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Remediation System Evaluation (RSE)

Millcreek Dump Superfund Site

Millcreek Township, Erie County, Pennsylvania

REMEDIATION SYSTEM EVALUATION

MILLCREEK DUMP SUPERFUND SITE
MILLCREEK TOWNSHIP, ERIE COUNTY, PENNSYLVANIA

Report of the Remediation System Evaluation
Site Visit Conducted at the Millcreek Dump Superfund Site
September 2, 2009

Revised Report
February 16, 2010

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 Work Assignment #48 of EPA contract EP-W-07-078 with Tetra Tech EM, Inc., Chicago, Illinois. Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

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	USEPA Headquarters – Potomac Yard 2777 Crystal Drive Arlington, VA 22202 phone: 703-603-8888 hovis.jennifer@epa.gov
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1.0 INTRODUCTION

1.1 PURPOSE

During fiscal years 2000 and 2001 independent reviews called Remediation System Evaluations (RSEs) were conducted at 20 operating Fund-lead pump and treat (P&T) sites (i.e., those sites with P&T 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*. A strong interest in sustainability has also developed in the private sector and within Federal, State, and Municipal governments. Consistent with this interest, OSRTI has developed a Green Remediation Primer (http://cluin.org/greenremediation/) and now as a pilot effort considers green remediation during independent evaluations.

The RSE process involves a team of expert hydrogeologists and engineers that are independent of the site, conducting a third-party evaluation of the operating remedy. It is a broad evaluation that considers the goals of the remedy, site conceptual model, available site data, performance considerations, protectiveness, cost-effectiveness, closure strategy, and sustainability. The evaluation includes reviewing site documents, potentially visiting the site for one day, and compiling a report that includes recommendations in the following categories:

- Protectiveness
- Cost-effectiveness
- Technical improvement
- Site closure
- Sustainability

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, and represent the opinions of the evaluation team. These recommendations do not constitute requirements for future action, but rather are provided for consideration by the Region and other site stakeholders.

Millcreek Dump Superfund Site was selected by EPA OSRTI based on a nomination from EPA Region 3 due to the potential need for improvements before the state accepts full financial responsibility for the site. The site is located in Erie, Pennsylvania. The P&T system was operated by the potentially responsible parties (PRP) during LTRA. The Commonwealth of Pennsylvania has taken over the full operation and maintenance activities for the Site in accordance with the State Superfund Contract. EPA Region 3 and PADEP agreed that an evaluation should be conducted to determine if there were any optimization opportunities for this system. In addition, EPA Region 3 conducted a Five Year Review for the Site in 2006 and identified certain issues relating to plume capture and the remedy's effectiveness. As a result, the Region proposed optimization of the system to EPA Headquarters.

1.2 TEAM COMPOSITION

The RSE team consists of the following individuals:

Name	Affiliation	Phone	Email
Doug Sutton	GeoTrans, Inc.	732-409-0344	dsutton@geotransinc.com
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Christopher Baer	GeoTrans, Inc.	610-337-7660	chris.baer@geotransinc.com

In addition, the following individuals from EPA Headquarters participated in the RSE site visit.

- Jennifer Hovis
- Jennifer Edwards

1.3 DOCUMENTS REVIEWED

The following documents were reviewed. The reader is directed to these documents for additional site information that is not provided in this report.

- EPA Superfund Record of Decision – May 1986
- EPA Superfund Explanation of Significant Differences – April 1997
- EPA Superfund Explanation of Significant Differences – May 1999
- EPA Five-Year Review Report – September 1996, September 2001, September 2006
- 2008 Annual Ground Water Monitoring Report, URS
- Draft Remedial Process Optimization Report, URS
- Millcreek Quarterly Progress Reports, 4th Quarter 2008, 1st Quarter 2009, 2nd Quarter 2009, URS
- Change order 3 for site operations, URS
- Millcreek Capture Zone Analysis, HGL
- Millcreek Vapor Intrusion Technical Memorandum, HGL
- Discharge Monitoring Reports, January through April 2009
- Millcreek Treatment Plant O&M Manual, USACE 2007

1.4 PERSONS CONTACTED

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

Name	Affiliation	Phone	Email
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PADEP = "Pennsylvania Department of Environmental Protection"

1.5 BASIC SITE INFORMATION AND SCOPE OF REVIEW

1.5.1 LOCATION

The Millcreek Dump Site is located at 3081 W. 17th street, Millcreek Township, Erie County, Erie, Pennsylvania. The Millcreek Dump site is 124 acres which includes 84 acres of a former freshwater wetland that was used as a dump for foundry sands, solvents, waste oils, and other industrial and municipal wastes and 40 acres of land where the potentially responsible parties (PRP) constructed a flood retention basin and wetlands. Figure 3 of the 2008 Annual Ground Water Monitoring Report prepared by URS for PADEP, which is provided in Attachment A of this report, is an aerial photograph of the area and indicates the site location along with other notable features in the area. The Millcreek Dump Site is accessed by W. 17th Street along the eastern property edge. The ground water treatment area of the property includes the Millcreek Treatment building, paved parking area located on the western side of the treatment building, and a retention pond located northwest of the treatment building. The Millcreek Golf and Learning Center is located on the site. The Millcreek Golf and Learning center consists of a 9-hole golf course, driving range, a clubhouse which includes a pro shop, restrooms, a classroom and snack bar, a maintenance building and associated parking areas. A stream, Marshall Run, is located adjacent to and east of the site. Marshall Run discharges to Lake Erie 1.2 miles northwest of the site. Industrial and residential properties surround the Site towards the east and north. The Erie International Airport (EIA) is located adjacent to and west of the site. A CSX railroad is located adjacent to and south of the Site.

1.5.2 Site History, Potential Sources, and RSE Scope

According to the September 2006 Five-Year Review, the site was operated as an unpermitted landfill for foundry sand and municipal and industrial waste from 1941 to 1981. Operations between 1977 and 1979 included disposal of non-halogenated solvents, ink waste, 900 drums of polyester resins, 19,800 gallons of caustics, 3,000 drums of paint waste, and 6,480 drums of slag at the site. Bulk waste oils were also reportedly disposed of at the site. A metals reclamation facility was operated in the eastern portion of the site. The metals reclamation facility included a deep pond to supply water for foundry sand washing.

PADEP discovered the dumping of drums in the central portion of the site in April of 1981. The drums were sampled and found to contain trichloroethene (TCE). PADEP closed the site in 1981. In August 1982, the Erie County Health Department (ECHO) discovered drums on the surface of the site while investigating a gas well fire. The Environmental Protection Agency (EPA) dispatched its Environmental Response Team (ERT) to the site to conduct drum, soil, sediment, ground water, and surface water sampling to determine the potential health risks. Initial removal actions started in 1983 and included securing the site with fences and gates across access roads, demolishing sheds onsite, crushing 600 clean drums and sending them to a metal recycling facility, removing 75 drums of hazardous liquids, and storing 364 drums filled with non-hazardous materials in the northeastern corner of the site. EPA completed a Remedial Investigation/Feasibility Study (RI/FS) in August 1985. Warning signs were posted at the site by EPA in 1986. The following is a summary of the contamination identified on the site during the RI/FS and ERT investigations.

<u>*Soil*</u>

- Elevated levels of Polychlorinated Biphenyls (PCBs) were detected in the eastern and south central portions of the site. The maximum concentration of PCBs identified was 31 mg/kg wet weight.
- Elevated levels of Polycyclic Aromatic Hydrocarbons (PAHs) were detected throughout the site, especially the southwestern portion. The maximum concentration of PAHs identified was 539 mg/kg wet weight.
- Elevated levels of phthalates were detected throughout the site. Most of the phthalate contamination was found in the southern portion of the site. The maximum concentration of phthalates was 72 mg/kg wet weight.
- Elevated levels of volatile organic chemicals (VOCs) were detected in the south central portion of the site. The maximum concentration of VOCs identified was 6 mg/kg. Elevated levels of VOCs are also believed to be located in the eastern portion of the site based upon ground water monitoring well data.
- Two metals of concern, copper and lead, were detected throughout the site. The maximum concentration of copper and lead were 20,500 and 2,375 mg/kg wet weight, respectively.

<u>*Sediment*</u>

- Except for VOCs, which were not detected, many of the same compounds detected in soil were detected in sediment in the wetland in the southern portion of the site, in ditches within and along the perimeter of the site, and in Marshall Run.
- The maximum PCBs concentration identified was 1.50 mg/kg wet weight.

- The maximum Phthalate concentration identified was 5.0 mg/kg wet weight
- The maximum Phenols concentration identified was 0.99 mg/kg wet weight
- The maximum metals concentration of copper and lead identified was 6.61 and 0.67 mg/kg wet weight respectively.

Ground Water

- Except for metals manganese and iron, elevated levels of ground water contamination were restricted to the eastern portion of the site.
- The maximum concentration of total VOCs identified was approximately 30,000 ug/L. The following list shows the most frequently detected VOCs and their maximum concentrations.

Contaminant of Concern	**Maximum Concentration (ug/L)**
1,1-Dichloroethane (DCA)	260
1,1-Dichloroethene (DCE)	16
1,2-DCE	29,000
TCE	300
1,1,1-Trichloroethane (TCA)	960
Vinyl chloride (VC)	220

- Phthalates were detected in ground water on site. Diethyl phthalate was identified at concentration up to 41 µg/L, and di-n-butyl phthalate was identified at concentrations up to 21 µg/L.
- The maximum concentrations of iron and manganese identified on site were 20,800 and 1,920 µg/L respectively.

Surface water

- The maximum concentration of VC and 1,1,1-TCA identified in surface water were 18 and 93 µg/L, respectively.
- Metals were detected in the wetland area in the southern portion of the site and in Marshall Run. The following tables show the list of metals detected and the maximum concentration identified.

Contaminant of Concern	Concentration (ug/L)
Copper	9,560
Iron	21,600
Manganese	1,580
Lead	1,940
Zinc	6,270
Aluminum	6,270
Mercury	0.81
Nickel	386
Tin	385
Cadmium	3.7

A Record of Decision (ROD) was signed on May 7, 1986 specifying the following remedial action remedy components:

- Excavation of soil and sediments with elevated contaminant levels and consolidation of these materials on-site under a Resource Conservation and Recovery Act (RCRA) compliant cap
- Consolidation of any drums found containing solid Non-RCRA waste under the RCRA cap
- Dispose of any drums containing a liquid or RCRA hazardous waste off-site
- Placement of soil cover over remaining areas with low level contamination
- Grade and revegetate soil cover and cap
- Construction of flood retention basins (FRBs)
- Treatment of contaminated ground water by pumping and treating (P&T)
- Installation of additional monitoring wells

To manage the technical aspects of the site, EPA divided the site into two Operable Units (OUs). OU-1 includes the contaminated ground water to be remediated using P&T. OU-2 includes the source material on-site to be remediated by installing a cap and surface water management basins. Two ESDs, one in 1997 and one in 1999, have modified the remedy for OU-2. The final OU-2 remedy was deemed construction complete in 2001. It did not include any excavation of contaminated soils and included use of a 12-inch soil cover with a warning mesh rather than installation of a RCRA cap.

This RSE focuses on OU-1 and addresses OU-2 only as it may affect the evaluation of OU-1.

1.5.3 HYDROGEOLOGIC SETTING

The Draft Remedial Process Optimization report prepared by URS in April 2009 provides the most recent description of the site geology and hydrogeology. The following description is based on the information provided in that report.

The regional geology in the area of the site consists mainly of unconsolidated deposits of glacial till overlying shale. Successive glacial advances and retreats formed till deposits that occur throughout the region. Following the final glacial retreat, waters in the Erie basin ponded in front of the glaciers to form a succession of pro-glacial lakes at elevations higher than present-day Lake Erie. Glaciolacustrine deposits between the beach ridges and overlying the till deposits are predominantly fine sand and silt deposited in low energy, off-shore lake environments, with thicknesses ranging from less than 50 feet to more than 200 feet.

The bedrock geology of the area includes a thick succession of stratified Upper Devonian sedimentary rocks, forming the northern flank of the Allegheny Basin. Bedrock that subcrops beneath the glacial deposits of the region consists of shales, siltstones, and thinly-bedded sandstones of the Conneaut Group, and underlying shales, with thin layers of interbedded sandstone, of the Canadaway Formation. On-site boring logs indicate subsurface materials consist of blue/gray sandy/silt with varying amounts of clay. Shale bedrock is encountered at approximately 50 feet below grade in the area of the Site.

Monitoring wells at the site have been classified as shallow (Zone B) and deep (Zone A) wells. The well intervals appear to be based arbitrarily on depth rather than on specific, distinct formations. There is no continuous aquitard between the Zone A and Zone B wells and there is not necessarily a consistent difference in the geology between the Zone A and Zone B wells. The Zone B wells are approximately 15 to 20 feet deep and the Zone A wells are approximately 25 to 30 feet deep with the exception of MW-23A, MW-25A, MW-28A, and MW-33A, which are 10 to 30 feet deeper than the rest of the Zone A wells. Despite the relative lack of distinction between Zone B and Zone A wells (e.g., generally similar depths and no reported aquitards that separate them), water quality parameters clearly indicate a different water quality. In the October 2008 event, the temperature was typically 2°C lower in the Zone A wells than the Zone B wells and the ORP was typically substantially lower in the Zone A wells than the Zone B wells, likely indicating that the Zone B wells are substantially affected by recharge.

Regional flow direction of ground water is predominantly to the north toward Lake Erie, with local variances due to the influences of topography, land use, and drainage. The depth to water is approximately 4 feet to 5 feet below ground surface (bgs). Average horizontal hydraulic gradients were calculated to be approximately 0.0025 feet per foot. Due to the essentially unlimited amounts of water provided by Lake Erie to surrounding townships, including Millcreek Township, ground water is not extensively utilized.

Vertical hydraulic gradients vary between upward and downward for some wells but are relatively consistent in the upward or downward directions for others. The following table summarizes the vertical gradient direction for locations where the gradient is relatively consistent in one direction (i.e., in one direction more than two times as often as the other direction).

Well Cluster/Location	Vertical Gradient Direction
MW-25	Upward
MW-33	Downward
MW-37	Downward
MW-38	Upward
MW-40	Downward
MW-41	Downward
MW-42	Downward
MW-46	Downward
MW-47	Downward

Notes:

- *MW-23, MW-43, and MW-44 tend to be downward during the first 5years but more recently appear to be upward. It is unclear if this is due to changes in operation of Trench #2, which is the most productive recovery trench at the site.*

- *The tables that summarize the vertical gradients in the Draft RPO report incorrectly summarize the vertical gradient directions. The description is reversed from the actual condition (i.e., the gradient is described as upward when the actual gradient is downward and the gradient is described as downward when the actual gradient is upward). The above table correctly summarizes the gradient direction.*

It is evident from the above table that the gradient is typically downward at most of these well locations, with the exception of MW-25 and MW-38, and it is noted that the magnitudes of vertical gradients at these two locations are relatively slight compared to those at many of the other wells. It is also evident that the well locations that have consistent downward gradients are typically not near the recovery trenches with the exception of MW-41 and MW-42. It is noted, however that these two wells are near Trench #3, which has a very low recovery rate. This overall finding suggests that the general pattern of vertical flow at the site may be downward but that vertical flow in the vicinity of the recovery trenches is variable, perhaps resulting from an upward influence from pumping that sometimes (but not always) overcomes the background downward gradient. An upward gradient in the vicinity of a recovery trench would suggest that the trench is drawing some water up from a deeper aquifer interval.

Representative hydraulic conductivities for the site based on a pumping test were not available for review, and the modeling review presented in the Draft RPO report did not indicate any of the aquifer properties that were used in the calibrated model. The model generally indicates that flow from the site will discharge to Marshall Run approximately 2,500 feet to the north/northwest, on the west side of the cemetery. The model output is discussed in further detail in Section 4.0 of this report.

1.5.4 POTENTIAL RECEPTORS

According to the 1986 ROD, the public health and environmental objectives of the remedy include the following.

- Prevent onsite air dispersal of particles containing potentially hazardous substances
- Prevent direct dermal contact with potentially hazardous substances
- Prevent offsite transport of contaminated soil and sediment via erosion or storm water transport
- Remediate offsite ground water contamination to ground water protection goals
- Remediate soil contamination to safe soil levels capable of preventing future ground water contamination
- Remediate sediment contamination capable of causing an impact on aquatic life or wildlife in the wetlands and Marshall Run
- Remediate potential surface water contamination by remediating ground water, soil, and sediment contamination

Currently, contaminated ground water poses a potential risk due to the potential for direct contact by construction workers and for vapor intrusion in surrounding businesses and homes. Future use of ground water is unlikely; however, institutional controls preventing such use are being evaluated by Region 3 and, if necessary, will be documented in a future decision document. All water in the area is reportedly provided by the public water supply system that draws water from Lake Erie. The site team indicated that a back-up water supply well is located along 26th Street approximately 1 mile up-gradient from the site. The well is reportedly a dug well that is shallow (10 feet to 12 feet deep).

