EPA 542-R-07-018
September 2007
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REMEDIATION SYSTEM EVALUATION (RSE)

NORTHWEST PIPE AND CASING SITE
CLACKAMAS, OREGON

Report of the Remediation System Evaluation
Site Visit Conducted May 9, 2007

Final Report
September 2007

NOTICE

Work described herein was performed by GeoTrans, Inc. (GeoTrans) for the U.S. Environmental Protection Agency (U.S. E.P.A). Work conducted by GeoTrans, including preparation of this report, was performed under EPA contract 68-C-02-092 to Dynamac Corporation, Ada, Oklahoma. Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

EXECUTIVE SUMMARY

A Remediation System Evaluation (RSE) involves a team of expert hydrogeologists and engineers, independent of the site, conducting a third-party evaluation of site operations. It is a broad evaluation that considers the goals of the remedy, site conceptual model, above-ground and subsurface performance, and site closure strategy. The evaluation includes reviewing site documents, visiting the site for up to 1.5 days, and compiling a report that includes recommendations to improve the system. Recommendations with cost and cost savings estimates are provided in the following four categories:

- Improvements in remedy effectiveness
- Reductions in operation and maintenance costs
- Technical improvements
- Gaining site closeout

The recommendations are intended to help the site team identify opportunities for improvements. In many cases, further analysis of a recommendation, beyond that provided in this report, may be needed prior to implementation of the recommendation. Note that the recommendations are based on an independent evaluation by the RSE team, and represent the opinions of the RSE team. These recommendations do not constitute requirements for future action, but rather are provided for the consideration of all stakeholders.

The Northwest Pipe and Casing Site is located in Clackamas, Oregon, approximately 20 miles southeast of Portland. The site consists of approximately 53 acres, and has historically been divided into two parcels (Parcel A to the north and Parcel B to the south). As discussed in the OU2 ROD, a highway project called the “Sunrise Corridor” may be constructed within the next decade. This would include highway lanes located on or above the NWPC site. This has implications for future use of the site, as well as for infrastructure associate with current or future remedial actions. Specifically, minimizing the remedial infrastructure at the site is highly desirable. In the more immediate future, a new rail spur and associated “lay-down yard” may be implemented on the northern part of the site. This may only be a temporary land use until the highway project is constructed.

Site characterization and remediation has been divided into two operable units (OUs): OU1 to address soils and OU2 to address ground water. This RSE pertains to OU2. Groundwater is impacted by VOCs. A system consisting of 15 in-situ air stripping wells (groundwater circulation wells, or GCWs) was installed and began operating in March 2004. Groups of extraction wells are connected to a total of six extraction sheds (EQ-1 to EQ-6) that each house a blower, vapor extraction equipment, and activated carbon canisters for treatment. Of the 15 wells, 12 were intended to address source area concentrations (via 5 equipment sheds). The other three extraction wells (and one equipment shed) were intended to mitigate potential off-site migration of contaminants near the northern site boundary. A “partial shutdown” of the GCW treatment system was implemented in September, 2006 to focus efforts on GCWs with the greatest mass recovery and the GCWs intended for containment near the northern property boundary. EPA Region 10 requested this RSE to obtain additional perspective regarding shutdown of the existing system and potential future remedy alternatives.

The observations and recommendations contained in this report are not intended to imply a deficiency in the work of either the system designers or operators, but are offered as constructive suggestions in the best interest of the EPA, the public, and the facility. These recommendations have the benefit of being formulated based on operational data unavailable to the original designers.

Recommendations are provided in all four of the categories: effectiveness, cost reduction, technical improvement, and site closeout. The recommendations for improving system effectiveness are as follows:

- Improve delineation of Plume 1 to the south in the Shallow WBZ
- Finalize ICs on Parcel A
- Continue/conclude efforts to evaluate potential for vapor intrusion on Parcel A

The recommendation for cost reduction is as follows:

- Eliminate operation of GCWs

This site has an existing funding pool of approximately $3 million. The existing GCWs appear to remove contaminant mass inefficiently and provide little or no benefit with respect to horizontal or vertical hydraulic capture. Therefore, the RSE team recommends that operation of the existing GCW system be terminated immediately. This will save the approximately $166,300 per year estimated by Parametrix for O&M of the current GCW system (i.e., 7 operating GCWs). Terminating the GCW system immediately will preserve as much of the existing funding pool as possible for other remedial approaches.

The recommendation for technical improvement is as follows:

- Revise sequencing for collecting site-wide water level data

The recommendations regarding site closeout are as follows:

- Clarify and document goals for active remediation
- Implement in-situ bioremediation to reduce highest VOC concentrations, in conjunction with natural remediation

A preliminary estimate for implementing the in-situ bioremediation is a total of approximately $1.8 million. The only long-term cost would then be long-term monitoring. At this site, that cost is currently estimated to cost less than $30,000/yr, and that cost would likely diminish over time as sampling frequency and/or number of sampling locations is reduced. Assuming an annual cost of $30,000 over 30 years for long-term monitoring yields a 30-year cost of $900,000. Thus, a preliminary estimate for total cost of the groundwater remedy would be $2.7 million, which is within the approximately $3 million of funding currently available. It is possible that actual costs might exceed the remaining available funding if actual costs exceed these preliminary estimates, in which case additional funding would be required. Benefits include the fact that success in reducing the highest concentrations will be determined within 1-2 years, the only required short-term infrastructure is the temporary injection points, and no long-term infrastructure or O&M will be required after the 1-2 year period. This approach will likely require a ROD Amendment.

Future costs will also include decommissioning the existing GCW system. The RSE team has not specifically estimated these costs, but expects those costs might be on the order of $200,000. The RSE team recommends that any such decommissioning wait until absolutely necessary, to maximize potential to utilize some of those wells and/or equipment in the future if the need arises.

A table summarizing the recommendations, including estimated costs and/or savings associated with those recommendations, is presented in Section 7.0 of this report.

PREFACE

This report was prepared as part of a project conducted by the United States Environmental Protection Agency Office of Superfund Remediation and Technology Innovation (U.S. EPA OSRTI) in support of the "Action Plan for Ground Water Remedy Optimization" (OSWER 9283.1-25, August 25, 2004). The objective of this project is to conduct Remediation System Evaluations (RSEs) at selected pump and treat (P&T) systems that are jointly funded by EPA and the associated State agency. The project contacts are as follows:

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1.0 INTRODUCTION

1.1 PURPOSE

During fiscal years 2000 and 2001 Remediation System Evaluations (RSEs) were conducted at 20 Fund-lead pump and treat (P&T) sites (i.e., those sites with pump and treat systems funded and managed by Superfund and the States). Due to the opportunities for system optimization that arose from those RSEs, EPA OSRTI has incorporated RSEs into a larger post-construction complete strategy for Fund-lead remedies as documented in *OSWER Directive No. 9283.1-25, Action Plan for Ground Water Remedy Optimization*. OSRTI has since commissioned RSEs at additional Fund-lead sites with P&T systems. An independent EPA contractor is conducting these RSEs, and representatives from EPA OSRTI are participating as observers.

The RSE process was developed by the US Army Corps of Engineers (USACE) and is documented on the following website:

http://www.environmental.usace.army.mil/library/guide/rsechk/rsechk.html

An RSE involves a team of expert hydrogeologists and engineers, independent of the site, conducting a third-party evaluation of site operations. It is a broad evaluation that considers the goals of the remedy, site conceptual model, above-ground and subsurface performance, and site closure strategy. The evaluation includes reviewing site documents, visiting the site for up to 1.5 days, and compiling a report that includes recommendations to improve the system. Recommendations with cost and cost savings estimates are provided in the following four categories:

- Improvements in remedy effectiveness
- Reductions in operation and maintenance costs
- Technical improvements
- Gaining site closeout

The recommendations are intended to help the site team (the responsible party and the regulators) identify opportunities for improvements. In many cases, further analysis of a recommendation, beyond that provided in this report, may be needed prior to implementation of the recommendation. Note that the recommendations are based on an independent evaluation by the RSE team, and represent the opinions of the RSE team. These recommendations do not constitute requirements for future action, but rather are provided for the consideration of all site stakeholders.

The Northwest Pipe and Casing (NWPC) Site (the Site) was selected by EPA OSRTI based on a recommendation from EPA Region 10. Site characterization and remediation has been divided into two operable units (OUs): OU1 to address soils and OU2 to address ground water. This RSE pertains to OU2. In particular, this current groundwater system consisting of ground water circulation wells (GCWs) has been partially shut down, and complete shutdown has been recommended by the site contractor. EPA Region 10 requested this RSE to obtain additional perspective regarding shutdown of the existing system and potential future remedy alternatives. This report provides a brief background on the site and current operations, a summary of observations made during a site visit, and recommendations regarding the remedial approach. The cost impacts of the recommendations are also discussed.

1.2 TEAM COMPOSITION

The team conducting the RSE consisted of the following individuals:

Rob Greenwald, Hydrogeologist, GeoTrans, Inc.
Doug Sutton, Water Resources Engineer, GeoTrans, Inc.

1.3 DOCUMENTS REVIEWED

Author	Date	Title
Weston	9/98	Remedial Investigation Report, Addendum 1
URS	8/99	March/April 1999 Long-Term Groundwater Monitoring Report
URS	8/99	Appendix D-2: Residual Risk Assessment. Groundwater Transport Model Results
USEPA	9/01	Record of Decision, OU2
URS	1/03	Groundwater Circulation Well Pilot Test Technical Memorandum
CDM	5/04	Operations and Maintenance Manual
Parametrix	6/06	Technical Memorandum No. 1: Data Needs for GCW Evaluation
Parametrix	6/06	Technical Memorandum No. 2a: Short-Term O&M Strategy
Parametrix	6/06	Technical Memorandum No. 2b: Supplemental Data Determinations
Parametrix	9/06	Technical Memorandum No. 3: Recommendations for Continued Long-Term Remedial Action
Parametrix	10/06	Five Year Review Report
ODEQ	12/8/06	Letter Regarding Draft Technical Memorandum #3
Harris Group	2/07	Preliminary drawings (2) regarding conceptual layout of Sunrise Corridor Rail Spur
??	??	Air photo with future highway alignment provided during site visit
Parametrix	3/07	Final Sitewide Groundwater Monitoring Report, November 2006

1.4 PERSONS CONTACTED

The following individuals associated with the site were present for the visit:

Mark Ader, Remedial Project Manager, EPA Region 10
Bernie Zavala, Hydrogeologist and Regional Optimization Liaison, EPA Region 10
Deb Yamamoto, EPA Region 10
Martha Lentz, EPA Region 10
Ken Cameron, Oregon Department of Environmental Quality (ODEQ)

Eric Roth, Parametrix (Primary Site Contractor)
Scott Elkind, Parametrix
Larry Robinson, CDM
Tom Sweet, CDM (On-site Operator)

1.5 SITE LOCATION, HISTORY, AND CHARACTERISTICS

1.5.1 LOCATION

The NWPC is located in Clackamas, Oregon, approximately 20 miles southeast of Portland. The site is bounded to the north by SE Lawnfield Road and to the south by SE Mather Road. There are railroad tracks along the western boundary of the site. Interstate 205 is located approximately one-half mile west of the site. The vicinity of the site consists primarily of light industrial and commercial properties, with some residences more than one-half mile from the site.

