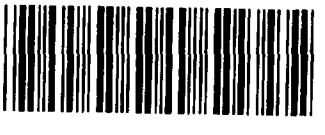
Five-Year Review Report

First Five-Year Review Report for the Crystal Chemical Company Site Houston, Harris County, Texas

September 2000

U.S. Environmental Protection Agency
1445 Ross Avenue
Dallas, Texas 75202-2722



FIVE-YEAR REVIEW

Crystal Chemical Company Site
EPA ID# TXD990707010
Houston, Harris County, TX.

This memorandum documents EPA's approval of the Crystal Chemical Company Site Five-Year Review Report prepared by Tetra Tech EM Inc. on behalf of EPA.

Summary of Five-Year Review Findings

The site's 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. Some minor erosion was noted on the soil cap.

The site's ground water remedy called for pumping and treating the part of the arsenic plume amenable to arsenic removal. The ground water pump and treat system is operating and functioning as designed and modified. The ground water remedy also called for construction of a slurry wall around the remaining portion of the arsenic plume where it was determined that removal of arsenic is technically impracticable. Part of the slurry wall was constructed as part of the soil cap construction activities. Ground water monitoring of the 15 and 35-foot sands was conducted on the site and on the recently acquired Levy property in August 2000. Ground water monitoring of the 100-foot sands has not detected arsenic concentrations above the cleanup criteria of 50 parts per million since 1994. The need for institutional controls was identified for the area of the ground water plume not on the Union Pacific Railroad property.

No community concerns were identified during the review.

Actions Needed

The minor erosion identified on the cap will be repaired. The ground water monitoring data collected in August will be used to perform a slurry wall alignment assessment and an attenuation feasibility assessment. Institutional controls for the area of the ground water plume not on the Union Pacific Railroad property will be considered by EPA and Union Pacific Railroad.

Determinations

I have determined that the remedy for the soil operable unit is protective of human health and the environment, and will remain so provided the action items identified in the Five-Year Review Report are addressed as described above.

I have determined that the remedy for the ground water operable unit is expected to be protective of human health and the environment upon completion, and immediate threats have been addressed.

Pamela Phillips, Acting

Myron O. Knudson, P.E.
Director
Superfund Division
U.S. Environmental Protection Agency
Region 6

9/25/2000

Date

CONCURRENCES

FIVE-YEAR REVIEW

for the

Crystal Chemical Company Site
EPA ID# TXD990707010

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FIVE-YEAR REVIEW REPORT

FOR THE

CRYSTAL CHEMICAL COMPANY SITE
HOUSTON, HARRIS COUNTY, TEXAS

Prepared for

U.S. ENVIRONMENTAL PROTECTION AGENCY
1445 Ross Avenue
Dallas, TX 75202-2722

Work Assignment No.	:	034-FRFE-06ZZ
EPA Region	:	6
Date Prepared	:	September 1, 2000
Contract No.	:	68-W6-0037
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ACRONYMS AND ABBREVIATIONS

ARAR	Applicable or relevant and appropriate requirements
ATSDR	Agency for Toxic Substances and Disease Registry
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CO	Carbon monoxide
COC	Contaminant of concern
COH	City of Houston
Crystal Chemical	Crystal Chemical Company
EPA	U.S. Environmental Protection Agency
ERM	Environmental Resources Management
ESD	Explanation of significant differences
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Maps
FRP	Fiberglass reinforced plastic
GPM	Gallons per minute
GWTP	Ground water treatment plant
HASP	Health and Safety Plan
HCFCD	Harris County Flood Control District
HDPE	High-density polyethylene
MCL	Maximum contaminant level
mg/kg	Milligrams per kilogram
mg/L	Milligrams per liter
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
O&M	Operation and maintenance
OUs	Operable units
POTW	Publicly owned treatment works
PRP	Potentially responsible party
PVC	Polyvinyl chloride
RAC	Response Action Contract
RCRA	Resource Conservation and Recovery Act
RD/RA	Remedial design/remedial action
RI/FS	Remedial investigation/feasibility study
ROD	Record of decision
Southern Pacific	Southern Pacific Transportation Company
TAC	Texas Administrative Code
TCLP	Toxicity characteristic leaching procedure
Tetra Tech	Tetra Tech EM Inc.
TI	Technical impracticability
TNRCC	Texas Natural Resource Conservation Commission
µg/L	Micrograms per liter
UPR	Union Pacific Railroad
yd^3	Cubic yards

EXECUTIVE SUMMARY

The purpose of this five-year review is to evaluate whether the selected remedy for the Crystal Chemical Company site is protective of human health and the environment.

The Crystal Chemical site is located at 3502 Rogerdale Road, in southwestern Houston, Harris County, Texas (Figure 1). The company operated from 1969 to 1981 on approximately 6.8 acres. The acreage is bounded on the west by the Harris County Flood Control District (HCFCD) ditch number D124-00-00 and bounded on the north by Westpark Drive.

Crystal Chemical Company produced arsenical, phenolic, and amine-based herbicides which affected soils and ground water on the site and adjacent properties. The contamination covered approximately 24.4 acres, which was comprised of 6.8 acres on-site and 17.6 acres off-site.

In the late 1970s, the Crystal Chemical Company was cited for several violations of State of Texas environmental standards. 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 on-site deep well injection permit to dispose of the process wastewaters; however, the permit was denied.

In September 1981, Crystal Chemical Company filed for bankruptcy and abandoned the site. EPA initiated an Emergency Removal Action to stabilize to the site. In 1983, the Crystal Chemical property was added to the National Priorities List (NPL).

In January 1984, the EPA issued the remedial investigation/feasibility study (RI/FS) report stating that arsenic was detected in surface and subsurface soil and ground water. The RI/FS report delineated arsenic contamination across the site to an average depth of 5 to 6 feet. High concentrations of arsenic were found at depths of 3 to 10 feet in areas throughout the site. Off-site soil borings reported high concentration levels of arsenic as deep as 9 feet.

In September 1990, EPA issued a Record of Decision (ROD) that addressed soil and ground water contamination. The ROD called for the use of in situ vitrification as the soil remedy and an extraction, treatment, and discharge system as the ground water treatment remedy.

Due to the unavailability of the in situ vitrification technology, EPA reconsidered the alternatives evaluated during the feasibility study. Capping, a nontreatment alternative, became the preferred alternative. In June 1992, EPA issued this decision in a ROD amendment, which modified the soil remedy alternative but left the ground water remedy unchanged. A cap was subsequently installed on the Crystal Chemical site in September 1995.

Southern Pacific Transportation Company, now Union Pacific Railroad Company (UPR), was identified as a potentially responsible party (PRP). UPR had previously owned the property and performed the remedial design/remedial action (RD/RA).

During the design of the ground water treatment system, it was discovered that the arsenic had adsorbed onto fine-grained sediments of the splay and off-channel deposits, which could not be remediated. A technical impracticability (TI) assessment for the splay and off-channel deposits was completed in February 1996.

EPA issued an Explanation of Significant Differences which called for construction of a slurry wall around the portions of the site where ground water cannot be restored. The extraction and treatment of arsenic contaminated ground water would be implemented on the remainder of the site. The ground water treatment plant (GWTP) was completed in 1997, and a pump-around loop system was installed in 1998. The GWTP officially started operating in January 1999.

Only partial construction of the slurry wall has been completed to date due to property access issues. In April 2000, UPR completed the purchase agreement for 12 acres of the Levy property where the remaining portion of the slurry wall is to be constructed. Additional ground water wells have been installed to assess the ground water in former Levy property.

Currently, ground water is being monitored in the 100-foot zone. No arsenic contamination has been detected above the 50 micrograms per liter (µg/L) cleanup level in the 100-foot zone since 1994. Additional monitoring in the 15-foot and 35-foot zones took place in August 2000, in an effort to define the current northeastern extent of arsenic-affected ground water exhibiting concentrations of 50 µg/L or more.

The ARAR review didn't find any discrepancies which would effect the protectiveness of the remedies at this time. However, EPA is proposing to lower the maximum contaminant level (MCL) for arsenic from 50 µg/L to 5 µg/L. The final decision for lowering the MCL should be reached by January 2001. The next five-year review for the site should evaluate the effect of any changes to the MCL on the protectiveness of the remedy.

The site inspection noted minor deficiencies in the condition of the cap; however, the remedy is protective of human health and the environment.

Five-Year Review Summary Form

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

SITE STATUS	
NPL Status: ☒ Final ☐ Deleted ☐ Other (specify) _____	
Remediation Status (choose all that apply): ☐ Under Construction ☒ Operating ☐ Complete	
Multiple OUs?* ☒ YES ☐ NO	**Construction Completion Date:** 9/95 for contaminated soil remedy, 11/96 for ground water treatment plant, 5/98 for gound water treatment plant modifications.
Has site been put into reuse? ☐ YES ☒ NO	

REVIEW STATUS	
Reviewing Agency: ☒ EPA ☐ State ☐ Tribe ☐ Other Federal Agency _____	
Author Name: Amy Swartz	
Author Title: Site Manager	**Author Affiliation:** EPA Region 6 Contractor
Review Period: 3/95 to 9/00	
Date(s) of Site Inspection: 6/26/00	
Type of review: ☒ Statutory ☐ Policy (☐ Post-SARA ☐ Pre-SARA ☐ NPL-Removal only ☐ Non-NPL Remedial Action Site ☐ NPL State/Tribe-lead ☐ Regional Discretion)	
Review Number: ☒ 1 (first) ☐ 2 (second) ☐ 3 (third) ☐ Other (specify) _____	
Five-Year Review Triggering Action: ☒ Actual RA Onsite Construction at OU # 1 ☐ Actual RA Start at OU #____ ☐ Construction Completion ☐ Previous Five-Year Review Report ☐ Other (specify) 5 years have elapsed since soil remedy was implemented.	
Five-Year Review Triggering Action Date: 3/95 (start of remedial action construction)	
Due Date (Five Years After Triggering Action Date): 3/00	

Five-Year Review Summary Form

Deficiencies:

The following deficiency was identified:

- Small erosion rills have developed in the topsoil along the west side of the cap on the side slope.

Recommendations and Follow-up Actions:

The following actions are required to correct these deficiencies and ensure that protectiveness is maintained in the future:

- Repair the cap

Protectiveness Statement(s):

The remedial action for the soils is protective, and the remedial action for the ground water is expected to be protective. Because the remedial actions associated with both media are protective, the remedy for the site is protective of human health and the environment.

Other Comments:

None.

1.0 INTRODUCTION

The Environmental Protection Agency (EPA) has conducted the first five-year review of the remedial actions implemented at the Crystal Chemical Company (Crystal Chemical) site in Houston, Texas. This report documents the results of the review conducted from March 2000 to July 2000. The purpose of five-year reviews is to determine whether the remedy at the site is protective of human health and the environment. The methods, findings, and conclusions of the reviews are documented in five-year review reports. In addition, five-year review reports identify deficiencies found during the review, if any, and present recommendations for addressing them.

This review is required by statute. EPA must implement five-year reviews consistent with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). CERCLA §121(c), as amended, 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.

The NCP Part 300.430(f)(4)(ii) of the Code of Federal Regulations (CFR) 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 action no less often that every five years after the initiation of the selected remedial action.

This is the first five-year review for the Crystal Chemical site. The triggering action for this review is the start of remedial action construction activities which began in March 1995, and ended in September 1995. Due to the fact that hazardous substances, pollutants, or contaminants remain at the site above levels that allow for unrestricted use and unlimited exposure, another five-year review will be required.

2.0 SITE CHRONOLOGY

Table 1 lists the chronology of events for the Crystal Chemical site.

TABLE 1

CHRONOLOGY OF SITE EVENTS
CRYSTAL CHEMICAL COMPANY—HOUSTON, TEXAS

Date	Event
1968	Crystal Chemical began production of arsenical, phenolic, and amine-based herbicides.
June 1976	Flooding occurred at the site, causing runoff from process and material storage areas.
1977	Harris County Flood Control District ditch no. D124-00-00 was constructed along the western portion of the site.
December 1977	Crystal Chemical's operation and maintenance problems were cited for several environmental standards violations by TDWR.
1978	Crystal Chemical submitted an application to State of Texas for an on-site deep well injection permit to dispose of wastewaters being stored in four evaporation ponds. The permit was denied.
September 1981	Crystal Chemical filed for bankruptcy and abandoned site.
September 1981 through February 1983	EPA initiated a number of Emergency Removal Actions to stabilize site: 1) disposed of pond wastewater 2) top 12 inches of pond soil treated 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 1983	Crystal Chemical was added to the National Priorities List.
1983	EPA took measures to further control surface water runoff and site access by constructing drains, fencing, and placing additional fill on site.
1983	TDWR, through a cooperative agreement with EPA, initiated a site characterization study.
1984	"Final Report Site Investigation Crystal Chemical Company, Houston, Texas" was published citing arsenic as the primary contaminant of concern.
June 1984	TDWR completed an Initial Feasibility Study.
December 1984	EPA and TDWR completed an Addendum Feasibility Study modifying the selected remedy as a response to public concerns on cost. The study determined that EPA's preferred alternative (cap the onsite contaminated area after excavating all offsite soils contaminated with arsenic greater than 100 ppm) was protective of human health and welfare and the environment and was cost-effective.
October 1986	Passage of the SARA, which called for feasibility study to focus on use of treatment technologies for the site.

