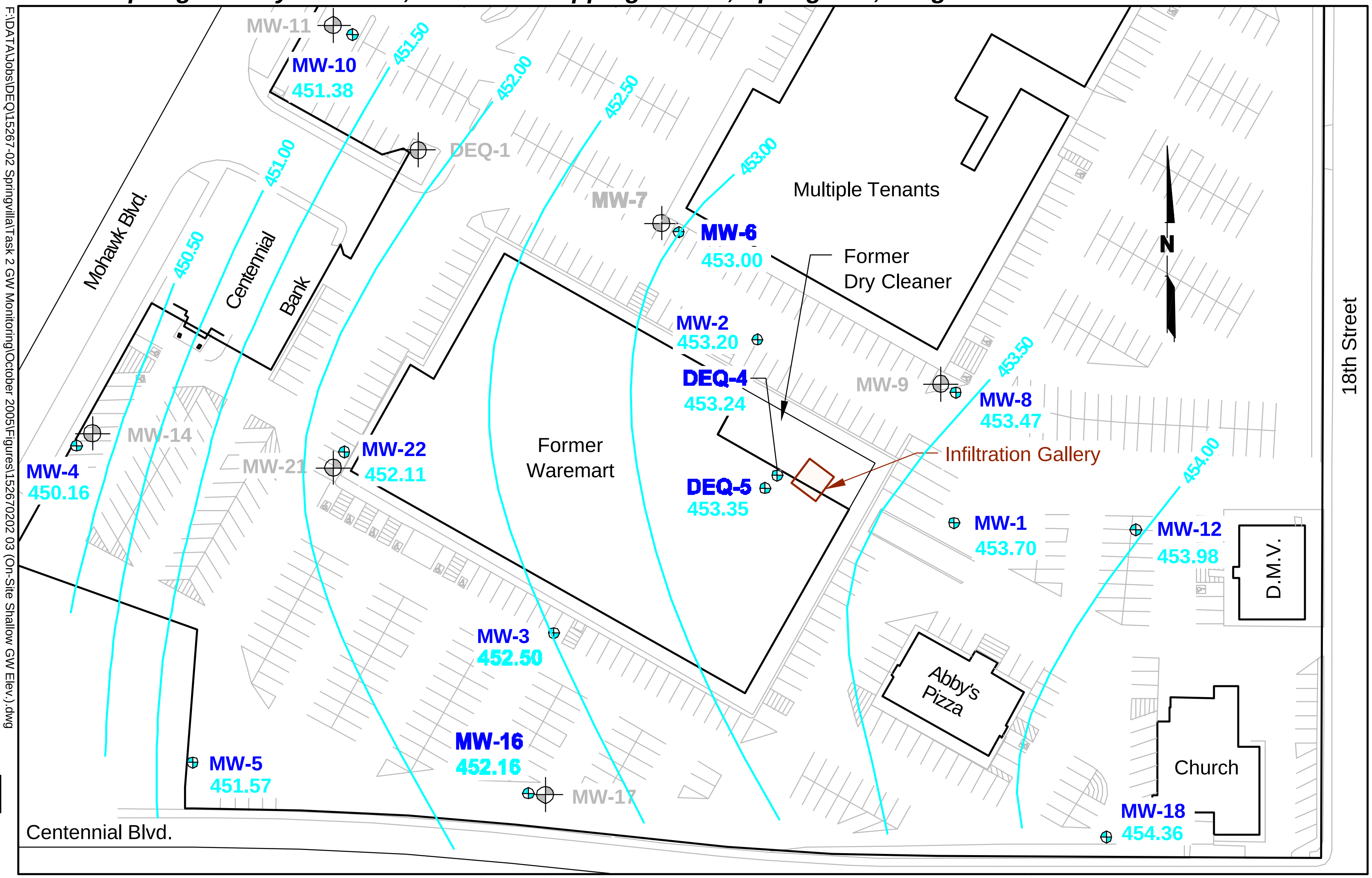
15267-02/Task 2 *4/06*
Figure 2

Shallow Groundwater Elevations (On-Site) - October 2005
Former Springvilla Dry Cleaners, Mohawk Shopping Center, Springfield, Oregon



