Final Report

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

Site Optimization Tracker: Croychem Superfund Site Berks County Boyertown, Pennsylvania

EPA Region III

Solid Waste and
Emergency Response
(5102P)

EPA 542-R-06-006c
December 2006
www.epa.gov

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

Site Optimization Tracker: Croychem Superfund Site Berks County Boyertown, Pennsylvania

EPA Region III

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Croychem Superfund Site
Berks County
Boyertown, Pennsylvania

EPA Region III

December 30, 2005

SECTION 1:

CURRENT SITE INFORMATION FORM

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

A. Site Location, Contact Information, and Site Status

1. Site name	2. Site Location (city and State)	3. EPA Region
Cryochem	**Boyertown, PA**	**3**

4a. EPA RPM	5a. State Contact
Alexis K. Hanlon	**Richard Morgan**
4b. EPA RPM Phone Number	5b. State Contact Phone Number
215-814-5146	**717-705-4844**
4c. EPA RPM Email Address	5c. State Contact Email Address
hanlon.alexis@epa.gov	**rimorgan@state.pa.us**

5. Is the ground water remedy an interim remedy or a final remedy? Interim ☐ Final ☒

6. Is the site EPA lead or State-lead with Fund money? EPA ☒ State ☐

B. General Site Information

1a. Date of Original ROD for Ground Water Remedy	1b. Dates of Other Ground Water Decision Documents (e.g., ESD, ROD Amendment)
OU2 September 28, 1990	**ESD 8/3/04**
2a. Date of O&F	2b. Date for transfer to State
May 1998	**5/30/2008**

3. What is the primary goal of the P&T system (select one)?

- ☐ Contaminant plume containment
- ☐ Aquifer restoration
- ☒ Containment and restoration
- ☐ Well-head treatment

4. Check those classes of contaminants that are contaminants of concern at the site.

- ☒ VOCs (e.g., TCE, benzene, etc.)
- ☐ SVOCs (e.g., PAHs, PCP, etc.)
- ☐ metals (e.g., arsenic, chromium, etc.)
- ☐ other

5. Has NAPL or evidence of NAPL been observed at the site? Yes ☐ No ☒

6. What is the approximate total pumping rate? **45 gpm**

7. How many active extraction wells (or trenches) are there? **9**

8. How many monitoring wells are regularly sampled? **33**

9. How many samples are collected from monitoring wells or piezometers each year? (e.g., 40 if 10 wells are sampled quarterly) **33**

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) **24**

11. What above-ground treatment processes are used (check all that apply)?

- ☒ Air stripping
- ☐ Carbon adsorption
- ☐ Filtration
- ☒ Off-gas treatment
- ☐ Ion exchange
- ☐ Metals precipitation
- ☐ Biological treatment
- ☐ UV/Oxidation
- ☐ Reverse osmosis
- ☐ Other

12. What is the approximate percentage of system downtime per year? 10% ☒ 10 - 20% ☐ >20% ☐

C. Site Costs

1. Annual O&M costs

O&M Category	Actual[1] Annual Costs for FY04	Actual[2] Annual Costs for FY05	Estimated[2] Annual Costs for FY06
Labor: project management, reporting, technical support	**$33,000**	**$33,000**	**$33,000**
Labor: system operation	**$55,000**	**$55,000**	**$55,000**
Labor: ground water sampling	**$135,000**	**$35,000**	**$35,000**
Utilities: electricity	**$9,900**	**$11,000**	**$11,000**
Utilities: other	**$2,500**	**$2,500**	**$2,500**
Consumables (GAC, chemicals, etc.)	**$5,000**	**$5,000**	**$5,000**
Discharge or disposal costs			
Analytical costs	**$6,000***	**$6,000***	**$6,000***
Other (parts, routine maintenance, etc.)	**$10,000**	**$10,000**	**$10,000**
O&M Total	**$256,400**	**$157,500**	**$157,500**

The O&M total should be equal to the total O&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.

2. Non-routine or other costs			

Additional costs beyond routine O&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&M total plus the costs entered in item 2.

Notes on costs:

All annual O&M costs provided above are for OU2 only.

1. FY04 and FY05 costs, with the exception of the analytical costs, were provided by the RPM based on work plan cost estimates.

2. FY06 costs are estimated by the ROET based on RPM estimates from previous years and discussions during the optimization process.

* 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 will likely be incurred by the State when the site is transferred to the State after LTRA. The decrease from FY05 to FY06 reflects the assumed sampling reduction.

Decrease in annual sampling costs reflects a change from quarterly sampling to annual sampling.

D. Five-Year Review

1. Date of the Most Recent Five-Year Review	**9/30/2003**

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

- DCA cleanup level below RGC
- Gasoline plume impacts on treatment systems (OU1 and OU2)
- Collect quarterly ground water samples
- 1-4, dioxane detected in wells
- Develop performance monitoring plan
- Extraction system evaluation

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.

- No sitewide ground water sampling was conducted prior to year 2003.
- The number of impacted residential wells has been reduced as the P&T system started operation.
- The time decay calculations have been performed.
- Since original optimization evaluation meeting in December 2004, the ground water monitoring frequency has been reduced to annually, and the process monitoring has been reduced from monthly to quarterly. Thus, the information in Item B.9 of this form has been reduced to 33 (annually at 33 wells) and the information in item B.10 on this form has reduced by a factor of 3 (monthly to quarterly) to reflect the lower number of samples.

