FOURTH FIVE-YEAR REVIEW REPORT FOR CRYSTAL CHEMICAL COMPANY SUPERFUND SITE HARRIS COUNTY, TEXAS

Prepared by

U.S. Environmental Protection Agency
Region 6
Dallas, Texas

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FOURTH FIVE-YEAR REVIEW REPORT
Crystal Chemical Company Superfund Site
EPA ID No. TXD990707010
Houston, Harris County, Texas

This memorandum documents the U.S. Environmental Protection Agency's (EPA) performance, determinations, and approval of the Crystal Chemical Company Superfund Site (Crystal Chemical or the Site) fourth five-year review (FYR) under Section 121(c) of the Comprehensive Environmental Response, Compensation, and Liability Act, 42 U.S.C. Section 9621(c), as provided in the attached Fourth FYR Report.

Summary of Fourth FYR Findings

The site soil remedy called for on-site consolidation and capping of arsenic-contaminated soils. The constructed cap effectively contains contaminants by preventing infiltration of rainwater and preventing direct contact with contaminated soils. The groundwater remedy called for pumping and treating the part of the arsenic plume amenable to arsenic removal. The groundwater remedy also called for the construction of a slurry wall around the remaining portion of the arsenic plume where it was determined that removal of the arsenic is technically impracticable. The construction of the slurry wall and accompanying ground water pressure relief system (PRS) was completed in August 2003. This fourth FYR includes a review of relevant decision documents, implementation documents, remedy performance documents, O&M documents, and legal documents and focused on the data obtained during routine cap inspections and groundwater sampling and gauging. The finding of the review indicated that no soil institutional controls are in place for protection of the monofill cap. The O&M Plan notes that surface water samples were to be collected annually from three discharge points and no surface water samples were collected during the review period. For the groundwater remedy, the downgradient extent of arsenic exceeding the remediation goal of 0.050 milligrams per liter (mg/L) and the current MCL of 0.010 mg/L outside of the slurry wall in the 35-foot (ft) zone has not been defined. Since the zone is not defined, it is not possible to determine if the Municipal Settings Designation (MSD), which acts as an institutional control to prevent groundwater use, covers the extent of the arsenic plume. Well protective casings, vaults, and pads continue to deteriorate. Arsenic concentrations in the 100-ft sand zone were found to be above the MCL indicating some communication between the 35- and 100-ft zones.

Actions Recommended

Based on the issues identified, the following recommendations were made for the Site:

- Soil Remedy

  — File a deed notice for cap protection in perpetuity.

  — Collect surface water samples as specified in the O&M Plan.

— Perform the routine monofill cap inspections as scheduled.

- Groundwater Remedy

  — Additional monitoring points are necessary to delineate the extent of arsenic levels above the remediation goal of 0.050 mg/L and the current MCL of 0.010 mg/L for areas outside of the slurry wall. Once the arsenic plume is defined, it may be necessary to amend the decision document for this area to be protective in the long-term.

  — Assess the condition of all well protective casings, covers, and concrete pads and perform maintenance and repairs as necessary.

  — Based on information provided by the PRPs, the EPA will assess the need for the currently inactive pressure relief system or other method for maintaining containment inside the slurry wall.

  — Continue to monitor arsenic concentrations in the 100-ft sand zone.

  — Further delineation of the groundwater plume needs to be done.

Determinations

The remedy for arsenic impacted soils at the Crystal Chemical Company Superfund Site is protective of human health and the environment and will remain so provided the action items identified in the FYR Report are addressed as described above. The soil cleanup levels for arsenic have not changed. The arsenic levels exceeding human health protective levels are contained in the on site monofill.

The remedy for the the groundwater is protective in the short term. Groundwater in the area is not being used for drinking water purposes. The City of Houston provides drinking water for the area. Addressing the action items described above will ensure the long-term protection of human health and the environment.

By: Pam Phillips, Acting 9/25/15

Carl E. Edlund, P.E. Date
Director, Superfund Division
U.S. Environmental Protection Agency Region 6

CONCURRENCES

FOURTH FIVE-YEAR REVIEW REPORT
CRYSTAL CHEMICAL COMPANY SUPERFUND SITE
EPA ID No. TXD990707010

By: Carlos A. Sanchez for Date: 9/9/15
Ruben Moya
U.S. Environmental Protection Agency
Remedial Project Manager

By: Carlos A. Sanchez Date: 9/9/15
Carlos Sanchez
U.S. Environmental Protection Agency
Chief, Texas/Arkansas Section

By: Carlos A. Sanchez for Date: 9/11/15
John C. Meyer
U.S. Environmental Protection Agency
Associate Director, Remedial Branch

By: Anne Foster Date: 9/22/15
Anne Foster
U.S. Environmental Protection Agency
Attorney, Office of Regional Counsel

By: Mark Peycke Date: 09/23/15
Mark Peycke
U.S. Environmental Protection Agency
Chief, Superfund Branch, Office of Regional Counsel

By: Pam Phillips Date: 9/25/15
Pamela Phillips
U.S. Environmental Protection Agency
Deputy Director, Superfund Division

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Crystal Chemical Company Superfund Site – Fourth Five Year Review

ISSUES/RECOMMENDATIONS AND FOLLOW-UP ACTIONS

OU No.	Issue	Recommendations/ Follow-Up Actions	Party Responsible	Oversight Agency	Milestone Date	Affects Protectiveness? (Y/N)	
						Current	Future
Soil	No IC is in place for protection of the monofill cap in perpetuity.	File a deed notice for cap protection in perpetuity.	UPRR	EPA	Within 1 year	No	Yes
Soil	No surface water samples were collected during the review period. The O&M Plan notes the EPA and COH agreed that surface water samples were to be collected annually from three discharge points.	Collect surface water samples as specified in the O&M Plan	UPRR	EPA	As specified in the O&M Plan	No	Yes
Soil	Monofill cap inspections are not performed in April and October of each year as specified in the O&M Plan.	Perform the routine monofill cap inspections as scheduled.	UPRR	EPA	As specified in the O&M Plan	No	Yes
Ground-water	The remediation goal in effect for the area outside of the TI waiver zone is 0.050 mg/L, while the current MCL for arsenic is 0.010 mg/L (EPA 2014).	Additional monitoring points are necessary to delineate the extent of arsenic levels above the remediation goal of 0.050 mg/L and the current MCL of 0.010 mg/L for areas outside of the slurry wall. Once the arsenic plume is defined, it may be necessary to amend the decision document for this area to be protective in the long-term.	UPRR	EPA	Within 1 year	No	Yes
Ground-water	The southern, downgradient extent of arsenic exceeding the MCL in the 35-ft zone has not been defined. As the zone is not defined, it is not possible for the MSD to cover the extent of the arsenic plume.	Additional monitoring points are necessary to delineate the extent of arsenic levels above the remediation goal of 0.050 mg/L and the current MCL of 0.010 mg/L for areas outside of the slurry wall. Once the arsenic plume is defined, it may be necessary to amend the MSD to include the affected area.	UPRR	EPA	Within 1 year	No	Yes
Ground-water	Well protective casings, vaults, and pads continue to deteriorate.	Assess the condition of all well protective casings, covers, and concrete pads and perform maintenance and repairs as necessary.	UPRR	EPA	Within 1 year	No	Yes

OU No.	Issue	Recommendations/ Follow-Up Actions	Party Responsible	Oversight Agency	Milestone Date	Affects Protectiveness? (Y/N)	
						Current	Future
Ground-water	Arsenic concentrations in the 100-ft sand zone were found to be above the MCL indicating some communication between the 35- and 100-ft zones.	Continue to monitor arsenic concentrations in the 100-ft sand zone.	UPRR	EPA	Per the O&M Schedule	No	Yes
Ground-water	The Pressure Relief System has been inactive since 2009 due to pilot studies that were conducted through 2013.	Based on information provided by the PRPs, the EPA will assess the need for the currently inactive pressure relief system or other method for maintaining containment inside the slurry wall.	EPA	EPA	Within 1 year	No	Yes

In addition, the following are recommendations that improve effectiveness of the remedy, but do not affect current protectiveness and were identified during the FYR:

- Continue to perform regular cap inspections, taking note of grass growth during drought conditions.
- Continue regular maintenance to rid the Site of ant mounds, animal burrows, etc.

CRYSTAL CHEMICAL COMPANY SUPERFUND SITE
FOURTH FIVE-YEAR REVIEW REPORT

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LIST OF ACRONYMS

ARAR	Applicable or relevant and appropriate requirement
bgs	Below ground surface
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
COH	City of Houston
CRA	Conestoga-Rovers and Associates
Crystal Chemical	Crystal Chemical Company Superfund Site
EA	EA Engineering, Science, and Technology, Inc., PBC
EPA	U.S. Environmental Protection Agency Region 6
ERM	Environmental Resources Management
ESD	Explanation of Significant Differences
FS	Feasibility study
ft	Feet/foot
FYR	Five-year review
GWTP	Groundwater treatment plant
IC	Institutional control
MCL	Maximum Contaminant Level
mg/kg	Milligrams per kilogram
mg/L	Milligrams per liter
MSD	Municipal Settings Designation
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NPL	National Priorities List
O&M	Operation and maintenance
OU	Operable unit
POTW	Publically Owned Treatment Works
PRP	Potentially Responsible Party
PRS	Pressure release system
RAO	Remedial action objective
RCRA	Resource Conservation and Recovery Act
RI	Remedial investigation
ROD	Record of Decision

LIST OF ACRONYMS AND ABBREVIATIONS (concluded)

Shearton	Shearton Development, Inc.
Southern Pacific	Southern Pacific Transportation Company
TCEQ	Texas Commission on Environmental Quality
TI	Technical impracticability
UPRR	Union Pacific Railroad Company

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EXECUTIVE SUMMARY

This is the fourth Five-Year Review (FYR) for the Crystal Chemical Company Superfund Site (Crystal Chemical or the Site) located in Harris County, Texas. The purpose of this FYR is to review information to determine if the remedy is and will continue to be protective of human health and the environment. The triggering action for this statutory FYR was the signing of the previous FYR on 9/30/2010.

The fourth FYR for the Site was performed through a review of site documents and site-specific requirements, the Site inspection performed on 12/3/2014, interviews with stakeholders, and a review of data collected at the Site during the fourth FYR period. The previous FYR was performed in September 2010.

Issues noted during this FYR include:

- **Soil Remedy**
  - No institutional control (IC) is in place for protection of the monofill cap in perpetuity.
  - No surface water samples were collected during the review period. The Operation and Maintenance (O&M) Plan notes that surface water samples were to be collected annually from three discharge points.
  - Conduct Monofill cap inspections as specified in the O&M Plan.

- **Groundwater Remedy**
  - The groundwater remediation goal in effect for the area outside of the technical impracticability (TI) waiver zone is 0.050 milligrams per liter (mg/L), while the current Maximum Contaminant Level (MCL) for arsenic is 0.010 mg/L (EPA 2014).
  - The southern, downgradient extent of arsenic exceeding the remediation goal or the MCL in the 35-foot (ft) zone has not been defined. As the zone is not defined, it is not possible to know if the MSD covers the extent of the arsenic plume.
  - Well protective casings, vaults, and pads continue to deteriorate.
  - Arsenic concentrations in the 100-ft sand zone were found to be above the MCL indicating some communication between the 35- and 100-ft zones.
  - Based on information provided by the PRPs, the EPA will assess and determine the need for the currently inactive pressure relief system or other method for maintaining containment inside the slurry wall.

Government Performance and Results Act Measures Review
As part of this FYR, the Government Performance and Results Act Measures have also been reviewed. The measures and their status are as follows:
Environmental Indicators

Human Health: Human Exposure is under control

Groundwater Migration: Groundwater migration is under control.

Sitewide Ready for Anticipated Use

The Site has achieved Sitewide Ready for Anticipated Use status.

FIVE-YEAR REVIEW SUMMARY FORM

SITE IDENTIFICATION		
Site Name: Crystal Chemical Company		
EPA ID: TXD 990707010		
Region: 6	**State:** TX	**City/County:** Harris County

SITE STATUS	
NPL Status: Final	
Multiple Operable Units (OUs)? No	**Has the site achieved construction completion?** Yes

REVIEW STATUS
Lead agency: EPA ***[If "Other Federal Agency," enter Agency name]*:**
Author name (Federal or State Project Manager): Mr. Ruben Moya
Author affiliation: EPA Region 6
Review period: 7/1/2010 – 1/19/2015
Date of site inspection: 12/3/2014
Type of review: Statutory
Review number: 4
Triggering action date: 9/30/2010
Due date *(five years after triggering action date)*: 9/30/2015

Issues/Recommendations
OU(s) without Issues/Recommendations Identified in the FYR:
Issues are for the Site's soil and groundwater remedies. See below.

FIVE-YEAR REVIEW SUMMARY FORM (continued)

Issues and Recommendations Identified in the FYR:

OU(s): Soil	**Issue Category: Institutional Controls**			
	Issue: No IC is in place for protection of the monofill cap in perpetuity.			
	Recommendation: File a deed notice for cap protection in perpetuity			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Party Responsible**	**Oversight Party**	**Milestone Date**
No	Yes	PRP	EPA	Within 1 year
OU(s): Soil	**Issue Category:** Monitoring			
	Issue: No surface water samples were collected during the review period. The O&M Plan notes that surface water samples were to be collected annually from three discharge points.			
	Recommendation: Collect surface water samples as specified in the O&M Plan			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Party Responsible**	**Oversight Party**	**Milestone Date**
No	Yes	PRP	EPA	As specified in the O&M Plan.
OU(s): Soil	**Issue Category:** Operations and Maintenance			
	Issue: Monofill cap inspections are not performed in April and October of each year as specified in the O&M Plan.			
	Recommendation: Perform the routine monofill cap inspections as scheduled.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Party Responsible**	**Oversight Party**	**Milestone Date**
No	Yes	PRP	EPA	As specified in the O&M Plan.
OU(s): Groundwater	**Issue Category:** Monitoring			
	Issue: The remediation goal in effect for the area outside of the TI waiver zone is 0.050 mg/L, while the current Maximum Contaminant Level (MCL) for arsenic is 0.010 mg/L (EPA 2014).			
	Recommendation: Additional monitoring points are necessary to delineate the extent of arsenic levels above the remediation goal of 0.050 mg/L and the current MCL of 0.010 mg/L for areas outside of the slurry wall. Once the arsenic plume is defined, it may be necessary to amend the decision document for this area to be protective in the long-term.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Party Responsible**	**Oversight Party**	**Milestone Date**
No	Yes	PRP	EPA	Within 1 year.

OU(s): Groundwater	**Issue Category:** Monitoring/ICs			
	Issue: The southern, downgradient extent of arsenic exceeding the remediation goal or the MCL in the 35-ft zone has not been defined. As the zone is not defined, it is not possible to determine if the MSD covers the extent of the arsenic plume.			
	Recommendation: Additional monitoring points are necessary to delineate the extent of arsenic levels above the remediation goal of 0.050 mg/L and the current MCL of 0.010 mg/L for areas outside of the slurry wall. Once the arsenic plume is defined, it may be necessary to amend the MSD to include the affected area			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Party Responsible**	**Oversight Party**	**Milestone Date**
No	Yes	PRP	EPA	Within 1 year.
OU(s): Groundwater	**Issue Category:** Operations and Maintenance			
	Issue: Well protective casings, vaults, and pads continue to deteriorate.			
	Recommendation: Assess the condition of all well protective casings, covers, and concrete pads and perform maintenance and repairs as necessary.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Party Responsible**	**Oversight Party**	**Milestone Date**
No	Yes	PRP	EPA	Within 1 year, and as needed.
OU(s): Groundwater	**Issue Category:** Monitoring			
	Issue: Arsenic concentrations in the 100-ft sand zone were found to be above the MCL indicating some communication between the 35- and 100-ft zones.			
	Recommendation: Continue to monitor arsenic concentrations in the 100-ft sand zone.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Party Responsible**	**Oversight Party**	**Milestone Date**
No	Yes	PRP	EPA	Per the O&M Plan schedule.
OU(s): Groundwater	**Issue Category:** Remedy Performance			
	Issue: The pressure relief system (PRS) used to maintain containment inside the slurry wall is inactive and the EPA has not determined whether containment is being currently maintained.			
	Recommendation: Based on the information provided by the PRPs, the EPA needs to assess the need for the currently inactive pressure relief system or other method for maintaining containment inside the slurry wall.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Party Responsible**	**Oversight Party**	**Milestone Date**
No	Yes	PRP	EPA	Within 1 year.

Protectiveness Statement(s)		
Operable Unit: Soil	*Protectiveness Determination:* Protective	*Addendum Due Date (if applicable):*
Protectiveness Statement: The remedy for arsenic impacted soils at the Crystal Chemical Company Superfund Site is protective of human health and the environment and will remain so provided the action items identified in the FYR Report are addressed as described above. The soil cleanup levels for arsenic have not changed. The arsenic levels exceeding human health protective levels are contained in the on site monofill.		
Operable Unit: Groundwater	*Protectiveness Determination:* Short-term Protective	*Addendum Due Date (if applicable):*
Protectiveness Statement: The remedy for the the groundwater is protective in the short term. Groundwater in the area is not being used for drinking water purposes. The City of Houston provides drinking water for the area. Addressing the action items described above will ensure the long-term protection of human health and the environment.		

I. INTRODUCTION

The purpose of a Five-Year Review (FYR) is to evaluate the implementation and performance of a remedy in order to determine if the remedy will continue to be protective of human health and the environment. The methods, findings, and conclusions of reviews are documented in FYR reports. In addition, FYR reports identify issues found during the review, if any, and document recommendations to address them.

The U.S. Environmental Protection Agency (EPA) prepares FYRs pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Section 121 and the National Contingency Plan (NCP). CERCLA 121 states:

> *If the President selects a remedial action that results in any hazardous substances, pollutants, or contaminants remaining at the site, the President shall review such remedial action no less often than each five years after the initiation of such remedial action to assure that human health and the environment are being protected by the remedial action being implemented. In addition, if, upon such review, it is the judgment of the President that action is appropriate at such site in accordance with section [104] or [106], the President shall take or require such action. The President shall report to the Congress a list of facilities for which such review is required, the results of all such reviews, and any actions taken as a result of such reviews.*

EPA interpreted this requirement further in the NCP; 40 Code of Federal Regulations Section 300.430(f)(4)(ii), which states:

> *If a remedial action is selected that results in hazardous substances, pollutants, or contaminants remaining at the site above levels that allow for unlimited use and unrestricted exposure, the lead agency shall review such actions no less often than every five years after the initiation of the selected remedial action.*

The EPA Region 6 conducted a FYR on the remedy implemented at the Crystal Chemical Company Superfund Site (Crystal Chemical Company or the Site) in Harris County, Texas. EPA is the lead agency for developing and implementing the remedy for the Site. The Texas Commission on Environmental Quality (TCEQ), as the support agency representing the state of Texas, has reviewed all supporting documentation and provided input to EPA during the FYR process.

This is the fourth FYR for the Site. The triggering action for this statutory review is the completion date of the previous FYR. The FYR is required due to the fact that hazardous substances, pollutants, or contaminants remain at the Site above levels that allow for unlimited use and unrestricted exposure. The Site consists of one operable unit (OU), which is addressed in this FYR. A chronology of existing Site information is included as Appendix A. Site figures and annual arsenic concentrations are included in Appendix B.

II. PROGRESS SINCE THE LAST REVIEW

Table 1: Protectiveness Determinations/Statements from the 2010 Five-Year Review

OU No.	Protectiveness Determination	Protectiveness Statement
Soil	Protective	The remedy for arsenic impacted soils at the Crystal Chemical Company Superfund Site is protective of human health and the environment and will remain so provided the issues identified in the Third FYR Report are addressed.
Groundwater	Protectiveness Deferred	A protectiveness determination for groundwater cannot be made at this time. The extent of impacted groundwater exceeding the arsenic Maximum Contaminant Level (MCL) is unknown. However, there is a public drinking water supply that is capable of supplying drinking water to the designated property and property within 0.5 mile of the site. Implementing the recommendations described in the Third FYR Report will ensure the long-term protection of human health and the environment

Table 2: Status of Recommendations from the 2010 Five-Year Review

OU No.	Issue	Recommendations/ Follow-Up Actions	Party Responsible	Oversight Party	Original Milestone Date	Current Status	Completion Date (if applicable)
Soil	No IC is in place for protection of the monofill cap in perpetuity.	File a deed notice for cap protection.	PRP	EPA	1/1/2011	Ongoing	
Soil	In 2009, one cap inspection was performed. The Operation and Maintenance (O&M) Plan requires that the minimum frequency of inspections be semi-annually.	Perform semi-annual inspections as specified in the O&M Plan.	PRP	EPA	1/1/2010	Ongoing	
Soil	No surface water samples were collected during the review period. The O&M Plan notes the EPA and City of Houston (COH) agreed that surface water samples were to be collected annually from three discharge points.	Collect annually surface water samples as specified.	PRP	EPA	1/1/2010	Ongoing	
Soil	Grass on the monofill cap was not mowed at the 6-inch height required by the O&M Plan.	Mow the grass according to specification. Perform routine site inspection after grass is mowed so any issues with the monofill cap are visible.	PRP	EPA	1/1/2010	Ongoing	

Table 2: Status of Recommendations from the 2010 Five-Year Review (continued)

OU No.	Issue	Recommendations/ Follow-up Actions	Party Responsible	Oversight Party	Original Milestone Date	Current Status	Completion Date (if applicable)
Soil	Recurring problems were recorded during the routine inspections as well as the FYR site inspection: debris accumulation at surface water drains, rutting in the cap cover, ant hills, and minor erosion at the southern gate area. A significant number of ant hills were noted during the FYR inspection and an estimation of extent of the problem was precluded by tall vegetation.	Address recurring problems noted during routine inspections including: debris accumulation at surface water drains, rutting in the landfill cover, ant hills, and minor erosion at the southern gate area.	PRP	EPA	1/1/2011	Ongoing	
Soil	Monofill cap inspections are not performed in April and October as specified in the O&M Plan.	Perform the routine monofill cap inspections as scheduled.	PRP	EPA	1/1/2010	Ongoing	
Ground-water	Remediation goal action objective (RAO) in effect for the area outside of the technical impracticability (TI) waiver zone is 0.050 mg/L, while the new MCL for arsenic is 0.010 mg/L.	Issue an Explanation of Significant Differences to change the RAO to the current arsenic MCL.	EPA	EPA	1/1/2010	Ongoing	
Ground-water	The extent of arsenic exceeding the MCL in the 35-foot (ft) zone has not been defined.	Additional monitoring points are necessary to delineate the extent of the arsenic impact above RAO (i.e., MCL). A water well survey will need to be conducted to determine if the impacted water is being utilized. If impacted water is being utilized, appropriate actions will need to be taken to address exposure.	PRP	EPA	1/1/2010	Ongoing	

Table 2: Status of Recommendations from the 2010 Five-Year Review (continued)

OU No.	Issue	Recommendations/Follow-up Actions	Party Responsible	Oversight Party	Original Milestone Date	Current Status	Completion Date (if applicable)
Ground-water	The capture zone for recovery well RW-1 was not depicted in any documentation available for review. Plume capture by RW-1 has not been demonstrated.	After plume delineation, demonstrate the capture zone for recovery well RW-1 through groundwater elevation monitoring or modeling.	PRP	EPA	1/1/2010	RW-1 is not operational	
Ground-water	Since 1996, the groundwater treatment plant (GWTP) has treated more than 7.8 million gallons of water. During the FYR period, arsenic concentrations in the influent samples have ranged from a high of 36.8 mg/L in 2005 to a low of 6.95 mg/L in 2009. While concentrations have decreased, the influent concentrations are still significantly above the RAO for groundwater.	Evaluate the groundwater extraction and treatment system's effectiveness toward attaining the groundwater RAO and if the TI waiver area needs to be expanded, the implementation of the current remedy needs to be more aggressive, or if other alternatives should be implemented	EPA	EPA	1/1/2010	The GWTP is not operational	
Ground-water	The Municipal Settings Designation (MSD) for the site is pending with TCEQ due to lack of approval from a local utility company.	Determine if the current extent of the MSD is still adequate after the RAO for the area outside of the TI Waiver is changed to the new arsenic MCL. Follow up on the MSD status.	EPA	EPA	2010	MSD issued, RAO /MCL aspect not addressed	

Table 2: Status of Recommendations from the 2010 Five-Year Review (continued)

OU No.	Issue	Recommendations/Follow-up Actions	Party Responsible	Oversight Party	Original Milestone Date	Current Status	Completion Date (if applicable)
Ground-water	The performance RAO of the pressure relief system (PRS) wells is to maintain containment inside of TI waiver area such that no more than a 1-ft elevation difference between the interior and exterior PRS wells is measured. At two times during the FYR period, this RAO was exceeded. One exceedance occurred before the PRS was shut down.	Determine if changes in the current PRS are necessary or additional actions need to be implemented to maintain, on average, inward or at least neutral gradient across the slurry wall/natural levee to maintain containment.	EPA	EPA	1/1/2010	PRS not operable	1/1/2009
Ground-water	Phytohydraulic control performance in the Levy Tract was tested against the performance of the PRS that did not meet RAOs.	Evaluate the performance of the phytohydraulic control against the ROD requirements.	EPA	EPA	1/1/2010	Levy Tract Trees have been removed	Trees removed 6/26/2013
Ground-water	Sampling and gauging schedules have changed almost yearly due to pilot testing. Long-term monitoring regimen is not established. Adherence to schedule and commitments is cumbersome to track in present form.	Gauging and sampling should be adequate for meaningful trend analysis and comparison of data. The schedule of well gauging and sampling should be compiled in tabular format instead of identifying changes in various correspondences and plans. Criteria for performance evaluation should be clearly defined so conclusion and recommendations can be made in a consistent manner.	PRP	EPA	1/1/2010	Ongoing	

Table 2: Status of Recommendations from the 2010 Five-Year Review (continued)

OU No.	Issue	Recommendations/Follow-up Actions	Party Responsible	Oversight Party	Original Milestone Date	Current Status	Completion Date (if applicable)
Ground-water	Well protective casings, vaults, and pads are starting to deteriorate.	Assess the condition of all well protective casings, covers, and concrete pads and perform maintenance and repairs as necessary.	PRP	EPA	1/1/2010	Ongoing	
Ground-water	Access to the Shearton Tract is not controlled due to lack of fencing beyond the drain on the southern border of the tract. Gate to the Levy Tract was not locked.	Assess the extent of the uncontrolled perimeter on the southern boundary of Shearton Tract and complete the fence to preclude unauthorized access to areas where remedies are in place.	PRP	EPA	1/1/2010	Completed	1/1/2014
Ground-water	Location of trees used for phytohydraulic control is not depicted correctly on the site maps.	Use Global Positioning System to more accurately locate the remedy features on site maps.	PRP	EPA	1/1/2010	Completed	1/1/2010

- No IC is in place for protection of the monofill cap in perpetuity - There remains no IC in place for the protection/maintenance of the monofill cap in perpetuity.