Note: **Base map prepared from a plan provided by Maul Foster & Alongi (from a Groundwater Assessment Report, dated November 21, 2001).**

0 100 200

Approximate Scale in Feet

MW-10 451.38 — Shallow Monitoring Well Location and Number (Screen Depth 25-30 Feet bgs) Groundwater Elevation in Feet Above MSL

MW-7 — Intermediate Monitoring Well Location and Number (Screen Depth 60-90 Feet bgs)

452.00 — Groundwater Elevation Contour in Feet Above MSL

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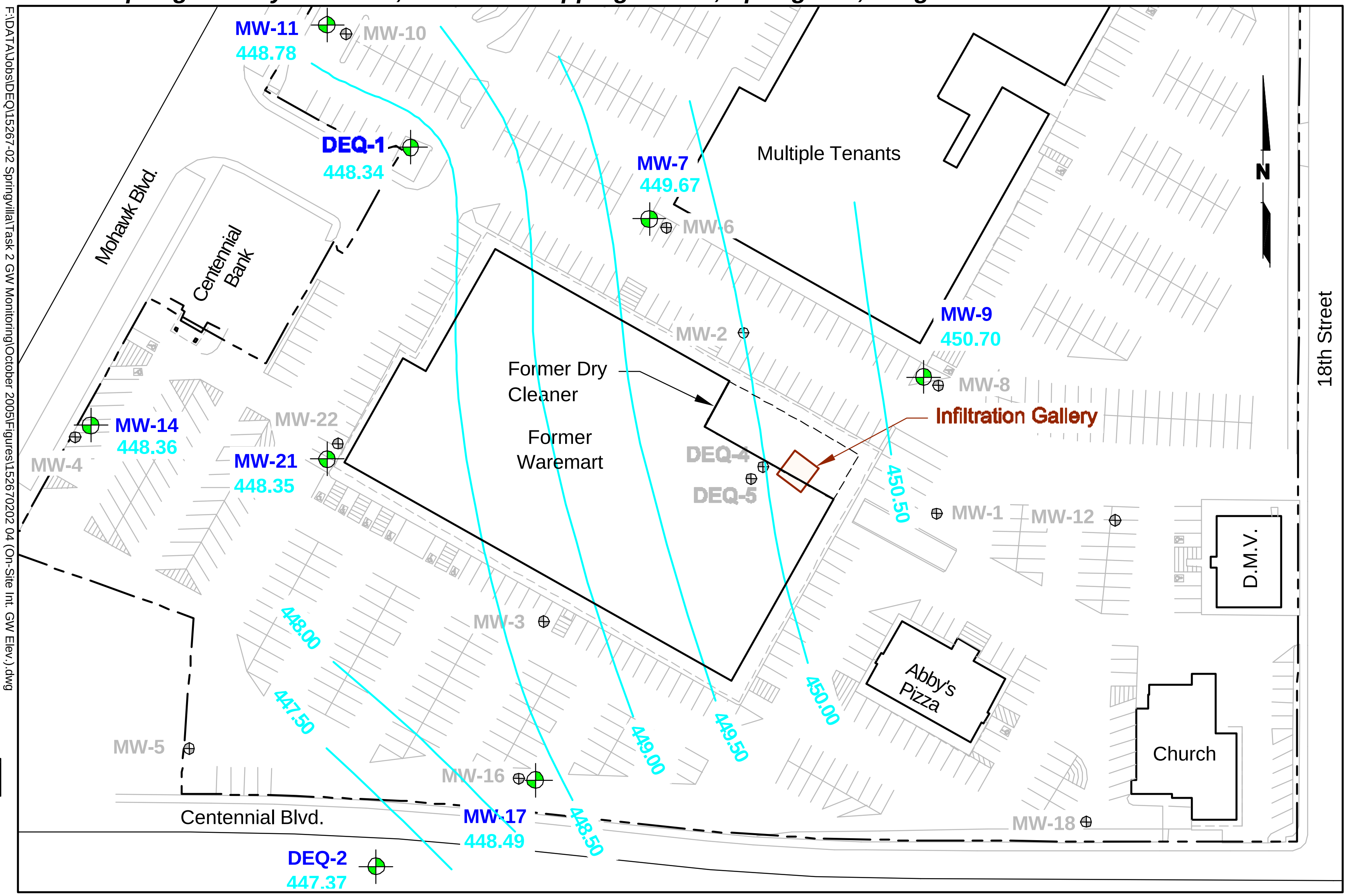
15267-02/Task 2 4/06