TABLE 1 (Continued)

CHRONOLOGY OF SITE EVENTS
CRYSTAL CHEMICAL COMPANY—HOUSTON, TEXAS

Date	Event
May 1987	EPA entered into an Administrative Order of Consent with Southern Pacific (PRP) to conduct the Supplemental Feasibility Study (SFS).
1988	EPA took additional measures to further control surface water runoff and site access by constructing additional drains, fencing, and fill on site.
January 1988	Southern Pacific suspended work on the SFS.
February 1989	New federal regulations allowing off-site treatability studies were promulgated.
July 1989	Nine water supply wells near the site were sampled, which aided the delineation of the ground water contamination.
September 1989	Southern Pacific requested an extension to complete the SFS—EPA denied the request.
June 1990	Regulation published identifying in situ vitrification as the best demonstrated available treatment technology for arsenic as a RCRA characteristic waste as well as a RCRA listed waste.
May 1990	EPA completed the SFS.
June 1990	Proposed plan for the site was released for public comment.
September 1990	The ROD for the site was issued by EPA Region 6.
February 1992	An Amended Proposed Plan was released for public comment due to the unavailability of the ROD's selected soil treatment technology—in situ vitrification.
June 1992	EPA entered into an Administrative Order on Consent with Southern Pacific for ground water remedy at the site.
June 1992	EPA issued an Unilateral Administrative Order with Southern Pacific addressing the RD/RA for the site.
June 1992	The amended ROD for the site was issued by EPA Region 6.
November 1994	Southern Pacific implemented the Remedial Action Operation and Maintenance Plan to ensure the long-term integrity of the multi-layer cap.
September 1995	Construction of portion of slurry wall within boundary of site, and under Westpark Drive.
January 1996	EPA approves Soil Remedial Action Construction Documentation Report summarizing the construction of the soil remedy.
February 1996	Assessment of the TI of ground water remediation for the site was completed. Physical containment of contaminated ground water was the recommended alternative.
March 1997	Issuance of Explanation of Significant Differences that revised the ROD by replacing a portion of the pump and treat system with a slurry wall.

TABLE 1 (Continued)

CHRONOLOGY OF SITE EVENTS
CRYSTAL CHEMICAL COMPANY—HOUSTON, TEXAS

Date	Event
August 1998 Revised July 1999	Revised Work Plan for Additional Ground Water Investigation was issued.
July 1999	A review of historical information was conducted on the Levy property (adjacent to the site) to identify potential environmental issues prior to a proposed property transfer to Union Pacific Railroad. Ownership of this property was required to complete the slurry wall construction.
December 1999	Confirmation sampling was completed on the Levy property to identify potential environmental issues prior to a proposed property transfer to Union Pacific Railroad.
April 2000	EPA initiates the first Five-Year Review.
August 2000	Additional ground water sampling of the 15-foot and 35-foot zones occurred as defined in the Work Plan for Additional Ground Water Investigation.

Notes:

Crystal Chemical	Crystal Chemical Company
EPA	U.S. Environmental Protection Agency
ISV	In situ vitrification
POTW	Publicly owned treatment works
PRP	Potentially responsible party
RA	Remedial action
RCRA	Resource Conservation and Recovery Act
RD/RA	Remedial Design/Remedial Action
RI/FS	Remedial Investigation/Feasibility Study
ROD	Record of Decision
SARA	Superfund Amendments and Reauthorization Action of 1986
SFS	Supplemental Feasibility Study
Southern Pacific	Southern Pacific Transportation Company
TDWR	Texas Department of Water Resources
TI	Technical Impracticability
TWC	Texas Water Commission

3.0 BACKGROUND

The Crystal Chemical site is located at 3502 Rogerdale Road, in southwestern Houston, Harris County, Texas (Figure 1). The company operated from 1969 to 1981 on approximately 6.8 acres. The acreage is bounded on the west by the Harris County Flood Control District (HCFCD) ditch number D124-00-00 and bounded on the north by Westpark Drive.

Crystal Chemical Company produced arsenical, phenolic, and amine-based herbicides, which affected soils and ground water 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.

Vacant, commercial, and industrial properties immediately surround the site. There is no designated Texas significant habitat, agricultural land, or historic landmark site directly or potentially effected by contamination from the Crystal Chemical site. 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.

Operation and maintenance problems at the Crystal Chemical 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 (FEMA) Flood Insurance Rate Maps (FIRM), the site lies within the limits of the 100-year flood plain of the adjacent HCFCD 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 on-site deep well injection permit to dispose of the process wastewaters. The permit was denied by the State of Texas.

In September 1981, Crystal Chemical 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 with the building and process equipment. Approximately 600,000 gallons of wastewater from the evaporation ponds were disposed of off site. The top 12 inches of pond soils were treated with lime and deposited back into the ponds.

In 1983, the Crystal Chemical property was added to the National Priorities List (NPL), pursuant to CERCLA, qualifying the site for investigation and remediation under Superfund. EPA is the lead agency for the site, and through a cooperative agreement with the State regulatory body, the Texas Natural Resource Conservation Commission (TNRCC) 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/Feasibility Study (RI/FS) for the site. Therefore, EPA and TNRCC conducted an RI/FS to define the types and extent of contamination at the site.

In January 1984, EPA issued the RI/FS report that found arsenic and phenol as the contaminants detected in surface and subsurface soil and ground water. Phenol is a chemical used in the production of plastics, disinfectants, pharmaceuticals, and other industrial compounds. During the feasibility study, the Agency for Toxic Substances and Disease Registry (ATSDR) reviewed the potential risks to human health posed by the Crystal Chemical site. Although phenol was found on the site in concentrations up to 157 milligrams per liter (mg/L), the ATSDR Health Assessment determined that phenolic compounds did not present a potential health problem to area residents and workers in the area due to the low detection levels.

The RI/FS report delineated arsenic contamination across the site to an average depth of five to six feet. Concentrations of 5,000 mg/kg were found to have penetrated from three to ten feet in areas throughout the site. Off-site soil borings reported arsenic concentrations of 50 mg/kg as deep as 9 feet. Contamination of ground water and subsurface soils was determined to have been caused by percolation of storm water and surface water. The volume of off-site soils contaminated with arsenic greater than 30 mg/kg was reported to be 55,000 cubic yards (yd^3). The volume of on-site soils contaminated with arsenic greater than 300 mg/kg was estimated to be 16,500 yd^3. An estimated 101,000 yd^3 of on-site soils were reported to be contaminated with arsenic greater than 30 mg/kg.

During the RI/FS, 21 monitoring wells were installed. Based upon soil borings taken during the well installation, three water-bearing zones at 15 feet, 35 feet, and 100 feet below the ground surface were identified. Based on the information gathered during the RI/FS, an estimated 3 million gallons of water was contaminated with arsenic. The major arsenic contamination is present in the 35-foot water bearing sand layer.

In September 1990, the EPA issued a Record of Decision (1990 ROD) which selected a remedy for soil and ground water contamination at the Crystal Chemical Company site. As discussed in the 1990 ROD, the selected remedy for soil called for the excavation of off-site 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 technology, EPA selected a new soil remedy (soil consolidation and capping) in a ROD amendment issued in June 1992. The soil consolidation and capping remedy was completed in September 1995.

The remedy selected in the 1990 ROD for ground water called for the extraction and treatment of arsenic contaminated ground water. The remediation goal specified in the 1990 ROD for the affected ground water zones is 50 µg/L, the Maximum Contaminated Level (MCL) for arsenic. The 1990 ROD also includes several contingency measures that could be implemented if an extraction and treatment system would not produced the ground water remediation goal.

During the course of the design for the ground water remedy, EPA and the TNRCC determined that restoration of the ground water is technically impracticable for portions of the Crystal Chemical Company site. Therefore, EPA determined that the applicable or relevant and appropriate requirement (ARAR) for groundwater restoration to the MCL of 50 µg/L for arsenic should be waived and a slurry wall should be constructed around the portions of the site where ground water cannot be restored. The extraction and treatment of arsenic contaminated groundwater will be implemented on the remainder of the site, as specified in the 1990 ROD. The decision to waive the ground water ARAR and construct the slurry wall is documented in the Crystal Chemical Company site Superfund Explanation of Significant Differences of the Record of Decision (March 1997).

Southern Pacific Transportation Company (Southern Pacific) (now Union Pacific Railroad [UPR] Company), was identified as a PRP. Southern Pacific had previously owned the property and performed the remedial design/remedial action (RD/RA) pursuant to a Unilateral Administrative Order (UAO). Southern Pacific was also authorized to begin designing an efficient and effective ground water treatment system.

4.0 REMEDIAL ACTIONS

The following sections discuss remedy selection, remedy implementation, system operations, and progress.

4.1 REMEDY SELECTION

In September 1990, EPA issued a Record of Decision (ROD) that addressed soil and ground water contamination. EPA determined that contaminated soil was the principal threat at the site because of direct contact, ingestion, and inhalation risks and because of the soil's impact on ground water. The remedial objectives were thus based on eliminating potential direct exposure and reducing the amount of contaminated soil that is causing ground water contamination. Arsenic concentrations of 30 mg/L were determined to represent a safe, health-based risk action level. The alternative selected to meet these goals called for in situ vitrification, which uses electricity to generate heat and in the process, destroy contaminants and permanently bond the remaining contaminants into a crystalline structure. The ROD called for on-site in situ vitrification, while off-site soils with contamination levels of 30 mg/L and higher were to be excavated and placed on site.

The ground water remedy selected had to meet the maximum contaminant level (MCL) standard for arsenic. EPA determined that the MCL standard for arsenic, 0.05 mg/L, would be the target remediation level for ground water. The alternative selected consisted of a ground water extraction system, ground water treatment plant for removal of arsenic, and discharge to the City of Houston (COH) storm sewer. The 1990 ROD included several contingency measures that could be implemented if an extraction and

treatment system would not produce remediation goals set for the Crystal Chemical site. The contingency measures specified in the 1990 ROD were as follows:

- Discontinuing operation of extraction wells in areas where cleanup goals have been attained
- Alternating pumping at wells to eliminate stagnation points
- Establishing an Alternate Concentration Limit for arsenic throughout the area of attainment, provided compliance with CERCLA section 121 (d)(2)(B)(ii) could be demonstrated
- Waiving the ground water applicable or relevant and appropriate requirements (ARAR) for those portions of the aquifer based on the technical impracticability (TI) of achieving further contaminant reduction
- Implementing low level pumping as a long-term gradient control or construction of a containment measure such as a slurry wall
- Implementing additional source control treatment to further reduce arsenic migration to ground water

The risk assessment determined that the major aquifers below the contaminated water bearing zones were unlikely to become contaminated in the future unless an artificial penetration allowed the contaminants to bypass the overlying thick clay formation.

4.2 REMEDY IMPLEMENTATION

The following remedies were implemented at the Crystal Chemical site.

4.2.1 Soil Remedy

In 1992, due to the unavailability of the in situ vitrification technology, EPA reconsidered the alternatives evaluated during the feasibility studies. Solidification/stabilization and soil washing were evaluated, but not chosen, as these remedies may not be effective and could cause further environmental problems.

Capping, a nontreatment alternative, became the preferred alternative. In June 1992, EPA issued this decision in a ROD amendment, which modified the soil remedy alternative but left the ground water remedy unchanged. The cap would be designed to act as a barrier that restricts the flow of water through the soils, thus preventing contaminants from migrating to the ground water. It also prevents the release of soil contaminants into the air, and direct contact with site contaminants. Neither the volume of the contaminated soils nor the toxicity of the contaminants would be reduced with this alternative. A cap was installed on the Crystal Chemical site in September 1995 (Figure 1). A security fence with locking gate prevents access to the site.

While implementing the soil remedy, contaminated soils associated with the wastewater evaporation ponds were excavated and placed under the cap. This was done to reduce the migration of arsenic to the ground water given the fact that these heavily contaminated arsenic-contaminated soils were located at or near the ground water table.

4.2.2 Ground Water Remedy

Data generated during the investigations and evaluations necessary to design an efficient and effective ground water treatment system indicated that portions of the site's contaminated ground water zones could not be restored. The portions of the site that cannot be remediated consist of splay deposits, or off-channel deposits. The splay or off-channel deposits consist of sandy material with an abundance of fine-grained material (clay and/or silt). The portion of the site that can likely be restored through the extraction and treatment remedy consists of a subsurface stream channel that contains more sand and less fine-grained material. A TI assessment for the site was completed and a subsequent waiver was granted for ground water remediation at the site. The decision in the TI assessment was reached based on the following factors:

- Complexity of site geology. The areas associated with off-channel deposits of the 35-foot zone are composed of sediments. These sediments are fine-grained and represent lacustrine (lake deposits), overbank, relic channel, and flood plain deposits.
- Large quantities of arsenic are located in the fine-grained sediments and off-channel deposits.
- Analytical testing indicated that arsenic had adsorbed onto fine-grained sediments.
- An estimated 700 million gallons of water would have to be treated, a volume over 200 times greater than the original estimate of 3 million gallons, due to additional information gained while modeling was performed for the TI assessment.
- Limited rate of release from the fine-grained sediments would extend the treatment time to an estimated 200 to 650 years to restore the ground water.

The extent of the TI zone was defined as that portion of the site north of the southern boundary that contains arsenic in shallow ground water at a concentration greater than 50 µg/L. This area included the overbank deposits of the 35-foot zone and the channel of the 15-foot zone. The zone extends from the water table to the base of the 35-foot zone, a depth of 50 to 60 feet below ground surface. Ground water in the southern portion of the site was not defined in the TI zone.

EPA waived the ARAR for ground water restoration (contingency measure #4) and proposed construction of a slurry wall around the portions of the site where ground water cannot be restored. An Explanation of Significant Differences for the ROD was issued in March 1997. Arsenic contaminated ground water at the remainder of the site would be extracted and treated. The slurry wall alternative

involves excavating a vertical trench and filling the trench with a low permeability material such as a bentonite mix to prevent migration of contaminated ground water. The bottom of the slurry wall is keyed into a low permeability geologic unit. See Figure 1 for the location of the slurry wall.

Two small areas where ground water concentrations exceeded 50 µg/L in the 15-foot zone will remain outside of the proposed slurry wall. A maximum of one pound of arsenic is estimated to be present in each area. The arsenic concentrations may be much lower due to the limited sample data available.

Only part of the slurry wall has been completed to date as the property owner immediately north of the Crystal Chemical site restricted access to that property. In April 2000, UPR completed a purchase agreement for 12 acres of the Levy property where the proposed slurry wall is to be constructed. Additional field activities were planned and outlined in the approved Revised Work Plan for Additional Ground Water Investigation, dated July 12, 1999. The planned field activities took place in August 2000. A report documenting the results of the investigation will be submitted to the EPA for review in October 2000. The purpose of the investigation is to perform a slurry wall alignment assessment and an attenuation feasibility assessment.