1.5.5 DESCRIPTION OF GROUND WATER PLUME

The predominant contaminants of concern that remain in ground water are 1,1-dichloroethane (1,1-DCA), cis-1,2-dichloroethene (cis-1,2-DCE), and vinyl chloride (VC). Figures 7 and 8 of the 2008 Annual Ground Water Monitoring Report (see Attachment A) present the distribution of total VOCs (which is basically the sum of concentrations of these three contaminants). The highest concentrations are in the northern corner of the site. The wells with the highest concentrations are MW-42A (over 5,000 ug/L total VOCs), MW-23B (over 1,500 ug/L total VOCs), and MW-40A (over 1,000 ug/L total VOCs). Based on the values observed at MW-42A and MW-40A, it appears that concentrations increase with depth. The concentrations for the same constituents at MW-23A are three orders of magnitude lower or non-detect, but it should be noted that MW-23A is another 20 feet deeper than MW-40A and MW-42A. The elevated concentrations at MW-42A and MW-40A are not vertically delineated at those locations.

The horizontal extent of contamination in Zone B as depicted in Figure 8 of the 2008 Annual Ground Water Monitoring Report indicates VOC contamination at well MW-31 and does not connect that contamination with other contamination from the site. Based on the pre-pumping conditions presented in the model, MW-31 is not downgradient from the site; however, there was little data available at the time to determine the ground water flow directions in the vicinity of MW-31. As discussed in Section 4.0 of this report, it is debatable if the contamination currently detected at MW-31 results from this site.

The horizontal extent of contamination as depicted in Figure 7 of the 2008 Annual Ground Water Monitoring Report is influenced by the relative lack of data to the east and west for Zone B and to the north for Zone A. There are no water level measurements or water quality sampling locations for Zone A between the northern boundary of the site and MW-25A, which is approximately 1,000 feet downgradient. As a result, the direction of ground water flow, the extent of contaminant transport, and the trend in concentrations downgradient of the site in Zone A cannot be determined.

2.0 SYSTEM DESCRIPTION

According to the 2006 Five-Year Review, construction of the OU-1 treatment plant was completed in June 1990 and the ground water extraction system was completed in December 1990. The United States Army Corps of Engineers (USACE) operated and maintained (O&M) OU-1 from February 1992 through September 30, 1997. The identified potentially responsible parties (PRPs) took over O&M of the plant and ground water extraction system, OU-1, on October 1, 1997 for a period of ten (10) years, ending in 2007.

2.1 EXTRACTION SYSTEM

The ground water extraction system consists of five (5) trenches arranged in an "L" shape along portions of the northern and eastern site boundaries. According to the 2006 Five-Year Review, four (4) of the trenches have a flow rate as designed, however Trench #3 developed a lower flow rate over time. EPA added an additional extraction well to Trench #3 to increase the ground water capture in that trench, but overall extraction from Trench #3 is still less than the design rate.

Each of the five collection trenches consists of a 6-inch slotted well pipe that is wrapped in a polypropylene fabric sleeve. The well pipe is positioned horizontally in a trench approximately 25-30 feet deep and 200 feet long. The trench is backfilled with coarse sand. The trench allows contaminated ground water to flow by gravity into the 4-foot diameter collection sumps where the ground water may then be pumped to the treatment plant for treatment. Each collection trench is furnished with a Trench Monitoring Piezometer (TMP), which is a 2-inch piezometer located in the center section of the backfill of each collection trench that is not connected to the trench piping. Each of the trenches is outfitted with two pumps that alternate operation and are reportedly capable of producing 50 gpm each. The operator estimates the following production rates for the trenches.

Trench	Estimated Production Rate (gpd)
Trench #1	19,000 to 22,000
Trench #2	55,000 to 65,000
Trench #3	1,800 to 2,000*
Trench #4	25,000
Trench #5	25,000
Total	**~130,000 gpd or 90 gpm**

** This is the flow rate when conditions are wet. The rate is lower when conditions are dry.*

The treatment plant operator indicated that the flow rates from the extraction trenches are manually controlled and that extraction rates from individual trenches are varied daily to maintain an overall system flow of approximately 90 gpm. For example, the extraction rate in Trench #1 may be decreased for a day to allow the water level in the trench to recover, but during this time, the extraction rate in Trench #5 may be increased to compensate for the reduced flow from Trench #1. The daily flow rates and water levels are recorded in the quarterly reports.

2.2 TREATMENT SYSTEM

According to the Operation and Maintenance (O&M) Manual, ground water extracted from the site is treated in the site treatment plant via the process mode B described in the O&M Manual.

Influent ground water is pumped into the Inclined Plate Clarifier (IPC) wet well, where potassium permanganate is added to oxidize iron, manganese and phenols. An anionic polymer is also added to the influent in the IPC wet well to flocculate the metals. Beginning in 2000 the PRPs added additional piping to the system that allowed the effluent from the plant to be used for mixing chemicals and dilution purposes. The chemically treated influent is then pumped to the IPC where the solids are precipitated out of the process water. The IPC effluent drains by gravity to an equalization tank, where it is pumped through the packed tower air stripper for VOC removal. The effluent from the treatment plant gravity drains into Marshall Run. From May to September the treatment plant effluent is pumped to a holding pond where it is used to irrigate the golf course. The use of the effluent as irrigation water for the golf course was approved by EPA in 2000.

2.3 MONITORING PROGRAM

Ground Water Monitoring

Ground water monitoring is conducted in April and October. The following table lists the wells included in the monitoring plan and during which events the wells are sampled.

Well	April	October
MW-11	X	X
MW-12	X	X
MW-29	X	X
MW-31	X	X
MW-32	X	X
MW-35	X	X
MW-23A	X	X
MW-23B	X	X
MW-25A	X	X
MW-25B	X	X
MW-28A	X	X
MW-28B	X	X
MW-33A	X	X
MW-33B	X	X
MW-37A		X
MW-37B		X
MW-38A		X
MW-38B		X
MW-39A		X
MW-39B		X
MW-40A		X
MW-40B		X
MW-41A		X
MW-41B		X

MW-42A		X
MW-42B		X
MW-43A		X
MW-43B		X
MW-44A		X
MW-44B		X
MW-45A		X
MW-45B		X
MW-46A		X
MW-46B		X
MW-47A		X
MW-47B		X

Samples from all wells are analyzed in the field for temperature, dissolved oxygen, ORP, and conductivity. Samples from all wells in the April event are analyzed in a laboratory for VOCs, SVOCs, total and dissolved metals, and general chemistry. Samples from all wells in the October event are analyzed in a laboratory for VOCs, total and dissolved metals, and general chemistry.

Process Monitoring

Process monitoring is conducted daily, weekly, and monthly. The sample locations include IPC influent (1-B), IPC effluent (2-B), and air stripper effluent (3-B). These sample locations are referred to as process monitoring sample locations in the following text.

Daily process monitoring samples are collected as grab samples five (5) days a week, Monday through Friday. The daily process monitoring includes collection of samples from the process monitoring sampling locations. The samples are analyzed for temperature, pH, turbidity, conductivity, total dissolved solids, and total suspended solids in the onsite laboratory

Weekly process monitoring samples are collected as grab samples one (1) day per week, preferably on Monday, from the process monitoring sample locations. The samples are analyzed for total organic carbon, total iron, dissolved iron, total manganese, and dissolved manganese. Weekly process monitoring sample analysis is conducted in the onsite laboratory.

Monthly Permit Compliance sampling is conducted during the first week of the month. Samples are collected from process monitoring sample locations 1-B and 3-B. The monthly samples are collected as an eight hour composite, with the exception of the VOC sample which is collected as a grab sample. The composite samples are collected by collecting 1/8 of the sample volume needed every hour for eight hours. The samples are analyzed for VOCs using method SW 846 8260 B, metals using method SW 846 6010 B and SW 846 7470 A, free cyanide, oil & grease, and phenol. Samples are shipped to an off-site independent laboratory via priority overnight delivery on the day they are collected. In addition to the process monitoring sample locations, the filter press feed sludge and the filter press cake solids are sampled monthly. The samples are collected as grab samples. The filter press feed sludge sample is analyzed for total suspended solids. The filter press cake is sampled for percent total solids. Additional monthly samples have been collected from each of the extraction trenches for VOC analysis.

Quarterly process monitoring sampling is no longer required and was discontinued in 1994 after the first year of operation.

TCLP sampling for Filter Press Cake solids disposal is conducted once every five (5) years. Sampling is conducted in October to ensure analytical results are received in time for the certification process. A grab sample is collected from the Filter Press Cake solids and shipped to an outside approved/contract laboratory via priority overnight delivery.

3.0 SYSTEM OBJECTIVES, PERFORMANCE, AND CLOSURE CRITERIA

3.1 CURRENT SYSTEM OBJECTIVES AND CLOSURE CRITERIA

The ROD for the Millcreek Site identified the following Remedial Action Objectives (RAOs):

- Prevent onsite air dispersal of particles containing potentially hazardous substances
- Prevent direct dermal contact with potentially hazardous substances
- Prevent offsite transport of contaminated soil and sediment via erosion or storm water transport
- Remediate offsite ground water contamination to ground water protection goals
- Remediate soil contamination to safe soil levels capable of preventing future ground water contamination
- Remediate sediment contamination capable of causing an impact on aquatic life or wildlife in the wetlands and Marshall Run
- Remediate potential surface water contamination by remediating ground water, soil, and sediment contamination

The cleanup standards specified in the ROD are the EPA derived treatment standards in the following table.

Chemical	1986 ROD Ground Water Protection Goals (µg/L)
Vinyl Chloride (VC)	0.015
TCE	1.8
1,2-DCE	70
1,2-DCA	0.95
1, 1, 1 - TCA	22
1,1-DCE	0.24
Chloroform	0.19
Benzene	0.70
Xylene (total)	440
Toluene	2000
Ethyl Benzene	680
Lead	11
Copper	27
Arsenic	50
Cadmium	3
Chromium III	341
Chromium VI	11

Chemical	1986 ROD Ground Water Protection Goals (µg/L)
Mercury	0.012
Zinc	710
Nickel	150
Iron	300
Manganese	50

3.2 TREATMENT PLANT OPERATION STANDARDS

The treatment standards for discharging the treated water to the Marshall Run are the based on a NPDES equivalency permit with the following monitoring and reporting requirements.

Parameter	Average Monthly	Max. Daily	Instant. Max.	Measurement Frequency	Sample Type
Flow	Monitoring only			Daily	Measured
COD	Monitoring only			5/week	Grab
Conductivity	Monitoring only			5/week	Grab
TOC	Monitoring only			5/week	Grab
TSS	30	60	75	1/month	8-hr comp.
O&G	15	--	30	1/month	3 grab/8-hr comp.
Iron (dissolved)	0.3	0.6	0.7	1/month	8-hr comp.
Iron (total)	1.5	3.0	3.7	1/month	8-hr comp.
Manganese	1.0	2.0	2.5	1/month	8-hr comp.
Arsenic	0.05	0.10	0.13	1/month	8-hr comp.
Cadmium	0.01	0.02	0.03	1/month	8-hr comp.
Chromium, Total	0.05	0.10	0.13	1/month	8-hr comp.
Copper	0.01	0.02	0.025	1/month	8-hr comp.
Lead	0.05	0.10	0.13	1/month	8-hr comp.
Mercury	0.002	0.004	0.005	1/month	8-hr comp.
Nickel	0.322	0.64	0.80	1/month	8-hr comp.
Zinc	0.04	0.08	0.10	1/month	8-hr comp.
10A Phenol	0.005	0.010	0.012	1/month	8-hr comp.
Vinyl Chloride	0.002	0.004	0.005	1/month	8-hr comp.*
Cyanide (free)	0.005	0.01	0.013	1/month	Grab
Trichloroethene	0.005	0.01	0.013	1/month	Grab
1,1-Dichloroethene	0.007	0.014	0.02	1/month	Grab
1,1,1-Trichloroethane	0.20	0.40	0.50	1/month	Grab
pH	Between 6.0 and 9.0 standard units at all times				

Additional notes are provided, including specific analytical methods for mercury and phenol.
** The RSE team was informed that VOC samples are grab samples. The indication that vinyl chloride is an 8-hour composite sample may be a misprint in the O&M manual or may have been modified to a grab sample since the printing of the O&M manual.*

4.0 FINDINGS

4.1 GENERAL 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 PLUME CAPTURE

Previous Modeling Effort

The Draft RPO report included an evaluation of a previously constructed model and evaluated capture using this model and particle tracking; however, insufficient information was provided to determine the validity of this evaluation. Some of this missing information or concerns include the following:

- The simulated vs. observed heads for a model run using 2004 pumping conditions are not encouraging, especially in the vicinity of the trenches, suggesting a poor calibration.

- The mass balance of the model, which is important for confirming that the model correctly solves the equations that govern ground water flow, was not provided for any of the model runs. A poor mass balance would invalidate the results.

- Changes were obviously made to the model to change the extraction rate from the trenches from those in 2004 to those in 2008, but the model changes that were made were not clear. The drain boundary condition was likely used, but this would require a change in hydraulic parameters, and this change was not stated.

- Various symbols are used to represent various hydraulic heads on the simulated vs. observed head plots, but the meaning of these various symbols was not provided. It is unclear how the observation points used for calibration were selected, which points are in the shallow zone and which points are in the deep zone.

- Insufficient water level information is available to determine the direction of ground water flow north of the site to clearly establish regional ground water flow and the fate of contamination after it leaves the landfill. The figures indicate that water flows toward Marshall Run to the west of the cemetery; however, there is another equally likely location for ground water to discharge to surface water near the intersection of 8th Street and Peninsula Drive (see Figure 1). Contamination has been detected at MW-32 (in the direction of 8th Street and Peninsula Drive) to an equal or greater extent that at the MW-25 cluster (in the direction of the cemetery).

- Model construction parameters, including hydraulic conductivity distribution, model layer thicknesses, boundary condition values, etc. are not provided.

- The model does not appear to simulate the hydraulic head mound near MW-11, which is presumably caused be infiltration from the pond in this location. This mound is a prominent feature on Zone B potentiometric surface maps.

- The particle tracking did not initiate any particles in the vicinity of the MW-42 cluster where significant contamination is present.

- The vertical release points of the particles are unclear. The particles should be released from various vertical locations to determine the vertical extent of the capture zone.

- The reason for waviness in the upgradient hydraulic head contours (e.g., the 715 foot contour) is unclear.

The model run using 2008 pumping conditions suggests a gap in capture, and although the simulated vs. observed heads appear to be close (suggesting a decent calibration), these results should not be accepted without addressing the above issues and integrating the data obtained from the recommended field investigations (Section 6).

HGL Capture Zone Analysis

The HGL capture zone analysis apparently used MODFLOW as interpolation software and then used MODPATH for particle tracking to evaluate capture. The study concluded that there was a gap in capture between Trenches #1 and #3. The RSE team raises a number of issues with respect to this analysis.

- MODFLOW is a numerical ground water modeling tool and not a contouring tool. The use of MODFLOW as interpolation software is not a typical application of MODFLOW, and additional detail should be provided to describe the process for generating the potentiometric surface map.

- Professional judgment should be used when preparing potentiometric surface maps rather than relying mainly on the output of contouring software. For this analysis, note the contours between Trench #5 and MW-28B. There are no other points between these two points, and the software linearly interpolated the water levels between these two points. This is likely not accurate because the gradient between the two points is likely not linear. There is likely a much steeper change in the hydraulic gradient near the trench and a more linear or uniform change further upgradient of the trench. In this case, there is a bias of flow between MW-28B and the low point in the center of the trench, resulting in the appearance that significantly more particles flow toward Trench #5 than Trench #1. Despite Trench #1 and Trench #5 extracting a similar amount of water, particles make a sharp turn away from Trench #1 to flow toward Trench #5.

- The water levels measured in the trenches are assigned to a single point within the trench, and the contouring is based on these individual points. Given the construction of the trenches, it is likely more appropriate to assign the water level from each trench along the entire length of the trench.

- The capture zone analysis is only based on a single water level event, and based on the historical water level information, it appears that plume capture may be sensitive to variations in recharge.

- Conducting a capture zone evaluation using a potentiometric surface map is only one line of evidence and the results from this one line of evidence alone is often quite inconclusive given relatively sparse water level data from available monitoring points.

- The capture zone memorandum does not provide the average extraction rates from the trenches at the time the water levels were measured. This is important in general when interpreting capture from a potentiometric surface map. In this case, it is particularly important because the trench water levels were used in the analysis and the trenches are known to cycle during operation. If the trench monitoring points are being used in developing the potentiometric surface maps, then it is not only important to know the average extraction rates but also the rate at the time the measurements were collected and where each trench was in its individual pumping cycle.

Based on the above points, the RSE team believes that the potentiometric surface map used for the capture zone analysis is unreliable and that the capture zone analysis as whole is incomplete.

The recent EPA capture zone document (EPA 600/R-08/003) specifies that it is not appropriate to use water levels from operating extraction wells in the development of potentiometric surface maps unless those water levels are corrected for well losses. In this case, however, the TMPs in these trenches are within the trench backfill and not in the sumps or trench piping. Therefore, these monitoring points are not necessarily influenced by well losses and are likely appropriate to use in the analysis. As stated above, however, professional judgment should be used in interpreting the weight of this water level when interpreting contours far from the trenches.

