# FIVE-YEAR REVIEW REPORT
# FOR
# PETRO-CHEMICAL SYSTEMS INC. (TURTLE BAYOU) SITE
# LIBERTY COUNTY
# LIBERTY, TEXAS

**Prepared by:**

**REGION 6**
**UNITED STATES ENVIRONMENTAL PROTECTION AGENCY**
**1445 Ross Avenue**
**Dallas, Texas 75202-2733**

| | | |
|---|---|---|
| Work Assignment No. | : | 034-FR-FE-06ZZ |
| EPA Region | : | 6 |
| Date Prepared | : | September 8, 2000 |
| Contract No. | : | 68-W6-0037 |
| Prepared by | : | Tetra Tech EM Inc. |
| Telephone No. | : | (214) 754-8765 |
| EPA Work Assignment Manager | : | Linda Carter |
| Telephone No. | : | (214) 665-6665 |



CONTENTS


| Section | | | Page |
|---|---|---|---|
| ACRONYMS AND ABBREVIATIONS | | | iv |
| EXECUTIVE SUMMARY | | | ES-1 |
| 1.0 | INTRODUCTION | | 1 |
| 2.0 | SITE CHRONOLOGY | | 2 |
| 3.0 | BACKGROUND | | 2 |
| 4.0 | REMEDIAL ACTIONS | | 9 |
| | 4.1 | REMEDY SELECTION | 9 |
| | 4.2 | REMEDY IMPLEMENTATION | 13 |
| | | 4.2.1 OPERABLE UNIT 1 | 13 |
| | | 4.2.2 OPERABLE UNIT 2 | 14 |
| | | 4.2.2.1 SOIL REMEDY | 15 |
| | | 4.2.2.2 GROUND WATER REMEDY | 16 |
| | | 4.2.2.3 TREATMENT SYSTEMS | 16 |
| | 4.3 | SYSTEM OPERATIONS | 17 |
| 5.0 | FIVE-YEAR REVIEW PROCESS | | 19 |
| 6.0 | FIVE-YEAR REVIEW FINDINGS | | 19 |
| | 6.1 | INTERVIEWS | 20 |
| | 6.2 | SITE INSPECTION | 22 |
| | 6.3 | ARAR REVIEW | 25 |
| | | 6.3.1 CHEMICAL-SPECIFIC ARARs | 25 |
| | | 6.3.2 LOCATION-SPECIFIC ARARs | 27 |
| | | 6.3.3 ACTION-SPECIFIC REQUIREMENTS | 27 |
| | | 6.3.4 TO BE CONSIDERED REQUIREMENTS | 30 |
| | 6.4 | DATA REVIEW | 30 |
| 7.0 | ASSESSMENT | | 31 |
| 8.0 | DEFICIENCIES | | 33 |

CONTENTS (Continued)


| Section | | Page |
|---|---|---|
| 9.0 | RECOMMENDATIONS AND FOLLOW-UP ACTIONS | 34 |
| 10.0 | PROTECTIVENESS STATEMENTS | 35 |
| 10.1 | OPERABLE UNIT 1 | 35 |
| 10.2 | OPERABLE UNIT 2 | 37 |
| 10.3 | CR 126 WEST AREA | 37 |
| 11.0 | NEXT REVIEW | 37 |
| 12.0 | OTHER COMMENTS | 37 |

Appendices

| | |
|---|---|
| A | DOCUMENTS REVIEWED |
| B | SITE-VISIT REPORT |
| C | INTERVIEW DOCUMENTATION FORMS |
| D | FACT SHEET |

## TABLES


| Table | | Page |
|---|---|---|
| 1 | CHRONOLOGY OF SITE EVENTS | 3 |
| 2 | CONTAMINATED SOIL REMEDIAL COMPONENTS FOR OU2 FROM THE 1998 ROD AMENDMENT | 11 |
| 3 | SOIL HOT SPOT REMEDIAL COMPONENT FOR OU2 FROM THE 1998 ROD AMENDMENT | 12 |
| 4 | CONTAMINATED GROUND WATER REMEDIAL COMPONENTS FOR OU2 FROM THE 1998 ROD AMENDMENT | 12 |
| 5 | IDENTIFIED DEFICIENCIES | 34 |
| 6 | RECOMMENDATIONS AND FOLLOW-UP ACTIONS | 36 |