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

Date of Original Optimization Evaluation	December 1, 2004 (Evaluation meeting) August 5, 2005 (Final report)

	Meeting Date	Report Date	Item
X	July 13, 2005	August 5, 2005	Follow-Up #1 (conducted as part of pilot project)
X	October 19, 2005	December 30, 2005	Follow-Up #2 (conducted as part of pilot project)
			Follow-Up #3
			Follow-Up #4
			Follow-Up #5
			Follow-Up #6
			Follow-Up #7
			Follow-Up #8

"x" in box indicates the item has been completed

SUMMARY OF FOLLOW-UP #2

Site or System Name	Cryochem Superfund Site
Date of This Follow-Up Summary	December 30, 2005
Date of Follow-Up Meeting or Call (Indicate if Meeting or Call)	October 19, 2005 – Meeting

ROET MEMBERS CONDUCTING THE FOLLOW-UP EVALUATION:

Name	Affiliation	Phone	Email
Norm Kulujian	U.S. EPA Region 3	215-814-3130	kulujian.norm@epa.gov
Kathy Davies	U.S. EPA Region 3	215-814-3315	davies.kathy@epa.gov
Paul Leonard	U.S. EPA Region 3	215-814-3350	Leonard.paul@epa.gov
Peter Rich	GeoTrans, Inc.	410-990-4607	prich@geotransinc.com
Rob Greenwald	GeoTrans, Inc.	732-409-0344	rgreenwald@geotransinc.com
Doug Sutton	GeoTrans, Inc.	732-409-0344	dsutton@geotransinc.com
Steve Chang	U.S. EPA OSRTI	703-603-9017	Chang.steven@epa.gov

SITE TEAM MEMBERS (INCLUDING CONTRACTORS) INTERVIEWED

Name	Affiliation	Phone	Email
Alexis Hanlon	U.S. EPA Region 3 (RPM)	215-814-5146	Hanlon.alexis@epa.gov
Mindi Snoparsky	U.S. EPA Region 3 (Hydro)	215-814-3316	Snoparsky.mindi@epa.gov

IMPLEMENTATION STATUS OF ALL RECOMMENDATIONS UNDER CONSIDERATION BUT NOT PREVIOUSLY IMPLEMENTED

Recommendation	**E-2.1 Perform a More Detailed Capture Zone Analysis**		
Recommendation Reason	Protectiveness	**Implementation Status**	In Progress
Comments: Through a technical assistance item (described in Appendix A of this tracker), the ROET evaluated the modeling conducted by the site contractor that would be used for evaluating the capture zone. The evaluation concluded that the numerical modeling was flawed and needed to be recalibrated. The RPM agrees with the analysis and is working with the site contractor to determine how best to revisit the model and the cost of improving it.			

Recommendation	**E-2.3 Work with Town or County to Identify and/or Implement Institutional Controls**		
Recommendation Reason	Protectiveness	**Implementation Status**	In Progress
Comments: The attorney for the town board of supervisors said that the previously mentioned approach of creating a non-releasable map to identify areas that are affected by the ground water plume would create water rights issues and should be avoided. The ROD calls for institutional controls if the plume cannot be cleaned up. The RPM is considering other approaches to instituting institutional controls.			

Recommendation	**E-4.1 Produce Timely Annual Ground Water Monitoring Reports**		
Recommendation Reason	Technical Improvement	**Implementation Status**	In progress
Comments: The report for the January to May period was received in October, which is a delay of approximately 4 to 5 months since the end of the reporting period. The ROET reemphasized that reports should be available within six weeks or less. The RPM should ask the contractor to continue its efforts to deliver reports in a timelier manner. In the mean time, the RPM can request that a copy of the lab data be sent directly to the RPM.			

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

Recommendation	**E-2.2 Continue Monitoring for MTBE and 1,4-Dioxane**		
Recommendation Reason	Protectiveness	**Implementation Status**	Implemented
Comments: The monitoring will continue. The RPM added that 1,4-Dioxane is seen more in residential wells than monitoring wells, suggesting the continued importance of the analysis for this parameter. During the previous follow-up meeting, the ROET also noted that terminating the extraction at any specific extraction well, even if it is "clean", could cause the discharge level of 1,-4-Dioxane to increase above the discharge standard of 5.7 ug/l (current discharge is approximately half this value). This issue should be considered when evaluating whether extraction should be terminated at any individual well. The October sampling results were not available for review at the time of the follow-up meeting.			
Recommendation	**E-3.1 Reduce Ground Water Sampling Frequency**		
Recommendation Reason	Cost Reduction	**Implementation Status**	Implemented
Comments: Recent rounds of sampling were conducted in Oct 2004 and May 2005. Annual sampling is to commence beginning with the October 2005 sampling.			
Recommendation	**E-3.2 Eliminate Analysis for Metals in Extraction Wells Sampling Program**		
Recommendation Reason	Cost Reduction	**Implementation Status**	Implemented
Comments: Metals analysis was eliminated as of May 2005 (not done during the most recent sampling round).			
Recommendation	**E-3.3 Reduce the Number of Process Water Samples**		
Recommendation Reason	Cost Reduction	**Implementation Status**	Alternative Implemented
Comments: Influent and effluent are now sampled quarterly instead of monthly, effectively reducing the number of process water samples. If 1,4-Dioxane levels change in the future, then frequency may revert to monthly. The RPM reports that NPDES permit equivalent requirement is to report both average and instantaneous results, and the average is based on three discrete samples. The RPM is continuing to follow-up with the State to see if there is an alternative to the three-sample approach.			
Recommendation	**E-3.4 Reduce Data Validation**		
Recommendation Reason	Cost Reduction	**Implementation Status**	Alternative Implemented
Comments: Given that sampling frequency has been reduced (as per other recommendations), turnover to the State is within a few years, and potential human receptors are present, data validation will remain at highest levels. Since the sampling frequency has been reduced, the extent of data validation has effectively been reduced, and the spirit of the recommendation has been implemented.			

Recommendation	**E-5.1 Continue Pumping to Meet ARARs**		
Recommendation Reason	Site Closeout	**Implementation Status**	Consideration Acknowledged
Comments: Pumping is continuing.			

