

# **Final Report**

## **Pilot Region-Based Optimization Program for Fund-Lead Sites in EPA Region 3**

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### **Site Optimization Tracker: Havertown PCP Site Havertown, Pennsylvania**

**EPA Region III**



Solid Waste and  
Emergency Response  
(5102P)

EPA 542-R-06-006j  
December 2006  
[www.epa.gov](http://www.epa.gov)

# **Pilot Region-Based Optimization Program for Fund-Lead Sites in EPA Region 3**

## **Site Optimization Tracker: Havertown PCP Site Havertown, Pennsylvania**

**EPA Region III**

# **Site Optimization Tracker:**

## **Havertown PCP Site Havertown, Pennsylvania**

**EPA Region III**

December 30, 2005

**SECTION 1:**

**CURRENT SITE INFORMATION FORM**

Date: 12/30/05 Filled Out By: GeoTrans, Inc.

<b>A. Site Location, Contact Information, and Site Status</b>		
1. Site name <b>Havertown PCP Site</b>	2. Site Location (city and State) <b>Havertown, Pennsylvania</b>	3. EPA Region <b>3</b>
4a. EPA RPM <b>Jill Lowe</b>	5a. State Contact	
4b. EPA RPM Phone Number <b>215-814-3123</b>	5b. State Contact Phone Number	
4c. EPA RPM Email Address <b>lowe.jill@epa.gov</b>	5c. State Contact Email Address	
5. Is the ground water remedy an interim remedy or a final remedy? Interim <input checked="" type="checkbox"/> Final <input type="checkbox"/>		
6. Is the site EPA lead or State-lead with Fund money? EPA <input checked="" type="checkbox"/> State <input type="checkbox"/>		
<b>B. General Site Information</b>		
1a. Date of Original ROD for Ground Water Remedy <b>9/30/91 (interim remedy)</b>	1b. Dates of Other Ground Water Decision Documents (e.g., ESD, ROD Amendment) <b>NA</b>	
2a. Date of O&F <b>Projected for December 2008</b>	2b. Date for transfer to State <b>Projected for 2018</b>	
3. What is the primary goal of the P&T system (select one)?	4. Check those classes of contaminants that are contaminants of concern at the site.	
<input type="checkbox"/> Contaminant plume containment <input type="checkbox"/> Aquifer restoration <input checked="" type="checkbox"/> Containment and restoration <input type="checkbox"/> Well-head treatment	<input checked="" type="checkbox"/> VOCs (e.g., TCE, benzene, etc.) <input checked="" type="checkbox"/> SVOCs (e.g., PAHs, PCP, etc.) <input type="checkbox"/> metals (e.g., arsenic, chromium, etc.) <input type="checkbox"/> other	
5. Has NAPL or evidence of NAPL been observed at the site? Yes <input checked="" type="checkbox"/> No <input type="checkbox"/>		
6. What is the approximate total pumping rate?	<b>~25 gpm</b>	
7. How many active extraction wells (or trenches) are there? <b>1 trench</b>	8. How many monitoring wells are regularly sampled? <b>~70</b>	
9. How many samples are collected from monitoring wells or piezometers each year? (e.g., 40 if 10 wells are sampled quarterly) <b>75-80</b>	10. How many process monitoring samples (e.g., extraction wells, influent, effluent, etc.) are collected and analyzed each year? (e.g., 24 if influent and effluent are sampled monthly) <b>68</b>	
11. What above-ground treatment processes are used (check all that apply)?		
<input type="checkbox"/> Air stripping <input checked="" type="checkbox"/> Carbon adsorption <input checked="" type="checkbox"/> Filtration <input type="checkbox"/> Off-gas treatment <input type="checkbox"/> Ion exchange	<input checked="" type="checkbox"/> Metals precipitation <input type="checkbox"/> Biological treatment <input checked="" type="checkbox"/> UV/Oxidation <input type="checkbox"/> Reverse osmosis <input type="checkbox"/> Other	
12. What is the approximate percentage of system downtime per year? 10% <input type="checkbox"/> 10 - 20% <input checked="" type="checkbox"/> >20% <input type="checkbox"/>		

<b>C. Site Costs</b>			
<b>1. Annual O&amp;M costs</b>			
<b>O&amp;M Category</b>	<b>Actual<sup>1</sup> Annual Costs for FY04</b>	<b>Estimated Annual Costs for FY05<sup>2</sup></b>	<b>Estimated Annual Costs for FY06<sup>3</sup></b>
Labor: project management, reporting, technical support	<b>\$57,000</b>	<b>\$60,000</b>	<b>\$60,000</b>
Labor: system operation	<b>\$170,000</b>	<b>\$175,000</b>	<b>\$175,000</b>
Labor: ground water sampling	<b>\$82,000</b>	<b>\$82,000</b>	<b>\$82,000</b>
Utilities: electricity	<b>\$68,000</b>	<b>\$50,000*</b>	<b>\$50,000*</b>
Utilities: other	<b>\$12,000</b>	<b>\$12,000</b>	<b>\$12,000</b>
Consumables (GAC, chemicals, etc.)	<b>\$87,000</b>	<b>\$75,000**</b>	<b>\$50,000**</b>
Discharge or disposal costs	<b>\$56,000</b>	<b>\$58,000**</b>	<b>\$29,000**</b>
Analytical costs	<b>\$40,000***</b>	<b>\$40,000***</b>	<b>\$40,000***</b>
Other (parts, routine maintenance, etc.)	<b>\$60,300</b>	<b>\$63,000</b>	<b>\$63,000</b>
<b>O&amp;M Total</b>	<b>\$632,300</b>	<b>\$615,000</b>	<b>\$561,000</b>
<i>The O&amp;M total should be equal to the total O&amp;M costs for the specified fiscal years, including oversight from USACE or another contractor. For costs that do not fit in one of the above cost categories, include them in the "Other" category. If it is not possible to break out the costs into the above categories, use the categories as best as possible and provide notes in the following box.</i>			
<b>2. Non-routine or other costs</b>	<b>\$30,000</b>	<b>\$63,000</b>	<b>\$63,000</b>
<i>Additional costs beyond routine O&amp;M for the specified fiscal years should be included in the above spaces. Such costs might be associated with additional investigations, non-routine maintenance, additional extraction wells, or other operable units. The total costs billed to the site for the specified fiscal years should be equal to the O&amp;M total plus the costs entered in item 2.</i>			
<b>Notes on costs:</b>			
<ol style="list-style-type: none"> <li>Costs, with the exception of the analytical costs, were provided by the RPM.</li> <li>FY05 and FY06 costs were estimated by the ROET based on the RPM projections and discussion during the optimization follow-up meetings.</li> </ol>			
Ground water sampling labor also includes shipment of samples, sampling supplies, rental of equipment, and travel expenses.			
Utilities Others: Includes mowing and snow removal			
Disposal Costs: Includes sludge disposal only			
Non-routine costs are for plant improvement and do not reflect the costs of additional investigation or the installation/testing of new extraction wells.			
* Decrease in electricity costs represents the use of one UV/oxidation unit instead of two.			
** Decreases in consumables and disposal are associated using one UV/oxidation unit instead of two and decreasing the amount of ferric sulfate (which decreases costs and the amount of sludge produced).			
*** Analytical costs were estimated by the ROET based on the sampling program. The analytical costs are not incurred by the EPA site team because the samples are analyzed by the CLP program. However, analytical costs similar to those estimated by the ROET, will likely be incurred by the State when the site is transferred to the State after LTRA.			

## D. Five-Year Review

1. Date of the Most Recent Five-Year Review

2. Protectiveness Statement from the Most Recent Five-Year Review

Protective

Not Protective

Protective in the short-term

Determination of Protectiveness Deferred

3. Please summarize the primary recommendations in the space below

## E. Other Information

If there is other information about the site that should be provided please indicate that information in the space below. Please consider enforcement activity, community perception, technical problems to be addressed, and/or areas where a third-party perspective may be valuable.

The site team continues to investigate the site and determine an appropriate final remedy while continuing to operate and improve the treatment plant associated with the operating interim P&T system.

The contaminant plume was delineated in 2005, and current efforts are focused on determining an appropriate extraction system for a final remedy.

## **SECTION 2:**

### **FOLLOW-UP HISTORY AND SUMMARIES**

Note: Follow-up summaries are provided in reverse chronological order and include updated and/or new recommendations.



## FOLLOW-UP HISTORY

<b>Date of Original Optimization Evaluation</b>	August 5, 2003 (Evaluation meeting) March 4, 2004 (Final Report)
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	<u>Meeting Date</u>	<u>Report Date</u>	<u>Item</u>
<input checked="" type="checkbox"/>	December 16, 2004	March 14, 2005	Follow-Up #1 (conducted as part of pilot project)
<input checked="" type="checkbox"/>	October 18, 2005	December 30, 2005	Follow-Up #2 (conducted as part of pilot project)
<input type="checkbox"/>			Follow-Up #3
<input type="checkbox"/>			Follow-Up #4
<input type="checkbox"/>			Follow-Up #5
<input type="checkbox"/>			Follow-Up #6
<input type="checkbox"/>			Follow-Up #7
<input type="checkbox"/>			Follow-Up #8

“x” in box indicates the item has been completed

## SUMMARY OF FOLLOW-UP #2

<b>Site or System Name</b>	Havertown PCP Site
<b>Date of This Follow-Up Summary</b>	December 30, 2005
<b>Date of Follow-Up Meeting or Call (Indicate if Meeting or Call)</b>	October 18, 2005 – Meeting

### ROET MEMBERS CONDUCTING THE FOLLOW-UP EVALUATION:

<b>Name</b>	<b>Affiliation</b>	<b>Phone</b>	<b>Email</b>
Norm Kulujian	U.S. EPA Region 3	215-814-3130	<a href="mailto:kulujian.norm@epa.gov">kulujian.norm@epa.gov</a>
Kathy Davies	U.S. EPA Region 3	215-814-3315	<a href="mailto:davies.kathy@epa.gov">davies.kathy@epa.gov</a>
Peter Ludzia	U.S. EPA Region 3	215-814-3224	<a href="mailto:ludzia.peter@epa.gov">ludzia.peter@epa.gov</a>
Eric Johnson	U.S. EPA Region 3	215-814-3313	<a href="mailto:johnson.eric@epa.gov">johnson.eric@epa.gov</a>
Peter Rich	GeoTrans, Inc.	410-990-4607	<a href="mailto:prich@geotransinc.com">prich@geotransinc.com</a>
Rob Greenwald	GeoTrans, Inc.	732-409-0344	<a href="mailto:rgreenwald@geotransinc.com">rgreenwald@geotransinc.com</a>
Doug Sutton	GeoTrans, Inc.	732-409-0344	<a href="mailto:dsutton@geotransinc.com">dsutton@geotransinc.com</a>
Kathy Yager	U.S. EPA OSRTI	617-918-8362	<a href="mailto:yager.kathleen@epa.gov">yager.kathleen@epa.gov</a>
Chuck Sands	U.S. EPA OSRTI	703-603-8857	<a href="mailto:sands.charles@epamail.epa.gov">sands.charles@epamail.epa.gov</a>

### SITE TEAM MEMBERS (INCLUDING CONTRACTORS) INTERVIEWED

<b>Name</b>	<b>Affiliation</b>	<b>Phone</b>	<b>Email</b>
Jill Lowe	U.S. EPA Region 3 (RPM)	215-814-3123	<a href="mailto:lowe.jill@epa.gov">lowe.jill@epa.gov</a>
Mindi Snoparsky	U.S. EPA Region 3 (Hydro)	215-814-3316	<a href="mailto:Snoparsky.mindi@epa.gov">Snoparsky.mindi@epa.gov</a>
Harish Mital (by phone)	Tetra Tech (contractor)	302-738-7551	<a href="mailto:harish.mital@tetrattech.com">harish.mital@tetrattech.com</a>

**IMPLEMENTATION STATUS OF ALL RECOMMENDATIONS UNDER CONSIDERATION BUT NOT PREVIOUSLY IMPLEMENTED**

<b>Recommendation</b>	<b>E-6.1.1 Properly Seal Abandoned 12-Inch Sewer Line and Remediate Surface Soils Near the Seep</b>		
<b>Recommendation Reason</b>	Effectiveness	<b>Implementation Status</b>	Alternative Implemented
<b>Comments:</b> The site team has plugged the entire abandoned sewer line and has conducted an investigation of the Residential Open Space (ROS) area near the seep, including 15 borings with shallow and deep soil samples plus ground water samples. The site team noted that concentrations were not high enough to warrant removal because they are more than 8 feet below ground surface. Ground water contamination associated with this area appears to have migrated northward toward the original plume.			
<b>Recommendation</b>	<b>E-6.1.2 Improve Plume Delineation to the South and Vertically</b>		
<b>Recommendation Reason</b>	Effectiveness	<b>Implementation Status</b>	Implemented
<b>Comments:</b> The site team has installed additional wells since the last follow-up meeting, completing the horizontal and vertical delineation of the plume.			
<b>Recommendation</b>	<b>E-6.1.3 Evaluate Plume Capture Once Plume is Delineated</b>		
<b>Recommendation Reason</b>	Effectiveness	<b>Implementation Status</b>	Substantial Progress
<b>Comments:</b> The site team has completed delineation of the plume and can now evaluate capture. The site team developed a ground water model to evaluate capture, but in technical assistance provided as a result of the previous follow-up meeting, the ROET determined that the model was not calibrated correctly and is not appropriate for evaluating capture at this stage. The site team will recalibrate the model using data from pump tests, including a pump test on a new extraction well in the source area that will be labeled RW-5.			
<b>Recommendation</b>	<b>E-6.2.2 Evaluate Areas to Reduce Labor Costs</b>		
<b>Recommendation Reason</b>	Cost Reduction	<b>Implementation Status</b>	Will be implemented
<b>Comments:</b> Labor costs will be reevaluated once the final extraction and treatment systems are operating.			
<b>Recommendation</b>	<b>E-6.3.1 Continue Improving Treatment Plant to Facilitate Operation and Potentially Increase Capacity</b>		
<b>Recommendation Reason</b>	Technical Improvement	<b>Implementation Status</b>	In progress/Ongoing
<b>Comments:</b> The site team continues to make improvements to the treatment plant. The specific recommendation to increase the capacity of the first metals removal tank has not been implemented, but may be considered, particularly if a higher flow rate is required due to increased extraction. The ferric sulfate addition has been reduced from 200-250 ppm to approximately 50 ppm, resulting in smoother operation of the metals removal system, reduced chemical usage, and approximately 50% less sludge production.			

<b>Recommendation</b>	<b>E-6.4.1 Adapt P&amp;T System to Focus Primarily on Cost-Effective Containment with Decreased Emphasis on Restoration</b>		
<b>Recommendation Reason</b>	Site Close-out	<b>Implementation Status</b>	Under Consideration
<b>Comments:</b> This recommendation will be taken into consideration as the site moves forward with the final remedy. During the meeting, the site team indicated that they see pumping from a new extraction well (to be labeled RW-5) as a primary component of the extraction system because of the high yield (approximately 30 gpm) and high concentrations (5 to 8 mg/L). Another component of the extraction system may be another extraction well (to be labeled RW-6) to be located near, but deeper than the recovery trench.			
<b>Recommendation</b>	<b>E-6.4.2 Potential Options for Improving Capture</b>		
<b>Recommendation Reason</b>	Site Close-out	<b>Implementation Status</b>	Considered
<b>Comments:</b> The site team is considering various options for improving capture, including those mentioned in the recommendation.			
<b>Recommendation</b>	<b>1F-1 Recalibrate the Site Ground Water Model</b>		
<b>Recommendation Reason</b>	Protectiveness	<b>Implementation Status</b>	Under Consideration
<b>Comments:</b> The ground water flow model will be a valuable tool for evaluating various extraction scenarios, but as discussed in the technical assistance appendix, the review of the model by the evaluation team suggests that further model calibration is needed prior to using the model to evaluate capture zones.			
<b>Recommendation</b>	<b>1F-2 Manually Recover Product from New Source Area Wells to Evaluate Potential for Long-Term Product Recovery</b>		
<b>Recommendation Reason</b>	Site Close-out	<b>Implementation Status</b>	Under Consideration
<b>Comments:</b> The site team did not report on product recovery during the recent follow-up meeting. Rather, it focused on reporting the high yield and concentration at the new extraction well (to be labeled RW-5).			
<b>Recommendation</b>	<b>1F-3 Continue Delineation Efforts</b>		
<b>Recommendation Reason</b>	Protectiveness	<b>Implementation Status</b>	Implemented
<b>Comments:</b> See comments under E-6.1.2.			

*Key for recommendation numbers:*

- *E denotes a recommendation from the original optimization evaluation*
- *F1, F2, etc. denote recommendations from the first, second, etc. follow-up meeting*
- *The number corresponds to the number of the recommendation as stated in the optimization evaluation or follow-up summary where the recommendation was provided*

## RECOMMENDATIONS PREVIOUSLY IMPLEMENTED OR THAT WILL NOT BE IMPLEMENTED

<b>Recommendation</b>	<b>E-6.1.4 Take Measures to Further Reduce System Downtime</b>		
<b>Recommendation Reason</b>	Effectiveness	<b>Implementation Status</b>	Implemented/Ongoing
<b>Comments:</b> The operation of the treatment plant has significantly improved due to internal optimization efforts. The system influent is routinely 28 to 30 gpm. The main system components, however, are treating ~40 gpm due to recycling/backwash within the plant.			
<b>Recommendation</b>	<b>E-6.2.1 Use Fewer UV/Oxidation Units</b>		
<b>Recommendation Reason</b>	Cost Reduction	<b>Implementation Status</b>	Implemented/Ongoing
<b>Comments:</b> The site team has shut off all but one of the UV/Oxidation units, and the treatment plant still effectively meets standards. The site team is considering a pilot test using just GAC as treatment for organics, but there have been problems with the recovery wells that have detracted from moving forward with this pilot test. The site team will likely wait until additional extraction wells are brought on line before further considering the GAC-only treatment for organics. The change is resulting in annual cost savings of approximately \$35,000 per year.			
<b>Recommendation</b>	<b>E-6.3.2 Make Piping Changes to Better Use the Second Equalization Tank</b>		
<b>Recommendation Reason</b>	Technical Improvement	<b>Implementation Status</b>	Implemented
<b>Comments:</b> This recommendation has not been implemented, but an alternative, which includes converting the free product storage tank into a wastewater storage tank has been implemented. This has facilitated system operation.			

