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REMEDIATION SYSTEM EVALUATION (RSE)

ELLIS PROPERTY SUPERFUND SITE
EVESHAM AND MEDFORD TOWNSHIPS, NEW JERSEY

Report of the Remediation System Evaluation
Site Visit Conducted April 19, 2006

Final Report
September 2006

NOTICE

Work described herein was performed by GeoTrans, Inc. (GeoTrans) for the U.S. Environmental Protection Agency (U.S. EPA). 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 exit 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 implementation 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 Ellis Property Superfund Site is located in a rural area of Burlington County, New Jersey. Most of the land at the site has not been developed. However, there is a building in a fenced area that is used to house the remedial system, and land use is limited to the remedial activities. Land use in areas adjacent to the site is predominantly agricultural, though some residential development has occurred and is continuing to expand within a one-mile radius of the site. A drum recycling operation began in 1968 and was terminated in 1978 after a fire; however, drums continued to be stored at the site into the early 1980s. Soil and ground water contamination resulted from these historical facility operations. The site was listed on the National Priorities List in September 1983. A remedial investigation and feasibility study (RI/FS), was initiated in November 1985 and was completed in April 1992. A Record of Decision (ROD) outlining the selected remedial action was issued in September 1992. The selected remedy included:

- Excavation of contaminated soil and treatment/disposal at an approved off-site facility
- Extraction of contaminated ground water from the shallow aquifer beneath the site
- Treatment of contaminated ground water at a treatment facility to be built on the site
- Disposal of contaminated ground water at the site by reinjection
- Implementation of an environmental monitoring program

Excavation of contaminated soil was completed in 1998. Site clearing and construction of the pump and treat (P&T) ground water remediation system was initiated in November 1999, with completion occurring in June 2000. The P&T system was declared "operational and functional" in August 2000, at which time long-term monitoring began. This RSE focuses on the ground water extraction, treatment, discharge, and monitoring aspects of the remedy.

In general, the RSE team found a well-operated system. 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, NJDEP, and the public. 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: remedy effectiveness, cost reduction, technical improvement, and site closeout. The recommendations for improving system effectiveness are as follows:

- Install piezometer pairs along the length of the extraction trench to provide water level measurements and use these measurements to evaluate plume capture.

- Based on the above capture zone analysis, modify the treatment plant and potentially the infiltration trench to increase the hydraulic capacity and extract and treat water at a higher rate.

- Install two monitoring wells to improve plume characterization.

- Conduct limited sampling of the wetlands to evaluate potential impacts.

- Confirm that the ground water monitoring network provides enough information to evaluate plume capture.

Recommendations for cost reduction include the following:

- Optimize the process monitoring program by reducing the sampling frequency for some locations from monthly to quarterly. Implementing this recommendation may save approximately $5,000 per year in analytical costs.

- Avoid implementation of some items in the proposed work plan provided by another contractor. The RSE team believes pursuing these items would not provide worthwhile information for making future decisions at the site. Implementing this recommendation (i.e., not implementing the identified aspects of the work plan) might save approximately $75,000 in upfront costs.

The recommendation for technical improvement involves installing a timer for wasting sludge from the clarifier. The plant operator has been contemplating making this change, and the RSE team agrees with this modification. The recommendation for site closure suggests that aggressive source removal may be appropriate at this site, and the RSE team suggests that in-situ chemical oxidation with permanganate may be an appropriate technology. The RSE team recommends a pilot test in one of the hot spot locations.

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:

Organization	Key Contact	Contact Information
U.S. EPA Office of Superfund Remediation and Technology Innovation (OSRTI)	Jennifer Hovis	2777 S. Crystal Drive, 5th floor Arlington, VA 22202 Mail Code 5204P phone: 703-603-8888 hovis.jennifer@epa.gov
Dynamac Corporation (Contractor to U.S. EPA)	Daniel F. Pope	Dynamac Corporation 3601 Oakridge Boulevard Ada, OK 74820 phone: 580-436-5740 fax: 580-436-6496 dpope@dynamac.com
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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 P&T systems funded and managed by EPA 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 10 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 Remediation System Evaluation (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 exit 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 implementation 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 Ellis Property Superfund Site (the "site") was selected by EPA OSRTI based on a recommendation from EPA Region 2 and the New Jersey Department of Environmental Protection (NJDEP). In particular, the site team is planning further activities and wanted the third-party perspective of an RSE to provide input on these activities. 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:

Valerie Lane, Hydrogeologist, GeoTrans, Inc.
Peter Rich, Civil and Environmental Engineer, GeoTrans, Inc.
Doug Sutton, Water Resources Engineer, GeoTrans, Inc.

The RSE team was also accompanied by the following observers:

Matthew Charsky from EPA OSRTI
Sherri Clark from EPA OSRTI
Jennifer Hovis from EPA OSRTI

1.3 DOCUMENTS REVIEWED

Author	Date	Title
NJDEP	9/30/1992	Record of Decision
ACRES	8/1998	Design Report Groundwater Remediation/Remedial Design Services
NJDEP	Ongoing	Spreadsheet with historical data
ACRES	1999	Design drawings
NJDEP	N/A	MAROS monitoring evaluation output
Handex	3/2005 to 12/2005	Ellis Property Groundwater Remediation System Monthly System Operations Reports
USEPA	9/2005	Five-Year Review
The Louis Berger Group and PMK Group	11/2005	Pre-design Investigation Workplan

1.4 PERSONS CONTACTED

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

Carlton Bergman, Project Manager, Bureau of Design and Construction, NJDEP
Chad VanSciver, Operations Project Manager, Bureau of Construction, NJDEP
Tom O'Neill, Division of Publicly Funded Site Remediation, NJDEP
John Esposito, Plant Operator, Handex
Rob Alvey, Geologist, EPA Region 2

Richard Ho, the EPA Remedial Project Manager, was not available for the site visit.

1.5 Site Location, History, and Characteristics

1.5.1 Location

The Ellis Property Superfund Site (the "site") is located in a rural area of Burlington County, New Jersey, in the vicinity of Sharp Road and Evesboro-Medford Road. It is situated on the eastern side of Sharp Road, approximately 2,000 feet north of Evesboro-Medford Road. The site is identified on the Evesham Township tax map as Block 14, Lot 4. The total acreage of land at the site is 36 acres, with 24 acres situated in Evesham Township and 12 acres situated in Medford Township.

Most of the land at the site has not been developed. However, there is a building in a fenced area that is used to house the remedial system, and land use is limited to the remedial activities. The remainder of the land at the site is primarily covered by grass and native vegetation. The easternmost portion of the site has been identified by the U.S. Fish and Wildlife Service as a palustrine wetland.

Land use in areas adjacent to the site is predominantly agricultural. Cultivated fields border the site to the north and south; another lies to the west on the other side of Sharp Road. Some residential development has occurred within a one-mile radius of the site, with new development in the area continuing.

1.5.2 Historical Perspective

The site, on which dairy farming activities had been previously conducted, was purchased by Irving and Reba Ellis in 1968. Subsequently, a drum recycling operation was conducted on about four acres of the site. Activities associated with the drum recycling operation included drum delivery, storage, and reconditioning that consisted of rinsing or cleaning. After reconditioning, the drums were resold. Drum recycling activities were terminated in 1978 after a fire and resulting structural damages; however, drums continued to be stored at the site into the early 1980s.

Initial investigation of the site by the New Jersey Department of Environmental Protection and Energy (currently referred to as the New Jersey Department of Environmental Protection, "NJDEP") occurred in September 1980. At that time, a two-story building, in which several washing tanks with troughs were found, a storage area, and three sheds were present at the site. Numerous drums and other containers containing unidentified liquids or substances were found in the building and sheds. Approximately 100 plastic 55-gallon drums were found distributed near the sheds. Hundreds of other drums and containers were randomly distributed across the site. Removal of the drums from the site occurred in stages, beginning in March 1983 when NJDEP removed about 100 drums from the site. In late 1989 the removal process for an additional 218 drums containing hazardous waste material and 400 empty drums was begun. Drum removal from the site was completed in April of 1990.