Recommendation	**E-5.2 Do Not Conduct Source Removal at this Time**		
Recommendation Reason	Site Closeout	**Implementation Status**	Consideration Acknowledged
Comments: RPM agreed with this consideration.			

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

- None.

NEW OR UPDATED RECOMMENDATIONS FROM THIS FOLLOW-UP

- None.

SUMMARY OF FOLLOW-UP #1

Site or System Name	Cryochem Superfund Site
Date of This Follow-Up Summary	August 5, 2005
Date of Follow-Up Meeting or Call (Indicate if Meeting or Call)	July 13, 2005 – Meeting

ROET MEMBERS CONDUCTING THE FOLLOW-UP EVALUATION:

Name	Affiliation	Phone	Email
Norm Kulujian	U.S. EPA Region 3	215-814-3130	kulujian.norm@epa.gov
Peter Schaul	U.S. EPA Region 3	215-814-3183	schaul.peter@epa.gov
Kathy Davies	U.S. EPA Region 3	215-814-3315	davies.kathy@epa.gov
Peter Rich	GeoTrans, Inc.	410-990-4607	prich@geotransinc.com
Rob Greenwald	GeoTrans, Inc.	732-409-0344	rgreenwald@geotransinc.com
Doug Sutton	GeoTrans, Inc.	732-409-0344	dsutton@geotransinc.com

SITE TEAM MEMBERS (INCLUDING CONTRACTORS) INTERVIEWED

Name	Affiliation	Phone	Email
Alexis Alexander	U.S. EPA Region 3 (RPM)	215-814-5146	Alexander.alexis@epa.gov
Mindi Snoparsky	U.S. EPA Region 3 (Hydro)	215-814-3316	Snoparsky.mindi@epa.gov

IMPLEMENTATION STATUS OF PREVIOUSLY IDENTIFIED RECOMMENDATIONS

Recommendation	2.1 Perform a More Detailed Capture Zone Analysis		
Recommendation Reason	Protectiveness	**Implementation Status**	In Progress
Comments: Based on the recommendation to improve the capture zone analysis, and a previous request from the evaluation team for clarification of the previous numerical modeling efforts, technical assistance from the evaluation team was requested by the RPM. This technical assistance was initiated soon after the follow-up meeting (a conference call was held with the site contractor to discuss the previous modeling) and is ongoing. Results of the ongoing technical assistance will be reported in a separate document and summarized in the next follow-up. Preliminary results from the technical assistance suggests that previous potentiometric surface maps are highly biased by water levels at the extraction wells (as mentioned in the evaluation report), and that the previous numerical model had flaws (particularly related to basing the model calibration largely on water levels at extraction wells) such that the numerical model would need to be re-calibrated prior to using it for evaluating capture.			

Recommendation	2.2 Continue Monitoring for MTBE and 1,4-Dioxane		
Recommendation Reason	Protectiveness	**Implementation Status**	Implemented
Comments: The monitoring will continue. Also, it was noted that terminating the extraction at any specific extraction well, even if it is "clean", could cause the discharge level of 1,-4-Dioxane to increase above the discharge standard of 5.7 ug/l (current discharge is approximately half this value). This issue should be considered when evaluating whether extraction should be terminated at any individual well.			

Recommendation	2.3 Work with Town or County to Identify and/or Implement Institutional Controls		
Recommendation Reason	Protectiveness	**Implementation Status**	In Progress
Comments: Discussions with Jeff Young, Zoning Officer for Earl Township (Technicon Enterprises, Inc. 610-286-1622) and Thomas Unger, Zoning Officer for Douglass Township (Systems Design Engineering, Inc. 610-916-8500) to create ordinances for ground water well control are underway. There are privacy issues, and a strategy being pursued is a non-releasable map to identify areas that are affected by the ground water plume.			

Recommendation	3.1 Reduce Ground Water Sampling Frequency		
Recommendation Reason	Cost Reduction	**Implementation Status**	Implemented
Comments: Recent rounds of sampling were conducted in Oct 2004 and May 2005. Annual sampling is to commence beginning with the October 2005 sampling.			

Recommendation	3.2 Eliminate Analysis for Metals in Extraction Wells Sampling Program		
Recommendation Reason	Cost Reduction	**Implementation Status**	Implemented
Comments: Metals analysis was eliminated as of May 2005 (not done during the most recent sampling round).			

Recommendation	3.3 Reduce the Number of Process Water Samples

Recommendation Reason	Cost Reduction	**Implementation Status**	Alternative Implemented
Comments: Influent and effluent are now sampled quarterly instead of monthly, effectively reducing the number of process water samples. If 1,4-Dioxane levels change in the future, then frequency may revert to monthly. The RPM reports that NPDES permit equivalent requirement is to report both average and instantaneous results, and the average is based on three discrete samples. The RPM will follow up with the state to see if there is an alternative to the three-sample approach.			

Recommendation	**3.4 Reduce Data Validation**		
Recommendation Reason	Cost Reduction	**Implementation Status**	Alternative Implemented
Comments: Given that sampling frequency has been reduced (as per other recommendations), turnover to the State is within a few years, and potential human receptors are present, data validation will remain at highest levels. Since the sampling frequency has been reduced, the extent of data validation has effectively been reduced, and the spirit of the recommendation has been implemented.			

Recommendation	**4.1 Produce Timely Annual Ground Water Monitoring Reports**		
Recommendation Reason	Technical Improvement	**Implementation Status**	Under consideration
Comments: The RPM indicates that data from the May 2005 sampling event were received mid-June reflecting that data management is occurring in a timely manner. The idea of moving forward with an annual report will be revisited during the next optimization evaluation follow-up meeting.			

Recommendation	**5.1 Continue Pumping to Meet ARARs**		
Recommendation Reason	Site Closeout	**Implementation Status**	Consideration Acknowledged
Comments: Pumping is being continued.			