4.3 SYSTEM OPERATIONS

Currently, ground water sampling is conducted annually in the 100-foot zone. After the slurry wall is completed (pending the results of the additional ground water investigation), compliance monitoring in the 15-foot and 35-foot zones will be implemented. The slurry wall will be evaluated by monitoring for arsenic in ground water outside of the TI zone.

4.3.1 Modifications to the Ground Water Treatment Plant

The first operations and maintenance (O&M) manual was prepared in 1995, and modifications were made in 1998, 1999, and 2000. The current O&M manual includes a troubleshooting section with a flow chart; daily and long-term inspection checklists; a major equipment and spare parts list, which aids in the effective maintenance of the site; and a COH discharge permit with a "Notice to Employees" giving emergency contact information.

The following paragraphs describe several of the ground water treatment plant (GWTP) modifications made since 1997.

4.3.1.1 Pump-around Loop System

The GWTP was shut down in May 1997, while operating in a testing and startup phase, due to an exceedance of the COH permit limit for arsenic. The plant remained closed until the following measures were completed in January 1999:

- A pump-around loop for was installed to allow for the testing and retreatment of effluent
- An operation and maintenance plan was accepted by the COH
- A sampling and analysis plan for process control was prepared
- Repair of mechanical failures
- Testing and startup phase

The pump-around loop consisted of two 21,000-gallon fiberglass tanks, which were installed to the north of the GWTP. Additional piping was also installed inside the building to allow for testing and retreatment of effluent, if necessary. Each tank has a storage capacity of roughly three days during actual operating conditions. The piping is also connected to the holding tanks, which are located on a concrete slab surrounded by an earthen berm, lined with a geomembrane. In April 2000, a 30,000-gallon effluent storage tank was installed as an emergency spare tank.

The system is operated so that discharges to the COH wastewater system occur in batch modes. The tank effluent is tested before every discharge. If the arsenic concentration is within the permit requirement of less than 2 mg/L for composite samples or 3 mg/L for grab samples, the effluent is discharged to the COH water system. If the arsenic concentration exceeds the permit requirement, the tank effluent is pumped back through the treatment plant for further treatment.

The GWTP went through a second testing and startup phase in June 1998, and was officially placed "on-line" with the COH in January 1999.

4.3.1.2 Replacement of the Hydrogen Peroxide Tank

In November 1999, the fiberglass reinforced plastic (FRP) tank was replaced with a high-density polyethylene (HDPE) tank, after the supplier of hydrogen peroxide would no longer provide shipments to a tank constructed of FRP. Polyvinyl chloride (PVC) piping to the tank was replaced with stainless-steel piping.

4.3.1.3 Minor Process Design Modifications

Minor modifications have been made to the treatment system operations including:

- Level controls were upgraded in the influent storage tank from two control points (low and high) to a multiple-control point system
- Level controls were added in the oxidation tank to prevent overtopping
- Polymer feed was switched to pure product instead of blending

4.3.1.4 Installation of Additional Safety and Security Measures

Additional safety and security measures have been installed at the GWTP in the last two years and include the following:

- Additional outdoor lighting for the effluent tank storage area
- Emergency backup lighting inside the GWTP building
- Security system for the GWTP building
- Hand wash station
- Additional fire extinguisher
- Process tank covers for the oxidation tank, co-precipitation tank, pH adjustment tank, and the polymer tank
- Stainless-steel shutoff valve for the caustic tank
- Two building ventilation fans

4.3.2 Additional Ground Water Investigation on the Former Levy Property

On April 26, 2000, UPR acquired the Levy property where a portion of the slurry wall has been planned for construction. Additional field activities were planned and outlined in the EPA approved Revised Work Plan for Additional Ground Water Investigation, dated July 12, 1999. The planned field activities took place in August 2000. The purpose of the investigation is to perform a slurry wall alignment assessment and an attenuation feasibility assessment.

4.3.3 O&M Costs

Annual O&M costs for the site include GWTP operation and maintenance, ground water monitoring, compliance monitoring, site maintenance, and project management.

Based on data provided by Environmental Resources Management (ERM), the total cost for the Crystal Chemical site over the last five years is $7,846,748. A large portion of the cost was due to construction of the GWTP in 1997 and major modifications to the GWTP in 1998. Table 2 presents a representation of normal annual O&M activities from January 1999 to May 2000, when the GWTP was operating. The estimated annual O&M cost from January 1999 to May 2000 was $265,246. If the slurry wall is constructed on the Levy property, the annual O&M costs will increase.

4.4 PROGRESS SINCE THE LAST FIVE-YEAR REVIEW

This is the first five-year review to be conducted. The second five-year review is scheduled for 2005.

5.0 FIVE-YEAR REVIEW PROCESS

EPA performed the five-year review with the assistance of Tetra Tech EM, Inc. The EPA Remedial Project Manager is Chris Villarreal. The Tetra Tech Crystal Chemical site five-year review team was led by Matt Garcia, Project Manager for the Multi-Site Five-Year Reviews. The following team members assisted in the review:

- Amy Swartz, site project manager
- Victoria Tyson, technical support
- Steve Fry, site inspection support
- Theresa Gioia, ARAR review technical support
- Shanna Collie, ARAR review technical support
- Eric Johnstone, editorial and technical support
- Cristina Radu, technical review support
- Lou Barinka, QA/QC review support

The five-year review was conducted in accordance with EPA's document, Comprehensive Five-Year Review Guidance (540R-98-050). The purpose of a five-year review is to determine whether the remedy implemented at the site is protective of human health and the environment. It is an evaluation of the implementation and performance of the selected remedy. The five-year review also documents any deficiencies identified during the review and recommends specific actions to ensure that a remedy is protective.

TABLE 2

ANNUAL O&M COSTS
CRYSTAL CHEMICAL COMPANY—HOUSTON, TEXAS

Dates		Total Cost* (Rounded to nearest $100)
From	To	
January 1999	January 2000	$254,500
January 2000	May 2000	$115,000
	Yearly Average	$265,000

Notes:

* O&M costs prior to 1999 include construction and modification of the GWTP and are not true representations of anticipated annual O&M costs.

The five-year review for the Crystal Chemical site consisted of the following activities: (1) a review of relevant documents (see Appendix A); (2) a site visit; (3) interview surveys with local government officials, and the Union Pacific Railroad representative; and (4) a site inspection. In addition, a notice regarding the review was placed in the Houston Chronicle, Sunday edition, on June 17, 2000 (Appendix B). The completed five-year review report will be made available in the information repository at Judson Robinson Westchase Library, 3223 Wilcrest, Houston, Texas. A fact sheet detailing the results of the five-year review will be mailed to local contacts and community members.

6.0 FIVE-YEAR REVIEW FINDINGS

The following sections discuss interviews, the site inspection, the ARAR review, and the data review.

6.1 INTERVIEWS

Site surveys were sent to local authorities, residents, and the PRP and its representatives. The comments have been summarized in this review report and are located in Appendix C.

Mr. Ed Honig, the UPR representative, stated that operations are going well at the Crystal Chemical site. He also stated that UPR is committed to the proper remediation of the Crystal Chemical site and adjacent land parcels by (1) constructing a COH-compliant GWTP, (2) plugging and abandoning monitoring wells on adjacent properties to reduce the real or perceived negative impact the Superfund site had on real estate transactions, and (3) implementing a security system to discourage vandalism and trespassing.

Ms. Jennifer McKnight of the COH stated that quarterly sampling is performed at the Crystal Chemical site and that no violations of the wastewater permit have been detected. Ms. McKnight receives a monthly report from ERM, and feels that the project is going well.

Mr. Alan Etheredge of TNRCC feels that the PRP is managing the Crystal Chemical site in a prudent and timely manner. Mr. Etheredge commented that institutional controls may need to be implemented in the portion of the plume not contained within the property owned by the PRP.

Mr. Scott Weinstein of ERM listed process modifications to the GWTP that have made the system more efficient: the pump-around loop, additional level controls, and the addition of a timer on the sludge transfer pump, thereby giving the operator the ability to adjust the rate of operations.

Mr. Weinstein of ERM pointed out potential O&M problems including (1) an air compressor that needs a dryer to keep condensation from forming in the pipes, so the pipes will not have to be emptied of the

condensate daily; (2) difficult access to lighting fixtures to change light bulbs; and (3) an off-site recovery well that is difficult to access due to overgrown weeds and grasses. Tetra Tech EM Inc. and ERM agree that these are not potential problems, but high maintenance tasks. Since completion of the survey, ERM has rectified the recovery well access problems and anticipates no further problems with recovery well access.

Mr. Weinstein also stated that there have been no unexpected difficulties with the GWTP, and the addition of the third effluent storage tank will allow the plant to run continuously, reducing the number of shutdowns.

Ms. Marsha Lutz of ERM stated that UPR has purchased the Levy property to alleviate further delays to the project.

Mr. Robert Coffman of ERM stated that the overall design and implementation of the remedy is well executed and appropriate.

6.2 SITE VISIT, INSPECTION, AND INSTITUTIONAL CONTROLS

The following sections detail the site visit, site inspection, and access and institutional controls at the Crystal Chemical site as observed during the five-year review. The site inspection report is included as Appendix D to this report. Photographs of the site inspection are included as part of the site inspection report.

6.2.1 Site Visit

The site visit was conducted on June 1, 2000. The purpose of the site visit was to (1) tour the Crystal Chemical site, (2) discuss the current O&M of the site including the soil cap and the GWTP, and (3) discuss the acquisition of the newly-acquired Levy property. The following individuals were present during the site visit:

- Chris Villarreal, EPA
- Amy Swartz, Tetra Tech
- Alan Etheredge, TNRCC
- Ed Honig, UPR
- Marsha Lutz, ERM
- Scott Weinstein, ERM

Ms. Lutz and Mr. Weinstein led the tour of the site and discussed its history and current O&M activities. Maintenance activities are performed at the GWTP on a daily basis. The soil cap is monitored for erosion and other degenerative problems and the grass is mowed every 2 months. The site appeared to be well maintained, and no deficiencies were noted at that time.

After walking the site, everyone went to the ERM offices to discuss site operations and the acquisition of the Levy property, which is located across Westpark Drive, northeast of the soil cap. The current ground water remediation activities called for installation of the slurry wall on the Levy property; however, the slurry wall could not be completed because access onto the property was denied. The plumes on the Levy property have not been tested since 1994. The additional ground water investigation was initiated on August 11, 2000, after a new access driveway to the former Levy property was installed. The investigation included sampling of CPT/Hydropunch locations and temporary ground water monitoring wells. The findings will be reported in October 2000.

6.2.2 Site Inspection

The following individuals attended the site inspection on June 26, 2000:

- Chris Villarreal, EPA
- Amy Swartz, Tetra Tech
- Steve Fry, Tetra Tech
- Marsha Lutz, ERM

During the site inspection, two small erosion rills were observed on the west side of the cap on the side slope, approximately 8 to 12 inches deep and 12 to 16 inches wide. These channels are within the topsoil layer of the cap and probably developed from heavy rain activity. EPA recommends repairing the cap at this time to minimize future maintenance needs and repair costs. The site inspection report is included as Appendix D of this report.

The vegetation (grass) appears to be in good condition; additional watering of the grass has been necessary in past years. The grass is mowed every 2 months, and weed control measures are performed on an as-needed basis. Monitoring wells were in good condition with locks and barrier posts around each well. O&M records were kept in a log book inside the GWTP. Also on hand were O&M manuals, as-built drawings, the site health and safety plan, and daily access and security logs. Photographs of the site inspection are in Appendix A of the site inspection report.

6.2.3 Access and Institutional Controls

The long-term effectiveness of the remedy will be contingent upon the implementation of all necessary institutional controls. The legal and administrative institutional controls are necessary to prevent exposure to contaminants at concentrations above health-based risk levels that may remain at the site. The institutional controls may also limit activities at or near the site and include requirements for providing a notice (i.e., deed recordation) in the real property records of the remaining residual contamination.

Union Pacific Railroad currently owns the site and the majority of the property where contaminated ground water has migrated, thereby having full control over these areas to prevent exposure to contaminated soils and ground water. In accordance with the Remedial Action Operation and Maintenance Plan, November 1994, Southern Pacific Transportation Company (now Union Pacific Railroad) will record a notation on the deed or any instrument normally examined during a title search, which will allow any potential buyer to be made aware, in perpetuity, of the site conditions.

The Crystal Chemical site is surrounded by a security fence with barbed wire at the top, and a locking gate, to restrict site access. The cap is also segregated from the GWTP by a locked gate and security fence along the west side of the access road. The security fence is in good condition, and no repairs are needed at this time. The GWTP has high-powered security lighting, and an alarm system. Security signs stating "No Trespassing" are located at intervals along the security fence. No animal activity was observed.

The GWTP is maintained by an operator for at least 2 hours each day, depending on the maintenance and activity schedule. Daily and long-term maintenance checklists are located in the O&M manual detailing the necessary activities. The operators maintain a daily log book of activities, concerns, and comments at the site. The access and institutional controls for the Crystal Chemical site are adequate.

6.3 ARAR REVIEW

The amended ROD identified the following ARARs for the Crystal Chemical site soil remedial action:

- Resource Conservation and Recovery Act (RCRA) landfill requirements in 40 CFR 264.111 Subpart G, 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.
- RCRA requirements in 40 CFR 264.228 Subpart K, which provides closure requirements for surface impoundments.
- RCRA landfill closure requirements in 40 CFR 264.310 Subpart N.

- RCRA post-closure and monitoring requirements in 40 CFR 264.117(a)(1), which requires a 30-year post-closure period or another period determined by the Regional Administrator.
- Ambient air quality standards in 40 CFR 50 to protect the quality of air during implementation of the soil remedy.
- Clean Water Act regulations in 33 CFR 303 that require on-site surface water to meet the water quality criteria for arsenic of 0.0175 µg/L.
- RCRA requirements in 40 CFR 264.18 that address the location of a hazardous waste transportation, storage, or disposal facility in a 100-year floodplain.
- Floodplain protection requirements in 40 CFR 6, Appendix A.