Listing of the site on the National Priorities List occurred in September 1983. A remedial investigation and feasibility study (RI/FS), initiated in November 1985, was completed in April 1992. A Record of Decision (ROD) outlining the selected remedial action was issued in September 1992. The selected remedy included:

- Excavation of contaminated soil and treatment/disposal at an approved off-site facility
- Extraction of contaminated ground water from the shallow aquifer beneath the site
- Treatment of contaminated ground water at a treatment facility to be built on the site
- Disposal of treated ground water at the site by reinjection
- Implementation of an environmental monitoring program

Excavation of contaminated soil was completed in 1998. Site clearing and construction of the ground water remediation system was initiated in November 1999, with completion occurring in June 2000. The P&T system was declared "operational and functional" in August 2000, at which time long-term monitoring began. The initial Five-Year Review Report for the site was issued in September 2005. Figure 1-1 provides a map of the site indicating key site features including parts of the P&T system and site monitoring wells.

1.5.3 POTENTIAL SOURCES

The contents of drums found at the site consisted of acids, heavy metals, oils, grease, and a variety of organic compounds. Evidence of spills from leaking, corroded drums to the ground surface was present in several areas. PCE, in the solvent phase, was observed in soil during construction that occurred from 1999 to 2000.

Analytical results showed that soils at the site were contaminated with hydrochloric acid, heavy metals (including arsenic and lead), oil and grease, polychlorinated biphenyls (PCBs) and other semi-volatile compounds, such as bis(2-ethylhexyl)phthalate. At the time the ROD was issued in 1992, the concentrations of arsenic, lead, and PCBs exceeded USEPA risk-based soil remediation levels.

Analyses of ground water, also performed in 1992, showed that metals and volatile organic compounds (VOCs) were present in ground water. Detected metals included antimony, arsenic, beryllium, nickel, chromium, and lead. Detected VOCs included 1,2-dichloroethylene (1,2-DCE); methylene chloride; tetrachloroethylene (PCE); trichloroethylene (TCE); and 1,1,2-trichloroethane (1,1,2-TCA). The ground water concentrations of the metals, except lead, exceeded drinking water maximum contaminant levels (MCLs). The ground water concentrations of all of the VOCs exceeded MCLs.

During the RI surface water and sediment samples from the wetlands and the discharge area to the wetlands were analyzed. The results from these analyses showed that the surface waters contained metals and the sediments contained metals and PCBs. The results indicated exceedances for copper, lead, and zinc in surface water and for PCBs, 4,4-DDE (breakdown product of DDT), cadmium, chromium, lead, mercury, and zinc in sediments.

1.5.4 HYDROGEOLOGIC SETTING

Geographically the site is located in the central portion of the Coastal Plain Physiographic Province. Topography across the site generally is at its highest in the western and southern areas of the site. The maximum surface elevation of about 67 feet above mean sea level (amsl) occurs near Sharp Road and the minimum surface elevation of about 50 feet amsl occurs in the wetlands in the eastern part of the site. Surface drainage flows from west to east, into the wetlands. The wetlands drain into a nearby stream, Sharps Run, which is a tributary of Rancocas Creek.

The site is underlain by an aquifer system. Unconsolidated deposits of silty sand and clay lenses are present at the surface. The Hornerstown Formation, the shallow aquifer that is also comprised of silty sand and clay lenses, is present beneath the surficial unconsolidated deposits. The thickness across the site of the Hornerstown Formation is between about 7 and 20 feet. Ground water is typically encountered in the Hornerstown Formation between 3.5 to 15 feet below ground surface. The direction of ground water flow in this shallow aquifer is to the east and east-northeast. Aquifer tests used to estimate the aquifer parameters of the shallow aquifer indicate that hydraulic conductivity is between 0.41 and 1.63 feet per day (USEPA) to as much as 3.0 feet per day (Berger/PMK). The site team has identified a sand channel within the Hornerstown Formation oriented parallel to flow that may serve as a preferential flow path for contamination.

The Navesink Formation, which is comprised of interbedded clay and sand, lies below the Hornerstown Formation. The clay content increases with depth, reducing permeability. The thickness across the site of the Navesink Formation is between about 51 and 57 feet.

An aquifer, the Wenonah-Mount Laurel Sand, is present beneath the Navesink Formation. This aquifer is a major source of potable water for domestic wells located near the site. The thickness across the site of the Wenonah-Mount Laurel Sand is greater than 30 feet.

Another aquifer system, comprised of the Magothy-Raritan aquifers, is present beneath the Wenonah-Mount Laurel Sand. The Magothy-Raritan aquifers, separated by clay layers from the upper aquifers, are more productive than the upper aquifers. Combined, the Wenonah-Mount Laurel Sand and the Magothy-Raritan aquifers are a major source of municipal water for the area.

1.5.5 POTENTIAL RECEPTORS

Ground water contamination appears to be restricted to the shallow aquifer. Ground water beneath the site has been designated part of the New Jersey Coastal Plain Sole Source Aquifer, and it is considered to be “Class II, potable water.” While the shallow aquifer is relatively unproductive and does not serve as a drinking water source, it does provide recharge to the aquifers below. Other facilities near the site (including the public works facility, ball fields, and commercial establishments) have well water for irrigation but use public water for potable water. Therefore, the site team does not know of any potable water wells near the site. Sharps Run (surface water) and wetlands at the site are potential ecological receptors of contaminated ground water.

1.5.6 DESCRIPTION OF GROUND WATER PLUME

The contaminants of concern at the site are TCE and PCE. Figure 1-2 (with information gathered from Figure 6 of the November 2005 Pre-Design Investigation Workplan) shows interpretations of the TCE and PCE distributions at the site as of October 2004. Based on this map the TCE plume appears to extend from behind the treatment facility in the vicinity of MW-8 into the wetlands in the vicinity of MW-19. The following table indicates TCE concentrations from three recent sampling events.

TCE Concentration (ug/L)							
Date	**MW-2**	**MW-5**	**MW-6**	**MW-7**	**MW-8**	**MW-10**	**MW-18**
October 2004	7,400	2.3	5,000	6.7	ND	ND	850
March 2005	2,800	12	580	3 J	1 J	1J	370
July 2005	11,500	15	5,900	7.1	0.45	2.1	393

Figure 3.5 from the August 1998 Design Report by Acres International Corporation shows the PCE distribution at the site as of August 1995. Based on this map, the PCE distribution is localized in the vicinity of MW-7. The following table indicates PCE concentrations from the three most recent sampling events.

PCE Concentration (ug/L)							
Date	**MW-2**	**MW-5**	**MW-6**	**MW-7**	**MW-8**	**MW-10**	**MW-18**
October-04	ND	ND	ND	12	ND	ND	ND
March-05	ND	ND	ND	2J	ND	9J	ND
July-05	ND	ND	ND	3.8	ND	3.4	ND

2.0 SYSTEM DESCRIPTION

2.1 SYSTEM OVERVIEW

The P&T system, which became operational and functional in August 2000, consists of an extraction trench, two source area extraction wells, a treatment plant, and an infiltration trench. The extraction and injection networks are designed to form a closed loop such that ground water that is reinjected at the trench is extracted, forming a recirculation pattern.