Recommendation	**5.2 Do Not Conduct Source Removal at this Time**		
Recommendation Reason	Site Closeout	**Implementation Status**	Consideration Acknowledged
Comments: RPM agreed with this consideration.			

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

- It was noted that terminating the extraction at any specific extraction well, even if it is "clean", could cause the discharge level of 1,-4-Dioxane to increase above the discharge standard of 5.7 ug/l (current discharge is approximately half this value). This issue should be considered when evaluating whether extraction should be terminated at any individual well.

NEW OR UPDATED RECOMMENDATIONS FROM THIS FOLLOW-UP

None.

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)
Original Optimization Evaluation Recommendations						
2.1 Perform a More Detailed Capture Zone Analysis	Protectiveness	In progress	$10,000		Included in 4.1	
2.2 Continue Monitoring for MTBE and 1,4-Dioxane	Protectiveness	Implemented	$0	$0	$0	$0
2.3 Work with Town or County to Identify and/or Implement Institutional Controls	Protectiveness	In progress	$15,000		$0	
3.1 Reduce Ground Water Sampling Frequency	Cost Reduction	Implemented	$0	$0	($100,000)	Not yet quantified
3.2 Eliminate Analysis for Metals in Extraction Well Sampling Program	Cost Reduction	Implemented	$0	$0	Not quantified	Not quantified (analyzed by CLP)
3.3 Reduce the Number of Process Water Samples	Cost Reduction	Alternative Implemented	$0	$0	Not quantified	Not quantified (analyzed by CLP)
3.4 Reduce Data Validation	Cost Reduction	Alternative Implemented	$0	$0	Not quantified	$0
4.1 Produce Timely Annual Ground Water Monitoring Reports	Technical Improvement	In progress	$0		$22,000	
5.1 Continue Pumping to Meet ARARs	Site Closeout	Consideration Acknowledged	$0	$0	$0	$0
5.2 Do Not Conduct Source Removal at this Time	Site Closeout	Consideration Acknowledged	$0	$0	$0	$0
New or Updated Recommendations from Follow-up #1, July 13, 2005						
None.						

Recommendation	Reason	Implementation Status	Estimated Capital Costs ($)	Actual Capital Costs ($)	Estimated Change in Annual Costs ($/yr)	Actual Change in Annual Costs ($/yr)
New or Updated Recommendations from Follow-up #2, October 19, 2005						
None.						

Costs in parentheses imply cost reductions.

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 September 29, 2005

Comments on a capture zone evaluation and numerical modeling efforts

The attached memorandum documents feedback on the site team's efforts in evaluating capture and developing a site-wide numerical ground water flow model. Specifically, this technical assistance was provided by the optimization contractor for consideration by the site team and the rest of the ROET.

MEMORANDUM

To: Alexis Hanlon, RPM, EPA Region III

From: Rob Greenwald and Yan Zhang, GeoTrans, Inc.

Date: September 29, 2005

Subject: Cryochem, Technical Assistance
Ground Water Modeling and Capture Zone Analysis

GeoTrans was asked to provide technical assistance regarding capture zone evaluations at the Cryochem site, and in particular, to provide feedback regarding the use of numerical ground water modeling in that regard. The request for technical assistance was in part due to the following items presented in the RSE-Lite report:

> *"A ground water flow model was calibrated for this site, and some information about the modeling was provided to the evaluation team after the optimization evaluation meeting. However, it appears that particle tracking results to evaluate actual capture, or to compare actual capture to the extent of capture interpreted on the May 6, 2003 potentiometric surface map, have not been presented in reports."*

> *"A more detailed capture zone analysis is recommended to confirm that the extraction system is providing the intended containment. This is important given the potential receptors located downgradient of the extraction system. This analysis should include specifying a target capture zone on a map, and using as many lines of evidence as possible (potentiometric surface maps, concentration trends, particle tracking in conjunction with ground water modeling, etc.) to interpret the capture zone. Care must be taken to make sure the extent of capture is not over-estimated by relying on measured water levels at pumping wells when evaluating potentiometric surfaces. Also, it is recommended that a particle tracking analysis be performed with the already developed numerical flow model to evaluate predicted capture. The simulated capture should be compared to interpreted capture based on potentiometric surface evaluations, and any differences in those interpretations should be reconciled."*

The previously conducted ground water modeling was documented in a slide-style presentation dated March 2004. At the request of the RPM, a conference call was held on July 19, 2005 so that GeoTrans could ask questions regarding the ground water modeling. Participants included Alexis Hanlon (EPA RPM), GeoTrans, and EPA's contractor Tetra Tech NUS, Inc. Subsequent to that call, Tetra Tech NUS provided additional information (7 pages of text plus a spreadsheet with water levels from 5/92, 8/92, 5/03, 10/04, and 5/05).

Based on the information provided to GeoTrans to date, we offer the following comments for consideration of EPA Region III:

- Tetra Tech NUS has indicated that the ground water modeling was not really performed to assess capture zones from the on-site wells, but rather was developed to assess the impact of off-site recovery wells at Mike's Fancy Service Station on the Cryochem system. Nevertheless, GeoTrans suggests that the use of a properly calibrated numerical ground water model in conjunction with particle tracking is a potentially valuable line of evidence regarding the capture zone of the on-site wells.

- Use of ground water modeling as a line of evidence for capture is particularly important given the difficulty in developing potentiometric surface maps for evaluation of capture at this site. These difficulties in developing potentiometric surface maps are due to the fact that there are relatively few water level measurements other than the extraction wells, and water levels in the extraction wells are not representative of aquifer water levels (due to well losses and well inefficiencies). GeoTrans notes that the previously constructed potentiometric surface maps may be biased towards overestimating the interpreted zone of capture due the reliance on water levels at the extraction wells.