Potentiometric Surface Maps

The potentiometric surface maps presented in the 2008 Annual Ground Water Monitoring Report are informative, but the RSE team raises the following issues with regard to interpreting the contours:

- Contours should likely be drawn without allowing the water levels from the monitoring points within the active trenches from determining contours far from the trenches.

- For the purpose of drawing the water levels in the vicinity of the trenches, the water levels measured in the trenches should likely extend the full length of the trenches rather than just the center of the trenches.

- The water levels in the trench monitoring points vary substantially as a result of recharge and potentially from varying the pumping rates of the trenches. The following table summarizes the water level variation for each of the extraction trenches in October 2008, which is the month that corresponds to the potentiometric surface map included in the 2008 Annual Ground Water Monitoring Report.

	Minimum Water Level (ft msl)	**Maximum Water Level (ft msl)**	**Difference between Maximum and Minimum (ft)**
Trench #1	703.8	705.5	1.7
Trench #2	699.2	704.1	4.9
Trench #3	703.5	704.5	1.0
Trench #4	704.5	705.2	0.7
Trench #5	699.6	706.3	6.7

The flow rate in Trench #1 the day prior to the water level event was the lowest flow rate in that well for the month of October 2008. Although similar data are not available for water level measurements in nearby monitoring wells, the RSE team believes that the water levels may also vary considerably in wells close to the trenches such as MW-38A/B and MW-39A/B. This variation could result in preparing potentiometric surface maps that are representative of an "instant" in time rather than the average conditions at the site. The site team should post the extraction rates for each of the trenches at the time of the water level event and the average flow over the two or three days preceding the event.

- The measured water level at MW-25B is high relative to what would be expected, suggesting the potential for local recharge, a well construction issue, and/or a surveying issue. Because this well is important for understanding general flow directions and contaminant fate and transport at the site, the causes for this anomalous value should be investigated.

Consideration of these above issues could have a profound effect on the interpretation of ground water flow and plume capture. The RSE team notes several aspects of the 2008 potentiometric surface maps and water levels that are favorable for capture because they indicate an inward gradient (i.e., ground water flow back toward the trenches), but qualifies that these findings are subject to the uncertainty associated with water level and flow rate variations of the trench pumping:

- The water level at MW-12 is higher than the water levels at MW-38A/B, MW-39A/B. This pattern is consistent over many water level events.

- The water levels at MW-11 and MW-35 are higher than the water levels at MW-41A/B and MW-42A/B, and the water levels at MW-41A/B and MW-42A/B are higher than the water levels at MW-23A/B, MW-40A/B, and MW-43A/B. It should be cautioned, however, that the water level at MW-11 may be locally influenced by recharge from the pond and the actual mounding might be smaller in extent than depicted.

- The water level at MW-31 is higher than those at MW-43A/B, MW-44A/B, and MW-45B.

- There is a relatively strong gradient between the MW-40 cluster and the MW-39 cluster, though this gradient has not always been present in other water level events. When present, the gradient between the MW-40 cluster and the MW-39 cluster may indicate that Trench #1 may be capturing some contamination in the vicinity of the MW-40 cluster.

If extraction pumping at the time of the 2008 water level event is representative of average or typical pumping conditions, water levels and potentiometric surface maps appear to suggest an inward gradient in many locations, which would suggest some degree of hydraulic capture. Additional water level measurement points, particularly in Zone A, and consideration of variations due to recharge and trench extraction rates would strengthen this line of evidence.

It appears that much of the hydraulic capture provided in the northern corner of the site is provided by Trench #2. It appears that the high extraction rate from this trench (potentially in combination with extraction from upgradient Trench #4) may be capturing the contamination in the vicinity of the MW-41 and MW-42 clusters. This would be an inefficient means of providing capture because it involves sustaining a high enough extraction rate to pull contamination back, rather than intercepting contamination as it migrates downgradient. It may also be inefficient because Marshall Run appears to be contributing water to these trenches based on the measured water levels and stream level presented in the HGL capture zone analysis.

Concentration Trends

The downward trend in VOC concentrations at MW-11 is supportive of plume capture along the northwestern boundary; however, this downward trend may be the result of clean water infiltrating from the pond and diverting contaminated water around MW-11. The downward trend in VOC concentrations at MW-32, MW-43A/B, MW-44A/B, and MW-45A/B suggest capture along the northeastern boundary. The concentrations are historically too low at MW-12, MW-25A, and MW-25B to determine if capture is effective. The historically low concentrations suggest that little or no contamination reached these points prior to P&T operation. The absence of contamination at these points may be indicative of attenuation prior to reaching these locations or that ground water from the site did not flow through these points prior to remedial pumping, which would indicate that the wells might not be properly located to evaluate plume capture.

The concentration trends at some wells (e.g., MW-41 cluster and MW-42 cluster) are not useful for evaluating plume capture because the wells are sufficiently close to the extraction trenches that they may be within the capture zones of the trenches. Nevertheless, the concentrations for cis-1,2-DCE at MW-41A/B appear to be declining. The relatively stable concentration of VC in these two wells (compared to the decreases in cis-1,2-DCE) might suggest that the two contaminants follow separate flow paths (potentially due to different sources) or that VC reductions are offset by VC production from the dechlorination of cis-1,2-DCE. Conditions at the site, as measured by an ORP of less than -50 mV (and in many cases less than -100 mV), support anaerobic degradation. Additional sampling points in both Zone A and Zone B that are clearly outside of the capture zone would help determine the extent of the plume that exists beyond the extraction network and whether or not concentrations beyond the extraction network are declining as a result of capture.

A Note about the Target Capture Zone

All of the above comments discuss interpreting capture in the Zones A and B. However, it is likely that deeper contamination is present and may not be captured by the current extraction system. Section 6 of this report discusses characterization efforts to vertically delineate the contamination and determine the target capture zone.

4.2.2 GROUND WATER CONTAMINANT CONCENTRATIONS

VOC concentrations in ground water appear to be decreasing in many wells while remaining relatively stable in other wells. The following table summarizes the concentration trends at each of the monitoring wells. To facilitate interpretation of the results, the monitoring wells are characterized as either upgradient of the extraction trenches, in the immediate area of the extraction trenches, or downgradient of the extraction trenches.

Mon. Well	Concentration Trend	Comment
Upgradient of Extraction Trenches		
MW-23A	Below standards	
MW-23B	No obvious trend	
MW-28A	Decreasing	Concentrations are now non-detect
MW-28B	Decreasing	Decreasing since 2002 and now below standards
MW-33A	Below standards	
MW-33B	Decreasing	Concentrations are now generally non-detect
MW-46A	Increasing	
MW-46B	No obvious trend	Decreasing for 1,1-DCA
MW-47A	Potentially increasing	Relatively low concentrations
MW-47B	No obvious trend	Relatively low concentrations
Immediate Area of Extraction Trenches		
MW-12	Below standards	Low detections of cis-1,2-DCE prior to P&T operation
MW-37A	Decreasing for VC	cis-1,2-DCE is typically below standards
MW-37B	Decreasing for VC	cis-1,2-DCE is typically below standards
MW-38A	Potentially increasing	
MW-38B	Decreasing	Increase then decrease with P&T, now non-detect
MW-39A	Potentially Increasing	
MW-39B	No obvious trend	
MW-40A	Decreasing for cis-1,2-DCE	No trend or slowly decreasing trend for VC
MW-40B	Potentially increasing	
MW-41A	Decreasing for cis-1,2-DCE	No trend or slowly decreasing trend for VC
MW-41B	Decreasing	
MW-42A	No obvious trend	
MW-42B	Increasing	Increasing since the P&T system began operation
MW-43A	Decreasing	
MW-43B	Decreasing	Concentrations are now generally non-detect
MW-44A	Decreasing	
MW-44B	Decreasing	Concentrations are now generally non-detect
MW-45A	Decreasing	Decrease began after P&T system began operation
MW-45B	Decreasing	Concentrations are now generally non-detect
Downgradient of the Extraction Trenches		
MW-11	Decreasing	Concentrations are now generally non-detect
MW-25A	Below standards	
MW-25B	Below standards	Low detections of cis-1,2-DCE prior to P&T operation
MW-29	Below standards	
MW-31	No obvious trend	
MW-32	Decreasing	Concentrations are now generally non-detect
MW-35	Below standards	

Notes: Shading indicates results that are favorable for plume capture and/or restoration

The results in the above table generally indicate favorable results for plume capture and restoration for many of the monitoring wells located near the extraction trenches and for all but one of the monitoring wells downgradient of the extraction trenches. This general finding, however, should be qualified by the absence of monitoring wells in critical locations of Zones A and B and the absence of vertical delineation of the contamination.

Wells with no obvious trend or increasing trends are discussed below:

- MW-46A/B – MW-46A has an increasing trend of VC with recent concentrations near 100 ug/L, and MW-46B has declining concentrations of cis-1,2-DCE and 1,2-DCA but stable concentrations of VC near 10 ug/L. The most significant increases at MW-46A appear to have occurred after P&T operation began in 1997. Prior to P&T operation, the VC concentrations were relatively stable at or below 26 ug/L. Since that time, the VC concentration has increased to as high as 144 ug/L in 2007. This apparent link to the start of the P&T system suggests that the contamination observed at MW-46A may be a result of ground water flow directions changing with the onset of P&T operation and contamination being redistributed. MW-46A is located upgradient of the trenches. Therefore, the increase in concentration at this location is not indicative of a gap in plume capture.

- MW-38A & MW-39A – The VC concentrations at these two Zone A wells appear to be increasing, especially when the 2007 and 2008 results are included. MW-38A and MW-39A screen the 5-foot interval below Trenches #1 and #5. That is, the screened intervals of MW-38A and MW-39A are approximately 689 to 694 feet above mean sea level, respectively, and the bottom elevations of Trenches #1 and #5 are approximately 695 feet. However, these wells are sufficiently close to extraction Trenches #5 and #1, respectively, that the wells may be in the capture zones of the trenches. Although detailed numerical modeling is beyond the scope of an RSE, the RSE team did informal numerical modeling with MODFLOW (results not presented here) to study the vertical and horizontal influence of a recovery trench. The modeling involved simulating a partially penetrating trench in a homogeneous aquifer, generally matching conditions to those of Trench #1 at the site, calibrating to the October 2008 heads at MW-39B and MW-46B, and assuming that the vertical hydraulic conductivity is two orders of magnitude lower than the horizontal hydraulic conductivity. Based on this informal modeling, the RSE team believes that, in the absence of significant heterogeneity, the capture zones for Trench #1 and Trench #5 likely extend significantly deeper than the screened intervals of MW-38A and MW-39A and that MW-38A and MW-39A are likely within the capture zones of the trenches. However, it is possible that contamination is present below or to the sides of the capture zone and is therefore not captured. It is also possible that there may be significant heterogeneity or other site-specific features that could limit the vertical influence of the trenches.

- The RSE team recognizes the increasing trend in VC at MW-39A and at upgradient MW-46A and believes there is likely a link between the increases in these two wells. One possibility is that ground water extraction with the trenches caused a change in ground water flow patterns that has caused contamination to migrate toward these wells rather than the direction it would migrate in the absence of pumping. The RSE team notes that, according to the historical data presented in Appendix E of the Draft RPO report, prior to system operation VC was undetectable in these two wells.

- MW-40B – The concentration trends for cis-1,2-DCE and VC in this well do not show an obvious relationship to the operation of the P&T system. The well is upgradient of the extraction trenches, and therefore cannot be used for assisting with a capture zone evaluation.

- MW-42A/B – cis-1,2-DCE concentration decreases at MW-42B appear to be related to the initiation of P&T operation in the mid-1990s. The VC concentrations at this well may have also been influenced by P&T operation. The concentrations of these two compounds at MW-42A have generally been stable. These changes or lack of changes in concentrations do not necessarily mean that these wells are within the capture zone of the trenches. The screened interval for MW-42A is from approximately 688 to 693 feet above mean sea level, and the bottom of Trench #2 is at approximately 693 feet above mean sea level. The interval screened by MW-42A (though not necessarily at the location of MW-42A) is very likely captured by Trench #2. However, contamination is not vertically delineated in the vicinity of MW-42A.

4.3 COMPONENT PERFORMANCE

4.3.1 EXTRACTION SYSTEM

With the exception of Trench #3, the extraction system appears to be performing as expected. The extraction rate from Trench #3, however, is substantially lower than that of the other trenches and substantially lower than expected. The site team indicated that this may be a combination of fouling and/or damage/collapse of the trench.

4.3.2 METALS REMOVAL SYSTEM

The metals removal system consists of potassium permanganate addition, flash mixing, solids recycling, addition of polymer, flocculation, and settling in an IPC. The metals removal system appears to operate as intended with few operational complications. Approximately 3,600 pounds of potassium permanganate are used per year for treatment. The metals removal system is the rate limiting step for the treatment plant. The treatment plant currently operates at approximately 90 to 95 gpm and can operate as high as 105 gpm before there is significant solids carryover from the clarifier.

4.3.3 AIR STRIPPER

The air stripper is a packed tower with a hydraulic capacity of 120 gpm. Two 2-HP blowers that provide approximately 1,000 cfm at 5.5 inches of water are provided for aeration and alternate operation. Two 3-HP transfer pumps, each with a capacity of 100 gpm at a total dynamic head of 35 feet, alternate operation and are located between the equalization tank and the air stripper to pump the water to the top of the air stripper. Air stripper operation has been reliable. Cleaning the packing material with muriatic acid has been required twice a year. The packing material has not been changed since operation began.

Influent VOC concentrations are approximately 10 ug/L of TCE, 120 ug/L of cis-1,2-DCE, and 40 ug/L of VC. This is substantially lower than the initial influent VOC concentrations. For comparison, the concentrations of the same constituents in 1994 were approximately 40 ug/L of TCE, 1,000 ug/L of cis-1,2-DCE, and 70 ug/L of VC. The air stripper should easily be able to accommodate the existing influent concentrations and provide some additional capacity. The RSE team does not have sufficient design information for the air stripper to accurately determine the additional loading that it could accommodate. The RSE team notes some limited concern regarding the air stripper performance. From January through May 2009, the effluent cis-1,2-DCE concentration was approximately 3.0 ug/L. Although this is well below standards, the air stripper should have easily reduced the cis-1,2-DCE concentration to a non-detect value. This may be the result of the air stripper packing fouling and the need for cleaning.

4.3.4 SOLIDS HANDLING

Solids that settle in the IPC are either recycled with a progressive cavity pump to the head of the metals removal system to enhance floc formation and improve settling or by diaphragm pump to the solids holding tank with a working capacity of 1,000 gallons. Approximately 18,000 to 37,000 pounds of lime are added each year to the solids holding tank to improve solids quality for dewatering.

The solids are dewatered with an 8 cubic foot filter press that is operated every day or every other day. Dewatered sludge totaling approximately 80 to 100 tons per year is stored in a 20 cubic yard roll-off container that is removed from the site approximately eight times per year. Analytical results confirm that the dewatered solids are non-hazardous, and filter cake is disposed of at the Lake View Landfill in Erie, Pennsylvania, approximately 10 miles from the site. Air for operating the diaphragm pumps for solids transfer and dewatering is provided by two 20-HP air compressors that alternate operation and operate intermittently.

4.3.5 SYSTEM CONTROLS

Systems controls are relatively limited compared to similar systems. Although there are emergency shutoffs and alarms for conditions such as high levels in tanks, high pressure differential across the air stripper, etc., the pumps in the extraction trenches are run manually rather than automatically, and the chemical feed rates for polymer and permanganate are also manual. This lack of control requires the operator to respond to alarms quickly to avoid discharges of permanganate, polymer, or other process chemicals to the discharge locations.

4.3.1 pH ADJUSTMENT

Sulfuric acid is added to the retention pond prior to using the treated water for irrigation so that the water will be pH 7. pH adjustment is not required when treated water is discharged to Marshall Run.

4.4 COMPONENTS OR PROCESSES THAT ACCOUNT FOR MAJORITY OF ANNUAL COSTS

The project status reports suggest an annual cost of $413,000 per year for site-related activities, including project management, data analysis, reporting, sampling, and treatment system O&M. Although information was provided to the RSE team regarding chemical and utility costs a complete breakdown of costs was not provided. The following table summarizes annual costs, including RSE team estimates where actual data are not available.

Item Description	Approximate Annual Cost
Project management, data validation/evaluation, reporting [1]	**$125,000**
Treatment Plant O&M	
O&M labor[4]	$150,000
Utilities – electricity[2]	$12,000
Utilities – natural gas (for heating) [2]	$4,000
Utilities – other (phone, sewer) [2]	$3,000
Treatment chemicals[3]	$23,000
Waste disposal[4]	$16,000
Treatment plant analytical costs (on-site and off-site analyses)[4]	$12,000
Miscellaneous parts, service, contingency[4]	$30,000
Total treatment plant O&M[1]	**$250,000**

Item Description	Approximate Annual Cost
Ground water sampling[5]	**$20,000**
Laboratory analysis (ground water only)[4]	**$18,000**
Total Estimated Annual Cost	**$413,000**

[1] Based on the amount spent or estimated to be spent during 2009 as indicated in the progress reports
[2] From utility bills and published utility rates
[3] From the treatment plant operator
[4] Estimated by the RSE team based on described monitoring programs, assuming approximate analytical costs of $90 for VOCs, $200 for SVOCs, $100 for metals, $50 for general chemistry, $25 for oil & grease, $25 for free cyanide, $25 for phenols, and between $1 and $2 per on-site test kit analysis. A duplicate sample for each parameter is assumed each month for process sampling. The cost for QA samples for ground water monitoring is assumed to be a 30% increase in the cost of analyses for the monitoring wells.
[5] Estimated by the RSE team assuming $2,500 per day for travel, labor, and equipment for a two-person crew, 3 days for the April event and 5 days for the October event.