## FIGURES


| Figure | | Page |
|---|---|---|
| 1 | SITE LOCATION MAP | 5 |
| 2 | SITE MAP | 8 |

## ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| AAMP | Ambient air monitoring plan. |
| AHA | Applied Hydrology Associates, Inc. |
| ARAR | Applicable or relevant and appropriate requirements |
| AWQC | Ambient water quality criteria |
| BDA | Bayou Disposal Area |
| BTEX | Benzene, toluene, ethylbenzene, and xylene |
| CERCLA | Comprehensive Environmental Response, Compensation, and Liability Act |
| CFR | Code of Federal Regulations |
| COC | Chemical of concern |
| CR | County Road |
| DO | Dissolved oxygen |
| EA | Easement Area |
| EPA | U.S. Environmental Protection Agency |
| FFS | Focused feasibility study |
| FM 563 | Farm to Market Road 563 |
| ft bgs | Feet below ground surface |
| $ft^3$ | Cubic feet |
| HASP | Health and safety plan |
| ISB | In-situ bioremediation |
| ISTD | In-situ thermal desorption |
| lbs | Pounds |
| LDR | Land disposal restrictions |
| MCL | Maximum contaminant levels |
| mg/kg | Milligrams per kilogram |
| mg/L | Milligrams per liter |
| MWA | Main Waste Area |
| NAAQS | National ambient air quality standards |
| NCP | National Oil and Hazardous Substances Pollution Contingency Plan |
| NPDES | National Pollutant Discharge Elimination System |
| NPL | National Priorities List |
| O&M | Operations and maintenance |
| OSHA | Occupational Safety and Health Administration |
| OTA | Office Trailer Area |
| OU1 | Operable Unit 1 |
| OU2 | Operable Unit 2 |
| OUs | Operable Units |
| PAH | Polycyclic aromatic hydrocarbons |
| PCS | Petro-Chemical Systems Inc. |
| PM-10 | Particulate less than 10 microns in size |
| PNA | Polynuclear aromatic |
| PRP | Potentially responsible party |
| QAPP | Quality assurance project plan |
| RA | Remedial action |
| RAC | Response Action Contract |
| RCRA | Resource Conservation and Recovery Act |

## ACRONYMS AND ABBREVIATIONS (Continued)

| | |
|---|---|
| RD | Remedial design |
| RG | Regulatory guidance |
| RI/FS | Remedial investigation/feasibility study |
| ROD | Record of Decision |
| ROP | Remedial operations plan |
| ROG | Remedial Operations Group, Inc. |
| RP/CP | Release prevention/contingency plan |
| SAP | Sampling and analysis plan |
| SOW | Scope of work |
| SRI | Supplemental remedial investigation |
| SVE | Soil vapor extraction |
| TAC | Texas Administrative Code |
| TDWR | Texas Department of Water Resources |
| Tetra Tech | Tetra Tech EM Inc. |
| TNRCC | Texas Natural Resource Conservation Commission |
| TOC | Total organic carbon |
| TSD | Treatment, storage, and disposal |
| TSWQS | Texas surface water quality standards |
| TVS | Total volatiles |
| TWQB | Texas Water Quality Board |
| TWC | Texas Water Code |
| TWC | Texas Water Commission |
| UAO | Unilateral Administrative Order |
| VOC | Volatile organic compounds |
| WQC | Water quality criteria |
| WRA | West Road Area |
| WTP | Water treatment plant |
| $yd^3$ | Cubic yards |
| µg/L | Micrograms per liter |
| $µg/m^3$ | Micrograms per cubic meter |

## EXECUTIVE SUMMARY

The purpose of this five-year review is to evaluate whether the selected remedy for the Petro-Chemical Systems, Inc. Superfund site (site) is expected to be protective of human health and the environment upon completion, and immediate threats have been addressed.

The site is located in rural Liberty County, 15 miles southeast of Liberty, Texas. The site is 6 miles north of Interstate 10 along Farm to Market Road 563 (FM 563), which borders the site to the west. County Road 126 (CR 126—previously known as Frontier Park Road) provides access to the site from FM 563. The site has also been referred to as the Turtle Bayou site, because it is bordered to the east by Turtle Bayou, a tributary to Lake Anahuac.

Unpermitted waste disposal appears to have started in the late 1960s. Since the site was never an authorized waste disposal facility, the exact nature of substances disposed of at the site is uncertain. However, it appears that the waste was simply dumped from trucks at numerous locations.