The original ROD identified the following ARARs for the ground water remedial action at the Crystal Chemical site:

- RCRA hazardous waste generator requirements in 40 CFR 262, Subparts A through D.
- RCRA hazardous waste management requirements in 40 CFR 264, Subparts A through G, J, and K apply to the hazardous sludges generated by the treatment of ground water.
- RCRA land disposal restrictions in 40 CFR 268, Subparts A through E apply to hazardous sludge from the treatment of ground water.
- Clean Water Act requirements in 40 CFR 122 through 125 for the establishment of discharge limitations to surface water in accordance with the National Pollution Discharge Elimination System (NPDES).
- Clean Water Act pretreatment requirements in 40 CFR 403.5 for discharges to publicly owned treatment works (POTW).
- RCRA ground water protection standards in 40 CFR 264.94 used to establish a cleanup goal of 0.05 parts per million for arsenic in ground water, which is equivalent to the federal MCL.
- Texas Groundwater Protection Act ground water protection goals.
- RCRA requirements in 40 CFR 264.18 that address the location of a hazardous waste transportation, storage, or disposal facility in a 100-year floodplain.
- Floodplain protection requirements in 40 CFR 6, Appendix A.

One of the requirements of a five-year review is to determine if there are any new requirements that may pertain to the site. Tetra Tech identified one proposed change to a federal requirement that needs to be considered.

Proposed Arsenic MCL. On June 22, 2000, EPA proposed in the *Federal Register* to change the MCL for arsenic to 5 µg/L to more adequately protect public health. The proposal is subject to a 90-day comment period. The existing MCL of 50 µg/L was set by EPA in 1975, based on a Public Health

Service standard originally established in 1942. A March 1999 report by the National Academy of Sciences concluded that the current standard does not achieve EPA's goal of protecting public health and should be lowered as soon as possible. Under the Safe Drinking Water Act Amendments of 1996, EPA is required to promulgate a final rule by January 1, 2001. For the portion of the ground water at the Crystal Chemical site that is subject to a TI waiver of the 50 µg/L arsenic MCL, the TI waiver will still apply. The TI waiver was granted to avoid pumping and treating in fine-grained sediments for an unreasonably long time (i.e., 200 to 650 years). For portions of the ground water contamination that are not subject to this waiver, if the MCL for arsenic is lowered, EPA proposes that a site-specific risk assessment be performed to determine whether the current action level is protective of human health. The next five-year review for this site will address this issue, if necessary.

ARARs pertaining to remedial action activities at the Crystal Chemical site divided into chemical, location, and action-specific categories and are discussed below.

6.3.1 Chemical-Specific ARARs

Chemical-specific ARARs are usually health or risk-based numerical values or methodologies that, when applied to site-specific conditions, result in the establishment of numerical values. These values establish the acceptable amount or concentration of a chemical that may remain in or be discharged to the ambient environment. If more than one chemical-specific ARAR exists for a contaminant of concern (COC), the most stringent level will be identified as an ARAR for the remedial action. There were no changes in chemical-specific standards for the Crystal Chemical site.

For the soil remediation, the only chemical-specific ARAR cited in the amended ROD was the Clean Water Act requirement that on-site surface water meet the ambient water quality criteria for arsenic (0.0175 µg/L). Surface water is not currently being sampled at the Crystal Chemical site since the site is capped.

For the ground water remediation, the chemical-specific ARAR cited in the original ROD was the MCL standard for arsenic, which is 50 µg/L. Based on the "Assessment of the Technical Impracticability of Ground-Water Remediation" (February 1996), EPA issued an Explanation of Significant Differences (ESD) in March 1997, which granted an ARAR waiver for the 50 µg/L arsenic cleanup level based on technical impracticability for parts of the site. The waiver applies to portions of the ground water contamination in the splay deposits or off-channel deposits. The ground water in the splay deposits is to be contained within a slurry wall, which has been partially constructed. Additional studies have been planned and are underway to assess the alignment of the remaining portion of the slurry wall and to assess the attenuation of arsenic in ground water.

The other portion of the contaminated ground water within the subsurface stream channel is not subject to the ARAR waiver and therefore, must be remediated to the arsenic MCL of 50 µg/L using the extraction and treatment remedy selected in the 1990 ROD. Ground water within the subsurface stream channel currently exceeds the MCL of 50 µg/L as indicated by the measured arsenic concentrations from recovery well RW-1. The measured arsenic concentrations from recovery well RW-1 ranged from a high of 83 mg/L in February 1999, to a low of 20.6 mg/L in May 2000. The remedial action is continuing. If the MCL for arsenic is lowered to the proposed level of 5 µg/L and EPA adopts it as the new cleanup level for the Crystal Chemical site ground water remedial action, a longer duration for the extraction and treatment of contaminated ground water in the subsurface stream channel can be expected.

6.3.2 Location-Specific ARARs

Location-specific ARARs are restrictions placed on the concentration of hazardous substances or the conduct of activities solely because they are in special locations. Some examples of locations that might prompt a location-specific ARAR include wetlands, sensitive ecosystems or habitats, flood plains, and areas of historical significance. The ROD identified two location-specific ARARs pertaining to the Crystal Chemical site:

- 40 CFR 264.18(b) (RCRA)—Facilities in the 100-year floodplain must be designed, constructed, operated, and maintained to avoid washouts.
- 40 CFR 6, Appendix A—Provides procedures for ensuring actions taken to avoid adverse effects and minimize potential harm to surrounding area in accordance with Executive Order 11988.

The original ROD states that the Crystal Chemical site may be in the 100-year flood plain of the HCFCD Channel, which runs adjacent to the western side of the site. Therefore, the ROD included ARARs related to floodplain management. The monofill and cap were constructed to promote drainage away from the capped area to surface water drainage points. The contaminated soil is contained beneath the sloping cap, which consists of a geocomposite layer, buffer soil, and topsoil. The cap was constructed and designed to avoid washouts, and the contaminated soil is located above the elevation of the 100-year flood level for the flood control channel; however, the site lies within the limits of the 100-year flood plain of the HCFCD ditch. No changes in location-specific requirements were identified for the Crystal Chemical site.

6.3.3 Action-Specific ARARs

Action-specific ARARs are usually (1) technology or activity-based requirements or limitations on actions taken with respect to hazardous wastes or (2) requirements to conduct certain actions to address particular site circumstances. These requirements are triggered by the particular remedial activities that

are selected to accomplish a remedy. Because there are usually several alternative actions for any remedial site, very different requirements can come into play. These action-specific requirements do not in themselves determine the remedial alternative; rather, they indicate how a selected alternative must be achieved.

6.3.3.1 Soil Remediation

Five action-specific ARARs were identified in the amended ROD for the soil remediation at the Crystal Chemical site. The compliance of the remedial action with each of these action-specific ARARs is discussed below.

RCRA landfill requirements in 40 CFR 264.111 Subpart G. These are RCRA closure and post-closure requirements that, among other things, specify a cap with permeability less than or equal to the permeability of any bottom liner of natural sub-soils present at the site. The soil remedial action complies with the RCRA capping requirements. The geocomposite liner made up of HDPE and bentonite has a low permeability, much less than the permeability of the natural sub-soils present at the site.

RCRA surface impoundment closure requirements in 40 CFR 264.228 Subpart K. The soil remedial action complies with the surface impoundment closure requirements. The site had three surface impoundments or ponds. The highly contaminated soil from Pond 1 and Pond 2 were excavated and consolidated in the source control placement area. Pond 3, which had lower levels of contamination that did not extend as deep as Pond 1or Pond 2, was not excavated. The contamination in the source control placement area and Pond 3 was covered with a low permeability cap that (1) provides long-term minimization of migration of liquid through the area, (2) functions with minimum maintenance, (3) promotes drainage and minimizes erosion or abrasion of the cover, (4) accommodates settling and subsidence, and (5) has a permeability less than or equal to the permeability of the natural subsoils. In addition, post-closure activities ensure that the capping system is maintained and repaired as necessary; ground water is monitored regularly, and surface water run-on and run-off controls prevent cover erosion. Finally, in accordance with the "Remedial Action Operation and Maintenance Plan," November 1994, Southern Pacific Transportation Company will record a notation on the deed or any instrument normally examined during a title search, which will allow any potential buyer to be made aware, in perpetuity, of the site conditions.

RCRA landfill closure requirements in 40 CFR 264.310 Subpart N. The soil remedial action complies with the landfill closure requirements, which are similar to the closure requirements for surface impoundments discussed above.

RCRA post-closure and monitoring requirements in 40 CFR 264.117(a)(1). The soil remedial action complies with this provision, which requires a 30-year post-closure period or another period determined by the Regional Administrator. Post-closure maintenance and monitoring is being conducted in accordance with the remedial action operation and maintenance plan.

Ambient air quality standards in 40 CFR 50. The soil remedial action complied with this ARAR by implementing engineering controls to manage fugitive dust emissions and by sampling to determine the effectiveness of the controls. Background air monitoring was conducted during the remedial design characterization program. Monitoring was also conducted upwind and downwind when soil excavation and consolidation activities were conducted. Arsenic and total suspended solids were the analytes of concern. According to the "Soil Remedial Action Report," December 1995, the results of the air monitoring program show that the remedial activities did not impact air quality.

6.3.3.2 Ground Water Remediation

The original ROD identified five action-specific ARARs for the ground water remediation. The remedy's compliance with each of these requirements is discussed in detail below.

RCRA hazardous waste generator requirements in 40 CFR 262, Subparts A through D. These requirements cover the responsibilities of a generator of hazardous waste for determining if the waste is hazardous; obtaining an EPA identification number; use of the appropriate manifest; packaging, labeling, marking, and placarding of the waste; accumulation time for the waste; and recordkeeping and reporting. To date, the filter cake generated from the ground water treatment process has been determined to be Class 2 nonhazardous waste. This waste is disposed of in accordance with TNRCC regulations.

RCRA hazardous waste management requirements in 40 CFR 264, Subparts A through G, J, and K. The ground water remedial action complies with the RCRA requirements for managing the hazardous sludges generated by the ground water treatment. The filter cake is disposed of off site at an approved RCRA Subtitle C facility. The treatment plant was designed and constructed to meet the general facility standards and emergency procedures. The tanks used for storing the ground water and roll-off box used for storing filter cake comply with the substantive requirements of 40 CFR 264 Subpart J, including containment provisions. Subpart K is not applicable because the ground water treatment system does not involve the use of surface impoundments.

RCRA land disposal restrictions in 40 CFR 268, Subparts A through E. The ground water remedial action complies with the RCRA land disposal restrictions. The filter cake is disposed off site in accordance with TNRCC regulations.

Clean Water Act requirements in 40 CFR 122 - 125. These regulations are used to establish discharge limitations to surface water in accordance with the NPDES. The treated ground water is discharged to a POTW under a COH permit, so these regulations are not applicable.

Clean Water Act pretreatment requirements in 40 CFR 403.5. These requirements apply to discharges to POTW. The treated ground water is discharged to the COH POTW. The COH established pretreatment standards of 2 mg/L for arsenic and a pH of not less than 5 or greater than 11. In May 1997, the COH shut down the GWTP due to an exceedance of the discharge permit limit for arsenic. A pump-around loop system was installed in 1998 to allow storage of treated ground water while awaiting analytical results so as to avoid permit exceedances. Batches of effluent that do not meet the arsenic standard are now retreated through the plant using the pump-around loop system. According to data provided by ERM, the operator of the ground water treatment plant, the arsenic pretreatment standard has not been exceeded since the pump-around loop system was installed.

6.4 DATA REVIEW

Ground water monitoring in the 100-foot sand zone has been conducted annually since September 1999. In 1999, ground water monitoring occurred semiannually. Prior to 1999, monitoring occurred quarterly. Table 3 lists the years samples have been taken (1993 to 1999), concentrations of total and dissolved arsenic in the water samples, and the cleanup level (50 µg/L). Concentrations of total arsenic varied from less than 2.0 µg/L to 678 µg/L. The concentration of dissolved arsenic varied from less than 2.0 µg/L to 60 µg/L.

Ground water samples in the 100-foot zone reveal that the cleanup level has been exceeded in MW-24, MW-25, and in MW-28A. In 1993, MW-24 and MW-25 had arsenic concentrations of 147.0 µg/L and 171 µg/L, respectively. MW-24 had an arsenic concentration of 8.0 µg/L in 1994 and was abandoned in 1995. MW-25 had an arsenic concentration of 61.4 µg/L in 1994 and was abandoned in 1995. MW-28A had an arsenic concentration of 678 µg/L in 1994, but has not exceeded the 50 µg/L cleanup level since. The MCL exceedances in the 100-foot zone were attributed to drilling process (mud rotary). The wells were aggressively developed with a surge block and no exceedances have been recorded since 1994.

Table 4 lists monitoring data collected in the 15-foot and 35-foot zones from 1983 to 1993. Monitoring of these zones has been postponed until the remaining portions of the slurry wall have been completed. Additional sampling of the 15-foot and 35-foot zones took place in August 2000, in an effort to define the current northeastern extent of arsenic-affected ground water exhibiting concentrations of 50 µg/L or more.