The site consists of approximately 53 acres, and has historically been divided into two parcels (see Figure 1-1):

- Parcel A (northern portion of the site) - Approximately 21 acres. The western 11 acres of Parcel A are currently owned by Oregon Department of Transportation (ODOT), and currently includes office/warehouse space, an equipment yard, a greenhouse and plant nursery, and a fueling station. The eastern 10 acres of Parcel A is owned by Northwest Development Company (NWDC) and consists of three warehouse/office spaces and associated parking lots. Some of the groundwater remedy infrastructure (GCWs, associated sheds, and monitoring wells) is located on Parcel A.

- Parcel B (southern portion of the site) - Approximately 32 acres. This was the location of former pipe-coating operations that are the suspected primary cause of the groundwater impacts. The parcel is now vacant, with the exception of wells and other infrastructure associated with the groundwater remedy. The entire 32-acre parcel is covered with a soil cap placed as part of OU1 soil remedy. A 1-acre mitigation wetland which drains north to Dean Creek was also created in the northeast portion of the parcel as part of the OU1 soil remedy. Gravel roads that provide access to remedy equipment sheds were installed after the soil cap was completed.

Well locations are also provided on Figure 1-1.

As discussed in the OU2 ROD, a highway project called the “Sunrise Corridor” may be constructed within the next decade. This would include highway lanes located on or above the NWPC site. This has implications for future use of the site, as well as for infrastructure associate with current or future remedial actions. Specifically, minimizing the remedial infrastructure at the site is highly desirable. In the more immediate future, a new rail spur and associated “lay-down yard” may be implemented on the northern part of the site. This may only be a temporary land use until the highway project is constructed.

1.5.2 HISTORICAL PERSPECTIVE

Pipe coating operations on Parcel B, which are believed to be the primary cause of the groundwater impacts, occurred under various ownerships from approximately 1956 through 1985. Selected milestones regarding the site remedy are listed below:

- ODEQ conducted a Preliminary Assessment in1987, and EPA prepared a Site Inspection Report in 1989
- The site was placed on the National Priorities List in 1992
- A CERCLA removal action, consisting of perimeter fencing, warning signs, demolition of vacant buildings, and off-site disposal of demolition debris was conducted on Parcel B in 1993.
- Approximately 230 tons of surface debris (coal tar, abandoned car tires, batteries, etc.) were removed from Parcel B in 1997 prior to the Remedial Investigation, and two underground storage tanks were removed from Parcel B in 1998.
- The OU1 ROD for soils was issued in 2000
- Excavation and/or treatment of contaminated soil or "hot spots" associated with the OU1 remedy was completed in 2001
- The OU2 ROD for groundwater was issued in 2001
- The OU2 Remedial Design was completed in 2003
- The soil capping on the entire extent of Parcel B associated with OU1 Remedial Action was completed in 2004
- An ESD associated primarily with wetlands mitigation and restoration was issued in 2004
- The OU2 remedy construction was completed in 2004, and operation began in 2004
- The Long-Term Remedial Action (LTRA) period began on July 20, 2005
- Technical Memorandum #3 with recommendations for long-term remedy actions was prepared by Parametrix on September 25, 2006
- The first Five-Year Review Report was submitted in October, 2006

1.5.3 POTENTIAL SOURCES

According to the OU2 ROD, soil was contaminated at the site by PAHs and PCBs:

- PAH contamination in the soil was caused primarily by coal tar
- PCBs in the soil most likely originated from cutting oils, hydraulic oils, cooling oils, and/or electrical transformers used at the site. PCB-contaminated oils may have been used for on site dust suppression based on their widespread detection in shallow soils.

According to the OU2 ROD, groundwater at the site was contaminated with volatile organic chemicals (VOCs) associated with cleaning solvents used in the site operations.

The OU2 ROD provides the following additional details: "Pipe coating operations involved sandblasting pipe with steel shot, spraying the pipes with primer, and applying the coating material. Coal tar, coal tar epoxy, asphalt, polyethylene epoxy, and concrete were used as coating materials. A volatile-organic based primer was used to adhere pipe coatings and solvents were used in the maintenance of pipe-coating equipment. Coal tar was brought to the site in solidified form and then heated to liquify it prior to use. Several underground tanks on Parcel B were used to store fuel and possibly waste oil. On Parcel A some used solvents, oil and water mixtures and metal filings were disposed of directly on the ground. Wastes from the pipe-coating operations were also disposed at various locations on Parcel B by burial, dumping, burning and spreading. These wastes included used solvents from maintenance activities, primers, excess coating material (coal tar), coating product containers, condensed coal tar residues and oils, pipe trimmings, and engine and hydraulic oils. Leaks and spills from equipment and containers also occurred on Parcel B."

During the RSE site visit, it was mentioned that sources of Plume 2 and Plume 3 have not been clearly established. It was also mentioned during the RSE site visit that there is an upgradient source of a chlorinated solvent plume in the deep "Troutdale aquifer" associated with the Temco site. The site team indicated that they could not state with certainty if that plume extended below the NWPC site, but subsequent to the RSE visit ODEQ indicated that they believe it is unlikely that the Temco contamination is impacting the NWPC site.

1.5.4 HYDROGEOLOGIC SETTING

The site topography is flat, but the site is located in a north-south trending valley bounded by Mount Talbert to the east (approximately 600 ft higher than the site elevation) and a low lying bluff to the west (approximately 40 ft higher than the site elevation). The valley is currently drained by Dean Creek and Mount Scott Creek, which flow to the north-northwest and ultimately to the Willamette River. However, surface water along the southern boundary of Camp Withycombe (located southeast of the site) drains south to the Clackamas River, indicating that a surface water divide exists south of NWPC. On-site runoff generally drains into manmade ditches on the eastern and western boundaries of the site, which in turn flow into Dean Creek.

Five distinct subsurface geologic units have been reported in site documents (e.g., Final Sitewide Groundwater Monitoring Report, Parametrix, November 2006):

Fill Unit. Consists of grayish brown silty gravel that was imported as fill material over much of Parcel B and portions of Parcel A. The fill unit is typically between 1 to 1.5 feet thick; however, it may be up to 5 feet thick in areas that were locally excavated. This unit does not include the fill material brought in as a cap as part of the OU1 RA.

Upper Silt Unit. Consists of grayish brown sandy silt and silt with moderate to high plasticity, with some fine gravel. The upper silt unit is encountered at a depth of 5 to 10 feet below ground surface (bgs), and is interpreted as Holocene overbank deposits and lacustrine sediments deposited by the ancestral Clackamas River.

Upper Gravel Unit. Consists of a grayish brown silty gravel in the upper portion of the unit (10 to 25 feet bgs) and grades to yellowish brown sandy gravel / gravel in the lower portion of the unit (25 to 90 feet bgs). Interbedded sands and silts of various thicknesses have been noted, but do not appear to be laterally continuous. The Upper Gravel Unit is interpreted as Pleistocene catastrophic flood deposit.

Lower Silt Unit. Consists of greenish gray to black gray silt that is dense and hard. The unit is encountered between 90 feet and 110 feet bgs, and is interpreted to be Eocene to Miocene low-energy environment deposits that may be associated with the ancestral Columbia River.

Lower Gravel Unit. Consists of sandy gravel, which is encountered at approximately 110 to 135 feet bgs. The unit is interpreted to be the Troutdale Formation or equivalent.

Additionally, hydrostratigraphic units have been described in terms of water bearing zones (WBZs) as follows:

Hydrostratigraphic Unit	Hydrostratigraphic Sub-Unit	Geologic Unit
Upper WBZ	Shallow WBZ (approximately 15 to 25 ft bgs)	Upper Gravel Unit
	Intermediate WBZ (approximately 25 to 60 ft bgs)	
	Deep WBZ (approximately 60 to 90 ft bgs)	
	Confining Unit	Lower Silt Unit
Lower WBZ	Lower WBZ	Lower Gravel Unit (Troutdale or equivalent)

The Lower WBZ (Troutdale Gravel Aquifer or equivalent) is observed at depths greater than 100 feet bgs. The Troutdale Aquifer is an important regional source of groundwater. During the RSE site visit, it was stated that there is some uncertainty whether or not the Lower Gravel Unit at the site is actually the Troutdale Formation, which is why this unit is referred to as "Troutdale or equivalent".

The water table at the site is quite shallow, generally just several feet below ground surface. The following information is provided in Technical Memorandum #1 (June 30, 2006) authored by Parametrix, the site contractor:

- The direction of groundwater flow in the Shallow water bearing zone (WBZ) is north-northwest with an estimated horizontal hydraulic gradient range from 2.0E-03 feet per foot (ft/ft) to 4.5E-04 ft/ft.

- The direction of groundwater flow in the Intermediate WBZ is north-northwest with an estimated horizontal hydraulic gradient range from 1.90E-03 ft/ft to 9.4E-04 ft/ft.

- An upward vertical hydraulic gradient is observed in the upper WBZ (Shallow and Intermediate) in the northern portion of the site; and a downward vertical gradient is observed in the upper WBZ in the southern and central portions of the site (based on Table 3 of the November 2006 Sitewide Groundwater Monitoring Report).

Groundwater flow direction in the Shallow WBZ is illustrated in Figure 1-2, and groundwater flow direction in the Intermediate WBZ is illustrated in the Figure 1-3. As discussed later, these are the two units where groundwater impacts are generally observed.

1.5.5 POTENTIAL RECEPTORS

The following information is provided in the Five-Year Review:

> *Businesses and residences at and in the vicinity of the site are connected to municipal water sources through the Clackamas County Water District (EPA OU2 ROD, 2001). No current use of groundwater for drinking water exists at or adjacent to the site. The nearest potential receptor well is the KEX industrial well, located approximately 450 feet north of Parcel A and SE Lawnfield Road. The well is not used for potable water and has no observed detections of COCs in groundwater. The closest reported domestic well downgradient of the NWPC is located approximately 3,000 feet north-northwest of SE Lawnfield Road. However, groundwater at the site is considered to be a potential source of drinking water and therefore is classified as Class II groundwater under the EPA Guidelines of Ground-Water Classification, Final Draft (December 1986). There are no immediate plans for groundwater beneficial use at or in the vicinity of the site (EPA OU2 ROD, 2001).*

The Five-Year Review states that institutional controls (ICs) are in place on Parcel B to restrict use of groundwater from the impacted areas as well as to prevent the disturbance of the soil cap and constructed wetland. ICs for the ODOT portion of Parcel A to restrict use of groundwater have been drafted but have not been adapted or implemented. The Five Year Review indicates that no ICs are required by the ROD on the NWDC portion of Parcel A, but the Five-Year Review Report recommends that ICs be required on that parcel via an ESD because groundwater impacts are observed in the NWDC portion of Parcel A. The five year review also identifies vapor intrusion at the ODOT facility as a potential concern, and during the RSE site visit is was stated that EPA is currently investigating this issue.