4.4.1 UTILITIES

The utilities account for less than 5% of the total costs for the site. The treatment plant does not pay for potable water. A trade has been made between the plant and the city, where the treatment plant provides irrigation water for the public golf course and the treatment plant is provided with potable water free of charge.

4.4.2 NON-UTILITY CONSUMABLES AND DISPOSAL COSTS

The consumables and disposal costs account for approximately 10% of the total annual cost for the site. The waste disposal costs are estimated by the RSE team based on roll-off costs of $300 per two week period (one example bill was provided), $80 per ton for disposal, and disposal of 100 tons per year.

4.4.3 LABOR

Labor is the largest component of the annual costs for the system. The majority of the project management/data evaluation/reporting budget is cost associated with labor and more than half of the ground water sampling cost is labor. Combining the project management cost, 50% of the ground water sampling cost, and the treatment plant operator costs results in over $290,000 or 70% of the total annual costs.

The RSE team has estimated a typical cost of $150,000 for full-time operator labor based on 2080 hours at a fully loaded rate of $65 per hour plus approximately 30 days per year of support from another operator/technician.

4.4.4 CHEMICAL ANALYSIS

Chemical analysis costs were estimated by the RSE team based on typical laboratory costs for VOCs, metals, SVOCs, and general chemistry and estimates of the materials/test kits that would be needed for the on-site analyses.

4.5 APPROXIMATE ENVIRONMENTAL FOOTPRINTS ASSOCIATED WITH REMEDY

4.5.1 ENERGY, AIR EMISSIONS, AND GREENHOUSE GASES

This section focuses on the carbon footprint of the remedy to provide an indication of greenhouse gas footprint. For this simplified analysis, the carbon footprint is also used as a proxy for energy usage and emissions of other pollutants such as nitrogen oxides and sulfur dioxide because most of the energy usage results from combustion of fossil fuels and the predominant sources of carbon dioxide, nitrogen oxides, and sulfur dioxide are from the combustion of fossil fuels. The annual emissions for carbon dioxide for the current system are presented in Table 4-1. The largest contributors are electricity usage (59% of the total footprint), natural gas usage for heating the treatment plant (18% of total footprint), chemical or laboratory analysis (11%), and treatment chemicals (8%). All other sources appear to be negligible.

The emissions of hazardous air pollutants associated with the site primarily result from air stripper off-gas or vapor intrusion. These items are discussed in Section 5 of this report in the context of protecting human health and the environment.

4.5.2 WATER RESOURCES

The ground water remedy has a limited affect on water resources in the area. Although some potable water is used for the treatment process, substantial amounts of treated water are used for irrigation of the local golf course. The majority of water used in the region is from Lake Erie, and water is not a scarce resource.

4.5.3 LAND AND ECOSYSTEMS

The ground water remedy has a limited effect on the land and local ecosystems because the infrastructure is either below ground or contained in the treatment building. The land has been redeveloped as a golf course and the treated water is used for irrigation.

4.5.4 MATERIALS USAGE AND WASTE DISPOSAL

The materials usage and waste disposal associated with the remedy are due to the need to remove iron and manganese from the treated water. The materials used and waste disposed of are as follows:

Item	Approximate Annual Usage
Lime	18,000 to 37,000 pounds
Potassium permanganate	3,600 pounds
Hydrochloric acid	300 gallons
Sulfuric acid*	800 gallons
Polymer (dry)	375 gallons
Waste disposal	80 to 100 tons

**Sulfuric acid is used to condition the water for irrigation and is not required for treatment*

Suggestions are provided in Section 6 to reduce some of the materials usage and waste disposal.

4.6 RECURRING PROBLEMS OR ISSUES

No recurring problems or issues were reported other than those mentioned in Section 4.7.

4.7 REGULATORY COMPLIANCE

Two chemical releases to surface water have occurred during treatment plant operation, and both of them were due to a lack of automation in controlling chemical feed rates. Because the extraction trenches and chemical feed rates are manually controlled, when a trench pump unexpectedly shuts down, the chemical feed does not automatically adjust. On one occasion an excess of potassium permanganate was released to Marshall Run when an extraction trench unexpectedly shut down. A similar release occurred with polymer. In both cases, no harm was caused to human health and no permanent harm was caused to the environment.

4.8 SAFETY RECORD

No health and safety issues were identified during the RSE site visit.

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

5.1 GROUND WATER

The ground water remedy appears to currently be protective of human health and the environment, but additional information is required to 1) confirm the plume is not migrating off-property and to 2) confirm that there is no human exposure through vapor intrusion in the vicinity of MW-31 (if the contamination at MW-31 is site-related). Several recommendations are provided in Section 6.0 to help evaluate control of the plume, and a recommendation is included to determine if the contamination at MW-31 is site-related.

Vapor intrusion sampling has been conducted near the site but not necessarily in the vicinity of MW-31. The sub-slab and indoor air sampling that was conducted and documented in Technical Memorandum for Vapor Intrusion Sampling at the Millcreek Dump Site, August 28, 2008 indicated concentrations of chemicals above screening levels, but the chemicals detected are not consistent with those currently observed at the site. One potential explanation for the detections is one or more household sources. MW-31 has continuing elevated concentrations of VC in shallow ground water and is approximately 300 feet northeast of the vapor intrusion study area (i.e., 300 feet further from the site than the vapor intrusion study area). Given that VC was not detected in the vapor intrusion study area it is likely that the observed VC at MW-31 is not site-related. However, the suggested investigations will help determine if the VC at MW-31 is site related. If it is, then the site team should delineate the contamination and test sub-slab and indoor air for VC in the immediate vicinity of MW-31. If it is not site-related then the regulating authority will likely need to identify the source, conduct appropriate ground water investigation, and evaluate indoor air and remedial options.

5.2 SURFACE WATER

Marshall Run flows adjacent to the site. As indicated in the HGL Capture Zone evaluation, the measured stage of Marshall Run and the water levels in the nearby monitoring wells show that water from Marshall Run is extracted by the extraction trenches rather than site-related contamination discharging to Marshall Run. The water quality of Marshall Run appears to be protected by the remedy but the water level or flow rate may be adversely affected.

5.3 AIR

Please refer to Section 5.1 for discussions related to indoor air. Other impacts to air include a discharge of contaminants through the untreated air stripper off-gas. With respect to compliance, the mass of contaminants emitted to the air is approximately 0.004 kg per hr, which is equivalent to approximately 0.09 kg per day, or 32 kg per year and is therefore substantially less than 1 megagram per year of hazardous air pollutant emissions that typically applies to site remediation from a compliance perspective.

Given this emission rate and the air stripper flow rate of approximately 1,000 cfm the concentration of VOCs in the air stripper off-gas is approximately 2,200 ug/m^3. Based on the influent concentrations to the treatment plant, approximately 25% of this concentration (i.e., approximately 550 ug/m^3) is due to

VC. For comparison, the VC target indoor air concentration level from the Draft EPA Subsurface Vapor Intrusion Guidance is approximately 0.28 ug/m^3 for a 10^{-6} incremental cancer risk. Dilution is expected between the air stripper off-gas tower and surrounding potential receptors. Under conservative, stable conditions, the RSE estimates using Gaussian dispersion modeling that the ground level VC concentration approximately 200 feet from a 30 foot air stripper stack would be significantly less than this target indoor air concentration and therefore likely protective of human health and the environment.

5.4 SOIL

The soil remedy was completed, leaving soil in place and providing a clean cover. Soils were not specifically evaluated as part of this RSE.

5.5 WETLANDS AND SEDIMENTS

Wetlands and sediments were part of OU-2 and were not specifically addressed as part of 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 generally consistent with EPA 540-R-00-002, *A Guide to Developing and Documenting Cost Estimates During the Feasibility Study*, July, 2000. The costs presented do not include potential costs associated with community or public relations activities that may be conducted prior to field activities. The costs and sustainability impacts of these recommendations are summarized in Tables 6-1 and 6-2.

6.1 RECOMMENDATIONS TO IMPROVE EFFECTIVENESS

6.1.1 FURTHER CHARACTERIZE EXTENT OF CONTAMINATION

The plume is not vertically delineated (particularly near MW-42A), and there is an insufficient number of wells off-property to horizontally delineate the contamination or monitor concentration trends in the shallow zone (Zone B), intermediate zone (Zone A), and deep zone (deeper than Zone A). The RSE team suggests the following additional characterization by using direct-push drilling to collect grab samples. Suggested sample locations are presented in Figure 2:

- Vertically delineate contamination in the northern corner of the site in the vicinity of MW-42A. Collect grab samples from at least two depth intervals below MW-42A and analyze the samples for VOCs to characterize contamination down to the top of the shale layer.

- Horizontally delineate the contamination at MW-42A (and any contamination detected deeper than MW-42A) to the northwest, north, and northeast. Collect grab samples at three more depth intervals equal to or deeper than MW-42A to the northwest, north, and northeast of MW-42A (see Figure 2 for potential locations). The results of these samples will help identify pathways where contamination has not been captured by the extraction system over the past 10 years. Where contamination is identified at concentrations comparable to on-property concentrations, permanent monitoring wells may be appropriate for long-term monitoring of concentration trends (see Section 6.1.2).

- Determine if contamination is present downgradient of MW-39A, MW40A, and MW-41A off-property at depth. Collect grab samples off-property to the northwest of these wells in multiple locations at three or more depth intervals that are equal in depth or deeper than these wells. See Figure 2 for suggested locations. The results of these samples will help identify pathways where contamination has not been captured by the extraction system over the past 10 years. Where contamination is identified at concentrations comparable to on-property concentrations, permanent monitoring wells may be appropriate for long-term monitoring of concentration trends (see Section 6.1.2). Note that the RSE team has not specifically recommended vertical delineation in the vicinity of MW-39A, MW-40A, and MW-41A. The RSE team believes that these locations are likely within the capture zones of the trenches and the detection of contamination in these locations would not necessarily contribute to plume delineation and capture zone evaluation in the same manner as the recommended locations. The RSE team, however, would not object or disagree with the site team if the site team preferred to vertically delineate at these locations.

- Determine if declining concentrations in MW-11 are due to infiltration of clean water from the pond or due to plume capture by the extraction system. Collect grab samples “side-gradient” to MW-11 in Zone B. See Figure 2 for locations.

- Determine if contamination at MW-31 is site-related or due to another source. Collect shallow grab samples between the landfill property and MW-31 as depicted in Figure 2. If contamination at MW-31 is determined to be linked to the Site, then another field event should be conducted to delineate the characterize the contamination at depth.

Any number of techniques can be used to collect these grab samples, including hydropunch or direct push points. The RSE team will defer to the site team for their local expertise to determine the appropriate method. The RSE team suggests, however, that cores be obtained and logged from key locations so that informative geological cross-sections can be prepared. Given that sampling at depths of up to 50 feet or more may be required, the site team should arrange for a sufficiently large direct push machine.

Figure 2 illustrates a total of 15 locations and a total of 39 samples. The RSE team has attempted to locate the sample points where access will not be an issue. The RSE team estimates that this characterization may take up to 8 days in the field at an approximate cost of $50,000, including laboratory analysis, waste disposal, preparation of boring logs, and reporting. These costs and this recommendation do not include the installation of permanent monitoring wells that may be needed for long-term monitoring in these locations. The following recommendation involves the installation of some permanent points, but other permanent monitoring wells may be needed as well.

6.1.2 INSTALL ADDITIONAL POINTS FOR WATER LEVEL MEASUREMENTS

The understanding of ground water flow off-property is fairly limited in Zone B and very limited in Zone A. With respect to Zone B, the modeling that has been conducted and the potentiometric surface maps that have been developed do not correlate very well with observed off-property contamination. The modeling and potentiometric surface maps suggest water flows toward the MW-25 cluster and the daylighting of Marshall Run to the east of the cemetery. However, significant levels of contamination continue to be observed at MW-31, and the VOC concentrations at MW-32 have historically been higher than those at MW-25. The Zone B potentiometric surface maps are highly biased by the MW-25B water level (actually, the MW-25A water level since the MW-25B result is anomalous) because MW-32 is not gauged. The potentiometric surface maps for Zone A differ significantly from those in Zone B, but this may be to the lack of monitoring points in Zone A. It is unclear if there is a difference in the strata that would cause a difference between the Zone A and Zone B potentiometric surface maps. The reviewed Zone A potentiometric surface map is highly dependent on the results from the MW-25 cluster because there are no other off-property monitoring wells or piezometers in this zone to suggest that ground water flows in another direction.

The RSE team recommends the following off-property piezometers for improving the understanding of the of ground water flow in the area:

- One well co-located with MW-11 but deeper is recommended to determine if the mounding observed in MW-11 is also present in Zone A or deeper. The depth to be chosen might be based on the water quality results from the direct push event. This point should be installed as a monitoring well to allow for sampling.

- One well co-located with or slightly northwest of MW-12 but deeper is recommended to improve the interpretation of ground water flow in the vicinity of Trenches #1 and #5. The water level differences between MW-12 and MW-38B/39B suggest and inward gradient and capture in the shallow zone. A deeper well in this location or slightly northwest may provide similar information for deeper zones. The depth to be chosen might be based on the water quality results from the direct push event. This point should be installed as a monitoring well to allow for sampling. The MW-29 location was not chosen for this purpose because it is too far down gradient to provide the hydraulic information. The RSE team does not suggest abandoning MW-12 as is suggested in the Draft RPO report, unless MW-12 is damaged or otherwise not providing reliable information.

- Any wells installed for long-term water quality monitoring resulting from the findings of the characterization recommended in 6.1.1 co-located with or northwest, north, and northeast of MW-42A are recommended to be used for measuring water levels. At a minimum (i.e., even if no wells are installed resulting from the characterization in 6.1.1), this should include one deep well co-located with MW-42A and one other deep well (depths to be determined based on findings from the characterization). The RSE team expects that at a maximum, this might include four deep wells (depth to be determined based on characterization), including one co-located with MW-42A, one co-located with MW-35, one midway between MW-35 and MW-11, and one 300 feet south of MW-35 in the street. The RSE team assumes that any of the wells installed as part of this effort would be in similar locations to the suggested direct push sample locations presented in Figure 2. The RSE team recognizes that these points may be too far from the trenches to allow the potentiometric surface map to be used effectively for interpreting capture, but the water level nevertheless provide useful information for understanding ground water flow and for future modeling efforts, if any.

Additional points are not suggested because it is unclear if a reasonable number of water level points would provide enough information to substantially improve the potentiometric surface maps. Rather, the RSE team suggests a capture zone evaluation based on several converging lines of evidence (see Section 6.1.4).

All of the above points should be surveyed, and during the survey effort the site team should consider resurveying all site wells if such an effort has not recently been done. At a minimum, the MW-25A, MW-25B, MW-11, and any other wells with potentially questionable survey data should be resurveyed.

For the purpose of this recommendation, the RSE team assumes that six wells will be installed with hollow stem auger for a total of 200 vertical feet (e.g., each of the five wells is 40 feet deep). The RSE team estimates that this effort, including drilling, disposal, and survey would cost approximately $40,000. Sampling the wells once per year for VOCs would likely increase the cost of the ground water monitoring program by approximately $4,000 per year, including laboratory analysis.

6.1.3 Conduct a Shutdown and Restart Test of the Extraction System

After the above-mentioned wells are installed, the RSE team suggests conducting a shutdown test of the entire extraction system and individual shutdown and restart tests for each of the extraction trenches to better understand ground water flow in the absence of pumping and to gain information from the transient data due to pumping. Understanding ground water flow in the absence of pumping may help conceptually with preparing potentiometric surface maps under pumping conditions. It will also provide the hydraulic gradient in the absence of pumping, which is useful in conducting a ground water flow budget for the site. The transient data can be used to estimate hydraulic conductivity and storativity in the vicinity of the trenches (i.e., pumping tests using the extraction trenches). The transient data will also help the site team better understand how the cycling of the trenches might affect water level measurements in and around the trenches so that these effects can be considered during development of the potentiometric surface maps.

Prior to the shutdown test of the entire system, conduct a site-wide water level event that includes the new and resurveyed monitoring points, MW-32, and the stage of Marshall Run in a few locations. For the shutdown test of the entire system, discontinue pumping from all of the extraction trenches. After approximately 4 or 5 days of non-pumping conditions, collect a site-wide water level event that includes the new and resurveyed monitoring points, MW-32, and the stage of Marshall Run in a few locations. Based on the above information, develop potentiometric surface maps for pumping and non-pumping conditions. Utilize conceptual information from the potentiometric surface map for non-pumping conditions to assist with developing the potentiometric surface map under pumping conditions. Use kriging or interpolation software augmented by professional judgment for developing the potentiometric surface maps. Document any software settings or assumptions made in developing the maps. Also document the average pumping rates of the trenches and any cycling of the trench pumping leading up to the water level event.