*Key for recommendation numbers:*

- *E denotes a recommendation from the original optimization evaluation*
- *F1, F2, etc. denote recommendations from the first, second, etc. follow-up meeting*
- *The number corresponds to the number of the recommendation as stated in the optimization evaluation or follow-up summary where the recommendation was provided*

## OTHER CHANGES, UPDATES, OR SIGNIFICANT FINDINGS SINCE LAST FOLLOW-UP

- The primary new finding by the site team is the high yield and high concentrations at a new source area extraction well (to be labeled RW-5). The well can yield approximately 30 gpm and has concentrations as high as 5 to 8 mg/L. The site team has considered making this well a primary component of the extraction system.
- The Philadelphia Chewing Gum plant has moved locations. The property may be redeveloped into a municipal complex with a library.

## **NEW OR UPDATED RECOMMENDATIONS FROM THIS FOLLOW-UP**

1. Make recalibrating the Model a Priority and Use the Calibrated Model for Selecting an Appropriate Extraction System for the Final Remedy

In technical assistance provided as part of the previous follow-up summary, the ROET indicated that the ground water model developed for the site had not been calibrated appropriately and that any conclusions derived from this model regarding capture zones and/or contaminant transport should be viewed with extreme skepticism. The ROET reemphasizes the need to recalibrate the model so that it can be used for evaluating various extraction scenarios, including extraction from the new extraction wells (to be labeled RW-5 and RW-6). Although the site team should consider optimizing the treatment plant, the ROET believes that various extraction scenarios should be evaluated through model scenarios before making any significant and/or costly improvements to the treatment system. Modeling will help the site team determine the appropriate distribution of pumping from the existing recovery trench, the existing extraction wells, and the future extraction wells (to be labeled RW-5 and RW-6).

Although pumping from RW-5 can significantly increase mass removal, the ROET cautions against excessive pumping from RW-5 if this pumping does not contribute to providing the desired plume capture and limits pumping at other wells that are more important for plume capture (due to treatment plant capacity limits). The site will likely remain impacted for several decades regardless of the mass recovery afforded by a P&T system. Therefore, if the site team focuses on mass removal, it could increase costs without substantially improving protectiveness or shortening the remedy lifetime, especially if source removal requires significant modifications to the treatment system that would otherwise not be needed.

2. Track Costs of P&T O&M and other Site Activities Separately

Operation of the interim P&T system has continued as the site team has continued to investigate the site. As a result, it can be quite easy for the costs of P&T O&M to blend with costs for other site activities, especially in categories such as ground water monitoring, project management, and reporting. The ROET encourages the site team to track the costs of P&T O&M separately from the costs of other site activities. This separate tracking will help the site team better estimate the costs of P&T operation as a final remedy.

## SUMMARY OF FOLLOW-UP #1

<b>Site or System Name</b>	Havertown PCP Site
<b>Date of This Follow-Up Summary</b>	March 14, 2005
<b>Date of Follow-Up Meeting or Call (Indicate if Meeting or Call)</b>	December 16, 2004 – Meeting

### ROET MEMBERS CONDUCTING THE FOLLOW-UP EVALUATION:

<b>Name</b>	<b>Affiliation</b>	<b>Phone</b>	<b>Email</b>
Norm Kulujian	U.S. EPA Region 3	215-814-3130	<a href="mailto:kulujian.norm@epa.gov">kulujian.norm@epa.gov</a>
Peter Schaul	U.S. EPA Region 3	215-814-3183	<a href="mailto:schaul.peter@epa.gov">schaul.peter@epa.gov</a>
Peter Rich	GeoTrans, Inc.	410-990-4607	<a href="mailto:prich@geotransinc.com">prich@geotransinc.com</a>
Rob Greenwald	GeoTrans, Inc.	732-409-0344	<a href="mailto:rgreenwald@geotransinc.com">rgreenwald@geotransinc.com</a>
Doug Sutton	GeoTrans, Inc.	732-409-0344	<a href="mailto:dsutton@geotransinc.com">dsutton@geotransinc.com</a>
Jean Balent (by phone)	U.S. EPA OSRTI	703-603-9924	<a href="mailto:balent.jean@epamail.epa.gov">balent.jean@epamail.epa.gov</a>
Chuck Sands	U.S. EPA OSRTI	703-603-8857	<a href="mailto:sands.charles@epamail.epa.gov">sands.charles@epamail.epa.gov</a>

### SITE TEAM MEMBERS (INCLUDING CONTRACTORS) INTERVIEWED

<b>Name</b>	<b>Affiliation</b>	<b>Phone</b>	<b>Email</b>
Jill Lowe	U.S. EPA Region 3 (RPM)	215-814-3123	<a href="mailto:lowe.jill@epa.gov">lowe.jill@epa.gov</a>
Mindi Snoparsky	U.S. EPA Region 3 (Hydro)	215-814-3316	<a href="mailto:Snoparsky.mindi@epa.gov">Snoparsky.mindi@epa.gov</a>
Harish Mital (by phone)	Tetra Tech (contractor)	302-738-7551	<a href="mailto:harish.mital@tetrattech.com">harish.mital@tetrattech.com</a>

## IMPLEMENTATION STATUS OF PREVIOUSLY IDENTIFIED RECOMMENDATIONS

<b>Recommendation</b>	<b>6.1.1 Properly Seal Abandoned 12-Inch Sewer Line and Remediate Surface Soils Near the Seep</b>		
<b>Recommendation Reason</b>	Effectiveness	<b>Implementation Status</b>	Significant progress
<b>Comments:</b> The site team has plugged the entire abandoned sewer line and has conducted an investigation of the Residential Open Space (ROS) area near the seep, including 15 borings with shallow and deep soil samples plus ground water samples. Most were contaminated above removal levels. As of the follow-up meeting, the site team was awaiting the results of additional samples.			
<b>Recommendation</b>	<b>6.1.2 Improve Plume Delineation to the South and Vertically</b>		
<b>Recommendation Reason</b>	Effectiveness	<b>Implementation Status</b>	Significant Progress
<b>Comments:</b> The site team has installed new wells (CW-16D, CW-17D, CW-18D, CW-19D, CW20-S, and CW20-D) in five locations that are consistent with the optimization evaluation recommendations. However, the results do not provide complete horizontal or vertical delineation of the plume. The site team will need to install additional wells, which is planned for the Summer of 2005.			
<b>Recommendation</b>	<b>6.1.3 Evaluate Plume Capture Once Plume is Delineated</b>		
<b>Recommendation Reason</b>	Effectiveness	<b>Implementation Status</b>	Significant Progress
<b>Comments:</b> The contaminant plume has not yet been fully delineated, so the capture zone cannot be effectively analyzed yet. The site team has constructed a three-dimensional ground water flow model and has conducted a preliminary capture zone analysis using particle tracking. The simulations suggest that the existing recovery system captures the known extent of dissolved contamination upgradient of the trench, but both the model and the analysis require further evaluation. The optimization evaluation team has reviewed the modeling report and preliminary capture zone analysis as part of the technical assistance task for the optimization project. Comments on the report are included in Appendix B. The independent review of the model recommends that further calibration be performed prior to using the model to evaluate capture zones. The Remedial Investigation is scheduled for completion during the Summer of 2005. The capture zone will be further evaluated at that time.			
<b>Recommendation</b>	<b>6.1.4 Take Measures to Further Reduce System Downtime</b>		
<b>Recommendation Reason</b>	Effectiveness	<b>Implementation Status</b>	Completed/Ongoing
<b>Comments:</b> The operation of the treatment plant has significantly improved due to internal optimization efforts. The system influent is routinely influent of 28 to 30 gpm. The main system components, however, are treating ~40 gpm due to recycling/backwash within the plant.			
<b>Recommendation</b>	<b>6.2.1 Use Fewer UV/Oxidation Units</b>		
<b>Recommendation Reason</b>	Cost Reduction	<b>Implementation Status</b>	Completed/In progress
<b>Comments:</b> The site team has shut off all but one of the UV/Oxidation units, and the treatment plant still effectively meets standards. The site team is considering a pilot test using just GAC as treatment for organics, but there have been problems with the recovery wells that have detracted from moving forward with this pilot test. The site team will likely wait until additional extraction wells are brought on line before further considering the GAC-only treatment for organics.			



<b>Recommendation</b>	<b>6.2.2 Evaluate Areas to Reduce Labor Costs</b>		
<b>Recommendation Reason</b>	Cost Reduction	<b>Implementation Status</b>	To be implemented
<b>Comments:</b> Labor costs will be reevaluated once the final extraction and treatment systems are operating.			
<b>Recommendation</b>	<b>6.3.1 Continue Improving Treatment Plant to Facilitate Operation and Potentially Increase Capacity</b>		
<b>Recommendation Reason</b>	Technical Improvement	<b>Implementation Status</b>	In progress
<b>Comments:</b> The site team continues to make improvements to the treatment plant. The specific recommendation to increase the capacity of the first metals removal tank has not been implemented, but may be considered, particularly if a higher flow rate is required due to increased extraction.			
<b>Recommendation</b>	<b>6.3.2 Make Piping Changes to Better Use the Second Equalization Tank</b>		
<b>Recommendation Reason</b>	Technical Improvement	<b>Implementation Status</b>	Completed
<b>Comments:</b> This recommendation has not been implemented, but an alternative, which includes converting the free product storage tank into a wastewater storage tank has been implemented. This has facilitated system operation.			
<b>Recommendation</b>	<b>6.4.1 Adapt P&amp;T System to Focus Primarily on Cost-Effective Containment with Decreased Emphasis on Restoration</b>		
<b>Recommendation Reason</b>	Site Close-out	<b>Implementation Status</b>	Under Consideration
<b>Comments:</b> This recommendation will be taken into consideration as the site moves forward with the final remedy.			
<b>Recommendation</b>	<b>6.4.2 Potential Options for Improving Capture</b>		
<b>Recommendation Reason</b>	Site Close-out	<b>Implementation Status</b>	Under Consideration
<b>Comments:</b> This recommendation stems from the potential need to improve capture downgradient of the trench. The optimization evaluation suggested potential alternatives to addressing downgradient contamination. The site team is beginning to look at potential alternatives. The ground water flow model will be a valuable tool for such evaluations, but as discussed in below and in Appendix A, the review of the model by the evaluation team suggests that further model calibration is needed prior to using the model to evaluate capture zones.			

## OTHER CHANGES, UPDATES, OR SIGNIFICANT FINDINGS SINCE LAST FOLLOW-UP

- The Philadelphia Chewing Gum plant has moved locations. The property may be redeveloped into a municipal complex with a library.
- The site team has conducted a number of investigation activities that are consistent with the optimization evaluations. Although it was hoped that the suggestions made in the optimization evaluation would be sufficient to delineate the plume, it is apparent that additional investigation is needed.

- Site institutional controls have not been addressed yet.
- Installation of CW-16D at the Young's Produce property revealed substantial free product prompting the need for additional product delineation, containment, and recovery efforts.

#### **NEW OR UPDATED RECOMMENDATIONS FROM THIS FOLLOW-UP**

1. A review of the modeling report is attached as Appendix A. This review indicates an overriding concern that the model calibration process appears to be significantly flawed, and any conclusions derived from this model regarding capture zones and/or contaminant transport should be viewed with extreme skepticism. As such, the optimization evaluation team recommends revisiting the model calibration and improving the model so that it will be a useful tool for making site decisions. The attached review provides a number of specific comments that can be considered in redeveloping the model. The optimization evaluation team could provide additional information with respect to model development or potentially assist with the development of the model as part of the technical assistance task for this project. The evaluation team estimates that the additional model development and calibration might cost up to \$20,000, including any assistance that might be provided by the evaluation team.
2. The optimization evaluation team recommends that the site team recover product from the new well near Young's Produce and from other wells near the source area (e.g., NW-6-81, R-2, HAV-02, NW-1-81). This product recovery could be done manually on a monthly basis for approximately six months to gather information on recovery volumes to determine whether skimming pumps or continuing manual recovery would be appropriate for interim removal. This information could be considered along with other site data when developing the final remedy and any future modifications that will be made to the treatment plant. At this point, the optimization evaluation team discourages the use of the P&T system to also act as a product recovery system. Total fluids pumping in the source area should be suspended until containment of the dissolved plume is achieved and the treatment system operation is stable. At that point source area mass removal options including pumping could be reevaluated. This temporary product recovery might cost \$20,000 (including disposal, but excluding reporting).
3. The optimization evaluation team also recommends that the site team continue its investigation activities to better delineate the plume both horizontally and vertically. Specific feedback from the optimization evaluation team on suggested investigation activities and conceptual model development will be provided in a separate technical assistance document, to be provided before the next followup meeting.

### Updated Cost Summary Table

Recommendation	Reason	Implementation Status	Estimated Capital Costs (\$)	Actual Capital Costs (\$)	Estimated Change in Annual Costs (\$/yr)	Actual Change in Annual Costs (\$/yr)
<b>Original Optimization Evaluation Recommendations</b>						
6.1.1 Properly Seal Abandoned 12-Inch Sewer Line and Remediate Surface Soils Near the Seep	Effectiveness	Alternative Implemented	\$200,000	Not quantified*	\$0	\$0
6.1.2 Improve Plume Delineation to the South and Vertically	Effectiveness	Implemented	\$120,000 to \$150,000	Not quantified*	\$5,000	Not quantified*
6.1.3 Evaluate Plume Capture Once Plume is Delineated	Effectiveness	Substantial Progress	\$55,000		\$0	
6.1.4 Take Measures to Further Reduce System Downtime	Effectiveness	Implemented/ Ongoing	\$0	Not quantified*	\$0	Not quantified*
6.2.1 Use Fewer UV/Oxidation Units	Cost Reduction	Implemented/ Ongoing	\$0	\$0	(\$32,000)	(\$35,000)
6.2.2 Evaluate Areas to Reduce Labor Costs	Cost Reduction	Will be implemented	\$0		(\$40,000)	
6.3.1 Continue Improving Treatment Plant to Facilitate Operation and Potentially Increase Capacity	Technical Improvement	In progress/ Ongoing	< \$10,000 to \$25,000		\$0	
6.3.2 Make Piping Changes to Better Use the Second Equalization Tank	Technical Improvement	Implemented	\$10,000	Not quantified*	\$0	Not quantified*

Recommendation	Reason	Implementation Status	Estimated Capital Costs (\$)	Actual Capital Costs (\$)	Estimated Change in Annual Costs (\$/yr)	Actual Change in Annual Costs (\$/yr)
<b>Original Optimization Evaluation Recommendations (continued)</b>						
6.4.1 Adapt P&T System to Focus Primarily On Cost-Effective Containment with Decreased Emphasis on Restoration	Site Closeout	Under Consideration	\$0		(\$30,000)	
6.4.2 Potential Options for Improving Capture	Site Closeout	Considered	No costs associated with this recommendation			
<b>New or Updated Recommendations from Follow-up #1, December 16, 2004</b>						
1. Redevelop ground water model	Effectiveness	Under Consideration	\$20,000		\$0	
2. Temporary manual recovery of product	Effectiveness	Under Consideration	\$20,000		\$0	
3. Continue investigation	Effectiveness	Implemented	Not quantified*		Not quantified*	

*Costs in parentheses imply cost reductions.*

\* *Indicates costs or savings have not been estimated independently of other site activities that have occurred since the optimization evaluation.*

## **APPENDIX: A**

### **ARCHIVE OF TECHNICAL ASSISTANCE PROVIDED BY THE ROET**

Note: Technical assistance items are provided in reverse chronological order.

**Technical Assistance Item #1**  
**Presented March 7, 2005**

*Comments on the Ground Water Modeling Report*

GeoTrans was asked to provide a technical review of the “Groundwater Model Report” prepared by Val F. Britton, revision dated July 29, 2004. The report was reviewed by Rob Greenwald and Pete Andersen. Based on our review, the overriding concern is that the model calibration process appears to be significantly flawed, and any conclusions derived from this model regarding capture zones and/or contaminant transport should be viewed with extreme skepticism.

Some specific comments are provided below.

- 1) The vast majority of figures are extremely difficult to read or interpret. All of the “three-dimensional” figures (such as Figures 1 to 4) present information in a manner that cannot be understood by the reader. For many of the other figures, the use of a colored background and/or excessive background features makes it impossible for the reader to discern information. Much of the text on the figures is not legible. The use of “perspective views” rather than pure map view (i.e., looking straight down) on many figures makes it very difficult to interpret the figures.
- 2) The basis for the model layering is not clearly presented. The model has six layers, but there is no real explanation or basis for the having five additional layers below layer 1, all of which are assigned the same properties. In contrast, layer 1 lumps saprolite and bedrock. It is not clear why a two-layer model (saprolite and bedrock) was not considered.
- 3) The approach to model calibration appears to be significantly flawed. As described in Section 2.0, the water table measurements used for model calibration were for a non-pumping condition. It is generally poor practice to calibrate a flow model to just a non-pumping condition without also calibrating it to one or more stressed (i.e., pumping) conditions. This is because the simulation of a stress (such as pumping) and the evaluation of the related drawdown response is the best way to calibrate aquifer parameters such as hydraulic conductivity. In the model described in the report, there will be little or no variation in heads due to variation in hydraulic parameters, especially if the drains are assigned a high value of conductance and thus act like a specified head. If that is the case (which we expect it is), then in the absence of pumping, same values of head will generally be simulated no matter what values of hydraulic conductivity or recharge are simulated. The simulated heads will be almost entirely controlled by the specified heads along the model boundary and the specified drain levels. That situation does not allow for true model calibration to occur. In fact, on page 11 the report author acknowledges that the model was run with a 20% increase and a 20% decrease in net recharge, with no significant impact on simulated heads. That is consistent with the analysis provided here. The proper approach is to calibrate the model to a *stressed* condition, using observed pumping rates, and comparing simulated water levels (and/or flow patterns or flow budgets) to the conditions observed in the field. Ideally, calibrating

to more than one different set of pumping stresses (by turning some wells off in the field, measuring the corresponding water levels, and then simulating that condition in the model) adds confidence in the model calibration.