1.5.6 DESCRIPTION OF GROUND WATER PLUME

The Five-Year Review provides figures for "Total Contaminants of Concern (COCs)", which represent the sum of concentrations for Tetrachloroethene (PCE), Trichloroethene (TCE), and Vinyl Chloride (VC). The groundwater impacts are primarily found in the Shallow Water Bearing Zone (15-25 ft bgs, see Figure 1-4) and the Intermediate Water Bearing Zone (25-60 ft bgs, see Figure 1-5). A north-south cross-section illustrating the attenuation of contaminant concentrations with depth (which provides vertical delineation) is depicted on Figure 1-6.

As illustrated on Figures 1-4 and 1-5, the site team refers to four groundwater "plumes":

- Plume 1: Central portion of site (north-central portion of Parcel B)
- Plume 2: Western portion of Parcel B
- Plume 3: Extreme southeastern portion of Parcel B
- Plume 4: Northwestern portion of Parcel A

In some places these plumes have become commingled over time. For instance, Plume 1 and Plume 4 commingle near SE Lawnfield Road, and Plume 1 and Plume 2 may commingle in the central portion of Parcel B. As illustrated on Figures 1-4 and 1-5, the Total COC concentrations are significantly higher in the core portion of Plume 1 than in the other areas.

In the Shallow WBZ (Figure 1-4) the Total COC concentrations exceed 1,000 ug/l at several locations in the “core area” of Plume 1 near the north-central portion of Parcel B (at wells MW-207, MW-04, and MW-206). These higher concentrations appear to attenuate to approximately 100 ug/ll within a distance of approximately 600 ft. It should be noted that there is no permanent monitoring points to define the southern boundary of Plume 1 in the Shallow WBZ. The concentrations of Total COC in the Shallow WBZ in Plumes 2 to 4 are much lower than the highest concentrations in Plume 1, generally on the order of 100 ug/l or less.

In the Intermediate WBZ (Figure 1-5) the highest Total COC concentrations (approximately 500 ug/l) are lower than in the Shallow WBZ (greater than 1,000 ug/l). Again, the highest concentrations are in Plume 1, in the north-central portion of Parcel B. Concentrations of Total COCs are generally less than 100 ug/l in the other plumes.

Based on the November 2006 groundwater sampling, there are some minor TCE and PCE impacts observed in the Deep WBZ (i.e., the lowest unit of the Upper WBZ). For instance, PCE and TCE concentrations on the order of 50 ug/l have been observed at Deep WBZ well MW-130, which is located near the “core area” of Plume 1. Similarly, minor PCE and/or TCE impacts are indicated at some of the Deep WBZ intervals of some of the CMT wells (which monitor multiple intervals) such as CMT-3 and CMT-7, which are located near the “core area” of Plume 1.

2.0 SYSTEM DESCRIPTION

2.1 SYSTEM OVERVIEW

A system consisting of 15 in-situ air stripping wells (groundwater circulation wells, or GCWs) was installed and began operating in March 2004. Groups of extraction wells are connected to a total of six extraction sheds (EQ-1 to EQ-6) that each house a blower, vapor extraction equipment, and activated carbon canisters for treatment. Of the 15 wells, 12 were intended to address source area concentrations (via 5 equipment sheds). The other three extraction wells (and one equipment shed) were intended to mitigate potential off-site migration of contaminants near the northern site boundary.

In a series of Technical Memorandums produced in 2006, Parametrix (the site contractor) concluded that the GCW Treatment System was not functioning as intended. They concluded the system:

- removed a lower than expected amount of contaminant mass at higher than expected O&M costs;
- had not been effective in hydraulically containing on-site contamination; and
- had not been effective in hydraulically capturing source area contamination.

As a result, a “partial shutdown” of the GCW treatment system was implemented in September, 2006 to focus efforts on GCWs with the greatest mass recovery and the GCWs intended for containment near the northern property boundary. This modified system was the current operating system at the time of the RSE site visit, and consisted of seven GCWs, as follows:

- GCW-01, GCW-12, and GCW-13 at the northern property boundary (equipment shed EQ-1)
- GCW-11 (equipment shed EQ-05)
- GCW-10 and GCW-15R (equipment shed EQ-04)
- GCW-14 (equipment shed EQ-02)

The seven operating GCWs at the time of the RSE site visit are indicated on Figure 1-1.

Technical Memorandum #3 (Parametrix, September 2006) recommends converting existing GCW wells and equipment into more conventional P&T extraction wells, with treatment and disposal options requiring further evaluation. It also recommends that the benefits, risks, and costs for implementing more aggressive remedial actions for the source areas (e.g., chemical oxidation, enhanced bioremediation) be evaluated.

2.2 EXTRACTION AND REINJECTION SYSTEM

The in-situ air-stripping wells were constructed in 2003 and have been operating since March 2004, with the exception of GCW-15R which replaced GCW-15 in April 2006 because the inflatable packer in GCW-15 had failed in 2005. Each well consists of two 10-inch diameter, 10-foot long stainless steel screens separated by an inflatable packer. Groundwater is pumped (variable speed drive) from the upper screen (i.e., from the shallow WBZ, which is the most impacted unit) through the influent pump, through the flow meter, and into the air-stripping unit inside the vault. Once treated by the air-stripper, the water is then pumped back down through the effluent pipe and out through the lower screen back into the formation. Influent and effluent sampling ports are provided to allow for the sampling of untreated and treated groundwater. The flow rates of the influent and effluent pumps need to be kept in balance.

2.3 TREATMENT SYSTEMS

The treatment systems actually consist of two components:

- A below-ground air stripper at each extraction location
- Equipment housed in multiple sheds that each services a group of extraction wells

Each is briefly described below.

At Each Extraction Location

A tray stripper is situated in each individual well vault. Clean air (which is supplied from effluent of the vapor treatment system located in the equipment sheds) is bubbled through the extracted water by diffusers in the bottom of the tank. The water then enters a settling basin, and is subsequently pumped (variable speed drive) to the effluent screen. The contaminated air is sent through the influent air line to the vapor treatment system housed in one of the six equipment sheds.

At Each Equipment Shed

The contaminated air flows into the treatment shed via the influent air line and through a moisture separator and vacuum blower (located in the shed), then into the first of two granular activated carbon (GAC) vessels in series. The air then flows to a zeolite vessel filled with permanganate, a strong oxidizer, to facilitate the breakdown of VC (which does not sorb well to GAC). Exhaust from the vapor treatment system is passed through a heat exchanger to reduce temperatures to near ambient, and is then passed through the effluent line and returned to the air-stripper unit at each GCW well. Vapor sampling ports are located before and after each vessel.

2.4 MONITORING PROGRAM

Ground Water Monitoring

Groundwater quality has been monitored for VOCs periodically since 1997. A sampling event was conducted in October 2003 to establish a baseline prior to the start-up of the GCW treatment system in March 2004. The January/February 2005 groundwater monitoring event was conducted approximately one year after the GCW treatment system start-up. The January/February 2005 groundwater sampling event included an expanded monitoring well network that included eight CMT wells (multiple depth sampling ports) and two monitoring wells. The CMT wells indicated previously undiscovered contamination in the shallow and intermediate WBZs hydraulically downgradient of the Plume 1 “core area”. A groundwater sampling event was conducted in March 2006 at eight new monitoring wells installed to evaluate the extent of contamination in the northeast and central portion of the site. The November 2006 groundwater sampling event was conducted approximately two years after the GCW treatment start-up, and approximately two months after the partial shutdown of the of the GCW system in September 2006.

In November, 2006 the following number of samples for VOCs were evaluated from the different intervals of the Upper WBZ:

- Shallow WBZ– 39
- Intermediate WBZ – 33
- Deep WBZ – 6

Monitoring wells and piezometers are sampled with passive diffusion bags (PDBs). In some cases multiple depths are sampled within the same well. CMT wells are sampled for multiple depth intervals using low flow methods. Therefore, the number of samples listed above for each interval does not represent the number of unique locations, since multiple depths are sampled at some of the locations. Laboratory analysis for VOCs is provided by a CLP lab (at no cost to the site budget).

Process Monitoring

During the RSE site visit, the following process monitoring activities were described:

- Monthly sampling for VOCs at each operating GCW (influent and effluent) analyzed by the CLP laboratory (no cost impact to project), which allows calculation of mass removal

- Air sampling between carbon vessels is currently performed periodically with a PID (historically it was done monthly with summa canisters or tetlar bags, but that is no longer performed).

There are also weekly checks performed at operating GCWs that include inspections at each operating well vault to vent air below the packer, check for air/water leaks, make sure the sump pump is working, and read flow meters.

3.0 SYSTEM OBJECTIVES, PERFORMANCE, AND CLOSURE CRITERIA

3.1 CURRENT SYSTEM OBJECTIVES AND CLOSURE CRITERIA

The ROD identifies three VOC constituents as COCs: PCE, TCE, and VC. The OU2 ROD specifies the following Remedial Action Objectives (RAOs) for groundwater:

- Prevent exposure of future off-site area residents and future on-site maintenance workers from direct contact (ingestion, dermal contact and inhalation) to contaminated upper aquifer groundwater that would result in an excess lifetime cancer risk greater than 1 in 1,000,000 for individual carcinogens, above 1 in 100,000 for additive carcinogenic contaminants, or above a Hazard Index of 1. These correspond to the following "remedial goals":
  - 1 ug/l for PCE
  - 1.6 ug/l for TCE
  - 1 ug/l for VC
- Prevent migration of upper aquifer groundwater with contaminant concentrations that would result in an excess lifetime cancer risk greater than 1 in 1,000,000 for individual carcinogens, above 1 in 100,000 for additive carcinogenic contaminants, or above a Hazard Index of 1 to off-site areas or deeper aquifers.
- Restore use of the upper aquifer groundwater as a drinking water source based on federal and state drinking water standards (MCLs), which are:
  - 5 ug/L for PCE
  - 5 ug/L for TCE
  - 2ug/L for VC

The RSE team notes differentiation in the ROD between "remedial goals" and the reference to drinking water standards, which have different values. ODEQ provides clarification as follows: " If the concentrations are below the [drinking water] standard but above the risk-based [remedial goal] concentration there is not a preference for treatment and active remediation is not necessarily required as long as the remedy remains protective through the use of institutional controls or engineering controls controlling for exposure. For potential exposure to contaminants in groundwater, it is not necessary to reach the remedial goals on a site if it can be shown that, even with the concentrations above the [remedial goals] on-site, the off-site concentrations will meet the goals. It is also assumed that the on-site exposure pathways involving groundwater do not result in unacceptable risk."

According to the OU2 ROD, the selected remedy was intended to treat the most highly contaminated groundwater using in-situ air stripping wells installed in the four groundwater plumes, in conjunction with natural processes to reduce the VOC concentrations in groundwater outside of the source areas of the plumes. The selected remedy was also intended to restrict the potential for off-site migration through the installation of in-situ air stripping wells at the northern site boundary, near Lawnfield Road. Institutional controls were intended to control potential exposure to on-site groundwater with VOC concentrations above the remediation goals.