Figure 3

Intermediate Groundwater Elevations (On-Site) - October 2005
Former Springvilla Dry Cleaners, Mohawk Shopping Center, Springfield, Oregon



Note: **Base map prepared from a plan provided by Maul Foster & Alongi (from a Groundwater Assessment Report, dated November 21, 2001).**

MW-1 ⊕ Shallow Monitoring Well Location and Number (Screen Depth 25-30 Feet bgs)

MW-9 450.70 Intermediate Monitoring Well Location and Number (Screen Depth 60-90 Feet bgs)
Groundwater Elevation in Feet Above MSL

449.50 Groundwater Elevation Contour in Feet Above MSL

0 100 200
Approximate Scale in Feet

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15267-02/Task 2 *4/06*
Figure 4

Groundwater Elevations (Off-Site) - October 2005

Former Springvilla Dry Cleaners
Mohawk Shopping Center, Springfield, Oregon

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Note: Base map prepared from the USGS 7.5-minute quadrangles of Eugene East and Springfield, OR, photorevised 1986.

0 1,000 2,000

Scale in Feet
Contour Interval 20 Feet

Q Street Well — SUB Production Well Location and Identification

DEQ-2 447.37 — Monitoring Well Location and Number; Groundwater Elevation in Feet Above MSL

Approximate Groundwater Flow Direction

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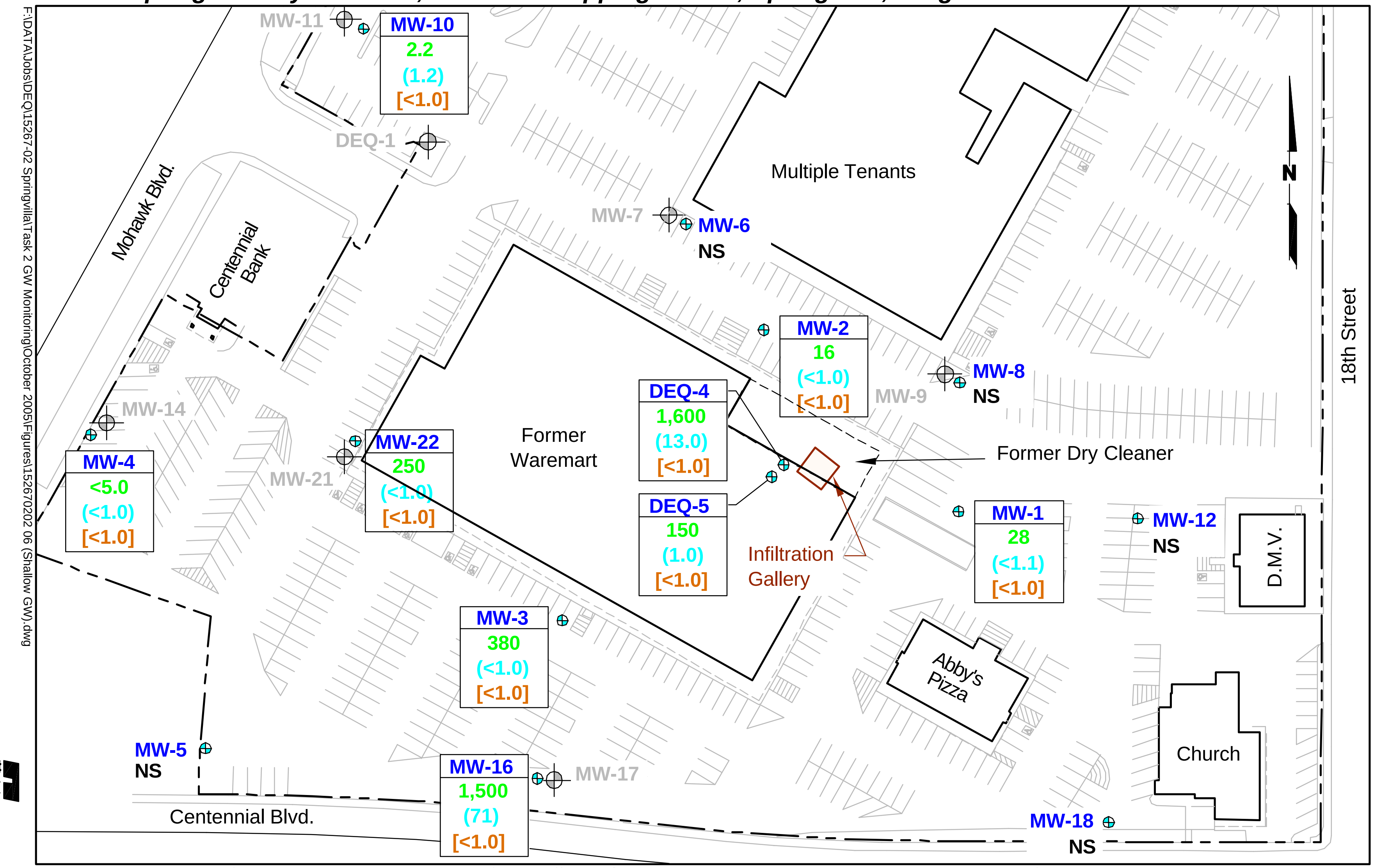
15267-02/Task 2 ***4/06***
Figure 5