2.2 EXTRACTION SYSTEM

The extraction trench is approximately 375 feet long and ranges from 12 to 17 feet deep. It is 4 feet wide and filled with sand and stone. A 6-inch diameter perforated pipe directs flow in the trench toward two sumps labeled Manhole-1 (MH-1) and Manhole-2 (MH-2). Electrical submersible pumps capable of pumping 20 gpm from the bottoms of MH-1 and MH-2 pump the water to the treatment plant through individual 1-inch discharge lines. Two extraction wells (PW-1 and PW-2) are located in high-concentration areas for “hot-spot” remediation. PW-1 is 23 feet deep and PW-2 is 21 feet deep, and both wells have 10-foot screened intervals. A 22-inch borehole was used to drill the wells, and the casings are 8-inches in diameter. The electrical submersible pumps in these wells pump ground water to the treatment plant through separate 1-inch discharge lines. Extraction rates from these components of the extraction system cycle on and off providing an average flow rate of approximately 3.5 gpm. It is believed that the cycling is caused by limited capacity of the treatment plant and infiltration trench and not by the potential yield from the extraction network. Given an average influent concentration of approximately 4,000 ug/L of total VOCs, the average rate of contaminant mass extracted is approximately 0.17 pounds per day.

$$\frac{3.5\,\text{gal}}{\text{min}} \times \frac{3.785\,\text{L}}{\text{gal}} \times \frac{4{,}000\,\text{ug}}{\text{L}} \times \frac{1\,\text{kg}}{10^9\,\text{ug}} \times \frac{2.2\,\text{lbs}}{\text{kg}} \times \frac{1440\,\text{min}}{\text{day}} = \frac{0.17\,\text{lbs}}{\text{day}}$$

2.3 TREATMENT SYSTEM

The treatment system is comprised of a solids settling tank, equalization tank, metals precipitation system, bag filters, pH, adjustment, air stripper, and effluent tank with a gravity discharge to the infiltration trench. The treatment system was designed to treat between 3 and 5 gpm with a maximum capacity of 15 gpm. Actual capacity appears to be approximately 7 gpm based on operating parameters at the time of the RSE. The treatment system treats on average 3.5 gpm of extracted water, but approximately 2.5 to 3 gpm is recycled from the clarifier to the head of the plant such that the metals treatment system is treating approximately 6 to 7 gpm on average. Air stripper offgas is treated by a 300-pound vapor phase granular activated carbon (GAC) unit, and sludge from the clarifier is thickened and then dewatered by a filter press.

2.4 MONITORING PROGRAM

The ground water monitoring program historically consisted of quarterly sampling of 38 monitoring wells for VOCs. However, the July and September 2005 events included 30 monitoring wells each. The site team recently optimized the monitoring program using MAROS software and has decided to reduce the sampling frequency to annual events and to reduce the number of monitoring wells sampled per event to 12.

Process monitoring includes monthly sampling for VOCs, metals, total dissolved solids, and total suspended solids in the blended process water from the equalization tank (which also includes recycled water from the metals removal system) and treatment plant effluent. It also includes quarterly sampling for the same parameters at MH-1, MH-2, PW-1, and PW-2 and for VOCs in the vapor phase GAC effluent.

3.0 SYSTEM OBJECTIVES, PERFORMANCE, AND CLOSURE CRITERIA

3.1 CURRENT SYSTEM OBJECTIVES AND CLOSURE CRITERIA

The remedial action objectives stated in the ROD for the site are as follows:

Soil

- Prevent contact with contaminated soil, which represents an unacceptable risk, or reduce contaminant concentrations in the soil below risk-based levels
- Prevent further migration of soil contaminants into the ground water
- Prevent migration of contaminated soils off site

Ground Water

- Prevent the migration of contaminated ground water off site
- Prevent the migration of contaminated ground water into the underlying aquifers
- Return the aquifer to its designated use as a source of drinking water by reducing contaminant concentrations in the shallow ground water to drinking water quality (see criteria below)

Contaminant of Concern	Cleanup Criteria (μg/L)
Antimony	6
Arsenic	50
Barium	1000
Beryllium	4
Cadmium	10
Chromium (total)	50
Copper	1300
Cyanide	200
1,1-Dichloroethene	2
1,2-Dichloroethene	10
Lead	15
Methylene Chloride	5
Nickel	100
Selenium	100
Silver	50
1,1,2-Trichloroethane	5
Tetrachloroethene (PCE)	1
Trichloroethene (TCE)	1

3.2 TREATMENT PLANT OPERATION STANDARDS

Treated ground water is discharged to the onsite infiltration trench. Discharge is governed by a New Jersey Pollution Discharge Elimination System (NJPDES) Permit Equivalent. Because the extraction and injection system for a closed loop, all water reinjected is theoretically extracted. As a result, the discharge criteria are that the effluent concentrations must be reduced to 5% or less than the influent concentrations or to meet the standards noted above, whichever is higher.

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, NJDEP, 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

Water level measurements have been collected on a quarterly basis during ground water sampling events; however, the data are not routinely used for generating potentiometric surface maps. A cursory review of recent water level data demonstrates that overall ground water flow is similar to that used during system design. Vertical gradients vary across the site but, in general, are upward or neutral in the upgradient portion of the site and are likely influenced by the trench near the downgradient portion of the site. No vertical gradient information is available downgradient of the extraction trench.

4.2.2 CAPTURE ZONES

Evaluation of capture has not been documented since the P&T system began operation. Evaluations during project design suggested a pumping rate of 3.5 gpm to provide capture while minimizing drawdown in the wetlands; however, the heterogeneity of subsurface materials and hydraulic conductivity make it difficult to rely on this pre-design evaluation. In addition, the heterogeneity (e.g., the sand channel) makes it difficult to conduct a water budget analysis or use potentiometric surface maps to interpret capture. Capture evaluations would most likely need to rely on evaluating local hydraulic gradients from pairs of water level measurements or on decreasing concentrations downgradient of the extraction trench. There currently are no pairs of water level measurements that are adequately located to evaluate hydraulic gradients from the downgradient of the trench toward the trench. The best indication of capture is that TCE concentrations in MW-18 have decreased by one to two orders of magnitude since the P&T system began operating. A continuing downward trend that eventually reaches background conditions would indicate complete capture, whereas a downward trend that asymptotically approaches a concentration above background would indicate incomplete capture. This form of capture zone evaluation would take several years of monitoring to conduct.

4.2.3 CONTAMINANT LEVELS

TCE concentrations in the source areas in the vicinity of MW-2 and MW-6 consistently remain elevated above 5,000 ug/L, but this represents a decrease from high concentrations above 60,000 ug/L in MW-2 and 30,000 ug/L in MW-6. These persistently elevated concentrations may indicate that residual source material remains in these areas and/or that the formation is relatively tight such that the contamination is not easily flushed toward the extraction trench. TCE concentrations at MW-5, MW-7, MW-8, MW-10, and MW-18 have consistently decreased. Concentrations in all wells with detections fluctuated during 2003 and 2004 when the site team experimented with various sampling methods (including diffusion bag samplers), but the site team has since returned to the original technique used at the site, which is sampling using a three volume purge. TCE concentrations in other monitoring wells are undetectable, providing both general horizontal and vertical delineation. However, the monitoring network is too sparse to determine which specific areas within this general area are impacted. That is, the contamination at MW-2 may be much more limited in extent than is represented by the monitoring network.

PCE has been detected at concentrations above 1 ug/L in wells MW-2, MW-6, MW-7, MW-9, MW-10, and MW-18. The highest PCE concentrations have been detected in MW-7. In MW-7 and MW-10, PCE concentrations have generally decreased from the high of 33,000 ug/L to approximately 10 ug/L. In all other wells, PCE has not been detected since 2003.

4.3 COMPONENT PERFORMANCE

4.3.1 EXTRACTION SYSTEM TRENCH, WELLS, PUMPS, AND HEADER

Although the total flow for the P&T system is lower than the design flow, each of these components has functioned as expected. Extraction rates from these components of the extraction system cycle on and off. Flow from the trench cycles on and off because of the limited capacity of the treatment plant and infiltration trench. Flow from the extraction wells cycles on and off because of the limited yield of these wells.

4.3.2 SOLIDS SETTLING AND EQUALIZATION TANKS

Extracted ground water discharges to a 500-gallon solids settling tank, which also receives filtrate from the filtrate storage tank and water from the building sump. Water from the solids settling tank flows by gravity into a 2,000-gallon equalization tank. Solids are transferred from the solids settling tank during each visit by the plant operator (e.g., three times per week). Dissolved iron in the ground water precipitates in the oxygenated conditions in the equalization tank, requiring frequent attention from the operator and routine inspection of y-strainers between the equalization tank and the subsequent process pumps.