As stated previously, Technical Memorandum #3 (Parametrix, September 2006) recommends converting existing GCW wells and equipment into more conventional P&T extraction wells, with treatment and disposal options requiring further evaluation. It also recommends that the benefits, risks, and costs for implementing more aggressive remedial actions for the source areas (e.g., chemical oxidation, enhanced bioremediation) be evaluated. In a letter from Oregon DEQ commenting on Technical Memorandum #3, the following is stated: "The concentrations in Plumes 2 and 3 are low enough to consider whether or not at this point those areas need to be addressed with active treatment. One alternative might be to implement pump and treat in Plume 1 and use natural attenuation for the remainder of the site." Oregon DEQ also states the following: "DEQ considers that at this time, in order to implement a cost effective remedy…that all the processes of natural attenuation should be considered for the project not just biodegradation. The cost of actively treating the entire groundwater plume to MCLs or drinking water RBCs is perhaps not justified at this point given the land uses and placement of institutional controls restricting groundwater use."

3.2 TREATMENT "PLANT" OPERATION STANDARDS

As described earlier, this remedy includes a separate below-ground air stripper for each extraction well. The design goal for the air strippers was to achieve a removal efficiency of 95% of influent COCs. An additional goal was for each system to operate with a maximum of 3 days per month downtime, assessed on a 3 month rolling average.

4.0 FINDINGS AND OBSERVATIONS FROM THE RSE SITE VISIT

4.1 FINDINGS

The observations provided below are not intended to imply a deficiency in the work of the system designers, system operators, or site managers but are offered as constructive suggestions in the best interest of the EPA and the public. These observations have the benefit of being formulated based upon operational data unavailable to the original designers. Furthermore, it is likely that site conditions and general knowledge of ground water remediation have changed over time.

4.2 SUBSURFACE PERFORMANCE AND RESPONSE

4.2.1 WATER LEVELS AND CAPTURE ZONE

The RSE team notes that the water level maps presented in Figures 1-2 and 1-3 do not indicate any substantial hydraulic impact from the GCWs. Water is extracted from the shallow screen and recirculated to the deep screen, but there are no obvious cones of depression in the Shallow WBZ, and no apparent mounding in the Intermediate WBZ, in the vicinity of the GCWs.

In Technical Memorandum #2b (Parametrix, October 2006) the following information is provided:

- Testing at GCW-8 revealed that influent concentrations were similar to effluent concentrations after continuous pumping, but those concentrations are approximately 20 times lower than the concentrations in the surrounding aquifer material in the Shallow WBZ. Under non-pumping conditions, the concentration at the shallow screen of GCW-8 returned to conditions representative of the aquifer. This suggests that the GWC is primarily recirculating treated water, and thus recovering very little impacted water from the aquifer. This was further supported by the lack of a significant hydraulic response at nearby observation points in response to pumping and recirculation at GCW-8.

- Sodium bromide tracer tests performed at multiple GCWs also indicated that the upper and lower well screens were more strongly connected than originally anticipated.

These results provide additional evidence that the GCWs likely do not provide significant capture. It seems likely that the GCWs each treat a very limited portion of the Shallow WBZ because of the high degree of recirculation of the treated water back into the influent screen.

In Technical Memorandum #3 (Parametrix, September 2006) the following conclusions are presented based on concentration trends:

- Commingled Plumes 1 and 4 are not hydraulically contained by the current GCW system, and concentrations of total COCs are increasing in offsite monitoring wells. Furthermore, hydraulic containment is not provided along the east boundary of commingled Plumes 1 and 4. {The RSE team notes that this conclusion by Parametrix appears to have been based on Shallow WBZ wells

MW-108 and MW-111, and the RSE team does not interpret that concentrations in these wells are increasing.)

- The current GCW system has not prevented lateral and downward migration of COCs in Plume 1
- The current GCW system has not prevented lateral and downward migration of COCs in Plumes 1 and 2.

Parametrix concludes that the concentration trends provide another line of evidence that the GCWs are not particularly effective with respect to capture. This is a potential concern because one of the RAOs in the OU2 ROD is to prevent the migration of impacted water to off-site areas or deeper aquifers. Although the RSE team interprets the off-site concentration trend differently than does Parametrix, the RSE team concurs that the GCW system is providing little or no tangible benefit.

4.2.2 CONTAMINANT LEVELS AND MASS REMOVAL

Contaminant concentrations have responded differently to the GCW remedy depending on location within the plume and on proximity to GCW wells. For example, the concentrations at MW-04, which is located near the core of Plume 1, decreased by over an order of magnitude prior to the remedy but increased by a factor of five during remedy operation. The concentrations at MW-19, which is near the toe of Plumes 1 and 4, were increasing prior to remedy operation and continued to increase after remedy operation. The concentrations at the downgradient, off-site wells MW-108 and MW-111 have shown no discernible change prior to or during remedy operation. Concentrations in MW-123, which is downgradient of the Plume 1 core and downgradient of GCW-09, have decreased since remedy operation. However, no data are available at this location before remedy operation to confirm if the decrease results from remedy operation or natural processes. The monitoring data before and during remedy operation do not demonstrate significant progress toward remediation across the plume as a result of the remedy.

By late 2006, Parametrix estimated that the total contaminant mass removed by the system was approximately 25 kg, and the removal rate at that time was approximately 0.2 kg per month. They also estimated that about 80 percent of the mass removed was from only three wells (GCW-9, GCW-10, and GCW-15), which are the three wells located in “core area” of Plume 1.

This GWC system does not appear to be an efficient approach to removing contaminant mass. The estimated mass removal of 25 kg would result in an avoided Total COC plume of only 6 ug/l spread over then entire 53 acres of the site, over a saturated thickness of 60 ft. The reality is that the recirculation wells are only “cleaning” a small zone in the immediate vicinity of the GCWs because much of the influent water is comprised of recirculated effluent from the air strippers (such that the extracted water is relatively clean and much of the impacted water remains in the aquifer). In addition, many of the GCWs are located in zones relatively low concentration. Total COC concentrations greater than 1,000 ug/l remain in the “core area” of Plume 1. As stated earlier, Total COC concentrations are much lower in Plume 2 and Plume 3, as well as near the northern boundary of the site. In those areas, Total COC concentrations are on the order of 100 ug/l or less.

4.3 COMPONENT PERFORMANCE

4.3.1 GROUNDWATER CIRCULATION WELLS

Based on process monitoring data provided to the RSE team for the period March 2004 to June 2005, the long-term average extraction rate at each GCW was typically in the range of 10 to 20 gpm, except for GCW-1 (approximately 3 gpm) and GCW-10 (approximately 6 gpm). Video inspection performed by Parametrix in 2006 indicated clogging of GCW screens with fine material. Bio-fouling was also found to be a contributor to well screen clogging in at least one well (GCW-01). Well redevelopment reportedly did not increase the flow rate significantly.

4.3.2 AIR STRIPPER AND VAPOR PHASE GAC UNITS

Based on monthly process monitoring data provided to the RSE team for the period March 2004 to June 2005, it appears that in many months multiple air stripping units did not achieve the 95% reduction goal for individual contaminants. This was particularly true in the early months of system operation. By the end of the period for which these data were provided, only occasional efficiency values of less than 95% were reported, presumably due to operational improvements by the site operator. However, it should be noted that even when 95% efficiencies were not achieved, the effluent concentration were typically below the restoration goals because of the relatively low influent concentrations at most of the GCWs. The RSE team did not review process monitoring data related to the vapor phase GAC units or the zeolite units associated with the various treatment sheds.

4.4 COMPONENTS OR PROCESSES THAT ACCOUNT FOR MAJORITY OF ANNUAL COSTS

Parametrix provided the following cost data based on actual costs for seven months after the partial GCW shutdown, annualized to a 12-month period:

Item Description	Estimated Annual Cost
Labor: oversight and project management (Parametrix)	$12,600
Labor: System operation (CDM)*	$85,200
Plan Updates (O&M, HASP) – labor, ODCs	$3,900
Ground water sampling and reporting (labor, equipment)	$12,300
Utilities: Electricity	$20,100
Non-electric utilities, trailer rentals, other services, other ODCs	$30,700
Non-utility consumables (e.g., GAC, zeolite, etc.)	$0
Disposal costs (if any)*	$0
Analytical cost	$0
Other (site visits, etc.)	$1,500
Total Estimated Annual Cost	**$ 166,300**

** includes routine and non-routine (major repairs, equipment replacement, etc.) O&M activities.*

Parametrix indicates that the costs presented above are only associated with the O&M of the site and do not include the costs for annual groundwater monitoring, system evaluations, site investigations, and general task order management. The RSE team expects that the annual long-term monitoring costs are

$30,000 or less. Future costs will also eventually include decommissioning of the existing GCW system and any other remedial components that are installed.

It was stated during the RSE site visit that this site has an existing funding pool of approximately $3 million. If this funding is exhausted, the site would then require traditional Superfund program funding.

4.4.1 UTILITIES

Electricity is primarily utilized for the blowers in each of the equipment sheds. Other utilities include phone/fax and internet. The trailer rental is included in this category in the table above.

4.4.2 NON-UTILITY CONSUMABLES AND DISPOSAL COSTS

None identified by the site team. The vapor phase carbon has not required change out in the most recent cost reporting period.

4.4.3 LABOR

After the partial system shutdown, the site operator labor has been 20 hours per week (4 hours per day). Historically this was 40 hours per week when the full system was operating.   This includes monitoring the integrity of the fence and checking the performance of the GCWs. Process monitoring of influent and effluent of the operating GCWs is conducted monthly. A monthly performance report was prepared historically, but that has been eliminated.

Annual ground water sampling includes two people for two days for water levels at approximately 75 wells, two people for two days to place the PDBs, two people for two days to pull the PDBs, and two people for two days to sample the CMT wells. Other labor is associated with overall project management and contract management by Parametrix, plus preparation of an annual report.

4.4.4 CHEMICAL ANALYSIS

Chemical analysis for long-term monitoring and process monitoring is provided by a CLP lab, at no cost to the site.

4.5 RECURRING PROBLEMS OR ISSUES

In addition to the relative ineffectiveness of the GCWs to remove mass or provide capture, it was noted that operationally it has been difficult to keep the influent and effluent pumps for many of the GCWs in balance. This causes alarm conditions in either the influent or effluent tank at the specific GCW, and these alarm conditions are often frequent in the rainy season.

The orientation and layout of the well vaults causes awkward access. These well vaults are non-permit required confined spaces.

There has been some vandalism at the site, include a break-in at the site trailer. The site currently uses a third-party security firm for daily checks.

4.6 REGULATORY COMPLIANCE

As discussed in Section 4.2.1, based on several lines of evidence, the GCWs are not particularly effective with respect to capture. This is a potential concern because one of the RAOs in the OU2 ROD is to prevent the migration of impacted water to off-site areas or deeper aquifers.

As discussed in Section 4.3.2, based on monthly process monitoring data provided to the RSE team for the period March 2004 to June 2005, it appears that in many months multiple air stripping units did not achieve the 95% reduction goal for individual contaminants. This was particularly true in the early months of system operation. By the end of the period for which these data were provided, only occasional efficiency values of less than 95% were reported, presumably due to operational improvements by the site operator. However, it should be noted that even when 95% efficiencies were not achieved, the effluent concentration were typically below the restoration goals because of the relatively low influent concentrations at most of the GCWs.

4.7 TREATMENT PROCESS EXCURSIONS AND UPSETS, ACCIDENTAL CONTAMINANT/REAGENT RELEASES

There were no reported major upsets or accidents reported during the RSE site visit.