- GeoTrans noted on the conference call of July 19 that there are issues with the method reportedly used for calibrating the existing ground water flow model. The most significant issue is the heavy reliance on water level targets at the extraction wells for calibrating the model, which in turn resulted in the assignment of zones of very low hydraulic conductivity in the vicinity of the pumping wells (on-site and at Mike's Fancy) relative to the adjacent aquifer material. For instance, the region containing the on-site extraction wells was assigned a hydraulic conductivity value of 0.005 ft/day, versus 20 ft/day in the adjacent material. This is not an appropriate approach to model calibration for two main reasons:

    - the measurements of water levels at the pumping wells are influenced by well losses and well inefficiencies, and therefore are not representative of aquifer conditions immediately adjacent to the well

    - the ground water model predicts water level at the center of a grid cell, representing an average water level for the entire cell, which may be quite a bit higher than the measured water level in the aquifer at the extraction well (even if well losses and well inefficiencies were absent)

- The information provided by Tetra Tech NUS after the conference call does not alter GeoTrans' opinion that the existing ground water model is not appropriately calibrated. However, the information provided by Tetra Tech NUS after the conference call includes discussion of previous pump tests in 1995, where individual extraction wells were pumped one at a time and drawdown responses were measured at adjacent wells that were not pumping.

  GeoTrans believes that a much improved calibration of the ground water model could be achieved by trying to match the drawdown responses from those 1995

pump tests. The drawdowns in the active pumping wells for a specific simulation should not be used as calibration targets, but the drawdowns in the other MW's and EW's (i.e., those not being pumped) could be used. The calibration would be achieved by simulating individual pumping at wells, one at a time, and varying hydraulic conductivity zonation and other parameters (e.g., recharge) such that a large portion of the observed drawdowns to individual pumping rates match reasonably well. Hydraulic conductivity zonation and values could be adjusted during this calibration process to best mimic the degrees of interconnection of the various wells observed from those 1995 pump test data. Additional calibration simulations could be performed using observed pumping rates and observed water level measurements (at non-pumping wells) for one or more recent pumping periods (such as May 5, 2005).

This is a complicated calibration approach because it involves multiple calibration simulations that will ultimately result in a single calibrated model that matches as many of the targets in the individual calibration simulations as reasonably as possible. This will require a somewhat iterative approach. For instance, hydraulic conductivity may first be assigned to best match one of the individual pump tests, but may later be refined to better match one of the other individual pump tests. Somewhat qualitative decisions will need to be made to select the best parameter values so that as many targets are matched as reasonably as possible.

Because this calibration approach is complicated due to the iterations that will be required, GeoTrans would estimate that a substantial effort would be required for the revised calibration and subsequent capture zone delineation (with particle tracking), perhaps in the $15K to $25K range. However, GeoTrans believes that this would be the most appropriate approach.

In summary, this calibration approach would be iterative and would include both of the following types of calibration simulations:

- Multiple simulations, where one well is pumped and drawdown observed at nearby wells during the pump tests are compared to simulated drawdowns

- One or more simulations with pumping at multiple extraction wells, based on measured values for pumping rate, with observed water levels at non-pumping wells compared to simulated water levels

- GeoTrans also notes (as does Tetra Tech NUS) that there is something odd about the water level data from May 6, 2003, because the lowest water level is reported at EW-3, which was reportedly not pumping. It seems likely that this extraction well was pumping a short time before water levels were measured, and that the well had not fully recovered. The assumption that the well was not pumping may not be valid. Therefore, it may be prudent to rely more on the pumping rates and

measured water levels from other time periods for calibrating absolute water levels (such as the May 5, 2005 pumping rates and water levels).

- During the conference call of July 19, GeoTrans indicated that it would be beneficial to have a few additional piezometers between extraction wells that would provide more aquifer water levels for developing potentiometric surfaces and for calibrating the model. It should be noted that the use of the 1995 pump test data, where wells were pumped one a time, may preclude the need for such piezometers for re-calibrating the ground water model. However, additional piezometers would certainly improve the accuracy of potentiometric surface maps. The cost of drilling those piezometers may be substantial due to the significant depth, and should be weighed against the value of those additional data points.

- During the conference call of July 19, Tetra Tech NUS indicated that there was a proposal in for geophysics. At the time, GeoTrans thought this would be at new borings, which might provide a reason for installing the additional piezometers discussed above. Based on information subsequently provided to GeoTrans, the geophysics would be performed on existing wells. Performing the geophysics work is somewhat tangential to the modeling work, and GeoTrans defers to the judgment of Region III as to whether or not the geophysics should be performed to resolve other issues unrelated to the modeling effort.

- In summary, there is value in using ground water modeling to better assess the capture zone at this site. GeoTrans believes the existing ground water model should be re-calibrated using an approach outlined above. Capture zones for different pumping scenarios can then be assessed with particle tracking, once the model has been re-calibrated. The extent of capture determined with particle tracking should be compared to a Target Capture Zone, which should be defined and represented on a map. This line of evidence regarding capture (i.e., modeling with particle tracking) can be used in conjunction with other lines of evidence, such as potentiometric surface maps and observed concentration trends, to provide a comprehensive capture zone evaluation.