- In 2009, one cap inspection was performed. The O&M Plan requires that the minimum frequency of inspections be semi-annually - Cap inspections were completed per the O&M plan (semi-annually in April and October) in 2011 and 2012. One inspection was completed in 2010, and inspections were completed in June and October in 2013 and 2014.

- No surface water samples were collected during the review period. The O&M Plan notes the EPA and COH agreed that surface water samples were to be collected annually from three discharge points - No surface water samples were collected during the current FYR period.

- Grass on the monofill cap was not mowed at the 6-inch height required by the O&M Plan - Grass was mowed once in 2010 and 2011, as needed after re-seeding in 2012, and twice each in 2013 and 2014. It is noted that drought conditions affected the need to mow the cap on a regular basis, and re-seeding has taken place.

- Recurring problems were recorded during the routine inspections as well as the FYR site inspection: debris accumulation at surface water drains, rutting in the cap cover, ant hills, and minor erosion at the southern gate area. A significant number of ant hills were noted during the FYR inspection and an estimation of extent of the problem was precluded by

tall vegetation - Routine problems persist (i.e., ant mounds), but do not appear to threaten the remedy's protectiveness.

- Monofill cap inspections are not performed in April and October of each year as specified in the O&M Plan - Not all inspections completed in the April/October timeframe (2010, one inspection; 2013, June and October; 2014, June and October).

- RAO in effect for the area outside of the TI waiver zone is 0.050 milligrams per liter (mg/L), while the new MCL for arsenic is 0.010 mg/L - No determination has been made that the Site RAO for arsenic of 0.050 mg/L remains protective.

- The extent of arsenic exceeding the MCL in the 35-ft zone has not been defined - The extent of the arsenic plume to the south (downgradient) of the Site is still not defined.

- The capture zone for recovery well RW-1 was not depicted in any documentation available for review. Plume capture by RW-1 has not been demonstrated - Recovery well RW-1 has not been operational since 2010; therefore, the capture zone will have to be revisited.

- GWTP influent concentration issues - The GWTP is not currently operational.

- The MSD for the site is pending with TCEQ due to lack of approval from a local utility company - The MSD has been issued, however, the RAO/MCL aspect has not been addressed.

- The performance RAO of the PRS wells is to maintain containment inside of TI waiver area such that no more than a 1-ft elevation difference between the interior and exterior PRS wells is measured. At two times during the Third FYR period, this RAO was exceeded. One exceedance occurred before the PRS was shut down in 2009. Based on information provided by the PRPs, the EPA will assess and determine the need for the currently inactive pressure relief system or other method for maintaining containment inside the slurry wall.

- Phytohydraulic control performance in the Levy Tract was tested against the performance of the PRS that did not meet RAOs - The trees that provided the phytohydraulic control in the Levy Tract were removed on 6/26/2013.

- Sampling and gauging schedules have changed almost yearly due to pilot testing. A long-term monitoring regimen is not established. Adherence to schedule and commitments is cumbersome to track in present form - Sampling and reporting continues to be cumbersome to track given implementation and completion of phytohydraulic control pilot tests, removal of trees in the Levy Tract, and subsequent groundwater monitoring after tree removal. Not all monthly reports were available for all years, and some years have no monthly reporting at all (2012).

- Well protective casings, vaults, and pads are starting to deteriorate - Wells continue to have these issues due to shrink/swell cycles in Site soils.

Remedy Implementation Activities

Table 3: Summary of Planned and/or Implemented Institutional Controls

Media, Engineered Controls, and areas that Do Not Support Unlimited Use/Unrestricted Exposure Based on Current Conditions	ICs Needed	ICs Called for in the Decision Documents	Impacted Parcel(s)	IC Objective	Title of IC Instrument Implemented and Date (or planned)
Soil	Yes	Yes	Monofill Cap	Restrict disturbance of the monofill cap.	The process for implementing this IC had not been initiated at the time of the last FYR.
Groundwater	Yes	Yes	Groundwater requires post-closure care or engineering control measures	Ensure appropriate future use	7/12/2012

For soils, no IC is in place for protection of the monofill cap in perpetuity.

Deed recordation documents for the Site groundwater and affected offsite properties were prepared by the site owner, Union Pacific Railroad Company (UPRR), and were submitted on 5/13/2005 to the COH. The Industrial Solid Waste Certification of Remediation, executed on 8/10/2005, notes that contaminants of concern remaining at the site in groundwater require post-closure care or engineering control measures for groundwater in this area. ICs or legal controls placed at the site will ensure appropriate future use. Future land use is considered suitable for nonresidential (i.e., industrial/commercial) purposes in accordance with EPA and TCEQ risk reduction standards applicable at the time of this filing. Future land use is intended to be nonresidential. This document was filed with the County Clerk of Harris County on 3/7/2006.

An MSD application was submitted to COH on 11/1/2007. MSD Ordinance No. 2008-253 was approved by COH on 3/26/2008. UPRR submitted an application to the TCEQ on 6/23/2008, to obtain an MSD for the site and adjacent area. An MSD certification issued by TCEQ and supported by the COH would prohibit the use of the affected groundwater at the Site, thus eliminating the groundwater ingestion exposure pathway. In turn, this will promote redevelopment of the property. Discussions on the application of an MSD were held in a meeting between EPA, UPRR, TCEQ, and COH on 11/20/2007, at the EPA Region 6 Dallas offices. At the time of the last FYR, UPRR had received support for the MSD from all municipalities and retail public utilities within the required 5-mile radius with the exception of one municipality, the Memorial Villages Water Authority. The MSD Certificate was finally issued on 7/12/2012 (TCEQ 2012).
During the FYR, no activities were observed that would have violated either the groundwater IC or physical control.

System Operation/Operation and Maintenance Activities

O&M for the soil and groundwater remedies are discussed below.

Operation and Maintenance for the Soil Remedy

After the construction phase of the soil remedy was completed in September 1995, the maintenance of the monofill cap was initiated in accordance with the remedial action O&M Plan, dated 11/30/1994 (Industrial Compliance 1994). In 2009, the date of the last five year review inspection performed, the monofill cap was in its fourteenth year of operation.

The O&M Plan requires that the soil remedy be monitored for 30 years, or such time as determined by the EPA. After completion of the monofill cap in September 1995, UPRR conducted monthly inspections of the monofill cap until July 2002, at which time UPRR reduced the frequency of inspections to once every quarter. In 2003, UPRR reduced the frequency of the inspections to semi-annually (in April and October), consistent with the minimum frequency required in the O&M Plan (Industrial Compliance 1994). However, in 2010, only one inspection was performed on 19 October (CRA 2011b). Semi-annual inspections resumed in 2011. The O&M Plan also provided for special site inspections to assess the integrity of the cap to be performed after a 5-year/24-hour storm, which is the equivalent of 7.2 inches of rain in 24 hours. No such inspections were noted during the review period.

O&M activities for the monofill cap include addressing the following issues (Industrial Compliance 1994):

1. Stressed vegetation and bare spots

2. Burrow holes

3. Fire ant nests

4. Depressions or eroded areas or other signs of settlement of the monofill cap

5. Incidental growth of wooded species with root structures that might negatively impact the cap integrity

6. Desiccation cracks in the final cover.

O&M activities for the surface structures include addressing the following issues (Industrial Compliance 1994):

1. Erosion that could cause failure of a structure
2. Silt buildup and debris accumulation that could cause overtopping of structures
3. Rip-rap or erosion management structures to ensure that they are operating as designed.

As per the ROD (EPA 1990), surface water runoff needs to comply with Clean Water Act regulations to meet water quality criteria for arsenic of 0.0175 micrograms per liter. The 1994 O&M Plan (Industrial Compliance 1994) notes that EPA and COH agreed that surface water samples should be collected annually from three discharge points: the COH sewer, the ditch to the south of the site, and the entrance to the Harris County Flood Control District drainage backslope drop structure to the west of the site. No surface water collection was noted in the Annual Reports reviewed for this fourth FYR.

Additional features that the site inspections should also include are fence, signage, and road conditions.

Maintenance of the monofill cap generally consists of mowing once every 2 months during the growing season (March-October), application of herbicide and insecticide, minor erosion repair of the side slopes, and maintenance of the perimeter fence. The grass should be mowed to a height of 6 inches. Contractors for UPRR are to conduct these maintenance activities during the regularly scheduled site inspections. The annual remedial action reports for 2010, 2011, 2012, and 2013 included monofill inspection reports as Appendix A. Noted major observations from the RA reports are as follows for the FYR period from July 2010 to through 2014.

- ***2010***—One inspection of the monofill cap took place on 10/19/2010. Noted observations included evidence of animal burrowing in the cover, and active ant mounds on the cap. The remedial action report states that no significant repairs were necessary in 2010 (CRA 2011b). The monofill cap was mowed on 5/12/2010 (UPRR 2010e).

- ***2011***—Two inspections of the monofill cap took place. The first was completed on 4/7/2011 and the second inspection took place on 10/12/2011 (CRA 2012). The monofill cap was mowed on 6/29/2011 (UPRR 2011a). The November 2011 monthly report states that prolonged drought had stressed the vegetative cover, and that efforts to re-vegetate the cap were in progress (UPRR 2011d).

- ***2012***—Two inspections of the monofill cap took place. The first was completed on 4/12/2012, where "a few active [ant] mounds" were noted. The second inspection took place on 10/1/2012 where vegetation higher than 5-inches, ant mounds, and holes in the south fence were noted. The remedial action report states that no significant repairs were necessary (other than grass re-seeding) in 2012 (CRA 2013). Grass re-seeding was necessary due to drought conditions in 2011. Re-seeding took place in late 2011/early 2012. According to the 2012 Annual Remedial Action Report, the cover was mowed every 2 months, or as needed, between March and October (CRA 2013).

- ***2013***—Two inspections of the monofill cap took place. The first was completed on 6/13/2013, and the second inspection took place on 10/11/2013. No issues were noted in either inspection (CRA 2014). The monofill cap was mowed on 6/28/2013 (UPRR 2013f) and on 8/28/2013 (UPRR 2013h).

- ***2014***—Two inspections of the monofill cap took place. The first was completed on 6/27/2014 (UPRR 2014f), and the second inspection took place on 10/17/2014 (UPRR

2014j). The monofill cap was mowed on 8/15/2014 (UPRR 2014h) and on 10/29/2014 (UPRR 2014j). No issues with the monofill cap were noted during either inspection.

In general, the annual reports document that the monofill cap was adequately maintained during the review period. However, some of the problems observed were recurring with each inspection. Also, inspections are supposed to take place in April and October of each year. As noted above, this schedule was not adhered to in April 2010 (no inspection), in April 2013 (completed in June), or in April 2014 (completed in June).

Operation and Maintenance for the Groundwater Remedies

The groundwater recovery and treatment system was designed to operate continuously unless operation was ceased for either maintenance, repairs, or other reasons related to site remedy testing (i.e., the phytohydraulic pilot testing). When operational, water removed through the PRS is treated in the GWTP; and, as a consequence, O&M activities for the recovery well and piping or wells related to the PRS may all affect the performance of the GWTP. Similarly, the unavailability of the GWTP to treat water from the PRS may affect the amount of water that can be pumped due to limits set by storage capability. Because of the interconnectedness of the groundwater remedies, O&M information is summarized jointly for both the groundwater treatment system and the PRS wells and piping system. The slurry wall O&M is discussed separately.

Groundwater Treatment System and Pressure Relief System Wells and Piping

Maintenance of the groundwater recovery and treatment system generally consists of replacing piping, pumps, and valves as necessary to maintain recovery. Groundwater recovery from well RW-1 and treatment at the GWTP were suspended on 1/13/2010 as part of the phytohydraulic control pilot test at the Shearton Tract. Groundwater recovery from the PRS was also suspended (UPRR 2010a, CRA 2011b). Based on the effective results of the phytohydraulic pilot test in the Levy Tract performed in 2008, the PRS was shut down in 2009 (CRA 2011b). In 2013, a 3-month study was conducted to determine "the influence of the eucalyptus trees on groundwater levels and flow in the slurry wall area of the Levy Tract" (CRA 2014). It was determined that the trees did not have a significant effect on groundwater levels within the slurry wall. As a result, the trees were removed on 6/26/2013 (CRA 2014). The 2013 Annual Remedial Action Report states that the "PRS [will] remain inactive based on Levy Tract phytohydraulic pilot test results" (CRA 2014).

Contractors for UPRR conduct maintenance activities on an as-needed basis. Annual remedial action reports, monthly progress reports, and semi-annual and annual groundwater monitoring laboratory reports are submitted to EPA and TCEQ. Dates of noted significant O&M activities, proposed and effective changes in operation of the groundwater remedies, as well as PRS inspection findings are as follows for the period from January 2010 to through 2013.

- **2010**
  - Operation of recovery well RW-1 and the GWTP system was temporarily suspended in January 2010 for the Phytohydraulic Control Pilot Test. However, a total of

26,543 gallons of treated groundwater was discharged to the COH Publically Owned Treatment Works (POTW) in early January 2010 prior to shutdown of well RW-1 (CRA 2011b). The discharge is authorized under a COH permit, with arsenic concentrations limits of 2.0 mg/L for a composite sample and 3.0 mg/L for a grab sample. Grab samples were collected from each discharge batch and used for compliance documentation. No exceedances in the discharge effluent occurred in 2010 (CRA 2011b).

- In January 2010, the filter assembly failed due to a corroded bolt on 1/6/2010. It was subsequently repaired. No significant repairs/replacements or events were noted at the GWTP (UPRR 2010a). As stated above, groundwater recovery from well RW-1 and treatment at the GWTP were suspended in January 2010 as part of the phytohydraulic control pilot test at the Shearton Tract (UPRR 2010a).

- In February 2010, the filter press feed and hydraulic pumps were not working properly. General press and pump maintenance was performed. Storage tanks T-2, T-3, and other storage tanks were pumped out to perform cleaning, leak tests, and repairs (UPRR 2010b).

- In March 2010/April 2010, no miscellaneous or significant repairs/replacements or events were noted for the GWTP operations (UPRR 2010c, 2010d).

- In May 2010, the T-1 transfer pump was re-built, and piping between tanks T-2 and T-3 was repaired. Fence repairs were made to the northwest corner of the GWTP area (UPRR 2010e).

- In August 2010, no miscellaneous or significant repairs/replacements or events were noted for the GWTP operations (UPRR 2010f).

- In October 2010, no miscellaneous or significant repairs/replacements or events were noted for the GWTP operations. The PRS inspection took place on 10/19/2010. No issues were noted (UPRR 2010g).

- In June/July/September/November/December 2010, no monthly reports were available for review.

- **2011**

  - Groundwater was pumped from well RW-1 in 2009 to support GWTP maintenance activities during suspension of groundwater recovery. In 2011, a total of 2,961 gallons of this recovered and treated water was discharged to the COH. No exceedances in the discharge effluent occurred in 2011 (CRA 2012).

  - The Shearton Tract Phytohydraulic Control Pilot Test Report was submitted to EPA on 4/26/2011 (CRA 2011a).

  - In January–May 2011, no monthly reports were available for review.

- On 4/4/2011, a broken backflow preventer was repaired (CRA 2012).

- From 6/6/2011 to 6/16/2011, a damaged overhead door was replaced (CRA 2012).

- In June, July, September, November 2011, no miscellaneous or significant repairs/replacements or events were noted for the GWTP operations (UPRR 2011a-d).

- **2012**

  - Groundwater was pumped from well RW-1 in 2009 to support GWTP maintenance activities during suspension of groundwater recovery. In 2012, a total of 1,123 gallons of this recovered and treated water was discharged to the COH. No exceedances in the discharge effluent occurred in 2012 (CRA 2013).

  - The 2012 Annual RA report states that "the EPA has agreed to continue suspension of groundwater recovery from the Shearton Tract RW-1 and the GWTP operation until evaluation of (the Phytohydraulic Control Pilot Test) report is complete" (CRA 2013).

  - No monthly reports were available for review for 2012.

  - UPRR received MSD certification from TCEQ on 6/25/2012 prohibiting the use of affected groundwater at the site (TCEQ 2012).

- **2013**

  - The suspension of groundwater recovery continued in 2013, pending evaluation of the Shearton Tract Phytohydraulic Control Pilot Test Report (CRA 2011a). No volume of the treated groundwater from 2009 was released to the COH POTW as performed in 2012 (CRA 2014).

  - In January–November 2013, no miscellaneous or significant repairs/replacements or events were noted for the GWTP operations (UPRR 2013a-2013k).
  - In December 2013, no monthly reports were available for review.

- **2014**

  - The suspension of groundwater recovery continued in 2014. No treated groundwater was discharged to the COH POTW from January through October 2014 (UPRR 2014a-j).

  - In January–October 2014, no miscellaneous or significant repairs/replacements or events were noted for the GWTP operations (UPRR 2014a-j).

— Inspections of the PRS took place on 6/27/2014 and 10/17/2014. No issues with the PRS were noted in the June or October monthly progress reports (UPRR 2014f and j).

Slurry Wall Operation and Maintenance

The slurry wall O&M is performed in conformance with the requirements set forth in the revised O&M Plan (Environmental Resources Management [ERM] 2004). This plan outlines a schedule for semi-annual inspections between 2005 and 2008, and annual inspections thereafter through 2032. The primary inspection requirement for the slurry wall consists of walking the length of the slurry wall to note locations where settlement of the backfill has created a drainage problem.

According to the O&M Plan (ERM 2004), the PRS is inspected concurrent with the slurry wall inspections and groundwater sampling events. Inspections include tests of the main system components and maintenance required by equipment manufacturers. The system components are wells, vaults, pumps, piping, electrical parts, and storage tank of recovered groundwater; findings relative to these components are outlined in the section above.

Slurry wall inspection findings are as follows:

- **2010**

  — One inspection took place on 10/19/2010 (UPRR 2010g).

  — The need for additional rock to bring the entrances to the Levy and Shearton tracts to grade was noted. A completion date for this item was not entered on the inspection form. The vaults were noted as filled with water and a note to evaluate the seals was placed on the inspection form (CRA 2011b).

- **2011**

  — Two inspections took place in 4/7/2011 and 10/14/2011 (CRA 2012).

  — In April, the need for additional rock to bring the entrances to the Levy and Shearton tracts to grade was noted. A completion date for this item was not entered on the inspection form. This item was not marked with a completion date in October; however, this same item was marked as “pass” where it was marked “fix” in April. The text of the Annual Report does not state that rock was added to this area (CRA 2012).

  — The vaults were noted as filled with water in April and October and a note was emplaced stating that the seals were being evaluated (CRA 2012).

- **2012**

  — Inspections took place on 4/13/2012 and 10/1/2012 (CRA 2013).

— In April, performance monitor well locks were noted as missing (MW-SW8), and vaults were noted as full of water. Lastly, the need for a new pull box was noted at well MW-SW11/12 (CRA 2013).

— In October, the vaults were again noted as full of water, and the need for a new pull box was reiterated (CRA 2013).

- **2013**

— Inspections took place on 6/13/2013 and 10/11/2013. In June and October, performance monitor well locks were noted as missing (MW-SW8), and vaults were noted as full of water. Lastly, the need for a new pull box was noted at well MW-SW11/12 in both June and October (CRA 2014).

- **2014**

— Copies of the inspection reports were not available for 2014; however, inspections took place on 6/27/2014 and 10/17/2014, according to the monthly reports (UPRR 2014f,j). No issues with the slurry wall were noted in the June or October monthly reports (UPRR 2014f, j).

Groundwater quality and elevation monitoring is conducted at the Site to assess whether the remedies are operating as designed. During the current FYR period, the groundwater monitoring was conducted at least annually as specified in the Groundwater Monitoring Plan, dated 7/23/2003 (UPRR 2003a), and amended 12/12/2003 (UPRR 2003b). Groundwater monitoring took place annually in 2010, annually in 2011, semi-annually in 2012, and annually in 2013. During the Phytohydraulic Control Pilot Test in the Shearton Tract, wells MW-30 and MW-33 were sampled monthly, and well MW-31A was sampled semi-annually (CRA 2011b). No records were available to review for 2014. Groundwater from the three shallowest water-bearing zones (15-, 35-, and 100-ft sand zones) are monitored. The monitoring well network consists of two wells in the 15-ft sand zone, 15 wells in the 35-ft sand zone, and 3 wells in the 100-ft sand zone.

Groundwater elevation measurements are meant to assess groundwater flow direction and the head difference between the interior and exterior wells located in the 35-ft zone so that containment can be evaluated.

Groundwater samples are collected to assess the performance of the containment system and evaluate the potential migration of arsenic contamination. Samples were to be analyzed using EPA SW-846 Methods 3020A and 7060A. Quality control samples were to be collected with a frequency of 5 percent and consist of a duplicate sample, additional aliquot for the laboratory to prepare a matrix spike/matrix spike duplicate sample, and an equipment blank, if non-disposable sampling equipment is used. The frequency of sampling and gauging was not established after 2004 in the monitoring plan (UPRR 2003a). Rather, the gauging results and analytical data for 2004 monitoring were going to be evaluated and a proposal for further monitoring provided in

the 2004 annual report. The Second FYR Report noted that, since December 2003, water level measurements have been collected on the same frequency as the regularly scheduled O&M activities. However, due to phytohydraulic control pilot tests, the frequency of monitoring has changed during the reporting period. Additional changes are described in the Data Review section of this report.

Operation and Maintenance Cost

The CRA project manager, Mr. Wisnowiecki, provided approximate associated costs for the Site for the years of 2010 through 2014. The costs are listed in Table 4 and in Appendix C.

This table also depicts the non-routine activities that took place at this Site during the review period. Pursuant to the O&M Plan, routine activities are supposed to include the following:

- Maintain the monofill cap and surrounding fencing
- Operate and maintain the groundwater recovery and treatment system, slurry wall and PRS, and surrounding fencing
- Conduct sampling and analysis of GWTP influent and effluent
- Collect groundwater elevation measurements
- Conduct sampling and analysis of groundwater.

The 1992 Amended ROD (EPA 1992b) for the soil remedy did not specifically list annual O&M costs; no itemized annual O&M costs were available for comparison of the actual cost incurred during the review period to projected costs.

Table 4. Annual Operation and Maintenance Costs.

Year	Annual Costs (inclusive)	Notes on Activities Performed Outside of the Routine Site Activities
2010	$71,897.29	None.
2011	$73,033.12	None.
2012	$87,455.56	None.
2013	$67,469.86	None.
2014	$15,961.85	None.
TOTAL	$315,817.68	**See items listed above for the individual years.**

III. FIVE-YEAR REVIEW PROCESS

Administrative Components

The Crystal Chemical Company Superfund Site FYR was led by Mr. Ruben Moya of the EPA, Remedial Project Manager for the Site. Mr. Lam Tran, of the TCEQ, assisted in the review as the representative for the support agency.

The review, which began on 10/1/2014, consisted of the following components:

- Community Involvement
- Document Review
- Data Review
- Site Inspection
- FYR Report Development and Review.

Community Notification and Involvement

A news release was published on 12/2/2014 wherein EPA lists 22 Superfund sites undergoing FYR. A copy of this news release is provided in Appendix D. The results of this review and the report will be made available at the Site information repository located at the Judson Robinson Westchase Library, 3223 Wilcrest Drive, Houston, Texas 77042-3349 (Phone 832-393-2011).

Document Review

This FYR consisted of a review of relevant documents including O&M records and monitoring data. Applicable soil and groundwater cleanup standards, as listed in the September 1990 Record of Decision (EPA 1990) and the 1992 ROD Amendment (EPA 1992b)/1997 ESD (EPA 1997), were also reviewed.

Data Review

Groundwater Monitoring Program

Groundwater monitoring is conducted in the three shallowest water-bearing zones: 15-, 35-, and 100-ft sand zones. The Site's Groundwater Monitoring Plan was revised in December 2003 (UPRR 2003b). Its objectives were as follows:

- Collect representative groundwater data using EPA-approved sample collection techniques.

- Perform data quality assurance/quality control procedures in accordance with the Quality Assurance Project Plan for the site.

- Evaluate groundwater elevation data to assess whether or not the groundwater elevations inside the slurry wall and natural levee (e.g., the groundwater containment system) are protective of the containment system components (i.e., no significant gradient between inside and outside the containment system walls).

- Demonstrate that affected groundwater is contained by the containment system and groundwater recovery system at the pumping well RW-1 (as stated above, well RW-1 was shut off in January 2010 (UPRR 2010a).

- Compare the groundwater monitoring data with the remediation goal or MCL for areas outside the slurry wall, which is the removal or containment of groundwater with concentrations of arsenic greater than 0.050 mg/L. In 2001, EPA set a revised arsenic MCL at 0.010 mg/L. This value became enforceable in January 2006. Note that none of the Annual Remedial Action reports reviewed for this fourth FYR reference the new arsenic MCL, which is still 0.010 mg/L as of May 2014 (EPA 2014).

Subsequent changes to the groundwater elevation monitoring have been implemented in various documents during the previous reporting period. Additional monitoring objectives were added when the phytohydraulic control pilot tests were initiated and completed; the groundwater elevation monitoring was also used to demonstrate if eucalyptus trees can be used to provide containment of the groundwater contaminated above the standard.

Groundwater Monitoring Data Analysis

The following sections present the analysis of the data collected during the fourth FYR period.

15-Foot Zone

The Groundwater Monitoring Plan specifies that water level measurements will be collected annually from wells MW-19 and MW-21, and a groundwater sample for arsenic analysis be collected from MW-21 (UPRR 2003a,). In 2010, 2011, 2012, and 2013, arsenic in well MW-21 was detected at concentrations of 0.00358 mg/L (CRA 2011b), 0.00326 mg/L (CRA 2012), 0.00323 mg/L (CRA 2013), and 0.00222 mg/L (CRA 2014), respectively. All values were laboratory estimates ("J" flagged). The remedial goal referenced in all four of the annual remedial action reports was 0.050 mg/L. No discussion of the water level measurements is presented in the 2010, 2011, 2012, or 2013 annual remedial action reports.