4.8 SAFETY RECORD

The site team reports no health and safety reportable incidents.

5.0 EFFECTIVENESS OF THE SYSTEM TO PROTECT HUMAN HEALTH AND THE ENVIRONMENT

5.1 GROUND WATER

The current implementation of the GCWs does not appear to be effective at removing mass or hydraulically containing impacted water from migrating horizontally or vertically. However, there does not appear to be any risks to current receptors due to incomplete exposure pathways. Although some groundwater impacts extend slightly beyond the northern property boundary, the concentrations are relatively low and there does not appear to be any imminent threat to potential receptors.

As stated in Section 1.5.5, the Five-Year Review states that ICs are in place on Parcel B to restrict use of groundwater from the impacted areas as well as to prevent the disturbance of the soil cap and constructed wetland. ICs for the ODOT portion of Parcel A to restrict use of groundwater have been drafted but have not been adapted or implemented. The Five Year Review indicates that no ICs are required by the ROD on the NWDC portion of Parcel A, but the Five-Year Review Report recommends that ICs be required on that parcel via an ESD because groundwater impacts are observed in the NWDC portion of Parcel A.

5.2 SURFACE WATER

Not identified as an issue.

5.3 AIR

As discussed in Section 1.5.5, the five year review also identifies vapor intrusion at the ODOT facility as a potential concern, and during the RSE site visit is was stated that EPA is currently investigating this issue.

5.4 SOIL

Not identified as an issue during this RSE.

5.5 WETLANDS AND SEDIMENTS

Not identified as an issue during this RSE.

6.0 RECOMMENDATIONS

Cost estimates provided herein have levels of certainty comparable to those done for CERCLA Feasibility Studies (-30%/+50%), and these cost estimates have been prepared in a manner consistent with EPA 540-R-00-002, *A Guide to Developing and Documenting Cost Estimates During the Feasibility Study*, July, 2000.

6.1 RECOMMENDATIONS TO IMPROVE EFFECTIVENESS

6.1.1 IMPROVE DELINEATION OF PLUME 1 TO THE SOUTH IN THE SHALLOW WBZ

Inspection of Figure 1-4 indicates that the highest Total COC concentrations (i.e., greater than 1,000 ug/l) are observed in the Shallow WBZ at MW-04, MW-206, and MW-207. However, there are no permanent monitoring points located immediately south of these wells, and therefore the extent of this “core area” of higher concentrations cannot be easily determined. This is important because consideration of more aggressive measures for reductions of the highest concentrations at the site (such as chemical oxidation or enhanced in-situ bioremediation) has been suggested by Parametrix, and is also recommended by the RSE team (see Section 6.4). The implementation and cost of these more aggressive approaches will depend on the size of the “core area” of highest concentrations. Therefore, unless the site team has information from other previous direct-push investigations that clarifies the delineation in this area, the RSE team recommends that an investigation be performed in the area south of the three wells listed above, in the Shallow WBZ, using direct push techniques or temporary wells installed with rotosonic drilling. It was stated during the RSE site visit that direct push techniques can be problematic at this site due to angular gravels, and the RSE team defers to the site team to select the appropriate technology. Assuming a brief work plan, up to two days of drilling work in the Shallow WBZ, analysis of up to 10 samples for VOCs, and a brief report summarizing results, a cost of approximately $30,000 is estimated.

6.1.2 FINALIZE ICS ON PARCEL A

ICs are reportedly in place for Parcel B, and have reportedly been drafted but not adapted and implemented on the ODOT portion of Parcel A. The RSE team recommends that these ICs be finalized as soon as possible. Also, the Five-Year Review notes that groundwater on the NWDC portion of Parcel A exceeds the remediation goals for PCE and TCE, yet beneficial use of groundwater on NWDC is not restricted by ICs. The Five-Year Review, recommends than ICs be adapted and implemented on the NWDC portion of Parcel A, and the RSE team agrees with this approach. It is difficult for the RSE team to quantify the extent of contractor involvement in these issues, but an estimate of $15,000 is provided herein.

6.1.3 CONTINUE/CONCLUDE EFFORTS TO EVALUATE POTENTIAL FOR VAPOR INTRUSION ON PARCEL A

The Five-Year review recommended that potential exposure to current onsite workers from indoor air vapor intrusion, associated with contaminated groundwater, be evaluated. This pertains to existing workers on Parcel A, since there are no buildings on Parcel B. During the RSE site visit, it was stated that EPA is currently investigating this issue regarding the ODOT portion of Parcel A. This seems reasonable, since the ODOT portion of Parcel A has concentrations of Total COCs in the groundwater greater than 100 ug/l (e.g., at MW-19) in conjunction with a shallow water table, whereas the NWDC portion of Parcel A has very low concentrations of Total COCs in the groundwater (generally less than 10 ug/l). The RSE team recommends that conclusions from the ongoing efforts to evaluate this issue be documented. The RSE team believes the most straightforward evaluation is to directly sample indoor air at the ODOT facility. ODEQ indicates that such sampling at the ODOT facility has been performed, and if that is the case, these data should be evaluated by the site team as a first step. If no impacts are indicated, no remedial action is warranted. If impacts are indicated, there will be uncertainty as to whether or not they are caused by impacted groundwater or on-site operations. If impacts are indicated, a very quick cost benefit analysis can then be performed to determine if the cost of remedial action is less than cost of further investigation (i.e., soil gas sub-slab sampling) that would be required to attempt to determine if the impacts are caused by groundwater. It might be more cost-effective to simply assume the impacts (if any are discovered during the initial air sampling) may be caused by impacted groundwater and to implement remedial measures in the building(s) accordingly. The RSE team is not sure if indoor sampling has already been performed, but estimates this can be performed (brief work plan, sampling at several locations, and brief report) for less than $20,000. At this point, no costs for remediation of air impacts are estimated because the likely need for such remediation is considered to be low.

6.2 RECOMMENDATIONS TO REDUCE COSTS

6.2.1 ELIMINATE OPERATION OF GCWS

As discussed in Section 4.4, this site has an existing funding pool of approximately $3 million. The existing GCWs appear to remove contaminant mass inefficiently and provide little or no benefit with respect to horizontal or vertical hydraulic capture. Therefore, the RSE team recommends that operation of the existing GCW system be terminated immediately. This will save the approximately $166,300 per year estimated by Parametrix for O&M of the current GCW system (i.e., 7 operating GCWs). Terminating the GCW system immediately will preserve as much of the existing funding pool as possible for other remedial approaches (discussed in Section 6.4). It was reported by the site contractor that operation of the GCW system was terminated May on 24, 2007 (several weeks after the RSE site visit).

Future costs will also include decommissioning the existing GCW system. The RSE team has not specifically estimated these costs, but expects those costs might be on the order of $200,000. The RSE team recommends that any such decommissioning wait until absolutely necessary, to maximize potential to utilize some of those wells and/or equipment in the future if the need arises.

6.3 RECOMMENDATIONS FOR TECHNICAL IMPROVEMENT

6.3.1 REVISE SEQUENCING FOR COLLECTING SITE-WIDE WATER LEVEL DATA

During the RSE site visit it was stated that data collection for site-wide water levels is performed over a two-day period, with data collected for all the shallow wells, then all the intermediate wells, etc. The RSE team recommends that the sequencing be changed so that all the wells in the same vicinity are sampled at approximately the same time, regardless of depth. In this manner, locations with multiple wells that screen multiple depths will likely yield more accurate information regarding vertical head differences. Furthermore, the water level measurements should be conducted within a one-day period. An additional person may be required, but since the activity will be completed in one day, the total number of man-hours should not increase. With this approach, the quality of horizontal water level information will also improve. There should be no increase in cost associated with implementing this recommendation, since the total number of man-hours should not increase.

6.4 CONSIDERATIONS FOR GAINING SITE CLOSE OUT

6.4.1 CLARIFY AND DOCUMENT GOALS FOR ACTIVE REMEDIATION

The RSE team recommends a strategy where active remediation is used to address the highest concentrations remaining on-site, in conjunction with natural attenuation and appropriate institutional controls, such that concentrations at off-site points of compliance are below remediation goals. This is consistent with the discussion presented in Section 3.1. It is recommended that goals for active remediation at this site be clarified and documented. This should be based on calculations or assumptions regarding concentrations that can remain on-site such that concentrations at downgradient compliance points will meet remedial goals. The RSE team assumes that this effort will likely include some simplified analytical modeling of contaminant fate and transport, plus some meetings among site stakeholders, with cost on the order of $15,000. This effort will be part of the overall ROD amendment process anticipated based on other recommended changes (see Section 6.4.2).

6.4.2 IMPLEMENT IN-SITU BIOREMEDIATION TO REDUCE HIGHEST VOC CONCENTRATIONS, IN CONJUNCTION WITH NATURAL REMEDIATION

As stated previously, Technical Memorandum #3 (Parametrix, September 2006) recommends converting existing GCW wells and equipment into more conventional P&T extraction wells, with treatment and disposal options requiring further evaluation. It also recommends that the benefits, risks, and costs for implementing more aggressive actions in the source areas (e.g., chemical oxidation, enhanced bioremediation) be evaluated. The RSE team does not recommend conversion of existing GCWs to a more conventional P&T system. Rather, the RSE team recommends that efforts be focused on more aggressive approaches to reduce the highest concentrations, in conjunction with natural remediation in the remaining areas.

Reasons why the RSE team does not recommend conversion of existing GCWs to conventional P&T include the following:

- There would likely be a need for an ex-situ treatment system, and given future land use considerations, it is highly beneficial to eliminate any long-term infrastructure (e.g., treatment plan, piping across the site) associated with the groundwater remedy.

- There are potential issues regarding the discharge of the treated water. It was stated during the RSE site visit that discharge to surface water is generally viewed as unfavorable in this setting. Discharge of treated water to groundwater may be difficult due to the high water table, and would also require infrastructure which is not desirable. Discharge to a wetlands area north of SE Lawnfield Road would be another possibility, but again this would require significant infrastructure as well as potential permitting issues. The site contractor has suggested that discharge of treated water to the deep WBZ is a potential option.

- Operation of a P&T system would require ongoing O&M labor.

- Retrofit of existing infrastructure would require significant effort and cost.

Focusing efforts on more aggressive approaches to reduce the highest concentrations, in conjunction with natural remediation in the remaining areas, is consistent with the letter from ODEQ commenting on Technical Memorandum #3. In that letter ODEQ indicates that concentrations in Plumes 2 and 3, which are on the order of 100 ug/l or less for Total COCs, are low enough to consider whether or not at this point those areas need to be addressed with active treatment. ODEQ suggests that the cost of actively treating the entire groundwater plume to MCLs or drinking water RBCs is perhaps not justified at this point given the land uses and placement of institutional controls restricting groundwater use.