Table 3

COMPARISON OF INITIAL AND CURRENT GROUND WATER CONCENTRATIONS
100-FOOT ZONE

Well ID	Year	Highest Annual Concentration of Arsenic (µg/L)	Highest Annual Concentration of Dissolved Arsenic (µg/L)	Cleanup Level (µg/L)
100-Foot Zone				
MW-4	1993	21.0	16.0	50
	1994	17.0	13.0	50
	1995	Abandoned		
MW-24	1993	147.0	NA	50
	1994	8.0	10.0	50
	1995	Abandoned		
MW-25	1993	171.0	NA	50
	1994	61.4	60.2	50
	1995	Abandoned		
MW-28A	1993	10.0	7.0	50
	1994	678	22.0	50
	1995	35.5	42.1	50
	1996	1.8	1.8	50
	1997	2.9	<1.9	50
	1998	2	2	50
	1999	1.4	<1	50
//////MW-31A	1994	9.0	8.0	50
	1995	1.7	1.5	50
	1996	1.2	<1.1	50
	1997	5.2	<1.9	50
	1998	2	2	50
	1999	<1	<1.3	50

Table 3 (Continued)

COMPARISON OF INITIAL AND CURRENT GROUND WATER CONCENTRATIONS
100-FOOT ZONE

Well ID	Year	Highest Annual Concentration of Arsenic (µg/L)	Highest Annual Concentration of Dissolved Arsenic (µg/L)	Cleanup Level (µg/L)
MW-32	1993	9.0	8.0	50
	1994	14.0	16.0	50
	1995	2.2	1.8	50
	1996	1.7	<1.1	50
	1997	2.8	1.5	50
	1998	2	2	50
	1999	1.7	<1	50

Notes:

NA Data not available
µg/L Micrograms per liter

TABLE 4

COMPARISON OF INITIAL GROUND WATER CONCENTRATIONS
CRYSTAL CHEMICAL COMPANY—HOUSTON, TEXAS
15-FOOT AND 35-FOOT ZONES

Well ID	Year	Highest Annual Concentration of Arsenic (µg/L)	Highest Annual Concentration of Dissolved Arsenic (µg/L)	Cleanup Level (µg/L)
15-Foot Zone				
MW-12	1983	NA	10	50
	1987	NA	<10	50
	1993	15	NA	50
	1994	2	3	50
	Abandoned			
MW-14	1989	29	5	50
	1993	18	19	50
	1994	15	6	50
	Abandoned			
MW-15	1989	161,000	171,000	50
	1993	166,000	NA	50
	1994	107,200	104,400	50
	Abandoned			
MW-16	1989	31	33	50
	1993	320	NA	50
	Abandoned			
MW-18	1989	14	17	50
	1993	31	NA	50
	Abandoned			
MW-19	1989	21	33	50
	1993	174	NA	50
	1994	45	39	50
MW-21	1989	6	7	50
	1993	15.7	NA	50
	1994	20	15	50

TABLE 4 (Continued)

COMPARISON OF INITIAL GROUND WATER CONCENTRATIONS
CRYSTAL CHEMICAL COMPANY—HOUSTON, TEXAS
15-FOOT AND 35-FOOT ZONES

Well ID	Year	Highest Annual Concentration of Arsenic (µg/L)	Highest Annual Concentration of Dissolved Arsenic (µg/L)	Cleanup Level (µg/L)
35-Foot Zone				
MW-1	1983	NA	1,100	50
	1987	NA	20	50
	1993	135,000	NA	50
	1994	77,000	83,500	50
	Abandoned			
MW-2	1983	NA	623,000	50
	1987	NA	291,000	50
	1993	434,000	NA	50
	1994	564,000	586,000	50
	Abandoned			
MW-3	1983	NA	363,000	50
	1987	NA	359,000	50
	1993	126,000	NA	50
	1994	82,500	89,000	50
	Abandoned			
MW-5	1983	NA	607,000	50
	1987	NA	366,000	50
	Abandoned			
MW-6	1983	NA	6,100	50
	1987	NA	<5	50
	1993	3	NA	50
	1994	8	3	50
	Abandoned			
MW-7	1983	NA	24,00	50
	Abandoned			

TABLE 4 (Continued)

COMPARISON OF INITIAL GROUND WATER CONCENTRATIONS
CRYSTAL CHEMICAL COMPANY—HOUSTON, TEXAS
15-FOOT AND 35-FOOT ZONES

Well ID	Year	Highest Annual Concentration of Arsenic (µg/L)	Highest Annual Concentration of Dissolved Arsenic (µg/L)	Cleanup Level (µg/L)
MW-8	1983	NA	12,000	50
	1987	NA	<5	50
	1993	5.7	NA	50
	1994	<2	6	50
MW-9	1983	NA	10	50
	1987	NA	5	50
	1993	3.6	NA	50
	1994	3	5	50
	Abandoned			
MW-10	1983	NA	10	50
	1987	NA	<5	50
	1993	6	NA	50
	1994	3	3	50
	Abandoned			
MW-11	1983	NA	10	50
	1987	NA	<5	50
	Abandoned			
MW-13	1983	NA	10	50
	1987	NA	<5	50
	1993	15	NA	50
	Abandoned			
MW-17A	1989	36	6	50
	1993	26	NA	50
	1994	16	<2	50

TABLE 4 (Continued)

COMPARISON OF INITIAL GROUND WATER CONCENTRATIONS
CRYSTAL CHEMICAL COMPANY—HOUSTON, TEXAS
15-FOOT AND 35-FOOT ZONES

Well ID	Year	Highest Annual Concentration of Arsenic (µg/L)	Highest Annual Concentration of Dissolved Arsenic (µg/L)	Cleanup Level (µg/L)
MW-20	1989	258,000	272,000	50
	1993	370,000	NA	50
	1994	396,800	395,200	50
MW-22	1993	284,000	NA	50
	1994	133,000	142,000	50
	Abandoned			
MW-23	1993	28,000	NA	50
	1994	26,900	16,500	50
MW-27	1993	37,400	NA	50
	Abandoned			
MW-29	1994	8	8	50
MW-30	1994	67,800	64,800	50
MW-33	1994	22	4	50
MW-34	1994	7	3	50
	Abandoned			
P1A	1993	2	NA	50
	1994	<2	2	50
P2A	1993	39.8	NA	50
P3	1993	7.6	NA	50
	Abandoned			

TABLE 4 (Continued)

COMPARISON OF INITIAL GROUND WATER CONCENTRATIONS
CRYSTAL CHEMICAL COMPANY—HOUSTON, TEXAS
15-FOOT AND 35-FOOT ZONES

Well ID	Year	Highest Annual Concentration of Arsenic (µg/L)	Highest Annual Concentration of Dissolved Arsenic (µg/L)	Cleanup Level (µg/L)
CC1	1983	NA	30	50
	1987	NA	6	50
	1993	27	NA	50
	Abandoned			
CC2	1983	NA	230	50
	1987	NA	483	50
	Abandoned			
RW-1[a]	May 98	82,200	NA	50
	Jun 98	58,300	NA	50
	Aug 98	61,900	NA	50
	Sept 98	26,000	NA	50
	Oct 98	53,000	NA	50
	Jan 99	56,000	NA	50
	Feb 99	83,000	NA	50
	May 99	82,200	NA	50
	Dec 99	37,000	NA	50
	Jan 00	41,000	NA	50
	Feb 00	28,000	NA	50
	Mar 00	26,000	NA	50
	Apr 00	30,000	NA	50
	May 00	23,000	NA	50

TABLE 4 (Continued)

COMPARISON OF INITIAL GROUND WATER CONCENTRATIONS
CRYSTAL CHEMICAL COMPANY—HOUSTON, TEXAS
15-FOOT AND 35-FOOT ZONES

Notes:

[a] Data reported for the influent recovery well to the ground water treatment plant; the highest monthly value was reported.

NA Data not available

µg/L Micrograms per liter

The highest concentrations of arsenic, both in soil and ground water, occur near the former evaporation ponds. The TI report estimated that approximately 300 pounds of arsenic is contained in the 15-foot zone and 18,000 pounds is contained in the 35-foot zone. Figure 2 shows the monitoring wells in the 100-foot zone, Figure 3 shows the monitoring wells in the 35-foot zone, and Figure 4 shows the monitoring wells in the 15-foot zone.

An inspection of water level data, summarized in Table 5, indicated that changes in ground water elevations have been minimal and there have been no noticeable changes in the direction of flow.

7.0 ASSESSMENT

The following conclusions support the determination that the remedy at the Crystal Chemical site is protective of human health and the environment.

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

- **Health and Safety Plan (HASP)**—The HASP is current and addresses potential risks to site workers.
- **Implementation of Institutional Controls and Other Measures**—The fence, security system, and institutional controls are in place, and no current or planned changes in land use at the site suggest that they are not effective. For impacted property not currently owned by Union Pacific Railroad (property south of the site where the 35-foot zone extraction well is located), institutional controls may need to be implemented to help prevent future exposure to contaminated ground water.
- **Remedial Action Performance**—The cap has been effective in isolating waste and contaminants, and the GWTP system is also effective in meeting discharge criteria. The remedial actions continue to be effective, and the GWTP continues to operate and function as modified.
- **System Operations/O&M**—System operations procedures are consistent with requirements. Modifications to the GWTP, including the pump-around loop, have made the system compliant with COH regulations, more effective, and more efficient. The PRP should continue to maintain the cap and GWTP in the same manner.
- **Cost of System Operations/O&M**—O&M costs since the GWTP has been operational (January 1999) average $265,246 annually.
- **Opportunities for Optimization**—The addition of the pump-around loop significantly adds to the efficiency and effectiveness of the GWTP system. No further opportunities for optimization have been identified at this time.
- **Early Indicators of Potential Remedy Failure**—No early indicators of potential remedy failure were noted during the review.

TABLE 5

GROUND WATER ELEVATION COMPARISON (100-FOOT ZONE)
CRYSTAL CHEMICAL COMPANY—HOUSTON, TEXAS

Well ID	Year	Top-Of-Casing Elevation (feet)	Depth to Ground Water Below Top-of-Casing (feet)
MW-4	1993	78.92	101.41
	1994	78.92	101.51
	1995	Abandoned	
MW-24	1993	82.11	102.71
	1994	82.11	012.80
	1995	Abandoned	
MW-25	1993	80.24	103.90
	1994	80.24	103.90
	1995	Abandoned	
MW-28A	1993	79.53	102.56
	1994	79.53	102.18
	1997	79.53	101.93
	1998	79.53	101.70
	1999	79.53	101.98
MW-31A	1994	70.36	102.90
	1997	80.36	102.01
	1998	80.36	102.14
	1999	80.36	102.35
MW-32	1993	80.44	102.97
	1994	80.44	103.25
	1997	80.44	102.82
	1998	80.44	102.79
	1999	80.44	102.74

Question B: Are the assumptions used at the time of remedy selection still valid?

- **Changes in Standards and to be Considereds**—This five-year review identified the proposed change in MCL for arsenic; however, this proposed change does not change the protectiveness of the ground water remedy at this time. If the proposed change (i.e., reducing the MCL for arsenic from 50 µg/L to 5 µg/L) is adopted, the protectiveness of the ground water remedy for areas outside the slurry wall will need to be reevaluated.

- **Changes in Exposure Pathways**—No changes in the site conditions that affect exposure pathways were identified as part of the five-year review. First, there are no current or planned changes in land use. Second, no new contaminants, sources, or routes of exposure were identified as part of this five-year review. Finally, there is no indication that hydrologic/hydrogeologic conditions are not adequately characterized.

- **Changes in Toxicity and Other Contaminant Characteristics**—Toxicity and other factors for COCs have not changed.

- **Changes in Risk Assessment Methodologies**—Changes in risk assessment methodologies since the time of the ROD do not call into question the protectiveness of the remedy.

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

No additional information has been identified that would call into question the protectiveness of the remedy.

8.0 DEFICIENCIES

The only deficiency discovered during the five-year review is the two shallow erosion rills on the west side slope of the cap in the topsoil layer. This deficiency is noted in Table 6. It is not sufficient to warrant a finding that the remedy is not protective, but should be addressed by Union Pacific Railroad, which is responsible for site operation and maintence.

9.0 RECOMMENDATIONS AND FOLLOW-UP ACTIONS

The erosion rills on the west side of the cap should be repaired. Impacted property that is not currently owned by Union Pacific Railroad (property south of the site where the 35-foot zone extraction well is located), may need institutional controls to prevent future exposure to contaminated ground water. The recommendations and follow-up actions are outlined in Table 6.

10.0 PROTECTIVENESS STATEMENTS

The protection of human health and the environment provided by the remedial actions for the arsenic contaminated soil and ground water is discussed below.

10.1 OPERABLE UNIT 1

The remedy for the arsenic contaminated soil is protective of human health and the environment. The cap effectively contains contaminants by preventing infiltration of rainwater and preventing direct contact with contaminated soils. Institutional controls at the landfill remain in place and are effective.

TABLE 6

RECOMMENDATIONS AND FOLLOW-UP ACTIONS
CRYSTAL CHEMICAL COMPANY—HOUSTON, TEXAS

Deficiencies	Recommendations/ Follow-up Actions	Party Responsible	Oversight Agency	Milestone Date	Follow-up Actions: Affects Protectiveness (Y/N)
Small erosion rills developing on west side of cap, along the side slope	Repair the cap.	UPR	EPA	12/2000	N
Institutional controls	Impacted property that is not currently owned by Union Pacific Railroad (property south of the site where the 35-foot zone extraction well is located), may need institutional controls to prevent future exposure to contaminated ground water.	UPR	EPA	None	N

Notes:

EPA U.S. Environmental Protection Agency
UPR Union Pacific Railroad

10.2 OPERABLE UNIT 2

The remedy for arsenic contaminated ground water is also protective of human health and the environment. The GWTP is operating and functioning as designed and modified. Additional ground water monitoring was conducted on the site and on the newly acquired Levy property in August 2000. The purpose of the investigation is to perform a slurry wall alignment assessment and an attenuation feasibility assessment.

11.0 NEXT REVIEW

This is a statutory site that requires ongoing five-year reviews. The next review should determine whether TI requirements have been satisfied after construction of the remaining portion of the slurry wall on the former Levy property. The next five-year review should address the proposed changes to the MCL level for arsenic from 50 µg/L to 5 µg/L. The next review should be conducted within five years of the completion of this five-year review report.

12.0 OTHER COMMENTS

There are no other comments. All comments have been incorporated into the report.

APPENDIX A

DOCUMENTS REVIEWED

(Three Pages)

DOCUMENTS REVIEWED

U.S. Environmental Protection Agency (EPA). 1988. CERCLA Compliance with Other Laws Manual. August.

EPA. 1990. CERCLA Record of Decision for Crystal Chemical Company Site, Houston, Texas, September.

EPA Region 6 Administrative Order, Docket No. VI-15-92, addressing the Remedial Design/Remedial Action for Crystal Chemical Company Superfund Site, September 3, 1990.

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

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

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

Interoffice Memorandum dated May 19, 1995, to Program Areas that Utilize the Risk Reduction Rules and Site Specific Risk Analysis, from Dan Pearson, TNRCC, on Arsenic Soil Cleanup Standards.

"Soil Remedial Action Documentation Report," prepared for Southern Pacific Transportation Company, San Francisco, California by Industrial Compliance, Overland Park, Kansas, December 22, 1995.