4.3.3 METALS PRECIPITATION SYSTEM

The site team originally used ferric chloride as a coagulant, but recently switched to a proprietary formula from the vendor. The plant operator reports that about 1 gallon per day of coagulant is used and about 0.5 gallons per day of sodium hydroxide is used for metals precipitation. This is a significant reduction from previous usage, which included approximately 5 gallons per day of sodium hydroxide. Polymer is also added to aid in flocculation. The clarifier is one of the capacity limiting steps of the treatment process and reaches its peak capacity at approximately 7 gpm. Sludge from the bottom of the clarifier is continuously wasted rather than being wasted periodically. This increases the amount of water that is recycled through the plant. Of the 7 gpm that is currently flowing through the metals removal system, approximately half of it is recycled water. Approximately once a week to once every two weeks, the operator conducts partial blowdowns of the clarifier and acid washes the lines after the clarifier to reduce scaling.

The metals precipitation unit is used primarily to remove iron and manganese to prevent fouling of the air stripper. Concentrations of metal contaminants of concern that were listed in the ROD decreased when pumping began and have not required treatment.

4.3.4 FILTERS

The filtration system includes two parallel sets of bag filters arranged in series. The first set of parallel filters historically had 100 micron filters and the second parallel set had 50 micron filters. However, due to a change in the coagulant used in the metals precipitation system, the turbidity coming from the clarifier was reduced, and the bag filter sizes were reduced to 50 microns and 25 microns. The plant operator changes the filters three times per week.

4.3.5 AIR STRIPPER

The air stripper is a tray aerator that is providing greater than 99% removal of VOCs. Influent VOC concentrations have averaged from 3,000 ug/L to 5,000 ug/L, and effluent VOC concentrations have historically ranged from "non-detect" to as high as 21 ug/L. Although this removal efficiency would not be sufficient for typical discharge scenarios to ground water or surface water, the P&T injection/extraction systems operate as a closed loop. Therefore, all water that is reinjected through the infiltration trench is theoretically extracted by the extraction wells or extraction trench. Under this scenario, the effluent concentration for each parameter only needs to be less than or equal to 5% of the respective influent concentration. Therefore, if the influent VOC concentration is 3,000 ug/L, the effluent VOC concentration would need to be less than 150 ug/L.

4.3.6 VAPOR PHASE GRANULAR ACTIVATED CARBON UNITS

There is one 300-pound vapor GAC unit that is used to treat the offgas from the air stripper. The influent and effluent to this unit is sampled weekly using a flame-ionization detector, the air flow velocity is measured weekly, the unit effluent is sampled quarterly for VOCs, and the unit is replaced every six to nine months.

4.3.7 EFFLUENT TANK AND INFILTRATION TRENCH

The infiltration trench is approximately 200 feet long and 4 feet wide. The trench consists of a 2-inch perforated HDPE line buried approximately 2 feet below ground surface, low permeability fill above the line and underdrain stone around and 3 feet beneath the line. Filter fabric separates the underdrain stone from underdrain sand which extends to the Navesink formation approximately 8 to 12 feet below the stone. The trench is gravity fed from the effluent tank. The site team has not experienced significant fouling of the trench, but they have blown air through the trench approximately once per year in an attempt to reduce fouling. The site team reports that the infiltration trench, in addition to the clarifier, is one of the capacity limiting aspects of the system.

4.3.8 SLUDGE HANDLING

Sludge from the clarifier is continuously wasted with water recirculating through the system. Solids are generated at a rate that typically requires filter press drops once per week, but filter drops have been conducted as frequently as eight times per month.

4.4 COMPONENTS OR PROCESSES THAT ACCOUNT FOR MAJORITY OF ANNUAL COSTS

The project team provided the monthly O&M costs for the past several years for evaluation. The costs provided include approximately $19,000 per month for the O&M contractor, $1,000 per month for electrical costs, and additional costs for grass cutting and chemicals. Historical grass cutting appears to have cost approximately $20,000 per year. Therefore, the total annual contractor cost for O&M is approximately $250,000 per year. There are additional costs to EPA and NJDEP for the NJDEP staff working on the project. A breakdown of annual costs was not provided by the site team. The RSE team has attempted to breakdown these costs into a variety of categories in the following table.

Item Description	Estimated Cost*
Labor: Project management, reporting, etc.	$35,000
Labor: System operation	$140,000
Labor: Ground water sampling	$18,000
Utilities: Electricity	$12,000
Utilities: Other	$6,000
Non-utility Consumables (GAC, chemicals, etc.)	$8,000
Discharge or disposal costs	$5,000
Analytical costs	$20,000
Other (parts, routine maintenance, etc.)	$6,000
Total Estimated Annual Cost	**$250,000**

** The total estimated cost is consistent with that reported by the site team. The values for each of the individual cost categories have been estimated by the RSE team.*

4.4.1 UTILITIES

The primary utility cost is for electricity. Electricity usage and costs suggest a unit rate of approximately $0.09 per kWh when both electrical usage and demand are considered. Other utilities include phone, public water, and trash disposal.

4.4.2 NON-UTILITY CONSUMABLES AND DISPOSAL COSTS

Non-utility consumables consist of vapor phase GAC, bag filters, sodium hydroxide, polymer, coagulant, and disposable personal protective equipment.

4.4.3 LABOR

The treatment plant operator is present on site three times per week. Assuming each site visit is 8 hours at an hourly rate of $108 (provided by NJDEP), this translates to an annual cost for O&M labor of approximately $135,000 per year. An additional $5,000 per year might be needed for engineering support, additional labor for complex tasks, and responding to alarms. Ground water sampling will be conducted on an annual basis. Assuming all 38 wells are sampled and gauged in 9 days at an average cost of $2,000 per day for labor and equipment, the cost for the labor and equipment for ground water sampling will likely be approximately $18,000. Project management, including the cost of an annual ground water report (which is expected for future events), is estimated at $35,000 per year

4.4.4 CHEMICAL ANALYSIS

Chemical analysis is provided for both the annual ground water monitoring event and the routine process monitoring. The ground water monitoring might include 50 samples, including QA/QC samples, for a total of approximately $5,000 (assumes $100 per sample). The process monitoring includes the following:

- monthly samples for VOCs, metals, TSS, and TDS at MH-1, the equalization tank, and the treatment plant effluent
- quarterly samples for VOCs, metals, TSS, and TDS at MH-2, PW-1, and PW-2
- quarterly samples for VOCs of the GAC effluent

Including QA/QC samples and assuming $100 per aqueous VOC analysis, $160 per inorganic analysis (i.e., metals, TSS, and TDS), and $150 per VOC air analysis, the total process monitoring cost is approximately $20,000.

4.5 RECURRING PROBLEMS OR ISSUES

The plant operator mentions routine issues with solids precipitation in the equalization tank and non-optimal wasting of solids from the clarifier. However, these issues have not resulted in problems complying with the discharge requirements. Rather, they have limited the capacity of the P&T system, which may adversely affect the ability of the system to provide capture.

4.6 REGULATORY COMPLIANCE

Since operation of the pretreatment system, discharge standards are routinely met and no issues regarding compliance were reported by the site team.

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

The site team reports that there have not been any uncontrolled releases of contaminants or reagents.

4.8 SAFETY RECORD

The site team reports no health and safety incidents.

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

5.1 GROUND WATER

The five-year review documents the effectiveness of the remedy to protect human health and the environment. The document indicates that ground water contamination is being captured to some extent by the extraction system (as indicated by the decreasing concentrations in MW-18) but that the extent of capture is unclear. Some limited contamination may or may not continue to migrate past the extraction trench toward the wetlands, but this migration is sufficiently limited such that concentrations have been decreasing. Therefore, the P&T system has had a positive effect in reducing contaminant migration. Contaminant concentrations in the intermediate and deep intervals screened by the monitoring network have consistently been below the 1 ug/L standard and have generally been undetectable, except for one recent detection of 2 ug/L in IW-6. Limited impacts (e.g., below 1 ug/L) have been detected in DW-2, IW-6, and DW-6, all of which are located in source areas. These limited impacts in the source areas suggest the potential for downward contaminant migration, but might also indicate contamination that was "pulled" down during well installation.