The RSE team has purposely avoided collecting transient data during the shutdown test of the entire system because it is expected that the influence of stopping or restarting one trench will influence water levels in neighboring trenches. In addition, the RSE team wants to minimize the amount of time that extraction is discontinued.

For the shutdown and restart tests of the individual extraction trenches, the following steps are suggested:

- Place pressure transducers and begin recording water levels in the subject trench TMP, nearby monitoring wells in Zones A and B, and one monitoring well that is expected to be outside of the zone of influence of all extraction trenches. As an example, for Trench #5, place transducers in the TMP, MW-38A, MW-38B, MW-12, and the new deep well proposed north of MW-12. The site team could also consider adding transducers in MW-39A, MW-39B, and the TMP for Trench #1.

- Document the extraction rates and cycling of the trench pumping for two days prior to the event (while transducers are recording). As best as possible, document fluctuations in precipitation and trench extraction rates.

- Shutdown the subject extraction trench for three days and then restart the extraction trench. The transducers should continue to record during this entire period plus a day or two after the trench was restarted. As best as possible, maintain steady flow rates in other extraction trenches during this time. Document precipitation events.

- Remove the transducers from the wells, download the data, interpret the data, and move the transducers to the monitoring wells for the testing of the next trench.

For each trench, use MODFLOW to construct a simple model of a single trench to simulate the transient data from nearby transducers. Based on a good calibration, estimate the hydraulic conductivity and storativity. For model construction, use trench construction information and the trench pumping rate. For calibration, use the transient data from the trench monitoring point nearby monitoring points.

Using the hydraulic conductivity and the non-pumping hydraulic gradient for each trench, conduct a simple water budget analysis for each trench. That is, compare the amount of water extracted from the trench with the amount of water flowing through a given cross-section of the aquifer. For example, during informal modeling, the RSE team estimated that the hydraulic conductivity near Trench #1 might be approximately 30 feet per day. Based on this value and an assumed non-pumping hydraulic gradient of 0.0025 feet per foot, and an aquifer thickness of approximately 50 feet, the RSE team estimates that approximately 1,875 cubic feet per day of ground water flows through a 500-foot width of the aquifer as follows:

$$Q = Thickness \times Width \times Darcy\ Velocity$$

$$1{,}875\ ft^3/day = 50ft \times 500ft \times 0.0025ft/ft \times 30\ ft/day$$

For comparison, the approximate extraction rate of the trench is approximately 20,000 gallons per day (2,700 cubic feet per day). This extraction rate is approximately 1.44 times higher than the calculated ground water flow volume. Therefore, assuming a factor of safety of approximately 1.44, and based on the example values used here, it would be reasonable to estimate that Trench #1 has a capture zone that is approximately 500 feet wide and approximately 50 feet deep. Conducting these analyses will help the site team determine if the current extraction rates approximate the extraction rates that are necessary for plume capture. These results can be used as one potential line of evidence in a capture zone analysis (see below).

The RSE team estimates that this recommendation might cost $50,000 to implement assuming $20,000 for the field effort (including transducer rentals) and $30,000 for data management, interpretation, and presentation.

6.1.4 Document the Findings from the Above Events, Use Findings For Capture Zone Analysis

With the above information, the site team should have several lines of evidence for conducting a capture zone evaluation. The direct push sampling should provide an indication of the depth of the target capture zone as well as if and where contamination might have been migrating through the extraction system over the past 10 years. Continued monitoring at new monitoring wells (installation and locations dependent on the direct push sampling) should allow the site to determine if contamination continues to migrate through the extraction system (or a modified system) in the future. Additional points for water level measurements and additional considerations during development of the potentiometric surface maps should provide additional information with respect to interpreting capture based on water levels. Finally, the simplistic capture zone analysis based on a water budget and location-specific gradient and hydraulic conductivity information should provide another line of evidence to evaluate capture. These three lines of evidence taken as a group should either confirm or deny successful capture and help the site team determine how the extraction system might be modified. Much of the work for this analysis is discussed (and the costs accounted for) in the above recommendations. The RSE team assumes that an additional $15,000 might be needed to compile the results, interpret them as a whole, and prepare a report.

If the information from the above capture zone analysis is inconclusive, then the RSE team suggests revisiting the site modeling, taking into consideration the items mentioned in Section 4 of this report and calibrating the model to the steady-state water level data from pumping and non-pumping conditions and to the transient data from the shutdown tests. The RSE team estimates that this modeling might add an additional $30,000 to the above costs, depending on the updates, modifications, or corrections that might be needed to be made to the existing model. The model would provide the additional benefit of allowing the site team to simulate various pumping scenarios that might result in reduced extraction while maintaining the same level of plume capture.

See Section 6.4 for additional comments regarding a path forward.

6.1.5 AUTOMATE CHEMICAL FEEDS OR PROVIDE APPROPRIATE INTERLOCKS TO DISCONTINUE CHEMICAL FEEDS IF ONE OR MORE EXTRACTION TRENCHES DISCONTINUE OPERATION

The two treatment plant excursions resulted from chemical feeds continuing at the same rate after process flow rates dropped due to unexpected shutdown of one or more extraction trenches. There are two primary methods of addressing this. One is to automate the chemical feeds based on flow rate, which would take some adjustment and trial and error, and the other is to force treatment plant shutdown if the process flow rate decreases below a critical value for a set amount of time. The latter method may be made more practical if variable frequency drives (VFDs) are installed on the extraction pumps, and decreases in flow trigger an increase in the extraction rate from one or more trenches to compensate for the decreased flow. The approach with the VFDs has the added benefit of the treatment plant operator being able to better control or set flow from each extraction trench and to save electricity when operating pumps where flow would otherwise be throttled manually with a valve. The installation of the VFDs would not likely pay for itself. This modification, if made, would therefore be done for treatment plant effectiveness or sustainability reasons and not for cost savings.

The approximate cost for implementing the first or second approach is likely on the order of $25,000. If the VFDs are purchased for six extraction pumps (i.e., both pumps in three of the trenches), then there would likely be an additional cost of $15,000.

6.1.6 IF OFF-SITE SHALLOW CONTAMINATION IS IDENTIFIED AND DETERMINED TO BE RELATED TO THE SITE, CONDUCT A VAPOR INTRUSION EVALUATION

The direct-push study might identify contamination off-site and might link the shallow contamination at MW-31 to the site. If off-site shallow contamination, such as that at MW-31, is detected and is determined to be related to the site, then the site team should conduct a vapor intrusion evaluation. Given the shallow water table and nearby residences, the RSE team assumes that this study would involve sub-slab sampling. If off-site contamination is identified at depth in a given location but is below clean shallow water, then the vapor intrusion pathway is incomplete and a vapor intrusion study is not merited in that location.

If the contamination at MW-31 is determined to result from a separate source, then the regulating authority will likely need to identify the source of contamination and pursue a separate characterization, risk assessment, and remediation effort.

No costs are provided for this recommendation because the scope is uncertain.

6.2 RECOMMENDATIONS TO REDUCE COSTS

6.2.1 DISCONTINUE APRIL SAMPLING EVENT

The current April sampling event provides little additional benefit to evaluating plume capture or documenting aquifer restoration. Six of the wells are located upgradient of the extraction network and are therefore monitoring progress toward restoration, which is a relatively slow process and is adequately monitored by an annual event. More importantly, the concentration trends at the wells do not look different if the semi-annual data are removed. The magnitude of contamination should not be used to determine sampling frequency, rather the additional information that is gained by sampling during additional events should be the deciding factor. The semi-annual event can be eliminated from the sampling program. If there is concern regarding seasonality, the season with the higher concentrations should be selected for the annual event. There is also little value in measuring water levels at only a subset of the monitoring wells during the Spring. The Spring water level measurement event should either be discontinued or converted into a full water level measurement event.

Eliminating the semi-annual sampling event should save approximately $15,000 per year in sampling costs based on the costs provided in the progress reports. If the water level event is maintained and converted into a full event, the savings might only be $13,000 per year. Additional savings should also be realized from discontinuing the report that summarizes the semi-annual event. The semi-annual water level event and potentiometric surface map can be presented and described in the annual report. Based on the costs provided, eliminating the semi-annual sampling report might save another $15,000 plus additional reductions in data validation and data management.

The semi-annual event is the only event where SVOC samples are collected. Although some SVOCs were original contaminants of concern, it appears that SVOCs are no longer detectable in ground water and can be eliminated from the monitoring program. If the site team feels there is a need to continue sampling for SVOCs, it can likely be done at select monitoring wells every five years in anticipation of a Five-Year Review.

6.2.2 DISCONTINUE ANALYSIS FOR DISSOLVED METALS

Analysis of ground water samples from the annual event and process water include both total and dissolved metals. Although dissolved metals is often helpful in characterizing the metals in ground water at a site, there is sufficient existing information to conclude that the majority of metals in site ground water are in the dissolved phase. Given that regulatory decisions regarding the site will not be made based on dissolved metals results and that the dissolved metals do not provide valuable information, the RSE team suggests eliminating this set of analyses from both the ground water and process water sampling. Given an estimated cost of $100 per dissolved metals sample and approximately 60 samples per year for both ground water and process water sampling, eliminating the dissolved metals analysis should result in an annual savings of about $6,000 per year in analytical costs plus additional savings associated with less data management and validation. Analysis for dissolved iron will need to continue at the treatment plant effluent to meet the requirements of the treatment plant discharge, but this is a negligible cost relative to the $6,000 in savings.

6.2.3 STREAMLINE PROCESS SAMPLING

The process sampling program likely provides more information than is needed to operate the plant. Streamlining this program could reduce operator level of effort, potentially help reduce the need for planned additional operator support, and reduce reporting efforts. The plant is currently staffed by one operator, but the budget and the plan is to add a technician on half-time basis. Implementing this and other modifications might help avoid adding the additional half-time staff.

Measurement of pH and turbidity are important parameters to monitor, particularly at the IPC effluent where the results are used to evaluate the performance of the metals removal, but the monitoring results for other parameters and other locations are not necessary and could likely be dropped from the program without sacrificing treatment plant effectiveness. Although total suspended solids is an important parameter for evaluating IPC effectiveness, IPC effectiveness can be effectively monitored (and is effectively monitored at other sites) with turbidity. Eliminating the total suspended solids sample from three locations, all parameters from the other locations, and the associated reporting should save a little time each day for both sampling, weekly reporting, and progress reporting. The weekly sampling for total manganese and dissolved iron at the IPC influent are also important because they too can be used to confirm potassium permanganate dosing and metals removal effectiveness. The other aspects of the weekly monitoring (including TOC analysis and metals analysis at other sample ports) could also be dropped from the program. The savings in materials from these monitoring modifications is likely negligible, but the time savings may be important for avoiding additional operator labor and for reducing the reporting level of effort.

6.2.4 REVISIT DATA AND REPORTING COSTS

Approximately $100,000 is allocated to data validation/reporting in 2009, which seems to be high relative to the monthly discharge monitoring reports (DMRs), quarterly progress reports, semi-annual ground water report, and annual ground water report. The following table summarizes reasonable, suggested costs for these items, including data validation.

Item	Suggested, Reasonable Annual Cost
DMRs	$12,000
Quarterly progress reports	$12,000
Data validation	$8,000
Semi-annual report (including data management & interpretation)	$15,000
Annual report (including data management & interpretation)	$15,000
Total	**$62,000**

The discrepancy between the allocated $100,000 and the above RSE-estimated $62,000 may partially be due to the preparation of the Draft RPO report, but this should not be an ongoing expense, and the reporting budget should likely be $62,000 per year given the current reporting scope. If the above suggested changes to the monitoring program are made, then additional savings should also be realized for the data and reporting task. The following table summarizes what reporting costs might be if the above-suggested monitoring changes are made.

Item	Suggested, Reasonable Annual Cost
DMRs	$12,000
Quarterly progress reports	$8,000
Data validation	$4,000
Annual report (including data management & interpretation)	$15,000
Total	**$39,000**

6.2.5 Reduce or Eliminate Lime Conditioning of Sludge

The majority of the solids that are disposed of at the site are from adding lime to the metals removal sludge for conditioning prior to dewatering. Approximately 5,000 pounds of iron and manganese are removed from ground water per year, and approximately 1,300 pounds of manganese is added per year due to the addition of potassium permanganate. These metals precipitate out as oxides and hydroxides, resulting in approximately 12,000 pounds of solids per year. By contrast, approximately 25,000 pounds of lime is added.

Although lime conditioning of waste activated (biological) sludge is common, lime conditioning for metal hydroxide sludge such as that found at the Millcreek Site is typically not needed. Another common conditioner for biological sludge is ferric chloride (in addition to lime) because it forms ferric hydroxide solids that add bulk to the biological sludge. The large majority of solids removed by the metals removal system at Millcreek are iron hydroxide. Reducing or eliminating the lime addition should reduce chemical costs by about $5,000 per year and decrease waste disposal fees by a similar amount. Less potable water would be used for making the lime, and operator time associated with adding the lime and extra filter press pulls could be allocated to other tasks. Currently, the operator needs to batch between one and two bags of lime per day and operate the filter press once a day or once every other day. The operator should experiment with reducing lime conditioning and evaluating dewatering performance.

These modifications, along with the process monitoring modifications, should help avoid the need for additional operator support.

6.3 Recommendations for Technical Improvement

6.3.1 Cleanup Up Treatment Plant

The treatment plant is generally functioning as intended but was somewhat disorderly during the RSE site visit. The treatment plant could be organized better and cleaned up to avoid potential health and safety issues.

6.3.2 Considerations Regarding Treatment Plant Modifications, If Necessary

The RSE team cautions that the limiting capacity of the treatment system is not just the air stripper but the metals removal system, which can only handle up to 105 gpm before there is significant carry over from the IPC. If the treatment plant needs to be modified to handle flow higher than 105 gpm, the budgeting should incorporate not only a new air stripper but also a metals removal system with a larger hydraulic capacity.

The metals removal system does not include filtration of the IPC effluent. As such, solids will continue to foul the air stripper. If the air stripper requires modification to increase hydraulic capacity and/or high influent concentrations, a tray aerator should be considered to facilitate cleaning.

6.4 CONSIDERATIONS FOR GAINING SITE CLOSE OUT

6.4.1 DETERMINING A PATH FORWARD

The RSE team finds it unlikely that even aggressive remedial efforts will be able to achieve the cleanup standards (particularly 0.015 ug/L for VC) for this site in a reasonable time frame. In addition, the RSE team believes that if concentrations above this standard are not permitted to migrate beyond a short distance from the property boundary (e.g., as part of a natural attenuation component of the remedy), then hydraulic containment is the preferred approach because other technologies (e.g., in-situ bioremediation) may not be able to reliably meet this low standard. An appropriate path forward therefore depends on the answers to two primary questions:

- What is the potential for allowing low contaminant concentrations to migrate off-site as part of a natural attenuation remedy for the dilute plume?

- Can the existing system reasonably provide plume capture?

The answer to the first question would depend on the outcome of a natural attenuation evaluation and the site team's interpretation of a reasonable distance from the property boundary for attenuation to occur. If the low concentration areas of the plume can be allowed to naturally attenuate, then the overall plume size requiring active remediation might be substantially smaller, making it more practical to target remediation in areas with high concentrations (perhaps with in-situ bioremediation or targeted pumping). Furthermore, if the area for targeted remediation is sufficiently small, then P&T may be abandoned for in-situ bioremediation. By contrast, if the remedy will need to continue to prevent contamination above standards from migrating beyond a short distance from the property boundary, then the future remedy will likely continue to involve P&T. The RSE team cautions against the use of P&T and in-situ bioremediation or in-situ chemical oxidation in overlapping areas because the in-situ remedies could lead to fouling and operational difficulties for the P&T system.

The answer to the second question should be available after implementing the above recommendations. If the P&T system is incapable of providing adequate capture, but low-level contamination is allowed to migrate and naturally attenuate beyond the property boundary, then it might be possible to discontinue pumping or substantially reduce pumping from some of the extraction trenches in favor of increasing extraction in areas where it is needed. If the P&T system is incapable of providing adequate capture and the contamination is not permitted to migrate above standards beyond a short distance from the property boundary, then upgrades to both the extraction system and treatment system will likely be needed. In this case, the modeling described in Section 6.1.4 should be conducted to help design an appropriate extraction system. All modifications or upgrades to the treatment plant should be postponed until a final flow rate has been determined.

The RSE team suspects that the current system likely provides a reasonable degree of capture but that the overall flow rate might need to be increased to the maximum treatment plant capacity and/or that extraction rates from various trenches might be redistributed to close gaps in capture. If new extraction points are required, extraction wells would likely provide sufficient additional extraction capacity and would be better suited to extracting deeper ground water than installing new trenches. Likewise, if extraction is needed in the vicinity of Trench #3, the RSE team believes it would be more cost-effective to install an extraction well than to repair or reinstall the trench. The RSE team estimates that a 6-inch, 50-foot deep, PVC extraction well might cost on the order of $30,000, including well installation, pump installation, wiring, and controls. A well in this area, if it is needed, should likely be screened from 20 feet below ground surface to the bottom of the unconsolidated material. During operation, care should be given to avoid dewatering the well screen.