"Assessment of the Technical Impracticability of Ground-Water Remediation, Crystal Chemical Site, Houston, Texas," prepared by Hydrologic Consultants, Inc., Lakewood, Colorado, February, 1996.

Hydrologic Consultants, Inc. 1996. Assessment of the Technical Impracticability of Ground-Water Remediation. February.

EPA Superfund Explanation of Significant Difference for Record of Decision: Crystal Chemical Company Superfund Site, Houston, Texas, March 17, 1997.

Letter dated May 8, 1997, to Chris Villarreal, EPA Region 6, Dallas, Texas, from Robert Coffman, Terranext, Houston, Texas, on 100-Foot Sand Zone Quarterly Ground Water Sampling, March 1997, Crystal Chemical Site.

"Second Quarter 1997 Ground Water Sampling Report, Crystal Chemical Site, Houston, Texas," prepared for Union Pacific Railroad Company, Omaha, Nebraska, by Environmental Management Resources (EMR)—Southwest, Houston, Texas, November 3, 1997.

Letter dated May 14, 1998, to Chris Villarreal, EPA Region 6, Dallas, Texas, from E.H. Honig, Union Pacific Railroad Company, Omaha, Nebraska, on Transmittal: First Quarter 1998 Ground Water Sampling Report: Crystal Chemical Site, Houston, Texas.

"Third Quarter 1997 Ground Water Sampling Report, Crystal Chemical Site, Houston, Texas," prepared for Union Pacific Railroad Company, Omaha, Nebraska, by EMR –Southwest, Houston, Texas, February 12, 1998.

"Fourth Quarter 1997 Ground Water Sampling Report, Crystal Chemical Site, Houston, Texas," prepared for Union Pacific Railroad Company, Omaha, Nebraska, by EMR –Southwest, Houston, Texas, February 12, 1998.

Letter dated May 14, 1998, to Chris Villarreal, EPA Region 6, Dallas, Texas, from E.H. Honig, Union Pacific Railroad Company, Omaha, Nebraska, on Transmittal: First Quarter 1998 Ground Water Sampling Report: Crystal Chemical Site, Houston, Texas.

DOCUMENTS REVIEWED (Continued)

Letter dated August 17, 1998, to Chris Villarreal, EPA Region 6, Dallas, Texas, from E.H. Honig, Union Pacific Railroad Company, Omaha, Nebraska, on Transmittal: Second Quarter 1998 Ground Water Sampling Report: Crystal Chemical Site, Houston, Texas.

ERM. 1998. Revised Work Plan for Additional Ground-Water Investigation. August 18.

Letter dated October 26, 1998, to Mr. Harry Shearer, Shearton Development Company, L.L.C., Minneapolis, MN, from Chris Villarreal, EPA Region 6, Dallas, Texas, on Crystal Chemical Company Superfund Site, Houston, Texas.

Letter dated November 12, 1998, to Chris Villarreal, EPA Region 6, Dallas, Texas, from E.H. Honig, Union Pacific Railroad Company, Omaha, Nebraska, on Transmittal: Third Quarter 1998 Ground Water Sampling Report: Crystal Chemical Site, Houston, Texas.

Letter dated May 17, 1999, to Chris Villarreal, EPA Region 6, Dallas, Texas, from E.H. Honig, Union Pacific Railroad Company, Omaha, Nebraska, on Transmittal: 1999 First Semiannual Ground Water Sampling Report: Crystal Chemical Site, Houston, Texas.

"Revised Work Plan for Additional Ground Water Investigation, Crystal Chemical Company Site, Houston (Alief), Texas," prepared for Union Pacific Railroad Company, by ERM, Houston, Texas, August 18, 1998, revised July 12, 1999.

"1999 Second Semiannual Ground Water Sampling Report, Crystal Chemical Site, Houston, Texas," prepared for Union Pacific Railroad Company, by ERM, Houston, Texas, December 10, 1999.

Letter dated February 7, 2000, to Mr. Harry Shearer, Shearton Development Company, L.L.C., Minneapolis, MN, from Chris Villarreal, EPA Region 6, Dallas, Texas, on Crystal Chemical Company Superfund Site, Houston, Texas.

Five-Year Review Site Assignment Worksheet, contract #68-W6-0037, EPA Region 6, WAM Linda Carter, RPM Chris Villarreal, April 2000.

Letter dated April 6, 2000, to Chris Villarreal, EPA Region 6, Dallas, Texas, from Marsha Lutz, ERM, Houston, Texas, on Ground Water Elevation Data for the Crystal Chemical Site.

"Monthly Progress Report for the Remedial Action for March 2000," prepared for Union Pacific Railroad Company, by ERM, Houston, Texas, April 7, 2000.

Letter dated April 7, 2000, to Mr. Chris Villarreal, EPA Region 6, Dallas, Texas, from Marsha Lutz, ERM, Houston, Texas, on EPA Docket No. CERCLA VI-15-92 – Crystal Chemical Site, Houston, Texas: Monthly Progress Report for the Remedial Action for March 2000.

Letter report, dated April 20, 2000, to Mr. David Young, Union Pacific Railroad Company, Houston, Texas, from Robert Coffman, ERM, Houston, Texas on Soil and Ground Water Sampling for Levy Estate Property Transfer Investigation; Crystal Chemical NPL Site, Houston, Texas.

Letter dated May 8, 2000, to Mr. Keith Westberry, Tetra Tech EM, Inc., Dallas, Texas, from Chris Villarreal, EPA Region 6, Dallas, Texas, on Multi-Site Five Year Reviews, Request for Additional Documents, Crystal Chemical Company Site.

Letter dated May 8, 2000, to Mr. Harry Shearer, Shearton Development Company, L.L.C., Minneapolis, MN, from Chris Villarreal, EPA Region 6, Dallas, Texas, on Crystal Chemical Company Superfund Site, Houston, Texas.

Letter dated June 5, 2000, to Ms. Mary Wimbish, Attorney, Houston, Texas, from Chris Villarreal, EPA Region 6, Dallas, Texas, on Wilcrest Green Property near the Crystal Chemical Company Superfund Site, Houston, Texas.

DOCUMENTS REVIEWED (Continued)

EPA. 2000. *Federal Register.* June 22.

ERM. 2000. Letter Regarding 5-Year Review Information. From Marsha L. Lutz, ERM. To Amy Swartz, Tetra Tech EM Inc. June 29.

APPENDIX B

PUBLIC ANNOUNCEMENT

(One Page)

The U.S.Environmental Protection Agency (EPA) is currently conducting a Five-Year Review of the Crystal Chemical Superfund Site located at 3502 Rogerdale Road, in southwestern Houston, Harris County, Texas. The purpose of a Five-Year Review is to determine whether the remedy chosen is still protective of human health and the environment. The results of this Five-Year Review will be made available to the public in October, 2000 at the Judson Robinson-Westchase Library, 9223 Wilcrest, Houston, Texas 77042. If you have any input or concerns surrounding the activities taking place at the Crystal Chemical Superfund Site, please contact Chris Villarreal, EPA Remedial Project Manager, either by phone at 214-665-6758, or by e-mail at: villarreal.chris@epa.gov.

APPENDIX C

INTERVIEWS

(13 Pages)

CRYSTAL CHEMICAL SITE SURVEY	
Site Name: Crystal Chemical Site	**EPA Work Assignment No.:** 034-FRFE-06ZZ
Subject: 5-Year Review Operation and Maintenance Survey	**Date:** 6/29/00

Contact Made By:

Name: Chris Villarreal	**Title:** Remedial Project Manager	**Organization:** EPA
Telephone No.: (214) 665-6758 **E-Mail:** villarreal.chris@epa.gov	**Street Address:** U.S. EPA 1455 Ross Avenue, Suite 1200 **City, State, Zip:** Dallas, Texas 75202	
Name: Amy Swartz	**Title:** Site Project Manager	**Organization:** Tetra Tech EM Inc.
Telephone No.: (214) 740-2031 **E-Mail:** swartza@ttemi.com	**Street Address:** 350 N. St. Paul, Suite 2600 **City, State, Zip:** Dallas, Texas 75201	

Individual Contacted:

Name: Scott Weinstein	**Title:** Graduate Engineer/ Site Supervisor	**Organization:** ERM
Telephone No.: (281) 600-1000 **E-Mail Address:** sweinstein@ermsw.com	**Street Address:** 16300 Katy Freeway, #300 **City, State, Zip:** Houston, TX 77094	

Survey Questions

Please return your survey in the enclosed envelope to Amy Swartz by July 5, 2000.

1. What is your impression of the project (general sentiment)?

   The project, to me, has been an excellent learning experience. After taking the reigns from Terranext, the plant has begun to operate more efficiently without unexpected discharge exceedences.

2. Please describe the on-site operation and maintenance (O&M) presence, including staff, frequency of site inspections, and (O&M) activities.

   A trained operator mans the treatment plant for approximately 2.5 hours per day. In addition, there are at least weekly visit by the site safety officer and site supervisor. O&M is performed daily in a "preventative" mode to prevent problems when possible. ERM project staff performs O&M, H&S, and inventory inspections monthly.

3. Please describe any significant changes in the O&M requirements, maintenance schedules, or sampling routines since start-up or in the last 5 years. Do they affect the protectiveness or effectiveness of the remedy? Significant changes in plant operations:

   a. Effluent sampling is performed prior to discharge via the effluent storage tanks. If necessary, the contents of these tanks may be pumped back into the system for retreatment.

   b. The system has additional level controls to help prevent overtopping of process tanks.

   c. The pump used for sludge wasting is now on a timer. If the operators identify any issues relating to sludge buildup in the clarifier, or too much free liquid in the sludge holding tank, they have the ability to adjust the rate sludge is wasted.

   All of these improvements positively impact the protectiveness and effectiveness of the remedy.

CRYSTAL CHEMICAL SITE SURVEY	
Site Name: Crystal Chemical Site	**EPA Work Assignment No.:** 034-FRFE-06ZZ
Subject: 5-Year Review Operation and Maintenance Survey	**Date:** 6/29/00

Survey Questions (Cont.)

4. Have the O&M manual and Health and Safety Plan been updated to reflect site changes?

   Yes.

5. Have there been unexpected O&M difficulties or costs at the site since start-up or in the last 5 years? If so, please give details.

   There have been no *unexpected* difficulties since ERM took over the site. As with any treatment process, there were difficulties, but none that qualify as unexpected.

6. Can you give insight to potential O&M problems?

   The most significant problem with the O&M is that the plant upgrades allow it to run well unattended. This sometimes results in less preventive maintenance performed by the operators. However, the weekly visits by the site supervisor help in maintaining a proactive maintenance attitude. Other potential problems include:

   a. An air compressor without a dryer,

   b. An offsite recovery well on property that is not well maintained, and

   c. Difficult access to lighting fixtures to change bulbs.

8. Is there an O&M manual available on site? Health and Safety Plan? As-built drawings? Maintenance logs? Are all documents up to date?

   Yes. Yes. Yes. Yes. Yes.

9. Are discharge permits readily available and up to date? Please list permits.

   Yes. City of Houston Permit No. 6109.

10. Are ground water monitoring records and discharge compliance records readily available and up to date?

    Yes.

11. Do you have any comments, suggestions, or recommendations regarding the project?

    I have no comments to add to the above information.

CRYSTAL CHEMICAL SITE SURVEY	
Site Name: Crystal Chemical Site	**EPA Work Assignment No.:** 034-FRFE-06ZZ
Subject: 5-Year Review Operation and Maintenance Survey	**Date:** 6/27/00

Contact Made By:		
Name: Chris Villarreal	**Title:** Remedial Project Manager	**Organization:** EPA
Telephone No.: (214) 665-6758 **E-Mail:** villarreal.chris@epa.gov	**Street Address:** U.S. EPA 1455 Ross Avenue, Suite 1200 **City, State, Zip:** Dallas, Texas 75202	
Name: Amy Swartz	**Title:** Site Project Manager	**Organization:** Tetra Tech EM Inc.
Telephone No.: (214) 740-2031 **E-Mail:** swartza@ttemi.com	**Street Address:** 350 N. St. Paul, Suite 2600 **City, State, Zip:** Dallas, Texas 75201	

Individual Contacted:		
Name: Robert Coffman	**Title:** Senior Geologist	**Organization:** ERM - Southwest
Telephone No.: (281) 600-1078 **E-Mail Address:** 4coffman@ermsw.com	**Street Address:** 16300 Katy Freeway, Suite 300 **City, State, Zip:** Houston, TX 77094	

Survey Questions

Please return your survey in the enclosed envelope to Amy Swartz by July 5, 2000.

1. What is your impression of the project (general sentiment)?

   This has always been a technically interesting project from a hydrogeologist standpoint. My general sentiment is that the overall design and implementation of the remedy well executed and appropriate.

2. Please describe the on-site operation and maintenance (O&M) presence, including staff, frequency of site inspections, and (O&M) activities.

   Not applicable—see Scott Weinstein's survey.

3. Please describe any significant changes in the O&M requirements, maintenance schedules, or sampling routines since start-up or in the last 5 years. Do they affect the protectiveness or effectiveness of the remedy?
   Not applicable—see Scott Weinstein's survey.

4. Have the O&M manual and Health and Safety Plan been updated to reflect site changes?

   Not applicable—see Scott Weinstein's survey.

5. Have there been unexpected O&M difficulties or costs at the site since start-up or in the last 5 years? If so, please give details.

   Not applicable—see Scott Weinstein's survey.

CRYSTAL CHEMICAL SITE SURVEY	
Site Name: Crystal Chemical Site	**EPA Work Assignment No.:** 034-FRFE-06ZZ
Subject: 5-Year Review Operation and Maintenance Survey	**Date:** 6/27/00

Survey Questions (Cont.)

6. Can you give insight to potential O&M problems?

   Not applicable—see Scott Weinstein's survey.

7. Have there been opportunities to optimize the operation, maintenance, or sampling efforts? Please describe changes and resultant or desired cost savings or improved efficiency.

   Not applicable—see Scott Weinstein's survey.

8. Is there an O&M manual available on site? Health and Safety Plan? As-built drawings? Maintenance logs? Are all documents up to date?

   Not applicable—see Scott Weinstein's survey.