35-Foot Zone

A summary of arsenic maximum annual concentrations in groundwater samples collected from the 35-ft sand zone PRS wells and monitoring wells during the fourth FYR reporting period is presented in Appendix B, Table B-1. A complete set of analytical data through 2013 is summarized in Table 6 of the 2013 Annual Report (CRA 2014).

The general 2013 gauging data for wells screened in the 35-ft zone indicate the direction of groundwater flow is generally toward the northeast in the northern portion of the site and toward the south/southwest to the south of the monofill cap. Recovery well RW-1 operates in the south end of the site, and did not influence this area during pumping in 2010 (CRA 2011b). Since recovery well RW-1 has not been operational since 1/13/2010, groundwater levels were not influenced by this well in 2011, 2012, and 2013 as they tend to be when well RW-1 is operational (CRA 2012, 2013, 2014).

Wells located outside of the TI waiver area (i.e. exterior wells) that are screened in this zone are as follows: RW-1, MW-30, MW-33, MW-SW2, MW-SW4, MW-SW6, MW-SW8A, MW-

SW10, and MW-SW12. The maximum annual concentrations for wells sampled between 2010 and 2014 are presented in Appendix B, Table B-1. Note that most of the wells in Table B-1 were sampled annually between 2010 and 2014; however, wells MW-30 and MW-33 were sampled monthly and well MW-31A was sampled semi-annually for the Shearton Tract pilot test in 2010 (CRA 2011b). It is the highest result for these wells that is shown in Table B-1. Well RW-1 was not sampled during the Shearton Tract pilot test.

Concentrations in wells MW-30 and MW-33 were higher than the remediation goal (as high as 2.92 mg/L in MW-30 in 2010). Moreover, because of the limited number of wells in the Shearton Tract area (southern end of the site), the arsenic plume cannot be fully delineated to the south. According to submitted Annual Remedial Action Reports, the groundwater gradient is to the south (offsite) near well MW-30 (Appendix B, Figure 2).

Testing of the eucalyptus tree stand (*Eucalyptus camaldulenis*) as a replacement for hydraulic control in the Shearton Tract began in January 2010 and was completed in December 2010. CRA submitted the Phytohydraulic Control Pilot Test Report to EPA on 4/26/2011 (CRA 2011a). The 2013 Annual Report states that "at present EPA has agreed to continue suspension of groundwater recovery from the Shearton Tract [extraction well] RW-1 and the GWTP operation until evaluation of…(the Phytohydraulic Control Pilot Test) report is complete" (CRA 2014). No documents indicating that this review has been completed were available during this FYR.

Interior PRS wells are required to be sampled every 5 years. The last sampling event was in 2005; therefore, these wells were sampled in 2010. Analytical results for samples collected from the interior wells in 2010 were as follows (in decreasing order): 15.1 mg/L in well MW-SW9; 7.88 mg/L in MW-SW7; 0.0672 mg/L in MW-SW11; 0.0179 mg/L in MW-SW3; 0.00829 in MW-SW1; and 0.00427J in well MW-SW5. All wells' reported concentrations, except MW-SW1 and MW-SW5, exceeded the current arsenic MCL. Wells MW-SW7, MW-SW9, and MW-SW11 exceeded the current remediation goal for arsenic. The difference between these concentrations and the highest arsenic values reported for the exterior paired wells appears to indicate that the containment of contamination has been successful during the last FYR period.

The phytohydraulic pilot test (CRA 2009) states that gauging data indicate a difference in groundwater elevation within the containment area, as defined by the natural subsurface levee and the slurry wall. Since the PRS has been taken out of service, potentiometric level differences between paired PRS wells did not appear to have changed to a noticeable extent. In addition, the gauging data were used in conjunction with additional information, i.e., precipitation data, to assess the efficacy of phytohydraulic control that could potentially replace the PRS operation. The phytohydraulic pilot test in the Levy Tract was initiated in March 2005 and concluded in October 2008. This pilot test was one of several alternative groundwater control approaches to the current hydraulic control activities being performed (slurry wall barriers and pump-and-treat methods). The revised pilot test report (CRA 2009) presents the data collected between May 2005 and October 2008. The report concludes that the data indicate phytohydraulic control is occurring within the slurry wall area without the PRS. The lack of groundwater removal by the PRS over more than 2 years indicates that rainfall infiltration within the slurry wall area is minimal; groundwater transpiration by the eucalyptus trees and other non-PRS hydraulic

processes (deeper vertical infiltration, evaporation, etc.) approximately matches or exceeds any such infiltration; and that hydraulic difference across the slurry wall has been maintained without use of the PRS (CRA 2009). As a result, CRA recommended that the PRS remain inactive and that the phytohydraulic control replace the PRS in the Levy Tract. On 11/11/2009, EPA concurred with this recommendation (EPA 2009).

During a meeting on 10/16/12, EPA requested the CRA perform a study to "demonstrate the influence of the eucalyptus trees on groundwater levels and flow in the slurry wall area of the Levy Tract" (CRA 2014). CRA conducted a 3-month study in 2013, placing pressure transducers in four pairs of performance wells at the north end of the slurry wall: MW-SW-3 (interior)/MW-SW4 (exterior), MW-SW5/MWSW6, MW-SW7/MW-SW-8A, and MW-SW9/MW-SW10. At the end of the 3-month study, it was determined that the trees did not have a significant effect on groundwater levels within the slurry wall. As a result, the trees were removed on 6/26/2013 (CRA 2014). The 2013 Annual Remedial Action Report states that the "PRS [will] remain inactive based on Levy Tract phytohydraulic pilot test results" (CRA 2014). This section of the report does not discuss the status of the PRS based on the 3-month study. Further discussion on the Levy Tract tree removal is presented in Section IV, "Technical Assessment Summary".

An evaluation of the apparent lateral gradients for the FYR period was reviewed for PRS well pairs (Appendix B, Figure 2) located on the interior and exterior of the slurry wall (MW-SW1/MW-SW2; MW-SW3/MW-SW4; MW-SW5/MW-SW6) or the subsurface levee (MW-SW7/MW-SW8A; MW-SW9/MW-SW10; MW-SW11/MW-SW12). The desired gradient would be toward the interior of the Site, or a gradient in the well pair from the exterior well toward the interior well. This review is a summary of the Annual Remedial Action Reports from 2010 through 2013 (CRA 2011b, 2012, 2013, 2014). The findings are as follows:

- ***10/19/2010***—The apparent gradients between well pairs was toward the outside of the containment zone for three of six pairs (MW-SW1/MW-SW2, MW-SW5/MW-SW6, and MW-SW7/MW-SW8A).

- ***10/14/2011***—The apparent gradients between well pairs was toward the outside of the containment zone for four of six pairs (MW-SW3/MW-SW4, MW-SW5/MW-SW6, MW-SW7/MW-SW8A, and MW-SW9/MW-SW10).

- ***10/1/2012***—The apparent gradients between well pairs was toward the outside of the containment zone for four of six pairs (MW-SW1/MW-SW2, MW-SW5/MW-SW6, MW-SW7/MW-SW8A, and MW-SW9/MW-SW10).

- ***10/11/13***—The apparent gradients between well pairs was toward the outside of the containment zone for the same four of six pairs as in 2012 (MW-SW1/MW-SW2, MW-SW5/MW-SW6, MW-SW7/MW-SW8A, and MW-SW9/MW-SW10).

Note that none of the gradients, either toward or away from the interior of the Site, were greater than 0.90 ft (MW-SW5/MW-SW6). From the data above, the apparent gradient from 2011 through 2013 between the slurry wall and the subsurface levee is typically (four of six well

pairs) from the interior of the Site to the exterior of the Site. The highest gradient was found between well pairs MW-SW5/MW-SW6, where between 2010 and 2013, the gradients were 0.82, 0.88, 0.90, and 0.90 ft, respectively.

This is a fairly significant gradient given the distance between the well pair. However, as noted above, arsenic concentrations between well pairs suggest that arsenic migration between the slurry wall or subsurface levee is not occurring.

Given the continued shut down of the PRS, the removal of the trees in the Levy Tract, and a gradient from the interior to exterior wells in four of six well pairs between 2011 and 2013, continued shutdown of the PRS may need to be reconsidered.

100-Foot Zone

A summary of maximum annual concentrations for arsenic in groundwater samples collected from the 100-ft sand zone PRS wells and monitoring wells during the FYR reporting period is presented in Appendix B, Table B-1. A complete set of analytical data through 2013 is summarized in Table 8 of the 2013 annual report (CRA 2014). The reported arsenic concentrations from the 100-ft monitoring wells were all below the remediation goal of 0.050 mg/L. Well MW-28A contained arsenic concentrations above the MCL of 0.010 mg/L in 2011 (0.0162 mg/L), 2012 (0.0102 mg/L), and 2013 (0.0131 mg/L). The last FYR indicated that data during the review period showed that contaminant flux between the 35- and 100-ft zones was not occurring, as all data from the 100-ft sand zone was below the remediation goal and the MCL. This statement cannot be reiterated here, and the 100-ft sand zone should continue to be monitored.

Site Inspection

The inspection of the Site was conducted on 12/3/2014. In attendance were Ruben Moya, EPA; Lam Tran, TCEQ; Geoffrey Reeder, UPRR; Mike Wisniowiecki, Conestoga-Rovers and Associates; Tommy Ray, Hatch Mott MacDonald; and April Ballweg, EA. The purpose of the inspection was to assess the protectiveness of the remedy. The Site Inspection Checklist in included as Appendix C. A photographic log of the Site inspection is included as Appendix E.

Maintenance of the monofill cap appeared to be adequate at the time of the site visit. However, wells and associated appurtenances are in need of maintenance or repair. Early indicators of potential remedy failure were not observed during the site inspection, and opportunities for optimization were not identified during the site inspection.

Interviews

During the FYR process, interviews were conducted with parties impacted by the Site, including the regulatory agency involved in Site and the Site contractor. The purpose of the interviews was to document any perceived problems or successes with the remedy that has been implemented to date. Interviews were conducted on 12/3/2014. Interviews are summarized below and complete interviews are included in Appendix F.

Mr. Lam Tran, of the TCEQ, completed an interview form for the current FYR on 12/3/2014. Mr. Tran noted the following:

- The liquid stored inside the two above ground storage tanks should be disposed of properly or the chemistry of the liquid should be maintained. With the wastewater treatment plant suspended indefinitely, the stored liquid may become contaminated (i.e., biological growth) and rendered more effort to site maintenance.

No other items of note were related by Mr. Tran.

Mr. Michael J. Wisniowiecki of CRA completed an interview form for the current FYR on 12/3/2014. Mr. Wisniowiecki noted the following:

- Mr. Wisniowiecki stated that the potential groundwater ingestion pathways have been removed by the deed restriction and MSD.

- He additionally noted that the MSD does not apply to the surrounding property, but only to UPRR property.

- "Based on 20 years of groundwater monitoring analytical results, deed restrictions, MSD certification, and a finding of technical impracticability by EPA, UPRR has recommended the groundwater monitoring program be terminated and the monitoring wells be plugged and abandoned. Suspension of groundwater recovery from well RW-1 and groundwater treatment and disposal from the GWTP previously approved by EPA should be made permanent" (Wisniowiecki interview, Appendix F).

No other items of note were related by Mr. Wisniowiecki.

IV. TECHNICAL ASSESSMENT

Question A: Is the remedy functioning as intended by the decision documents?

Remedial Action Performance

- Soil

  — Based on review of documents, applicable or relevant and appropriate requirements (ARARs), and the site inspection, the selected remedy for soil has been completed in accordance with the 1990 ROD and 1992 amended ROD. Cleanup goals and performance standards were achieved as documented by the annual inspection reports.
  — ICs for the protection of the monofill cap are still needed to help maintain remedy protectiveness.

- Groundwater

— Groundwater extraction and treatment remedy: the treatment of groundwater outside of the TI waiver zone has ceased as noted above. However, the extent of the arsenic plume above the remediation goal and/or the MCL in the 35-ft zone has not been defined to the south of the Site. In addition, one well in the 100-ft sand zone (MW-28A) was found to contain arsenic in excess of the MCL, suggesting communication between the 35-ft zone and the 100-ft zone. It cannot be ascertained whether the MSD extends over the entire impacted area. Moreover, this remedy is currently not operating and two phytohydraulic control tests have been completed in both the Levy and Shearton tracts. The test in the Levy Tract has been completed, and the trees were removed on 6/26/2013. A report summarizing the results of the test in the Shearton Tract was submitted to EPA and TCEQ on 4/26/2011. This report is still being evaluated by EPA. Furthermore, the responsible party believes that the EPA has agreed to continue suspension of groundwater recovery from the Shearton Tract (recovery groundwater well) RW-1 and the GWTP operation until evaluation of this report is complete.

— Groundwater containment: It should be noted that the status of the PRS is unclear, given that (1) it was shut down as a result of the successful phytohydraulic pilot test in the Levy Tract, and (2) the trees that provided the phytohydraulic control have been removed. The 2013 Annual Remedial Action Report states that the "PRS [will] remain inactive based on Levy Tract phytohydraulic pilot test results" (CRA 2014).

System Operations/Operation and Maintenance

- According to CRA, UPRR has recommended the groundwater monitoring program be terminated and the monitoring wells be plugged and abandoned. It is also suggested that suspension of groundwater recovery from well RW-1 and groundwater treatment and disposal from the GWTP should be made permanent. Given the issues with the 35- and 100-ft zone noted above and the status of the PRS, operating procedures, as currently implemented, may not maintain the effectiveness of the remedy.

- The total cost of O&M over the review period was $315, 817.68.

Opportunities for Optimization

- ***Soil***—In an effort to increase the potential for site redevelopment, UPRR will be evaluating alternatives to the current affected soil containment remedy.

- ***Groundwater***—Determining the extent of the communication between the 35- and 100-ft sand zones will be necessary, as will continued monitoring to determine if well MW-28A continues to contain arsenic above the MCL. In addition, the southern extent of the arsenic plume continues to be undefined.

Early Indicators of Potential Issues

- ***Soil***—None.

- ***Groundwater***—Vertical migration of the arsenic plume may be occurring. As stated, the southern extent of the arsenic plume has not been defined.

Implementation of Institutional Controls and Other Measures

- Access controls are in place and are effective in preventing exposure.

- Groundwater ICs are in place; however, there is no deed restriction in place for the monofill cap. In addition, the groundwater ICs may not cover the full extent of the groundwater contaminantion above the RAOs.

Question B: Are the exposure assumptions, toxicity data, cleanup levels, and remediation goal used at the time of the remedy section still valid?

Changes in Standards and To Be Considered

- ***Soil***—None.

- ***Groundwater***—The MCL for arsenic has changed from 0.050 to 0.010 mg/L, which became effective on 1/23/2006. The protectiveness of the current arsenic RAO of 0.050 mg/L will need to be considered for the area outside of the TI Waiver area.

Changes in Exposure Pathways

- Vertical migration of the arsenic plume may be occurring, as suggested by arsenic above the MCL in well MW-28A in the 100-ft zone during the review period. Arsenic results were an order of magnitude lower in this well during the third FYR period (EA Engineering, Science, and Technology, Inc. [EA] 2010).

Changes in Toxicity and Other Contaminant Characteristics

- None.

Changes in Risk Assessment Methods

- There have been no changes that bear on the protectiveness of the selected remedy.

Expected Progress Towards Meeting RAOs

- ***Soil***—The RAOs for the remedy have been met with the exception of the ICs, which are not in place for protection of the monofill cap.

- ***Groundwater***—Outside of the TI waiver area, the extent of the impact has not been defined and, as a consequence, it cannot be determined if the remediation goal for the groundwater has been met. The current arsenic MCL of 0.010 mg/L may result in a longer duration for the extraction and treatment of contaminated groundwater.

Question C: Has any other information come to light that could call into question the

protectiveness of the remedy?

- No other information has been identified that calls the protectiveness of the selected remedy into question.

Technical Assessment Summary

According to documents and data reviewed, the site inspection, and the interviews, the soil remedy appears to be functioning as intended by the 1990 ROD (EPA 1990) and 1992 amended ROD (EPA 1992b). The ARARs cited in the RODs for the soil cap have been met (Appendix G). There may be an issue with communication between the 35- and 100-ft zones, as evidenced by the order of magnitude increase in arsenic concentrations in well MW-28A between the third FYR period (EA 2010) and fourth FYR period. In addition, the southern extent of the arsenic plume has not been defined, an issue that has carried forward from the last FYR. Finally, the status of the PRS is unclear given that (1) it was shut down as a result of the successful phytohydraulic pilot test in the Levy Tract, and (2) the trees that provided the phytohydraulic control have been removed. The 2013 Annual Remedial Action Report states that the "PRS [will] remain inactive based on Levy Tract phytohydraulic pilot test results" (CRA 2014). This section of the report does not discuss the status of the PRS based on a 3-month study that showed that the trees were not impacting groundwater levels within the slurry wall area, which led to the trees' removal on 6/26/2013 (CRA 2014). This contradicts the initial effectiveness of the phytohydraulic control which led to the shutdown of the PRS initially: "The recommendation of Phytohydraulic Pilot Test Report (revised) for full-scale implementation was approved by EPA on 11/13/2009. Active PRS operations were suspended at that time" (CRA 2014). Furthermore, the length of time of the study seems inadequate given the length of time of the initial pilot test. The trees were planted in 2005 and the test was completed in 2008. A 3-month study was conducted prior to the trees beng removed in June 2013. Another 3-month study, after the trees were removed, measuring groundwater levels and rainfall data was conducted and results were submitted to EPA and TCEQ for review on 10/16/2013 (CRA 2014). The report concluded that the trees and the PRS are not needed for hydraulic control. Based on information provided by the PRPs, the EPA will assess and determine the need for the currently inactive pressure relief system or other method for maintaining containment inside the slurry wall.

V. ISSUES/RECOMMENDATIONS AND FOLLOW-UP ACTIONS

Table 5: Issues and Recommendations/Follow-Up Actions

OU No.	Issue	Recommendations/ Follow-Up Actions	Party Responsible	Oversight Agency	Milestone Date	Affects Protectiveness? (Y/N)	
						Current	Future
Soil	No IC is in place for protection of the monofill cap in perpetuity.	File a deed notice for cap protection in perpetuity.	UPRR	EPA	Within 1 year	No	Yes
Soil	No surface water samples were collected during the review period. The O&M Plan notes the EPA and COH agreed that surface water samples were to be collected annually from three discharge points.	Collect surface water samples as specified in the O&M Plan	UPRR	EPA	As specified in the O&M Plan	No	Yes

OU No.	Issue	Recommendations/ Follow-Up Actions	Party Responsible	Oversight Agency	Milestone Date	Affects Protectiveness? (Y/N)	
						Current	Future
Soil	Monofill cap inspections are not performed in April and October of each year as specified in the O&M Plan.	Perform the routine monofill cap inspections as scheduled.	UPRR	EPA	As specified in the O&M Plan	No	Yes
Ground-water	The remediation goal in effect for the area outside of the TI waiver zone is 0.050 mg/L, while the current MCL for arsenic is 0.010 mg/L (EPA 2014).	Additional monitoring points are necessary to delineate the extent of arsenic levels above the remediation goal of 0.050 mg/L and the current MCL of 0.010 mg/L for areas outside of the slurry wall. Once the arsenic plume is defined, it may be necessary to amend the decision document for this area to be protective in the long-term.	UPRR	EPA	Within 1 year	No	Yes
Ground-water	The southern, downgradient extent of arsenic exceeding the MCL in the 35-ft zone has not been defined. As the zone is not defined, it is not possible for the MSD to cover the extent of the arsenic plume.	Additional monitoring points are necessary to delineate the extent of arsenic levels above the remediation goal of 0.050 mg/L and the current MCL of 0.010 mg/L for areas outside of the slurry wall. Once the arsenic plume is defined, it may be necessary to amend the MSD to include the affected area.	UPRR	EPA	Within 1 year	No	Yes
Ground-water	Well protective casings, vaults, and pads continue to deteriorate.	Assess the condition of all well protective casings, covers, and concrete pads and perform maintenance and repairs as necessary.	UPRR	EPA	Within 1 year	No	Yes
Ground-water	Arsenic concentrations in the 100-ft sand zone were found to be above the MCL indicating some communication between the 35- and 100-ft zones.	Continue to monitor arsenic concentrations in the 100-ft sand zone.	UPRR	EPA	Per the O&M Schedule	No	Yes
Ground-water	The Pressure Relief System has been inactive since 2009 due to pilot studies that were conducted through 2013.	Based on information provided by the PRPs, the EPA will assess the need for the currently inactive pressure relief system or other method for maintaining containment inside the slurry wall.	EPA	EPA	Within 1 year	No	Yes

In addition, the following are recommendations that improve effectiveness of the remedy, but do not affect current protectiveness and were identified during the FYR:

- Continue to perform regular cap inspections, taking note of grass growth during drought conditions.
- Continue regular maintenance to rid the Site of ant mounds, animal burrows, etc.

VI. PROTECTIVENESS STATEMENT

Protectiveness Statement(s)		
Operable Unit: Soil	*Protectiveness Determination:* Protective	*Addendum Due Date (if applicable):*
Protectiveness Statement: The remedy for arsenic impacted soils at the Crystal Chemical Company Superfund Site is protective of human health and the environment and will remain so provided the action items identified in the FYR Report are addressed as described above. The soil cleanup levels for arsenic have not changed. The arsenic levels exceeding human health protective levels are contained in the on site monofill.		
Operable Unit: Groundwater	*Protectiveness Determination:* Short-term Protective	*Addendum Due Date (if applicable):*
Protectiveness Statement: The The remedy for the the groundwater is protective in the short term. Groundwater in the area is not being used for drinking water purposes. The City of Houston provides drinking water for the area. Addressing the action items described above will ensure the long-term protection of human health and the environment.		

VII. NEXT REVIEW

The next FYR report for the Crystal Chemical Company Superfund Site is required five years from the completion date of this review.

APPENDIX A

EXISTING SITE INFORMATION

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APPENDIX A – EXISTING SITE INFORMATION

A. SITE CHRONOLOGY

Table A-1: Site Chronology

Event	Date
Crystal Chemical Company began production of arsenical, phenolic, and amine-based herbicides.	1968
Flooding occurred at the site, causing runoff from process and material storage areas.	June 1976
Harris County Flood Control ditch No. D 124-00-00 was constructed along the western portion of the site.	1977
Texas Department of Water Resources cited operation and maintenance problems for several environmental standard violations.	December 1977
Crystal Chemical Company submitted an application to the state of Texas for an onsite deep well injection permit to dispose of wastewaters being stored in four evaporation ponds; permit was denied.	1978
Crystal Chemical Company filed for bankruptcy and abandoned the site.	September 1981
U.S. Environmental Protection Agency (EPA) initiated the following emergency removal action activities to stabilize the Site: 1. Disposed of pond wastewater 2. Treated top 12 inches of pond soil with lime and placed back in ponds 3. Installed temporary cap 4. Sold arsenic trioxide that was stored on site 5. Disassembled, decontaminated, and sold buildings and process equipment.	September 1981 through February 1983
Crystal Chemical Company was added to the National Priorities List.	September 1983
EPA took measures to further control surface water runoff and site access by constructing drains, and fencing and placing additional fill onsite.	1983
Texas Department of Water Resources, through a cooperative agreement with EPA, initiated a site characterization study.	1983
"Final Report Site Investigation Crystal Chemical Company, Houston, Texas" was published citing arsenic as the primary contaminant of concern.	1984
Texas Department of Water Resources completed an initial feasibility study (FS).	June 1984
EPA and Texas Department of Water Resources completed an Addendum FS modifying the selected remedy as a response to public concerns on cost.	December 1984
Passage of the Superfund Amendments and Reauthorization Act, which called for FS to focus on use of treatment technologies for the site.	October 1986
EPA entered into an Administrative Order of Consent with Southern Pacific Transportation Company (Southern Pacific) to conduct the Supplemental FS.	May 1987
EPA took additional measures to further control surface water runoff and site access by constructing additional drains, and fencing and placing fill onsite.	1988
Southern Pacific suspended work on the Supplemental FS.	January 1988

Table A-1: Site Chronology (continued)

Event	Date
New federal regulations allowing offsite treatability studies were promulgated.	February 1989
Nine water supply wells near the site were sampled, which aided the delineation of the groundwater contamination.	July 1989
Southern Pacific requested an extension to complete the Supplemental FS; EPA denied the request.	September 1989
Regulation published identifying *in situ* vitrification as the best demonstrated available treatment technology for arsenic as a Resource Conservation and Recovery Act characteristic waste, as well as a Resource Conservation and Recovery Act-listed waste.	June 1990
EPA completed the Supplemental FS.	May 1990
Proposed Plan for the site was released for public comment.	June 1990
ROD for the site was issued by EPA Region 6.	September 1990
Amended Proposed Plan was released for public comment due to the unavailability of the RODs selected soil treatment technology, *in situ* vitrification.	February 1992
EPA entered into an Administrative Order of Consent with Southern Pacific for groundwater remedy at the site.	March 1992
The amended ROD for the site was issued by EPA Region 6.	June 1992
EPA issued a Unilateral Administrative Order to Southern Pacific addressing the remedial design/remedial action for the site.	September 1992
Southern Pacific implemented the Remedial Action Operation and Maintenance Plan to ensure the long-term integrity of the multi-layer cap.	November 1994
EPA approved Soil RA Documentation Report summarizing the construction of the soil remedy design.	January 1995
Construction of portion of slurry wall within boundary of site, and under Westpark Drive; completion of monofill cap.	September 1995
Assessment of the technical impracticability of groundwater remediation for the site was completed; physical containment of contaminated groundwater was the recommended alternative.	February 1996
Construction of Groundwater Treatment Plant (GWTP) completed.	November 1996
Remedial Design Addendum for the slurry wall is issued.	June 1996
Explanation of Significant Differences of the ROD for the groundwater remedy was issued.	March 1997
Major modifications to GWTP completed.	May 1998
Revised Work Plan for additional investigation of groundwater was submitted.	August 1998 Revised July 1999
GWTP went online with City of Houston (COH).	January 1999
A review of historical information and confirmation sampling was conducted on the 12.5-acre tract (north of the site) to identify potential environmental issues prior to approving a proposed property transfer; ownership of this property was required to complete the slurry wall construction.	July-December 1999
EPA initiates the first Five-Year Review (FYR); Union Pacific Railroad Company (UPRR) purchased 12.5-acre tract north of Westpark Drive from Levy estate.	April 2000
Additional monitoring of the 15- and 35-foot (ft) zones occurred as defined in the Work Plan for Additional Groundwater Investigation.	August 2000
EPA issued first FYR Report.	September 2002