Shallow Groundwater Chemical Results (On-Site) - October 2005
Former Springvilla Dry Cleaners, Mohawk Shopping Center, Springfield, Oregon



Note: **Base map prepared from a plan provided by Maul Foster & Alongi (from a Groundwater Assessment Report, dated November 21, 2001).**

0 100 20

Approximate Scale in Feet

MW-7 — Intermediate Monitoring Well Location and Number (Screen Depth 60-90 Feet BGS)

MW-16 — Shallow Monitoring Well Location and Number (Screen Depth 25-30 Feet BGS)

1,500 — Tetrachloroethene Concentration in µg/L

(71) — Trichloroethene Concentration in µg/L

[<1.0] — cis - 1,2 - Dichloroethene Concentration in µg/L

NS = Not Sampled

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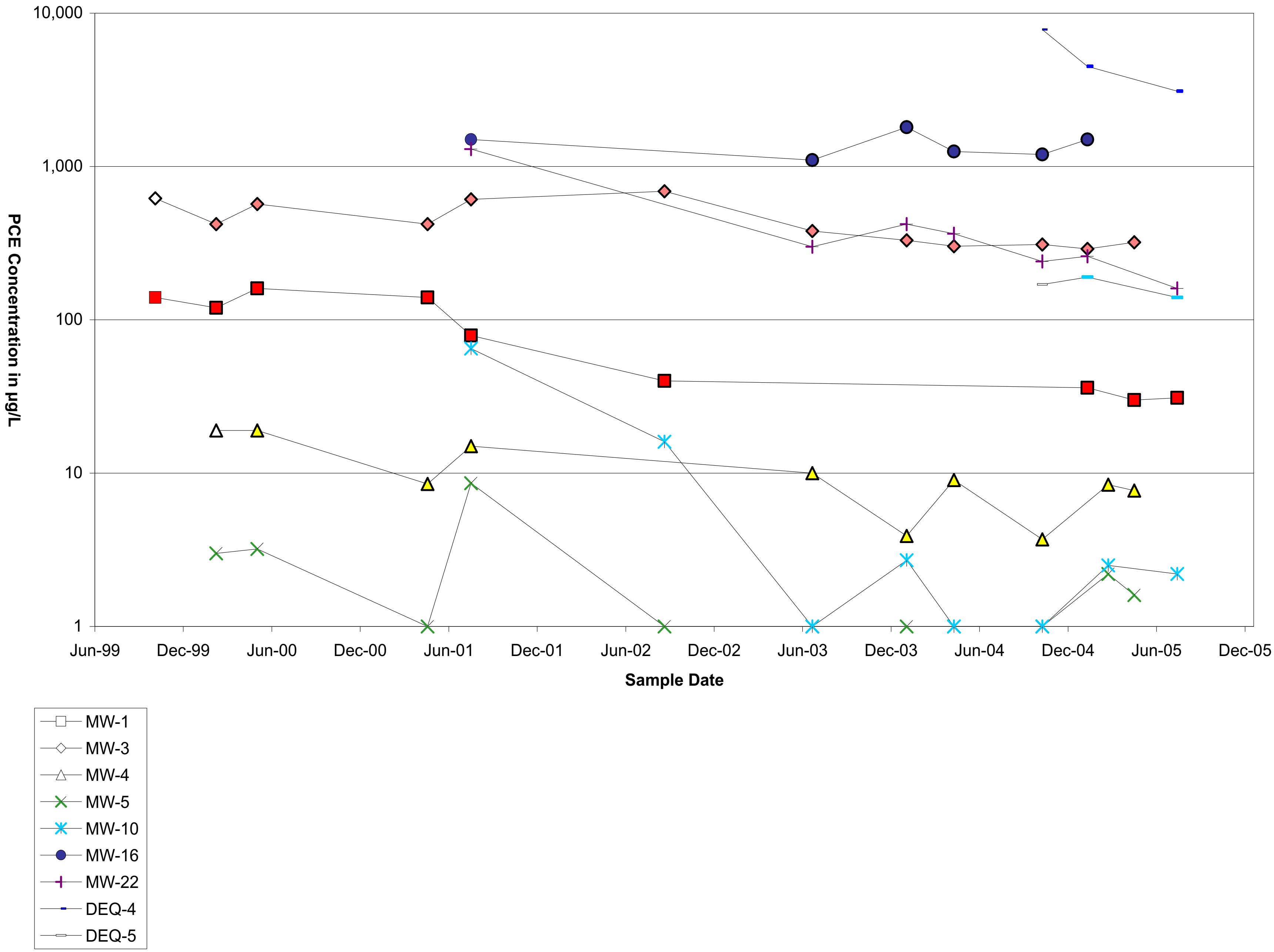
15267-02/Task 2 4/06

Figure 6

PCE Concentrations in Shallow Groundwater
Former Springvilla Dry Cleaners
Mohawk Shopping Center, Springfield, Oregon