9. Are discharge permits readily available and up to date? Please list permits.

   Not applicable—see Scott Weinstein's survey.

10. Are ground water monitoring records and discharge compliance records readily available and up to date?

    Ground water monitoring records from 1997 to present and discharge compliance records are readily available and up to date. Historical records prior to 1997 should be accessible in off-site storage areas.

11. Do you have any comments, suggestions, or recommendations regarding the project?

    My involvement on this project has primarily been associated with design and implementation of the remedy and not operations and maintenance of the treatment plant. Most of these questions are not applicable to my history with this project.

CRYSTAL CHEMICAL SITE SURVEY		
Site Name: Crystal Chemical Site		**EPA Work Assignment No.:** 034-FRFE-06ZZ
Subject: 5-Year Review Operation and Maintenance Survey		**Date:** June 30, 2000
Contact Made By:		
Name: Chris Villarreal	**Title:** Remedial Project Manager	**Organization:** EPA
Telephone No.: (214) 665-6758 **E-Mail:** villarreal.chris@epa.gov	**Street Address:** U.S. EPA 1455 Ross Avenue, Suite 1200 **City, State, Zip:** Dallas, Texas 75202	
Name: Amy Swartz	**Title:** Site Project Manager	**Organization:** Tetra Tech EM Inc.
Telephone No.: (214) 740-2031 **E-Mail:** swartza@ttemi.com	**Street Address:** 350 N. St. Paul, Suite 2600 **City, State, Zip:** Dallas, Texas 75201	
Individual Contacted:		
Name: Marsha L. Lutz	**Title:** Project Manager	**Organization:** ERM
Telephone No.: (281) 600-1035 **E-Mail Address:** mlutz@ermsw.com	**Street Address:** 16300 Katy Freeway, Suite 300 **City, State, Zip:** Houston, TX 77077	

Survey Questions

Please return your survey in the enclosed envelope to Amy Swartz by July 5, 2000.

1. What is your impression of the project (general sentiment)?

   The project is usually fairly smooth going, but there are plenty of old and new issues that keep it interesting. ERM started working on the project in August 1997, with the task of improving the ground water treatment plant (GWTP) so as to avoid discharges to the City of Houston (COH) that have concentrations of arsenic that exceed the COH permit limit. It seems that in the past something relatively minor, such as access, has created long, unnecessary delays. The issue of the additional ground water investigation on the former Levy property (on the north side of Westpark Drive) and final configuration of the proposed slurry wall has dragged on since 1996 because of access problems. UPR ended up buying the property in April 2000 so that the project could move forward. It will be interesting to see the results of the investigation and if something other than a slurry wall can be implemented as an effective remedy. Some major decisions will be forthcoming following this investigation—and now the EPA is proposing to lower the arsenic standard in drinking water.

2. Please describe the on-site operation and maintenance (O&M) presence, including staff, frequency of site inspections, and (O&M) activities.

   O&M for monofill—completed cover is inspected once/month, mowed every 2 months during the growing season, and other maintenance, such as weed or ant control as needed.

   O&M for GWTP—Daily operation and inspection by plant operators (minimum 2.5 hours/day). The site supervisor visits the site once/week at a minimum. Activities include monitoring the plant operations and maintaining equipment, running the filter press, collecting process and effluent samples, discharging the effluent in batch modes, maintaining inventory of chemicals and parts. As the project manager, I visit the site approximately once/month but more often if necessary such as during implementation of design changes. A safety inspection is performed once/month.

CRYSTAL CHEMICAL SITE SURVEY	
Site Name: Crystal Chemical Site	**EPA Work Assignment No.:** 034-FRFE-06ZZ
Subject: 5-Year Review Operation and Maintenance Survey	**Date:** June 30, 2000

Survey Questions (Cont.)

3. Please describe any significant changes in the O&M requirements, maintenance schedules, or sampling routines since start-up or in the last 5 years. Do they affect the protectiveness or effectiveness of the remedy?
   ERM implemented a design change for the discharge of effluent by installing the pumparound loop system. We also made many other improvements and modifications to the GWTP—some are small but just make operations safer, more efficient and less troublesome. See Scott Weinstein's survey.

4. Have the O&M manual and Health and Safety Plan been updated to reflect site changes?

   Yes—O&M Manual updated in January 2000, Health and Safety Plan in August 2000.

5. Have there been unexpected O&M difficulties or costs at the site since start-up or in the last 5 years? If so, please give details.

   Yes—Prior to ERM becoming the engineering consultant for UPRR, the plant was shut down in May 1997 due to a discharge permit exceedance for arsenic. Construction of a pump-around loop system cost approximately $100,000 for design and construction and delayed use of the GWTP for over a year. In the fall of 1999, the supplier of hydrogen peroxide required us to replace the FRP storage tank with one constructed of stainless steel or HDPE. An HDPE tank was installed in December 1999. Costs for engineering, materials, and installation were approximately $30,000.

6. Can you give insight to potential O&M problems?

   See Scott Weinstein's survey.

7. Have there been opportunities to optimize the operation, maintenance, or sampling efforts? Please describe changes and resultant or desired cost savings or improved efficiency.

   Yes—see Scott Weinstein's survey for discussion of sampling optimization. Also, the installation of additional controls such as high and low level controls has improved operating efficiency.

8. Is there an O&M manual available on site? Health and Safety Plan? As-built drawings? Maintenance logs? Are all documents up to date?

   Yes to all.

9. Are discharge permits readily available and up to date? Please list permits.

   Yes—COH Permit No. 6109 is renewed every 2 years.

CRYSTAL CHEMICAL SITE SURVEY	
Site Name: Crystal Chemical Site	**EPA Work Assignment No.:** 034-FRFE-06ZZ
Subject: 5-Year Review Operation and Maintenance Survey	**Date:** June 30, 2000

Survey Questions (Cont.)

10. Are ground water monitoring records and discharge compliance records readily available and up to date?

    Yes.

11. Do you have any comments, suggestions, or recommendations regarding the project?

    As mentioned in Item 1, I am looking forward to the evaluation of the additional ground water investigation and hopefully being able to perform a risk assessment that will demonstrate that a risk-based closure is an effective remedy, instead of completing a slurry wall which will have to be maintained with ground water pumping controls for a very long time. I believe that the staff of ERM does a very good job of monitoring and maintaining the soil and ground water remedies at the Crystal Chemical site and tries to keep the project moving forward despite the obstacles caused by outside influences.

CRYSTAL CHEMICAL SITE SURVEY		
Site Name: Crystal Chemical Site		**EPA Work Assignment No.:** 034-FRFE-06ZZ
Subject: 5-Year Review Background Information Survey		**Date:** 7/11/00
Contact Made By:		
Name: Chris Villarreal	**Title:** Remedial Project Manager	**Organization:** EPA
Telephone No.: (214) 665-6758 **E-Mail:** villarreal.chris@epa.gov	**Street Address:** U.S. EPA 1455 Ross Avenue, Suite 1200 **City, State, Zip:** Dallas, Texas 75202	
Name: Amy Swartz	**Title:** Site Project Manager	**Organization:** Tetra Tech EM Inc.
Telephone No.: (214) 740-2031 **E-Mail:** swartza@ttemi.com	**Street Address:** 350 N. St. Paul, Suite 2600 **City, State, Zip:** Dallas, Texas 75201	
Individual Contacted:		
Name: Edwin H. Honig	**Title:** Mgr. Site Remediation	**Organization:** Union Pacific RR
Telephone No.: (402)271-5979 **E-Mail Address:** ehhonig@notes.up.com	**Street Address:** 1416 Dodge St., Room 930 **City, State, Zip:** Omaha, NE 68179	

Survey Questions

Please return your survey in the enclosed envelope to Amy Swartz by July 5, 2000.

1. What is your impression of the project (general sentiment)?

   ERM has done an excellent job of managing the site for Union Pacific. Union Pacific has invested a considerable amount of money at the Crystal Site to ensure the Water Treatment Plant runs properly and the water we discharge to the City meets its discharge limits. We are all committed to doing things right. We look forward to addressing the ground water condition off-site (former Levy Property).

2. What effect have site operations had on the surrounding community?

   The only effect I am aware of is in Real Estate Sales. Prospective buyers are wary of buying contaminated property and being drawn into a Superfund Site. We have plugged and abandoned monitoring wells on adjacent properties in support of Real Estate transactions.

3. Are you aware of any community concerns regarding the site or its operation and administration? If so, please give details.

   No.

CRYSTAL CHEMICAL SITE SURVEY	
Site Name: Crystal Chemical Site	**EPA Work Assignment No.:** 034-FRFE-06ZZ
Subject: 5-Year Review Background Information Survey	**Date:** 7/11/00

Survey Questions (Cont.)

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

   We experienced an attempted break in about 1 year ago. The door was damaged - Consultants told me of a break in several years ago - a telephone was stolen. Those 2 incidents are the only ones I am aware of.

   The building has a security alarm that was installed about a year ago. Before that, we had a security service drive by each night.

   I am not aware of any incidents of vandalism, trespassing or emergency responses from local authorities.

5. Do you feel well informed about the site's activities and progress?

   Yes - I communicate with ERM (Marsha and/or Scott) several times a week.

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

   I think things are going very well.

CRYSTAL CHEMICAL SITE SURVEY		
Site Name: Crystal Chemical Site		**EPA Work Assignment No.:** 034-FRFE-06ZZ
Subject: 5-Year Review Local Authority Survey		**Date:** 6/29/00
Contact Made By:		
Name: Chris Villarreal	**Title:** Remedial Project Manager	**Organization:** EPA
Telephone No.: (214) 665-6758 **E-Mail:** villarreal.chris@epa.gov	**Street Address:** U.S. EPA 1455 Ross Avenue, Suite 1200 **City, State, Zip:** Dallas, Texas 75202	
Name: Amy Swartz	**Title:** Site Project Manager	**Organization:** Tetra Tech EM Inc.
Telephone No.: (214) 740-2031 **E-Mail:** swartza@ttemi.com	**Street Address:** 350 N. St. Paul, Suite 2600 **City, State, Zip:** Dallas, Texas 75201	
Individual Contacted:		
Name: Jennifer McKnight	**Title:** Asst. Manager	**Organization:** City of Houston
Telephone No.: (281) 575-2802 **E-Mail Address:** jemcknig@pwe.ci.houston.tx.us	**Street Address:** 10500 Bellaire Blvd. **City, State, Zip:** Houston, TX 77650	

Survey Questions

Please return your survey in the enclosed envelope to Amy Swartz by July 5, 2000.

1. What is your impression of the project (general sentiment)?

   Going well.

2. Has your office conducted routine communications or activities (site visits, inspections, reporting activities, etc.) regarding the site? If so, please give purpose and results.

   Yes, this site is sampled quarterly. No violations of the wastewater permit have been detected.

3. Have there been any complaints, violations, or other incidents related to the site requiring a response by your office? If so, please give details of the events and results of the responses.

   No.

CRYSTAL CHEMICAL SITE SURVEY	
Site Name: Crystal Chemical Site	**EPA Work Assignment No.:** 034-FRFE-06ZZ
Subject: 5-Year Review Local Authority Survey	**Date:** 6/29/00

Survey Questions (Cont.)

4. Do you feel well informed about the site's activities and progress?

   Yes, the consulting firm overseeing this site sends in reports every month indicating the status of the site.

5. Have there been any changes in State laws and regulations that may impact the protectiveness of the ground water or soil remedies?

   None that I am aware of.

6. Has the site been in compliance with permitting and reporting requirements?

   Yes.

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

   No.

CRYSTAL CHEMICAL SITE SURVEY		
Site Name: Crystal Chemical Site	**EPA Work Assignment No.:** 034-FRFE-06ZZ	
Subject: 5-Year Review Local Authority Survey	**Date:** 6/30/00	
Contact Made By:		
Name: Chris Villarreal	**Title:** Remedial Project Manager	**Organization:** EPA
Telephone No.: (214) 665-6758 **E-Mail:** villarreal.chris@epa.gov	**Street Address:** U.S. EPA 1455 Ross Avenue, Suite 1200 **City, State, Zip:** Dallas, Texas 75202	
Name: Amy Swartz	**Title:** Site Project Manager	**Organization:** Tetra Tech EM Inc.
Telephone No.: (214) 740-2031 **E-Mail:** swartza@ttemi.com	**Street Address:** 350 N. St. Paul, Suite 2600 **City, State, Zip:** Dallas, Texas 75201	
Individual Contacted:		
Name: Alan Etheredge	**Title:** Project Manager	**Organization:** TNRCC
Telephone No.: (512) 239-2139 **E-Mail Address:** aethered@tnrcc.state.tx.us	**Street Address:** P. O. Box 13087 MC.143 **City, State, Zip:** Austin, TX 78711-3087	

Survey Questions

Please return your survey in the enclosed envelope to Amy Swartz by July 5, 2000.

1. What is your impression of the project (general sentiment)?

   Project is progressing reasonably well. Respondents (PRP) are performing timely.

2. Has your office conducted routine communications or activities (site visits, inspections, reporting activities, etc.) regarding the site? If so, please give purpose and results.

   Monthly review of progress reports; provide comment to EPA on proposed modifications and reports required for order.

3. Have there been any complaints, violations, or other incidents related to the site requiring a response by your office? If so, please give details of the events and results of the responses.

   None known in recent years.

CRYSTAL CHEMICAL SITE SURVEY	
Site Name: Crystal Chemical Site	**EPA Work Assignment No.:** 034-FRFE-06ZZ
Subject: 5-Year Review Local Authority Survey	**Date:** 6/30/00

Survey Questions (Cont.)

4. Do you feel well informed about the site's activities and progress?

   Yes, via monthly progress reports.

5. Have there been any changes in State laws and regulations that may impact the protectiveness of the ground water or soil remedies?

   None known to impact protectiveness; possible need to implement institutional control re: portion of ground water plume not contained within property owned by respondent (PRP).

6. Has the site been in compliance with permitting and reporting requirements?

   Yes.

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

   Respondent (PRP) is managing site in reasonably prudent manner.