The contamination in the shallow aquifer does not pose a current threat to human health because there are no buildings on the property other than the treatment plant and the water in the shallow aquifer is generally unsuitable for drinking, regardless of VOC contamination.

5.2 SURFACE WATER

Historical concentrations in MW-18 indicate that TCE is present downgradient of the extraction trench and may be discharging to the wetlands. No water quality sampling of the wetlands has been conducted to determine impacts to the wetlands, but such sampling was recommended during the Five-Year Review that was completed in September 2005.

5.3 AIR

There are no buildings on or adjacent to the property that would be adversely affected by vapor intrusion. The Five-Year Review indicates that due to the elevated TCE concentrations (e.g., over 1,000 ug/L) and the shallow depth to ground water that any development that would occur on the property should be limited in area and restricted in use to avoid the risks associated with vapor intrusion.

5.4 SOIL

The soil aspects of the remedy, primarily consisting of excavation, have been implemented, but it is possible unsaturated soil (in addition to saturated soil) remains impacted and a continuing source of contamination. The RSE team did not review post-excavation samples. Surface soils, however, have been remediated, therefore risks due to direct contact with impacted soil or from migration of impacted dust from the site are not indicated.

5.5 WETLANDS AND SEDIMENTS

Please refer to the discussion under Section 5.3 (Surface Water) for comments regarding potential impacts to the wetlands.

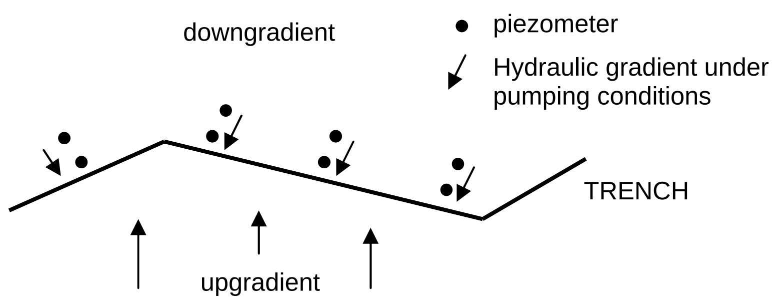
6.0 RECOMMENDATIONS

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 CAPTURE ZONE EVALUATION WITH INSTALLATION OF PIEZOMETER PAIRS

Determining the necessary flow rate from the extraction trench to maintain adequate capture is a difficult task given the subsurface heterogeneity, the impact of the sand channel, and the variable rate of ground water flow through the area. As discussed in Section 4.0 of this report, the decreasing concentration trends at MW-18 suggest that capture is occurring, but it is uncertain if capture is complete such that concentrations downgradient of the extraction trench will decrease to background levels over time. Rather than wait several years to form a conclusion based on the concentration trends, the RSE team suggests installing piezometer pairs (with the pair oriented perpendicular to the trench) at certain intervals along the length of the trench on the downgradient side as illustrated in the figure below. In each pair, one piezometer might be approximately 1 to 3 feet from the trench and the other might be 10 feet further from the trench. The piezometer pairs would likely be installed to a depth of approximately 15 feet below ground surface with a 5-foot screened interval. The figure illustrates four sets of piezometer pairs, which is appropriate for this site. At least one piezometer pair should be placed in the area of the sand channel. If the extraction rate is sufficient to provide capture, then the piezometer pairs should indicate flow toward the trench. If the extraction rate is not sufficient then, in some portions along the trench, water will continue to migrate through the trench and the hydraulic gradient will be directed to the east (e.g., regionally downgradient). The water levels in these peizometers can be evaluated seasonally to determine at what periods capture is sufficient. If possible, the site team should consider a step extraction test with the trench to determine how much more extraction might be necessary to find an extraction rate that balances plume capture and maintaining the water level in the wetlands.



If possible, the site team should use MW-10 and MW-11 as components of these piezometer pairs to reduce the number of points that need to be installed. The RSE team estimates that this effort might require up to $20,000 in upfront costs to implement. For additional costs, piezometers could also be installed further downgradient of the trench to evaluate potential drawdown in the wetlands. The site team will need to evaluate the value of the piezometers closer to the wetlands given that monitoring wells are already present in the wetlands. The effect on long term costs of this approach should be negligible since the water levels in these piezometers could be easily added to a routine well gauging event and data analysis is comprised of only evaluating the direction of flow for each of these piezometer pairs.

6.1.2 Based on Capture Zone Evaluation, Consider Modification of Treatment Plant and Injection Trench to Increase Hydraulic Capacity

In net, the P&T system is extracting and treating approximately 3.5 gpm, but because of extensive water recycling within the treatment plant, the treatment plant is treating approximately 7 gpm and is operating at or near capacity (even though it was designed for a maximum capacity of 15 gpm). The capture zone analysis above may indicate that additional extraction is necessary to provide adequate capture without adversely affecting the water level in the wetlands. If this is the case the site team will want to modify the treatment plant to accommodate additional flow. The site team will want a good understanding of the amount of flow it will need to treat, so a step test with the extraction trench and the above-noted piezometer pairs would be advisable to determine the optimal flow rate. Based on its review of the system and discussions with the plant operator, the RSE team sees the following options for modifying the overall system capacity if an increase in capacity is needed.

Option 1: An Increase in Flow Rate of 2 gpm or Less is Needed – For this minimal increase in flow, it may be sufficient to set sludge wasting from the clarifier to a timer (rather than continuous wasting) so that less water is recycled from the clarifier to the head of the plant. With the increased flow and solids loading to the filters, the site team might also want to install additional bag filters in parallel to reduce the frequency with which filter changeouts are required. The infiltration trench may also need to be augmented. The site team might consider adding to the existing infiltration trench or adding an additional trench to the north or east side of the treatment plant. With the increased flow rate, the tray aerator will likely provide enough removal to meet discharge standards, but the site team may want to aim for additional removal to avoid reinjecting concentrations that are above the cleanup standards. This could be achieved by improving maintenance/cleaning of the tray aerator to increase performance or adding another tray. In very unusual circumstances, the site team might need to install the spare tray aerator (in series with the current tray aerator) or a liquid phase GAC polishing step. If the spare tray aerator is installed in series with the existing tray aerator, the VOC offgas from the lag tray aerator would be undetectable and would not require vapor treatment. This option might require $20,000 to $100,000 in upfront costs to implement, but additional annual costs would not change significantly. The above range depends on what items are implemented. Adding another infiltration trench would be one of the more costly items (approximately $40,000).

Option 2: An Increase in Flow Rate of Greater than 2 gpm is Needed – The site team should consider the same modifications above, but they should also consider installing a larger clarifier to accommodate additional flow. The need for additional injection capacity, VOC treatment, and bag filters would be higher than that for Option 1. In addition, given the higher extraction rate, there may be a greater likelihood of dewatering the wetlands. If this stress on the wetlands is observed, the site team should consider discharging some or all of the treated water to the wetlands. Discharging water directly to the wetlands (i.e., downgradient of the extraction trench) should effectively reduce the amount of "clean" water that needs to be extracted. Furthermore, because the treated water is discharged downgradient of the extraction trench, it minimizes the potential for reducing the water level in the wetlands. Changing the discharge location, however, has disadvantages. Extending a discharge line this far (over 1,000 feet) would be fairly costly, and changing the discharge location to surface water would likely be accompanied by a change in discharge criteria. The second air stripper available at the treatment plant would likely need to be added in series. This option might require $50,000 to $150,000 in upfront costs to implement, but additional annual costs would not change significantly. The above range depends on what items are implemented. The primary cost differences between Options 1 and 2 are the purchase and installation of a clarifier and the potential for extending a discharge line over 1,000 feet to the wetlands.