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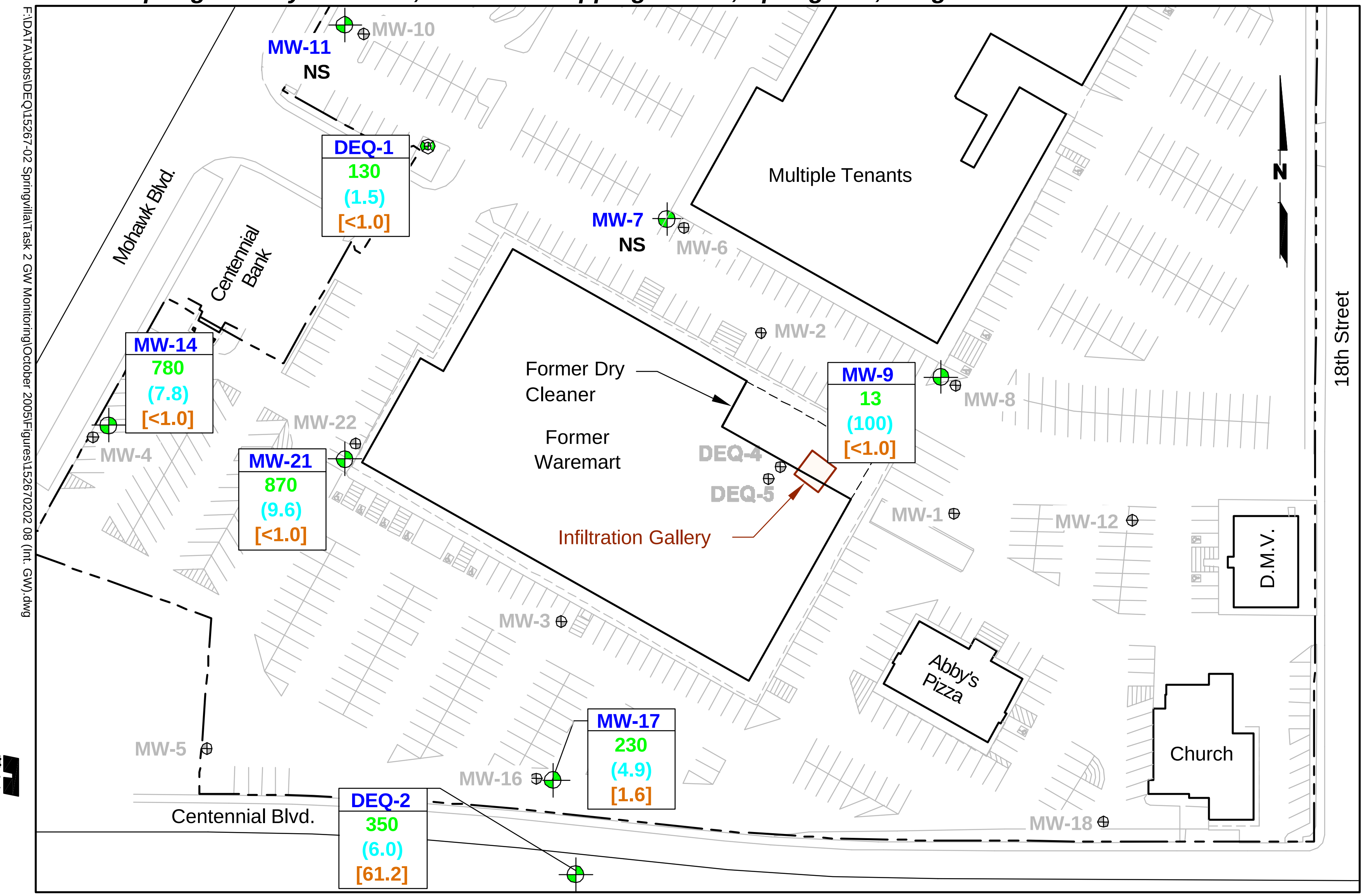
15267-02/Task 2 *4/06*
Figure 7

Intermediate Groundwater Chemical Results (On-Site) - October 2005
Former Springvilla Dry Cleaners, Mohawk Shopping Center, Springfield, Oregon



MW-1 — Shallow Monitoring Well Location and Number (Screen Depth 25-30 Feet BGS)

DEQ-1 — Deep Monitoring Well Location and Number (Screen Depth 80-90 Feet BGS)

MW-17	Intermediate Monitoring Well Location and Number (Screen Depth 60-70 Feet BGS)
230	Tetrachloroethene Concentration in µg/L
(4.9)	Trichloroethene Concentration in µg/L
[1.6]	cis - 1,2 - Dichloroethene Concentration in µg/L

NS = Not Sampled

Note: **Base map prepared from a plan provided by Maul Foster & Alongi (from a Groundwater Assessment Report, dated November 21, 2001).**