- 4) The method of evaluating and presenting the results of the calibration is not at all clear. On Figures 21-24, there are green and yellow bars of varying lengths each superimposed on a line with 3 cross hatches. There is no explanation as to why some are longer than others (assumed that longer means greater error), or how to tell where heads are simulated too high versus too low. On maps such as these, residuals (simulated minus observed) should be presented with symbols, not bars, with the residual values clearly indicated (including the sign, positive or negative). The text does not clarify the approach used in this study. It seems to indicate that a 1-foot residual was the target. It then says “the majority of wells fell within a 95% or better match”, but does not indicate what the 95% refers to (i.e., 95 % of what?). The proper approach is to present a table of simulated versus observed values, and to calculate basic statistics such as mean of residuals (should be close to zero) and mean absolute error (the mean of the absolute value of the residuals), which should generally be within 5 percent of the observed head range of the target observations. Since no such data or statistics are provided, the calibration is impossible to assess on this basis.
- 5) The presentation of drain assignment (Figure 18) and related discussion of flow budgets (Table 3 and text on Page 10-11) is also confusing:
  - It is suspected by GeoTrans that the conductance values in the unlined drain areas were set high enough that the drains act like specified head cells (especially given the discussion on page 10 that indicated high hydraulic conductivity material was assumed around the drains). As previously discussed, this leads to very non-unique results regarding calibration of model parameters given the use of an unstressed condition.
  - On Figure 18, it is not clear what the node numbers signify (why include them on the figure?). The segment numbers are not legible for many of the segments.
  - Table 3 does not clearly indicate whether the reported flows are observed or simulated, but it is assumed they are simulated values.
  - In the section on Storm Water Drains and Sanitary Lines, it says “a rate of 1 to 2 gpm through the drains was utilized. An exception to this flow rate was the abandoned sewer line (10 gpm)...”. Is this saying these flow rates were calibration targets? If so, a comparison with simulated conditions is not presented. Or is it suggesting that somehow the flow rates associated with the drains was assigned? That is not consistent with the MODFLOW Drain Package, which calculates flows in drains based on simulated heads and assigned parameters.
  - The comparison of simulated outflow of Naylor's Run (409 gpm) is much greater than the measured flow measured downgradient of the “site” (not quite sure how far, 314 gpm). Although such measurements of flow in streams are highly

uncertain (as properly discussed in the report), it is likely that the simulation of too much water discharging to Naylor's run is an indication of poor model calibration (too much net recharge in the model). It is likely that recharge rate in the model is too high, but this could not be determined during model calibration due to the reasons discussed earlier.

- 6) No true sensitivity analysis is presented except for changes in net recharge. As discussed earlier, the construction and calibration of this particular model, based on an unstressed condition, is not well suited to a sensitivity analysis for model calibration. The proper approach is, under stressed conditions, to change key parameter values (including hydraulic conductivity, drain elevations and conductance, horizontal anisotropy, vertical anisotropy, and perhaps other items such as boundary heads) and to present maps illustrating change in head relative to the base model (i.e., contour the result of base model heads versus changed model heads). In that way the spatial impacts of the parameter variation can be evaluated. Ideally, sensitivity analysis is also presented for model prediction scenarios and not just for model calibration. For instance, the horizontal anisotropy (a very difficult parameter to get a handle on in reality) appears to simply be assigned, and likely has a significant impact on model predictions, but it is simply not possible for the reader of this report to determine how significant variation in this parameter might impact model predictions.
- 7) The solute transport analysis indicates that concentrations observed at some locations cannot be replicated by the model, and suggests this may indicate additional contaminant sources. GeoTrans notes that this could equally be (or even more likely be) further indication of imperfect model calibration.
- 8) Given these issues, GeoTrans does not believe this model has been sufficiently calibrated to be used as a predictive tool. As such, any conclusions derived from this model regarding capture zones and/or contaminant transport should be viewed with extreme skepticism. If further modeling is performed, it is strongly suggested that more thorough calibration be performed to one or more stressed conditions, that the calibration be presented in a more traditional manner, that sensitivity analysis be performed for multiple parameters as part of model calibration, that at least one alternate form of the model with different parameters but similar calibration characteristics be used to assess sensitivity of model predictions to parameter uncertainty, and that figures be produced with different software using simpler backgrounds and legible text.



## **APPENDIX B:**

### **BASELINE SITE INFORMATION SHEET AND OPTIMIZATION EVALUATION REPORT**

**Note: The attached information sheet was generated during an original nationwide screening effort in 2000 and 2001 and has a different format than the currently used information sheet included in Section 1 of this document. The optimization evaluation report that is provided is a full-scale Optimization Support Evaluation (OSE) funded by the Region in 2003.**

**Havertown PCP OU2**  
 Havertown, PA (Region 3)  
 CERCLIS ID PAD002338010

**Contact Information**

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**System Information and Data**

<table> <tr><td>Type of Fund-lead Site:</td><td>EPA-lead</td></tr> <tr><td>Date original ROD was signed:</td><td>9/30/91</td></tr> <tr><td>Date of last modification to ROD:</td><td></td></tr> <tr><td>Type of ROD:</td><td>Interim</td></tr> <tr><td>Status of P&amp;T system:</td><td>Being Installed</td></tr> <tr><td>Primary goal of system:</td><td>Containment &amp; Restoration</td></tr> <tr><td>Presence of NAPLs</td><td>Observed</td></tr> <tr><td>Approximate annual O&amp;M costs:</td><td>\$1,000,000</td></tr> <tr><td>Costs related to monitoring:</td><td>\$283,300</td></tr> <tr><td>Approximate pumping rate:</td><td>45 gpm</td></tr> <tr><td>Result of previous evaluation of performance/effectiveness:</td><td>Not evaluated</td></tr> </table>	Type of Fund-lead Site:	EPA-lead	Date original ROD was signed:	9/30/91	Date of last modification to ROD:		Type of ROD:	Interim	Status of P&T system:	Being Installed	Primary goal of system:	Containment & Restoration	Presence of NAPLs	Observed	Approximate annual O&M costs:	\$1,000,000	Costs related to monitoring:	\$283,300	Approximate pumping rate:	45 gpm	Result of previous evaluation of performance/effectiveness:	Not evaluated	<table> <tr><td>Number of extraction wells:</td><td>4</td></tr> <tr><td>Date of construction completion:</td><td>5/2001</td></tr> <tr><td>Date of operational and functional:</td><td>4/2002</td></tr> <tr><td>Expected date of turnover to state:</td><td>4/2012</td></tr> <tr><td>Expected date of completion:</td><td>4/2033</td></tr> <tr><td>Approximate downtime per year:</td><td></td></tr> <tr><td>Number of monitoring wells used:</td><td>15</td></tr> <tr><td>Frequency of sampling:</td><td>2 times per year</td></tr> <tr><td>Is plume migration controlled?</td><td></td></tr> <tr><td>Progress of aquifer restoration:</td><td></td></tr> <tr><td>Difficulty (due to social/political factors) of implementing minor/major changes:</td><td>minor/moderate</td></tr> </table>	Number of extraction wells:	4	Date of construction completion:	5/2001	Date of operational and functional:	4/2002	Expected date of turnover to state:	4/2012	Expected date of completion:	4/2033	Approximate downtime per year:		Number of monitoring wells used:	15	Frequency of sampling:	2 times per year	Is plume migration controlled?		Progress of aquifer restoration:		Difficulty (due to social/political factors) of implementing minor/major changes:	minor/moderate
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**Contaminants of Concern:**

Benzene and Toluene  
 Dioxin (TCDD equivalents)  
 Pentachlorophenol (PCP)  
 Trichloroethylene (TCE)

**Treatment Processes:**

Metals precipitation      yes  
 Air stripping  
 Biological treatment  
 UV oxidation              yes  
 Carbon adsorption        yes  
 Filtration                  yes  
 Ion Exchange  
 Reverse Osmosis  
 Off-gas treatment  
 other/not sure

**Comments:**

This system includes a 200 foot long collection trench and four oil/water extraction wells. There is free product (PCP/oil) being recovered from most of the wells.

**Streamlined  
Optimization Evaluation Report**

**Havertown PCP Site  
Havertown, Pennsylvania**

**EPA Region III**

**Report of the Optimization Support Evaluation  
Site Visit Conducted at the Havertown PCP Site  
August 5, 2003**

Final Report  
March 4, 2004

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## **NOTICE**

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Work described herein was performed by GeoTrans, Inc. (GeoTrans) for the U.S. Environmental Protection Agency (U.S. EPA). Work conducted by GeoTrans, including preparation of this report, was performed under S&K Technologies Prime Contract No. GS06T02BND0723 and under Dynamac Corporation Prime Contract No. 68-C-02-092, Work Assignment ST-1-08. Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

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## EXECUTIVE SUMMARY

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

- improvements in remedy effectiveness
- reductions in operation and maintenance costs
- technical improvements
- gaining site closeout

The recommendations are intended to help the site team identify opportunities for improvements. In many cases, further analysis of a recommendation, beyond that provided in this report, may be needed prior to implementation of the recommendation. Note that the recommendations are based on an independent evaluation and represent the opinions of the evaluation team. These recommendations do not constitute requirements for future action, but rather are provided for the consideration of all site stakeholders. This OSE report pertains to conditions that existed at the time of the OSE site visit, and any site activities that have occurred subsequent to the OSE site visit are not reflected in this OSE report.

The Havertown PCP site is located in Havertown, Haverford Township, Delaware County, in southeastern Pennsylvania. The site contamination was first discovered in 1962 when the Pennsylvania State Department of Health became aware of contaminants in Naylor's Run and attributed the source of PCP and dioxin contamination to the disposal practices of a nearby wood treating facility. Investigation and remedial activities have included the removal of existing waste from the site, treatment of effluent discharging from the existing storm sewer, installation of an oil/water separator, off-site disposal of generated wastes, installation of a cap over soils impacted by dioxin, and operation of an interim P&T system, which began operation in 2001. This OSE focused on the operating interim P&T system but also considers potential enhancements to this system for addressing deeper ground water contamination as part of the final remedy for Operable Unit 3 (OU3).

The evaluation team observed a conscientious and knowledgeable site team (i.e., EPA and its contractor) that has effectively managed this interim remedy, provided a number of much needed plant improvements, and initiated the remedial investigation for OU3. The observations and recommendations contained in this report are not intended to imply a deficiency in the work of either the system designers or operators but are offered as constructive suggestions in the best interest of the EPA, the public, and the facility. These recommendations have the obvious benefit of being formulated based upon operational data unavailable to the original designers.

The recommendations to improve remedy effectiveness include the following:

- The site team should continue with their efforts to investigate and properly seal the abandoned sewer line that has allowed contaminated ground water to migrate downgradient and then surface as a seep in a residential area. The site team should make this effort and the remediation of the associated soils and sediments their first priority.

- Further delineation of the contaminant plume is suggested, especially to the south and at depth. Locations and depths for seven new monitoring wells are proposed.
- Once the plume is delineated, a target capture zone should be determined and the site team should conduct a thorough capture zone analysis. A preliminary analysis has been conducted as part of this report and is provided in Section 4.2.2.
- Modifications should be made to O&M practices to reduce system downtime. Foremost among the suggested items is to bypass one or two of the UV/Oxidation units.

Implementation of these recommendations might cost \$375,000 to \$405,000 in capital costs, but these costs may be offset by savings associated with cost-reduction recommendations. Recommendations to reduce cost include the following:

- Although the site team suggests bypassing one UV/Oxidation unit, process data suggests that two UV/Oxidation units can be bypassed. As a further option, the site team could consider bypassing all three UV/Oxidation units and relying on GAC as the primary treatment technology for organic compounds. Annual savings of approximately \$32,000 per year might be possible with little or no capital costs if a second UV/Oxidation unit is bypassed. An additional \$15,000 per year might be saved if the UV/Oxidation system is bypassed altogether.
- The majority of the annual O&M costs are due to labor. Reductions in both project management and sampling labor are likely possible, especially in the near future as contractor modifications further simplify the operation of the system. Potential annual savings of \$40,000 per year may be feasible within one or two years.

Recommendations for technical improvement include modifying the system to improve treatment capacity and making minor modifications to the equalization tanks. Recommendations for site closeout include focusing the remedy on plume containment in the near term rather than aquifer restoration and considering options for addressing contamination that may be outside of the current capture zone.

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

---

## PREFACE

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This report was prepared at the request of EPA Region 3 as part of a project to optimize the Region's pump and treat (P&T) systems that are jointly funded by EPA and the associated State agency. The effort was made possible with the help of the Office of Superfund Remediation and Technology Innovation. The project contacts are as follows:

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# 1.0 INTRODUCTION

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## 1.1 PURPOSE

During fiscal years 2000, 2001, and 2002 Remediation System Evaluations (RSEs) were conducted at 24 Fund-lead pump and treat (P&T) sites (i.e., those sites with pump and treat systems funded and managed by Superfund and the States). Due to the opportunities for system optimization that arose from those RSEs, EPA Region 3 is expanding efforts to optimize its Fund-lead remedies. Region 3 requested that GeoTrans conduct RSEs at two of its Fund-lead P&T systems: Havertown PCP and Greenwood Chemical. Because GeoTrans has a business relationship with Tetra Tech, the contractor at these two facilities, Optimization Support Evaluations (OSEs) were conducted in place of the RSEs. The OSE process is identical to the RSE process, but the name change indicates the business relationship between GeoTrans and Tetra Tech.

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

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

The evaluation involves a team of expert hydrogeologists and engineers, independent of the site, conducting a third-party evaluation of site operations. It is a broad evaluation that considers the goals of the remedy, site conceptual model, above-ground and subsurface performance, and site exit strategy. The evaluation includes reviewing site documents, visiting the site for 1 to 1.5 days, and compiling a report that includes recommendations to improve the system. Recommendations with cost and cost savings estimates are provided in the following four categories:

- improvements in remedy effectiveness
- reductions in operation and maintenance costs
- technical improvements
- gaining site closeout

The recommendations are intended to help the site team identify opportunities for improvements. In many cases, further analysis of a recommendation, beyond that provided in this report, might 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 the consideration of all site stakeholders. This OSE report pertains to conditions that existed at the time of the OSE site visit, and any site activities that have occurred subsequent to the OSE site visit are not reflected in this OSE report.

The Havertown PCP site was selected by EPA Region 3 based the potential to improve the effectiveness of the remedy to protect human health and the environment and to reduce the annual costs of operating the remedy. This report provides a brief background on the site and current operations, a summary of the observations made during a site visit, and recommendations for changes and additional studies. The cost impacts of the recommendations are also discussed.

## 1.2 TEAM COMPOSITION

The team conducting the evaluation consisted of the following individuals:

Rob Greenwald, Hydrogeologist, GeoTrans, Inc.  
Peter Rich, Civil and Environmental Engineer, GeoTrans, Inc.  
Doug Sutton, Water Resources Engineer, GeoTrans, Inc.

The evaluation team was also accompanied by Kathy Davies and Norm Kulujian from EPA Region 3.

## 1.3 DOCUMENTS REVIEWED

Author	Date	Title
USEPA	8/1989	Focused Feasibility Study
USEPA	9/30/1991	Operable Unit 2 Record of Decision
Calgon Carbon Corp.	4/2001	Operation and Maintenance Manual, Volume I: RAYOX Advanced Oxidation System
Calgon Carbon Corp.	4/2001	Operating Manual: Mobil Model 6 Granular Carbon Adsorption System
URS	6/13/2001	Preliminary Draft Operations and Maintenance Manual: Havertown PCP Superfund Site
Tetra Tech	10/2002 - 7/2003	Project Meeting Agendas
Tetra Tech	8/5/2003	NAPL Recovery Data
Tetra Tech	8/5/2003	Process Monitoring Data
Tetra Tech	8/8/2003	Supplementary Data and Figures

## 1.4 PERSONS CONTACTED

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

Jill Lowe, Remedial Project Manager, EPA Region 3  
Mindi Snoparsky, Hydrogeologist, EPA Region 3

Harish Mital, Project Manager and Engineer, Tetra Tech  
Andy Westerbaan, Hydrogeologist, Tetra Tech  
J.B. Moore, Project Engineer, Tetra Tech  
Dale Gant, Plant Operator, Tetra Tech

## **1.5 SITE LOCATION, HISTORY, AND CHARACTERISTICS**

### **1.5.1 LOCATION AND BRIEF HISTORY**

The Havertown PCP site is located in Havertown, Haverford Township, Delaware County, in southeastern Pennsylvania. The site is located approximately 10 miles west of Philadelphia and is surrounded by a mixture of commercial establishments, industrial companies, parks, schools, and private homes. The location of the site and the surrounding area are depicted in Figure 1-1. The entire Havertown PCP site is approximately 12 to 15 acres, and is comprised of a former wood-treatment facility operated by National Wood Preservers (NWP), the Philadelphia Chewing Gum Company (PCG) manufacturing plant adjacent to the wood-treatment facility, Naylor's Run (a creek that drains the area), and neighboring residential and commercial properties. A more detailed plan of the site is shown in Figure 1-2.