APPENDIX: B

BASELINE SITE INFORMATION SHEET AND OPTIMIZATION EVALUATION REPORT

Streamlined
Optimization Evaluation Report

Croychem Superfund Site
Berks County
Boyertown, Pennsylvania

EPA Region III

August 5, 2005

SECTION 1:

BASELINE SITE INFORMATION FORM

Date: 2/14/05 Filled Out By: GeoTrans

A. Site Location, Contact Information, and Site Status

1. Site name	2. Site Location (city and State)	3. EPA Region
Cryochem	**Boyertown, PA**	**3**

4a. EPA RPM	5a. State Contact
Alexis K. Alexander	**Richard Morgan**
4b. EPA RPM Phone Number	5b. State Contact Phone Number
215-814-5146	**717-705-4844**
4c. EPA RPM Email Address	5c. State Contact Email Address
alexander.alexis@epa.gov	**rimorgan@state.pa.us**

5. Is the ground water remedy an interim remedy or a final remedy? Interim ☐ Final ☒

6. Is the site EPA lead or State-lead with Fund money? EPA ☒ State ☐

B. General Site Information

1a. Date of Original ROD for Ground Water Remedy	1b. Dates of Other Ground Water Decision Documents (e.g., ESD, ROD Amendment)
OU2 September 28, 1990	**ESD 8/3/04**
2a. Date of O&F	2b. Date for transfer to State
May 1998	**5/30/2008**

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.
☐ Contaminant plume containment	☒ VOCs (e.g., TCE, benzene, etc.)
☐ Aquifer restoration	☐ SVOCs (e.g., PAHs, PCP, etc.)
☒ Containment and restoration	☐ metals (e.g., arsenic, chromium, etc.)
☐ Well-head treatment	☐ other

5. Has NAPL or evidence of NAPL been observed at the site? Yes ☐ No ☒

6. What is the approximate total pumping rate? **45 gpm**

7. How many active extraction wells (or trenches) are there?	**9**	8. How many monitoring wells are regularly sampled?	**33**
9. How many samples are collected from monitoring wells or piezometers each year? (e.g., 40 if 10 wells are sampled quarterly)	**172**	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)	**72**

11. What above-ground treatment processes are used (check all that apply)?

☒ Air stripping	☐ Metals precipitation
☐ Carbon adsorption	☐ Biological treatment
☐ Filtration	☐ UV/Oxidation
☒ Off-gas treatment	☐ Reverse osmosis
☐ Ion exchange	☐ Other

12. What is the approximate percentage of system downtime per year? 10% ☒ 10 - 20% ☐ >20% ☐

C. Site Costs

1. Annual O&M costs

O&M Category	Actual Annual Costs for FY03	Actual Annual Costs for FY04	Projected Annual Costs for FY05
Labor: project management, reporting, technical support	**32,000**	**33,000**	**33,000**
Labor: system operation	**56,000**	**55,000**	**55,000**
Labor: ground water sampling	**135,000**	**135,000**	**135,000**
Utilities: electricity	**9,900**	**9,900**	**11,000**
Utilities: other	**2,500**	**2,500**	**2,500**
Consumables (GAC, chemicals, etc.)	**5,000**	**5,000**	**5,000**
Discharge or disposal costs			
Analytical costs			
Other (parts, routine maintenance, etc.)	**10,000**	**10,000**	**10,000**
O&M Total	**250,400**	**250,400**	**251,500**

The O&M total should be equal to the total O&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.

2. Non-routine or other costs			

Additional costs beyond routine O&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&M total plus the costs entered in item 2.

Notes on costs:

- Costs are from work plan cost estimates.

- The annual O&M costs provided above are for OU2 only.

- The system operation labor costs include cost associated with monthly reporting.

D. Five-Year Review

1. Date of the Most Recent Five-Year Review	**9/30/2003**

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

- DCA cleanup level below RGC
- Gasoline plume impacts on treatment systems (OU1 and OU2)
- Collect quarterly ground water samples
- 1-4, dioxane detected in wells
- Develop preformance monitoring plan
- Extraction system evaluation

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.

- No sitewide ground water sampling was conducted prior to year 2003.
- The number of impacted residential wells has been reduced as the P&T system started operation.
- The time decay calculations have been performed.

SECTION 2:

STREAMLINED OPTIMIZATION EVALUATION

Cryochem Superfund Site

Date of Evaluation Meeting: December 1, 2004 Date of Final Report: August 5, 2005

ROET MEMBERS CONDUCTING THE STREAMLINED OPTIMIZATION EVALUATION:

Name	Affiliation	Phone	Email
Peter Schaul	U.S. EPA Region 3	215-814-3183	schaul.peter@epa.gov
Norm Kulujian	U.S. EPA Region 3	215-814-3130	Kulujian.norm@epa.gov
Kathy Davies	U.S. EPA Region 3	215-814-3315	Davies.kathy@epa.gov
Rob Greenwald	GeoTrans, Inc.	732-409-0344	rgreenwald@geotransinc.com
Peter Rich	GeoTrans, Inc.	410-990-4607	prich@geotransinc.com
Kathy Yager (by phone)	U.S. EPA OSRTI	617-918-8362	Yager.kathy@epa.gov
Jean Balent (by phone)	U.S. EPA OSRTI	202-564-1709	Balent.jean@epa.gov

SITE TEAM MEMBERS (INCLUDING CONTRACTORS) INTERVIEWED

Name	Affiliation	Phone	Email
Ashee Rudolph	VISTA	215-814-3187	Rudolph.ashee@epa.gov
Mary Mang	Tetra Tech NUS	610-491-9688	MangM@TTNUS.com
Steve Demars	PADEP	717-705-4832	SDemars@state.pa.us
Richard Morgan	PADEP	717-705-4844	RImorgan@state.pa.us
Mindi Snoparsky	U.S. EPA Region 3 (Hydro)	215-814-3316	Snoparsky.mindi@epa.gov
Alexis Alexander	U.S. EPA Region 3 (RPM)	215-814-5146	Alexander.alexis@epa.gov
Tony Dappalone	U.S. EPA Region 3 (Sec. Chief)	215-814-3188	dappalone.anthony@epa.gov

1.0 SIGNIFICANT FINDINGS BEYOND THOSE REPORTED ON SITE INFORMATION FORM

The evaluation team observed an RPM who appears to be an effective manager of a complex site, making decisions based on a comprehensive understanding of the site that considers the hydrogeology, engineering, costs, and relationships with other entities. The RPM appears to effectively utilize Regional technical resources (e.g., hydrogeologists), and Regional Management appears to be well informed regarding site progress. The observations and recommendations herein are not intended to imply a deficiency in the work of either the designers or operators, but are offered as constructive suggestions in the best interest of the EPA and the public. Recommendations made herein obviously have the benefit of site characterization data and the operational data unavailable to the original designers.