0 100 200
Approximate Scale in Feet

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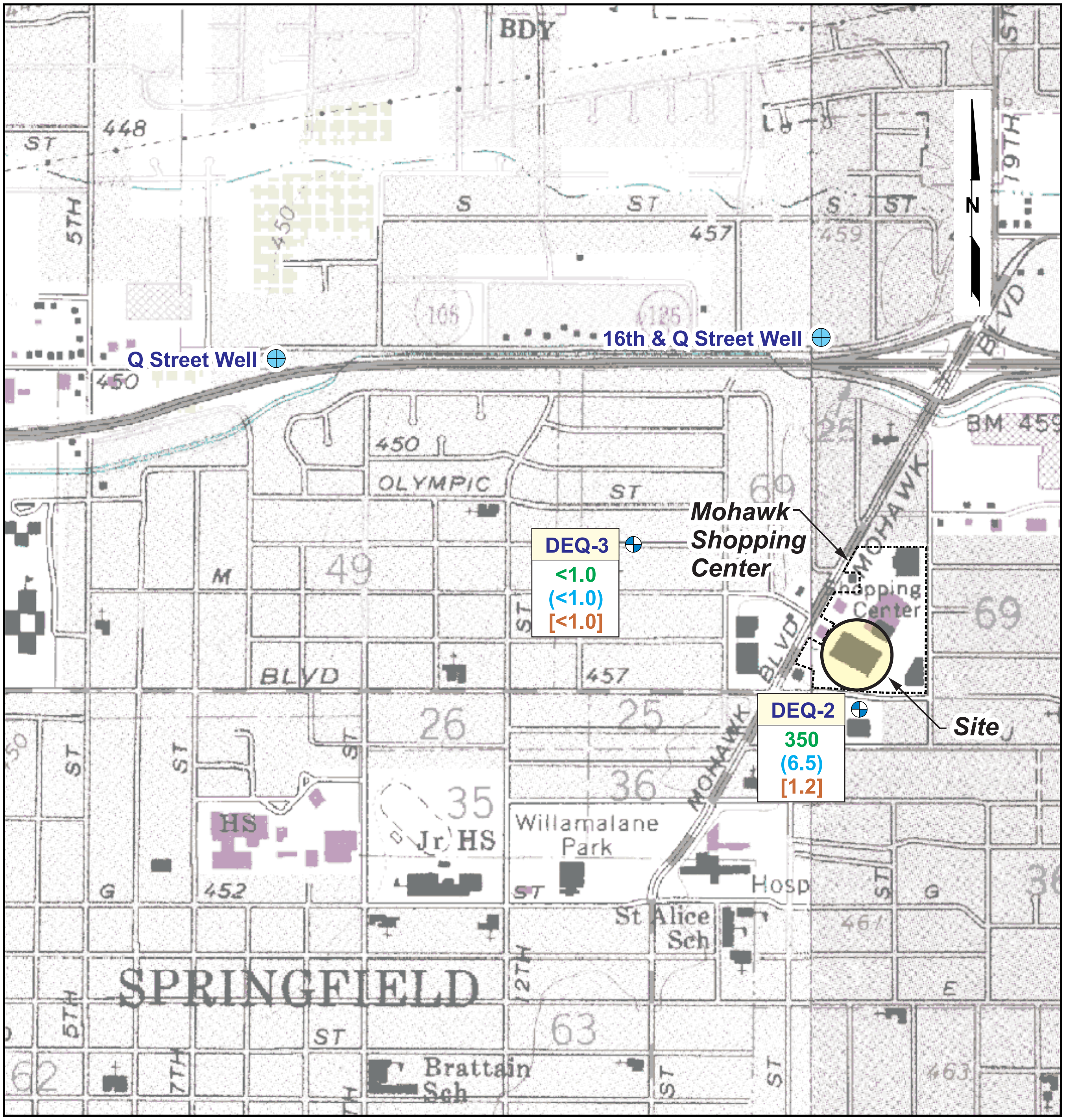
15267-02/Task 2 3/06
Figure 8

Groundwater Chemical Results (Off-Site) - October 2005

Former Springvilla Dry Cleaners
Mohawk Shopping Center, Springfield, Oregon



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Note: Base map prepared from the USGS 7.5-minute quadrangles of Eugene East and Springfield, OR, photorevised 1986.