Table A-1: Site Chronology (continued)

Event	Date
Eastern and northern portions of slurry wall complete.	June 2002
Pressure relief system (PRS) construction complete with exception of recovery piping under Westpark Drive.	October 2002
Groundwater samples collected from Shearton Development, Inc. (Shearton) Tract.	November 2002
Final section of PRS installed beneath Westpark Drive; groundwater remedy construction complete.	August 2003
Site investigation activities conducted at properties to the west of Shearton Tract.	September 2003
Revised Groundwater Monitoring Plan was issued; groundwater monitoring resumed in fourth Quarter 2003.	December 2003
UPRR purchased western 3.8 acres of the Shearton Tract located south of the site.	December 2004
Installation of phytohydraulic control pilot test completed.	March 7, 2005
EPA initiates the second FYR.	June 2005
Second FYR is completed.	September 2005
2005 Annual Remedial Action Report is completed.	February 2006
Deed Recordation with Harris County for groundwater use.	March 2006
2006 Annual Remedial Action Report is completed.	April 2007
2007 Annual Remedial Action Report is completed.	January 2008
COH ordinance 2008-253 for Municipal Setting Designation (MSD) for groundwater at the site is approved.	March 2008
Phytohydraulic Control Pilot Test Report is submitted.	October 2008
2008 Annual Remedial Action Report is completed.	January 2009
Phytohydraulic Control Pilot Test Proposal, Shearton Tract is submitted.	March 2009
EPA provides response to the Shearton Tract proposal.	November 2009
Revision of the Phytohydraulic Control Pilot Test Report, Levy Tract.	November 2009
Amendment of the Phytohydraulic Control Pilot Test Proposal for Shearton Tract.	December 2009
Site-Specific Health and Safety Plan.	January 2010
2009 Annual Remedial Action Report is completed.	January 2010
Third FYR is initiated.	March 2010
Third FYR is completed.	September 2010
January 2010 Monthly Progress Report submitted to EPA	February 2, 2010
February 2010 Monthly Progress Report submitted to EPA	March 3, 2010
March 2010 Monthly Progress Report submitted to EPA	April 8, 2010
April 2010 Monthly Progress Report submitted to EPA	May 6, 2010
May 2010 Monthly Progress Report submitted to EPA	June 9, 2010
August 2010 Monthly Progress Report submitted to EPA	September 10, 2010
October 2010 Monthly Progress Report submitted to EPA	November 4, 2010
UPRR submits the 2010 Annual Remedial Action Report to EPA	January 14, 2011
Conestoga Rovers and Associates (CRA) submit the Phytohydraulic Control Pilot Test Report to EPA.	April 26, 2011
June 2011 Monthly Progress Report submitted to EPA	July 7, 2011
July 2011 Monthly Progress Report submitted to EPA	August 9, 2011
September 2011 Monthly Progress Report submitted to EPA	October 5, 2011
November 2011 Monthly Progress Report submitted to EPA	December 13, 2011
No Monthly Progress Reports submitted to EPA	2012 – Calendar Year

Table A-1: Site Chronology (continued)

Event	Date
CRA submits the 2011 Annual Remedial Action Report to EPA	January 2012
UPRR received MSD certification from TCEQ prohibiting the use of affected groundwater at the site	June 25, 2012
TCEQ submits the Municipal Settings Designation (MSD) Certificate for the Site to UPRR	July 12, 2012
CRA submits a memorandum to TCEQ and EPA regarding testing goals and methods to assess and evaluate groundwater hydraulic response characteristics of the 35-ft saturated zone and overlying clay unit in the slurry wall enclosure area of the Levy Tract at the Site.	October 26, 2012
UPRR submits the 2012 Annual Remedial Action Report to EPA	January 23, 2013
January 2013 Monthly Progress Report submitted to EPA	February 5, 2013
February 2013 Monthly Progress Report submitted to EPA	March 6, 2013
March 2013 Monthly Progress Report submitted to EPA	April 1, 2013
CRA submits a letter to EPA summarizing the October 16, 2012 meeting between UPRR, EPA, and CRA regarding the discussion of closure alternatives for the Site.	April 11, 2013
April 2013 Monthly Progress Report submitted to EPA	May 6, 2013
May 2013 Monthly Progress Report submitted to EPA	June 6, 2013
CRA sends an electronic message to EPA stating that after a 3-month study, the Levy Tract trees were not having a significant effect on groundwater levels within the slurry wall.	June 13, 2013
As a result of the 3-month study, the Levy Tract Trees were removed, and a subsequent 3-month study of groundwater level and rainfall data collection was started.	June 26, 2013
June 2013 Monthly Progress Report submitted to EPA	July 1, 2013
July 2013 Monthly Progress Report submitted to EPA	August 1, 2013
August 2013 Monthly Progress Report submitted to EPA	September 3, 2013
September 2013 Monthly Progress Report submitted to EPA	October 3, 2013
Results of the second 3-month study sent to EPA and TCEQ (results not available for review for the Fourth FYR)	October 16, 2013
October 2013 Monthly Progress Report submitted to EPA	November 7, 2013
November 2013 Monthly Progress Report submitted to EPA	December 3, 2013
UPRR submits the 2013 Annual Remedial Action Report to EPA	January 16, 2014
January 2014 Monthly Progress Report submitted to EPA	February 5, 2014
February 2014 Monthly Progress Report submitted to EPA	March 3, 2014
March 2014 Monthly Progress Report submitted to EPA	April 1, 2014
April 2014 Monthly Progress Report submitted to EPA	May 1, 2014
May 2014 Monthly Progress Report submitted to EPA	June 4, 2014
June 2014 Monthly Progress Report submitted to EPA	July 1, 2014
July 2014 Monthly Progress Report submitted to EPA	August 4, 2014
August 2014 Monthly Progress Report submitted to EPA	September 2, 2014
September 2014 Monthly Progress Report submitted to EPA	October 1, 2014
October 2014 Monthly Progress Report submitted to EPA	November 4, 2014
Fourth FYR submitted to EPA by EA	January 2015

B. BACKGROUND

This section discusses the Crystal Chemical Company Superfund Site's (the Site's) physical characteristics, land and resource use near the Site, history of site contamination, initial response actions, and basis for the response.

Physical Characteristics

The Site is located at 10985 Westpark Drive (formerly 3502 Rogerdale Road), in southwest Houston, Harris County, Texas (Figure 1).

The Site spans approximately 6.8 acres and is bounded to the west by the Harris County Flood Control District drainage ditch (No. D124-00-00); to the east by Union Pacific Railroad (UPRR) 5-acre tract that houses the GWTP; to the south by the Shearton Development, Inc. (Shearton) tract (purchased by UPRR in November 2004), which is currently undeveloped; and to the north by Westpark Drive (Figure 2).

The tract to the north of the Westpark Drive spans 12.5 acres and was purchased from the Levy estate by UPRR in April 2000; this tract houses a portion of the PRS. The land is currently undeveloped and bounded by light industrial property. The tract to the south, formerly owned by Shearton, houses the groundwater recovery system for purposes of hydraulic control and spans 6.8 acres.

According to the second FYR Report (EPA 2005), soils at the site are poorly drained and consist primarily of silty clay and sandy clay. Surface waters that enter the flood control channel flow south and are discharged into Brays Bayou approximately 1 mile south of the site. Brays Bayou drains into the Houston Ship Channel, which terminates at Galveston Bay. Two shallow groundwater sand zones are located under the site at approximately 15 and 35 ft below ground surface (bgs). A third water-bearing zone is located under the site at approximately 100 ft bgs. A clay confining layer is located beneath the 35-ft zone that reduces the potential for vertical migration between the 35-ft zone and the 100-ft zone and deeper water-bearing zones. The 15-ft zone is discontinuous and is generally present along Westpark Drive. The 35- and 100-ft zones are continuous at and in the vicinity of the site. Information regarding use or potential use of groundwater from these three zones was not available in the documentation reviewed.

According to the most recent hydraulic testing that took place in October 2009 (CRA 2010a), the direction of groundwater flow in the 35-ft zone was toward the northeast at a gradient of approximately 0.006-0.0085 ft/ft, which was consistent with 2008 data. South of the capped monofill, groundwater flow in the 35-ft zone is estimated to be toward the southwest at an approximate gradient of 0.012 ft/ft, although there are only two monitoring wells installed in this area of the site and the zone is influenced by the pumping effects from RW-1. In the 100-ft water-bearing sand zone, the direction of groundwater flow is toward the west-northwest at a gradient of approximately 0.0006 ft/ft, lower than that indicated by the 2008 data. Water levels were gauged at only two wells in the 15-ft zone; therefore, groundwater flow direction was not evaluated.

Land and Resource Use

The site is located in a mixed use commercial, light industry, and residential area.

Crystal Chemical produced arsenical, phenolic, and amine-based herbicides on the site from 1968 to 1981. Between 1968 and 1979, Crystal Chemical leased the 6.8-acre tract from the

owner Southern Pacific), now UPRR. In 1979, Crystal Chemical purchased the property. In 1981, Crystal Chemical ceased operations, filed for bankruptcy, and abandoned the site. With the exception of investigation and remedial activities, the site has been inactive since September 1981 (EPA 2005).

The area surrounding the Crystal Chemical Site is primarily used for commercial, light industry, and residential purposes. Figure 2 presents the site layout.

History of Contamination

The production of arsenical, phenolic, and amine-based herbicides at the Crystal Chemical Site from 1968 to 1981 affected soils and groundwater on the site and adjacent properties. The contamination covered approximately 24.4 acres, which included 6.8 acres on site and 17.6 acres off site. The following paragraphs summarize the assessment and remedial history at the site (EPA 2005).

Operation and maintenance (O&M) problems at the Site facility during the late 1970s resulted in several violations of state of Texas environmental standards. Although the site is not located within a flood prone area, as defined by Federal Emergency Management Agency Flood Insurance Rate Maps, the site lies within the limits of the 100-year flood plain of the adjacent Harris County Flood Control District drainage ditch. In 1976, the site was subject to repeated flooding, which carried arsenic contaminated wastewaters off site. In 1978, Crystal Chemical applied to the state of Texas for an onsite deep well injection permit to dispose of the process wastewaters. The permit was denied by the state of Texas (EPA 2005).

In September 1981, Crystal Chemical Company filed for bankruptcy and abandoned the site. EPA initiated an emergency removal action to stabilize the site. Approximately 99,000 gallons of arsenic trioxide were sold along with the building and process equipment. Approximately 600,000 gallons of wastewater from the evaporation ponds were disposed of offsite. The top 12 inches of pond soils were treated with lime and re-deposited into the ponds. In 1983, the Crystal Chemical Company property was added to the National Priorities List (NPL) (EPA 2005).

EPA is the lead agency for the site and, through a cooperative agreement with the State regulatory body, the TCEQ, formerly the Texas Natural Resource Conservation Commission, has been involved in all site activities. In 1982 and 1983, EPA identified 13 potential responsible parties (PRPs) for the site. All PRPs declined to participate in the remedial investigation (RI)/FS for the site. Therefore, EPA and TCEQ conducted an RI/FS to define the types and extent of contamination at the site (EPA 2005).

In January 1984, EPA issued the RI/FS Report, which indicated that arsenic and phenol were detected in surface and subsurface soil and groundwater. The RI/FS Report delineated arsenic contamination across the site to an average depth of 5-6 ft bgs. Arsenic concentrations of 5,000 milligrams per kilogram (mg/kg) were found to have penetrated from 3 to 10 ft bgs in areas throughout the site. Offsite soil borings reported arsenic concentrations of 50 mg/kg as deep as 9 ft bgs. Contamination of groundwater and subsurface soils was determined to have been caused by percolation of storm water and surface water. The volume of offsite soils contaminated with

arsenic greater than 30 mg/kg was reported to be 55,000 cubic yards. The volume of onsite soils contaminated with arsenic greater than 300 mg/kg was estimated to be 16,500 cubic yards. An estimated 101,000 cubic yards of onsite soils was reported to be contaminated with arsenic greater than 30 mg/kg (EPA 2005).

During the RI/FS, 21 monitoring wells were installed. Based upon soil borings collected during the well installation, three water-bearing zones (15, 35, and 100 ft bgs) were identified. Based on the information gathered during the RI/FS, an estimated 3 million gallons of water was contaminated with arsenic. The highest concentrations of contaminants were found in the 35- to 50-ft water-bearing sand layer (EPA 2005).

Based on the data collected during the RI, it was determined that if no action was taken to address the soil and groundwater contamination, hazardous substances could be released from the Crystal Chemical Site and endanger public health, welfare, or the environment.

The ROD for soil and groundwater at the Crystal Chemical Site was issued in September 1990 (EPA 1990). Due to unavailability of the *in situ* vitrification technology, the soil remedy was revised in a ROD Amendment issued in June 1992 (EPA 1992b). In 1996, the selected groundwater remedy was determined to be technically impracticable for portions of the affected area, and an ESD was issued in March 1997 (EPA 1997).

Southern Pacific (now UPRR), was identified as the PRP. UPRR had previously owned the property and responded to EPA's request to participate in the remedial design/remedial action. In March 1992, an administrative order (U.S. EPA Docket No. 6-11-92) (EPA 1992a) was signed by the EPA and Southern Pacific for the groundwater remedial design. In September 1992, EPA issued an administrative order (U.S. EPA Docket No. VI-15-92) to Southern Pacific for the soil remedial design/remedial action specified in the 6/16/1992 amended ROD (EPA 1992c) and the groundwater remedy remedial action, as specified in the 9/27/1990 ROD (EPA 1990).

The soil remedy involved the excavation of approximately 55,000 cubic yards of offsite soils with arsenic concentrations exceeding 30 mg/kg and placement of excavated soils into a capped monofill on the Crystal Chemical Site. The soil remedy was completed in September 1995. The groundwater remedy involved the construction of a GWTP and installation of a groundwater containment system consisting of a slurry wall and PRS. The GWTP was completed in November 1996, with major modifications completed in May 1998. The groundwater containment system was completed in several phases from 1995 to 2003 (EPA 2005).

Initial Response

As noted in the previous section, after Crystal Chemical filed for bankruptcy and abandoned the site, EPA initiated an Emergency Removal Action in September 1981 to stabilize the site and sold arsenic trioxide with the building and process equipment and disposed of wastewater from the evaporation ponds off site. Pond soils were treated with lime and re-deposited into the ponds (EPA 2005).

Basis for Taking Action

Several violations of State of Texas environmental standards due to problems with the O&M of the Crystal Chemical facility during the late 1970s constitute the basis for taking action at this site. Moreover, in 1976, the site was subject to repeated flooding, which carried arsenic contaminated wastewaters off site (EPA 2005).

C. REMEDIAL ACTIONS

This section discusses the selected remedy, remedy implementation, O&M activities, and O&M costs.

Selected Remedy

Soil Selected Remedy

The soil remedy specified in the 27 September 1990 ROD (EPA 1990) called for the excavation of offsite soils contaminated with arsenic, treatment of soils using an innovative treatment technology (*in situ* vitrification), and capping of the entire site after the soil treatment had been completed. Due to the unavailability of the treatment technology, EPA selected a new soil remedy consisting of soil consolidation and capping in the ROD amendment issued on 16 June 1992 (EPA 1992b). The soil consolidation and capping remedy was completed in September 1995.

The ROD Amendment (EPA 1992b) described the remedy as follows:

1. Resample offsite areas previously identified as contaminated with arsenic in order to identify all offsite soils with arsenic concentrations exceeding 30 mg/kg

2. Excavate approximately 55,000 cubic yards of offsite soils with arsenic concentrations exceeding 30 mg/kg. Backfill offsite excavated areas to previously existing grades

3. Place excavated soils into a monofill on the Crystal Chemical Site

4. Install multi-layer low permeability cap over entire Crystal Chemical Site after excavated off site soils have been placed onsite.

Groundwater Selected Remedy

The groundwater remedy specified in the 1990 ROD (EPA 1990) called for the extraction and treatment of arsenic-contaminated groundwater. The remediation goal specified in the 1990 ROD for the affected groundwater zones was 0.050 mg/L, the MCL for arsenic at that time. The 1990 ROD also included several contingency measures that could be implemented if an extraction and treatment system would not yield the groundwater remediation goal.

During the course of the design for the groundwater remedy, EPA and Texas Natural Resource Conservation Commission determined that restoration of the groundwater is technically impracticable for portions of the Crystal Chemical Superfund Site. Laboratory data and model calculations showed that achievement of a 0.050 mg/L concentration in groundwater of the 35-ft zone would require a minimum of 650 years, if the goal can be attained at all (Terranext 1996). As a result, pump and treatment of groundwater to the ROD-specified 50-microgram per liter level was determined to be technically impracticable and, therefore, the contingency measures provided in the ROD were evaluated. The timing of this technical impracticability (TI) decision was consistent with EPA's program guidance on such waivers, *Guidance for Evaluating the Technical Impracticability of Groundwater Restoration (OSWER Directive 9234.2-25, September 1993)* (EPA 1993). EPA determined that the applicable or relevant and appropriate requirement (ARAR) for groundwater restoration to the MCL of 0.050 mg/L for arsenic should be waived, and a slurry wall should be constructed around the portions of the site where groundwater cannot be restored. Of note is the fact that, in 2001, EPA revised the arsenic standard for drinking water to 0.010 mg/L. This value became enforceable in January 2006.

Extraction and treatment of arsenic-contaminated groundwater remained the selected remedy for the remainder of the site, as specified in the 1990 ROD (EPA 1990). In June 1996, a remedial design addendum that addressed the slurry wall design was prepared. The decision to waive the groundwater ARAR for a portion of the site and construct a groundwater containment system is documented in the 1997 ESD (EPA 1997). Figure 3 of the ESD depicts the area of the TI, which encompasses the monofill area, the majority of the Levy Tract, and extends slightly into the northern portion of Shearton Tract. Recovery well RW-1 and monitoring wells MW-30 and MW-33, which are located outside of the TI area (Figure 2), are thus subject to the requirements of the 1990 ROD for treatment of arsenic in groundwater above 0.050 mg/L.

The groundwater containment is meant to horizontally isolate the 15- and 35-ft zones through a slurry wall, a natural subsurface levee, and a PRS (Terranext 1996). The site is underlain by a moderate plastic clay that continues to prevent the downward migration of impacted groundwater to the 100-ft sand zone, as demonstrated by analytical data from monitoring wells screened in the 100-ft sand zone. This would be accomplished by properly keying the slurry wall and the underlying clay (Terranext 1996).

Because the slurry wall is designed to prevent impacted groundwater from migrating beyond the limits of the slurry wall, rainfall that seeps into the ground surface within the limits of the wall will add to the volume of water within the wall. The rainfall will result in a gradual increase in the water level inside the slurry wall and hydraulic gradient from the inside of the wall outwards. The southern part of the slurry wall containment area is covered by the soil monofill and a multi-layer cap, which effectively prevents infiltration of the rainfall into the subsurface environment. The property to the north (Levy property) is not covered by an impermeable cap and recharge can occur. The need for a PRS to prevent the buildup of a hydraulic head inside of the slurry wall was investigated using the site MODFLOW model. The results of the study indicated a linear drainage system located in the center of the Levy property will effectively control the rise of water levels caused by water recharge.

The performance criterion of the PRS is to remove water from the interior of the containment system as needed to reduce pressure on the barrier walls, thereby reducing the potential that affected groundwater could migrate through the containment walls. The system was designed so that if the level of the water in the interior well is more than 1 ft higher than in the exterior well, pumps will recover groundwater and deliver it to the GWTP. The 1-ft criterion was selected based on reasonable judgment and experience with other similar containment systems. This criterion may be revised in the future depending on site-specific conditions. Prior to the automated functions being in place, groundwater was pumped manually when water levels in the pairs of performance monitoring wells exceeded the performance criteria (Environmental Resources Management [ERM] 2003).

In 2004, UPRR and their contractor, CRA, initiated evaluation of alternate RAs to the PRS (CRA 2004). In 2004, a CRA letter to EPA summarizes the discussion that took place on 8/17/2004, between UPRR, EPA, TCEQ, and CRA. This discussion included the appropriate level of hydraulic potential maintenance within the slurry wall containment by the PRS, and the hydrogeological documentation necessary to demonstrate to reduce or terminate PRS groundwater recovery and treatment. The PRS functions to reduce the potentiometric surface inside of the containment area to at least 1 ft below the potentiometric surface outside of the wall. Over time, the average potentiometric surface inside the wall fluctuates from relatively neutral to slightly negative. This explanation of proposed long-term PRS O&M of appropriate hydraulic conditions along the slurry wall was accepted and approved by EPA and TCEQ (CRA 2004). In absence of other remedial action goals, this decision constitutes the standard against which a replacement solution for the PRS will be evaluated. CRA and UPRR introduced the goal of decreasing the PRS groundwater recovery for the reduction or diversion of rainfall on the northern Levy Tract, through capping, paving, or phytohydraulic control. To demonstrate that alternate remedies are in compliance with the ROD, EPA stated that a simple hydraulic model detailing rainfall infiltration, projected water diversion, and related hydrogeological elements would be sufficient (CRA 2004).

A formal design for phytohydraulic control was not available for review. The criteria noted above will be utilized to determine the efficacy of the phytohydraulic control implemented at the Site.

D. REMEDY IMPLEMENTATION

UPRR (formerly Southern Pacific) has performed the remediation activities for the Crystal Chemical Site. EPA provided oversight during the remedial design and remedial action, and continues in this function during the O&M phase. Remedial activities have been completed in phases.

Soil Remedy Implementation

The soil remedial activities for the Crystal Chemical Site were initiated in August 1992. The remediation consisted of excavating approximately 55,000 cubic yards of soil with arsenic concentrations greater than 30 mg/kg located off site. The excavated soils were consolidated into a monofill at the Crystal Chemical Site (see Figure 2 for monofill location). The monofill

was covered with an engineered cap consisting of a geocomposite clay liner covered by 18 inches of buffer soil and 6 inches of seeded topsoil. The geocomposite clay liner consists of a 20-millimeter high-density polyethylene flexible membrane liner with a bentonite backing. The monofill is located over the entire 6.8-acre Crystal Chemical Site and extends onto a portion of the adjacent eastern property owned by UPRR.

After excavation areas were completed, the excavations were backfilled with clean fill from offsite sources. A security fence with locking gate was installed to prevent access to the site. The soil remedy was completed in September 1995.

Groundwater Remedy Implementation

The groundwater remedy for the Crystal Chemical consists of a groundwater recovery and treatment system, satisfying the requirements of the 1990 ROD (EPA 1990), and a groundwater containment system satisfying the requirements of the ESD (EPA 1997). The following paragraphs summarize the groundwater remedies operated at the Crystal Chemical Site.

Groundwater Recovery and Treatment System

The groundwater recovery and treatment system consists of a recovery well (designated RW-1) located south of the monofill on the 3.8-acre tract, a GWTP located east of the monofill on the UPRR owned 5-acre tract, and associated piping connecting RW-1 to the GWTP (Figure 2). Recovery well RW-1 is located outside of the southern tip of the TI zone (see Figure 3 of the ESD for TI boundary [EPA 1997]).

Groundwater is pumped and conveyed from the 35-ft zone at RW-1 and treated at the GWTP. Construction of the GWTP was completed in October 1996, followed by pilot testing and startup operations. In May 1997, the COH shut down the GWTP due to an exceedance of the discharge permit for arsenic. The discharge permit requires arsenic concentrations of less than 3 mg/L for grab samples and less than 2 mg/L for composite samples. In response to the discharge exceedance, a pump-around loop system was installed in 1998. The pump-around loop system allows for the storage of treated groundwater while waiting for laboratory analytical results. Subsequent to the installation of the pump-around loop system, additional pilot testing and startup operations were conducted. The GWTP was issued a revised COH discharge permit and went back online in January 1999. Currently, the discharge of treated water to the COH's sewer system is covered under a permit issued by the COH Department of Public Health and Engineering; grab samples are being collected for analysis. This permit was renewed in March 2010 and expires on 4/4/2012 (COH 2010).

According to the construction documentation report (ERM 2003), the GWTP was designed to remove arsenic from the affected groundwater using an iron precipitation process, operating 7 days a week, 24 hours per day, at a maximum influent flow rate of 10 gallons per minute.

The major elements of the groundwater recovery and treatment system include (ERM 2003):

- Recovery well, RW-1, south of the monofill.

- Approximately 900 linear ft of double-walled recovery pipe from RW-1 to the GWTP.
- A building for weather and security protection.
- GWTP where the major treatment operations are conducted in the following equipment components:
  - Influent Storage Tank, T-1
  - Oxidation Tank, T-2
  - Co-Precipitation Tank, T-3
  - pH Adjustment Tank, T-4
  - Clarifier
  - Filter Feed Tank, T-5
  - Solids Holding Tank, T-6
  - Sump Tank, T-7
  - Filter Press
  - Effluent Storage Tanks, T-A, B, and C.

A pump-around loop was added later, with three storage tanks. Process chemicals delivered to the site and stored in tanks include hydrogen peroxide (Oxidant Storage Tank, T-8), ferric chloride (storage tank, T-9), and caustic sodium hydroxide (storage tank, T-10). Flocculent polymer and acid are also delivered to the plant. The design maximum limit for arsenic concentrations in the influent was 310 mg/L. The GWTP decreases arsenic concentrations in the affected groundwater to less than 3 mg/L and discharges the effluent via a batch mode to the COH wastewater system. The groundwater discharged into the COH wastewater system is subsequently treated at a COH publicly-owned treatment works.

A phytohydraulic control pilot test using eucalyptus trees located in the southern portion of the Shearton Tract south of recovery well RW-1 has been completed. The goal of the test was to: (1) evaluate if discernable changes will be observed in water levels, flow direction, and arsenic migration after extraction at RW-1 ceases; and (2) make recommendations for remedy changes based on additional data collected during the 1-year period of the test. EPA approved this test in a letter dated 11/13/2009 (EPA 2009). As part of the test, the groundwater treatment system operations were temporarily suspended on 1/14/2010. This test is described in the section below. During this 1-year period, EPA requested supplemental groundwater monitoring activities be included as part of the study.