6.1.3 IMPROVE SITE CHARACTERIZATION WITH INSTALLATION OF TWO MONITORING WELLS

The RSE team believes there are two additional points for long-term monitoring that could help long-term plume delineation and evaluation of remedial progress. The RSE team believes one monitoring well should be installed at a location triangulated between MW-5, MW-6, and MW-12 (e.g., near CPT-13 and CPT-14) to improve understanding of contamination in the sand channel upgradient of the trench. This well could be installed to the bottom of the sand channel so that the water sampled from the well accounts for contamination that might be present along the bottom of the channel. The RSE team does not see the need for additional investigation along the bottom of the sand channel at this point. Given that this new well would be installed along the bottom of the sand channel, the RSE team also does not see the need for re-installing MW-2 or MW-5 to the bottom of the sand channel. The other monitoring well that the RSE team recommends installing is triangulated between MW-6, MW-7, and MW-3. This new well would help delineate the southern boundary of the plume over the life of the remedy. Installation of these wells might cost $10,000 if the effort can be coordinated with other field activities (e.g., the piezometer installation noted in Section 6.1.1.) There will be additional costs on an annual basis to include these two new wells in the sampling program. Given that ground water sampling is conducted annually, that increase in costs might be $1,500 per year for both sampling and analysis.

6.1.4 CONDUCT LIMITED SAMPLING OF THE WETLANDS SURFACE WATER AND SEDIMENTS AS INDICATED IN THE FIVE-YEAR REVIEW

The Five-Year Review recommends limited sampling of the wetlands surface water and sediments to determine compliance with New Jersey guidance/standards and to confirm that the remedy is protective of ecological receptors. Recent wetlands evaluations have indicated vigorous/healthy vegetation growth and colonization of plant species native to the area. Some wildlife browsing has also been noted. The site team may benefit from a consultation from EPA Region 2 Biological Technical Assistance Group (BTAG) regarding the health of the wetlands. It may be appropriate to limit the scope of the wetlands sampling because, depending on the health of the wetlands, remedial action may be more damaging than the impacts of contaminants. The most appropriate measures would likely be to improve the capture offered by the P&T system, which the site team will already be evaluating and improving due to impacts seen in MW-18. The wetlands sampling, from perhaps 3 to 5 locations could be added to the upcoming 2006 ground water monitoring event. This might cost approximately $3,000 for labor, equipment, and analysis.

6.1.5 CONFIRM THAT GROUND WATER MONITORING NETWORK PROVIDES ENOUGH INFORMATION TO EVALUATE CAPTURE

The site team recently optimized the ground water monitoring network using the MAROS software. The sampling was reduced from 30 monitoring wells sampled on a quarterly basis to 12 monitoring wells sampled on an annual basis. The site team did not report which 12 wells would continue to be sampled. The RSE team agrees with reducing the sampling frequency to annual sampling and the RSE team agrees with reducing the number of sampling locations. However, the RSE team encourages the site team to revisit their analysis and confirm that they will have enough sampling to help confirm plume capture. In addition to sampling the two new wells recommended in Section 6.1.3, the RSE team sees the value in sampling the following wells on an annual basis with respect to monitoring plume containment.

Shallow Wells: MW-3, MW-4, MW-9, MW-10, MW-11, MW-18, MW-19, MW-21
Intermediate or Deep Wells: DW-2, IW-4, IW-5, IW-6, DW-7, IW-11

MW-2 and MW-6 are not included in the above list because they are source area wells. The concentration trends will not likely decrease in the absence of source area remediation, and the trends in these wells would not be meaningful for evaluating capture. Rather, emphasis has been placed on monitoring those wells that either outline the plume or are located in areas that are expected to clean up if capture is adequate. It would be beneficial to sample MW-2 and MW-6 on a less frequent basis (perhaps in coordination with a Five-Year Review) to track the concentrations. Alternatively, it may be beneficial to continue sampling these two wells on an annual basis if source area remediation is implemented and the site team wishes to evaluate effectiveness of those measures.

The importance of sampling the above-mentioned wells depends on the remedy objectives regarding plume capture and other lines of evidence that support capture is adequate. Sampling the above-noted wells would likely cost 50% more per year than sampling the 12 wells selected by the site team. This might translate to a difference of $5,000 more per year in sampling costs.

6.2 RECOMMENDATIONS TO REDUCE COSTS

6.2.1 REVISE PROCESS MONITORING PROGRAM

The RSE team estimates that process monitoring accounts for approximately $15,000 of the annual O&M costs. Now that the treatment plant has been operating for over five years with relatively consistent influent data and plant operation has stabilized, the site team should consider reducing the monitoring frequency from monthly at MH-1 and the equalization tank to quarterly. This would save approximately $5,000 per year.

6.2.2 CONSIDER NOT IMPLEMENTING ASPECTS OF THE PROPOSED WORK PLAN

As part of the RSE effort, the RSE team reviewed a draft pre-design investigation work plan that was provided to the site team by another contractor (i.e., not the RSE team or the site contractor). The work plan included several items that the RSE team believes would not be worth the cost of conducting. The following items that the RSE team advises against implementing are discussed below. The RSE team was not provided with estimated costs for implementing these aspects of the work plan. As a result, the estimated cost savings shown are estimated by the RSE team.

Consider not implementing the following items from the proposed work plan:

- Ground water assessment – The work plan suggests conducting a ground water assessment that includes measurement of water levels during pumping and non-pumping conditions, plus sampling of approximately 15 wells for VOCs, iron, and natural attenuation parameters. Water levels have been collected several times from site monitoring wells, and it is clear that the density of monitoring wells is not sufficient to generate potentiometric surface maps that will be useful for a capture zone evaluation. Therefore, the RSE team sees little value in moving forward with the proposed additional water level measurements. Several rounds of VOC sampling have occurred, so the RSE team does not see the need for any additional sampling events beyond the routinely scheduled annual sampling. It is known that the aquifer is high in iron based on influent to the treatment plant; therefore, sampling from the monitoring wells will provide little or no additional benefit. Historical analytical data shows that dichloroethene concentrations (all isomers) are undetectable or very low (e.g., less than 5 ug/L) relative to TCE concentrations (well over 1,000 ug/L). This indicates that there is little natural potential for monitored natural attenuation given the current conditions. Given this strong evidence for limited natural attenuation and the remaining source areas, the evaluation of natural attenuation appears premature. The RSE team does not recommend moving forward with this ground water assessment. The RSE team estimates that this will save approximately $15,000 of field work and analysis.

- Source Area Delineation – The work plan suggests a broad grid of membrane interface probe (MIP) sampling (with approximately 20 locations) to identify source areas at the site and to search for DNAPL. Delineation has already narrowed the plume to an approximate 1.25-acre area, and the RSE team understands that several direct-push sampling events have been conducted in the past to evaluate source areas. As a result, the RSE team recommends revisiting some of this past data and then focusing any remaining investigation around known source areas such as those around MW-2, MW-6, PW-1, and PW-2 rather than pursuing the proposed source area delineation in the work plan. Some of the reason for the proposed source area delineation is the possible presence of DNAPL. The RSE team believes that such an evaluation will indicate potentially high areas of contamination but will not conclusively determine if there is no DNAPL, residual DNAPL, or free-phase DNAPL. Furthermore, whether DNAPL is identified as present or not, the more important issue is the performance of various remedial activities at the site. Therefore, rather than pursuing a DNAPL investigation in this very tight formation, the RSE team is more in favor of identifying source areas (possibly from existing data) and then piloting appropriate remedial technologies and carefully evaluating their effectiveness. With respect to the geotechnical samples proposed in the work plan, the RSE team notes that several cone penetrometer tests have been conducted at the site, providing sufficient information about the soil properties. Assuming four days in the field at $7,500 per day, avoiding this item would save approximately $30,000 of field work.

- Aquifer Tests – The work plan proposes 120 hours (i.e., 72 hours of pumping and 48 hours of recovery) of aquifer tests at two or more wells. These tests include the replacement of MW-2 and MW-5, the installation of seven other monitoring wells, and the potential for additional well installation for pumping and observation purposes. The RSE team does not see the value of conducting pump tests or installing the additional wells. The RSE team has proposed installing two additional wells, and one of these wells serves multiple purposes, including providing information about ground water quality at the bottom of the sand channel. With this RSE-recommended well, the re-installation of MW-2 and MW-5 (which would be done to increase the depth of the two wells by approximately 1.5 to 2 feet each) would be redundant. Furthermore, the RSE team believes that the performance of the P&T system to date demonstrates that the system can be effective for providing capture but will not provide timely restoration of the aquifer. Recovery from the two extraction wells, which were installed with 22-inch borings, has been very low (less than 1 gpm each) suggesting that the formation is tight and that any remediation strategy will require a dense network of points to either extract contamination or inject reagents. The RSE team believes that an estimate of hydraulic conductivity and storativity will not provide information that is more beneficial than the information the site team already possesses. Assuming three days in the field for drilling at approximately $5,000 per day and seven days in the field for pump testing and sampling at $2,500 per day, avoiding this item would likely save over $30,000 in field work.