Although the RSE team has not thoroughly considered the option, if the hydraulic conditions are appropriate, the site team could consider damming Marshall Run in the vicinity of Trench #4 to increase the creek stage and create a higher constant head boundary to prevent ground water from migrating to the northeast in this location. This might cause a small influx of water into the site at this location, but it would also free-up the approximately 25,000 gpd of capacity (from discontinuing operation of Trench #4) so that extraction could be increased in other portions of the site without requiring an increase in treatment plant capacity. Further consideration of this option (if appropriate) would likely require an impact assessment of the creek and model simulations to evaluate effectiveness.

For analysis and reporting only (not additional field work or well installation), the RSE team expects that up to $50,000 will be needed for contractor support in determining a path forward. This funding would include the above-mentioned evaluation, plus initial feasibility analysis of various remedial options and potentially focused feasibility or conceptual designs for remedial options that do not significantly differ from the current remedy.

6.5 RECOMMENDATIONS FOR IMPROVED SUSTAINABILITY

6.5.1 REVISED APPROACH TO METALS REMOVAL

The treatment plant influent appears to already meet the discharge standard for manganese, and manganese is one of the principal reasons why potassium permanganate is needed for metals removal. A metals removal process that involves minor pH adjustment and aeration may have an overall lower footprint than continuing with the permanganate oxidation. A detailed footprint analysis is not conducted because insufficient information is available on the footprint of potassium permanganate, though it likely does have a larger footprint than aeration and the small amount of caustic or lime that would be needed for pH adjustment.

One potential approach to implementing this metals removal approach is to replace the existing air stripper with a non-fouling type air stripper (e.g., one manufactured by Specialty Systems Integrators), and operate the system in Mode A where water flows through the air stripper, removes volatiles and oxides the water for solids removal. This approach would likely require pilot testing to confirm that the discharge standards could be met. The modifications might require $100,000 to implement, but savings on the order of $10,000 per year would be realized from discontinuing the use of potassium permanganate, and the modifications would likely pay for themselves over 10 or more years.

6.5.2 CONSIDERATIONS FOR RENEWABLE ENERGY AT THE SITE

Although the site is large, the presence of the golf course limits the potential development of solar energy on the ground. The roof of the treatment building, however, could likely support approximately 10 kW of installed solar. A system of this size could provide approximately 10,000 to 12,000 kWh of electricity per year. The installed price for a system of this size (given approximate current market prices) might be on the order of $70,000. The annual savings from offset energy (less than $1,000 per year) would not provide a reasonable payback for the system. To apply or assign the renewable energy generated by the system to the site, the renewable energy credits generated from such as system should be “retired” by the site rather than sold to another party. As a result, the renewable energy credits would not help offset the cost. A state grant program is in place that could potentially offer a grant on the order of $20,000 for this type of project, but 1) the grant, which is partially administered by PADEP, does not apply to state run facilities and 2) the payback from offset energy would still be on the order of 50 years.

With the respect to wind power, the future expansion of the airport may complicate implementation of wind energy. There is no active gas extraction system for landfill gas, so the use of landfill gas is also not a renewable energy option.

Cost Analysis and Rationale for Green Tags

Renewable energy can also be used to power the P&T system by purchasing "green tags" or renewable energy certificates. The market price is approximately $0.025 per kWh. It would therefore cost approximately $4,000 additional per year to power the P&T system with renewable energy that is generated elsewhere in the country/region. Comparing this option to the solar option described above, this option would have no upfront capital costs but would cost approximately $40,000 additional over the next 10 years (assuming green tag prices do not increase) to address all of the system electricity usage. By comparison, the solar option described above would still be approximately $60,000 from breaking even after 10 years and would have addressed less than approximately 10% of the system's electricity usage during that 10-year operation period.

Table 4.1 Energy and Atmosphere Footprint Analysis

	Quantity	Unit	CO2 equiv (lbs)		
			emission factor (lbs/unit)	**total**	**% of Total**
Energy					
Electricity	140,000	kWh	1.15	161000	58%
Natural gas	4,000	ccf	12.2	48800	18%
Diesel	196	gallons	22	4312	2%
Gasoline	310	gallons	19	5890	2%
Energy subtotal				**220002**	**80%**
Materials and Chemicals					
Treatment chemicals	23,000	dollars	1	23000	8%
Materials subtotal				**23000**	**8%**
Waste Disposal					
Non-hazardous waste disposal	100	tons	25	2500	1%
Disposal subtotal				**2500**	**1%**
Other Services					
Chemical analysis (on-site and laboratory)	$30,000	dollars	1	30000	11%
Other services subtotal				**30000**	**11%**
Treatment Process Emissions					
Air stripper off-gas	no GHGs emitted				
Process emissions subtotal					
P&T System Total				**275502**	**100%**

Usage and Emission Factor Notes for Table 4-1.

Except where otherwise noted, information regarding emission factors was obtained from eGRID, EPA Climate Leaders Program, the National Renewable Energy Laboratory life-cycle inventory at www.nrel.gov/lci, or the EUROPA Reference Life-Cycle Database. Costs used in deriving emission factors are consistent with costs during late 2010. The emissions factors developed here are rough approximations based on simplifying assumptions. They are intended to provide only approximate environmental footprints to help understand the affects potential changes to the remedy may have on the footprint of the remedy.

Electricity

Quantity – 140,000 kWh, see report text for additional information

Emission Factor – Based on eGRID2007 for RFCE output emission rate for base-load using equivalency ratios of 21:1 methane to carbon dioxide and 310:1 nitrous oxide to carbon dioxide from http://www.epa.gov/solar/energy-resources/calculator.html

Diesel

Quantity – 196 gallons per year based on 0.023 gallons per ton-mile of transport in a single-unit truck, for 100 tons of waste per year transported 10 miles to local landfill and 15 tons of lime per year transported approximately 500 miles from source to site.

Emission Factor – 22 pounds of carbon dioxide per gallon of diesel (Climate Leaders)

Gasoline

Quantity – 310 gallons per year based on usage for treatment plant operator commute and travel for ground water sampling. For local treatment plant operator, assume 20 miles round trip in a passenger car (20 miles per gallon) for 260 trips per year. For ground water sampling, assume technicians travel once per event from Pittsburg, PA in a light duty truck (assume 10 miles per gallon). For two round trips, this is approximately 500 miles, which results in approximate usage of 50 gallons per year.

Emission Factor – 19 pounds of carbon dioxide per gallon of gasoline (Climate Leaders)

Materials & Chemicals

Quantity – $23,000 of chemical usage.

Emission Factor – 1 pound of carbon dioxide per dollar of materials/chemicals based on 10% of the cost of the materials resulting from the direct use of fossil fuels or electricity derived from fossil-fuels and approximately pounds of carbon dioxide per dollar spent on energy. This is equivalent to a blend of energy usage from electricity, diesel, and gasoline assuming approximately $0.10 per kWh , $2.80 for diesel, and $2.70 for gasoline.

Non-Hazardous Landfill Disposal

Quantity – 100 tons per year based (see text for more information)

Emission Factor – 25 pounds of carbon dioxide per ton, based on the carbon emissions from EUROPA file location: Inert waste disposal. Inert waste used so that methane and carbon dioxide from decomposing waste is not included.

References

Climate Leader GHG Inventory EPA-430--K-08-004, May 2008

EGRID 2007 v1.1

(EUROPA) European Reference Life Cycle Database (ELCD core database), version II compiled under contract on behalf of the European Commission - DG Joint Research Centre - Institute for Environment and Sustainability with technical and scientific support by JRC-IES from early 2008 to early 2009. (http://lca.jrc.ec.europa.eu/lcainfohub/datasetArea.vm)

National Renewable Energy Laboratory (NREL), Life-Cycle Inventory Database (www.nrel.gov/lci) maintained by the Alliance for Sustainable Energy, LLC.

Table 6-1. Cost Summary Table

Recommendation	Reason	Additional Capital Costs ($)	Estimated Change in Annual Costs ($/yr)	Estimated Change in Life-Cycle Costs $*	Discounted Estimated Change in Life-Cycle Costs $**
6.1.1 Further Characterize Extent Of Contamination	Effectiveness	$50,000	$0	$50,000	$50,000
6.1.2 Install Additional Points For Water Level Measurements	Effectiveness	$40,000	$4,000	$160,000	$118,000
6.1.3 Conduct A Shutdown And Restart Test Of The Extraction System	Effectiveness	$50,000	$0	$50,000	$50,000
6.1.4 Document the Findings from the Above Events, Use Findings For Capture Zone Analysis	Effectiveness	$15,000 to $45,000	$0	$15,000 to $45,000	$15,000 to $45,000
6.1.5 Automate Chemical Feeds or Provide Appropriate Interlocks to Discontinue Chemical Feeds if One or More Extraction Trenches Discontinue Operation	Effectiveness	$25,000 To $40,000	$0	$25,000 To $40,000	$25,000 to $40,000
6.1.6 If Off-Site Shallow Contamination Is Identified And Determined To Be Related To The Site, Conduct A Vapor Intrusion Evaluation	Effectiveness	Not estimated	Not estimated	Not estimated	Not estimated
6.2.1 Discontinue April Sampling Event	Cost-Effectiveness	$0	($30,000)	($900,000)	($588,000)
6.2.2 Discontinue Analysis for Dissolved Metals	Cost-Effectiveness	$0	($6,000)	($180,000)	($118,000)
6.2.3 Streamline Process Sampling	Cost-Effectiveness	Not quantified, but can help limit additions to operator labor			

Recommendation	Reason	Additional Capital Costs ($)	Estimated Change in Annual Costs ($/yr)	Estimated Change in Life-Cycle Costs $*	Discounted Estimated Change in Life-Cycle Costs $**
6.2.4 Revisit Data and Reporting Costs***	Cost Effectiveness	$0	($46,000)	($1,380,000)	($902,000)
6.2.5 Reduce or Eliminate Lime Conditioning of Sludge	Cost Effectiveness	$0	($10,000)	($300,000)	($196,000)
6.3.1 Cleanup Treatment Plant	Technical Improvement	$0	$0	$0	$0
6.3.2 Considerations Regarding Treatment Plant Modifications, If Necessary	Technical Improvement	$0	$0	$0	$0
6.4.1 Determine a Path Forward	Site Closure	$50,000	$0	$50,000	$50,000
6.5.1 Revised Approach to Metals Removal	Sustainability	$100,000	($10,000)	($200,000)	($96,000)
6.5.2 Considerations for Renewable Energy	Sustainability	Cost Analysis Provided for Solar Energy and Renewable Energy Certificates			

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 3%
*** presented cost savings is the current reporting cost of $100,000 minus the suggested cost of $39,000 minus the $15,000 that was already counted for recommendation 6.2.1

Table 6-2. Sustainability Summary Table

Recommendation	Reason	Effects on Sustainability
6.1.1 Further Characterize Extent Of Contamination	Effectiveness	Additional minor footprint associated with collecting and analyzing samples. Information is critical to evaluating remedy protectiveness
6.1.2 Install Additional Points For Water Level Measurements	Effectiveness	Additional minor footprint associated with installing wells. Information is critical to evaluating remedy protectiveness
6.1.3 Conduct A Shutdown And Restart Test Of The Extraction System	Effectiveness	A small decrease in the footprint is expected while the P&T system is shut down.
6.1.4 Document the Findings from the Above Events, Use Findings For Capture Zone Analysis	Effectiveness	None beyond the improvement evaluating remedy protectiveness
6.1.5 Automate Chemical Feeds or Provide Appropriate Interlocks to Discontinue Chemical Feeds if One or More Extraction Trenches Discontinue Operation	Effectiveness	Should ultimately help protect the water resource of Marshall Run
6.1.6 If Off-Site Shallow Contamination Is Identified And Determined To Be Related To The Site, Conduct A Vapor Intrusion Evaluation	Effectiveness	Potential additional minor footprint associated with collecting and analyzing samples if study is conducted. Information is critical to evaluating remedy protectiveness
6.2.1 Discontinue April Sampling Event	Cost-Effectiveness	Potential decrease in remedy footprint from reduced field mobilization and reduced laboratory analysis
6.2.2 Discontinue Analysis for Dissolved Metals	Cost-Effectiveness	Potential decrease in remedy footprint from reduced laboratory analysis
6.2.3 Streamline Process Sampling	Cost-Effectiveness	Potential decrease in remedy footprint from materials usage.
6.2.4 Revisit Data and Reporting Costs	Cost Effectiveness	None.

Recommendation	Reason	Effects on Sustainability
6.2.5 Reduce or Eliminate Lime Conditioning of Sludge	Cost Effectiveness	Potential substantial decrease in remedy footprint from reduced materials usage and reduced waste generation
6.3.1 Cleanup Treatment Plant	Technical Improvement	None.
6.3.2 Considerations Regarding Treatment Plant Modifications, If Necessary	Technical Improvement	None.
6.4.1 Determine a Path Forward	Site Closure	The path forward could substantially alter the remedy footprint if a different remedial technology is used or if the extraction rate for the P&T system is significantly altered.
6.5.1 Revised Approach to Metals Removal	Sustainability	Potential decrease in remedy footprint from reduced materials usage and reduced waste generation.
6.5.2 Considerations for Renewable Energy	Sustainability	Cost Analysis Provided for Solar Energy and Renewable Energy Certificates

FIGURES

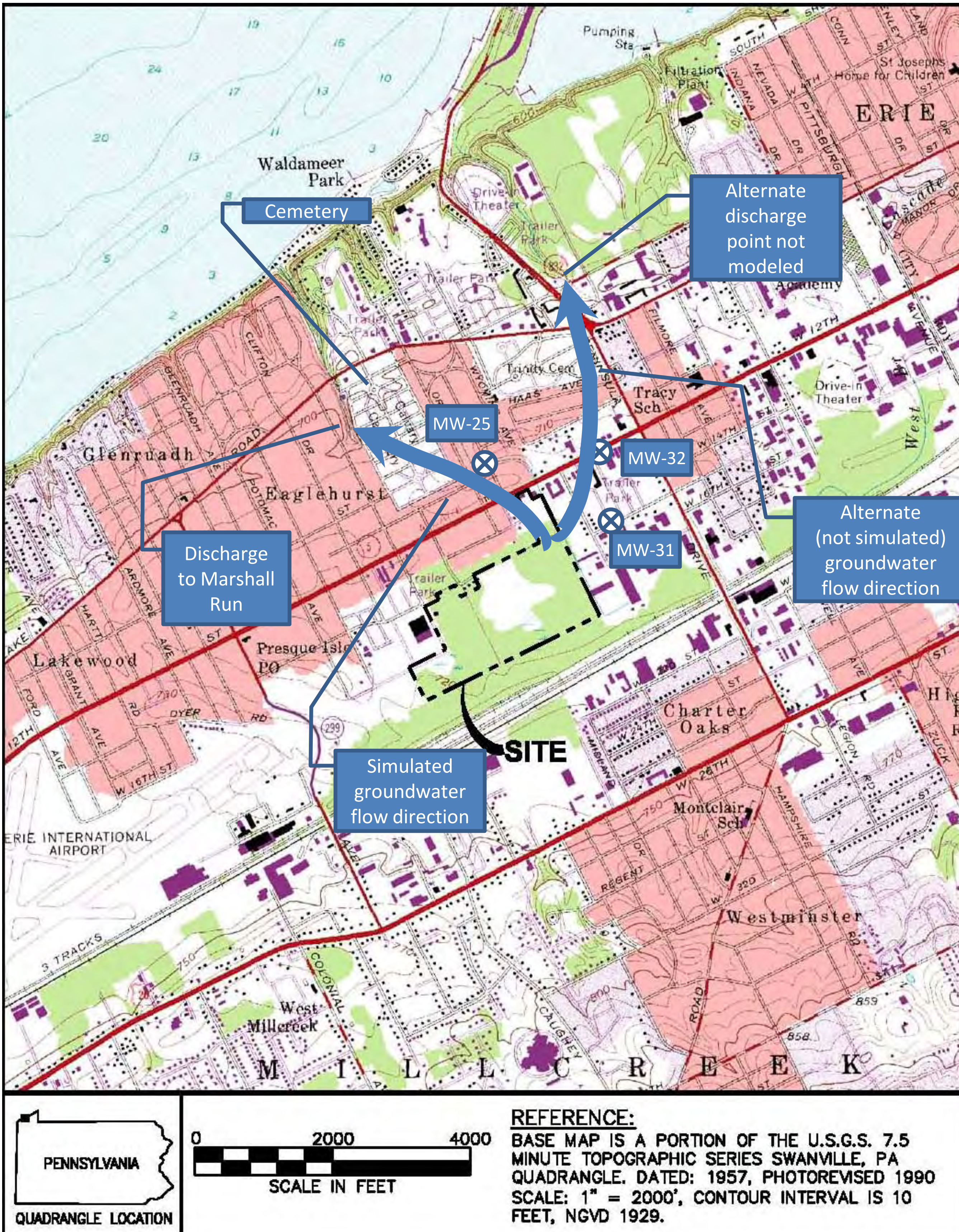


Figure 1. Alternate groundwater flow paths.