The RSE team believes that the best use of the available funding pool (and additional funding, if necessary) at this site is to more aggressively address the highest concentration areas associated with the "core area" of Plume 1. This area may require further delineation to the south in the shallow WBZ, as recommended in Section 6.1.1. Both enhanced in-situ bioremediation and chemical oxidation are viable alternatives, as noted by Parametrix. Both technologies can address the relatively small region of highest concentrations associated with the "core area" of Plume 1, in a relatively short time period (months to several years), without the need for remediation infrastructure or the need for O&M beyond efforts for long-term monitoring. This approach will require coordination with ODEQ to document that hydraulic capture will not be required. The RSE team conceptually prefers enhanced in-situ bioremediation to chemical oxidation, for the following reasons:

- The presence of VC indicates bioremediation is occurring naturally, and enhanced in-situ bioremediation will essentially accentuate this natural process

- Materials utilized for chemical oxidation might be consumed by oxidation of other aquifer materials before being effectively delivered throughout the target treatment zone

- The materials introduced into the aquifer to help create reducing conditions for enhanced in-situ bioremediation would likely have a longer residence time, and therefore be more likely to successfully remediate low-permeability regions within the aquifer

Readers who wish to become more familiar with the application and performance of this technology at other sites are referred to the document "In Situ Bioremediation of Chlorinated Ethene DNAPL Source Zones: Case Studies" (ITRC, April 2007), which provides general discussion as well as six case studies. The primary question posed to the expert panel associated with that effort was "Do we have credible evidence that bioremediation of chlorinated ethene source zones is a viable remediation option?", and the conclusion of the panel was a unanimous "Yes."

The RSE team recommends the following general approach, which can be refined and implemented with the assistance of numerous contractors who perform enhanced in-situ bioremediation:

1) Complete the delineation recommended in Section 6.1.1. This could likely be completed within two to three months.

2) Based on stakeholder agreement, develop specific compliance points where remediation goals will ultimately be met as well as goals for active remediation on-site (see Section 6.4.1), which will serve as the basis for determining the treatment zone (such as the portion of the plume within the 200 ug/l contour or within the 500 ug/l contour) so that the approximate volume of three-dimensional treatment zone can be estimated. This could likely be completed within one month of the completion of Step 1.

3) Perform baseline sampling from several existing monitoring wells within the most impacted portions of the treatment zone. Sample for the presence of Dehalococcoides (DHC) bacteria, which is required to completely demineralize PCE and TCE to ethene, which is the desired result (the DHC can be added to the aquifer if found to not be present). Sample for VOCs, pH, DO, ORP, FE+2, TOC, nitrate, sulfate, ethane, ethene, methane, and volatile fatty acids. This can likely be done simultaneously with Step 2.

4) Perform an in-well pilot test (three to six months). Select a location with one or two existing monitoring locations, ideally with one monitoring well located a small distance downgradient of the other. Inject a specific amount of the selected donor material to help create or enhance reducing conditions (determined by the bioremediation contractor based on Step 3), via direct push or at a temporary well point installed with rotosonic drilling, at a location close to (but upgradient from) the existing monitoring points. With either delivery method, a temporary well at the delivery point that can be used for further injections. Monitoring is then performed at the injection point and the monitoring locations for the same parameters monitored in Step 3 (except for the DHC), after 1 week and monthly thereafter for approximately 3-6 months. The goal of this test is to verify the delivery method, confirm that dechlorination occurred, determine if dechlorination went all the way to ethene (if not, DHC population may require enhancement), and determine the longevity of the impacts from the injected material from the volume of injected material.

5) Based on the results of the previous steps, design a full-scale implementation plan for injections and monitoring at selected points, including a cost estimate for a primary injection round, followed by potential additional rounds of injection into temporary well points created during the first round of injection.

6) Implement the first round of injection and related monitoring

7) Implement one or more additional rounds if concentrations do not decline to anticipated values from the first round (perhaps a year after the initial injection)

The RSE team estimates that the cost of Steps 1 to 5 is likely on the order of $250,000. The cost for Step 6 and Step 7 will depend heavily on the size of the selected treatment zone. For instance, the RSE team is familiar with site with a treatment zone 1250 ft long, 45 ft wide, and 60 ft deep (3,375,000 ft^3). The initial round of injection was approximately $500,000, and a subsequent injection into temporary points created during the initial injection cost approximately $170,000 (i.e., about one-third the initial application). For the NWPC site, based on Figures 1-4 and 1-5, the treatment zone might be on the order of 300 ft * 500 ft * 45 ft (6,750,000 ft^3), which is twice the volume of the example provided above. Thus, the following costs are preliminarily estimated as follows:

- Steps 1 to 5: $ 250,000
- Step 6: $1,000,000
- Step 7: $ 350,000 (assume one additional injection)
- Misc: $ 200,000 (engineering, monitoring during the aggressive remediation)

This is a total of approximately $1.8 million. The only long-term cost would then be long-term monitoring. At this site, that cost is currently estimated to cost less than $30,000/yr, and that cost would likely diminish over time as sampling frequency and/or number of sampling locations is reduced. Assuming an annual cost of $30,000 over 30 years for long-term monitoring yields a 30-year cost of $900,000 without discounting or $484,000 assuming a discount rate of 5%. Thus, a preliminary estimate for total cost of the groundwater remedy would be $2.7 million or less, which is within the approximately

$3 million of funding currently available. It is possible that actual costs might exceed the remaining available funding if actual costs exceed these preliminary estimates, in which case other funding will be required). Note that decommissioning of the existing GCW system will be an additional future cost, as indicated in Section 6.2.1.

Benefits of the recommended approach include success in reducing the highest concentrations will be determined within 1-2 years, the only required short-term infrastructure is the temporary injection points, and no long-term infrastructure or O&M will be required after the 1-2 year period. This will likely require a ROD Amendment. Although some of the existing GCWs could conceptually be utilized for injections, the RSE team believes it is likely more trouble than it is worth and recommends leaving the GCWs in place for the short term but not using them for the recommended aggressive treatment.

Evaluation and potential implementation of “contingent actions” should occur between Step 6 and Step 7. At that point, the success of the first round of injections can be evaluated. Possible actions at that time include the following:

- Terminate active remediation because goals of active remediation are met
- Proceed with one or more rounds of injections for enhanced bioremediation (i.e., Step 7 as listed above)
- Implement alternative in-situ measures (e.g., chemical oxidation)
- Implement a more conventional pump-and-treat system intended to provide hydraulic containment

The RSE team believes that the first two actions listed above, which would be associated with significant progress as a result of the active remediation, are far more likely to occur than the last two actions.

7.0 SUMMARY

The observations and recommendations contained in this report are not intended to imply a deficiency in the work of either the system designers or operators, but are offered as constructive suggestions in the best interest of the EPA and the public. These recommendations have the obvious benefit of being formulated based upon operational data unavailable to the original designers.

Recommendations are provided in all four categories: effectiveness, cost reduction, technical improvement, and gaining site closeout. The effectiveness recommendations include delineating the southern extent of the most impacted area, and finalizing efforts already underway regarding ICs and evaluation of potential for indoor vapor intrusion. The recommendation for cost reduction is to eliminate the operation of the current GCW system, which will preserve as much of the existing funding pool as possible for other remedial approaches. The recommendation for technical improvement is to revise the sequence for water level data collection so that wells close to each other, but at different depths, are measured at nearly the same time. The recommendations for site closure are to clarify and document the goals for active remediation and to implement in-situ bioremediation to reduce the highest VOC concentrations, in conjunction with natural remediation.

Table 7-1 summarizes the costs and cost savings associated with each recommendation. Both capital and annual costs are presented. Also presented is the expected change in life-cycle costs over a 30-year period for each recommendation both with discounting (i.e., net present value) and without it.

Table 7-1. Cost Summary Table

Recommendation	Reason	Additional Capital Costs ($)	Estimated Change in Annual Costs ($/yr)	Estimated Change in Life-cycle Costs ($)*	Estimated Change in Life-cycle Costs ($)**
6.1.1 Improve delineation of Plume 1 to the south	Effectiveness	$30,000	$0	$30,000	$30,000
6.1.2 Finalize ICs on Parcel A	Effectiveness	$15,000	$0	$15,000	$15,000
6.1.3 Continue/conclude efforts to evaluate potential for vapor intrusion on Parcel A	Effectiveness	$20,000	$0	$20,000	$20,000
6.2.1 Eliminate operation of GCWs	Cost Reduction	$0(1)	($166,300)	($4,989,000)	($2,680,000)
6.3.1 Revise sequencing for collecting site-wide water level data	Technical Improvement	$0	$0	$0	$0
6.4.1 Clarify and document goals for active remediation	Site Closeout	$15,000	$0	$0	$15,000
6.4.2 Implement in-situ bioremediation to reduce highest VOC concentrations, in conjunction with natural remediation	Site Closeout	$1,800,000	$0(2)	$1,800,000	$1,800,000
Total		**$1,880,000**	**($166,300)**	**($3,124,000)**	**($800,000)**

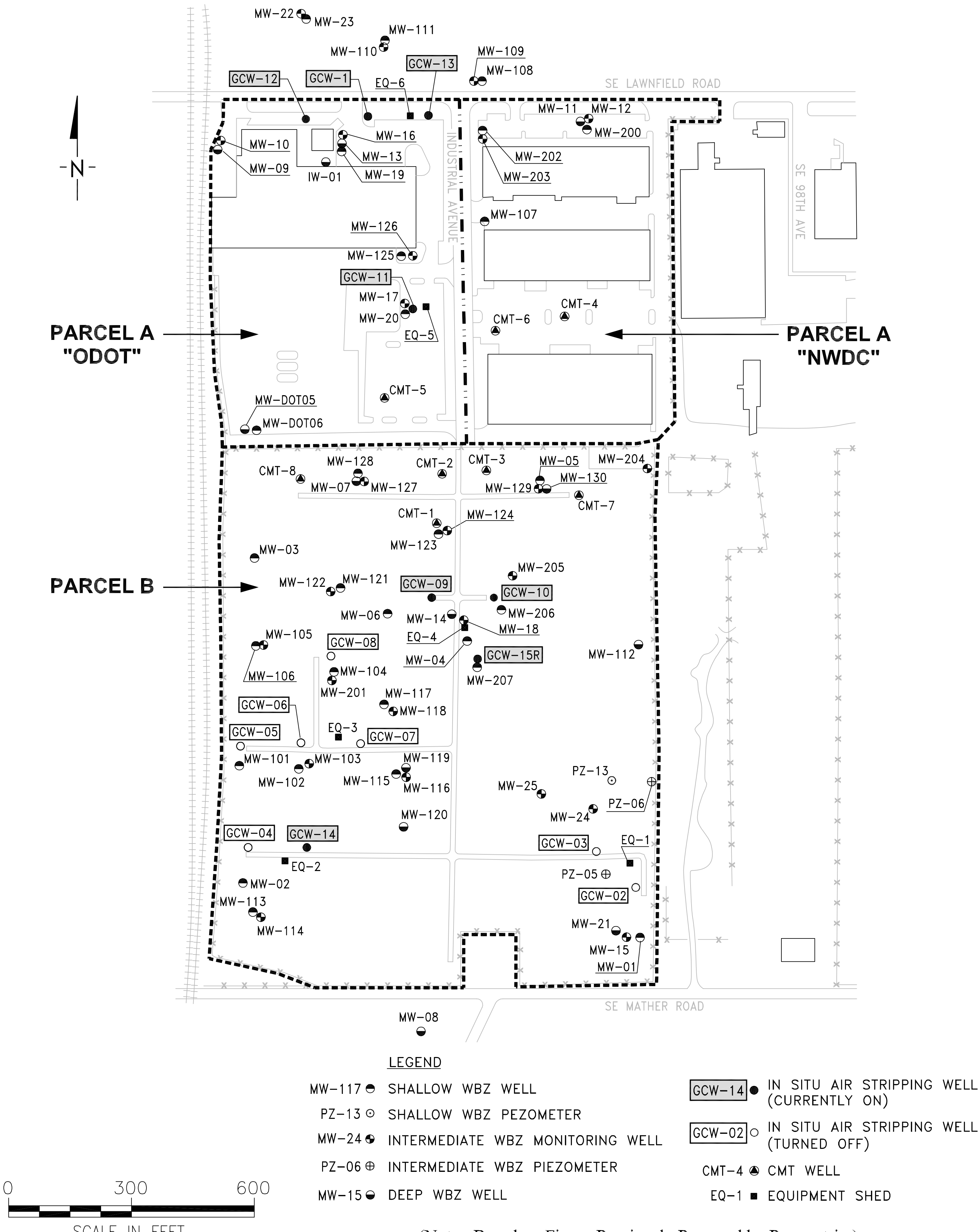
Costs in parentheses imply cost reductions
* assumes 30 years of operation with a discount rate of 0% (i.e., no discounting)
** assumes 30 years of operation with a discount rate of 5% and no discounting in the first year