APPENDIX D

SITE INSPECTION REPORT

(27 Pages)

SITE INSPECTION REPORT

CRYSTAL CHEMICAL SITE
HOUSTON, TEXAS

Prepared for

U.S. ENVIRONMENTAL PROTECTION AGENCY
1445 Ross Avenue
Dallas, TX 75202-2722

Work Assignment No.	:	034-FRFE-06ZZ
EPA Region	:	6
Date Prepared	:	July 26, 2000
Contract No.	:	68-W6-0037
Prepared By	:	Tetra Tech EM Inc.
Telephone No.	:	(214) 754-8765
EPA Work Assignment Manager	:	Ms. Linda Carter
Telephone	:	(214) 665-6665

CONTENTS

ABBREVIATIONS AND ACRONYMS

ARAR	Applicable or relevant and appropriate requirements
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
Crystal Chemical	Crystal Chemical Superfund Site
EPA	U.S. Environmental Protection Agency
ERM	Environmental Resources Management
ESD	Explanation of significant differences
GWTP	Ground water treatment plant
MCL	Maximum contaminant level
NPL	National Priorities List
O&M	Operations and maintenance
ppb	Parts per billion
ppm	Parts per million
PRP	Potentially responsible party
RAC	Response Action Contract
ROD	Record of decision
Tetra Tech	Tetra Tech EM Inc.
TI	Technical impracticability
TNRCC	Texas Natural Resource Conservation Commission
UPR	Union Pacific Railroad
µg/L	Micrograms per liter

1.0 INTRODUCTION

Tetra Tech conducted a site visit and a site inspection to verify that all components of the source control/ground water remediation are operating in accordance with criteria established in the Record of Decision (ROD), amended ROD, and the ground water remedial design addendum. This report summarizes the results of the site visit and site inspection at the Crystal Chemical site, in Houston, Texas. Tetra Tech also sent out site surveys to local authorities, residents, and the potentially responsible parties (PRPs).

2.0 BACKGROUND

EPA is the lead agency for the Crystal Chemical site, and the State of Texas, through the Texas Natural Resource Conservation Commission (TNRCC), and has been involved in all aspects of site activities. Union Pacific Railroad (UPR) Company (formerly Southern Pacific Transportation Company) has been identified as one of 13 potentially responsible parties (PRPs) for the Crystal Chemical site, and EPA has authorized UPR, through an Administrative Order on Consent and an Unilateral Administrative Order, to design and implement the soil and ground water remedies for the Crystal Chemical site, as set forth in the 1990 ROD.

Crystal Chemical produced arsenical, phenolic, and amine-based herbicides from 1968 to 1981. Operation and maintenance problems at the Crystal Chemical facility during the late 1970s resulted in several violations of the State of Texas environmental standards. In September 1981, the Crystal Chemical property was added to the National Priorities List (NPL), qualifying the site for investigation and remediation under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA).

In September 1990, EPA issued the ROD that addressed soil and ground water contamination. The selected remedy for soil called for (1) the excavation of off-site soils contaminated with arsenic greater than 30 parts per million (ppm), (2) treating all the soils contaminated with arsenic greater than 300 ppm with a process called in situ vitrification, and (3) capping the entire site after the soils treatment had been completed. Due to the unavailability of the in situ vitrification technology, EPA selected a new soil

remedy in a ROD amendment issued in June 1992. The soil consolidation and capping remedy was completed in September 1995.

The remedy selected in the 1990 ROD for ground water called for the extraction and treatment of arsenic-contaminated ground water. The remediation goal specified in the 1990 ROD for the affected ground water zones is 50 micrograms per liter (µg/L), the maximum contaminant level (MCL) for arsenic. The 1990 ROD also included several contingency measures that could be implemented if an extraction and treatment system does not produce the remediation goals set for the Crystal Chemical site.

At the time of the 1990 ROD, EPA called for investigations and evaluations necessary to design the extraction and treatment system for the ground water remedy. Through an Administrative Order on Consent, EPA authorized Southern Pacific Transportation Company to undertake, with EPA oversight, the investigations and evaluations necessary to design an efficient and effective ground water extraction and treatment system.

During the course of the design investigations and evaluations, data indicated that portions of the site's contaminated ground water zones could not be restored. The portions of the site that cannot be remediated (the technical impracticability [TI] zone) consists of splay deposits, or off-channel deposits. These splay or off-channel deposits consist of sandy material with an abundance of fine-grained material (clay and/or silt). The other portion of the site, which was not part of the TI zone and is therefore not affected by the 1997 Explanation of Significant Differences (ESD), consists of a subsurface stream channel. The subsurface stream channel contains more sand and less fine-grained material, and this portion of the site can likely be restored through the extraction and treatment remedy based on the information collected and evaluated.

As a result of EPA's conclusion that restoration of the ground water was technically impracticable for portions of the Crystal Chemical site, EPA determined that the applicable or relevant and appropriate requirements (ARARs) for ground water restoration would be waived (*ROD ground water contingency measure #4*) and a slurry wall would be constructed around the portions of the site where ground water cannot be restored (*ROD ground water contingency measure #5*). The extraction and treatment of arsenic-contaminated ground water remedy is being implemented on the remainder of the site. Partial construction of the slurry wall has been completed on the site. An additional ground water investigation

will occur on property recently acquired by UPR to determine if the remainder of the slurry wall should be constructed. The primary purpose of the additional ground water investigation will be to ensure that the slurry wall encompasses the arsenic plume by defining the northeastern extent of arsenic-affected ground water exhibiting concentrations of 50 µg/L or more. A secondary objective of the additional ground water investigation will be to assess whether migration has stopped since the majority of the source material was removed in 1995 as part of the remedial action. If the data demonstrates that migration has not occurred, additional work will be conducted to evaluate the potential for eliminating the construction of a slurry wall and conducting long-term ground water monitoring.

3.0 SITE VISIT

The site visit occurred on June 1, 2000. The purpose of the site visit was to (1) tour the Crystal Chemical site, (2) discuss the current operations and maintenance (O&M) of the site including the soil cap and the ground water treatment plant (GWTP), and (3) discuss the acquisition of the newly-acquired Levy property.

The following individuals were present during the site visit:

- Chris Villarreal, EPA
- Alan Etheredge, TNRCC
- Ed Honig, UPR
- Marsha Lutz, Environmental Resources Management (ERM)
- Scott Weinstein, ERM
- Amy Swartz, Tetra Tech

Ms. Lutz and Mr. Weinstein, representatives for UPR, led the tour of the site and discussed its history and current O&M activities. Maintenance activities are performed at the GWTP on a daily basis. The soil cap is monitored for erosion and other degenerative problems, and the grass is mowed every 2 months. The site appeared to be well maintained, and no deficiencies were noted at that time.

After walking the site, everyone went to the ERM offices to discuss site operations and the acquisition of approximately 12 acres of the Levy property. UPR and EPA have been trying to gain access to the Levy property since 1996 in order to confirm the northern extent of arsenic-contaminated ground water.

The Levy property is located across Westpark Drive, north of the soil cap. Original ground water remediation activities called for the slurry wall to be installed on the Levy property. The plumes on the Levy property have not been tested since 1994. During the site visit, ERM stated that recent samples taken from eight existing monitoring wells—six wells in the 35-foot plume and two wells in the 15-foot plume—showed acceptable levels of arsenic (3 to 10 ppb), and that monitoring wells along the perimeter of the Levy property showed similar levels. Additional ground water monitoring will be conducted as soon as monitoring wells and a driveway access are installed on the property.

4.0 SITE INSPECTION

The following individuals attended the site inspection on June 26, 2000:

- Chris Villarreal, EPA
- Amy Swartz, Tetra Tech
- Steve Fry, Tetra Tech
- Marsha Lutz, ERM

During the tour of the site, Tetra Tech observed minor erosion on the north side of the cap on the side slope. Two shallow erosion rills, approximately 8 to 12 inches deep and 12 to 16 inches wide, have developed here, probably from hard rains. No maintenance is required at this time; however, this side of the cap should be monitored for future maintenance purposes. The vegetation (grass) appears to be in good condition. Additional watering of the grass has been necessary in past years. The grass is mowed every 2 months, and weed control measures are performed on an as-needed basis. Monitoring wells are in good condition with locks and barrier posts around each well. O&M records were kept in a log book inside the GWTP. Also on hand were O&M manuals, as-built drawings, the site health and safety plan, and daily access and security logs.

Ground water monitoring in the 100-foot sand zone has been conducted annually since 1999. In 1999, ground water monitoring occurred semiannually. Prior to 1999, monitoring occurred quarterly. Since post-closure care ground water monitoring began, arsenic has not been detected above 50 µg/L in the 100-foot ground water zone. No significant discrepancies were noted during the site visit.

5.0 ACCESS AND INSTITUTIONAL CONTROLS

The Crystal Chemical site is surrounded by a security fence with barbed wire at the top and a locking gate. The cap is also segregated from the GWTP by a locked gate and fence along the west side of the access road. The GWTP has high-powered security lighting and an alarm system. Although no damage to the site has been noted, trash had been found on the property before the security fence was installed, probably from trespassers. Security signs stating "No Trespassing" are located at intervals along the security fence. No further trespassing activity has been noted, and no animal activity was observed.

The GWTP is maintained by an operator for at least 2 hours each day, depending on the maintenance or activity schedule. Daily and long-term maintenance checklists are located in the O&M manual detailing the necessary activities. The operators maintain a daily log book of activities, concerns, and comments at the site. The access and institutional controls for the Crystal Chemical site are adequate.

APPENDIX B

SITE CHECKLIST

(2 Pages)

CRYSTAL CHEMICAL SUPERFUND SITE

SITE VISIT CHECKLIST

INSPECT FOR	COMMENTS
CAP	
Evidence of subsidence or settling	
Evidence of burrowing animals	
Vegetative condition	
Slope stability	
Presence of erosion gullies	
Establishment of undesirable vegetation	
Stressed vegetation	
Other irregularities	
CAP INFILTRATION DRAINAGE SYSTEM	
Leaking or damaged drains	
Deteriorated drain pipes	
Blockage or obstruction of flow	
Slime buildup on pipe walls	
GAS VENT SYSTEM	
Tampering of the vents	
Damage from landfill subsidence	
Organic breakthrough from carbon canisters	
Emission testing	
STORMWATER DRAINAGE SYSTEM	
Obstruction of flow	
Structural damage	
Condition of channel lining	
Evidence of rerouting or overflow	
ACCESS ROAD	
Surface condition (potholes, cracks, etc.)	

CRYSTAL CHEMICAL SUPERFUND SITE

SITE VISIT CHECKLIST

INSPECT FOR	COMMENTS
SITE SECURITY	
Damage to fencing	
Proper warning signs	
GROUND WATER MONITORING WELL	
Damage to concrete pad and/or protective casings	
Damaged or missing well caps and locks	
Evidence of tampering	
Overgrowth of vegetation	
Sediment accumulation	

APPENDIX C

O&M COST RECORDS

(One Page)

TABLE A2-1

Summary of Estimated Costs - 5-Year Review
Crystal Chemical NPL Site

Union Pacific Railroad
Houston, Texas

PROJECT TASKS	1/1 - 12/31/96 SP (1)	1/1 - 4/30/97 SP (1)	3/1 - 8/31/97 Terranext	8/1-12/31/97 ERM	1/1-12/31/98 ERM	1/1-12/31/99 ERM	1/1-5/31/00 ERM	TOTAL
A. Project Scoping and Review				$ 17,900.00	$ -	$ -	$ -	**$17,900**
				$ -	$ -	$ -	$ -	
B. Ground Water Treatment Plant System Modifications				$ -	$ -	$ -	$ -	
B1. GWTP Modifications				$ 70,627.00	$ 161,350.00	$ 5,127.00	$ 8,271.00	**$245,375**
				$ -	$ -	$ -	$ -	
C Ground Water Treatment Plant Operation and Maintenance								
C1. GWTP Operation & Maintenance				$ 4,860.00	$ 143,164.00	$ 192,497.00	$ 86,970.00	**$427,491**
C2. Waste Disposal				$ -	$ 1,142.00	$ 606.00	$ 805.00	**$2,553**
C3. Analytical				$ -	$ 836.00	$ 6,251.00	$ 1,962.00	**$9,049**
D. Ground Water Monitoring								
D1. Semiannual 100-foot Sand Zone Monitoring				$ 14,500.00	$ 21,072.00	$ 9,927.00	$ 1,612.00	**$47,111**
E. Slurry Wall				$ 2,500.00	$ 33,730.00	$ 40,113.00	$ 31,467.00	**$107,810**
E1. Perform Risk Assessment with Respect to Eliminating Slurry Wall				$ -	$ -	$ -	$ -	
E2. Fate Transport Modeling				$ -	$ -	$ -	$ -	
E3. Prepare Construction Drawings & Specifications, Solicit Bids				$ -	$ -	$ -	$ -	
E4. Construction of Slurry Wall - 2030 LF (Includes Wall on Levy Property)				$ -	$ -	$ -	$ -	
F. Compliance Monitoring								
F1. Semiannual Monitoring of the 15-foot and 35-foot sand zone				$ -	$ -	$ 4,262.00	$ 7,247.00	**$11,509**
G. Site Maintenance								
G1. Monofill Cap Repair and Maintenance				$ 1,500.00	$ 28,335.00	$ 5,000.00	$ 4,000.00	**$38,835**
G2. General Site Maintenance				$ 1,500.00	$ 32,364.00	$ 4,538.00	$ 2,509.00	**$40,911**
H. Project Management and Regulatory Interaction								
H1. Monthly Invoice, EPA Progress Reports, Annual Site Report				$ 6,000.00	$ 34,650.00	$ 25,350.00	$ 9,911.00	**$75,911**
H2. Additional Agency Studies (New Scope as of 8/97)				$ 2,500.00	$ 12,435.00	$ 6,023.00	$ -	**$20,958**
TOTALS	**$1,604,082**	**$5,007,026**	**$190,227**	**$ 121,887.00**	**$ 469,078.00**	**$ 299,694.00**	**$ 154,754.00**	**$7,846,748**

$7,846,748

NOTE:

(1) This information was provided by Southern Pacific (SP) when UPRR and SP merged and is assumed to include total costs incurred for the site, i.e., ground water and soil remedial investigation, design and construction, and O&M.