Findings beyond those reported on the site information form include the following:

- The OU1 remedy (water treatment at impacted homes) continues to operate with 12 home treatment systems. Eight of the original 20 systems have been removed based on ground water monitoring results. OU2 pertains to the ground water remedy for the site.

- MTBE believed to be from a separate downgradient source (Mike's Fancy Service Station) is present in site ground water and could impact the pumping strategy in the future if MTBE concentrations increase. The current MTBE influent concentration is reported to be approximately 2 to 3 ug/L and the effluent concentration is less than 1.0 ug/L so MTBE is not impacting treatment at this time. A discharge standard is not provided but it is likely to be 10 to 20 ug/L (or higher) if added.

- Mike's Fancy Service Station has a P&T system, with a total design capacity of 35 gpm. EPA reportedly has completed a hydrologic review to assess the impact of their system on the Cryochem system and the neighboring residences. The cones of influence for that system are very tight, and based on observed water levels, no impacts on the Cryochem system have been noted.

- 1,4-Dioxane is present at the site and could impact future treatment. Current influent and effluent levels are approximate 3 ug/L, and the highest concentration in ground water is 15 ug/L detected at EW-8. The RPM indicates that a state standard of 5.7 ug/l was adapted as the discharge standard for 1,4-Dioxane in an ESD dated August 3, 2004.

- The extraction wells are deep bedrock wells with the depth about 250 feet to 350 feet below ground surface. The source of the impacts has never been well defined, and the plume is spread out within the deep bedrock. Thus any in-situ source removal would likely be very difficult and costly.

- It was thought that the source of the ground water impacts was near well RI-2D, but soil sampling in that vicinity showed little impacts. Factors that may have led to plume spreading and complicating source identification include one or more of the following: a storm water collection system that may have served as a conduit; pumping at private wells that could have caused transience in the flow direction; complicated flow patterns due to fractures in the

bedrock; and plant production wells near MW-1 and MW-2 that might have complicated flow patterns.

- 1,1-DCE is the only COC remaining above MCLs, and the maximum concentration during the March 2003 sampling event at an extraction well was 57 ug/L. The highest observed concentration at a monitoring well was 150 ug/l at MW-3. Only three of the nine extraction wells (EW-4, EW-8, and EW-9) had 1,1-DCE concentrations above MCLs.

- It is considered likely that there is some continuing source of 1,1,1-TCA in the unsaturated zone that breaks down to 1,1-DCE when it enters the ground water. The continuing source may be located beneath a building.

- There is a tradeoff associated with pumping more water at the extraction wells. On one hand, increasing extraction may increase the size of the capture zone. However, it may also cause too much drawdown at residences, negatively impacting the yields of those wells.

- A ground water flow model was calibrated for this site, and some information about the modeling was provided to the evaluation team after the optimization evaluation meeting. However, it appears that particle tracking results to evaluate actual capture, or to compare actual capture to the extent of capture interpreted on the May 6, 2003 potentiometric surface map, have not been presented in reports.

- No institutional controls have been implemented to date.

2.0 RECOMMENDATIONS TO IMPROVE SYSTEM PROTECTIVENESS

2.1 PERFORM A MORE DETAILED CAPTURE ZONE ANALYSIS

The P&T system design flow rate was 65 gpm, however, the system has operated at approximately 35 to 45 gpm based on sustained yield at the extraction wells, and has been sustained at approximately 45 gpm recently. An additional P&T system was recently installed downgradient for the MTBE plume, and some analysis (with a ground water flow model) has reportedly been performed to conclude that the off-site system does not impact the on-site system. Site-wide potentiometric data have been collected quarterly in 2003 and 2004, and a preliminary capture zone analysis was presented in the Technical Review Report (June 2003). A more detailed capture zone analysis is recommended to confirm that the extraction system is providing the intended containment. This is important given the potential receptors located downgradient of the extraction system. This analysis should include specifying a target capture zone on a map, and using as many lines of evidence as possible (potentiometric surface maps, concentration trends, particle tracking in conjunction with ground water modeling, etc.) to interpret the capture zone. Care must be taken to make sure the extent of capture is not over-estimated by relying on measured water levels at pumping wells when evaluating potentiometric surfaces. Also, it is recommended that a particle tracking analysis be performed with the already developed numerical flow model to evaluate predicted capture. The simulated capture should be compared to interpreted capture based on potentiometric surface evaluations, and any differences in those interpretations

should be reconciled. A detailed capture zone analysis effort will indicate the degree of capture effectiveness (relative to the Target Capture Zone) and suggest if additional/revised pumping be required. Estimated cost of this capture zone analysis is approximately $10,000. Updating it annually is incorporated in the cost of Recommendation 4.1.

2.2 CONTINUE MONITORING FOR MTBE AND 1,4-DIOXANE

It is recommended that monitoring the influent for MTBE and 1,4-Dioxane be continued. If either compound becomes present at concentrations that are greater than (potential) discharge standards, a modification to the pumping strategy and/or ground water treatment strategy will likely be required, and a source remediation strategy may become more important. No change in current costs is anticipated.

2.3 WORK WITH TOWN OR COUNTY TO IDENTIFY AND/OR IMPLEMENT INSTITUTIONAL CONTROLS

EPA and PADEP should meet with the town and/or county to identify if there are measures in place to prevent exposure to contaminants, and to determine what (if anything) needs to be done to make sure no new wells can be drilled in areas potentially impacted by the site. EPA efforts for coordinating and/or participating in these activities might cost $15,000 assuming contractor support for meetings and other support tasks are required.