(1) Future costs will also include decommissioning the existing GCW system. The RSE team has not specifically estimated these costs, but expects those costs might be on the order of $200,000. These costs are not included in this table because these costs would have expected to occur at some point in the future in any remediation scenario.

(2) The annual cost of $30,000 for monitoring over a 30-year period is not shown in this table as a change in annual costs because monitoring is already conducted at the site for a similar cost.

FIGURES

FIGURE 1-1. SITE LAYOUT AND WELL LOCATIONS.



(Note: Based on Figure Previously Prepared by Parametrix.)

Figure 1-2. Water Levels in Shallow Water Bearing Zone

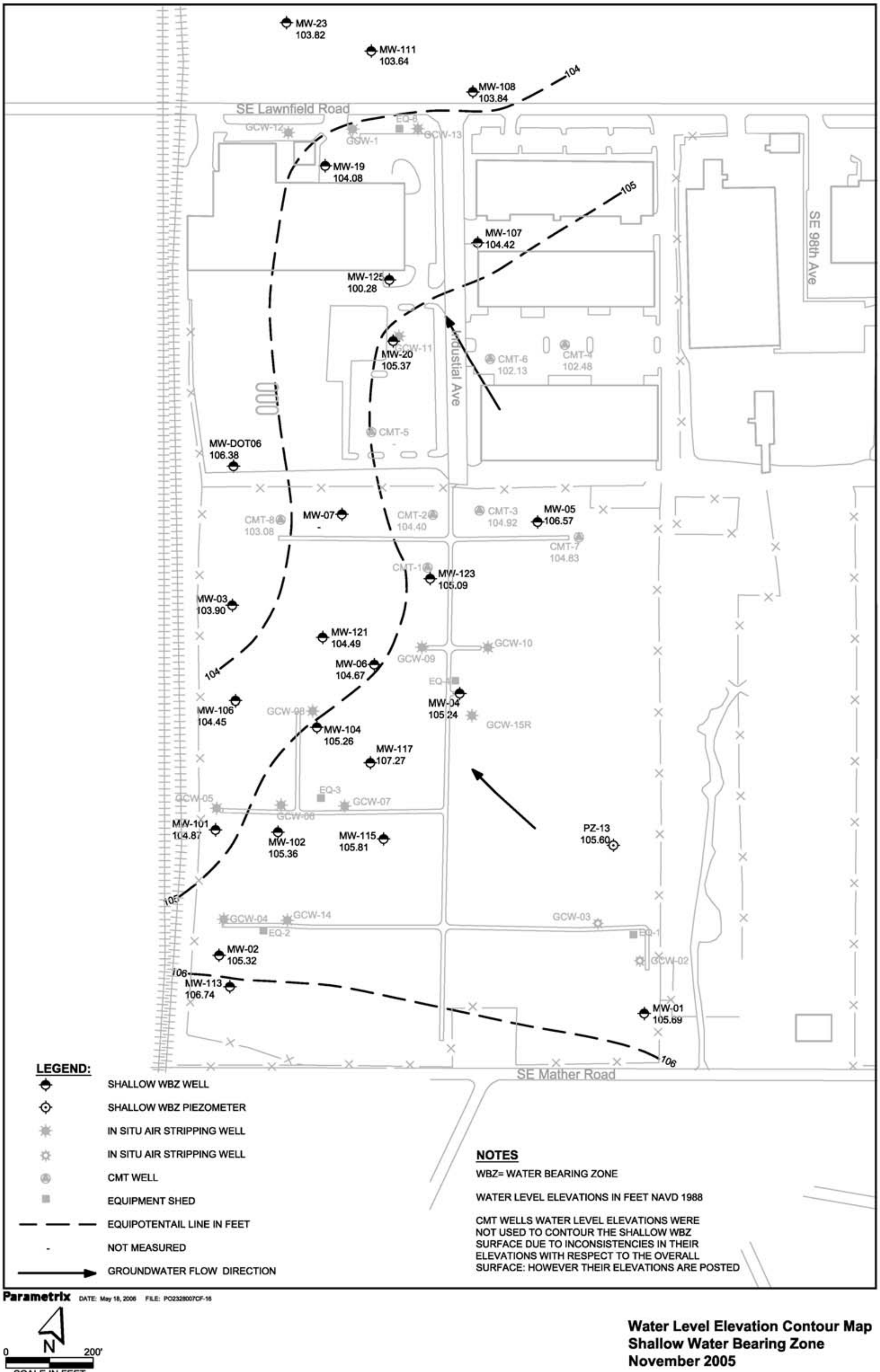
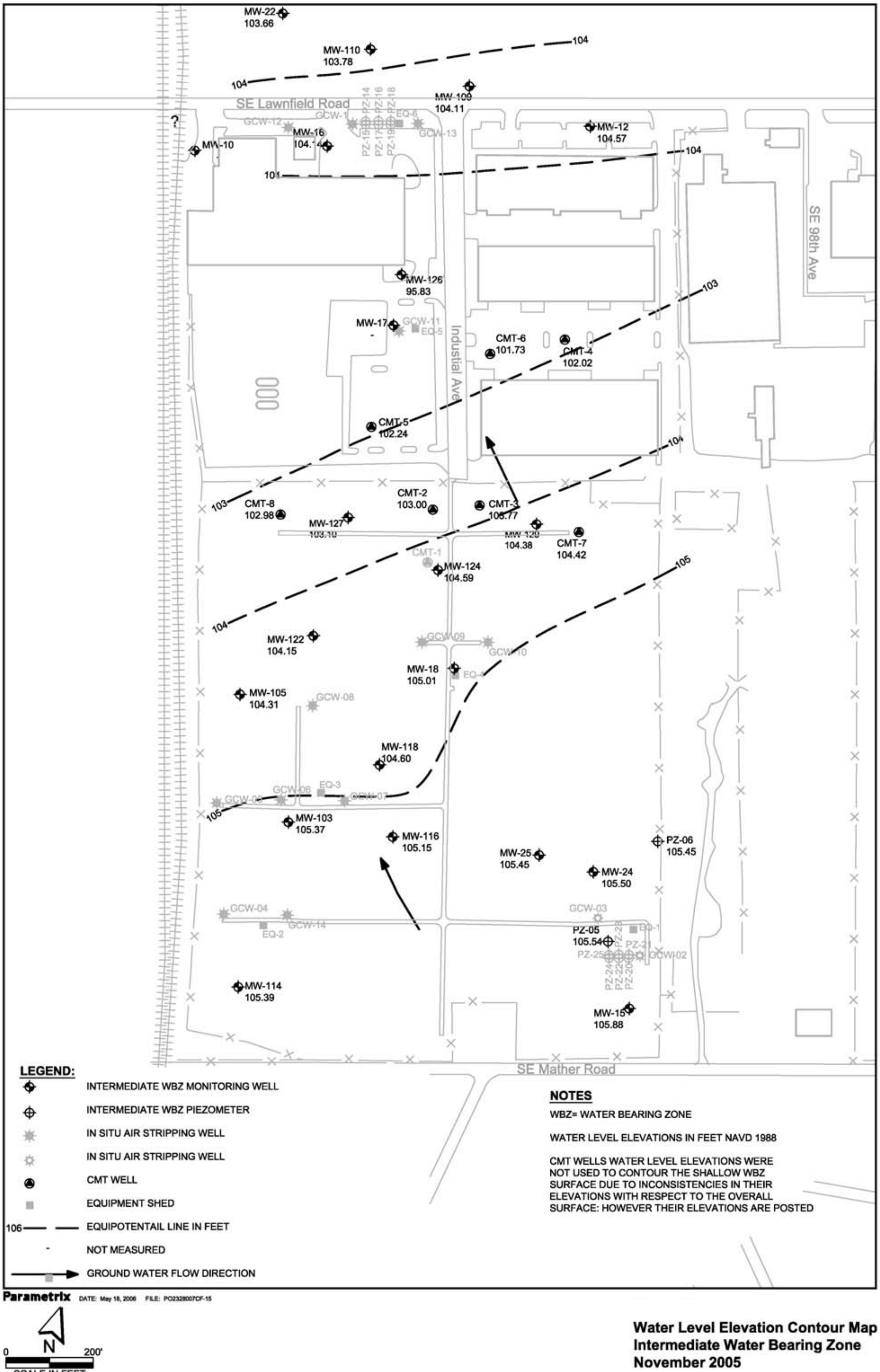


Figure 1-3. Water Levels in Intermediate Water Bearing Zone



Water Level Elevation Contour Map
Intermediate Water Bearing Zone
November 2005

Figure 1-4. Total Concentration of PCE, TCE, and VC in Shallow Water Bearing Zone