6.3 RECOMMENDATIONS FOR TECHNICAL IMPROVEMENT

6.3.1 INSTALL TIMER FOR WASTING SLUDGE FROM CLARIFIER

As part of Section 6.1.2, the RSE team recommends installing a timer for wasting sludge from the clarifier. The plant operator has been contemplating making this change, and the RSE team is in favor of this change being made even if increasing treatment plant capacity is not needed. This is a relatively low cost item and should be feasible for under $2,000.

6.4 CONSIDERATIONS FOR GAINING SITE CLOSE OUT

6.4.1 PILOT IN-SITU CHEMICAL OXIDATION WITH PERMANGANATE FOR AGGRESSIVE SOURCE REMOVAL

The RSE team notes that the P&T system (perhaps with a few modifications to increase capacity) has the ability to contain the plume in the horizontal direction. However, the system will not likely succeed at providing cleanup in a reasonable time frame or guaranteeing containment in the vertical direction. Given the relatively limited source areas, a reduction in the time to cleanup, and the additional protectiveness of removing contamination so that it will not migrate vertically, the RSE supports the evaluation and piloting of aggressive source area remediation at this site. The RSE team suggests first considering in-situ chemical oxidation with permanganate for the following reasons:

- In-situ chemical oxidation can easily and cost-effectively be delivered by a shallow trench or by several small injection points. Based on recent discussions with chemical oxidation vendors for work in the New Jersey and New York area, the RSE team estimates that large scale chemical oxidation at this site might cost approximately $1,100 per 100 square feet assuming an injection radius of influence of approximately 7.5 feet, injection at two depth intervals, and use of permanganate. Assuming the entire 1.25 acres of impacted area as delineated by the current monitoring network would be treated, this translates to a cost of approximately $1,200,000 (excluding performance/confirmation sampling) if two rounds of injections are conducted. Given that this is equal to approximately four to five years of P&T operation, it appears worthwhile to pilot this technology, especially if the area to be treated can be reduced by improved hot spot delineation.

- In-situ chemical oxidation performance depends on total oxidant demand, which can easily be tested at the bench scale, but its performance is not heavily dependent on other subsurface parameters or biological activity (in particular permanganate is effective over a wide pH range).

- Permanganate is suitable for oxidizing TCE, PCE, and breakdown products of these two compounds.

- Permanganate is stable relative to other oxidants, improving its ability to persist in ground water and improving the coverage of each injection point.

- Permanganate is inexpensive relative to other oxidants and other reagents that might be used for other remedial technologies, such as zero-valent iron.

- Chemical oxidation works relatively quickly, allowing the site team to quickly evaluate the success of the pilot test and the need for subsequent injections.

- Chemical oxidation is appropriate at the high concentrations seen at this site.

The RSE team recommends pursuing this path in a phased approach as follows:

- Evaluate past data from monitoring wells and direct-push events to best determine source areas.

- Based on consideration of past data, conduct a limited investigation in the vicinity of MW-2 to isolate an approximate 4,000 square-foot area to pilot remediation technologies. The ideal area would address concentrations that are above 1,000 ug/L, would not be downgradient of TCE contamination that could re-contaminate the pilot area, and would include MW-2. Include vadose zone soils in the sampling to determine if vadose zone soil also requires treatment. Install two additional monitoring points within the pilot area (in addition to MW-2) that can be used to evaluate the success of remediation. Obtain baseline samples from these monitoring points plus IW-2 and DW-2. The TRIAD method (www.triadcentral.org) of dynamic work planning may be appropriate for this work.

- Have a chemical oxidation vendor conduct the proper bench scale testing (including total oxidant demand) for permanganate using site water and soil. (Note that the total oxidant demand may be relatively high due to the high concentrations of reduced iron in ground water.)

- Assuming the bench testing is successful, obtain bids from at least two chemical oxidation vendors to treat the pilot area with one round of injections.

- At two months, four months, and six months after the injection, sample ground water from within the pilot area (three sampling locations including MW-2, plus IW-2 and DW-2) to determine contaminant reductions, potential rebound, and potential contaminant migration toward IW-2 and/or DW-2. If contaminant concentrations show at least a 75% reduction after six months with no significant downward migration, consider a second injection and repeat pilot area monitoring.

If contaminant concentrations show a greater than 90% decrease relative to initial sampling results, consider applications in other areas.

The RSE team estimates that TRIAD-based investigation might take two days on site and might cost approximately $20,000 for field work, plus an additional $10,000 for work plans, health and safety plans, and final reporting. The RSE team further estimates that the bench scale in-situ oxidation tests and pilot test might cost $130,000, including the sampling conducted after each round of injections and final reporting. This is a significantly higher unit cost than the estimated full-scale application, due to inclusion of sampling/reporting and economies of scale.

6.5 CONSIDERATIONS FOR GAINING SITE CLOSE OUT

The RSE team suggests moving forward concurrently with 6.1.1, 6.1.3, and 6.1.4 as a comprehensive field event. Recommendation 6.2.2 would be effectively implemented if the above recommendations are implemented in place of the proposed work plan. After this work is completed, the site team could move forward with 6.4.1 to determine the effectiveness of aggressive source remediation. Recommendations

6.2.1 and 6.3.1 can be implemented as soon as possible, and Recommendation 6.1.5 can be implemented along with the next regularly scheduled ground water sampling event. Recommendation 6.1.2 may require substantial capital costs and is contingent on the results from Recommendations 6.1.1 and 6.4.1. Therefore, it should be implemented after the other recommendations are implemented and the associated data has been evaluated.

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 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 site closeout. The effectiveness recommendations focus on methods of improving the evaluation of capture, cost-effective ideas from increasing the treatment plant hydraulic capacity (if needed), improved delineation through addition of monitoring wells, and limited sampling of the wetlands. The recommendations for cost reduction focus on further optimizing the ground water and process water monitoring programs as well as not implementing selected items from a recently proposed work plan from another contractor. The recommendation for technical improvement involves optimizing the sludge processing from the clarifier, and the recommendation for site closure involves a pilot test of aggressive hot spot remediation using in-situ chemical oxidation.

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 10-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 capture zone evaluation with installation of piezometer pairs	Effectiveness	$20,000	$0	$20,000	$20,000
6.1.2 Based on capture zone evaluation, consider modification of treatment plant and injection trench to increase hydraulic capacity	Effectiveness	$20,000 to $150,000	$0	$20,000 to $150,000	$20,000 to $150,000
6.1.3 Improve site characterization with installation of two monitoring wells	Effectiveness	$10,000	$1,500	$55,000	$34,000
6.1.4 Conduct limited sampling of the wetlands surface water and sediments as indicated in the five-year review	Effectiveness	$3,000	$0	$3,000	$3,000
6.1.5 Confirm that Ground Water Monitoring Network Provides Enough Information to Evaluate Capture	Effectiveness	$0	$5,000	$150,000	$81,000
6.2.1 Revise process monitoring program	Cost Reduction	$0	($5,000)	($150,000)	($81,000)
6.2.2 Consider not implementing aspects of the proposed work plan	Cost Reduction	($75,000)	$0	($75,000)	($75,000)
6.3.1 Install timer for wasting sludge from clarifier	Technical Improvement	$2,000	$0	$2,000	$2,000
6.4.1 Pilot in-situ chemical oxidation with permanganate for aggressive source removal	Site Closure	$160,000	$0	$160,000	$160,000