Notes: Base map taken from Figure 4 of the 2008 Annual Groundwater Monitoring Report, URS.

⊕ Shallow location

⊗ Deep location with two or more sample intervals deeper than MW-42A

○ Deep location with three or more sample intervals equal to and/or deeper than 30 feet bgs.

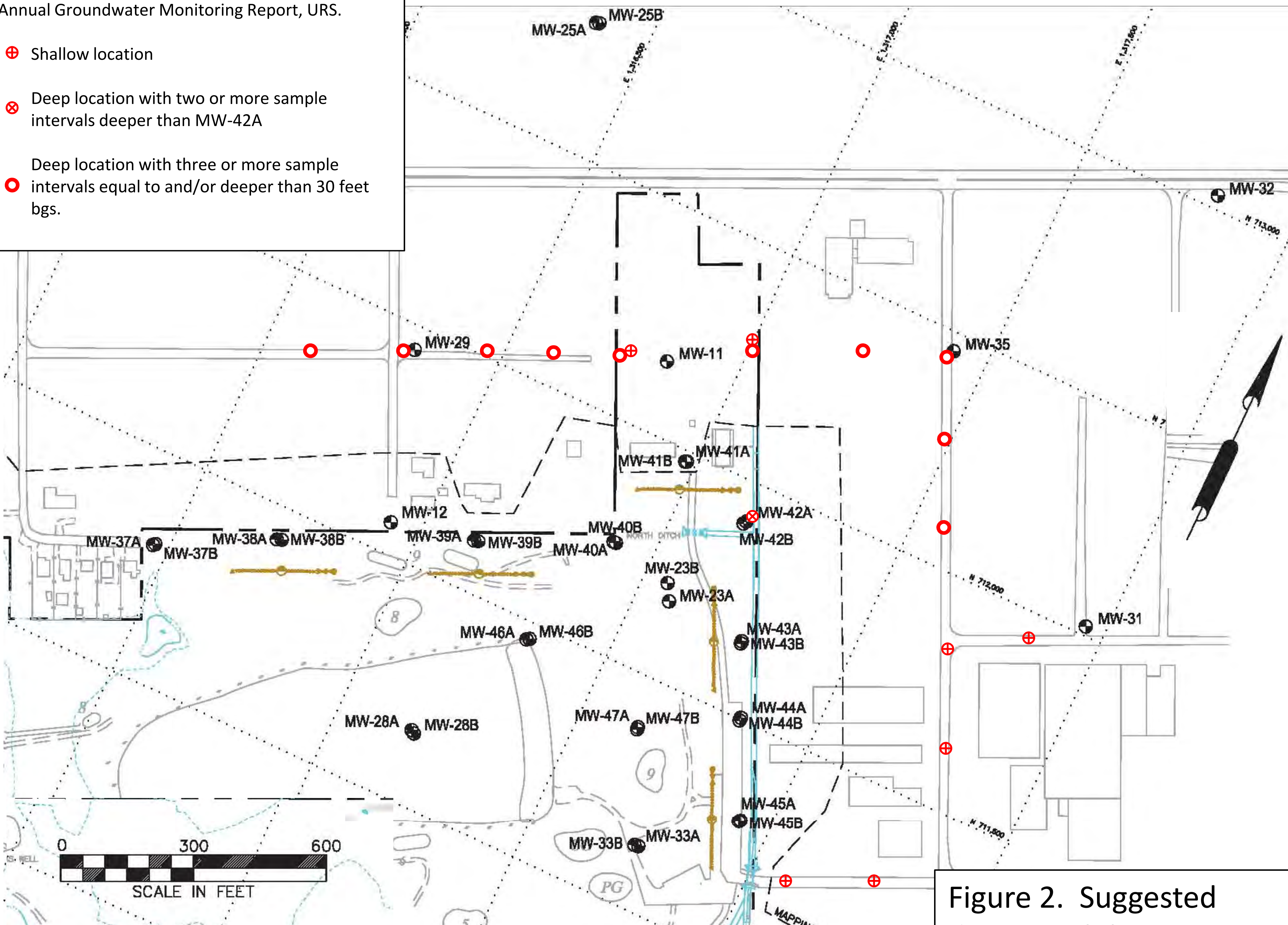
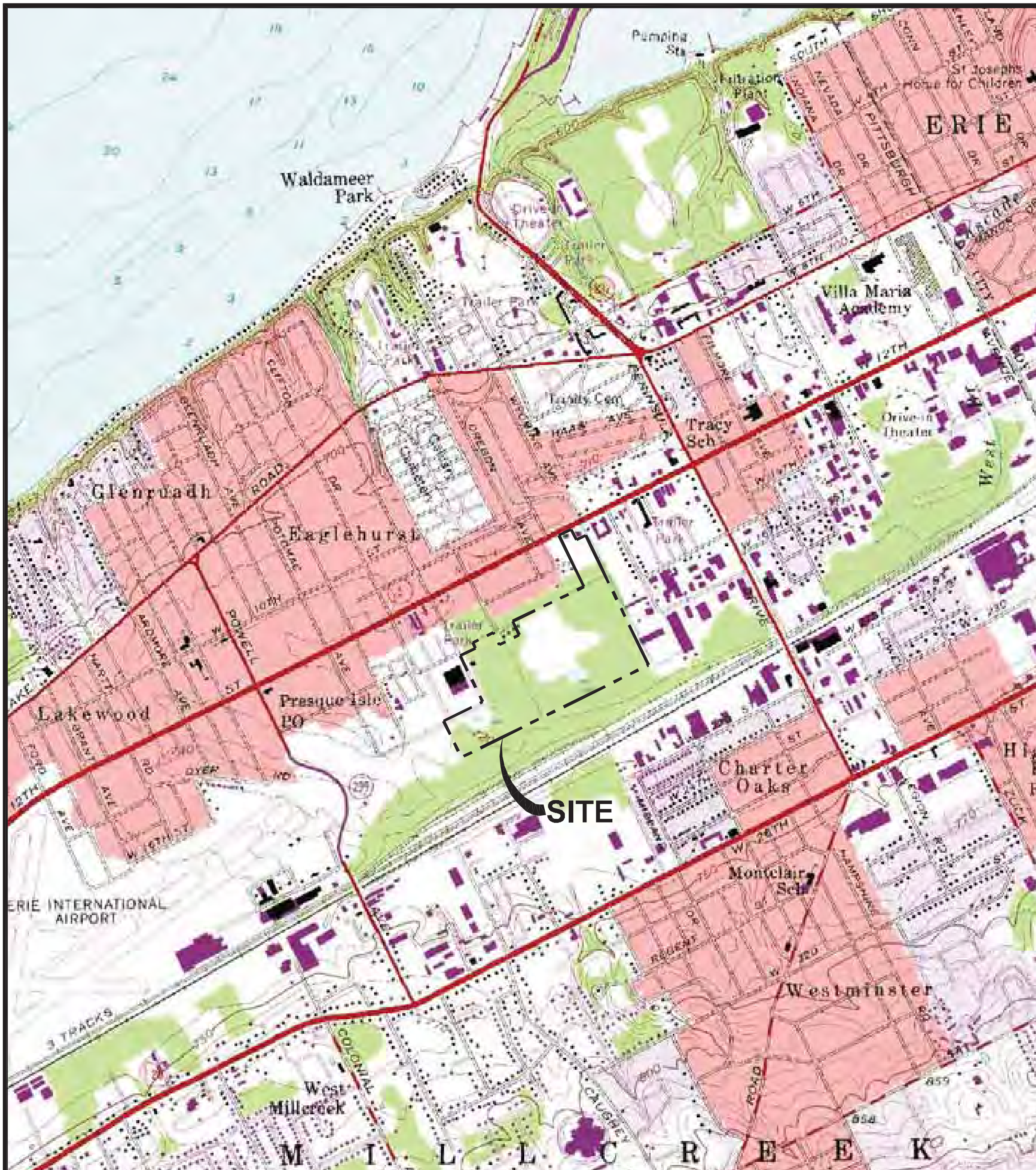


Figure 2. Suggested direct-push locations

ATTACHMENT A



REFERENCE:
BASE MAP IS A PORTION OF THE U.S.G.S. 7.5 MINUTE TOPOGRAPHIC SERIES SWANVILLE, PA QUADRANGLE. DATED: 1957, PHOTOREVISED 1990 SCALE: 1" = 2000', CONTOUR INTERVAL IS 10 FEET, NGVD 1929.

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PITTSBURGH, PENNSYLVANIA 15205

2008 GROUNDWATER MONITORING REPORT
SITE LOCATION MAP

MILLCREEK DUMP NPL SITE — ERIE, PA

CLIENT: PA DEPT. OF ENVIRONMENTAL PROTECTION	JOB NUMBER: 41785924
SCALE: AS SHOWN	FIGURE NUMBER 1	REV 0

00 32 10 66 00 99 KK GG

BASE MAP REFERENCE:

BASE MAP PLANIMETRICS (PROPERTY LINE AND TRENCHES) ARE TAKEN FROM D'APPOLONIA DRAWING SHEET C-4, REV 6, "AS-BUILT" FINAL GRADE AND WETLAND MITIGATION/ BORROW AREA PLAN, PA STATE PLANE NORTH NAD83. MONITORING WELLS WERE LOCATED USING M. BAKER GMS COORDINATE DATA. COORDINATES WERE IN PA STATE PLANE NORTH NAD27, AND TRANSLATED TO PA STATE PLANE NORTH NAD83.

ORTHOPHOTO REFERENCE:

BASE IMAGE IS A COMPOSITE OF PORTIONS OF 71001310PAN.TIF AND 72001310PAN.TIF ORTHOPHOTOS, PROVIDED BY THE PAMAP PROGRAM 2005 ORTHOPHOTOS OF PENNSYLVANIA, PADCNR. COORDINATE SYSTEM IS PA STATE PLANE NORTH WITH A NAD83 DATUM.

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PITTSBURGH, PENNSYLVANIA

2008 ANNUAL GROUNDWATER MONITORING REPORT SITE AERIAL PHOTO - 300 SCALE			
MILLCREEK DUMP NPL SITE		ERIE, PA	
CLIENT: PA DEPT. OF ENVIRONMENTAL PROTECTION		JOB NUMBER:	41785924
SCALE: AS SHOWN	FIGURE NUMBER 3		REV 0

FILE: \PADEP\MILLCREEK\GW-MON\PLAN-EXPANDED

BASE MAP REFERENCE:
BASE MAP PLANIMETRICS WITHIN THE MAPPING LIMIT BOUNDARY ARE TAKEN FROM D'APPOLONIA DRAWING SHEET C-4, REV 6, "AS-BUILT" FINAL GRADE AND WETLAND MITIGATION/ BORROW AREA PLAN, PA STATE PLANE NORTH NAD83. PLANIMETRICS OUTSIDE THE MAPPING LIMIT BOUNDARY WERE TRACED FROM THE ORTHOPHOTO REFERENCED BELOW. MONITORING WELLS WERE LOCATED USING M. BAKER GMS COORDINATE DATA. COORDINATES WERE IN PA STATE PLANE NORTH NAD27, AND TRANSLATED TO PA STATE PLANE NORTH NAD83.

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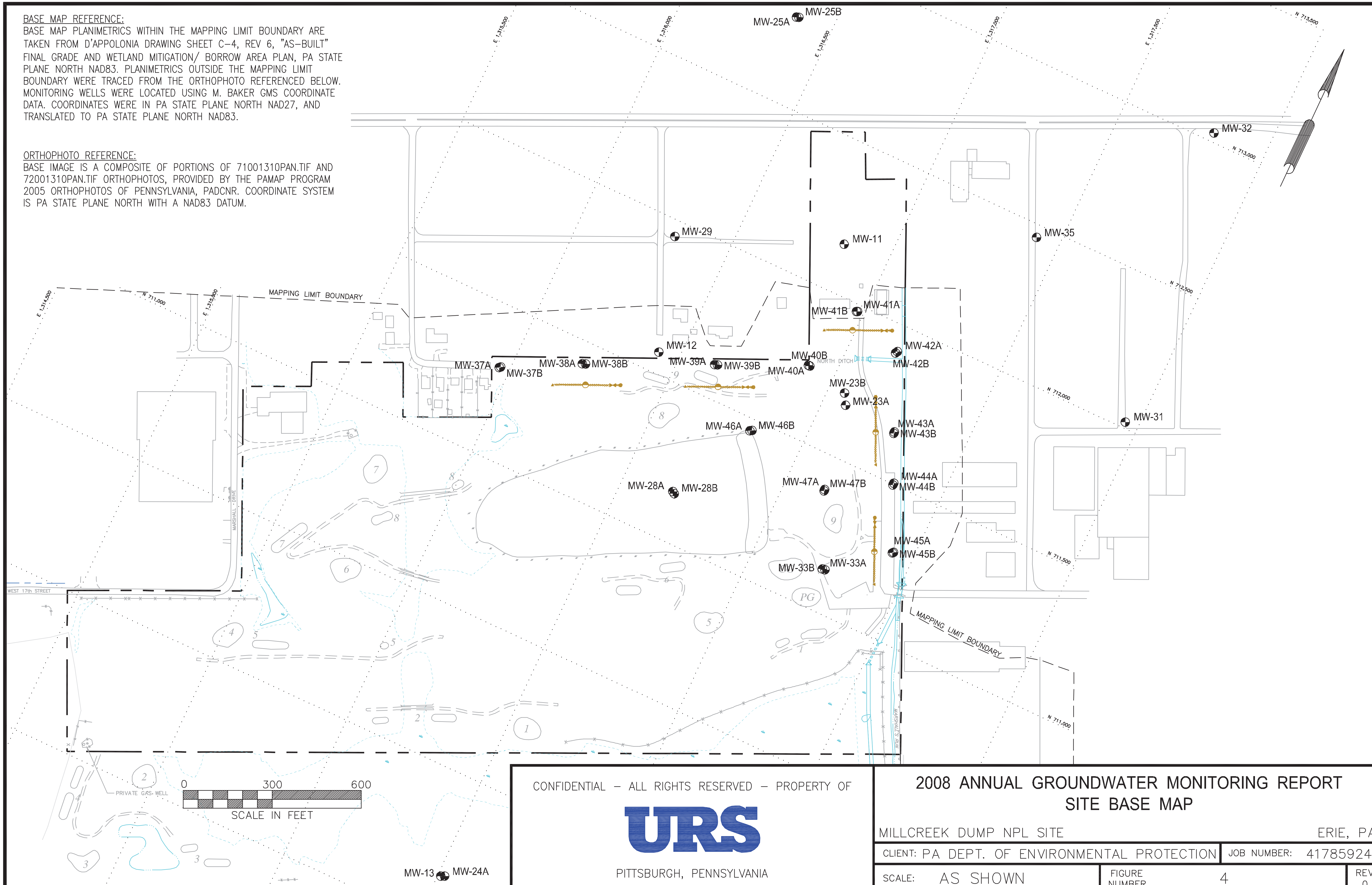

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PITTSBURGH, PENNSYLVANIA

2008 ANNUAL GROUNDWATER MONITORING REPORT
SITE BASE MAP

MILLCREEK DUMP NPL SITE	ERIE, PA
CLIENT: PA DEPT. OF ENVIRONMENTAL PROTECTION	JOB NUMBER: 41785924
SCALE: AS SHOWN	FIGURE NUMBER 4
REV 0	