0 1,000 2,000

Scale in Feet
Contour Interval 20 Feet

Q Street Well SUB Production Well Location and Identification

DEQ-2 Monitoring Well Location and Number
350 Tetrachloroethene Concentration in µg/L
(6.5) Trichloroethene Concentration in µg/L
[1.2] cis - 1,2 - Dichloroethene Concentration in µg/L

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15267-02/Task 2 *4/06*
Figure 9

PCE Concentrations in Intermediate Groundwater
Former Springvilla Dry Cleaners
Mohawk Shopping Center, Springfield, Oregon

F:\DATA\Jobs\DEQ\15267-02 Springvilla\Task 2 GW Monitoring\July 2005\Figures\1526702 02 10 (PCE graph).cdr

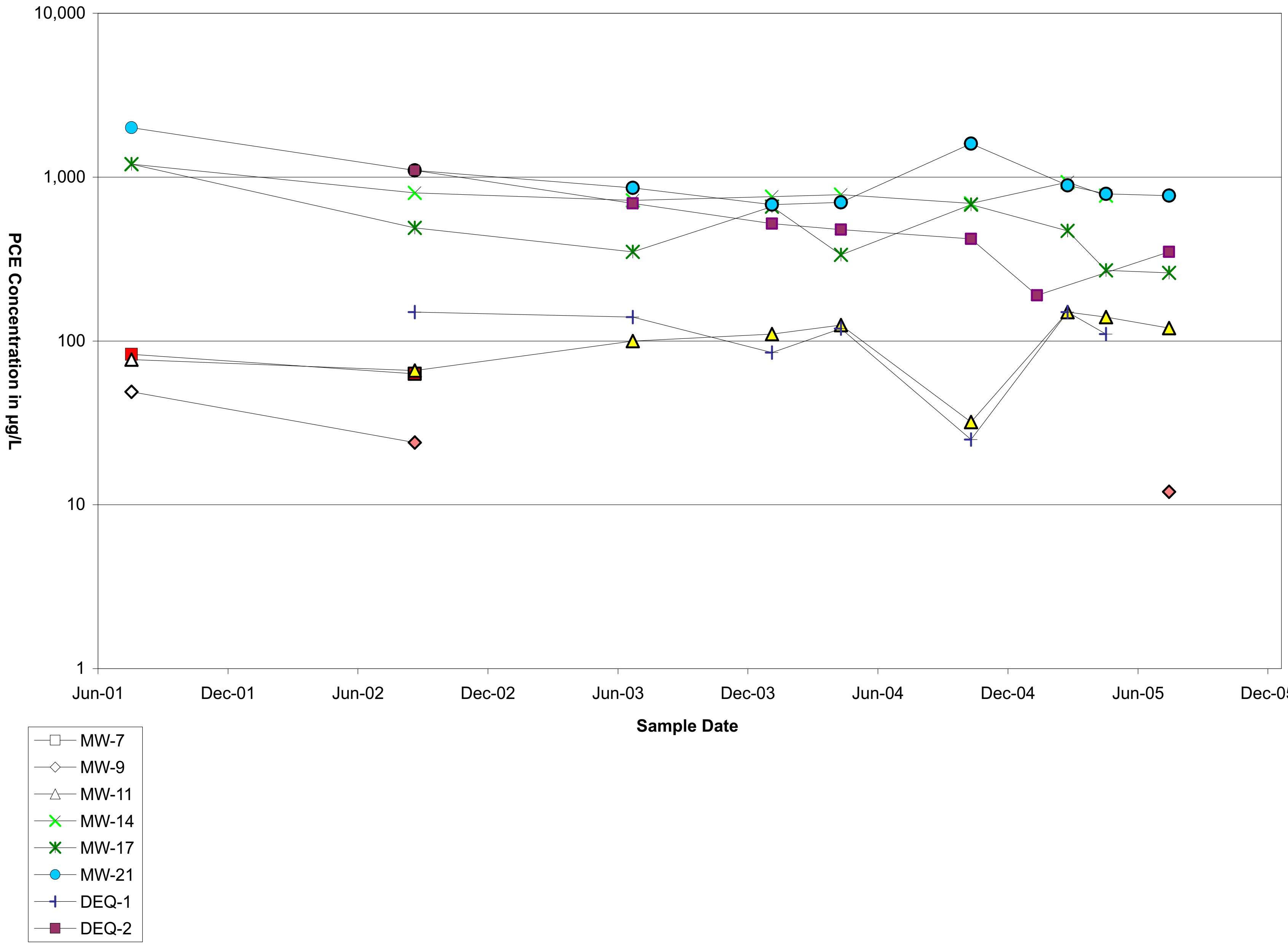

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Figure 10