The NWP facility is the primary source of the contamination for the site. The NWP facility was first developed as a railroad storage yard, and in 1947 it began operation as a wood-preserving facility. The site contamination was first discovered in 1962 when the Pennsylvania State Department of Health became aware of contaminants in Naylor's Run and linked the source of contamination to the NWP waste disposal practices. The following four media have been documented as being affected by contaminants originating from the site:

- on-site soils
- on-site and downgradient ground water
- surface water in storm sewers and off-site in Naylor's Run
- air on-site and in the vicinity of the catch basin on Naylor's Run

Investigation and remedial activities have included the removal of existing waste from the site, capping of impacted soil and debris on-site, treatment of effluent discharging from the existing storm sewer, installation of an oil/water separator and off-site disposal of generated wastes. Other investigation and remedial activities conducted at this site include the following:

- 1972 - The Pennsylvania Department of Environmental Resources (PADER) identified contaminated ground water discharging from a storm sewer into Naylor's Run
- 1976 - The EPA initiated activities and commenced containment operations under Section 311 of Clean Water Act in response to request from PADER
- 1982 - The site was placed on the National Priorities List
- 1982-84 - PADER and EPA conducted subsequent inspections and found many deficiencies with the containment operations, and EPA issued a unilateral Administrative Order against NWP which required NWP to perform various abatement activities
- 1987-89 - PADER performed the Remedial Investigation/Feasibility Study for Operable Unit One (OU1), and the EPA issued an interim Record of Decision (ROD) for OU1 which addressed the cleanup of wastes currently staged on the site from previous investigative actions and included interim remedial measure of designing and installing an oil/water separator
- 1988 - A catch basin was installed in Naylor's Run to trap the discharge from the storm pipe by EPA's Emergency Response Team to prevent the release of PCP-contaminated oil into Naylor's Run

- 1991 - The EPA initiated the Remedial Investigation/Feasibility Study for Operable Unit Two (OU2), and issued a ROD for OU2 that addressed the treatment of the shallow ground water aquifer
- 1994 - A cap completed to cover soils impacted by dioxin
- 2001 - A P&T system was completed and began operation under Operable Unit 2 (OU2) as an interim remedy for shallow ground water

The principal threat at the site remains the ground water contamination by PCP and other contaminants of concern that occurred as a result of wood-treatment operations at NWP, including dioxins and dibenzofurans, fuel oil and mineral spirits components, heavy metals, certain volatile organic compounds, and phenols. This OSE report pertains to the ground water contamination, the operating interim P&T system, potential alternative approaches to addressing the ground water contamination, and site conditions that directly affect the ground water remediation.

### **1.5.2 POTENTIAL SOURCES**

The use of an injection or disposal well to collect the spent wood-treating solutions containing PCP and oil was allegedly the major source of contamination to the environment from 1947 until 1963 when disposal practices at NWP changed. It is estimated that up to one million gallons of spent solution may have been disposed of by this method. The uncontrolled disposal methods and typically poor housekeeping practices prior to 1963 resulted in significant contamination of the ground water surrounding the site. The presence of the light non-aqueous phase liquid (LNAPL) in wells R-2 and HAV-02 continue to contribute to the dissolved ground water contamination. An estimated volume of 6,000 gallons of NAPL (approximately 2 inches thick) is present over the ground water in this area.

During the ongoing OU3 investigation (OU3 pertains to the remediation of the sediment contamination in Naylor's Run, the deep ground water aquifer which is fractured bedrock, and surface water and sediment contamination due to runoff from on-site soils) an abandoned sanitary sewer line was found which may act as a preferential pathway for contaminant transport to the Residential Open Space area southeast of Achille Road on Naylor's Run.

### **1.5.3 HYDROGEOLOGIC SETTING**

The site is located in the Piedmont Upland section of the Piedmont Physiographic Province. Bedrock in the site vicinity consists of metamorphic rocks of Wissahickon Formation. The site is in an area that is relatively flat compared to the surrounding countryside. Much of the area's original topography has been altered by cut and fill activities on both the NWP plant site and the PCG property. The site lies approximately 300 ft above mean sea level (MSL). The depth to ground water beneath the site ranges from approximately 23 ft below ground surface in the Young's Produce Store area to approximately 0.5 ft below ground surface in the Rittenhouse Circle area. Ground water in the vicinity of the site flows in an easterly direction, with some unknown portion discharging to Naylor's Run. For the most part, surface runoff across the NWP site enters artificial drainage channels before discharging into Naylor's Run.

According to the 1991 OU2 ROD, ground water at the site flows in an easterly direction and occurs in two major zones. The upper zone consists of surficial soils and weathered schist saprolite. In general, this upper zone extends to approximately 30 feet below ground surface. The lower zone consists of highly fractured and jointed schist bedrock, with water movement occurring along interconnected fractures. The bedrock aquifer receives some of its recharge from the downward flow through the overburden aquifer, but upward flow from the bedrock to the overburden exists further downgradient,

presumably as ground water discharges to Naylor's Run. Some portion of the ground water in the deep aquifer likely travels under Naylor's Run via fractures and discharges further downgradient to the southeast.

According to the ROD, the ground water velocity in the shallow aquifer is approximately 85 ft per year, presumably based on aquifer testing and measurement of the hydraulic gradient. At the time of the ROD, however, the extent of contaminant migration suggested that other factors, such as adsorption, were limiting the rate of contaminant transport. Ground water flow velocity in the deep aquifer, within the underlying fractured bedrock, is estimated to be 25 ft per year according to the ROD.

The presence of underground sewers that intercept the water table has altered ground water flow patterns and contaminant transport at the site. Prior to site remedial activities, contaminated ground water infiltrated into a 30-inch sewer line near the PCG property. Although this sewer line reduced the amount of contamination that could migrate downgradient, this contaminated water discharged directly to Naylor's Run. As part of OU2, EPA lined the 30-inch sewer line to reduce its ability to collect and discharge contaminated water. A collector drain, which is a component of the interim ground water remedy, was installed in this general area to intercept and extract contaminated ground water in the shallow zone (i.e., overburden).

In 1999, the site team identified a contaminated seep adjacent to Naylor's Run (location indicated on Figure 1-1). By the Summer of 2003, the site team found an abandoned 12-inch sewer line that has likely been facilitating the transport of contaminated ground water downgradient and causing the seep. PCP concentrations of over 500 ug/L have been observed at this downgradient location even though upgradient monitoring points (such as the CW-12 cluster) show lower or undetectable concentrations. During the OSE visit, the site team showed the OSE team the seep area where impacted water was surfacing and indicated that addressing this sewer line, seep, and resulting contamination is a top priority.

#### **1.5.4 RECEPTORS**

The area potentially affected by contaminants released from the Havertown PCP site is almost entirely developed. The primary contamination source (NWP) is located in midst of several commercial establishments and surrounded by a mix of private homes, schools, stores, parks, and industrial facilities. Consequently, humans potentially make up the most important receptor group. Additional environmental receptors may include vegetation, aquatic biota, wildlife and domestic animals, and agricultural or garden products.

Because the contaminated soil has either been removed or covered with a cap, the primary routes of exposure to site-related contaminants would include extraction and use of contaminated ground water, direct contact with contaminated ground water that has seeped to the surface, or construction activities beneath the cap. With the exception of the above-mentioned seep caused by the 12-inch sewer line, recent surface water sampling indicates low (i.e., at or near MCLs) contaminant concentrations in Naylor's Run, which is a substantial improvement compared to the 1,200 ug/L that had been detected in Naylor's Run near the PCG property during the initial investigations.

#### **1.5.5 DESCRIPTION OF GROUND WATER PLUME**

Figure 1-3 shows the extent of PCP contamination near the NWP and PCG properties in the shallow aquifer (overburden), and Figure 1-4 shows the extent of PCP contamination in the same area for a deeper aquifer interval (fractured bedrock). The highest detected levels of PCP at the time of the OSE are 13,000 ug/L in R-2, 30,000 ug/L in HAV-02, and 8,700 ug/L in HAV-04 (March 2003 sampling

event). Wells R-2 and HAV-02 are located just downgradient of the site along Eagle Road, and well HAV-04 is located approximately 450 feet downgradient of the site. PCP contamination at further downgradient locations is relatively low compared to upgradient. The CW-9 and CW-13 clusters (see Figure 1-1) are the only clusters downgradient of the collector drain with detectable PCP concentrations since sampling began at downgradient locations in October 2002.

Dioxin is also present in the ground water. The last comprehensive ground water sampling round for dioxin was conducted in 2000, and the highest concentrations were found in CW-2D, HAV-02, and NW-1-81, which are located either on the former NWP property or immediately downgradient of it. In general, the highest dioxin concentrations are found in the wells with the highest PCP concentrations. Dioxin concentrations in wells downgradient of the collector drain (see Figure 1-2 for well locations) are below the MCL of 0.03 ppt (0.00003 ppb).

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## 2.0 SYSTEM DESCRIPTION

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### 2.1 SYSTEM OVERVIEW

The ground water extraction system consists of 4 recovery wells located along Eagle Road and a 180-foot long collector drain installed to the top of bedrock (16 feet bgs) downgradient of the PCG facility . The collector drain is located adjacent to the existing storm sewer line to collect contaminated shallow ground water for treatment at the treatment plant. The purpose of the collector drain is to effectively capture the plume of contaminated water in the shallow aquifer as it flows to the east. The recovery wells collect impacted ground water and LNAPL near the source area. The system was constructed by one contractor in 2001, operated by another contractor through July 2002, and has since been operated by a third contractor.

The treatment system consists of an oil/water separator (OWS), chemical precipitation system, an advanced oxidation process system, and granular activated carbon (GAC) system, sequentially. The treated water is discharged into Naylor's Run.

The following table summarizes the contaminant concentrations in the plant influent for June 2003. The effluent standards are also provided.

Parameter	June 2003 Influent Concentration (ug/L)	NPDES Monthly Average Effluent Standard (ug/L)
Cobalt	135	53
Iron	5,320	300
Manganese	10,300	50
Benzene	6.9	1
Trichloroethylene	9.9	5
Pentachlorophenol	2600	1
Phenanthrene	25 *	3
Dioxins/Furans (ppq***)	315.5 **	< 4.4

\* Concentration below the detection limit. The data comes from previous sampling event on 5/29/2003

\*\* No data during June 2003 sampling event. The data comes from previous sampling event on 5/29/03

\*\*\* ppq - parts per quadrillion or picograms per liter

### 2.2 EXTRACTION SYSTEM

The ground water extraction system includes 4 recovery wells labeled RW-1 through RW-4 and the collector drain. With the exception of RW-3, which is located on the PCG property directly downgradient of R-2, the recovery wells are on or adjacent to NWP property in the vicinity of the hot spot at well R-2.



They range from 26 to 28 feet deep (i.e. to the interface of the overburden and fractured bedrock). These wells have QED AP-4 pneumatic submersible pumps. Only 1 of the 4 wells, RW-1, is currently pumping over 2 gpm, and two of the wells (RW-3 and RW-4) are not pumping at all. The wells are in need of redevelopment, which was planned for late August 2003.

Three extraction wells (EW-1, EW-2, and EW-3) were drilled as part of the OU2 effort, but have not been used for ground water recovery purposes. R-2, a 4-inch monitoring well located on the former NWP property, is manually bailed. Eight events have taken place since October 2002, recovering approximately 19 gallons of product.

## 2.3 TREATMENT SYSTEM

The primary components of the treatment system are listed below.

### Free product separation and storage

- oil/water separator with the capacity of 100 gpm that gravity drains water to the equalization tanks
- 5,900 gallon free product tank with level transmitter to store product draining from the oil/water separator and bailed from R-2
- two 200 cfm capacity GAC units to treat vapors vented from the oil/water separator and free product tank

### Flow equalization, metals removal, and solids handling

- two 2,800 gallon equalization tanks
- 50 gpm equalization tank discharge pump with standby unit
- three 800 gallon oxidation and mixing tanks with chemical and polymer addition
- lamella plate clarifier unit with flash mix and flocculation chambers with a 55 gpm capacity
- double diaphragm sludge pump at the oil/water separator and clarifier
- upflow sand filter with a 50 gpm capacity
- 4,500 gallon sludge holding tank to store the sludge from the oil/water separator, the clarifier, and sand filter
- filter press with 20 cubic foot capacity

### UV/Oxidation

- 2,000 gallon metals removal effluent surge tank and 45 gpm RayOx feed pumps (two including one standby)
- RayOx system including three 30 KW UV reactors in series
- peroxide destruction unit with 2,000 pounds of GAC and 2,000-pound clay filter (currently off-line)
- two parallel cartridge filters

### GAC

- two 4,000-pound GAC units arranged in series
- two 3,000 gallon effluent tanks

In addition, the system includes a 450 gallon sump with a pump for recycling filter press filtrate, decant water from the sludge thickener and sand filter backwash water; an air compressor (to operate the recovery well extraction pumps); and controls with remote access and data storage capabilities.

The treatment system was designed to treat 40 gpm. The flow from the recovery wells and the collection drain is directed to the oil/water separator and the above-mentioned treatment components prior to being discharged to Naylor's Run.

## **2.4 MONITORING PROGRAM**

Process monitoring consists of monthly influent and semi-monthly effluent sampling for VOCs, SVOCs, metals, and dioxins/furans. Eight process samples are collected and analyzed quarterly to monitor the performance of individual treatment components, with analysis of each sample dependent on its location relative to individual treatment components.

Ground water monitoring includes sampling 10 wells quarterly, 10 wells semi-annually, and about 55 to 60 wells annually (planned). The last comprehensive ground water sampling event was conducted in October 2002 when approximately 33 wells were sampled. At least 7 of the wells that were not sampled were either dry or had product. All ground water samples (approximately 100 per year) are analyzed for VOCs, SVOCs, and metals. About 50 of those 100 samples are analyzed for dioxins/furans.

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## 3.0 SYSTEM OBJECTIVES, PERFORMANCE AND CLOSURE CRITERIA

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### 3.1 CURRENT SYSTEM OBJECTIVES AND CLOSURE CRITERIA

The 1989 ROD for OU1 identified three operable units (OUs) and associated remedies:

- OU1 - the removal of existing hazardous wastes from the site and the installation of an oil/water separator for removing some contaminants from Naylor's Run
- OU2 - the remediation of the shallow ground water aquifer (overburden), considered as an interim action for ground water
- OU3 - the remediation of the sediment contamination in Naylor's Run, the deep ground water aquifer (fractured bedrock), and surface water and sediment contamination due to runoff from on-site soils

Additionally, a cap was installed in 1994 (between OU1 and OU2) as a removal action.

This optimization evaluation primarily pertains to the OU2 remedy but also considers potential options for a final ground water remedy. As stated in a 1991 ROD, OU2 includes an interim remedy for shallow ground water. The objective of this interim remedy is to collect and treat the shallow ground water that flows into Naylor's Run and initiate the remediation of the shallow ground water. The primary purpose is to protect children that might play in Naylor's Run. This is not a final remedy for ground water because it only addresses shallow ground water and not both shallow and deep ground water. The information collected during this interim remedy will help in the planning of the OU3 remedy, which would include remediation of the contaminated sediment and a final remedy for ground water.

The selected interim OU2 remedy includes the following major features:

- Installation of free product recovery wells on the NWP property to recover product from the shallow aquifer
- Rehabilitation of the existing storm sewer line to reduce infiltration of contaminated ground water from the shallow aquifer to the storm sewer
- Installation of a ground water collection drain adjacent to the existing storm sewer line and to the top of bedrock to extract contaminated ground water in the overburden
- Installation of a ground water treatment plant at NWP to perform chemical precipitation, either powdered activated carbon treatment or an advanced oxidation treatment, and finally granulated activated carbon (GAC) polishing.

Concurrent with operating the OU2 remedy, the site team is conducting the OU3 Remedial Investigation. The objectives are to evaluate sources, nature, extent, migration pathways, and receptors of site-related contamination in deep ground water. These efforts include the addition of 13 monitoring wells (vertical well pairs CW-9 through CW-14 and single well CW-15), sampling of site-wide wells, sampling of surface water, pumping tests, ground water flow modeling, and an evaluation of the recovery system.

### 3.2 TREATMENT PLANT OPERATION STANDARDS

The design influent concentration and effluent concentration standards for the primary contaminants of concern are summarized in the following table.

<b>Contaminants of Concern</b>	<b>Design Influent Concentration</b>	<b>NPDES Monthly Average Effluent Standard</b>
PCP	11 mg/L	1 ug/L
Phenanthrene		3 ug/L
Benzene		1 ug/L
Trichloroethylene		5 ug/L
TCDD (dioxins/furans)	1 ug/L	< 4.4 ppq
TSS	10 mg/L	No standard
Cobalt		53 ug/l
Iron	270 mg/L	300 ug/L
Manganese	13.8 mg/L	50 ug/L
Oil & Grease	3,500 mg/L	15 mg/L

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## **4.0 FINDINGS AND OBSERVATIONS FROM THE OSE SITE VISIT**

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### **4.1 FINDINGS**

The evaluation team observed a conscientious and knowledgeable site team (i.e., EPA and its contractor) that has effectively managed this interim remedy, provided a number of much needed plant improvements, and initiated the remedial investigation for OU3. 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 obviously have the benefit of being formulated based upon operational data unavailable to the original designers. Furthermore, it is likely that site conditions and general knowledge of ground water remediation have changed over time.

### **4.2 SUBSURFACE PERFORMANCE AND RESPONSE**

#### **4.2.1 WATER LEVELS**

Water levels collected in both the shallow zone (overburden) and deep zone (bedrock) in March 2003 have been used by the site team to generate potentiometric surface maps. These maps are presented in Figures 4-1 and 4-2. Approximately 29 measurement points are used to generate the shallow potentiometric surface map, and approximately 14 measurement points are used to generate the deep potentiometric surface map. Both figures show ground water flow to the southeast, and both figures show the influence of the collector drain. As expected, the influence of the collector drain in the shallow zone is more predominant than the influence in the deeper zone. This is partially due to the use of water level measurement points within the drain when generating the shallow potentiometric surface. Nevertheless, the influence of the drain on the deeper water level measurements suggests that, under pumping conditions, some water in the deeper aquifer is entrained by the drain. These two figures, when compared with each other, can be used to interpret vertical ground water flow, but no easily discernible trend is recognized.