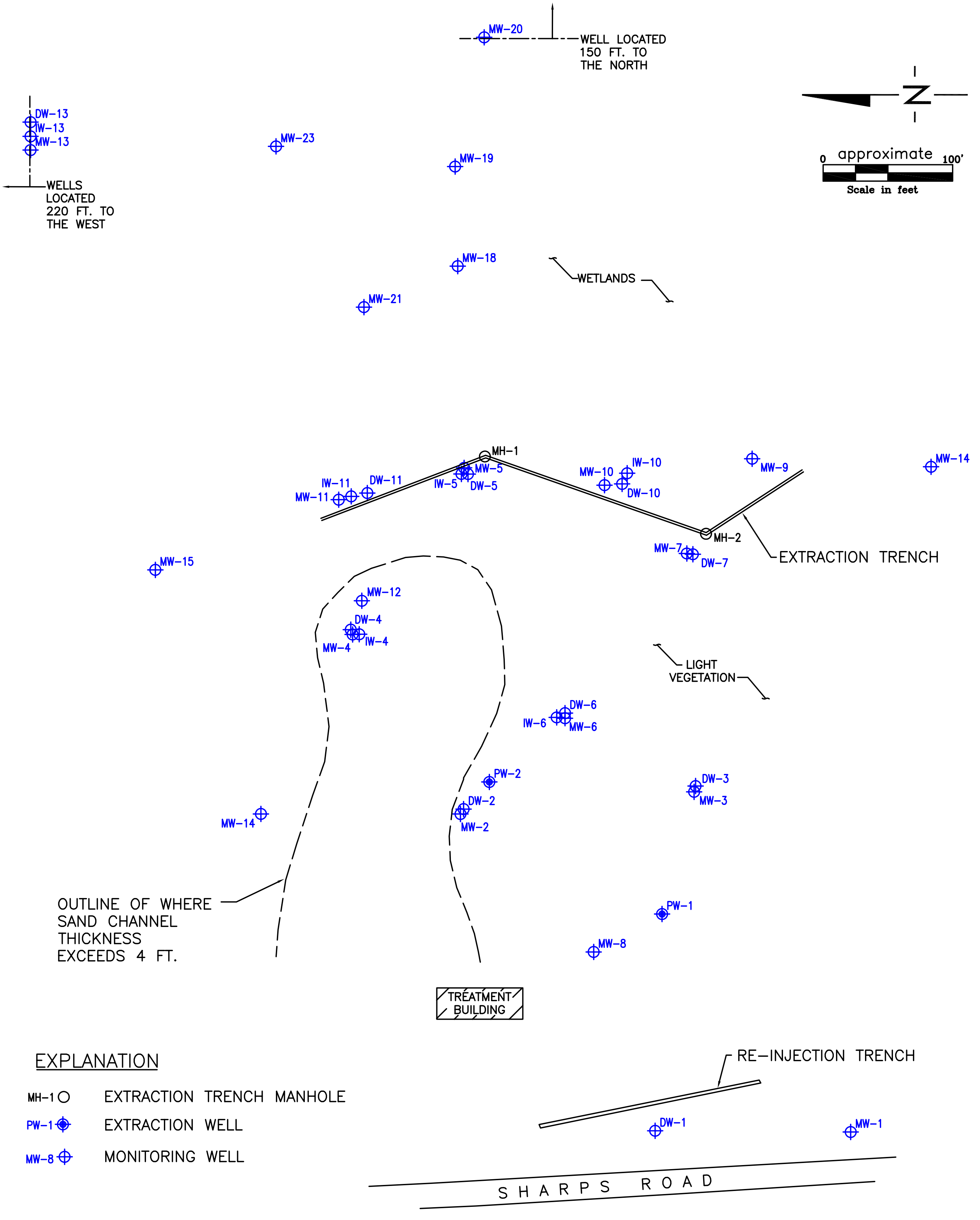
Costs in parentheses imply cost reductions

* 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

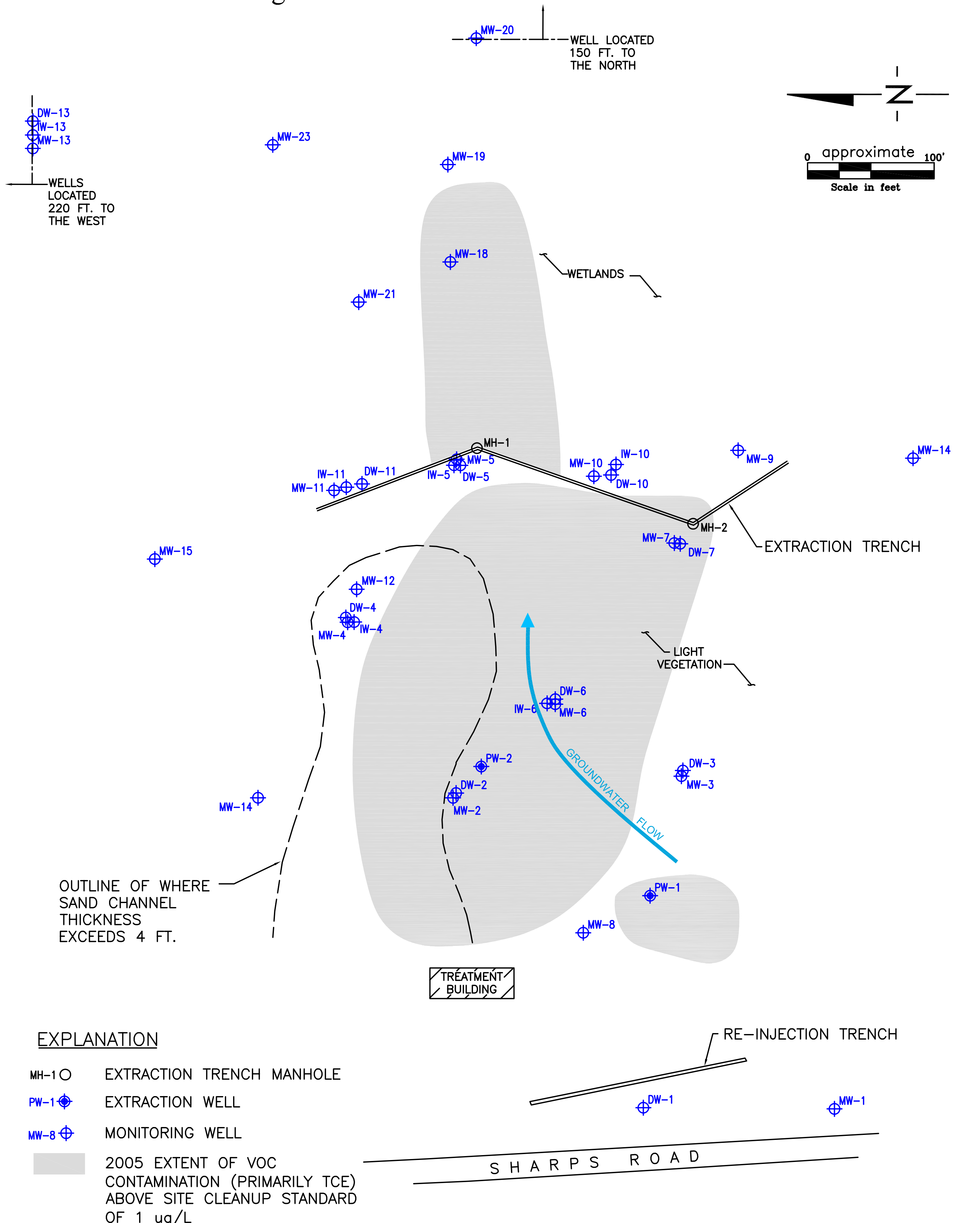
FIGURES

Figure 1-1 **Site map**



Note: Information obtained from design report by Acres, 1998 with a compilation of historical data from monitoring wells and direct push sampling events.

Figure 1-2 **Extent of VOC contamination**



Note: Maximum TCE concentrations in 2005 are at MW-2 (>10,000 ug/L) and at MW-6 (>5,000 ug/L)

Note: Information obtained from design report by Acres, 1998 with a compilation of historical data from monitoring wells and direct push sampling events.