BASE MAP REFERENCE:
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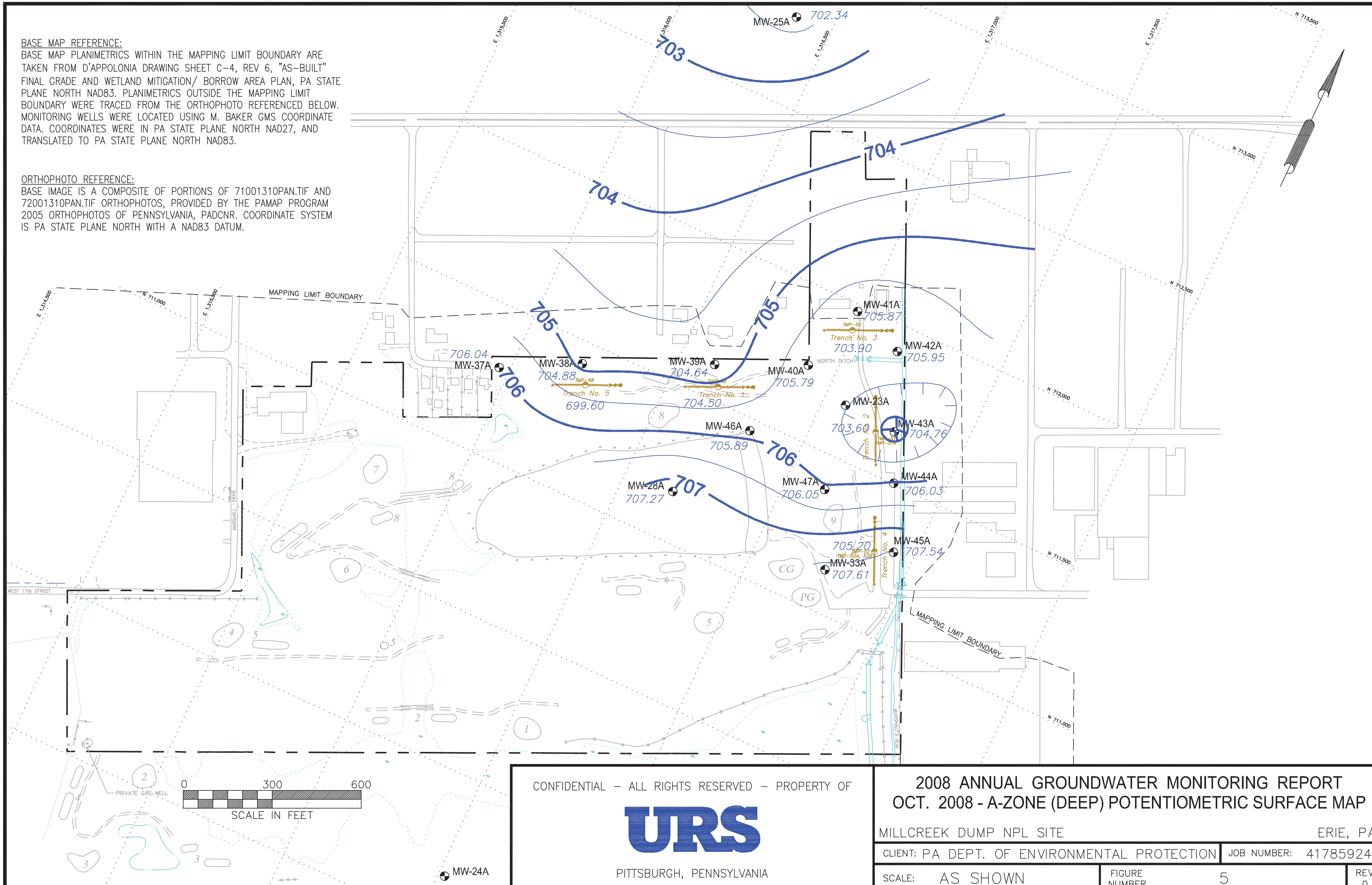

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PITTSBURGH, PENNSYLVANIA

2008 ANNUAL GROUNDWATER MONITORING REPORT
OCT. 2008 - A-ZONE (DEEP) POTENTIOMETRIC SURFACE MAP

MILLCREEK DUMP NPL SITE	ERIE, PA
CLIENT: PA DEPT. OF ENVIRONMENTAL PROTECTION	JOB NUMBER: 41785924
SCALE: AS SHOWN	FIGURE NUMBER 5
REV 0	

FILE: \PADEP\MILLCREEK\GW-MON\PLAN-EXPANDED

BASE MAP REFERENCE:
BASE MAP PLANIMETRICS WITHIN THE MAPPING LIMIT BOUNDARY ARE TAKEN FROM D'APPOLONIA DRAWING SHEET C-4, REV 6, "AS-BUILT" FINAL GRADE AND WETLAND MITIGATION/ BORROW AREA PLAN, PA STATE PLANE NORTH NAD83. PLANIMETRICS OUTSIDE THE MAPPING LIMIT BOUNDARY WERE TRACED FROM THE ORTHOPHOTO REFERENCED BELOW. MONITORING WELLS WERE LOCATED USING M. BAKER GMS COORDINATE DATA. COORDINATES WERE IN PA STATE PLANE NORTH NAD27, AND TRANSLATED TO PA STATE PLANE NORTH NAD83.

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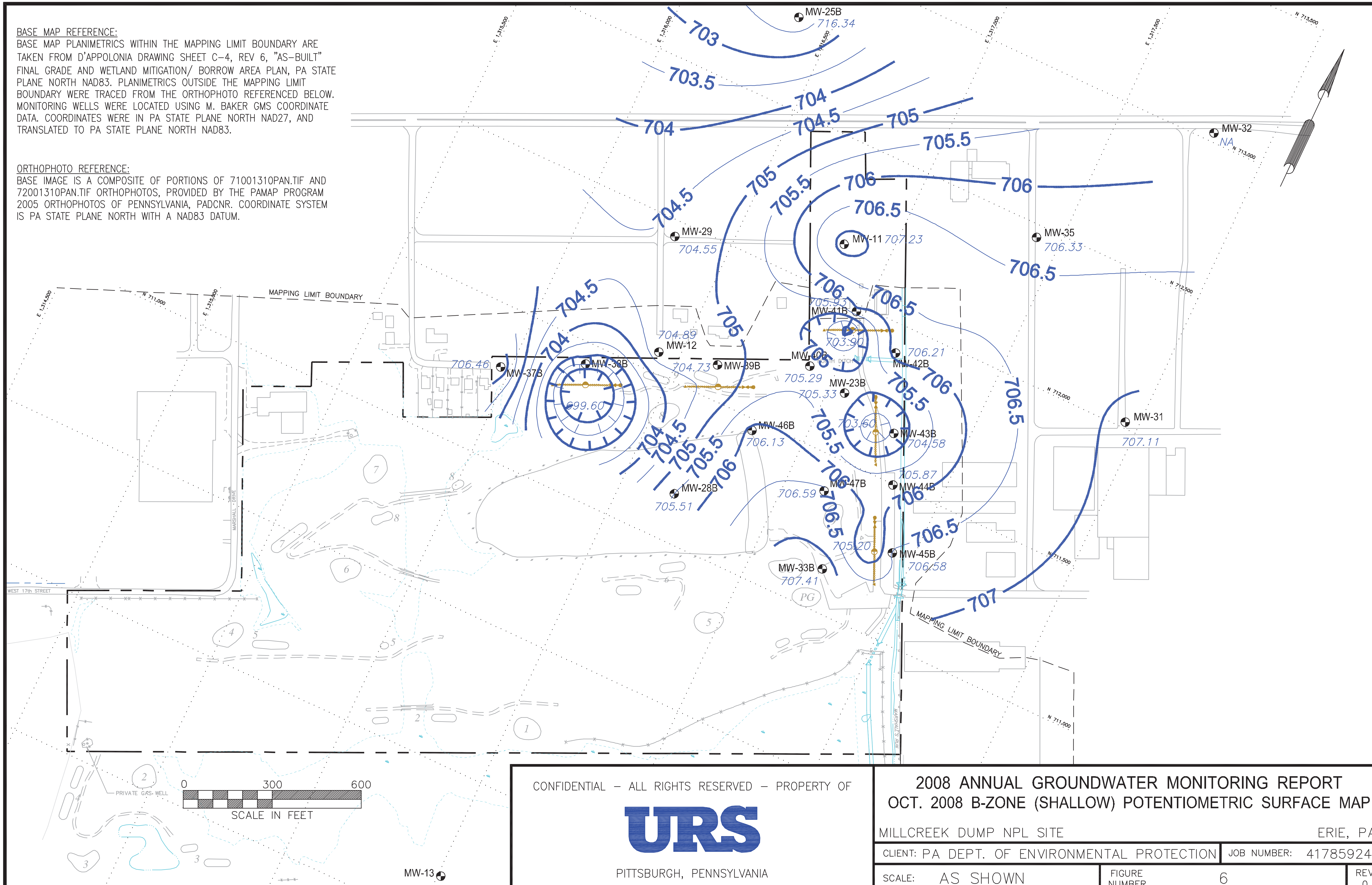

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SCALE IN FEET

FILE: \PADEP\MILLCREEK\GW-MON\PLAN-EXPANDED

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PITTSBURGH, PENNSYLVANIA

2008 ANNUAL GROUNDWATER MONITORING REPORT
OCT. 2008 B-ZONE (SHALLOW) POTENTIOMETRIC SURFACE MAP

MILLCREEK DUMP NPL SITE	ERIE, PA
CLIENT: PA DEPT. OF ENVIRONMENTAL PROTECTION	JOB NUMBER: 41785924
SCALE: AS SHOWN	FIGURE NUMBER 6 — REV 0

BASE MAP REFERENCE:
BASE MAP PLANIMETRICS WITHIN THE MAPPING LIMIT BOUNDARY ARE TAKEN FROM D'APPOLONIA DRAWING SHEET C-4, REV 6, "AS-BUILT" FINAL GRADE AND WETLAND MITIGATION/ BORROW AREA PLAN, PA STATE PLANE NORTH NAD83. PLANIMETRICS OUTSIDE THE MAPPING LIMIT BOUNDARY WERE TRACED FROM THE ORTHOPHOTO REFERENCED BELOW. MONITORING WELLS WERE LOCATED USING M. BAKER GMS COORDINATE DATA. COORDINATES WERE IN PA STATE PLANE NORTH NAD27, AND TRANSLATED TO PA STATE PLANE NORTH NAD83.

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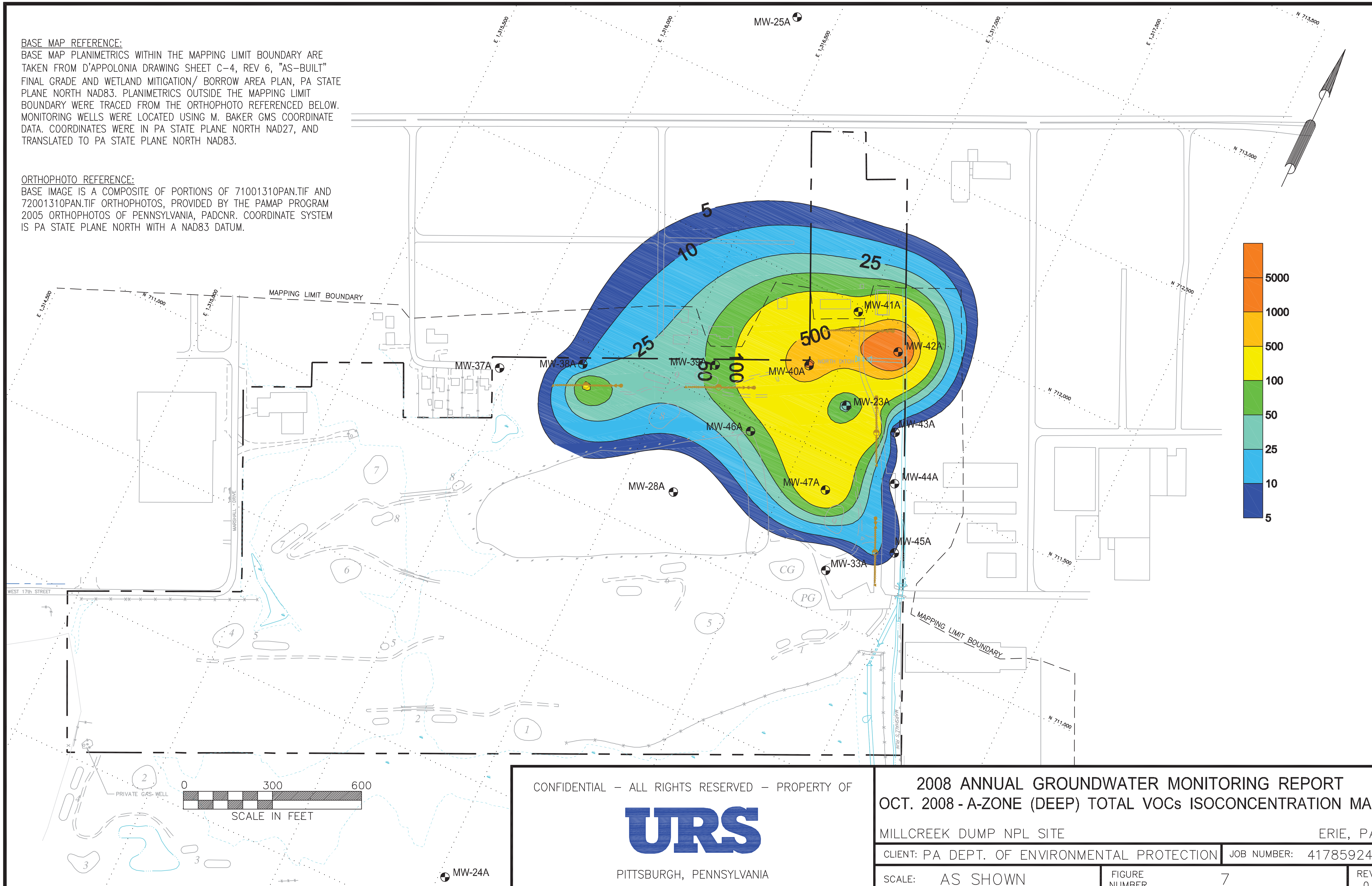

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PITTSBURGH, PENNSYLVANIA

2008 ANNUAL GROUNDWATER MONITORING REPORT
OCT. 2008 - A-ZONE (DEEP) TOTAL VOCs ISOCONCENTRATION MAP

MILLCREEK DUMP NPL SITE — ERIE, PA

CLIENT: PA DEPT. OF ENVIRONMENTAL PROTECTION — JOB NUMBER: 41785924

SCALE: AS SHOWN — FIGURE NUMBER 7 — REV 0

BASE MAP REFERENCE:
BASE MAP PLANIMETRICS WITHIN THE MAPPING LIMIT BOUNDARY ARE TAKEN FROM D'APPOLONIA DRAWING SHEET C-4, REV 6, "AS-BUILT" FINAL GRADE AND WETLAND MITIGATION/ BORROW AREA PLAN, PA STATE PLANE NORTH NAD83. PLANIMETRICS OUTSIDE THE MAPPING LIMIT BOUNDARY WERE TRACED FROM THE ORTHOPHOTO REFERENCED BELOW. MONITORING WELLS WERE LOCATED USING M. BAKER GMS COORDINATE DATA. COORDINATES WERE IN PA STATE PLANE NORTH NAD27, AND TRANSLATED TO PA STATE PLANE NORTH NAD83.

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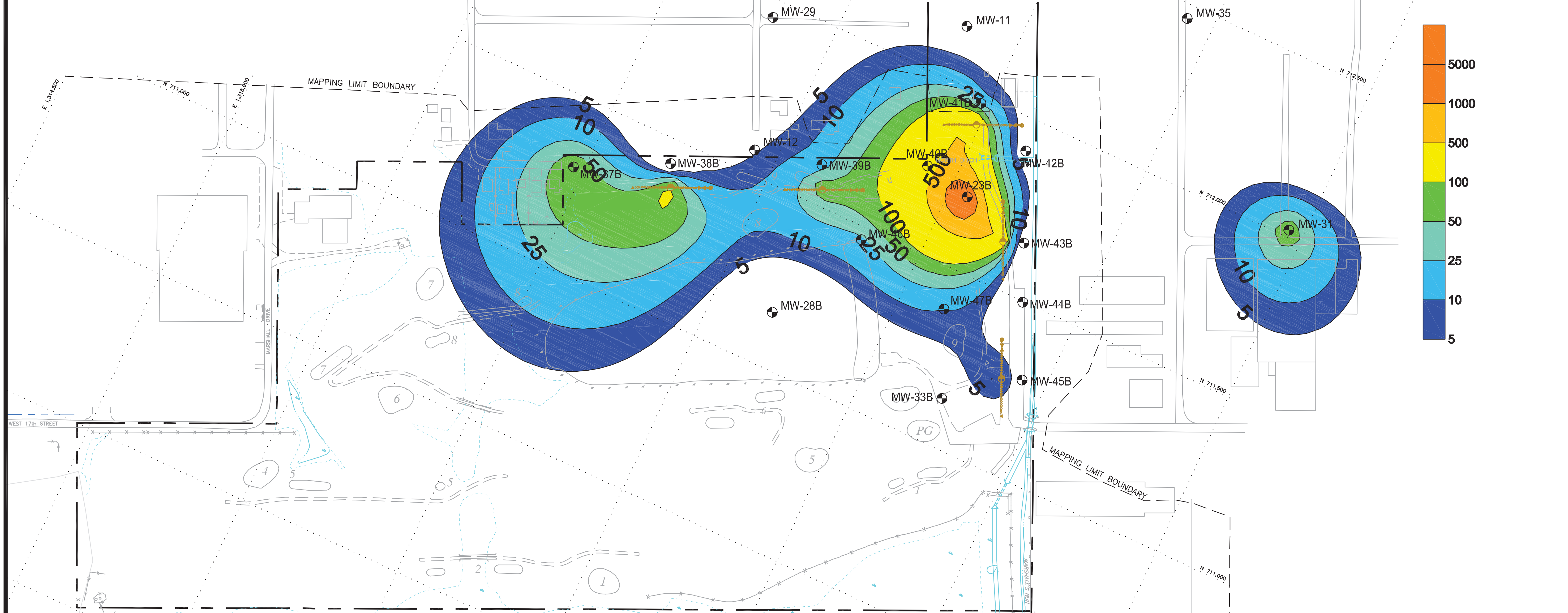

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2008 ANNUAL GROUNDWATER MONITORING REPORT
OCT. 2008 B-ZONE (SHALLOW) TOTAL VOCs ISOCONCENTRATION MAP

MILLCREEK DUMP NPL SITE — ERIE, PA

CLIENT: PA DEPT. OF ENVIRONMENTAL PROTECTION — JOB NUMBER: 41785924

SCALE: AS SHOWN — FIGURE NUMBER 8 — REV 0