These water levels only pertain to the conditions during the Spring of 2003, and more specifically to March 2003. Water levels conducted at different times may suggest seasonal variation in both horizontal and vertical ground water flow.

#### **4.2.2 CAPTURE ZONES**

As part of this report, the OSE team has used the March 2003 potentiometric surface maps generated by the site team to interpret the horizontal capture in both the shallow and deep zones. The interpreted areas of capture are depicted in Figures 4-1 and 4-2, with the shallow capture zone more extensive than the deeper capture zone. Therefore, ground water that flows up from within the deeper capture zone should be within the shallower capture zone. These preliminary analyses consider only one round of water levels and do not rigorously consider vertical flow. Because water levels may change seasonally affecting both horizontal and vertical flow, a more thorough capture zone analysis is merited.

No particular target capture zone appears to have been documented by the site team. This is likely because OU2 is an interim remedy and because the collector drain could not be extended as far to the

south as originally planned due to the residences. Nevertheless, the surface water contamination in Naylor's Run has decreased, and the interpreted shallow capture zone appears to provide capture for the most contaminated portions of the site, including the contamination at CW-4 and CW-5. This contrasts with a more thorough capture zone evaluation conducted by the site team with the water levels collected during December 2002 (not provided in this report). The deeper capture zone interpreted from the March 2003 data is also fairly extensive but does not appear to include the contamination at CW-4 and CW-5.

A water budget analysis can also be conducted to provide a simplistic evaluation of capture. The following parameter values are relevant.

- According to the 1991 ROD, the ground water velocity in the shallow aquifer is approximately 85 feet per year (0.23 feet per day). Assuming this ground water velocity was calculated using a porosity of 0.30, this translates to a Darcy velocity of approximately 25.5 feet per year (0.07 feet per day).
- Conservatively, the saturated thickness of the overburden (and perhaps the upper portion of the fractured bedrock) is 35 feet.
- Approximately 20 gpm (3,860 ft<sup>3</sup> per day) is extracted from the trench.

Assuming limited infiltration from precipitation or from the underlying formation, the amount of water extracted by the drain is equal to the amount of water flowing through a given cross-section of the aquifer. This equality can be expressed as follows ( $Q = V_d W b$ ), where  $V_d$  is the Darcy velocity,  $W$  is the width of the cross-section, and  $b$  is the saturated thickness. This equation can be rearranged to solve for the width.

$$W = \frac{Q}{V_d b} = \frac{3,860 \text{ ft}^3/\text{day}}{0.07 \text{ ft}/\text{day} \times 35 \text{ ft}} = 1,575 \text{ ft}$$

This result suggests that the width of capture is approximately 1,575 feet; however, this result is based on the simplifying assumption that there is no infiltration from precipitation or from the underlying formation. Much of the overlying ground is paved, which means that there is likely little contribution from precipitation. However, the potentiometric surface for the deeper zone indicates influence from the collector drain. Therefore, the capture zone width is likely smaller than the 1,575 feet because the effective capture zone depth is likely greater than the 35 feet that was assumed in the water budget calculation. In general, the water budget analysis supports the interpretation from the potentiometric surface maps that capture is fairly extensive across the site. Neither of the above evaluations, however, confirm complete capture across the site, especially in areas where contamination has not been fully delineated (i.e., vertically and to the south).

Water quality sampling from downgradient wells can also be used to evaluate capture. The October 2002 sampling event included sampling of clusters CW-9 through CW-14 and sampling of CW-15. With the exception of CW-9S, all of the shallow samples had undetectable concentrations of PCP. All of the shallow samples had concentrations of dioxins under the MCL of 0.03 ppt. The elevated PCP concentration at CW-9S (70 ug/L) suggests that contamination either reached this location prior to operation of the interim OU2 ground water remedy, that capture is incomplete and PCP contaminated ground water continues to migrate from the source area to this location, or that CW-9S is located inside the capture zone. It is reasonable to assume that this contamination at CW-9S was present prior to pumping, or, based on Figure 4-1, it is reasonable to conclude that CW-9S is within the capture zone. To evaluate capture in the future, the trend in CW-9S can be analyzed, but the results may be inconclusive.

If the trend shows decreasing concentrations toward background, this will indicate that CW-9S is outside of the capture zone and that capture is successful. If concentrations remain the same or increase, this could mean that CW-9S is either within the capture zone or that capture is not successful. Therefore, evaluation of capture should not depend heavily on sampling results from CW-9S.

With the exception of CW-9D and CW-13D, the downgradient wells in the October 2002 ground water sampling event had undetectable concentrations of PCP and dioxin levels below the MCL. As with the shallow zone, this contamination may have been present before operation of the OU2 system began. If capture is sufficient, the concentrations should decrease to background (i.e., zero) over time. If the concentrations consistently remain elevated or increase, then capture is likely insufficient.

A primary concern regarding capture is the presence of an abandoned 12-inch sewer line that is likely acting as a conduit for contaminated ground water. This sewer line apparently ends near Naylor's Run in the location of "impacted seeps" indicated on Figure 1-1.

In general, the interim remedy has functioned as designed by substantially reducing contaminant transport into Naylor's Run. Capture in the shallow zone may or may not be complete, but a number of lines of evidence suggest that the capture zone is fairly extensive and extends into the deeper zone. Addressing the abandoned sewer line, first discovered in Summer 2003, presents the most severe issue with respect to contaminant migration and further impacts to Naylor's Run.

#### **4.2.3 CONTAMINANT LEVELS**

Ground water sampling in October 2002 provides an indication of the extent of ground water contamination. The most impacted areas are beneath the former NWP property and the PCG property. Concentrations downgradient of these properties are relatively low and even undetectable in most locations. Ground water sampling has not been conducted long enough to evaluate a trend toward cleanup. However, it is reasonable to conclude that concentrations upgradient of the collector drain have not decreased substantially. NAPL remains a continuing source in this area, minimal background flow is present to flush the contaminants toward the collector drain, and the recovery wells have been fairly unsuccessful at recovering NAPL.

The ground water sampling is also relatively incomplete in terms of delineating the plume, particularly to the south and in the vertical direction. The wells in the CW-4 and CW-5 clusters are the southern most wells near Eagle Road, and as shown in Figures 1-3 and 1-4, the PCP concentrations at these wells exceed 1,000 ug/L. With no additional wells to the south, the PCP plume is not delineated. This lack of delineation affects the preliminary capture zone analysis conducted above because the degree of capture cannot be determined without full delineation. As depicted in Figure 1-4, a number of deep wells with screened intervals down to approximately 50 feet below ground surface have concentrations exceeding 1,000 ug/L. Without deeper wells, the PCP plume cannot be considered delineated vertically. In EW-1 through EW-3 (extraction wells located upgradient of the collector drain that have never been used for pumping), the concentrations are also above 1,000 ug/L. These wells are screened from approximately 40 to 80 feet bgs, whereas the collector drain is completed to approximately 16 feet bgs. With this relatively long screened interval, the vertical extent of contamination cannot be determined. The contamination may only be present near the tops of these relatively long screened intervals, but it may also be present at deeper levels. In addition, these wells may be acting as conduits, allowing contamination at approximately 40 feet to migrate to depths near 80 feet. The upward gradient in this area due to the operation of the collector drain makes this downward migration unlikely, but this possibility should not be eliminated without deeper sampling.

The concentrations entering the treatment plant are below the design values. The influent concentrations and the design concentrations are compared in the following table.

Parameter	Design Influent Concentration (ug/L)	Actual Influent Concentration* (ug/L)
PCP	11,000	3,900
Dioxins/Furans	1	0.0015
Iron	270,000	8,400
Manganese	13,800	11,000
Oil and Grease	3,500,000	15,000
Total VOCs	No design value	< 100

\* Average influent concentration between September 2002 and June 2003 rounded to two significant digits

The mass removal rate for PCP, assuming the above concentration and an extraction rate of 20 gpm, has been approximately 1 pound per day as shown in the following equation.

$$\frac{20 \text{ gal.}}{\text{min.}} \times \frac{3,900 \text{ ug}}{\text{L}} \times \frac{3.785 \text{ L}}{\text{gal.}} \times \frac{1440 \text{ min.}}{\text{day}} \times \frac{2.2 \text{ lbs}}{10^9 \text{ ug}} = \frac{0.94 \text{ lbs}}{\text{day}}$$

Mass removal of other VOCs and SVOCs (including benzene, trichloroethylene, and naphthalene) is also occurring, but at a much reduced level compared to the mass removal of PCP. The following table presents those constituents in the influent that are above the discharge standards and require treatment.

Parameter	Maximum Influent Concentration (ug/L)	NPDES Monthly Average Effluent Standard (ug/L)
Benzene	12	1
Trichloroethylene	15	5
Naphthalene	1,800	30
PCP	9,500	1
Phenanthrene	400	3
Oil and Grease	61,200	15,000
Aluminum	2,470	360
Cobalt	227	53
Iron	43,500	300
Lead	8.6	5
Manganese	12,300	50

\* Influent data from September 2002 through June 2003

Sampling data indicate that effluent concentrations of all the primary contaminants of concern are below the effluent standards with the exception of manganese. The site team determined that the manganese was leaching from the clay filter. The clay has since been taken off line, and exceedances of manganese have not occurred since.



## **4.3 COMPONENT PERFORMANCE**

### **4.3.1 EXTRACTION SYSTEM WELLS, PUMPS, AND HEADER**

The extraction system consists of the collector drain and the four recovery wells. The collector drain is constructed like a french drain in a trench that is approximately 2 feet wide, 180 feet long, and approximately 15 to 20 feet deep (completed to the top of bedrock). Water from the drain enters a four foot sump where a Grundfos electric submersible pump directs water to the treatment plant in a 2-inch pipe. Potential flow is limited by a 1-inch connection located in the piping near the drain. Four piezometers are completed within the trench to provide an indication of drawdown. The high and low level settings for transducers in the trench are not known, and there is not sufficient pumping capacity to reach the low level. The drain sump is reportedly full of solids and requires cleaning.

The recovery wells are completed to the top of bedrock, which is about 30 feet bgs. They operate well below expected recovery rates, with only one well pumping over 2 gpm. None of the wells produce much product. The majority of recovered product is collected manually from R-2, which is located adjacent to RW-2. All of the wells are in need of rehabilitation.

Three 6-inch wells (EW-1 through EW-3) were drilled, but were not converted to extraction wells and have not operated. These wells are screened from 40 to 80 feet bgs just upgradient of the trench.

The extraction system piping is equipped with a leak detection system, but this system frequently sets off alarms due to precipitation inflow (not associated with leaks). These alarms shut down the extraction, causing downtime. The site team has therefore disconnected the leak detection system, allowing the system to avoid unnecessary downtime during rain events.

### **4.3.2 OIL/WATER SEPARATOR AND EQUALIZATION TANK**

The oil/water separator receives an influent flow of about 20 to 25 gpm typically. Minimal LNAPL is recovered by the separator system. The free product tank is extremely oversized for this application; the site team has added a fill line and level transmitter to make the tank easier to use. The two 2,800-gallon equalization tanks receive water from the oil/water separator. The site contractor has added a level transmitter within the first tank and a site tube for local level reading. The equalization tank effluent pump basket strainers and ball check valves require daily cleaning to keep the plant operational.

### **4.3.3 METALS REMOVAL SYSTEM**

The three 800-gallon tanks allow for chemical addition and mixing. Transfer from one tank to the next is gravity fed, and the first tank is the rate-limiting step for the entire treatment plant. Although the plant is reportedly designed for 40 gpm, the first tank begins to overflow (or at least splash over) at just under 40 gpm. The other components of the metals removal system, including the other tanks, chemical addition, lamella clarifier, and sand filter operate as expected. Nevertheless, they require frequent cleaning. The May 2003 process sampling indicates that the effluent from the clarifier meets the metals discharge standards.

### **4.3.4 UV/OX SYSTEM**

Water from the sand filter discharges to a surge tank where a 50% hydrogen peroxide solution is added to the process water for a hydrogen peroxide concentration of 200 ppm. The water from this surge tank is then pumped through the UV/OX system, which consists of three 30 KW reactors arranged in series. The

May 2003 process sampling indicates that the effluent from the first UV reactor meets all of the organic discharge standards with the exception of PCP. The PCP concentration at this location in May 2003 was 2.3 ug/L compared to the discharge standard of 1 ug/L, which could easily be removed by remaining UV reactors or simply GAC units alone.

Maintenance of the UV/OX system involves replacement of the seals and bulbs and periodic cleaning of the surge tank and reactors. The site team plans to add bag filters between the sand filter and the surge tank to remove solids that pass through the sand filter. This should reduce the amount of solids entering the surge tank and the UV/OX system.

The UV/OX system has been the primary reason for the above-average downtime. Between April and July 2003, plant uptime was only 64%. Main problems include lamp failures, a blower motor failure, and an insufficient inventory of replacement parts. The blower motor failure alone resulted in a four-day shutdown because the part was not on hand.

#### **4.3.5 PEROXIDE DESTRUCTION UNIT, CLAY FILTER, AND GAC**

The peroxide destruction unit (PDU) operates as intended, reducing the hydrogen peroxide concentration to 10 ppm or less. The site team has replaced the 2,000 pounds of carbon in this unit once and has added the capability to backwash the PDU. The clay filter has been taken off line due to the leaching of manganese that had built up over time and was causing periodic exceedances of the manganese discharge standard. The clay filter was not needed or helpful in reaching organic treatment standards. Cartridge filters are used to further reduce solids prior to the GAC.

The two 4,000-pound GAC units have been replaced once since the plant began operation in 2001. The replacement was not due to organic contaminant loading or to pressure build up. It was due to the potential leaching of manganese that had built up over time and was potentially contributing to exceedances of the manganese discharge criteria.

Frequent backwashing of the GAC and PDU have contributed to the system downtime. This is primarily because the current design of the treatment plant does not allow for storage of the waste water generated from the backwashing. As a result, extraction needs to be temporarily stopped to allow continued treatment to provide capacity in the equalization tanks.

#### **4.3.6 EFFLUENT TANK AND DISCHARGE**

Prior to discharge via pumping to Naylor's Run, the process water is emptied into two 3,000-gallon effluent tanks that are located outside of the plant building. As with other treatment components, the effluent tanks and pumps require frequent cleaning due to biological build up.

#### **4.3.7 SLUDGE HANDLING TANKS AND EQUIPMENT**

Sludge from the system clarifier, oil/water separator, and the sand filter is thickened in a 4,500-gallon sludge holding tank prior to being dewatered in a filter press. The filter press is operated about once per week. Approximately 10 cubic yards of sludge is disposed of every 8 to 12 weeks. The sludge is hazardous because it is listed waste (F032) and contains dioxins. This sludge and the recovered product (in liquid form) is shipped and incinerated.

**4.3.8 SYSTEM CONTROLS**

The site team has added a number of flow meters, high and low level controls, and sensors to facilitate plant operation. It has also added a PC, software for trending analyses, and a DSL with PC Anywhere software for remote access and viewing. Original documentation on the control system is limited.

**4.4 COMPONENTS OR PROCESSES THAT ACCOUNT FOR MAJORITY OF ANNUAL COSTS**

Annual O&M costs for year two of the current contract (2003-2004) are approximately 591,000 per year, which marks a decrease of \$68,000 compared to the O&M costs for year one of the current contract (2002-2003). The following table presents an estimated breakdown of Year-2 annual costs as provided by the site contractor. A cost of \$50,000 was incurred in Year 1 and is expected in Year 2 for major equipment changes and plant improvements, but this \$50,000 cost is not included in the table because such repairs/improvement should not be indicative of future O&M. All presented costs are approximate.

<b>Item Description</b>	<b>Estimated Cost</b>
Labor: Project management and reporting, technical support, and design of plant improvements	\$75,000 per year
Labor: Plant operator (one full-time operator, one part-time engineer to upgrade the remedy)	\$180,000 per year
Labor: Process and ground water sampling and data analysis	\$75,000 per year
Utilities: Electricity (assumes two operating UV/OX units)	\$55,000 per year <sup>1</sup>
Utilities: Water, phone, garbage, and cap maintenance	\$15,000 per year
Non-utility consumables: chemicals	\$70,000 per year
Non-utility consumables: UV lamps/accessories (assumes two operating UV/OX units)	\$16,000 per year
Non-utility consumables: GAC	\$20,000 per year <sup>2</sup>
Chemical Analysis	N/A <sup>3</sup>
Routine maintenance items	\$30,000 per year <sup>4</sup>
Waste disposal	\$55,000 per year <sup>4</sup>
<b>Total Estimated Cost</b>	<b>\$591,000</b>

<sup>1</sup> Site contractor estimated \$75,000 using three UVOX units, \$55,000 is a rough estimate for two UVOX units (some of the electricity costs are due to pumps/motors and will not decrease with bypassing a UV/OX unit).

<sup>2</sup> Site contractor estimated \$40,000 in Year 1 for one replacement of two units and no replacements in Year 2. The OSE team estimates \$20,000 per year for one replacement of one unit.

<sup>3</sup> Chemical analysis is conducted by EPA and costs are not assigned to the site.

<sup>4</sup> Costs are incurred periodically, and the presented costs represent averages between Year 1 and Year 2.

**4.4.1 UTILITIES**

The primary contributor to utility costs is the electricity required to power the three UV/OX reactors. In Year 1, three UV/OX units were used at a total of 90 KW, which likely translates to an electricity cost of approximately \$75,000 per year. The remainder of the electric costs are likely due to the process pumps, blower motors, and compressor. In Year 2 and future years, the site team plans to reduce the number of UV/OX units to two, which should reduce electricity costs to approximately \$55,000 per year (some of the electricity costs are due to pumps/motors and will not decrease with bypassing a UV/OX unit). The remaining utilities include garbage pickup, maintenance of the cap, phone, and public water.