3.0 RECOMMENDATIONS TO REDUCE SYSTEM COST

3.1 REDUCE GROUND WATER SAMPLING FREQUENCY

Current plans are to sample 43 wells quarterly through September 2006. Quarterly sampling began in March/April 2003, and it was acknowledged during the evaluation meeting that this sampling has improved the understanding of the site and was a very worthwhile effort. However, the evaluation team feels that continuing quarterly sampling for two additional years is not likely to be worth the cost. Moreover, any seasonal impacts will have already been observed with 2003/2004 sampling data. A reasonable alternative program would be annual sampling of the 43 wells. Since the OU1 program is already in place with treatment of impacted supply wells and long-term data, the evaluation team could not identify any well where it recommends more frequent sampling than annually. The associated cost savings from reducing sampling frequency is about $100,000 per year (the current labor costs for quarterly sampling are reported to be $135,000 per year).

3.2 ELIMINATE ANALYSIS FOR METALS IN EXTRACTION WELL SAMPLING PROGRAM

Metals are not COCs at the site and the treatment system operates effectively without significant metals fouling. Analyzing for metals at all the extraction wells provides no useful data. A sample from the treatment system influent could be analyzed annually for metals to provide sufficient data for long-term consistent operations. There is no direct saving associated with this recommendation (due to the use of the contract lab), but the current practice causes unnecessary effort with respect to sampling, analysis at the lab, and reporting.

3.3 REDUCE THE NUMBER OF PROCESS WATER SAMPLES

Currently, the treatment system influent and effluent are sampled 3 times per month with sampling occurring at half-hour increments on the same day. For a ground water system with relatively consistent influent, this procedure provides little or no advantage to sampling one time per month. It is recommended that a variance be requested from whatever requirement is the basis for such sampling. The cost savings for the site are negligible given that analysis is performed by contract lab, but the current practice causes unnecessary effort with respect to sampling, analysis at the lab, and reporting.

3.4 REDUCE DATA VALIDATION

Based on the Sampling and Analysis Plan (June 2003) analytical data is currently validated to the highest level. Given that key regulatory decisions are not being made based on these data, and that the data are in many ways self validating due to the long-term nature of the system operation and ongoing monitoring, the evaluation team recommends going to the M-1 level of data validation. In addition to potential cost savings, this change will likely allow the data to be reported and used more quickly. Based on information provided by the RPM after the evaluation meeting, data validation costs appear to have been approximately $40,000 over a nearly 3.5 year period, or approximately $12,000 per year. However, future validation costs will be lower if recommendations 3.1 to 3.3 are also implemented. Thus, the potential savings from implementing this recommendation are not quantified at this time.

4.0 RECOMMENDATIONS FOR TECHNICAL IMPROVEMENT

4.1 PRODUCE TIMELY ANNUAL GROUND WATER MONITORING REPORTS

Quarterly ground water monitoring commenced in March 2003 and continued through 2004. However, the most recent ground water monitoring summary report provided to the evaluation team was a draft report describing the March 2003 event. The evaluation team recommends that an annual report be produced (which would be especially appropriate if the sampling frequency is changed to annual). That report should generally be produced within approximately 8 weeks of the ground water sampling event (or within one month of receiving results from the EPA lab, if that takes longer than a typical lab). It should include annual updates to the detailed capture zone evaluation suggested in Recommendation 2.1. This annual report should generally cost on the order of $25,000. Since the site information form reported expected costs of approximately $33,000 per year for project management and reporting, and project management might be expected to cost approximately $30,000 per year, the evaluation team believes that a well done ground water monitoring report, prepared annually, might add $22,000 per year to the current estimated costs.

5.0 RECOMMENDATIONS TO SPEED SITE CLOSEOUT

5.1 CONTINUE PUMPING TO MEET ARARS

Decay calculations reportedly indicate the timeframe for attenuation/remediation of downgradient residential wells and site wells to MCLs is about 7.5 years and 18 years, respectively. These results seem reasonable given the site conditions. As long as there is ground water pumping at homes downgradient of the P&T wells, it is recommended that P&T operations also continue.

5.2 DO NOT CONDUCT SOURCE REMOVAL AT THIS TIME

At present, the evaluation team does not recommend attempting to remove the contaminant source because of the expected difficulty and expense. The source has not been clearly identified, many factors have led to previous plume spreading (which further complicates identifying source locations), and some of the source material may be located under buildings. Therefore, the evaluation team believes that success in identifying the source area, removing the source, and substantially reducing the operating lifetime of the P&T system with source removal is unlikely. Furthermore, continued P&T system operation for containment would likely be required for a similar amount of time, whether or not source material is removed.

PRIORITIZATION AND SEQUENCING OF RECOMMENDATIONS

All recommendations can be implemented within several months, and none are dependent on the implementation of other recommendations.

OTHER ACTION ITEMS

None

Cost Summary Table

Recommendation	Reason	Estimated Additional Capital Costs ($)	Estimated Change in Annual Costs ($/yr)
2.1 Perform More Detailed Capture Zone Analysis	Effectiveness	$10,000	Included in 4.1
2.2 Continue Monitoring for MTBE and 1,4-Dioxane	Effectiveness	$0	$0
2.3 Work with Town or County to Identify and/or Implement Institutional Controls	Effectiveness	$15,000	$0
3.1 Reduce Ground Water Sampling Frequency	Cost Reduction	$0	($100,000)
3.2 Eliminate Analysis for Metals in Ground Water Sampling Program	Cost Reduction	$0	Not quantified
3.3 Reduce the Number of Process Water Samples	Cost Reduction	$0	Not quantified
3.4 Reduce Data Validation	Cost Reduction	$0	Not quantified
4.1 Produce Timely Annual Ground Water Monitoring Reports	Technical Improvement	$0	$22,000
5.1 Continue Pumping to Meet ARARs	Site Closeout	$0	$0
5.2 Do Not Conduct Source Removal at This Time	Site Closeout	$0	$0

Costs in parentheses imply cost reductions.