Groundwater Containment System

The groundwater containment system is composed of a natural subsurface levee, the slurry wall, and the PRS. The natural subsurface levee consists of low-permeability clay that serves as a natural barrier to groundwater migration along the northwestern boundary of the plume on the 12.5-acre tract formerly owned by the Levy Estate. The slurry wall was installed along the eastern boundary of the plume on the 12.5-acre tract, under Westpark Drive, and along the western, southern, and eastern edges of the monofill. Figure 2 shows the locations of the slurry

wall and natural subsurface levee. The depth of the slurry wall ranges from approximately 39 ft along the eastern segments to 52 ft along the western edge of the monofill. Testing was performed during construction to ensure that at least two feet of the slurry wall penetrated into the clay layer underneath the 35-ft zone. The eastern and northern portions of the slurry wall and most of the PRS, including performance monitoring wells, were installed in 2002. Construction of the groundwater remedy was completed when the final section of the PRS beneath Westpark Drive was installed in August 2003 (ERM 2003).

The PRS was installed inside the groundwater containment barrier to reduce the buildup of hydraulic head. The PRS consists of six pairs of performance monitoring wells screened in the 35-ft zone, electric submersible pumps, and double-walled recovery piping. Each well pair consists of a 4-inch-diameter monitoring well capable of containing an electric submersible pump located inside the water containment barrier (interior well), and a 2-inch-diameter monitoring well located outside of the water containment barrier (exterior well). Five of the PRS well pairs are located on the 12.5-acre tract, and one pair is located on the GWTP property. Only the interior wells located on the 12.5-acre tract are equipped with submersible pumps (ERM 2003). Figure 2 shows the locations of the PRS and associated wells. Groundwater elevations at each pair of the PRS wells are monitored to assess the hydraulic head across the groundwater containment barrier. Groundwater is pumped from the interior wells, as necessary, to regulate the hydraulic head inside the water containment barrier. These wells can be used to discharge water from inside the containment system via the double-walled recovery piping to the GWTP. Groundwater is pumped to a 500-gallon storage tank located in a containment area adjacent to the southwest comer of the GWTP building. The recovered groundwater is pumped from the storage tank into piping that runs between the sump and Tank T-7. From Tank T-7, the water is pumped into Tank T-1 for treatment. The tank is equipped with a solenoid valve that shuts off the PRS pumps in the wells if the storage tank is full. The sixth well pair is located on the GWTP property (MW-SW1/MW-SW2) and is of similar construction to the other pairs. The inner well of this pair is not currently included in the PRS, but can be incorporated in the PRS should the need arise (ERM 2003). The PRS has been set to operate in automatic mode since August 2003.

In an effort to evaluate alternative methods to relieve the hydraulic pressure on the slurry wall containment system, a phytohydraulic control pilot test was approved by EPA in January 2005 and implemented in late February 2005. Approximately 60 hybrid eucalyptus trees (*Eucalyptus camaldulenis*) were planted in a 100- × 40-ft area within the northeast corner of the slurry wall on the Levy Tract, upgradient of PRS wells MW-SW3 and MW-SW5. Each tree was planted in a 20-ft deep, 12-inch-diameter soil boring that was extended to the top of the 35-ft zone using Geoprobe techniques; borings were backfilled with sand and mulch. O&M activities are performed as necessary to inspect, water, weed, or replace the trees; monitor their growth; and evaluate the effectiveness of the pilot test. In a similar fashion, an additional 60 trees were planted in a 200- × 20-ft area to the immediate south and west of recovery well RW-1 in the southern Shearton Tract. These trees were planted in this area in the event that, if the Levy Tract pilot test area is deemed effective, the effectiveness of a phytohydraulic control approach could also be evaluated and considered for the RW-1 area of the Shearton Tract. Three piezometers were also installed in each area into the 35-ft zone immediately upgradient, downgradient, and

within the pilot test area to allow quarterly monitoring of the potentiometric surface across the tree stands (CRA 2009).

As of the time of the fourth FYR, the PRS remained off based on the success of the Levy Tract pilot test (CRA 2014).

D.3 OPERATION AND MAINTENANCE

O&M activities are discussed in Section II.

APPENDIX B

SITE FIGURES AND ANNUAL ARSENIC CONCENTRATIONS

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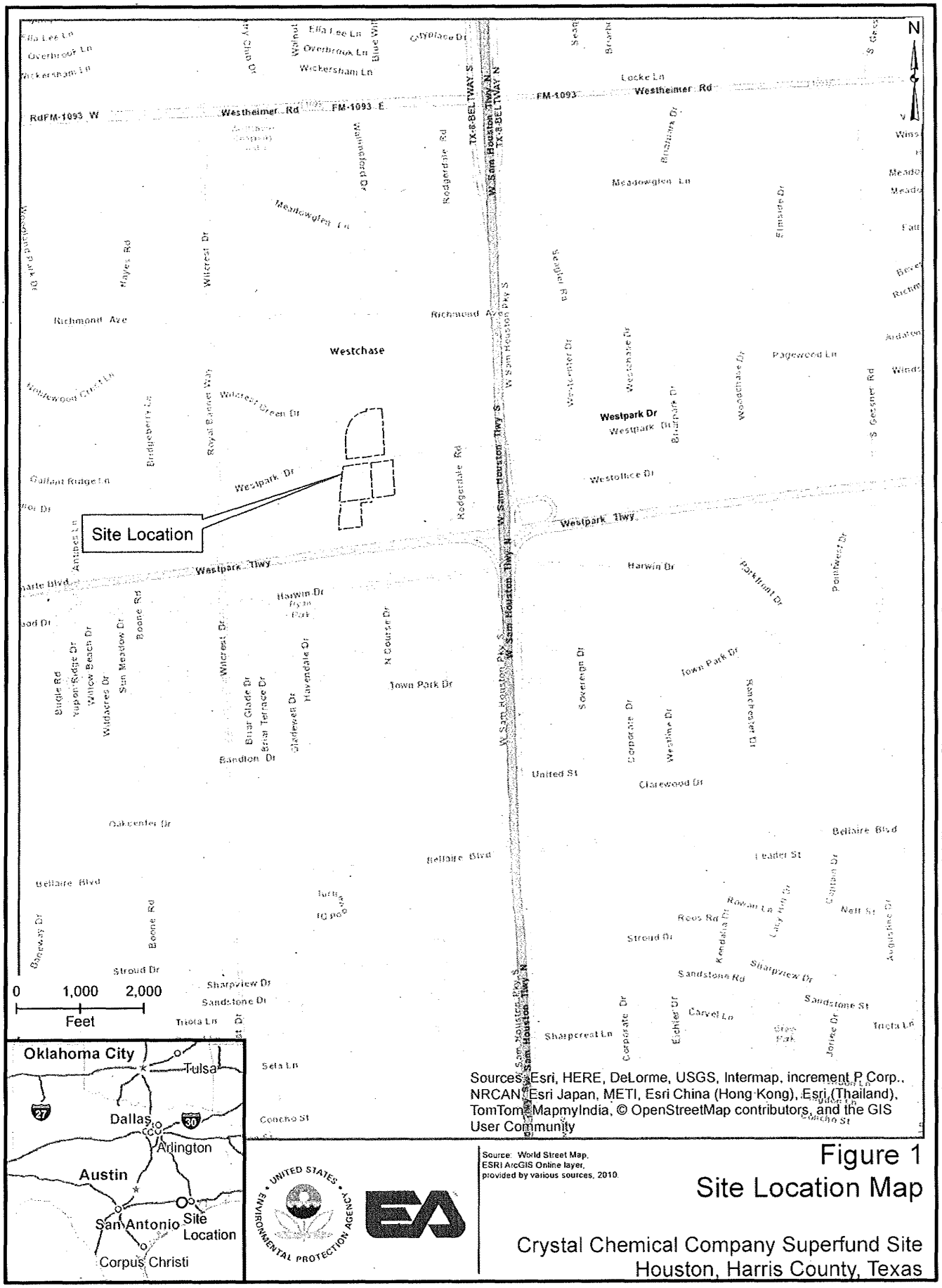

Source: World Street Map, ESRI ArcGIS Online layer, provided by various sources, 2010.

Figure 1
Site Location Map

Crystal Chemical Company Superfund Site
Houston, Harris County, Texas

2015-01-06 F:\Federal\Non DoD\EPA\projects\14342113 - Crystal Chemical\GIS\MXDs\Fig01_SiteLocation 2015.mxd EA-Lincoln rsmith

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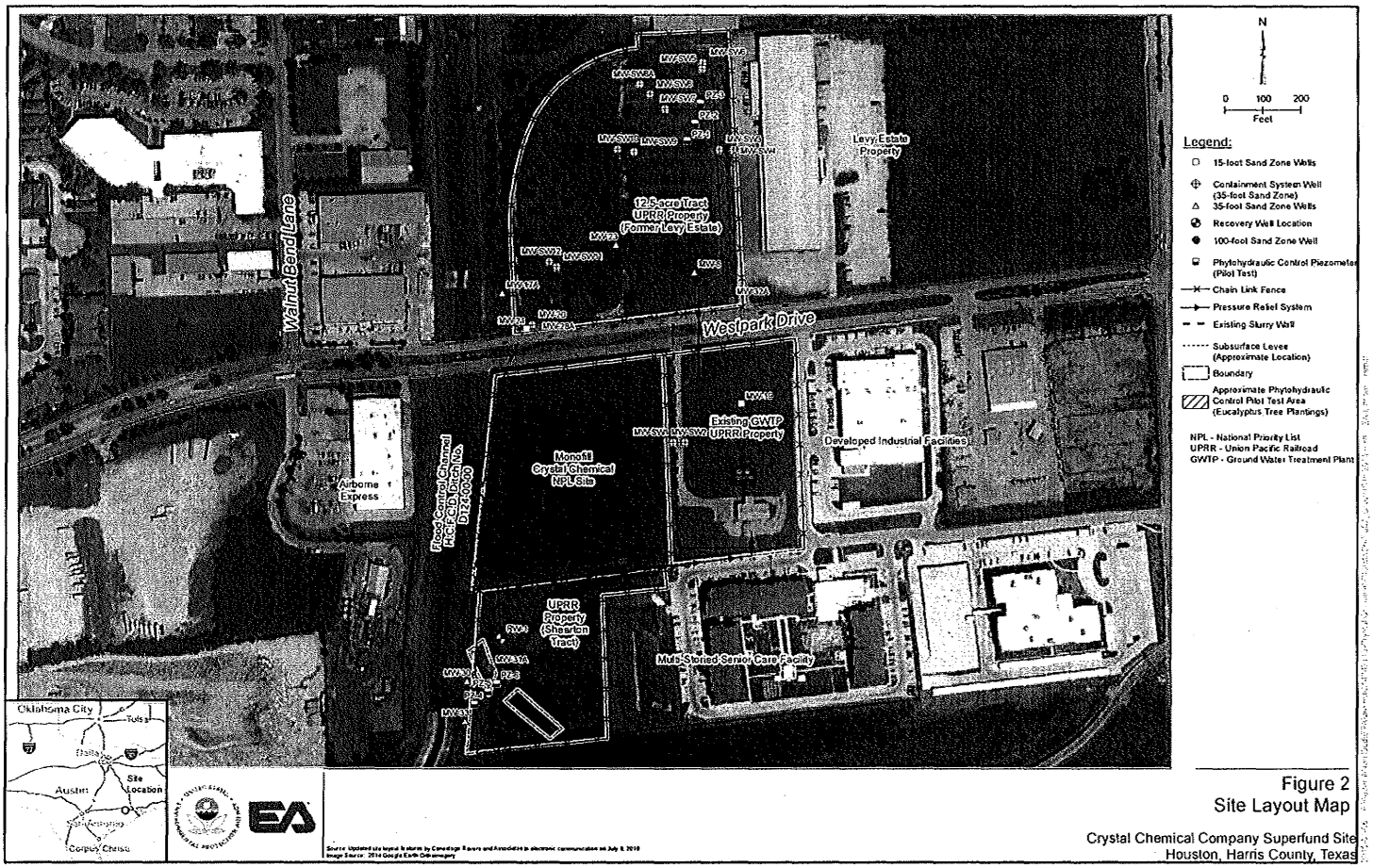

Figure 2
Site Layout Map

Crystal Chemical Company Superfund Site
Houston, Harris County, Texas

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APPENDIX B. TABLE B-1. SUMMARY OF ANNUAL ARSENIC CONCENTRATIONS

CRYSTAL CHEMICAL COMPANY SUPERFUND SITE HOUSTON, HARRIS COUNTY, TEXAS

Well ID	Annual Total Arsenic Concentration (mg/L)				
	2010	2011	2012	2013	2014*
15-foot Zone Wells					
MW-21	0.00358 J	0.00326 J	0.00323 J	0.00222 J	--
35-foot Zone - Interior Wells[1]					
MW-SW1	0.00829	NR	NR	NR	--
MW-SW3	*0.0179*	NR	NR	NR	--
MW-SW5	0.00427 J	NR	NR	NR	--
MW-SW7	**7.88**	NR	NR	NR	--
MW-SW9	**15.1**	NR	NR	NR	--
MW-SW11	**0.0672**	NR	NR	NR	--
35-foot Zone - Exterior Wells					
MW-30	**2.92[2]**	NS	**0.586**	NS	--
MW-33	**0.418[2]**	**0.883**	**0.786**	**0.632**	--
MW-SW2	0.00292 J	0.00445 J	0.00313 J	0.00181 J	--
MW-SW4	0.00145 J	0.00176 J	< 0.005	< 0.0010	--
MW-SW6	0.00753	0.0242	0.00345 J	0.00744	--
MW-SW8A	0.00279 J	0.00220 J	0.00246 J	0.00162 J	--
MW-SW10	0.00204 J	0.00130 J	0.00154 J	0.00459 J	--
MW-SW12	0.00297 J	0.00301 J	0.00189 J	0.00538	--
100-foot Zone Wells					
MW-28A	0.00174 J	*0.0162*	*0.0102*	*0.0131*	--
MW-31A[3]	0.0019 J	0.0020 J	< 0.0013	0.0012 J	--
MW-32A	0.00366 J	0.00408 J	0.00305 J	0.00223 J	--

NOTE:
* The annual report for 2014 was not available at the time of the fourth five-year review.
1 = Interior wells are to be sampled once every 5-years.
2 = Wells were sampled monthly in 2010 (35-foot zone) or semi-annually (100-ft zone) during the Phytohydraulic Pilot Test for the Shearton Tract. Highest result displayed.
3 = Well MW-31A was sampled twice during the Phytohydraulic Pilot Test for the Shearton Tract. Highest result displayed.
mg/L = Milligrams per liter.
J = Estimated value.
NR = Not required.
NS = Not sampled.
Bold = Exceeds 0.050 mg/L Remedial Action Goal.
Italic = Exceeds 0.010 mg/L Maximum Contaminant Level only.

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APPENDIX C

INSPECTION CHECKLIST

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FIVE-YEAR REVIEW SITE VISIT CHECKLIST

I. SITE INFORMATION

Site Name: Crystal Chemical Company Superfund Site	**Date of Inspection:** 12/3/2014
Location and Region: Houston, Harris County, Texas	**EPA ID:** TXD990707010
Agency, office, or company leading the five-year review: U.S. Environmental Protection Agency, Region 6	**Weather/temperature:** 60 to 64°F, east-northeast wind average of 6 miles per hour, cloudy/overcast, no precipitation.

Remedy Includes: (Check all that apply)

- ☒ Landfill cover/containment
- ☒ Access controls
- ☒ Institutional controls
- ☒ Ground water pump and treatment
- ☐ Surface water collection and treatment
- ☐ Other (Monitored natural attenuation)

Attachments: ☒ Inspection team roster attached ☒ Site map attached (Figure 2 of report)

II. INTERVIEWS (Check all that apply)

1. O&M Site Manager M. Wisniowiecki (Name) Project Manager, Conestoga-Rovers & Assoc. (Title) 12/3/2014 (Date)

Interviewed: ☒ by email ☐ at office ☐ by phone Phone no. 713-734-3090

Problems, suggestions: ☒ Report attached E-mail mwisniowiecki@craworld.com

2. O&M Staff _____ (Name) _____ (Title) _____ (Date)

Interviewed: ☐ by mail ☐ at office ☐ by phone Phone no. _____

Problems, suggestions: ☐ Report attached

3. Local regulatory authorities and response agencies (i.e.; State and Tribal offices, emergency response office, police department, office of public health or environmental health, zoning office, recorder of deeds, or other city and county offices, etc.). Fill in all that apply.

Agency Texas Commission on Environmental Quality

Contact Lam Tran (Name) Project Manager (Title) 12/3/2014 (Date) 713-422-8926 (Phone no.)

Problems, suggestions: ☒ Report attached Completed Interview/Survey Form

Agency _____

Contact _____ (Name) _____ (Title) _____ (Date) _____ (Phone no.)

Problems, suggestions: ☐ Report attached _____

4. Other interviews (optional): ☐ Report attached to Five-Year Review Report

III. ON-SITE DOCUMENTS & RECORDS VERIFIED (Check all that apply)

1. O&M Documents

☒ O&M manual (long term monitoring plan)	☒ Readily available	☐ Up to date	☐ N/A
☒ As-built drawings	☐ Readily available	☐ Up to date	☐ N/A
☒ Maintenance logs	☐ Readily available	☐ Up to date	☐ N/A

Remarks: Documentation available at Conestoga-Rovers and Associates, Inc. (CRA) office and some documents on-site at ground water treatment plant

2. Site-Specific Health and Safety Plan	☒ Readily available	☐ Up to date	☐ N/A
☐ Contingency plan/emergency response plan	☐ Readily available	☐ Up to date	☒ N/A

Remarks: _____

3. O&M and OSHA Training Records	☒ Readily available	☒ Up to date	☐ N/A

Remarks: On file at CRA office

4. Permits and Service Agreements

☐ Air discharge permit	☐ Readily available	☐ Up to date	☒ N/A
☒ Effluent discharge	☐ Readily available	☐ Up to date	☐ N/A
☐ Waste disposal, POTW	☐ Readily available	☐ Up to date	☒ N/A
☐ Other permits _____	☐ Readily available	☐ Up to date	☒ N/A

Remarks: No ongoing discharge of effluent since shut down of ground water treatment plant in 2010

5. Gas Generation Records	☐ Readily available	☐ Up to date	☒ N/A
6. Settlement Monument Records	☐ Readily available	☐ Up to date	☒ N/A
7. Ground Water Monitoring Records	☒ Readily available	☒ Up to date	☐ N/A
8. Leachate Extraction Records	☐ Readily available	☐ Up to date	☒ N/A

9. Discharge Compliance Records

☐ Air	☐ Readily available	☐ Up to date	☒ N/A
☒ Water (effluent)	☐ Readily available	☐ Up to date	☐ N/A

Remarks: No ongoing discharge of water (effluent) since 2010

10. Daily Access/Security Logs	☐ Readily available	☐ Up to date	☒ N/A

Remarks: _____

IV. O&M COSTS

1. O&M Organization

☐ State in-house ☐ Contractor for State ☐ PRP in-house

☒ Contractor for PRP ☐ Other _____

2. O&M Cost Records

☒ Readily available ☒ Up to date ☒ Funding mechanism/agreement in place

☐ Original O&M cost estimate ☐ Breakdown attached

Total annual cost by year for review period, if available

Date	Date	Total Cost[1]		
From 2010	to _____	$71,897.29	☐	Breakdown attached
From 2011	to _____	$73,033.12	☐	Breakdown attached
From 2012	to _____	$87,455.56	☐	Breakdown attached
From 2013	to _____	$67,469.86	☐	Breakdown attached
From 2014	to _____	$15,961.85	☐	Breakdown attached

[1]Costs provided by Conestoga-Rovers and Associates, Inc.

3. Unanticipated or Unusually High O&M Costs During Review Period

None.

V. ACCESS AND INSTITUTIONAL CONTROLS ☒ Applicable ☐ N/A

A. Fencing

1. Fencing damaged ☐ Location shown on site map ☒ Gates secured ☐ N/A

Remarks: Security perimeter fence appeared to be in good condition at the time of the inspection.

B. Other Access Restrictions

1. Signs and other security measures ☒ Location shown on site map ☐ N/A

Remarks: Signs located around monofill and at ground water treatment plant access gate.

C. Institutional Controls

1. Implementation and enforcement

Site conditions imply ICs not properly implemented ☐ Yes ☒ No ☐ N/A

Site conditions imply ICs not being fully enforced ☐ Yes ☒ No ☐ N/A

Type of monitoring (e.g., self-reporting, drive by) Self-reporting monitoring, no issues identified.

Frequency During operation and maintenance site visits.

Responsible party/agency Subcontractors for Union Pacific Railroad

Contact Geoffrey Reeder Manager Environmental Site Remediation N/A N/A

Name Title Date Phone no.

Reporting is up-to-date ☐ Yes ☐ No ☒ N/A

Reports are verified by the lead agency ☐ Yes ☐ No ☒ N/A

Specific requirements in deed or decision documents have been met ☒ Yes ☐ No ☐ N/A

Violations have been reported ☐ Yes ☒ No ☐ N/A

Other problems or suggestions: ☐ Report attached

Site surrounded by perimeter security fencing and locked access gates. Municipal Setting Designation Certification was issued by the Texas Commission on Environmental Quality on 7/12/12, which had been executed on 6/25/12.

2. Adequacy ☒ ICs are adequate ☐ ICs are inadequate ☐ N/A

Remarks: Site fencing to prevent access to monofill cap, ground water treatment plant, Shearton Tract, and Levy Tract appears to be adequate. Monitoring wells located outside of the fenced areas are secured with padlocks.

D. General

1. Vandalism/trespassing ☐ Location shown on site map ☒ No vandalism evident

Remarks:

2. Land use changes onsite ☒ N/A

Remarks:

3. Land use changes offsite ☐ N/A

Remarks: A multi-storied retirement community constructed in 2014 is located on the property south of the ground water treatment plant and southeast of the monofill cap. A portion of the Shearton tract was used for development (retention pond). New industrial structure (Waco Financial) located on property adjacent and east of the ground water treatment plant and the monofill cap.

VI. GENERAL SITE CONDITIONS

A. Roads ☒ Applicable ☐ N/A

1. Roads damaged ☐ Location shown on site map ☒ Roads adequate ☐ N/A

Remarks:

B. Other Site Conditions

Remarks: Multiple well vaults, lids, and concrete pads were observed to be in poor condition due to ground settlement. Ground water treatment plant and collection system not in use since 2010.

VII. LANDFILL COVERS ☒ Applicable ☐ N/A

A. Landfill Surface

1. **Settlement** (Low spots) ☐ Location shown on site map ☒ Settlement not evident
   Areal extent _____ Depth _____
   Remarks: _____

2. **Cracks** ☐ Location shown on site map ☒ Cracking not evident
   Lengths _____ Widths _____ Depth _____
   Remarks: _____

3. **Erosion** ☐ Location shown on site map ☒ Erosion not evident
   Areal extent _____ Depth _____
   Remarks: _____

4. **Holes** ☐ Holes evident ☐ Holes not evident
   Areal extent _____ Depth _____
   Remarks: One small, shallow animal borrow identified during site inspection; multiple fire ant mounds observed on monofill cap.

5. **Vegetative Cover** ☒ Grass ☒ Cover properly established ☒ No signs of stress
   ☐ Trees/Shrubs (indicate size and locations on a diagram)
   Remarks: No trees or shrubs noted on top of either cap, weeds observed in perimeter fence.

6. **Alternative Cover** (armored rock, concrete, etc.) ☒ N/A
   Remarks: _____

7. **Bulges** ☐ Location shown on site map ☒ Bulges not evident
   Areal extent _____ Depth _____
   Remarks: _____

8. **Wet Areas/Water Damage** ☒ Wet areas/water damage not evident

☐ Wet areas	☐ Location shown on site map	☐ Areal extent _____
☐ Ponding	☐ Location shown on site map	☐ Areal extent _____
☐ Seeps	☐ Location shown on site map	☐ Areal extent _____
☐ Soft subgrade	☐ Location shown on site map	☐ Areal extent _____

   Remarks: _____

9. **Slope Instability** ☐ Slides ☐ Location shown on site map
   ☒ No evidence of slope instability Areal extent _____
   Remarks: _____

B. Benches ☐ Applicable ☒ N/A

(Horizontally constructed mounds of earth placed across a steep landfill side slope to interrupt the slope in order to slow down the velocity of surface runoff and intercept and convey the runoff to a lined channel.)

1. Flows Bypass Bench ☐ Location shown on site map ☒ N/A

Remarks: _____

2. Bench Breached ☐ Location shown on site map ☒ N/A

Remarks: _____

3. Bench Overtopped ☐ Location shown on site map ☒ N/A

Remarks: _____

C. Letdown Channels ☐ Applicable ☒ N/A

(Channel lined with erosion control mats, rip rap, grout bags, or gabions that descend down the steep side slope of the cover and will allow the runoff water collected by the benches to move off of the landfill cover without creating erosion gullies.)