#### **4.4.2 NON-UTILITY CONSUMABLES AND DISPOSAL COSTS**

Non-utility consumables represent approximately \$106,000 per year in O&M costs for Year 2. Chemicals for the metals precipitation and peroxide for the UV/OX system are the dominant consumables costs, and ferric sulfate (for metals removal) is the dominant chemical cost. Of the remaining \$36,000 per year, approximately \$16,000 is need for UV/OX maintenance parts. It should be noted that the above table assumes replacement of one GAC unit per year, primarily due to solids build up. If solids fouling does not occur with the clay filter removed, GAC replacements may be less frequent. Because of the extremely low contaminant concentrations entering the GAC, frequent replacements are not expected due to loading of organic contaminants. Waste disposal costs are about \$55,000 per year and are mainly for disposing of sludge and recovered oil as hazardous waste.

#### **4.4.3 LABOR**

Labor contributes more than 50% of the total O&M costs at this site, and is divided into three primary categories: plant operation, PM/reporting, and ground water sampling/data analysis. Between Year 1 and Year 2, plant operation has been reduced by \$20,000 for an Year-2 cost of \$180,000. This cost includes one full-time operator and one part-time engineer that is contributing to system improvements. The PM/reporting corresponds to approximately \$6,500 per month and includes preparation and attendance at the monthly site meetings, engineering support for improving the treatment plant, and preparing monthly Discharge Monitoring Reports. The sampling costs of \$75,000 per year include the cost of the NPDES, quarterly process sampling, and ground water sampling. The majority of these sampling costs are related to the ground water sampling and associated data analysis because of the labor and equipment involved in low-flow sampling.

#### **4.4.4 CHEMICAL ANALYSIS**

Chemical analysis costs are not incurred by the site because EPA conducts the analysis through the Contract Laboratory Program.

### **4.5 RECURRING PROBLEMS OR ISSUES**

The previous manganese exceedances represent a recurring issue but have been addressed by removing the clay filter and replacing the carbon in the PDU and GAC units. Another recurring issue that has been addressed was the leak detection system response to precipitation inflow. The leak detection system has been shut down to avoid unnecessary downtime during rain events.

The limiting capacity of the first mixing tank in the metals removal system is also a recurring issue. Although the extraction rate is generally between 20 and 25 gpm, the process rate of the treatment plant is generally higher due to backwashing of filtrate from the filter press, and other recycled water or water added from outside the system. If the extraction rate is increased in the future, the limiting capacity of this tank will be problem.

Maintenance issues with the UV/OX system cause excessive down time. At the time of the OSE, it was practice to shutdown the entire treatment plant if one of the three UV/OX reactors was not working. Therefore, when the blower on the third reactor failed, this caused system-wide downtime. System-wide downtime was also caused by repeated lamp failures on the second reactor.

In general, a number of treatment plant features have required modification or replacement. The absence of level transmitters, flow meters, and flow controls at various parts of the plant (presumably due to cost-cutting measures during design and installation) have hampered O&M of the plant and general trouble shooting. The site team has worked to improve many of these features; nonetheless, issues with original design and construction (such as limited space and lack of as-built drawings and control system documentation) repeatedly arise and require both time and expense to address.

#### **4.6 REGULATORY COMPLIANCE**

With the exception of the manganese exceedances, which have now been addressed, the system regularly meets its discharge criteria.

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

No process excursions, accidents, or reagent releases were reported during as part of this optimization effort.

#### **4.8 SAFETY RECORD**

One accident has occurred at the treatment plant. The RPM, while visiting the plant, tripped on the door jamb and fell down a step resulting in a knee injury. The concrete pad has since been modified to reduce the tripping hazard, and safety paint has been applied to draw attention to corners, steps, and the door jamb.

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

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### **5.1 GROUND WATER**

The interim ground water remedy has accomplished many of its intended goals. The lining of the 30-inch storm sewer and the installation of the collector drain has reduced transport of contaminated water into Naylor's Run. Many of the surface water samples now have non-detect results because this portion of the remedy has functioned as intended.

Despite these success, the interim remedy is likely not suitable as the final remedy without modifications. First and foremost, the abandoned 12-inch sewer line that was first discovered in 2003 is likely facilitating transport of PCP and dioxin from ground water to a downgradient location. PCP concentrations in seeps as high as 750 ug/L have been detected. Human and other receptors can be exposed to this contamination if it is not controlled or removed.

The current remedy may also not provide adequate capture. Current site conditions (with the exception of the 12-inch sewer line) suggest that PCP is not reaching surface water in detectable amounts; however, if the plume containment is not adequate, contaminated ground water may impact surface water in the future. The interpreted capture zone, based on fairly preliminary analysis of the March 2003 ground water elevation data (See Section 4.2.2), appears fairly extensive. However, the interpreted capture zone based on other data is somewhat less extensive. Furthermore, the vertical extent of the capture zone is difficult to evaluate and the plume is not fully delineated in both the horizontal (especially to the south) and vertical directions.

It is understood that many of these items were not intended as part of OU2 and that they will be addressed as part of OU3, which represents the final remedy for ground water.

### **5.2 SURFACE WATER**

Conditions in Naylor's Run have improved substantially due to the operation of the OU2 interim remedy; however, portions of Naylor's Run still have substantial impacts likely due to a 12-inch sewer line providing a conduit for contaminated ground water to reach the surface and discharge into Naylor's Run. Seep concentrations of PCP have been as high as 750 ug/L and sediment PCP concentrations have been as high as 6,200 ug/kg. Dioxin concentrations are also elevated. This area is indicated on Figure 1-1.

Proper sealing of the abandoned sewer line and localized remediation efforts as part of OU3 should be able to address this contamination.

### **5.3 AIR**

Due to previous removal actions, air quality is no longer adversely affected by the site.

## **5.4 SOILS**

Soils beneath the NWP cap are impacted, but the cap prevents direct contact with these soils. Other soils downgradient of the cap and along the water table are also likely impacted due to the migration of free product and the ability of the free product to smear as the water table rises and recedes. These soils should not be a threat to human health unless there are invasive activities in these areas. Efforts should likely be taken to delineate these areas and provide institutional controls to notify construction workers or others that may be involved in these invasive activities.

A greater threat to human health and the environment are the surface soils that are impacted by PCP and dioxin from the contaminated water that is accumulating in the 12-inch abandoned sewer and discharging to the surface. These soils are located in a Residential Open Space and are accessible to homeowners in the area.

## **5.5 WETLANDS AND SEDIMENTS**

The discussion in the above sections regarding the impacted seep also apply to the sediments in this area. Conditions in the wetlands and sediments will be addressed as part of OU3.

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## 6.0 RECOMMENDATIONS

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

### 6.1 RECOMMENDATIONS TO IMPROVE EFFECTIVENESS

The recommendations in this section are not intended to imply deficiency of the OU2 remedy. It is recognized that the OU2 remedy is an interim measure to address shallow ground water contamination and its impacts on Naylor's Run. Many of these recommendations in this section are offered not as improvements to OU2 but as considerations for OU3. Some of these recommendations (particularly 6.1.1), however, should be implemented as soon as possible and potentially as part of an emergency response.

#### 6.1.1 PROPERLY SEAL ABANDONED 12-INCH SEWER LINE AND REMEDIATE SURFACE SOILS NEAR THE SEEP

The site team is already addressing this issue. The first step involves locating the upgradient portion of this abandoned sewer line immediately downgradient of the collection drain. It is thought that the line may have been broken or disturbed during construction of the collection drain, allowing ground water to infiltrate it. Once the upgradient portions are located, they can be evaluated to confirm that this line is the cause of the impacted seeps further downgradient. Once confirmed, the line and the associated bedding material should be plugged to prevent further infiltration and transport of contaminated water. With the line plugged, the seep area can be evaluated to confirm that the discharge has stopped, and then the contaminated soils and sediments can be addressed.

This recommendation is of primary importance and should be done as soon as practicable. Because this area is considered a Residential Open Space (ROS) and is available to nearby residents, the contaminated area should be clearly marked to warn residents of the contamination.

The abandoned line has been identified at possibly 9 feet bgs. Assuming that the line can be found, a dye test and possibly a video inspection can be used to confirm the connection to the ROS area. Once confirmed the line and bedding can be plugged with a cement/bentonite slurry. The length of the line to be plugged beyond the upgradient end would be determined by the condition and accessibility of the line between the collection drain and the ROS area. The exact scope of this work cannot be determined at this point but an expenditure of \$50,000 or less might be sufficient to eliminate this preferential pathway. Once the pathway has been eliminated, contaminated soil and sediment can be delineated and removed from the ROS; assuming that the amount of material to be removed is less than 500 cubic yards remediation might be accomplished for about \$150,000. Note these cost estimates were not rigorously determined by the OSE team, and higher costs are possible (estimates that suggest higher costs should be thoroughly reviewed).



## 6.1.2 IMPROVE PLUME DELINEATION TO THE SOUTH AND VERTICALLY

Monitoring well clusters CW-4 and CW-5 include the southern most wells at the site, and they are contaminated with PCP concentrations over 1,000 ug/L. An additional monitoring well cluster should likely be placed further south with monitoring wells at the shallow and deep intervals. For cost-effectiveness, wells at the intermediate elevations can likely be omitted. The optimization team suggests placing this single cluster (with a shallow and deep well) approximately 250 feet south of CW-4. This should place the well on Lawrence Road directly to the south of CW-4. It is expected that shallow and deep monitoring wells at this location will yield samples with concentrations of PCP and dioxin that are undetectable or below MCLs. This would delineate the plume to the south. If concentrations are low, but above the MCLs, perhaps the southern boundary of the plume can be determined by extrapolation between CW-4, CW-5, and this new cluster. If extrapolation is unacceptable, then the next likely place to locate a monitoring well cluster is on Achille Road, directly south of CW-4 and the new cluster.

To delineate the plume vertically, deeper wells should be installed in multiple locations (perhaps up to four locations). In addition to delineating the plume, these wells would provide monitoring points to confirm that the final remedy (when implemented) prevents contamination from migrating at depth. Due to the high concentrations found as deep as 50 feet below ground surface, it is likely that contamination is also present from 50 to 60 feet and possibly from 60 to 70 feet. Therefore, for delineation, the appropriate depths of the wells might be from 70 to 80 feet below ground surface, but a more appropriate depth may be determined by the site team after further reviewing historical data and well logs. The well logs from the construction of the extraction wells may be helpful. Alternatively, drilling techniques where different depths are sampled as drilling occurs (to determine a final screen interval), using packers, can be utilized.

Although the deeper portions of the extraction wells could be sampled to help determine the extent of vertical contamination, the results would likely be inconclusive. For example, if these deeper samples are contaminated, the contamination could be due to the following reasons:

- the lower portion of the screened interval is hydraulically connected to the upper portion and contamination from shallower intervals is being drawn down during sampling
- the wells have historically acted as conduits for downward migration of contamination, but this condition is not representative for other parts of the site
- contamination has migrated to this depth naturally and may be at this depth (or greater depths at other parts of the site)

Because the results would be potentially inconclusive, sampling of the deeper portions of the extraction wells is not recommended.

The following are suggested locations for installing deep wells.

*Downgradient of the collector drain beyond the interpreted zone of capture (perhaps 100 to 200 feet downgradient of the interpreted capture zone)* – The collector drain captures contamination from the overburden and likely from the shallower portions of the bedrock. A deep well would help determine if contamination is present at a depth of 70 to 80 feet and migrating beneath the collector drain. To evaluate capture at slightly shallower depths, this location would also be appropriate for a well screened at a shallower interval (perhaps 40 to 50 feet).

*Co-located with CW-9* – CW-9D is approximately 50 feet deep and has PCP concentrations above MCLs. In addition, CW-9D is downgradient of CW-4D and CW-5D, which have PCP concentrations as high as 5,200 and 1,700 ug/L, respectively. Co-locating a deep well (approximately 70 to 80 feet deep) with CW-9D should vertically delineate contamination in this area. Furthermore, the enhanced CW-9 cluster (i.e., with wells at three depths) should provide a downgradient monitoring point to confirm that the final remedy (when implemented) provides capture of the contamination found at CW-4D and CW-5D. If capture is adequate, concentrations at the three CW-9 wells should decrease to background (i.e., non-detect) over time.

*Co-located with CW-13* – CW-13D is the deepest downgradient point with contamination above the MCL. It had a concentration of 44 ug/L in October 2002. This deep well should provide vertical delineation of this contamination. Furthermore, along with the new deep wells at CW-9 and downgradient of the collector drain, this enhanced CW-13 cluster (i.e., with wells at three depths) should provide downgradient monitoring points (assuming deep ground water flow is in the same direction as ground water flow at shallower intervals) to enhance the capture zone evaluation of the final remedy (when implemented).

*Co-located CW-6D* – Of the four proposed locations, this is the only location upgradient of the collector trench. If samples from this new well have low or undetectable concentrations, then this location would help vertically delineate contamination. In addition, over time it could be monitored to determine if contamination is migrating downward.

In general, the proposed well locations have been chosen to both vertically delineate contamination and to serve as performance monitoring points for the final remedy. The main presumption is that contamination at depth will continue to migrate to the southeast (the deep hydraulic gradient can be evaluated with these new wells) and that as long as these performance monitoring points remain clean or decrease to background levels, then the plume is adequately contained and further vertical delineation is not necessary. If this presumption is not sufficient justification, then an additional deep well could be added at another location such as co-location with CW-2 or CW-3.

In summary, seven monitoring wells have been suggested. Two wells would be part of a cluster to the south with a shallow and deep well (40 to 50 feet), one is 50 feet deep and downgradient of the collector drain, and the other four are 80 feet deep. If contamination is found further to the south, an additional well may also be needed. The depths suggested are preliminary, and drilling techniques where different depths are sampled as drilling occurs (to determine a final screen interval), using packers, could be utilized. The installation and two rounds sampling of the seven proposed wells should cost approximately \$120,000 to \$150,000, including a work plan, oversight by a geologist, and a report describing the delineation of the plume and a proposed target capture zone. Adding annual sampling these wells to a sampling program would likely increase annual costs by up to \$5,000.

### **6.1.3 EVALUATE PLUME CAPTURE ONCE PLUME IS DELINEATED**

Once the site team has sufficiently delineated the plume both to the south and vertically, a capture zone analysis should be conducted. The capture zone analysis should include a clear statement of the target capture zone and consist of converging lines of evidence such as those discussed in Section 4.2.2. These lines of evidence include a water budget analysis, interpretation of capture using the potentiometric surface maps under pumping conditions, and trend analyses in wells expected to be downgradient of the capture zone.

A ground water flow model with particle tracking could also be applied at this site to evaluate capture. For evaluating horizontal capture this does not appear necessary, but for evaluating the vertical extent of capture it may be helpful because the model could be used to help understand vertical ground water flow. Furthermore, because additional extraction is likely necessary to provide adequate capture, a flow model could be helpful in evaluating various pumping scenarios. This is particularly crucial since the treatment plant has a limited capacity (under 40 gpm), and increasing this capacity significantly could be costly.

The estimated cost for the capture zone analysis without the model is approximately \$20,000, including documentation of this analysis in a report. The development of a well-calibrated flow model, and its use in evaluating both capture and various extraction scenarios might cost \$35,000.

#### **6.1.4 TAKE MEASURES TO FURTHER REDUCE SYSTEM DOWNTIME**

The maintenance problems associated with keeping three UV/Oxidation units operating continuously has resulted in excessive downtime of the system. Using three units in series to meet effluent standards is unnecessary and the site team is already considering bypassing one unit. Bypassing any number of the units will allow a standby unit to be available in case of the unexpected but common downtime of one operating UV/Oxidation unit. In addition, bypassing two units or all three units (i.e., using GAC for primary organics treatment) may also be more cost-effective (see section 6.2.1). For the purpose of reducing system downtime, we recommend that at least two of the units be bypassed. One UV/Oxidation unit could be kept as a standby unit, and the third unit could be either kept at the site in reserve or removed for use at another site. Even with additional flow likely from the final remedy one UV/oxidation unit followed by GAC polishing will be a conservative system. The site should also maintain a sufficient parts inventory to allow timely repair and/or replacement of system parts. Maintaining this inventory will reduce the likelihood that downtime will occur due to backlogs in obtaining parts.

A few other issues contribute to downtime. One issue, which is discussed further in Section 6.3.2, involves modifying the plant to provide storage of backwash waste water. The other pertains to the lack of documentation associated with the system controls. A number of alarms cause system shut downs, and in the absence of good documentation for these controls, the site team is in the process of learning the logic behind the various alarms. This issue will be addressed over time given that the site team continues its efforts to become familiar with the system.

There are no added cost to implementing these steps. There are likely cost reductions associated with reducing the number of UV/Oxidation units, but these potential saving are discussed in Section 6.2.1.

## **6.2 RECOMMENDATIONS TO REDUCE COSTS**

### **6.2.1 USE FEWER UV/OXIDATION UNITS**

The site team is considering bypassing one of the UV/Oxidation units which will save about \$20,000 per year in electricity, \$8,000 in lamps and accessories, and \$4,000 per year in hydrogen peroxide. These savings are already reflected in Section 4.4 of this report. Based on the May 2003 process sampling event, greater than 99.9% of the organics mass removal is achieved in the first UV/OX unit.

Parameter	Maximum Influent Concentration 9/2002 -6/2003 (ug/L)	5/2003 Influent Concentration (ug/L)	Effluent After First UV/OX Unit 5/2003 (ug/L)	NPDES Monthly Average Effluent Standard (ug/L)
Benzene	12	9.4	ND	1
Trichloroethylene	15	13	0.078 B	5
Naphthalene	1,800	24	ND	30
PCP	9,500	2,900+	2.3 J	1
Phenanthrene	400	25	0.02 B	3

B - contaminant found in laboratory blank

J - estimated value

Although the effluent of the first UV/Oxidation unit had a PCP concentration (2.3 ug/L) greater than the discharge standard, the two 4,000-pound GAC units can easily reduce this concentration below that standard without increasing the GAC replacement frequency. Furthermore, at 99.9% removal, one UV/Oxidation unit would reduce 9,500 ug/L of PCP (i.e., the maximum influent concentration between September 2002 and June 2003) to 9.5 ug/L, which can also easily be reduced below discharge standards with the GAC units without affecting the GAC replacement frequency. Therefore, two UV/Oxidation units can be bypassed without sacrificing effectiveness at an additional savings of approximately \$32,000 per year relative to the costs reported in Section 4.4 of this report. As mentioned in Section 6.1.4 system downtime can be reduced by using one of the bypassed units when the operating unit has failed or is undergoing maintenance.