In 1971, Petro-Chemical Systems Inc. (PCS) filed an application for a commercial industrial waste disposal permit with the State of Texas. In 1974, PCS withdrew the application after the state withheld approval for the application.

After 1974, the site was subdivided into 5-acre and 15-acre plots and sold for residential development. Residential use of the site has been continuous since 1974, except during previous remedial activity on Frontier Park Road in 1989. The 1991 Record of Decision (ROD) noted that five families lived within the 500-acre site at that time.

With the enactment of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) in 1980, interest in the site was renewed. In 1984, EPA proposed the site for inclusion on the National Priorities List (NPL). The site was placed on the NPL in 1986. As an interim precautionary measure, warning signs were posted at the Main Waste Area at the site and 2,400 feet of fence were installed.

The site was divided into two operable units. Contamination along Frontier Park Road (Operable Unit [OU] 1) was addressed first. A remedial investigation (RI) and feasibility study (FS) conducted in 1986 found that several sections of Frontier Park Road were contaminated with volatile organic compounds (VOC), polycyclic aromatic hydrocarbons (PAH), and polynuclear aromatics (PNA). Potential risk to local residents, particularly those living on the site, was high.

The ROD for OU1, signed on March 27, 1987, called for the excavation of 5,900 cubic yards ($yd^3$) of soil contaminated with PNA or total VOC concentrations greater than 100 milligrams per kilogram (mg/kg). Contaminated soils ranging from 1 to 5 feet in depth were excavated along the first 1,800 feet of CR 126, and the excavated materials were placed in a temporary, aboveground landfill on-site (in the Main Waste Area [MWA]). The excavated area was backfilled with clean soil, and the entire length of the road was paved. This work was completed in August 1988.

A second RI/FS was conducted in 1988 to define the nature and extent of contamination throughout the rest of the site (OU2). In addition to Frontier Park Road, the RI/FS identified five areas of the nearly 500-acre site as waste disposal areas: the West Road Area (WRA), the MWA, the Office Trailer Area (OTA), the Easement Area (EA), and the Bayou Disposal Area (BDA). Soil and underlying shallow ground water were contaminated primarily with VOCs and PAHs. Additionally, small isolated areas of soil contained lead concentrations up to 5,000 mg/kg.

Except for one sampling point in the deeper aquifer, all contaminated ground water was found in the shallow aquifer (upper 17 to 27 feet). Although the shallow aquifer is not currently used as a source of drinking water, contamination in the shallow aquifer was determined to present future potential risks above health-based levels. Therefore, exposure to contaminated ground water was considered the primary site risk at OU2.

The 1991 ROD for the site addressed OU2. Soil vapor extraction (SVE) and ground water sparging formed the major components of the selected remedy.

Since the Unilateral Administrative Order (UAO) was signed in 1993, the potentially responsible party (PRP), Lyondell Chemical Company (previously known as ARCO Chemical Company) and Atlantic

Richfield Company, have been working with EPA and the Texas Natural Resource Conservation Commission (TNRCC) to complete the site's remedial design (RD), which began on September 25, 1992 and was completed on May 22, 1998. On December 8, 1998, EPA entered into a Consent Decree with Lyondell Chemical Company and Atlantic Richfield Company. The Consent Decree supersedes the provisions of the UAO that address obligations of Lyondell Chemical Company and Atlantic Richfield Company.

In April 1998, EPA issued a ROD amendment that replaced aquifer sparging with in-situ bioremediation as the major remediation component for ground water. The soil remedies were enhanced by identifying additional in-situ soil treatment technologies for the site such as bioventing, thermal desorption, and soil washing. The 1991 ROD remedy for the BDA was modified from an engineered soil and synthetic liner cap to a living cap consisting or a graded clay cap and selected vegetation.

Most on-site construction has been completed as part of the extensive field pilot study work. Soil and ground water remediation systems are currently in operation. The necessity for construction of the living cap in the BDA and a traditional synthetic liner cap in the MWA as a containment remedy is being reevaluated based on current contamination levels.

A wastewater treatment plant (WTP) and two thermal oxidizers are the primary contaminant treatment systems. In addition, other treatment technologies such as ex-situ soil bioremediation, in-situ ground water bioremediation, in-situ thermal desorption, and soil washing are being used at the site. Water produced by all project wells form the influent for the WTP. The treated water is eventually discharged into Turtle Bayou. Thermal oxidizers are used to combust contaminant vapors produced by the SVE system.