1. Settlement ☐ Location shown on site map ☒ N/A

Areal extent _____ Depth _____

Remarks: _____

2. Material Degradation ☐ Location shown on site map ☒ N/A

Material type _____ Areal extent _____

Remarks: _____

3. Erosion ☐ Location shown on site map ☒ N/A

Areal extent _____ Depth _____

Remarks: _____

4. Undercutting ☐ Location shown on site map ☒ N/A

Areal extent _____ Depth _____

Remarks: _____

5. Obstructions Type _____

☐ No obstructions ☒ N/A

Areal extent _____ Size _____

Remarks: _____

6. Excessive Vegetative Growth Type _____

☐ No evidence of excessive growth ☒ N/A

☐ Location shown on site map Areal extent _____

Remarks: _____

D. Cover Penetrations ☐ Applicable ☒ N/A

1. **Gas Vents** ☐ Active ☐ Passive
   ☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition
   ☐ Evidence of leakage at penetration ☐ Needs O&M ☒ N/A
   Remarks: _____

2. **Gas Monitoring Probes**
   ☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition
   ☐ Evidence of leakage at penetration ☐ Needs O&M ☒ N/A
   Remarks: _____

3. **Monitoring Wells** (within surface area of landfill)
   ☐ Evidence of leakage at penetration ☐ Needs O&M ☒ N/A
   Remarks: _____

4. **Leachate Extraction Wells**
   ☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition
   ☐ Evidence of leakage at penetration ☐ Needs O&M ☒ N/A
   Remarks: _____

5. **Settlement Monuments** ☐ Located ☐ Routinely surveyed ☒ N/A
   Remarks: _____

E. Gas Collection and Treatment ☐ Applicable ☒ N/A

1. **Gas Treatment Facilities**
   ☐ Flaring ☐ Thermal destruction ☐ Collection for reuse
   ☐ Good condition ☐ Needs O&M ☒ N/A
   Remarks: _____

2. **Gas Collection Wells, Manifolds, and Piping** ☐ Good condition ☒ N/A
   Remarks: _____

3. **Gas Monitoring Facilities** (e.g., gas monitoring of adjacent homes or buildings)
   ☐ Good condition ☐ Needs O&M ☒ N/A
   Remarks: _____

F. Cover Drainage Layer ☐ Applicable ☒ N/A

1. **Outlet Pipes Inspected** ☐ Functioning ☒ N/A
   Remarks: _____

2. **Outlet Rock Inspected** ☐ Functioning ☒ N/A
   Remarks: _____

G. Detention/Sedimentation Ponds ☐ Applicable ☒ N/A

1. Siltation Areal extent _____ Size _____
☒ N/A ☐ Siltation not evident
Remarks: _____

2. Erosion Areal extent _____ Depth _____
☒ N/A ☐ Erosion not evident
Remarks: _____

3. Outlet Works ☐ Functioning ☒ N/A
Remarks: _____

4. Dam ☐ Functioning ☒ N/A
Remarks: _____

H. Retaining Walls ☐ Applicable ☒ N/A

1. Deformations ☐ Location shown on site map ☐ Deformation not evident
Horizontal displacement _____ Vertical displacement _____
Rotational displacement _____ ☒ N/A
Remarks: _____

2. Degradation ☐ Location shown on site map ☐ Degradation not evident
Remarks: N/A

I. Perimeter Ditches/Off-Site Discharge ☒ Applicable ☐ N/A

1. Siltation ☐ Location shown on site map ☒ Siltation not evident
Areal extent _____ Depth _____
Remarks: _____

2. Vegetative Growth ☐ Location shown on site map ☐ N/A
☒ Vegetation does not impede flow
Areal extent _____ Type _____
Remarks: _____

3. Erosion ☐ Location shown on site map ☒ Erosion not evident
Areal extent _____ Depth _____
Remarks: _____

4. Discharge Structure ☒ Functioning ☐ N/A
Remarks: Outlet drains observed were clear of vegetation at time of site inspection.

VIII. VERTICAL BARRIER WALLS ☒ Applicable ☐ N/A

1. Settlement ☐ Location shown on site map ☒ Settlement not evident

Areal extent _____ Depth _____

Remarks: N/A

2. Performance Monitoring Type of monitoring Paired Wells

☐ Performance not monitored Frequency Varies ☐ Evidence of breaching

Head differential _____

Remarks: Head differential elevation measured in interior pressure relief system (PRS) wells not to exceed the ground water elevation in the paired exterior PRS well by more than 1 foot; however during site inspection, team was informed that even without pumping occurring since the ground water treatment plant is off, there has not been an elevation difference more than 1 foot.

IX. GROUND WATER/SURFACE WATER REMEDIES ☒ Applicable ☐ N/A

A. Ground Water Extraction Wells, Pumps, and Pipelines ☒ Applicable ☐ N/A

1. Pumps, Wellhead Plumbing, and Electrical

☐ Good condition ☒ All required wells located ☒ Needs O&M ☒ N/A

Remarks: Continued deterioration of recovery well vault observed; no maintenance or activities conducted on recovery system since it was shut down in 2010.

2. Extraction System Pipelines, Valves, Valve Boxes, and Other Appurtenances

☐ Good condition ☒ Needs O&M

Remarks: Pipelines mostly underground and cannot be observed; currently not in use; multiple valve boxes observed to be damaged or not secured; other appurtenances (i.e., electrical control panel) off.

3. Spare Parts and Equipment

☐ Readily available ☐ Good condition ☐ Requires upgrade ☐ Needs to be provided

Remarks: Recovery system and treatment plant not in use since 2010.

B. Surface Water Collection Structures, Pumps, and Pipelines ☐ Applicable ☒ N/A

1. Collection Structures, Pumps, and Electrical

☐ Good condition ☐ Needs O&M

Remarks: N/A

2. Surface Water Collection System Pipelines, Valves, Valve Boxes, and Other Appurtenances

☐ Good condition ☐ Needs O&M

Remarks: N/A

3. Spare Parts and Equipment

☐ Readily available ☐ Good condition ☐ Requires upgrade ☐ Needs to be provided

Remarks: N/A

C. Treatment System ☒ Applicable ☐ N/A

1. Treatment Train (Check components that apply)

☒ Metals removal ☐ Oil/water separation ☐ Bioremediation
☐ Air stripping ☐ Carbon absorbers
☒ Filters _____
☒ Additive (e.g., chelation agent, flocculent) _____
☐ Others _____
☐ Good condition ☒ Needs O&M
☐ Sampling ports properly marked and functional
☐ Sampling/maintenance log displayed and up to date
☒ Equipment properly identified
☐ Quantity of ground water treated annually _____
☐ Quantity of surface water treated annually _____

Remarks: Ground water treatment plant and collection system shut down since 2010.

2. Electrical Enclosures and Panels (Properly rated and functional)

☐ N/A ☐ Good condition ☐ Needs O&M

Remarks: Currently not in use.

3. Tanks, Vaults, Storage Vessels

☐ N/A ☐ Good condition ☒ Proper secondary containment ☐ Needs O&M

Remarks: Some treated water located in storage tank outside of the ground water treatment plant. Residual chemicals in treatment tanks, treated water, and sludge cake need to be properly disposed of.

4. Discharge Structure and Appurtenances

☐ N/A ☐ Good condition ☐ Needs O&M

Remarks: Currently not in use.

5. Treatment Building(s)

☐ N/A ☒ Good condition (esp. roof and doorways) ☐ Needs repair
☒ Chemicals and equipment properly stored

Remarks: Currently not in use.

6. Monitoring Wells (Pump and treatment remedy)

☐ Properly secured/locked ☐ Functioning ☒ Routinely sampled ☐ Good condition
☒ All required wells located ☒ Needs O&M ☐ N/A

Remarks: Some wells not secured due to settlement of ground and unable to close lid.

D. Monitored Natural Attenuation ☐ Applicable ☒ N/A

1. Monitoring Wells (Natural attenuation remedy)

☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition
☐ All required wells located ☐ Needs O&M ☒ N/A

Remarks: Ground water treatment plant and collection system shut down since 2010.

X. OTHER REMEDIES

If there are remedies applied at the site that are not covered above, attach an inspection sheet describing the physical nature and condition of any facility associated with the remedy. An example would be soil vapor extraction.

XI. OVERALL OBSERVATIONS

A. Implementation of the Remedy

Describe issues and observations relating to whether the remedy is effective and functioning as designed. Begin with a brief statement of what the remedy is to accomplish (i.e., to contain contaminant plume, minimize infiltration and gas emission, etc.).

Visual observations made during the site inspection did not indicate that the remedy is not functioning as designed. No active remediation being performed since 2010; ground water monitoring and maintenance of the monofill cap continues to be conducted.

B. Adequacy of O&M

Maintenance of the monofill cap appeared to be adequate at the time of the site visit. Wells and associated appurtenances are in need of maintenance or repair.

C. Early Indicators of Potential Remedy Failure

Early indicators of potential remedy failure were not observed during the site inspection.

D. Opportunities for Optimization

Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy.

Opportunities for optimization were not identified during the site inspection.

INSPECTION TEAM ROSTER

Name	Organization	Title
GEOFFREY REEDER	UNION PACIFIC RR	MGR. ENV. SITE REMEDIATION
Tommy Ray	Hatch Mott MacDonald	operators
MIKE WISNIOWIECKI	CONESTOGA-ROVERS & ASSOC.	ENV. CONSULTANT
Lam Tran	TCEQ	Project Managers
April Ballweg	EA	Project Manager
Ruben Moya	EPA	RPM

APPENDIX D

NOTICE TO THE PUBLIC REGARDING THE FIVE-YEAR REVIEW

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United States
Environmental
Protection Agency

www.epa.gov/region6

News Release

Region 6
External Affairs (6XA)
1445 Ross Avenue
Dallas, Texas 75202-2733
Public Information: (800) 887-6063

For more information contact Joe Hubbard or Jennah Durant at 214-665-2200 or r6press@epa.gov
Subscribe to receive e-mail copies of Region 6 news releases at: www.epa.gov/region6/6xa/r6news_mailing_list.htm

EPA to Evaluate 22 Previously Cleaned Superfund Sites

DALLAS – (Dec. 2, 2014) The U.S. Environmental Protection Agency (EPA) will conduct five-year reviews at 22 sites to ensure that cleanup of each site continues to protect public health and the environment. The reviews also identify any deficiencies and present recommendations to address them. In conducting the five-year review, EPA will interview local citizens, and review site operations, maintenance and monitoring information.

Five-year reviews are required by law under Superfund and provides the public with an opportunity to evaluate preliminary findings and provide input on any potential follow up activities that may be required after the review process.

Arkansas
Jacksonville Municipal Landfill
http://www.epa.gov/earth1r6/6sf/pdffiles/jacksonville-ar.pdf

Mountain Pine Pressure Treating
http://www.epa.gov/earth1r6/6sf/pdffiles/mountain-ar.pdf

Rogers Road Municipal Landfill
http://www.epa.gov/earth1r6/6sf/pdffiles/rogers-ar.pdf

Louisiana
American Creosote Works Inc. (Winnfield Place)
http://www.epa.gov/earth1r6/6sf/pdffiles/american creosote-la.pdf

Gulf State Utilities – North Ryan Street
http://www.epa.gov/earth1r6/6sf/pdffiles/gsu-north-ryan-la.pdf

Southern Shipbuilding
http://www.epa.gov/earth1r6/6sf/pdffiles/southern-ship-la.pdf

New Mexico
Cal West Metal (USSBA)
http://www.epa.gov/earth1r6/6sf/pdffiles/cal-west-metals-nm.pdf

Lee Acres Landfill (USDOI)
http://www.epa.gov/earth1r6/6sf/pdffiles/lee-acres-nm.pdf

Prewitt Abandoned Refinery
http://www.epa.gov/earth1r6/6sf/pdffiles/prewitt-nm.pdf

South Valley
http://www.epa.gov/earth1r6/6sf/pdffiles/south-valley-nm.pdf

North Railroad Avenue Plume
http://www.epa.gov/earth1r6/6sf/pdffiles/north-railroad-ave-nm.pdf

Oklahoma
Hudson Refinery
http://www.epa.gov/earth1r6/6sf/pdffiles/hudson-ok.pdf

Sand Springs Petrochemical Complex
http://www.epa.gov/earth1r6/6sf/pdffiles/sand-springs-ok.pdf

Tar Creek
http://www.epa.gov/earth1r6/6sf/pdffiles/tar-creek-ok.pdf

Texas
Bailey Waste Disposal
http://www.epa.gov/earth1r6/6sf/pdffiles/bailey-tx.pdf

Bio Ecology System Inc.
http://www.epa.gov/earth1r6/6sf/pdffiles/bio-ecology-tx.pdf

Crystal Chemical Company
http://www.epa.gov/earth1r6/6sf/pdffiles/crystal-chem-tx.pdf

RSR Corporation
http://www.epa.gov/earth1r6/6sf/pdffiles/rsr-tx.pdf

Sheridan Disposal Services
http://www.epa.gov/earth1r6/6sf/pdffiles/sheridan-tx.pdf

Sol Lynn Industrial Transformers
http://www.epa.gov/earth1r6/6sf/pdffiles/sol-lynn-tx.pdf

Tex-Tin Corp
http://www.epa.gov/earth1r6/6sf/pdffiles/tex-tin-tx.pdf

United Creosoting Company
http://www.epa.gov/earth1r6/6sf/pdffiles/united-creosote-tx.pdf

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On Twitter: https://twitter.com/EPAregion6
Activities in EPA Region 6: http://www.epa.gov/aboutepa/region6.htm

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APPENDIX E

SITE INSPECTION PHOTOGRAPHS

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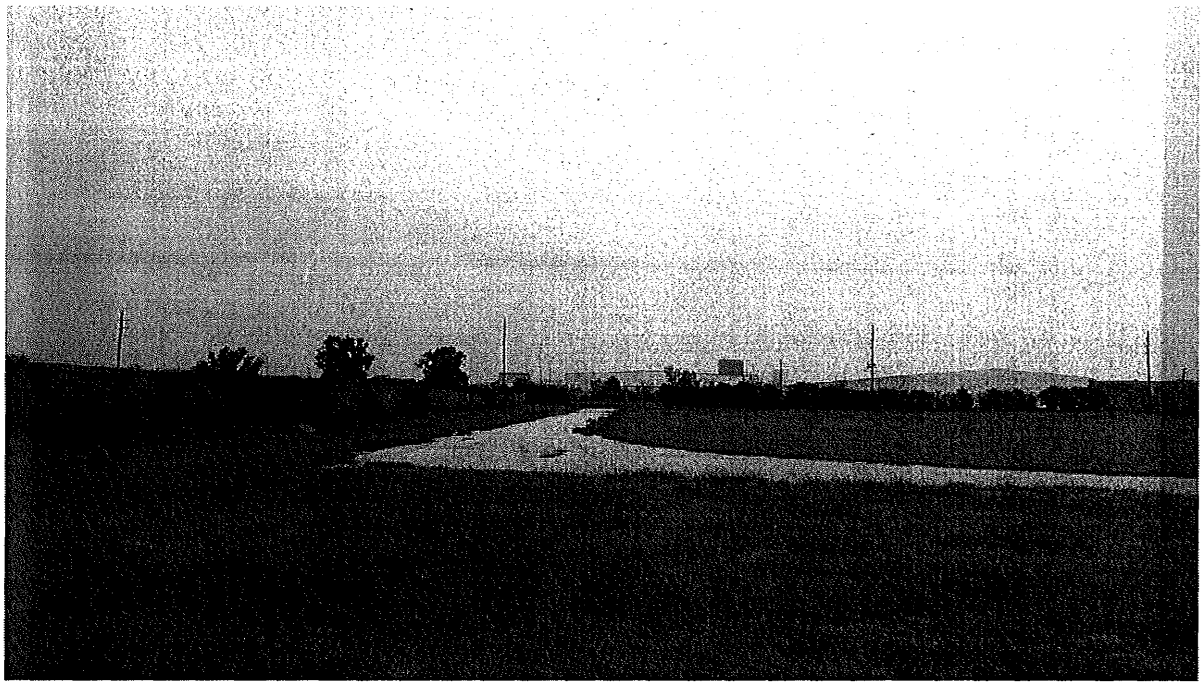
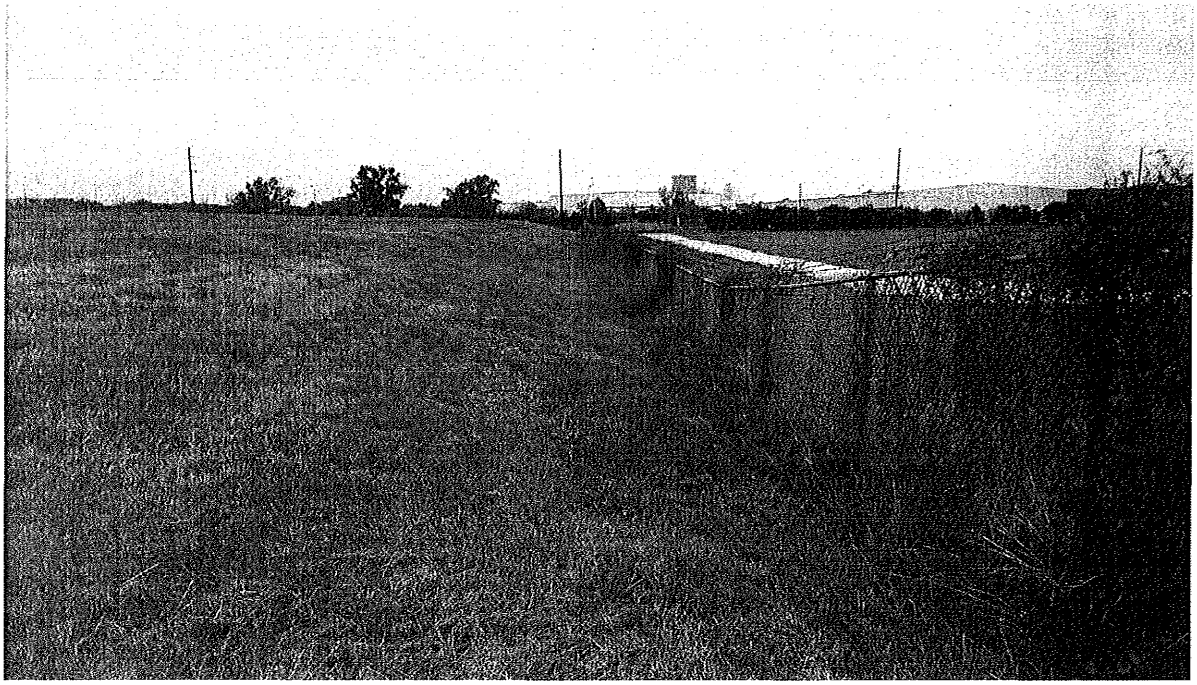
Photograph No. 1 Site: Crystal Chemical Superfund Site
Description: Main gate with warning signage and street address at entrance of groundwater treatment plant area and monofill cap.
Date: 12/3/2014 Direction: Southwest



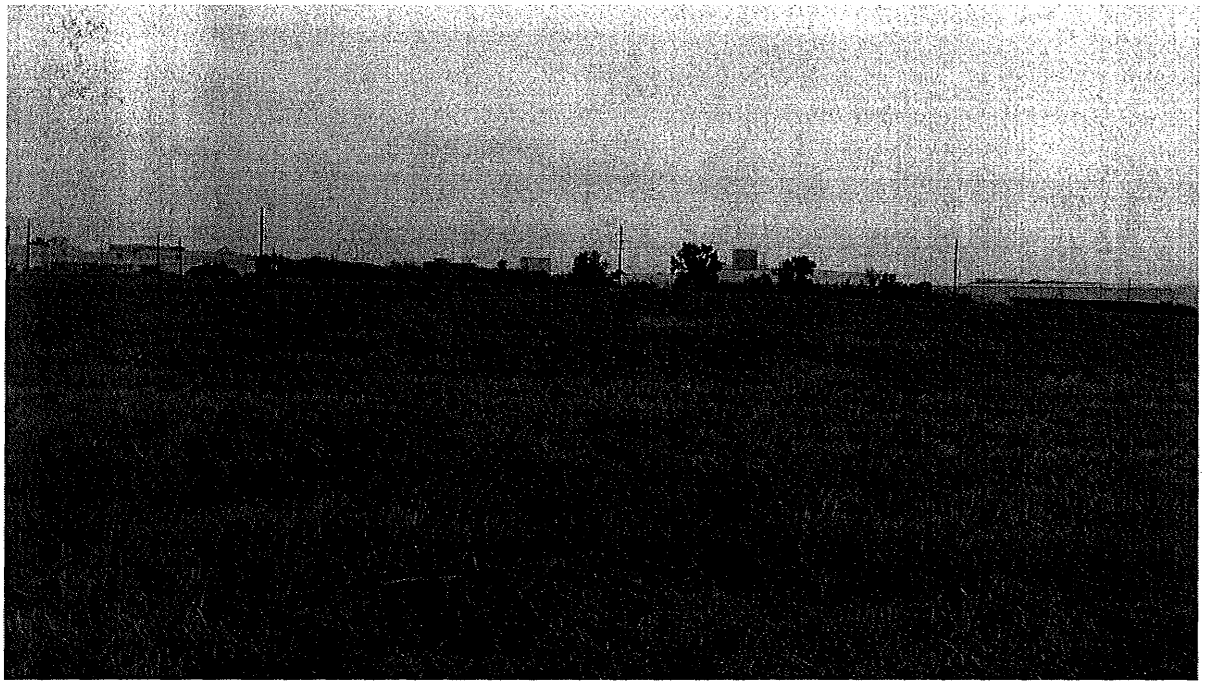
Photograph No. 2 Site: Crystal Chemical Superfund Site
Description: Access road to groundwater treatment plant; main entrance located at the end of the road.
Date: 12/3/2014 Direction: North



Photograph No. 3 Site: Crystal Chemical Superfund Site
Description: East edge of monofill cap; vegetation observed on perimeter fence.
Date: 12/3/2014 Direction: North

Photograph No. 4 Site: Crystal Chemical Superfund Site
Description: Surface water drain inlet with discharge to the Flood Control Channel; ant mound observed in west slope of monofill cap; multiple ant mounds observed in monofill cap during the site inspection.
Date: 12/3/2014 Direction: West

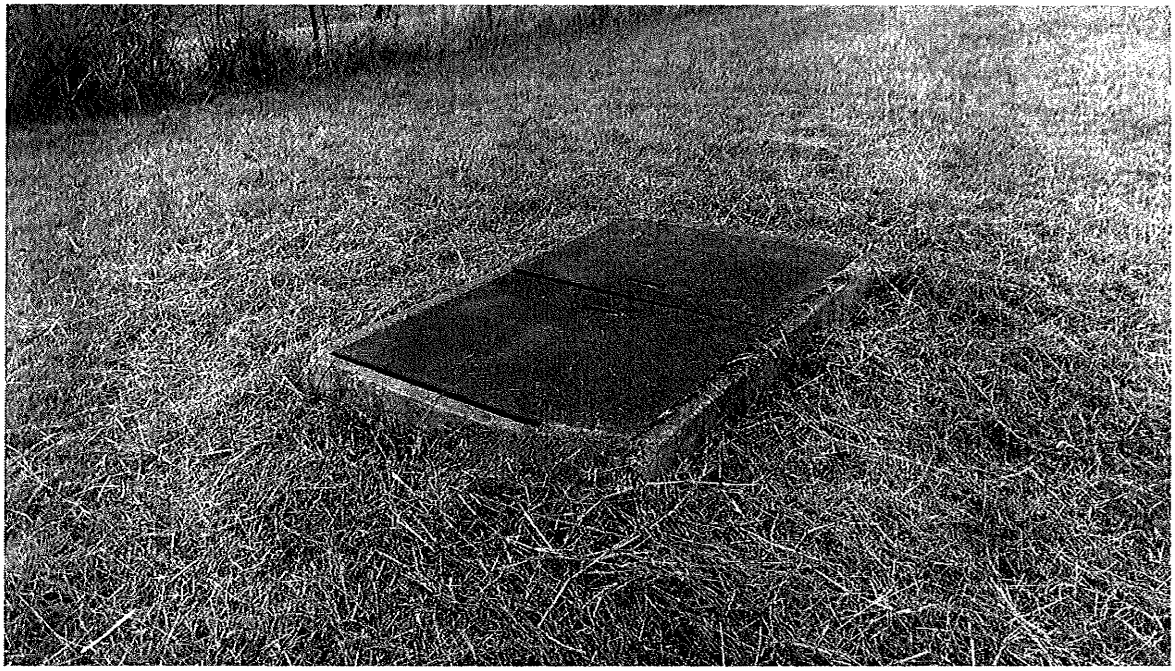
Photograph No. 5 Site: Crystal Chemical Superfund Site
Description: Small, shallow animal burrow observed in monofill cap; only borrow observed during inspection.
Date: 12/3/2014 Direction: Down



Photograph No. 6 Site: Crystal Chemical Superfund Site
Description: Overview of monofill cap.
Date: 12/3/2014 Direction: North

Photograph No. 7 Site: Crystal Chemical Superfund Site
Description: Overview of the top of the monofill cap and multi-storied retirement community located adjacent to and south of the groundwater treatment plant property and southeast of the monofill cap.
Date: 12/3/2014 Direction: Southeast

Photograph No. 8 Site: Crystal Chemical Superfund Site
Description: Overview of Shearton Tract and southern sloped edge of monofill cap; note Eucalyptus trees in phytohydraulic control pilot test area in the distance towards the power lines.
Date: 12/3/2014 Direction: Southwest



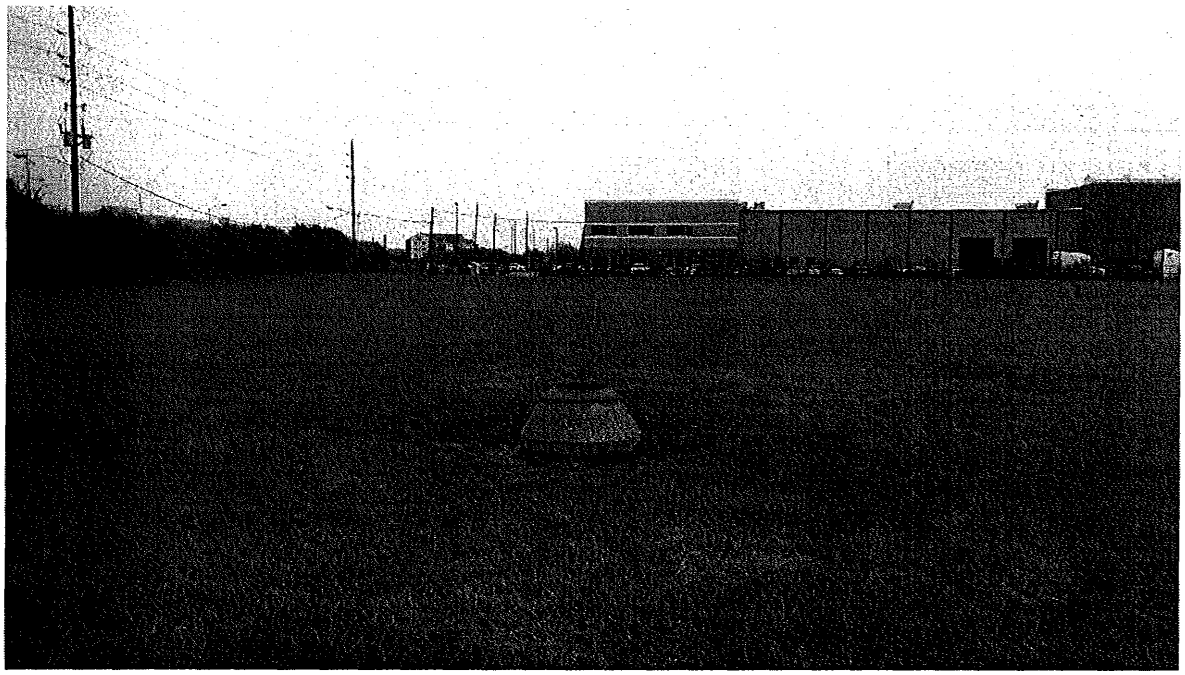
Photograph No. 9 Site: Crystal Chemical Superfund Site
Description: Recovery well vault for RW-1; recovery well inactivated in 2010.
Date: 12/3/2014 Direction: Down