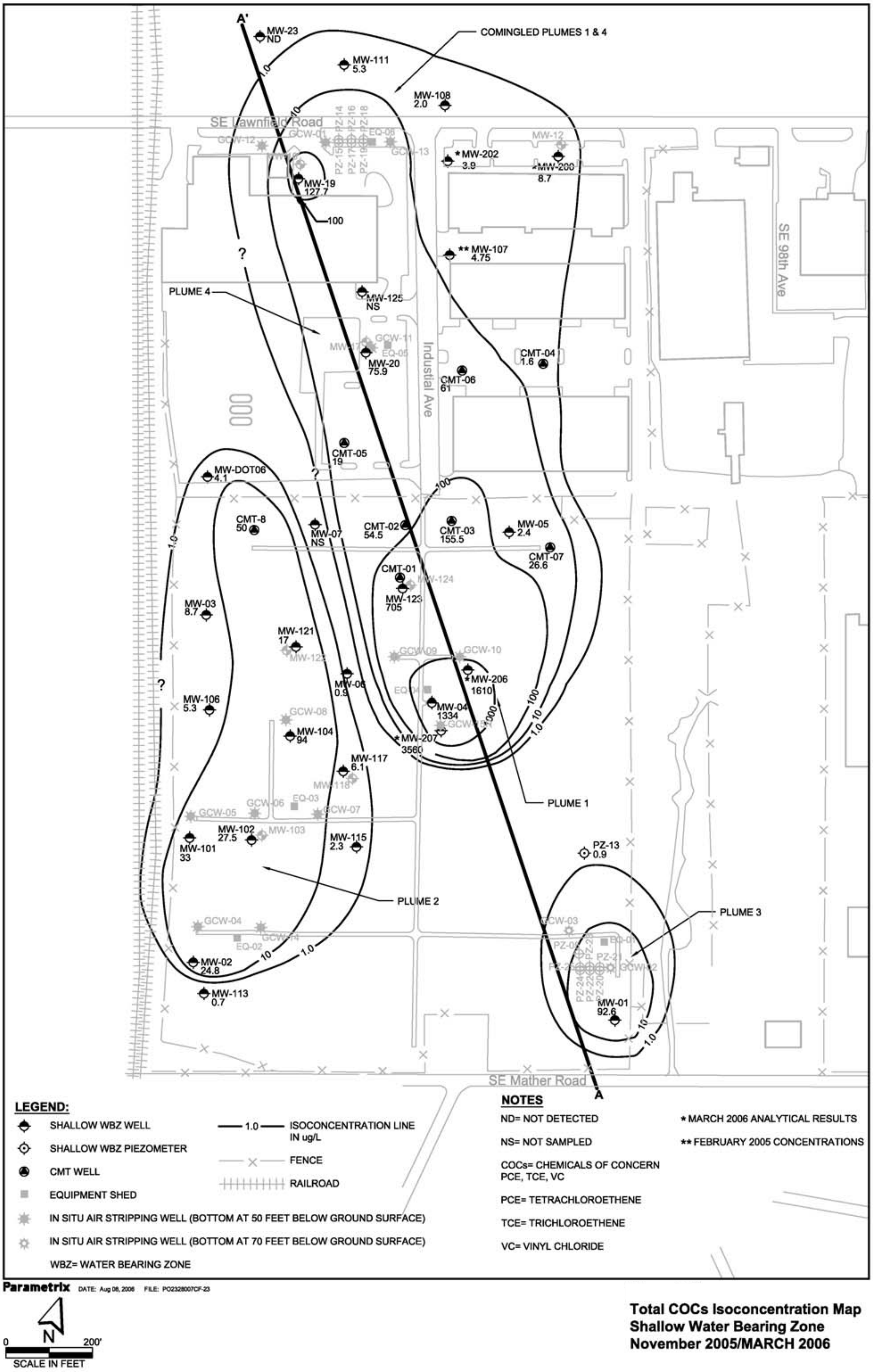
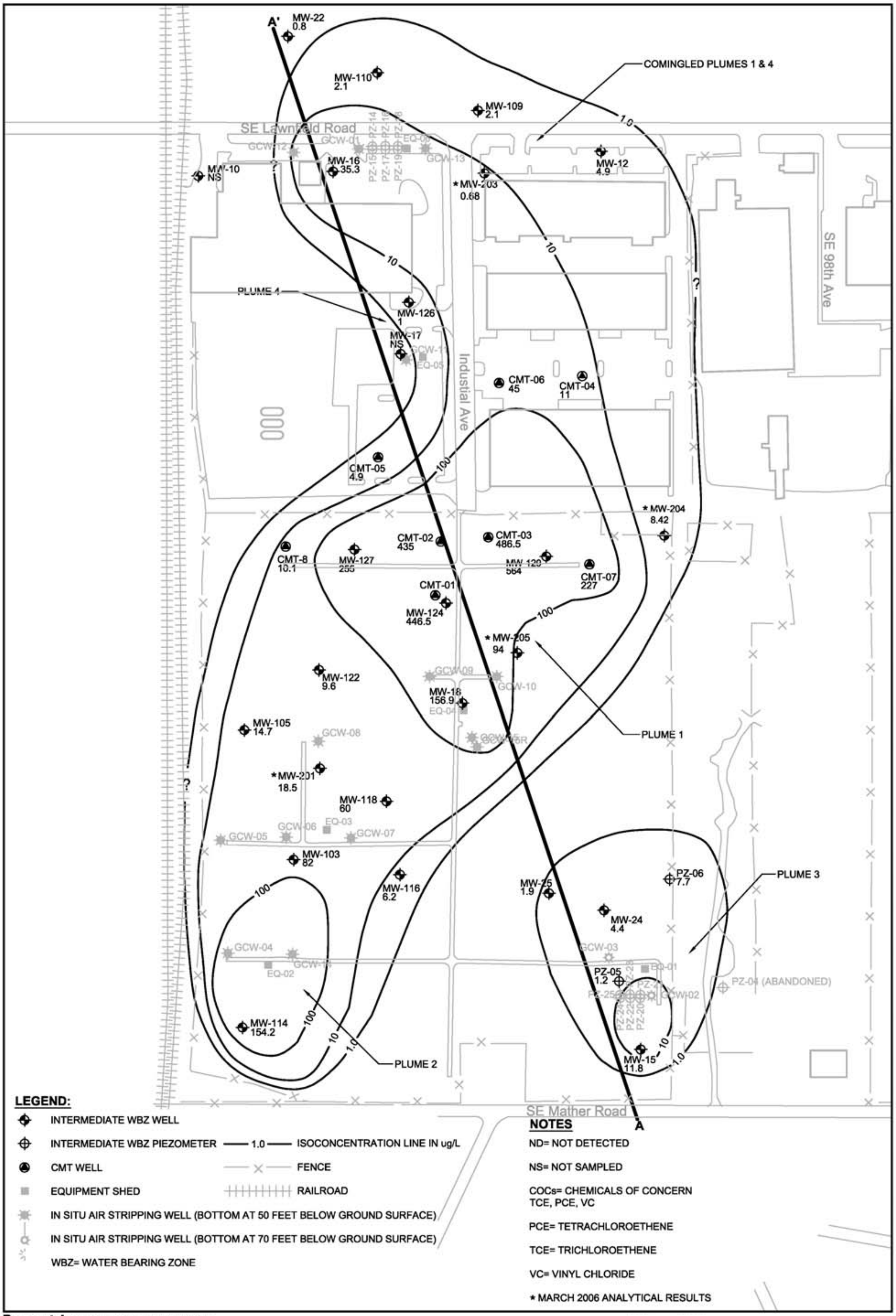


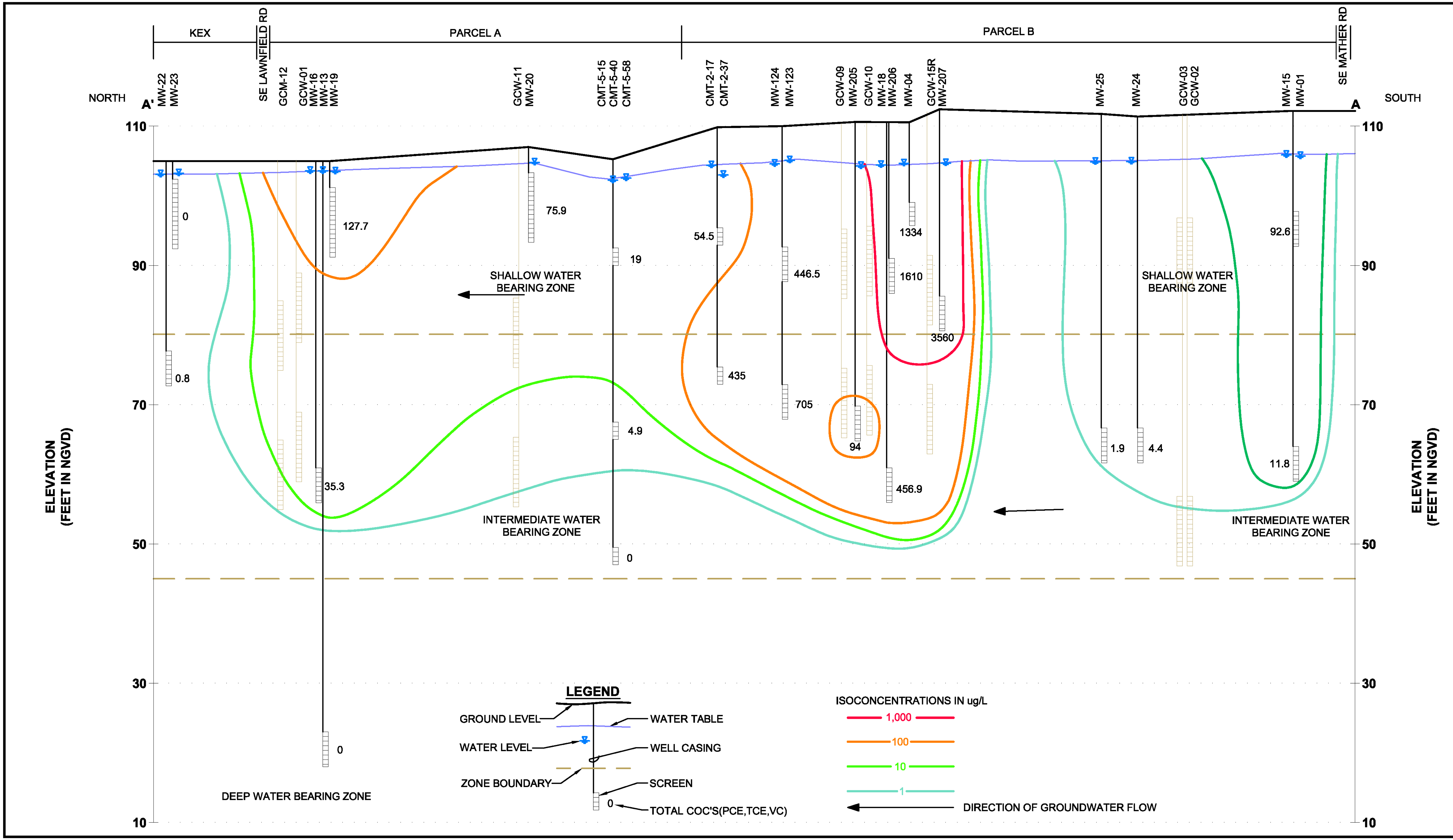
Figure 1-5. Total Concentration of PCE, TCE, and VC in Intermediate Water Bearing Zone



Parametrix DATE: Aug 08, 2006 FILE: PO2328007CF-26

N
0 200'
SCALE IN FEET

Total COCs Isoconcentration Map
Intermediate Water Bearing Zone
November 2005/March 2006



Parametrix DATE: May 18, 2006 FILE: PO2328007CF-27

HORIZONTAL SCALE (1"=200')
VERTICAL SCALE (1"=15')

NOTE:
CONCENTRATION AND WATER LEVELS FROM SITEWIDE SAMPLING EVENT (NOVEMBER 2005).

CONCENTRATIONS AND WATER LEVELS FOR NEW WELLS (MW-200 THROUGH MW-207) FROM FEBRUARY 2006.

A'-A Cross Section

Figure 1-6. Cross-Section Showing Vertical Delineation