Minor modifications of the area-specific remediation systems are anticipated and may include installation of additional wells and area-specific treatment units. The largest PRP construction activity that remains is dismantling the aboveground landfill (constructed during OU1) located within the site's MWA.

Progress has been made over the past few years in remediating the site. Previously known "hot spots" have been remediated. More are scheduled to be addressed within the next two years. Some areas of the site are being evaluated for monitored natural attenuation.

Within the last year, a new source area (CR 126 West Area) has been identified at the site; the contaminants of concern are 1,1-dichloroethane, vinyl chloride, and benzene. Characterization is in progress. EPA is currently reviewing alternatives to address this new area.

Fourteen families now live within the vicinity of the site. None of them live on any of the identified contaminated areas; however, seven families live adjacent to them. The current land use (residential) is not anticipated to change in the future.

The applicable or relevant and appropriate requirements (ARAR) review did not find any discrepancies in the protectiveness of the remedies at this time. The TNRCC's risk calculation, which was used to determine the residential exposure standard for benzene in soils from 0 to 2 feet below ground surface, has changed since the amendment to the ROD set the soil benzene cleanup criteria for 0 to 2 feet below ground surface at 1.33 mg/kg. However, the existing cleanup criteria are still considered protective. Changes to the state surface water criteria for benzene and lead have been proposed and if finalized, the protectiveness of the daily maximum treated water limits for benzene and lead may need to be evaluated.

The five-year review of the site was conducted from June through August 2000. The results of the five-year review indicate that the remedy is expected to be protective of human health and the environment upon completion, and immediate threats have been addressed. Overall, the ground water treatment system, soil vapor extraction, in-situ thermal desorption, and in-situ bioremediation systems have been functioning as required and have been operated and maintained in an appropriate manner.

Protection of human health and the environment by the remedial actions at OU1 and OU2 is discussed below. Both the site health and safety plan (HASP) and the site contingency plan are in place, are adequate to control risks, and are being properly implemented. The following sections discuss the protectiveness of OU1 and OU2.

Operable Unit 1

The remedy at OU1 is protective of human health and the environment. The objectives to prevent direct contact with highly contaminated soils and minimize direct contact with moderately contaminated soils were achieved. The remedial action for OU1, as described in the Remedial Action Report for Frontier Park Road, was completed in August 1988.

Operable Unit 2

The remedy at OU2 is expected to be protective of human health and the environment upon completion, and immediate threats have been addressed. Remedial operations are still in progress. The PRP contractor estimates the active remedial action at OU2 will be completed at the end of 2002.

CR 126 West Area

In August 1999, a new source area (CR 126 West Area) was discovered by Remedial Operations Group, Inc. (ROG), the PRP contractor, during a routine sampling event. Contaminant characterization is in progress, and EPA is currently reviewing alternatives to address this area. Because this area was not previously addressed in the 1990 ROD or the subsequent 1998 ROD Amendment, it is anticipated that a second ROD Amendment may be required to address this area.

## Five-Year Review Summary Form

| | | |
|---|---|---|
| **Site Name (from WasteLAN):** Petro-Chemical Systems Inc., (Turtle Bayou) | | |
| **EPA ID (from WasteLAN): TXD980873350** | | |
| **Region:** 6 | **State:** TX | **City/County:** Liberty County |
| **NPL Status:** ☒ Final ☐ Deleted ☐ Other (specify) _____ | | |
| **Remediation Status** (choose all that apply): ☐ Under Construction ☒ Operating ☒ Complete | | |
| **Multiple OUs?** ☒ YES ☐ NO | **Construction Completion Date:** Fall 2002 (anticipated) | |
| **Has site been put into reuse?** ☐ YES ☒ NO | | |
| **Reviewing Agency:** ☒ EPA ☐ State ☐ Tribe ☐ Other Federal Agency _____ | | |
| **Author Name:** Matt B. Garcia | | |
| **Author Title:** Project Manager | **Author Affiliation:** EPA Region 6 Contractor | |
| **Review Period:** 01/96 to 07/00 | | |
| **Date(s) of Site Inspection:** 06/28/00 | | |
| **Type of review:** ☒ Statutory<br>☐ Policy (☐ Post-SARA ☐ Pre-SARA ☐ Non-NPL Remedial Action Site ☐ Regional Discretion) ☐ NPL-Removal only ☐ NPL State/Tribe-lead | | |
| **Review Number:** ☒ 1 (first) ☐ 2 (second) ☐ 3 (third) ☐ Other (specify) _____ | | |
| **Triggering Action:**<br>☒ Actual RA On-site Construction at OU #2<br>☐ Construction Completion<br>☐ Other (specify) _____ ☐ Actual RA Start at OU #____<br>☐ Previous Five-Year Review Report | | |
| **Triggering Action Date (from WasteLAN):** 01/96 | | |
| **Due Date (Five Years After Triggering Action Date):** 9/1/2000 | | |