It is also possible to consider completely bypassing the UV/Oxidation units. For each of the organic contaminants found in the plant influent above discharge limits, the following table presents the average influent concentrations between September 2002 and June 2003, the estimated mass loading at a maximum flow rate of 40 gpm, a common GAC adsorption isotherm, the ratio of GAC usage to mass loading, and the estimated GAC per year usage assuming no UV/Oxidation units are operating.

Parameter	Average Influent Concentration 9/2002 - 6/2003 (ug/L)	Estimated Mass Loading at 40 gpm (lbs/year)	Isotherm*	Ratio of GAC Usage to Mass Loading (lbs/lb)	Estimated GAC Usage (lbs/year)
Benzene	8.72	1.5	$0.016 \times C^{1/0.40}$	401.5	602
Trichloroethylene	9.86	1.7	$0.028 \times C^{1/0.62}$	626.1	1,064
Naphthalene	277	48.5	$0.132 \times C^{1/0.42}$	13.0	631
PCP	3,936	688.8	$0.436 \times C^{1/0.34}$	1.4	964
Phenanthrene	2.63	0.5	$0.215 \times C^{1/0.44}$	63.5	32
<b>Total GAC Usage (lbs/year)</b>					<b>3,293</b>

\* Isotherms from (Dobbs and Cohen, 1980, EPA 600-8-80-023) require contaminant concentration in mg/L and provide the mass of contaminant sorbed per mass of GAC used. The isotherm for benzene assumes the use of Filtrisorb 400.

Dioxin is not included in the table because an isotherm could not be located. However, it is generally understood that GAC is a “best available technology” for dioxin. This is because dioxin is not water

soluble and would be removed by removing particles to which it has already sorbed. Any dissolved dioxin would be easily sorbed to GAC.

As is evident from the above table, it is estimated that less than 4,000 pounds of GAC would be required per year to provide treatment in the absence of the UV/Oxidation units. At 40 gpm, a 4,000-pound GAC unit would provide approximately 25 minutes of residence time, which should be more than adequate for effective contaminant removal. Ideally, this would translate to replacement of the lead GAC unit once per year. Practically, however, removal efficiency may decrease as fouling from solids increases. Therefore, it is reasonable to assume that two replacements of the lead vessel may be required each year. This is potentially one more unit replacement than anticipated with UV/Oxidation as the primary treatment. Using GAC alone would therefore save an additional \$15,000 per year (approximately) by eliminating the costs for the final UV/Oxidation unit and the 2,000 pound PDU unit and including the cost of an additional 4,000-pound GAC replacement.

Prior to fully eliminating the UV/Oxidation units, it is recommended that a thorough pilot test be conducted. At this time, to avoid a major change to the treatment process, we recommend only bypassing two UV/Oxidation units with continued consideration of bypassing the UV/Oxidation units completely once a final remedy extraction system is determined.

## **6.2.2 EVALUATE AREAS TO REDUCE LABOR COSTS**

The contractor has evaluated and implemented many improvements to the treatment system over the past year. Monthly site meetings have clearly been very useful in expediting changes and keeping all parties up to date. However, total labor costs for running this system are about \$330,000 per year which is higher than similar systems. As continued improvements make the system easier to operate, the site team should have a goal of reducing operating labor costs and project management costs. For example, the monthly site meetings and associated progress reporting can, within a year or two, be reduced to a quarterly frequency, likely saving approximately \$25,000 per year. Reporting and development of work plans should also become easier over time because site activities will be better understood and less will change on a monthly basis. As knowledge of the treatment plant increases and the need for system improvements decreases, the level of engineering support (and associated costs) will decrease. The operator will also be available to conduct other tasks such as NPDES and performance monitoring sample collection, which is currently part of the sampling task. A total labor cost reduction goal of about \$40,000 per year from the current costs could be used within 1 to 2 years. Adding OU3 flow (if that occurs as part of the OU3 ROD) may require some minor treatment system modifications and associated management and labor costs initially but should not increase long term annual labor costs. The site team has shown decreased labor costs between Year 1 and Year 2 of \$25,000, demonstrating that labor costs will decrease over time and that the suggested further decrease of \$40,000 may be possible of the next couple of years.

## **6.3 MODIFICATIONS INTENDED FOR TECHNICAL IMPROVEMENT**

### **6.3.1 CONTINUE IMPROVING TREATMENT PLANT TO FACILITATE OPERATION AND POTENTIALLY INCREASE CAPACITY**

The treatment system is cramped and performing maintenance is difficult due to the lack of working space. However, the contractor has already added level transmitters and sight tubes to monitor operations and many other improvements to operations. The plant continues to have downtime problems (see Section 6.1.4) and may need minor improvements to handle additional flow if pump and treat is

selected as the remedy for OU3 and additional pumping is required. The first metals removal process tank is currently the limiting unit for hydraulic capacity. Modifying or replacing this tank with a slightly larger one should be considered. The other reaction tanks may also need modification. The head space above the tanks and the general working space is limited and will complicate this task, but a solution should exist such that the current treatment plant can accommodate the necessary flow for OU2, and possibly OU3 if pump and treat is selected as the OU3 remedy. The tanks are all fiberglass reinforced plastic. As an option, a fiberglass repair contractor (tank, pipe, marine, automotive, etc.) should be able to modify the tanks to add freeboard. A section could be added to the top of the tank by using fiberglass cloth and resin around the joint between the existing tank and the new section. The repair would be watertight and, due to space limitations, would likely be easier than replacing the tank. Fiberglass repair should cost less than \$10,000, but tank replacement might cost up to \$25,000.

### **6.3.2 MAKE PIPING CHANGES TO BETTER USE THE SECOND EQUALIZATION TANK**

The equalization tank piping should be modified to include a line for potential influent flow directly to equalization tank #2. Recycle lines should also be added so that minor maintenance can be accomplished at equalization tank #1 without shutting down the extraction system. These piping changes should also help the current equalization tanks provide some or all of the capacity necessary to store the wastewater from backwashing. This effort should require less than \$10,000 in capital costs.

## **6.4 CONSIDERATIONS FOR GAINING SITE CLOSE OUT**

### **6.4.1 ADAPT P&T SYSTEM TO FOCUS PRIMARILY ON COST-EFFECTIVE CONTAINMENT WITH DECREASED EMPHASIS ON RESTORATION**

Ground water extraction as part of source removal efforts at RW-1 to RW-4 has had limited effectiveness in terms of mass removal and progress towards restoration, and the existing treatment system limits the volume of ground water that can be extracted to under 40 gpm. Rehabilitation of the recovery wells, or other aggressive removal technologies may reduce mass but would not likely significantly shorten the duration of the pump and treat system. A relatively large area with NAPL and high concentrations at depth are present and would need to be addressed. Aggressive remediation (other than pumping at the recovery wells) would therefore require substantial additional cost and interruption of above-ground activities (e.g., along Eagle Road, at Swiss Farms, and at Young's Produce). The oil and grease that comprises much of the NAPL would interfere with aqueous phase reactions (for dehalogenation or oxidation) and would serve as a scavenger of chemical oxidation chemicals.

For the final remedy, the site team should consider focusing on hydraulic containment of a targeted capture zone, even if it means reconsidering ground water extraction in the source area. LNAPL collection by product skimming in select locations could be considered and some ground water removal could be added over time if containment flow rates allow. No matter what ground water extraction scheme is applied at the site, restoration to ground water cleanup standards will take many decades to achieve and capture should not be compromised in the mean time to extract contamination from the source area.

By focusing on containment only over a long period of time, monitoring, management, and data analysis should be simplified, allowing for O&M costs to be "minimized" for an effective system. Ground water monitoring, for example, would be used to demonstrate capture, and monitoring of wells within the heart of the plume could be decreased in frequency or eliminated altogether. Ground water monitoring could likely be reduced to sample 50 or 60 samples per year rather than 100 samples per year, yielding potential

savings of approximately \$30,000 per year. We suggest that EPA and State funds will be utilized in the most effective manner by containing this site to eliminate the current risks to human health and the environment. Based on the reported costs in Section 4.4 and the recommendations made in Section 6.2, a target cost for long-term O&M of a containment-only system might be \$500,000 or less per year to be achieved within 1 to 2 years of the final remedy becoming operational and functional. After considering the potential savings in Section 6.2, implementing this recommendation might save an additional \$30,000 relative to the costs presented in Section 4.4 of this report.

#### **6.4.2 POTENTIAL OPTIONS FOR IMPROVING CAPTURE**

Capture of the fully delineated plume may require additional measures. To the south, there are elevated concentrations at the CW-4 and CW-5 clusters and delineation is not complete. Downgradient of the collector drain, there are PCP concentrations as high as 44 ug/L. The extent to which capture needs improvement will not be fully known until completion of recommendations 6.1.2 and 6.1.3.

To the south, installation of another downgradient collection drain does not appear to be feasible due to access considerations. Therefore, containment may require additional extraction wells south of the existing drain. These wells will likely have to be screened across the shallow and deep zones to allow the drawdown necessary to achieve flow rates required for containment. Pumped ground water from these wells can likely be combined in a header line and added to the flow from the collection drain. The 1-inch pipe that restricts flow near the drain should be replaced. The current treatment system will likely have adequate capacity for this additional flow, especially if the mixing tanks are modified as suggested in Section 6.3.1. The additional extraction and should not significantly increase the annual O&M costs.

Downgradient of the collector drain, it is uncertain if remediation or capture is required. To date, remediation efforts have not focused on the contamination at CW-9D and CW-13D. EPA appears to have a few options for addressing this downgradient contamination.

- Monitor existing and suggested monitoring wells to determine if concentrations are naturally attenuating
- Conduct temporary extraction events at this location to see if concentrations can be permanently reduced
- Install permanent extraction capabilities near CW-13D and pipe that extracted water to the upgradient extraction system (i.e., the trench and any new upgradient extraction wells)
- Inject nutrients or chemical reagents to enhance degradation of that contamination

Because this downgradient contamination appears fairly isolated, it would be difficult to monitor the effectiveness of any of the above approaches without either relying on CW-9D and CW-13D alone or installing additional monitoring wells. The decision on how to proceed may depend on the results of sampling some of the recommended wells (see Section 6.1.2). Assuming no additional contamination is found at depth, it might be most appropriate to monitor these downgradient wells (perhaps semi-annually) for two years to determine if there is a trend. If there is a decreasing trend, it may be reasonable to let that contamination attenuate. If there is persistent contamination, it may be reasonable to attempt one year of quarterly temporary extraction events. If concentrations are increasing and/or the temporary extraction events are unsuccessful, then either permanent extraction or the injection of nutrients/reagents should be considered. Permanent extraction would likely require well over \$100,000 in capital costs. The injection of nutrients/reagents might include lactate, molasses, or even nano-scale

iron (ARS Technologies or PARS Environmental) to foster reductive dechlorination. It should be noted, however, that the injection of nutrients/reagents (especially nano-scale iron) for enhancing the reductive dechlorination of PCP is in an experimental stage. Therefore, if this approach is taken, appropriate testing and piloting should be conducted prior to full-scale implementation. The costs for these options would vary but would likely be under \$100,000 for a few injection events in one or two existing wells over the course of a year, especially if monitoring is limited (i.e., limited to the injection well and/or one additional downgradient well).

## **6.5 SUGGESTED APPROACH TO IMPLEMENTATION**

Addressing the abandoned sewer line preferential pathway (Section 6.1.1) is ongoing and is of the greatest importance for risk minimization. These activities should be completed as soon as possible. If the preferential pathway is eliminated plume delineation and completion of plume capture evaluation (Sections 6.1.2 and 6.1.3) can be completed as part of the OU3 activities. We have identified several delineation issues to consider in Section 6.1.2.

There is strong evidence to support bypassing two of the UV/Oxidation units (Section 6.2.1) immediately. In addition to achieving cost savings without any negative impact on protectiveness bypassing these units will improve the poor system downtime record (Section 6.1.4).

The remaining recommendations are related to or can be considered and implemented in concert with selecting an OU3 remedy.



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## 7.0 SUMMARY

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The evaluation team observed a conscientious and knowledgeable site team (i.e., EPA and its contractor) that has effectively managed this interim remedy, provided a number of much needed plant improvements, and initiated the remedial investigation for OU3. The observations and recommendations contained in this report are not intended to imply a deficiency in the work of either the system designers or operators but are offered as constructive suggestions in the best interest of the EPA and the public. These recommendations have the obvious benefit of being formulated based upon operational data unavailable to the original designers.

Recommendations to improve effectiveness include proceeding with the investigation and proper abandonment of the sewer lines that led to downgradient contamination and remediation of the associated soils and sediments. Other effectiveness recommendations include delineating the contaminant plume, conducting a capture zone evaluation, and reducing system downtime. Specific items for each of these recommendations are provided. Recommendations for reducing cost include bypassing two of the UV/Oxidation units and reducing O&M labor. Recommendations for technical improvement include modifying the metals removal mixing tanks to allow increased flow, and modifying the equalization tanks to improve flexibility in operation and reduce downtime. Finally, recommendations associated with site closeout include focusing the remedy on containment rather than restoration and a discussion of options for potentially improving containment to the south and/or downgradient of the current extraction system, if determined to be necessary after the recommended capture zone analysis is completed.

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

**Table 7-1. Cost Summary Table**

<b>Recommendation</b>	<b>Reason</b>	<b>Additional Capital Costs (\$)</b>	<b>Estimated Change in Annual Costs (\$/yr)</b>	<b>Estimated Change In Life-cycle Costs (\$) *</b>	<b>Estimated Change In Life-cycle Costs (\$) **</b>
6.1.1 Properly Seal Abandoned 12-Inch Sewer Line and Remediate Surface Soils Near the Seep	Effectiveness	\$200,000	\$0	\$0	\$0
6.1.2 Improve Plume Delineation to the South and Vertically	Effectiveness	\$120,000 to \$150,000	\$5,000	\$285,000	\$216,000
6.1.3 Evaluate Plume Capture Once Plume is Delineated	Effectiveness	\$55,000	\$0	\$55,000	\$55,000
6.1.4 Take Measures to Further Reduce System Downtime	Effectiveness	\$0	\$0	\$0	\$0
6.2.1 Use Fewer UV/Oxidation Units	Cost Reduction	\$0	(\$32,000)	(\$960,000)	(\$516,000)
6.2.2 Evaluate Areas to Reduce Labor Costs	Cost Reduction	\$0	(\$40,000)	(\$1,200,000)	(\$646,000)
6.3.1 Continue Improving Treatment Plant to Facilitate Operation and Potentially Increase Capacity	Technical Improvement	< \$10,000 to \$25,000	\$0	< \$10,000 to \$25,000	< \$10,000 to \$25,000
6.3.2 Make Piping Changes to Better Use the Second Equalization Tank	Technical Improvement	\$10,000	\$0	\$10,000	\$10,000
6.4.1 Adapt P&T System to Focus Primarily On Cost-Effective Containment with Decreased Emphasis on Restoration	Site Closeout	\$0	(\$30,000)	(\$900,000)	(\$484,000)
6.4.2 Potential Options for Improving Capture	Site Closeout	Contingent on results from implementing 6.1.2 and 6.1.3			

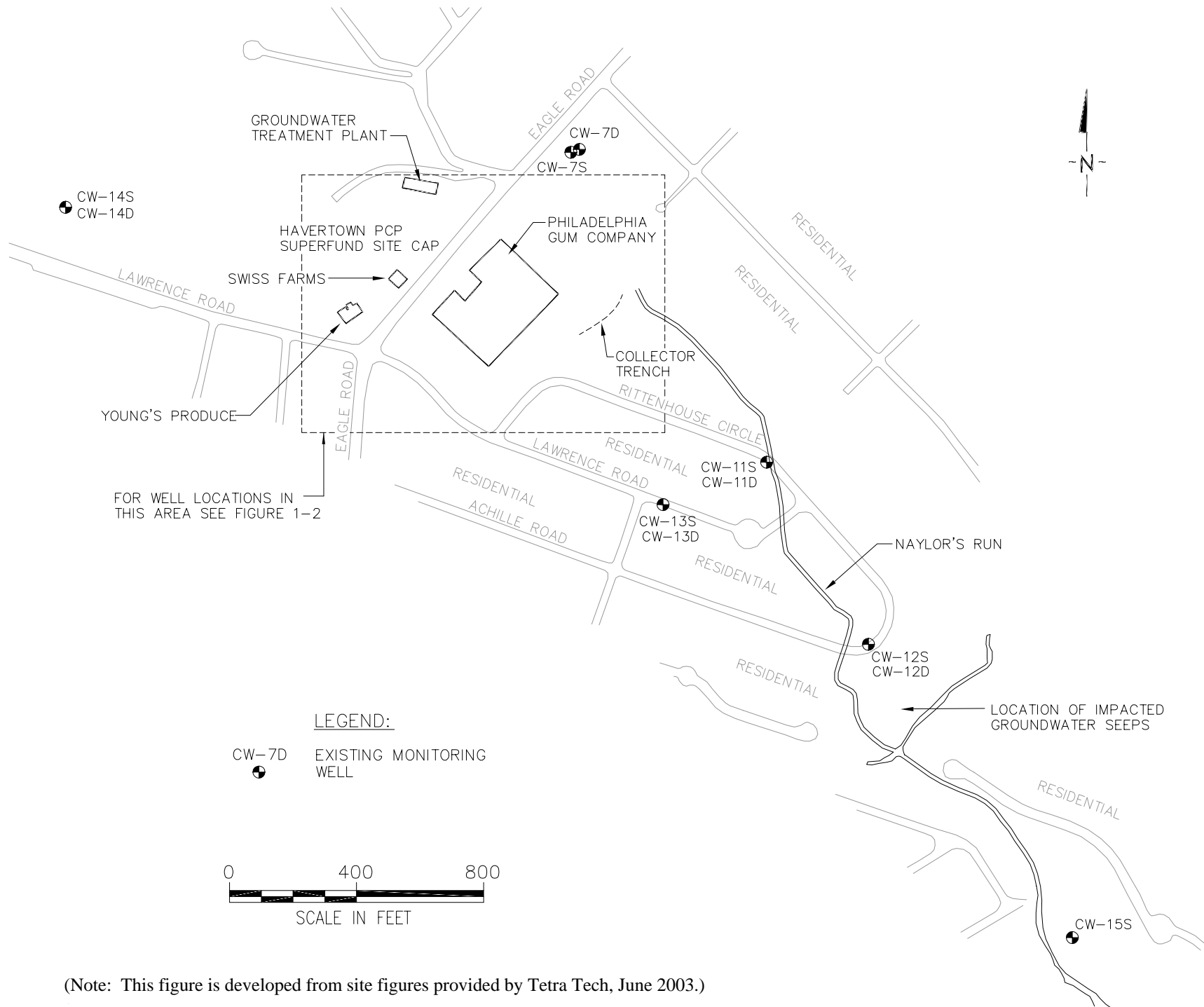
Costs in parentheses imply cost reductions.