Photograph No. 10 Site: Crystal Chemical Superfund Site
Description: Photohydraulic control piezometer PZ-4 located on Shearton Tract; security bolts missing.
Date: 12/3/2014 Direction: Down

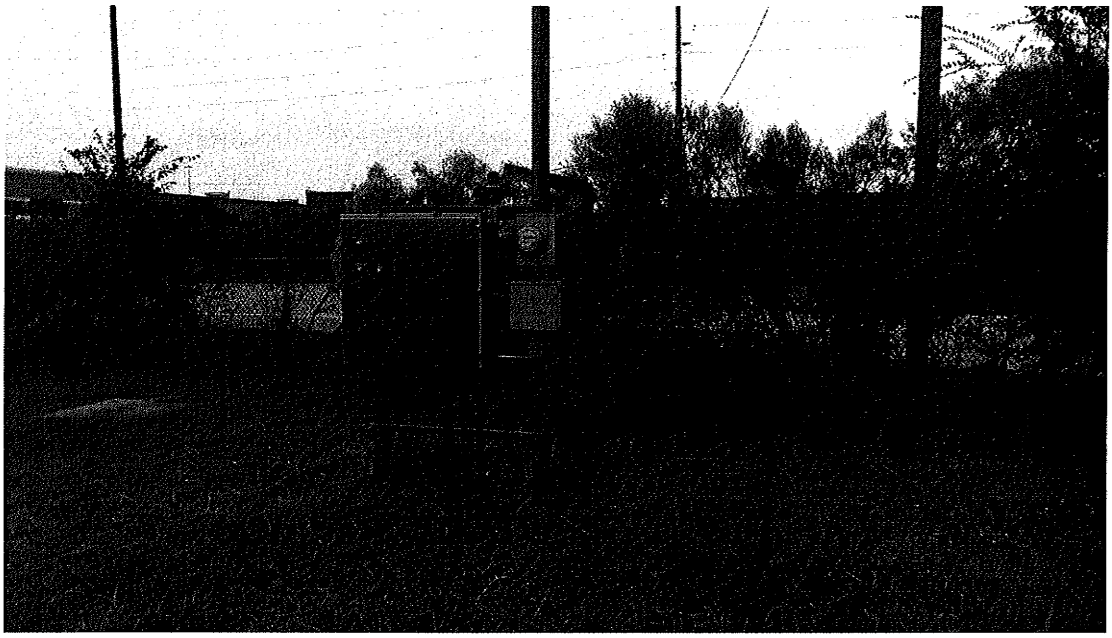
Photograph No. 11 Site: Crystal Chemical Superfund Site
Description: MW-33 located outside of the perimeter fence of the Shearton Tract; padlock appeared to be secure on well casing lid.
Date: 12/3/2014 Direction: West

Photograph No. 12 Site: Crystal Chemical Superfund Site
Description: Monitoring well MW-31A; ground elevation settlement observed under concrete pad.
Date: 12/3/2014 Direction: Southwest

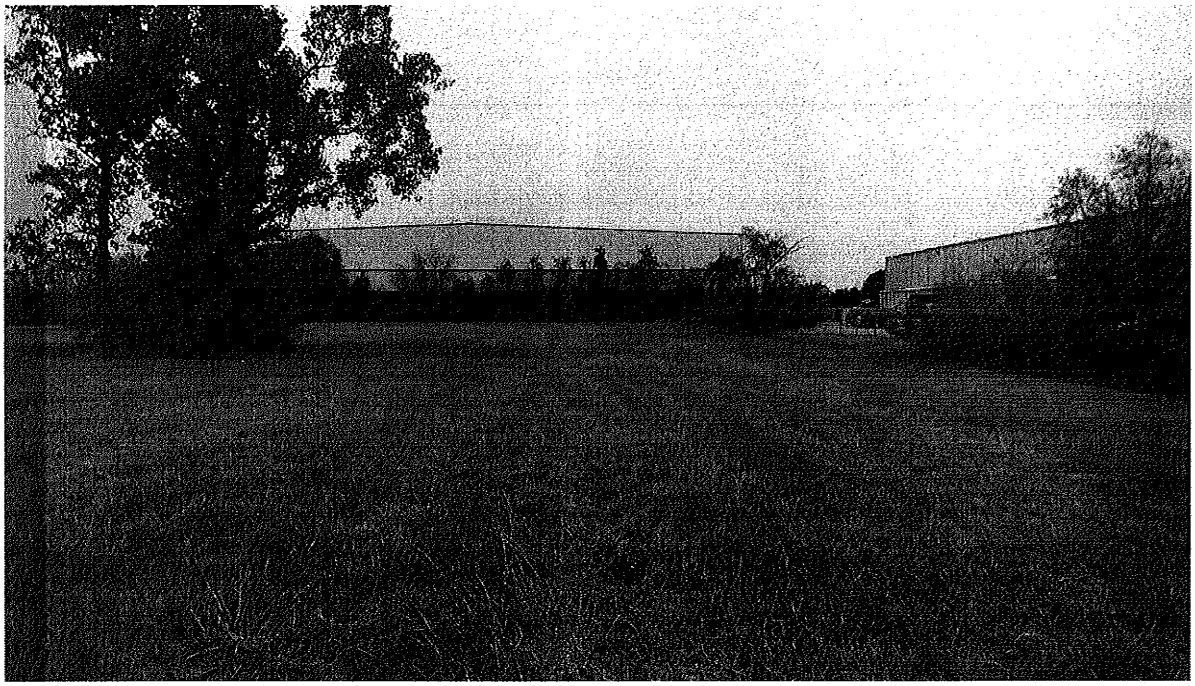
Photograph No. 13 Site: Crystal Chemical Superfund Site
Description: Monitoring well MW-30 located on west side of Shearton Tract; top of well casing cannot be closed due to ground subsidence.
Date: 12/3/2014 Direction: West



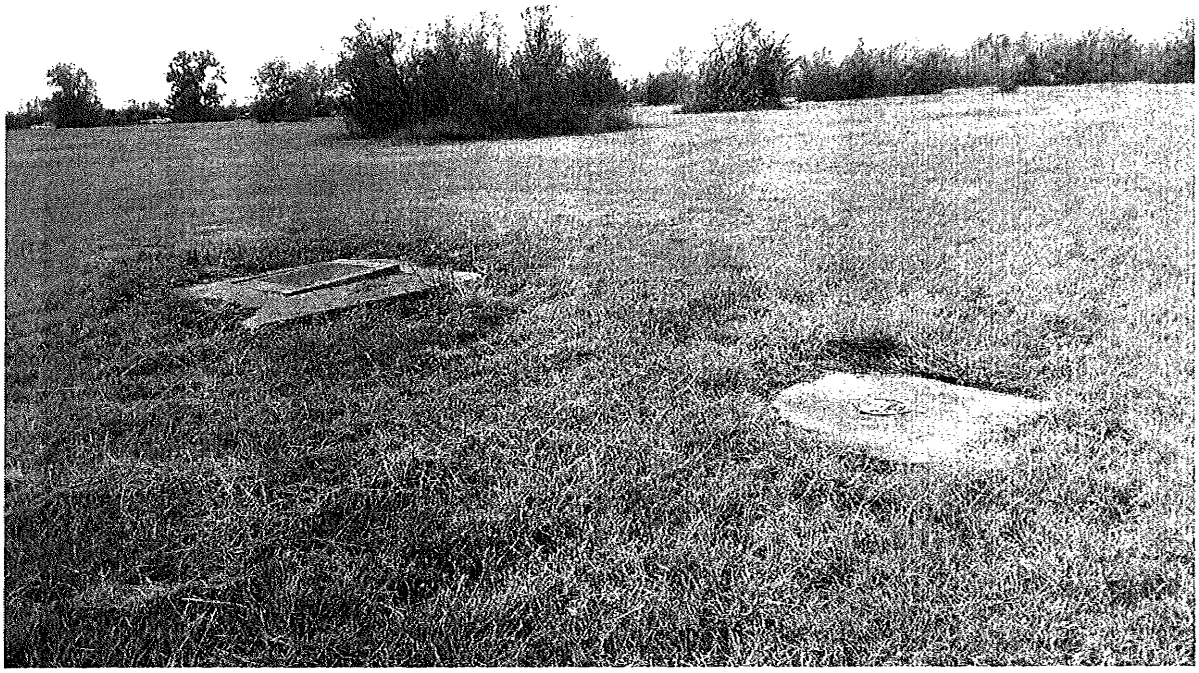
Photograph No. 14 Site: Crystal Chemical Superfund Site
Description: Manhole access point to the pressure relief system (PRS); standing water around PRS; note Waco Financial building located east of the groundwater treatment plant property.
Date: 12/3/2014 Direction: East



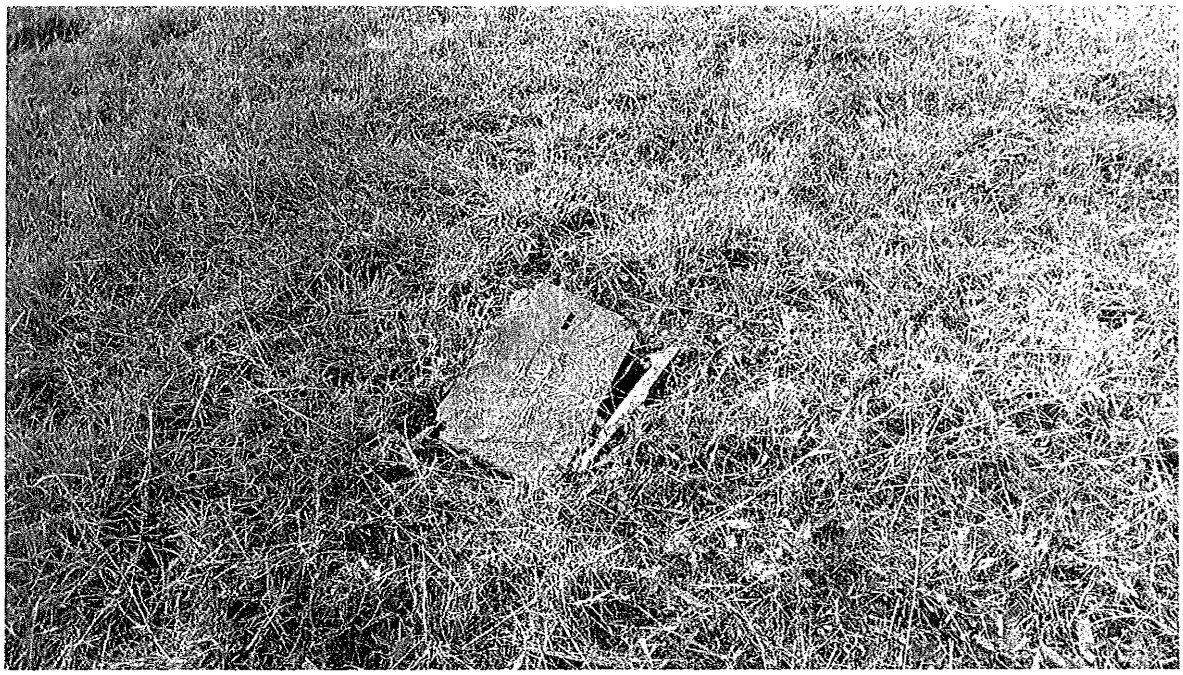
Photograph No. 15 Site: Crystal Chemical Superfund Site
Description: Electrical control box at southeast corner of Former Levy Estate Tract; currently inactive.
Date: 12/3/2014 Direction: Southeast



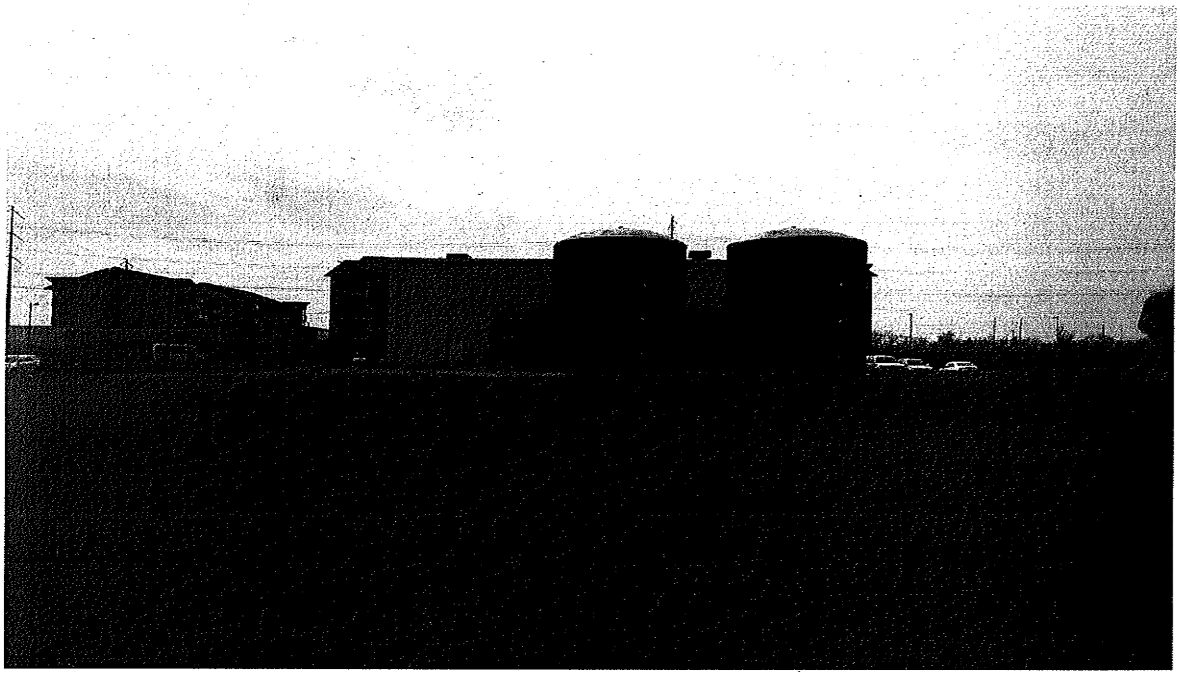
Photograph No. 16 Site: Crystal Chemical Superfund Site
Description: Overview of Former Levy Estate Tract; note Eucalyptus trees missing - removed in 2013; this property is currently under consideration to be sold.
Date: 12/3/2014 Direction: North



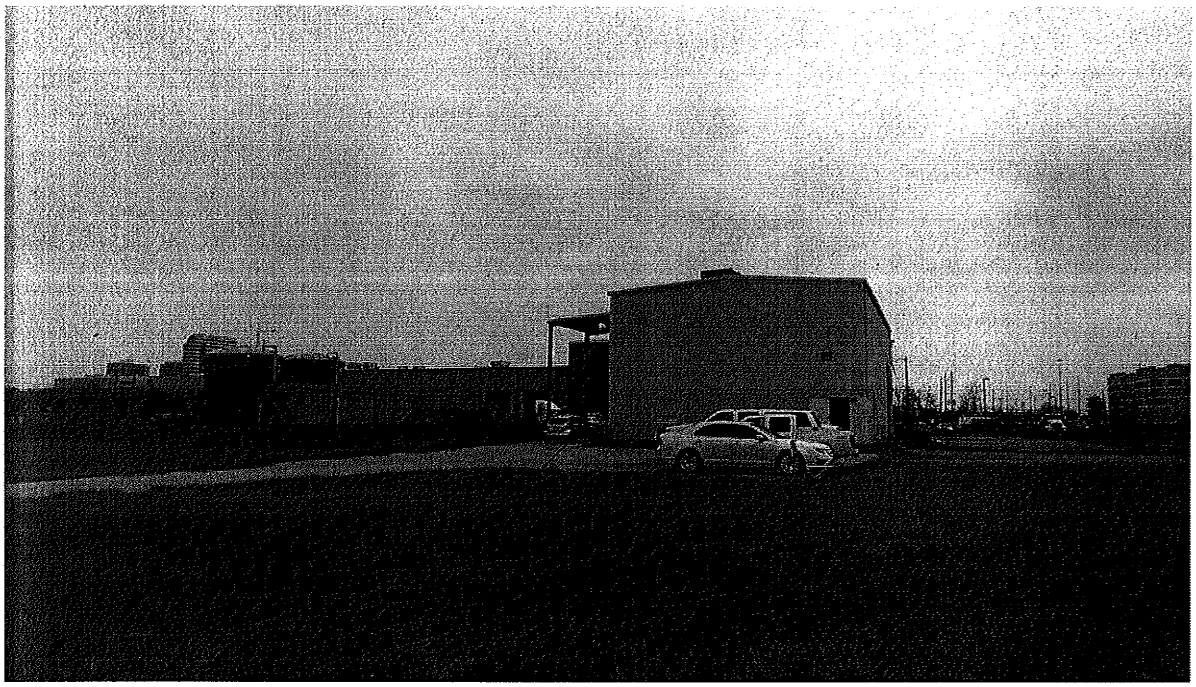
Photograph No. 17 Site: Crystal Chemical Superfund Site
Description: Containment system well pair located on the Former Levy Estate Tract.
Date: 12/3/2014 Direction: Southwest



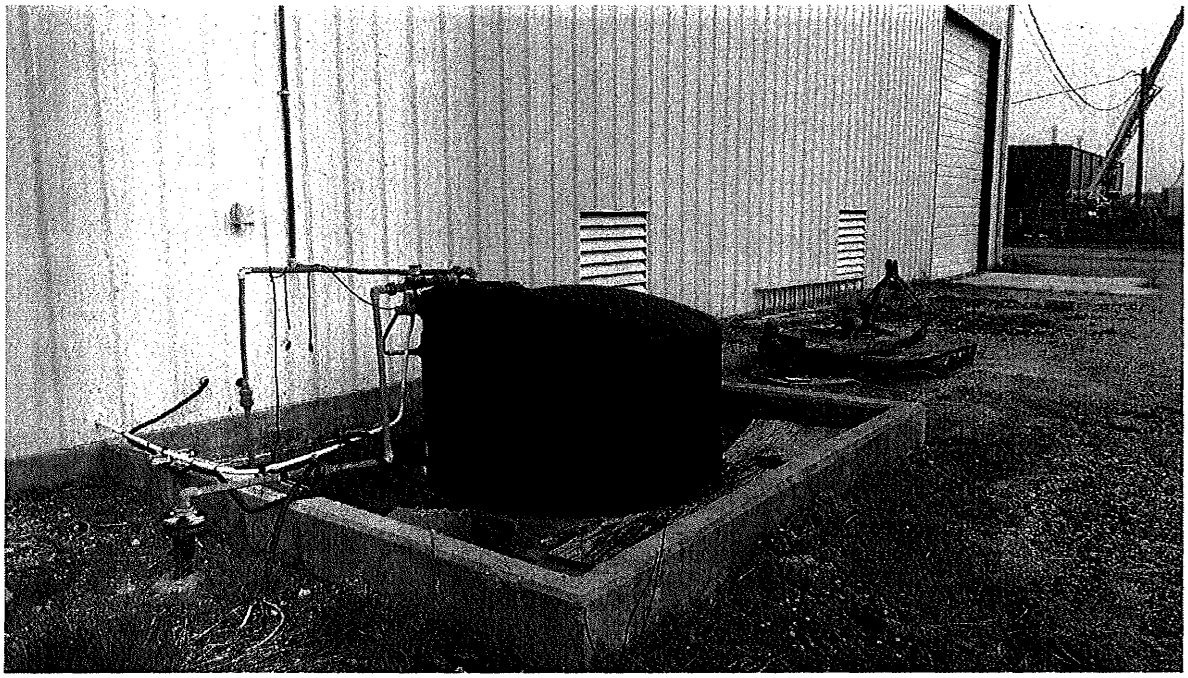
Photograph No. 18 Site: Crystal Chemical Superfund Site
Description: Pressure relief valve control box damaged in the area of the Former Levy Estate Tract.
Date: 12/3/2014 Direction: Down



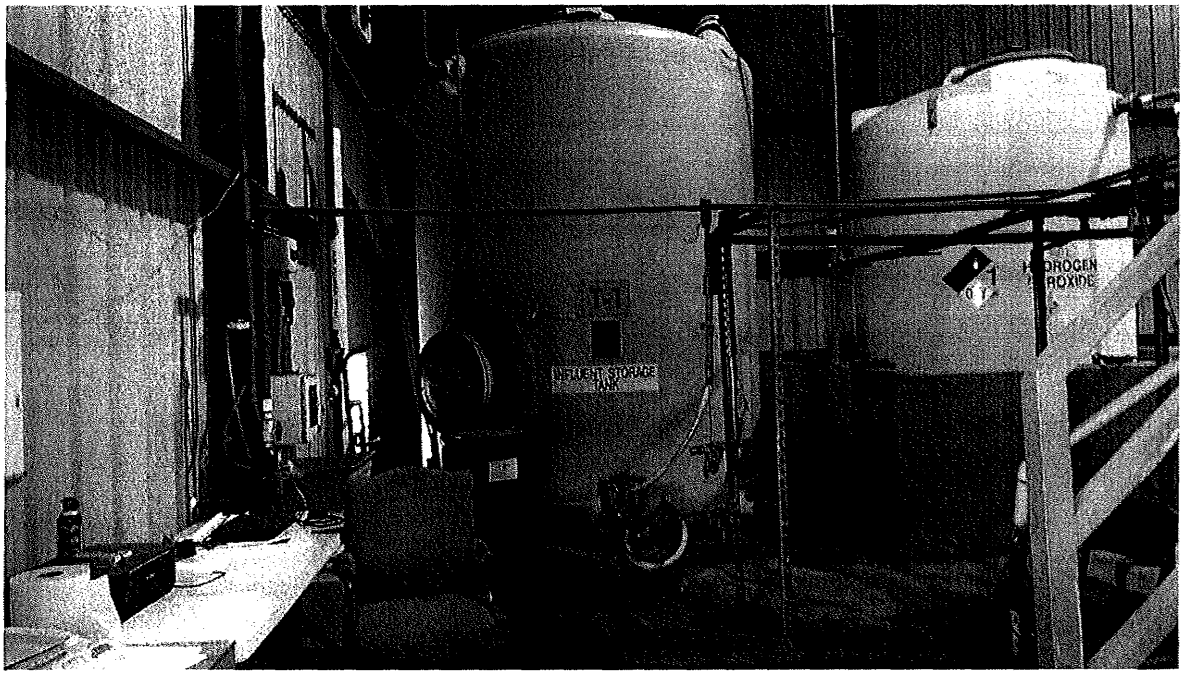
Photograph No. 19 Site: Crystal Chemical Superfund Site
Description: Overview of groundwater treatment plant and storage tanks located on the north side of groundwater treatment plant; tanks holding a small quantity of treated water (volume unknown); tanks no longer in use.
Date: 12/3/2014 Direction: South



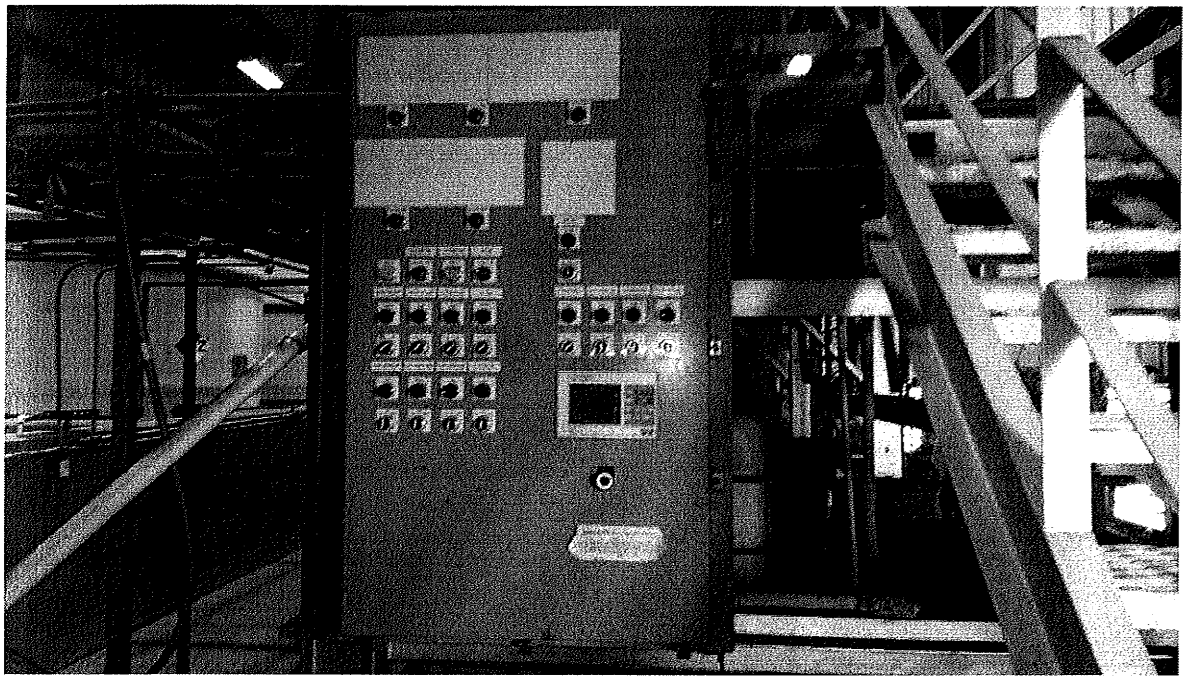
Photograph No. 20 Site: Crystal Chemical Superfund Site
Description: Groundwater treatment plant, parking lot, and exterior storage tanks (all no longer in use).
Date: 12/3/2014 Direction: East