**Five-Year Review Summary Form**

Deficiencies:

- Institutional controls such as deed restrictions and community residential development notification plans should be implemented.
- Particulate monitoring results were not reported among analytical data summarized in the latest available monthly reports.

None of these deficiencies currently cause the remedy to be nonprotective. However, if institutional controls are not developed, protectiveness of the remedy in the future cannot be ensured.

Recommendations and Follow-up Actions:

- Implement institutional controls.
- Monitor particulates whenever there are soil moving operations.

Protectiveness Statement:

The remedial action at OU1 is protective. The remedy for OU2 is expected to be protective of human health and the environment upon completion, and immediate threats have been addressed.

Other Comments:

A new source area (CR 126 West Area) has been discovered. Contaminant characterization is in progress, and the EPA is currently reviewing alternatives to address this area.

## 1.0 INTRODUCTION

The Environmental Protection Agency (EPA) has conducted the first five-year review of the remedial actions implemented at the Petro-Chemical Systems Inc. site (site) in Liberty, Texas. This report documents the results of the review, conducted from March 2000 to August 2000. The purpose of this five-year review is to evaluate whether the remedy at the site is expected to be protective of human health and the environment upon completion, and immediate threats have been addressed. 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 Title 40 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 than every five years after the initiation of the selected remedial action.

This is the first five-year review for the site. The triggering date for this review was January 18, 1996. Cleanup criteria have not been achieved and the remedy is still in progress. Because hazardous substances, pollutants, or contaminants remain at the site above levels that allow for unrestricted use and unlimited exposure, another five-year review is required.

## 2.0 SITE CHRONOLOGY

Table 1 lists the chronology of events for the site.

## 3.0 BACKGROUND

The site is located in rural Liberty County 15 miles southeast of Liberty, Texas. The site is 6 miles north of Interstate 10 along Farm to Market Road 563 (FM 563), which borders the site to the west. County Road 126 (CR 126—previously identified as Frontier Park Road) provides access to the site from FM 563. CR 126 traverses the middle of the site, spanning a total length of 2½ miles. It heads east from FM 563, and extends ½ mile beyond Turtle Bayou. A site location map is provided on Figure 1. The site is sometimes referred to as the Turtle Bayou site because Turtle Bayou, a tributary to Lake Anahuac, forms the eastern boundary of the site.

Land use in the surrounding area was divided among crop-land, pasture, range, forest, and small rural communities. A 1984 aerial photograph showed rice farms immediately north of the site, a heavy wooded area to the south, and timber operations east of the site.

The original 500-acre site is located in the southernmost portion of the county, partially within the Turtle Bayou flood plain. Contamination is concentrated in six waste disposal areas. An amendment to the Record of Decision (ROD) in 1998 narrowed the boundaries of the site to only those contaminated portions of the property (and all suitable property near to the contamination necessary to implement the remedial design [RD] and remedial action [RA]).

Local surface water drains across the site from northwest to southeast and eventually into Turtle Bayou. The hydroponic units beneath the site are the Chicot Aquifer and the Evangelize Aquifer. The Chicot Aquifer extends from the surface to a depth of more than 480 feet. Two water-bearing zones were identified in the upper 100 feet of this aquifer. The shallow water-bearing zone is confined beneath the upper 17 to 27 feet of Beaumont silty clay and clays, while the deeper water bearing zone occurs in the sands of the Lassie Formation and is separated from the shallow zone by 10 to 45 feet of stiff Beaumont clay.