\* assumes 30 years of operation with a discount rate of 0% (i.e., no discounting)

\*\* assumes 30 years of operation with a discount rate of 5% and no discounting in the first year

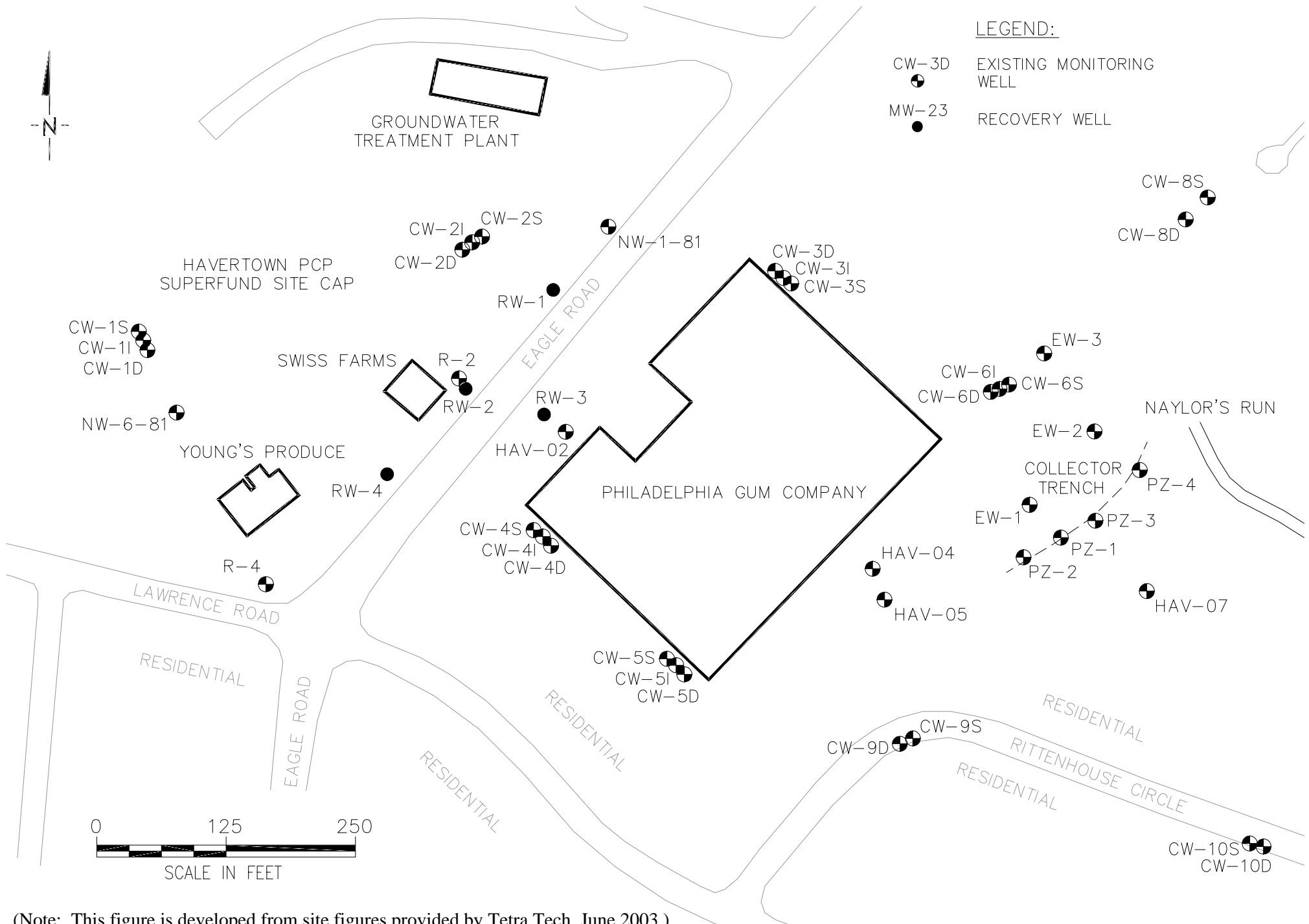
## **FIGURES**

**FIGURE 1-1. THE HAVERTOWN PCP SITE AND THE SURROUNDING AREA.**



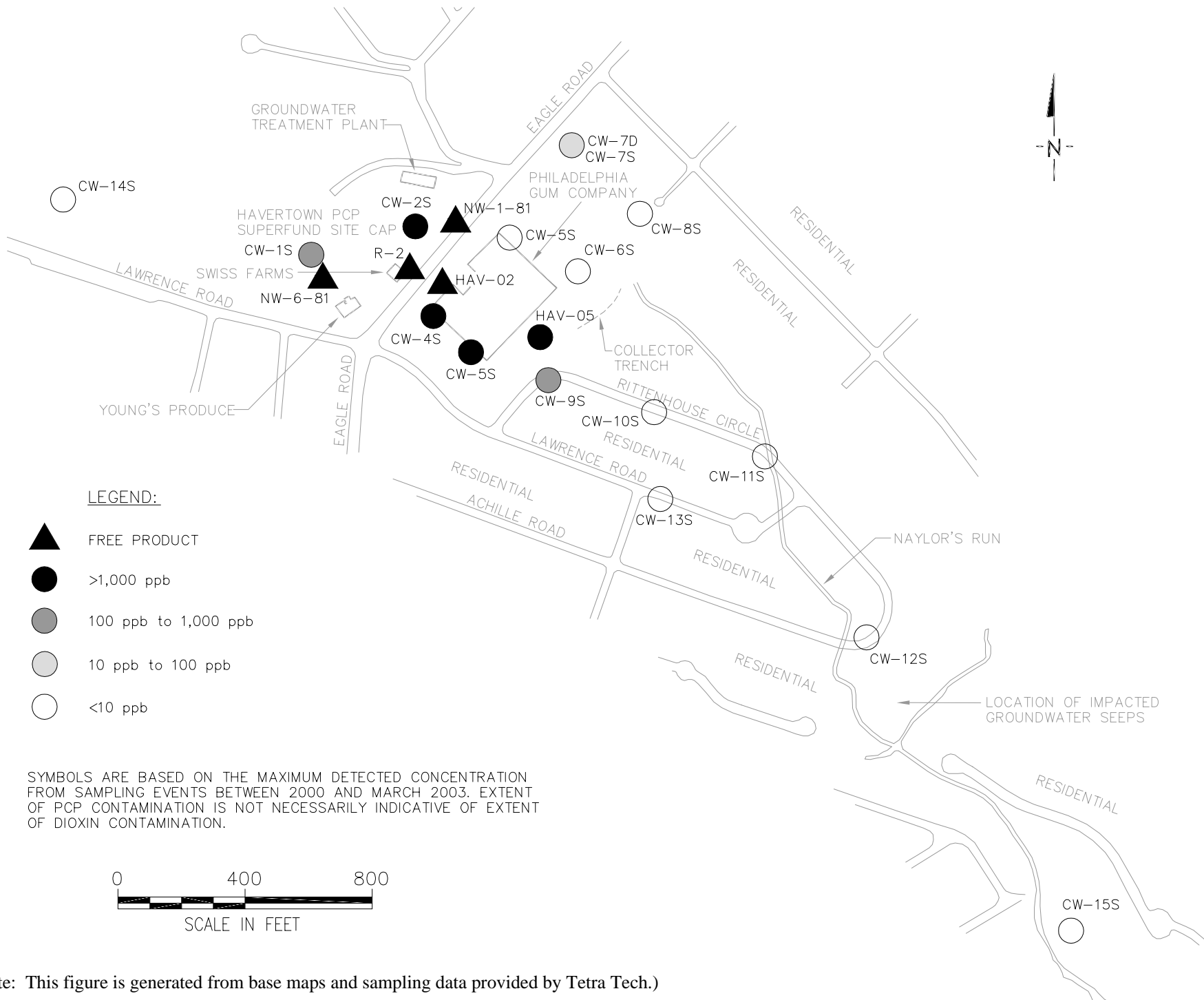
(Note: This figure is developed from site figures provided by Tetra Tech, June 2003.)

**FIGURE 1-2. AREA IMMEDIATELY SURROUNDING THE FORMER NWP FACILITY.**



(Note: This figure is developed from site figures provided by Tetra Tech, June 2003.)

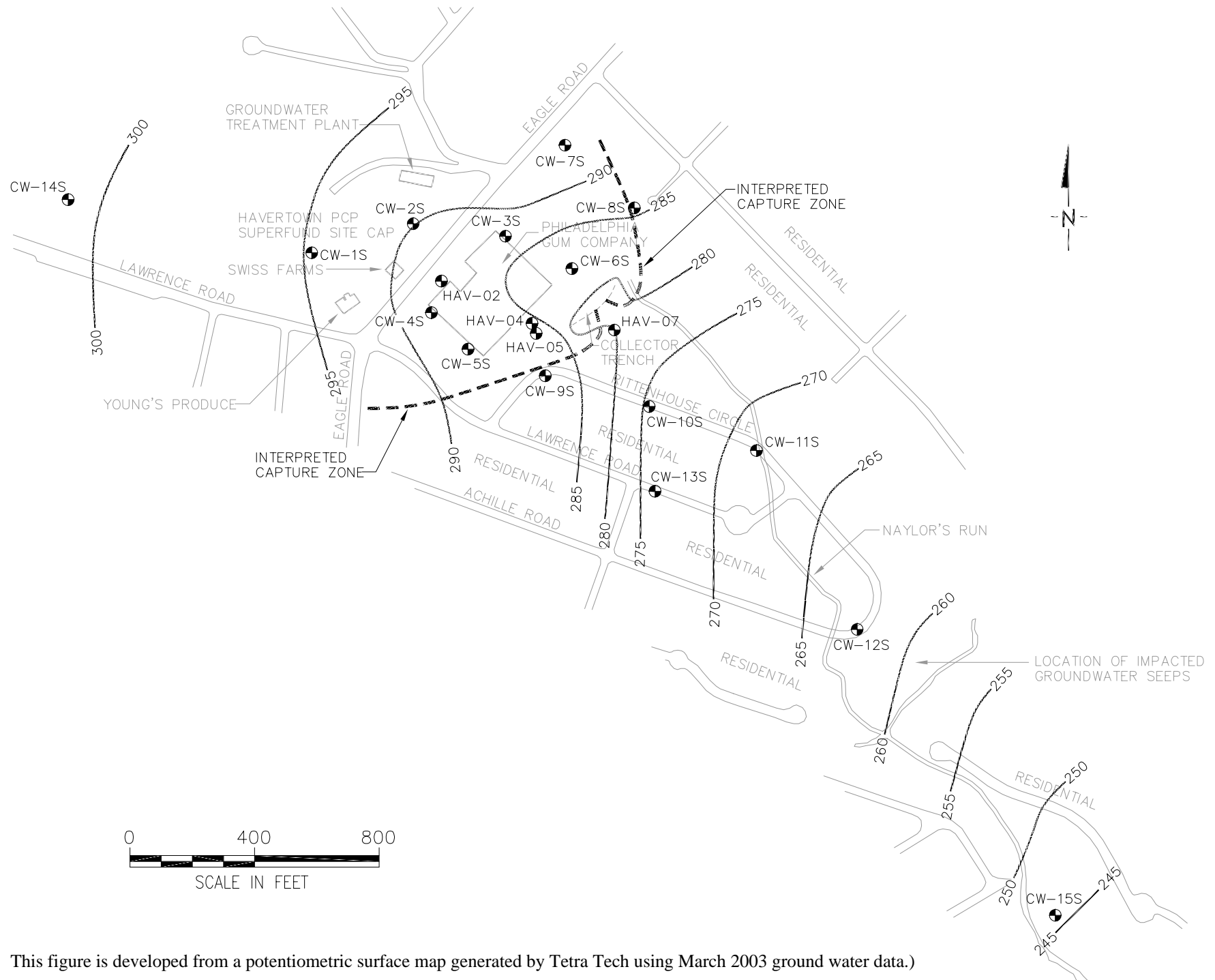
**FIGURE 1-3. EXTENT OF PCP CONTAMINATION IN THE SHALLOW ZONE (APPROXIMATELY 5 TO 20 FEET BGS).**



(Note: This figure is generated from base maps and sampling data provided by Tetra Tech.)



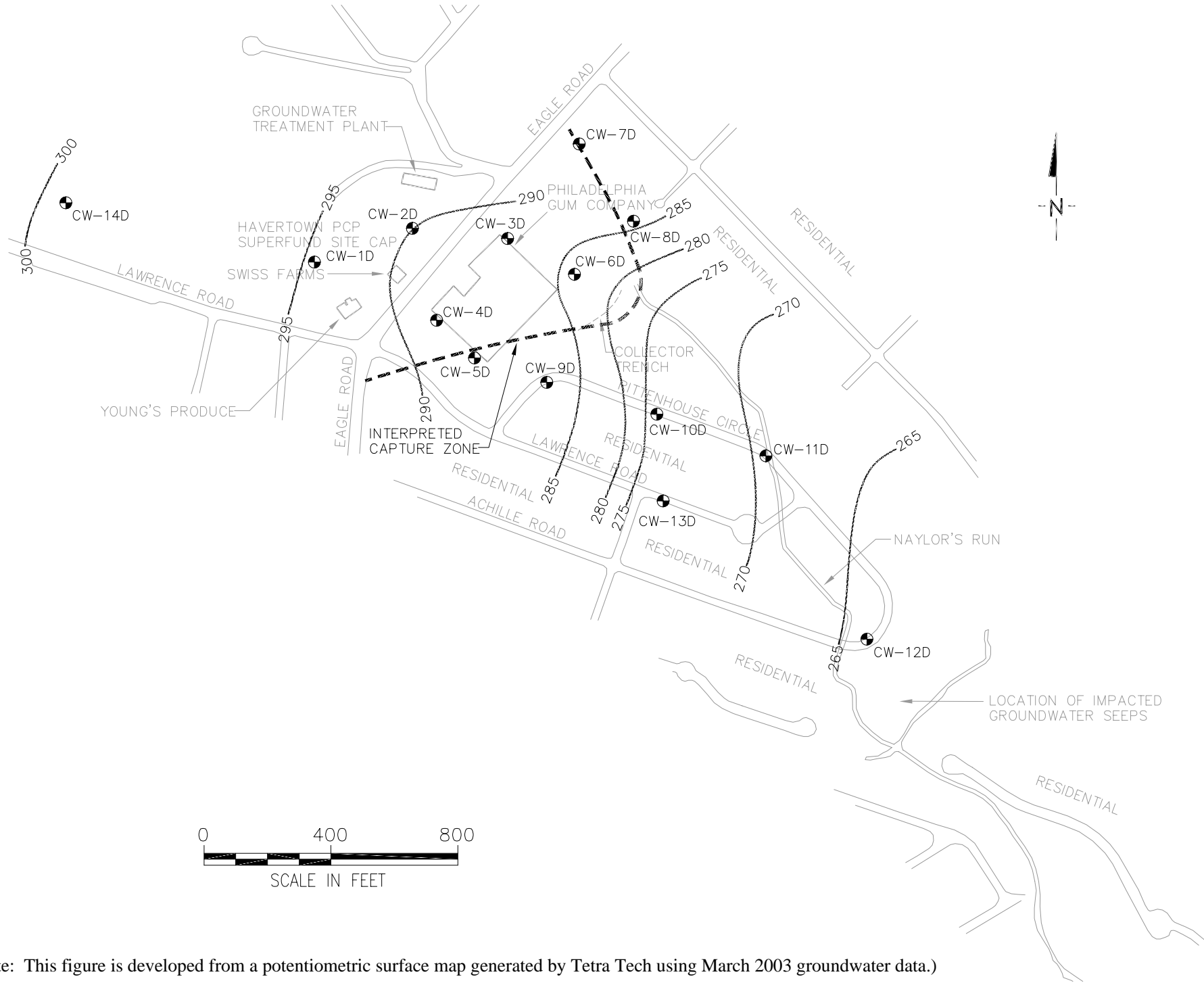
**FIGURE 4-1. POTENTIOMETRIC SURFACE FOR SHALLOW GROUNDWATER UNDER PUMPING CONDITIONS (APPROXIMATELY 5 TO 20 FEET BGS).**



(Note: This figure is developed from a potentiometric surface map generated by Tetra Tech using March 2003 ground water data.)



**FIGURE 4-2. POTENTIOMETRIC SURFACE FOR DEEP GROUNDWATER UNDER PUMPING CONDITIONS (APPROXIMATELY 40 TO 50 FEET BGS).**



(Note: This figure is developed from a potentiometric surface map generated by Tetra Tech using March 2003 groundwater data.)