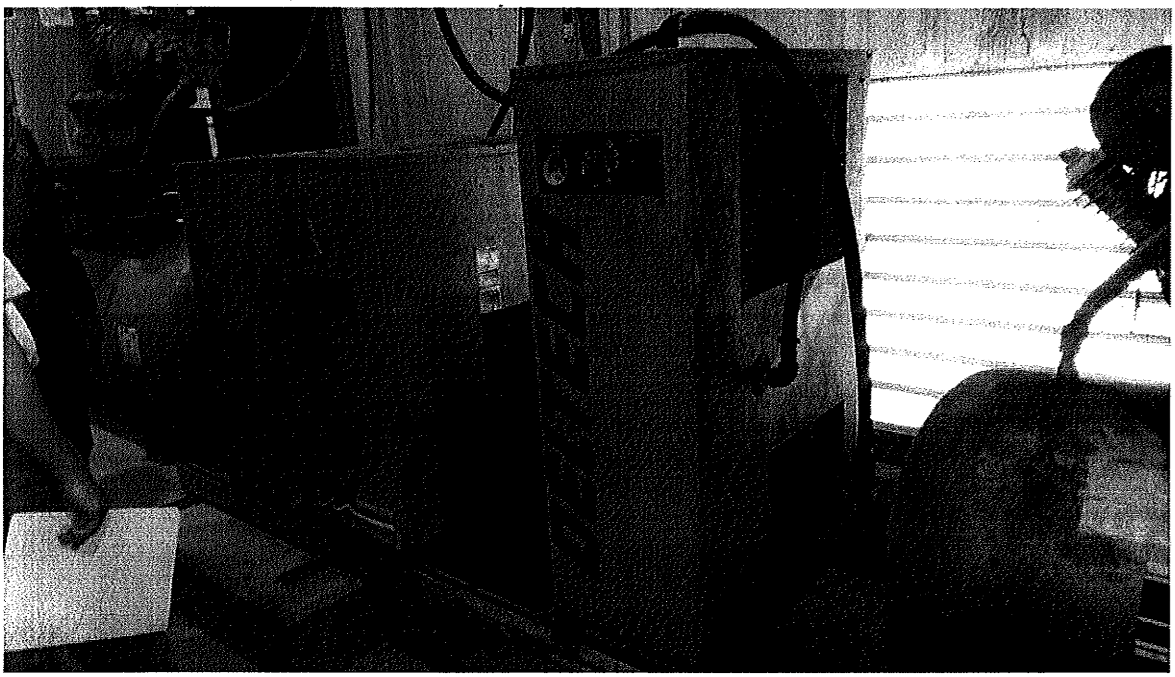
Photograph No. 21 Site: Crystal Chemical Superfund Site
Description: Storage tank located on south side of groundwater treatment plant; empty and not in use.
Date: 12/3/2014 Direction: Northeast



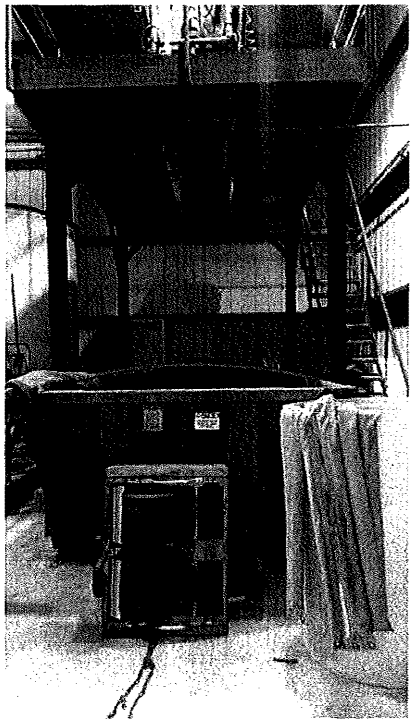
Photograph No. 22 Site: Crystal Chemical Superfund Site
Description: Storage tanks inside of groundwater treatment plant; no longer in use.
Date: 12/3/2014 Direction: Not applicable



Photograph No. 23 Site: Crystal Chemical Superfund Site
Description: Control panel for groundwater treatment plant; not powered or in use.
Date: 12/3/2014 Direction: Not applicable



Photograph No. 24 Site: Crystal Chemical Superfund Site
Description: Air compressors shut down and not in use.
Date: 12/3/2014 Direction: NA



Photograph No. 25 Site: Crystal Chemical Superfund Site
Description: Roll-off container located beneath sludge/filter cake press.
Date: 12/3/2014 Direction: Not applicable

Photograph No. 26 Site: Crystal Chemical Superfund Site
Description: General debris and remnants of filter cake in storage/roll-off container located below filter cake press; note system shut down in 2010.
Date: 12/3/2014 Direction: Not applicable

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APPENDIX F

INTERVIEW FORMS

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SUPERFUND FIVE-YEAR REVIEW SITE SURVEY		
Site Name: Crystal Chemical Company Superfund Site	**EPA ID No.:** TXD990707010	
Location: Harris County, TX	**Date:** 12/3/2014	
Contact Made By:		
Name: Ruben Moya	**Title:** Task Order Monitor	**Organization:** U.S. EPA
Telephone No.: (214) 665-2755 **E-Mail:** Moya.Ruben@epa.gov	**Street Address:** 1445 Ross Avenue, Suite 1200 **City, State, Zip:** Dallas, Texas 75202	
Name: April Ballweg	**Title:** Project Manager	**Organization:** EA Engineering, Science, and Technology, Inc.
Telephone No.: (972) 459-5019 **E-Mail:** aballweg@eaest.com	**Street Address:** 405 State Highway 121 Bypass, Suite C-100 **City, State, Zip:** Lewisville, Texas 75067	
Individual Contacted:		
Name: Lam Tran	**Title:** Project Manager	**Organization:** TCEQ
Telephone No.: 713-767-3559 **E-Mail:** lam.tran@tceq.texas.gov	**Street Address:** 5425 Polk Street **City, State, Zip:** Houston, Texas 77023	

Survey Questions

The purpose of the five-year review is to evaluate the implementation and performance of the remedy, and to confirm that human health and the environment continue to be protected by the remedial actions that have been performed at the site. This interview is being conducted as a part of the fourth five-year review for the Crystal Chemical Company Superfund Site. ***Should you choose to respond, please return your survey form to April Ballweg at EA Engineering, Science, and Technology, Inc. via e-mail or U.S. Postal Service by November 14, 2014].*** *The scope of the review is from 2010 to present.*

1. What is your general impression of the work conducted at the site during this review period?

   Very good

2. During this review period, are you aware of any community concerns regarding the site or its operation and administration? If so, please provide details.

   No.

SUPERFUND FIVE-YEAR REVIEW SITE SURVEY	
Site Name: Crystal Chemical Company Superfund Site	**EPA ID No.:** TXD990707010
Location: Harris County, TX	**Date:** 12/3/2014

Survey Questions (Continued)

3. Are you aware of any events, incidents, or activities at the site during this review period, such as vandalism, trespassing, or emergency responses from local authorities? If so, please provide details.

   None

4. Do you feel well informed about the site's activities and progress? If not, please indicate how you would like to be informed about the site activities – for example, by e-mail, regular mail, fact sheets, meetings, etc.

   The TCEQ is well informed about the site's activities and progress through monthly report and annual report.

5. Do you have any comments, suggestions, or recommendations regarding the site's management or operation?

   The liquid stored inside the two ground storage tanks (GST) should be disposed of properly or the chemistry of the liquid should be maintained. With the wastewater treatment plant suspended indefinitely, the stored liquid may become contaminated (i.e. biological growth) and rendered more effort to site maintenance.

6. Have there been routine communications or activities (site visits, inspections, reporting activities, etc.) conducted by your office regarding the site? If so, please describe the purpose and results.

   Yes. The TCEQ is participating in the submitted to the agencies documents review and phone conferences. Monthly Progress Reports are sent to TCEQ Project Manager on a regular basis.

SUPERFUND FIVE-YEAR REVIEW SITE SURVEY	
Site Name: Crystal Chemical Company Superfund Site	**EPA ID No.:** TXD990707010
Location: Harris County, TX	**Date:** 12/3/2014

Survey Questions (Continued)

7. Have there been any complaints, violations, or other incidents related to the site that required a response by your office? If so, please summarize the events and results.

   No

8. Are you aware of any problems or difficulties encountered which impacted the effectiveness of the remedial action or caused a change in operation and maintenance procedures? If so, please describe changes and impacts.

   No.

9. Have there been any changes in state or federal environmental standards which may call into question the protectiveness or effectiveness of the remedial action?

   No.

10. Do you know of opportunities to optimize the operation, maintenance, or sampling efforts at the site?

    No.

SUPERFUND FIVE-YEAR REVIEW SITE SURVEY		
Site Name: Crystal Chemical Company Superfund Site		**EPA ID No.:** TXD990707010
Location: Harris County, Texas		**Date:** 12/3/14
Contact Made By:		
Name: Ruben Moya	**Title:** Remedial Project Manager	**Organization:** U.S. EPA
Telephone No.: (214) 665-2755 **E-Mail:** Moya.Ruben@epamail.epa.gov	**Street Address:** 1445 Ross Avenue, Suite 1200 **City, State, Zip:** Dallas, Texas 75202	
Name: April Ballweg	**Title:** Project Manager	**Organization:** EA Engineering, Science, and Technology, Inc.
Telephone No.: (972) 459-5019 **E-Mail:** aballweg@eaest.com	**Street Address:** 405 State Highway 121 Bypass, Suite C-100 **City, State, Zip:** Lewisville, Texas 75067	
Individual Contacted:		
Name: Michael J. Wisniowiecki	**Title:** Project Manager	**Organization:** Conestoga-Rovers & Associates, Inc.
Telephone No.: 713-734-3090 **E-Mail Address:** mwisniowiecki@craworld.com	**Street Address:** 6320 Rothway, Suite 100 **City, State, Zip:** Houston, TX 77040	

Survey Questions

The purpose of the five-year review is to evaluate the implementation and performance of the remedy, and to confirm that human health and the environment continue to be protected by the remedial actions that have been performed at the site. This interview is being conducted as a part of the fourth five-year review for the Crystal Chemical Company Superfund Site. ***Should you choose to respond, please return your survey form to April Ballweg at EA Engineering, Science, and Technology, Inc. via e-mail or U.S. Postal Service by 14 November 2014.*** *The scope of the review is from 2010 to the present.*

1. What is your general impression of the work conducted at the site during this review period?

Union Pacific has progressed on evaluation of groundwater flow and control, demonstrating control of affected groundwater within the site boundaries. Obtaining deed restrictions and TCEQ Municipal Settings Designation (MSD) of affected groundwater also removes potential groundwater ingestion pathways. Site has been maintained and is ready for potential re-use.

2. From your perspective, what effects have site operations had on the surrounding community?

There are no site operations. The deed restriction and TCEQ Municipal Settings Designation (MSD) only apply to property owned by Union Pacific so they have no effect on the surrounding community.

SUPERFUND FIVE-YEAR REVIEW SITE SURVEY	
Site Name: Crystal Chemical Company Superfund Site	**EPA ID No.:** TXD990707010
Location: Harris County, Texas	**Date:** 12/3/14

Survey Questions (Continued)

3. During this review period, are you aware of any community concerns regarding the site or its operation and administration? If so, please provide details.

Union Pacific is not aware of any community concerns regarding the site. There was no opposition to the MSD, it received approval from all the required entities.

4. Are you aware of any events, incidents, or activities at the site during this review period, such as vandalism, trespassing, or emergency responses from local authorities? If so, please provide details.

No.

5. Do you feel well informed about the site's activities and progress? If not, please indicate how you would like to be informed about the site activities – for example, by e-mail, regular mail, fact sheets, meetings, etc.

N/A

6. Do you have any comments, suggestions, or recommendations regarding the site's management or operation?

Based on 20 years of groundwater monitoring analytical results, deed restrictions, MSD certification, and a finding of technical impracticability by USEPA, UPRR has recommended the groundwater monitoring program be terminated and the monitoring wells be plugged and abandoned. Suspension of groundwater recovery from well RW-1and groundwater treatment and disposal from the Groundwater Treatment Plant previously approved by USEPA should be made permanent.

SUPERFUND FIVE-YEAR REVIEW SITE SURVEY	
Site Name: Crystal Chemical Company Superfund Site	**EPA ID No.:** TXD990707010
Location: Harris County, Texas	**Date:** 12/3/14

Survey Questions (Continued)

7. Have there been routine communications or activities (site visits, inspections, reporting activities, etc.) conducted by your office regarding the site? If so, please describe the purpose and results.

Routine communications and activities conducted by CRA include semiannual site inspections of the Pressure Relief System (PRS), slurry wall and monofill cap; submission of Monthly Progress Reports summarizing site activities, submission of Annual Remedial Action Reports, coordination and site visits with EPA and TCEQ representatives regarding site issues, and discussions with Hatch, Mott & MacDonald site representative as needed to discussion Groundwater Treatment Plant and general site maintenance.

8. Have there been any complaints, violations, or other incidents related to the site that required a response by your office? If so, please summarize the events and results.

None

9. Are you aware of any problems or difficulties encountered which impacted the effectiveness of the remedial action or caused a change in operation and maintenance procedures? If so, please describe changes and impacts.

None

10. Have there been any changes in state or federal environmental standards which may call into question the protectiveness or effectiveness of the remedial action?

N/A

SUPERFUND FIVE-YEAR REVIEW SITE SURVEY	
Site Name: Crystal Chemical Company Superfund Site	**EPA ID No.:** TXD990707010
Location: Harris County, Texas	**Date:** 12/3/14

Survey Questions (Continued)

11. Do you know of opportunities to optimize the operation, maintenance, or sampling efforts at the site?

See discussions regarding suspension of groundwater monitoring, treatment and disposal activities referenced in Question 6.

Please add any other comments in the space below.

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APPENDIX G

APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENT SUMMARY

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Appendix G. Applicable or Relevant and Appropriate Requirement Summary

ARAR Citation	Requirement	Status
Chemical Specific		
National Primary Drinking Water Standards 40 CFR 141	Establishes MCLs for the protection of drinking water.	Current. No changes have been made which would affect the protectiveness of the remedy. In 1997 an ARAR waiver was granted for the 0.050 mg/L arsenic cleanup level for a limited portion of the aquifer.
30 Texas Administrative Code, Chapter 307.6(d)(1)	Establishes MCLs for the protection of drinking water. This regulation maintains the quality of water in the state consistent with public health and enjoyment and to ensure the propagation and protection of terrestrial and aquatic life.	Current. No changes have been made which would affect the protectiveness of the remedy.
Clean Water Act regulations in 33 U.S.C. 1251 et seq. Section 304(a)	Provides surface water quality criteria for the protection of human health.	Current. No changes have been made which would affect the protectiveness of the remedy.
Action Specific		
RCRA Landfill Requirements, 40 CFR 264.310 (a)(5)	Regulations which specify a cap with permeability less than or equal to the permeability of any bottom liner of natural sub-soils present at the site.	Current. Remedial action for the design and construction of a hazardous waste landfill has been completed. Ongoing operation of the landfill continues.
RCRA Requirements, Landfill Closure, 40 CFR 264.228	Regulations which provides closure requirements for surface impoundments RCRA landfill closure requirements in 40 CFR 264.310 Subpart N.	Current. Remedial action for the design and construction of a hazardous waste landfill has been completed. Ongoing operation of the landfill continues.
RCRA Post-closure and Monitoring Requirements, 40 CFR 264.117(a) (1)	Regulations which require a 30-year post-closure period and another period determined by the EPA Regional Administrator.	Current. Remedial action for the design and construction of a hazardous waste landfill has been completed. Ongoing operation of the landfill continues.
Ambient Air Quality Standards, 40 CFR 50	Regulations which provide protection for the quality of air during implementation of the soil remedy.	Current. Remedial action for the design and construction of a hazardous waste landfill has been completed.
Location Specific		
Flood Plain Protection Requirements, 40 CFR 6.302	This requires that federally funded or authorized actions within the 100-year floodplain avoid, to the maximum extent possible, adverse impacts associated with the development of a floodplain.	Current. Remedial action in the floodplain is complete.

Appendix G. Applicable or Relevant and Appropriate Requirement Summary

ARAR Citation	Requirement	Status
Location Standards, 40 CFR 264.18(b)	A facility located in a 100-year floodplain must be designed, constructed, operated, and maintained to prevent washout or any hazardous waste by a 100-year flood.	Current. Remedial action in the 100-year floodplain is complete.

NOTE:

ARAR = Applicable or Relevant and Appropriate Requirement
CFR = Code of Federal Regulation
EPA = U.S. Environmental Protection Agency
MCL = Maximum concentration level
mg/L = Milligram per liter
RCRA = Resource Conservation and Recovery Act
U.S.C. = United States Code

APPENDIX H

DOCUMENTS REVIEWED

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DOCUMENTS REVIEWED

City of Houston (COH). 2008. Municipal Setting Designation, Ordinance #2008-253. 26 March.

COH. 2010. Renewal of Industrial Waste Permit Number 6109. Issued by the Department of Public Health and Engineering. 4 March.

CRA. 2009. Revised Phytohydraulic Control Pilot Test Report for Levy Tract. 30 November.

CRA. 2011a. Phytohydraulic Control Pilot Test Report – Shearton Tract, EPA Docket No. CERCLA VI-15-92 – Crystal Chemical Site, Houston, Texas. 26 April.

CRA. 2011b. 2010 Annual Remedial Action Report, Crystal Chemical National Priorities List Site, CERCLA VI-15-92. January.

CRA. 2012. 2011 Annual Remedial Action Report, Crystal Chemical National Priorities List Site, CERCLA VI-15-92. January.

CRA. 2013. 2012 Annual Remedial Action Report, Crystal Chemical National Priorities List Site, CERCLA VI-15-92. January.

CRA. 2014. 2013 Annual Remedial Action Report, Crystal Chemical National Priorities List Site, CERCLA VI-15-92. January.

EA Engineering, Science, and Technology, Inc., PBC (EA). 2010. Third Five-Year Review Report for the Crystal Chemical Company Site, Houston, Harris County, Texas. September.

(U.S.) Environmental Protection Agency (EPA). 1990. CERCLA Record of Decision for Crystal Chemical Company Site, Houston, Texas. 27 September.

EPA. 1992a. Region 6 Administrative Order, Docket No. VI-11-92, on Consent for the Remedial Design of Ground Water Contamination at Crystal Chemical Company Site. 31 March.

EPA. 1992b. Amended CERCLA Record of Decision for Crystal Chemical Company Site, Houston, Texas. 16 June.

EPA. 1992c. Region 6 Administrative Order, Docket No. VI-15-92, on implementing the soil remedy specified in the amended ROD dated June 16, 1992, at Crystal Chemical Company Site. 3 September.

EPA. 1997. Explanation of Significant Difference for Record of Decision: Crystal Chemical Company Superfund Site, Houston, Texas. 19 March.

DOCUMENTS REVIEWED (continued)

EPA. 2009. EPA Approval of Phytohydraulic Pilot Test Report for the Shearton Tract (revised). 13 November.

EPA. 2014. Regional Screening Level Summary Table. May.

Environmental Resources Management (ERM). 2004. Operation and Maintenance Plan for Ground Water Remedial Design Addendum – Revised Slurry Wall with Pressure Relief System. March.

Harris County. 2006. Industrial Solid Waste Certification of Remediation; acknowledged on 10 August.

Industrial Compliance. 1994. Remedial Action Operation and Maintenance Plan, prepared for Southern Pacific Transportation Company, San Francisco, California. 30 November.

Texas Commission on Environmental Quality (TCEQ). 2012. Letter from TCEQ to Union Pacific Railroad Re: Municipal Settings Designation Certificate for Crystal Chemical National Priorities List Site, 10965 Westpark Drive, Houston, Texas; MSD No. 075. 12 July.

Terranext. 1996. Ground Water Remedial Design Addendum. Slurry Wall Design. 21 June.

Union Pacific Railroad (UPRR). 2003a. Groundwater Monitoring Plan. Crystal Chemical Site, Houston, Texas. EPA Docket No. CERCLA VI-15-92. 23 July.

UPRR. 2003b. Revision 2 of Groundwater Monitoring Plan. Crystal Chemical Site, Houston, Texas. EPA Docket No. CERCLA VI-15-92. 12 December.

UPRR. 2010a. EPA Docket No. CERCLA VI-15-92 – Crystal Chemical Site, Houston, Texas. Monthly Progress Report for the Remedial Action for January 2010. 2 February.

UPRR. 2010b. EPA Docket No. CERCLA VI-15-92 – Crystal Chemical Site, Houston, Texas. Monthly Progress Report for the Remedial Action for February 2010. 3 March.

UPRR. 2010c. EPA Docket No. CERCLA VI-15-92 – Crystal Chemical Site, Houston, Texas. Monthly Progress Report for the Remedial Action for March 2010. 8 April.

UPRR. 2010d. EPA Docket No. CERCLA VI-15-92 – Crystal Chemical Site, Houston, Texas. Monthly Progress Report for the Remedial Action for April 2010. 6 May.

UPRR. 2010e. EPA Docket No. CERCLA VI-15-92 – Crystal Chemical Site, Houston, Texas. Monthly Progress Report for the Remedial Action for May 2010. 9 June.

UPRR. 2010f. EPA Docket No. CERCLA VI-15-92 – Crystal Chemical Site, Houston, Texas. Monthly Progress Report for the Remedial Action for August 2010. 10 September.

DOCUMENTS REVIEWED (continued)

UPRR. 2010g. EPA Docket No. CERCLA VI-15-92 – Crystal Chemical Site, Houston, Texas. Monthly Progress Report for the Remedial Action for October 2010. 4 November.

UPRR. 2011a. EPA Docket No. CERCLA VI-15-92 – Crystal Chemical Site, Houston, Texas. Monthly Progress Report for the Remedial Action for June 2011. 7 July.

UPRR. 2011b. EPA Docket No. CERCLA VI-15-92 – Crystal Chemical Site, Houston, Texas. Monthly Progress Report for the Remedial Action for July 2011. 9 August.

UPRR. 2011c. EPA Docket No. CERCLA VI-15-92 – Crystal Chemical Site, Houston, Texas. Monthly Progress Report for the Remedial Action for September 2011. 5 October.

UPRR. 2011d. EPA Docket No. CERCLA VI-15-92 – Crystal Chemical Site, Houston, Texas. Monthly Progress Report for the Remedial Action for November 2011. 13 December.

UPRR. 2013a. EPA Docket No. CERCLA VI-15-92 – Crystal Chemical Site, Houston, Texas. Monthly Progress Report for the Remedial Action for January 2013. 5 February.

UPRR. 2013b. EPA Docket No. CERCLA VI-15-92 – Crystal Chemical Site, Houston, Texas. Monthly Progress Report for the Remedial Action for February 2013. 6 March.

UPRR. 2013c. EPA Docket No. CERCLA VI-15-92 – Crystal Chemical Site, Houston, Texas. Monthly Progress Report for the Remedial Action for March 2013. 1 April.

UPRR. 2013d. EPA Docket No. CERCLA VI-15-92 – Crystal Chemical Site, Houston, Texas. Monthly Progress Report for the Remedial Action for April 2013. 6 May.

UPRR. 2013e. EPA Docket No. CERCLA VI-15-92 – Crystal Chemical Site, Houston, Texas. Monthly Progress Report for the Remedial Action for May 2013. 6 June.

UPRR. 2013f. EPA Docket No. CERCLA VI-15-92 – Crystal Chemical Site, Houston, Texas. Monthly Progress Report for the Remedial Action for June 2013. 1 July.

UPRR. 2013g. EPA Docket No. CERCLA VI-15-92 – Crystal Chemical Site, Houston, Texas. Monthly Progress Report for the Remedial Action for July 2013. 1 August.

UPRR. 2013h. EPA Docket No. CERCLA VI-15-92 – Crystal Chemical Site, Houston, Texas. Monthly Progress Report for the Remedial Action for August 2013. 3 September.

UPRR. 2013i. EPA Docket No. CERCLA VI-15-92 – Crystal Chemical Site, Houston, Texas. Monthly Progress Report for the Remedial Action for September 2013. 3 October.

UPRR. 2013j. EPA Docket No. CERCLA VI-15-92 – Crystal Chemical Site, Houston, Texas. Monthly Progress Report for the Remedial Action for October 2013. 7 November.

DOCUMENTS REVIEWED (concluded)

UPRR. 2013k. EPA Docket No. CERCLA VI-15-92 – Crystal Chemical Site, Houston, Texas. Monthly Progress Report for the Remedial Action for November 2013. 3 December.

UPRR. 2014a. EPA Docket No. CERCLA VI-15-92 – Crystal Chemical Site, Houston, Texas. Monthly Progress Report for the Remedial Action for January 2014. 5 February.

UPRR. 2014b. EPA Docket No. CERCLA VI-15-92 – Crystal Chemical Site, Houston, Texas. Monthly Progress Report for the Remedial Action for February 2014. 3 March.

UPRR. 2014c. EPA Docket No. CERCLA VI-15-92 – Crystal Chemical Site, Houston, Texas. Monthly Progress Report for the Remedial Action for March 2014. 1 April.

UPRR. 2014e. EPA Docket No. CERCLA VI-15-92 – Crystal Chemical Site, Houston, Texas. Monthly Progress Report for the Remedial Action for April 2014. 1 May.

UPRR. 2014e. EPA Docket No. CERCLA VI-15-92 – Crystal Chemical Site, Houston, Texas. Monthly Progress Report for the Remedial Action for May 2014. 4 June.

UPRR. 2014f. EPA Docket No. CERCLA VI-15-92 – Crystal Chemical Site, Houston, Texas. Monthly Progress Report for the Remedial Action for June 2014. 1 July.

UPRR. 2014g. EPA Docket No. CERCLA VI-15-92 – Crystal Chemical Site, Houston, Texas. Monthly Progress Report for the Remedial Action for July 2014. 4 August.

UPRR. 2014h. EPA Docket No. CERCLA VI-15-92 – Crystal Chemical Site, Houston, Texas. Monthly Progress Report for the Remedial Action for August 2014. 2 September.

UPRR. 2014i. EPA Docket No. CERCLA VI-15-92 – Crystal Chemical Site, Houston, Texas. Monthly Progress Report for the Remedial Action for September 2014. 1 October.

UPRR. 2014j. EPA Docket No. CERCLA VI-15-92 – Crystal Chemical Site, Houston, Texas. Monthly Progress Report for the Remedial Action for October 2014. 4 November.