TABLE 1

CHRONOLOGY OF SITE EVENTS
PETRO-CHEMICAL SYSTEMS INC. (TURTLE BAYOU) SITE
LIBERTY, TEXAS

| Date | Event |
|---|---|
| 1970 | First waste disposal at the site documented by TWQB, although disposal started in the late 1960s |
| 1971 | Petro-Chemical Systems Inc. filed for a commercial waste disposal permit |
| 1974 | Petro-Chemical Systems Inc. withdrew the waste disposal permit application |
| 1982 | TDWR personnel collected soil samples in former waste pits and recommended the site for CERCLA funding |
| May 1984 | The State of Texas requested that the site be included on the NPL under CERCLA |
| October 15, 1984 | EPA proposed the site for inclusion on the NPL |
| January 1986 | TWC and EPA started RI/FS along Frontier Park Road (OU1) |
| May 12, 1986 | Start of removal action: Interim precautionary measure for OU1—warning signs and fence construction |
| May 16, 1986 | End of removal action |
| June 10, 1986 | Site was placed on the NPL |
| September 1986 | End of RI/FS for Frontier Park Road (OU1) |
| March 27, 1987 | EPA Issued a ROD for OU1 |
| June 5, 1987 | Start of remedial design for OU1 |
| October 30, 1987 | End of remedial design for OU1 |
| January 25, 1988 | Start of remedial action at OU1 |
| June 1988 | TWC and EPA initiated the second RI/FS to assess the nature and extent of contamination throughout the remainder of the site (OU2) |
| March 1, 1989 | End of remedial action at OU1 |
| November 1990 | OU2 RI report was completed |
| March 1991 | OU2 FS report complete. ARCO Chemical Company and EPA signed an Administrative Order on Consent to conduct a SRI/FFS at the site. |

TABLE 1 (Continued)

CHRONOLOGY OF SITE EVENTS
PETRO-CHEMICAL SYSTEMS INC. (TURTLE BAYOU) SITE
LIBERTY, TEXAS

| Date | Event |
|---|---|
| August 1991 | SRI/FFS report was completed |
| September 1991 | EPA issued a ROD for OU2 |
| September 25, 1992 | Start of remedial design for OU2 |
| December 22, 1993 | EPA issued a Unilateral Administrative Order for OU2 RD/RA |
| January 18, 1996 | PRP contractor, ROG begins remedial design pilot study at OU2 |
| April 30, 1998 | EPA issued a ROD Amendment for OU2 addressing cleanup criteria |
| May 22, 1998 | End of remedial design for OU2 |
| December 8, 1998 | EPA entered into Consent Decree with ARCO Chemical Company and Atlantic Richfield Company |
| August 1999 | Contamination at CR 126 West Area discovered |
| July 2000 | EPA Five-Year Review Fact Sheet announcing Open House (Appendix D) |

Notes:

| | |
|---|---|
| CERCLA | Comprehensive Environmental Response, Compensation, and Liability Act |
| EPA | U.S. Environmental Protection Agency |
| NPL | National Priorities List |
| PRP | Potentially Responsible Party |
| RA | Remedial action |
| RI/FS | Remedial Investigation/Feasibility Study |
| ROD | Record of Decision |
| ROG | Remedial Operations Group, Inc. |
| SRI/FFS | Supplemental Remedial Investigation/Focused Feasibility Study |
| TDWR | Texas Department of Water Resources |
| TWC | Texas Water Commission |
| TWQB | Texas Water Quality Board |

Historically, the site area has been used for cattle grazing, timber collection, and rice farming. Unpermitted waste disposal appears to have started at the site in the late 1960s. Disposal of waste at the site is documented in Texas Water Quality Board (TWQB) records as early as 1970. Records indicate waste oils were pumped into unlined pits and on Frontier Park Road. Since the site was never an authorized waste disposal facility, the exact nature of disposal at the site is uncertain. However, it appears that the waste was simply dumped from trucks at numerous locations. In some areas, it appears that the wastes were tilled into the soil.

In 1971, Petro-Chemical Systems Inc. filed an application for a commercial industrial waste disposal permit with the State of Texas. After public hearings were held and additional information was evaluated in response to a citizens' suit, the state's approval for the application was withheld indefinitely. In 1974, Petro-Chemical Systems Inc. withdrew the application.

After 1974, the site was subdivided into five-acre and 15-acre plots and sold for residential development. Residential use of the site has been continuous since 1974, except during previous remedial activity on Frontier Park Road in 1989. The 1991 ROD noted 21 residences and a small business within a one-mile radius of CR 126 along FM 563, with five families living within the boundaries of the site. Fourteen families currently live near the site. None of them live on any of the identified contaminated areas; however, seven families live adjacent to them. The current land use (residential) is not anticipated to change in the future.

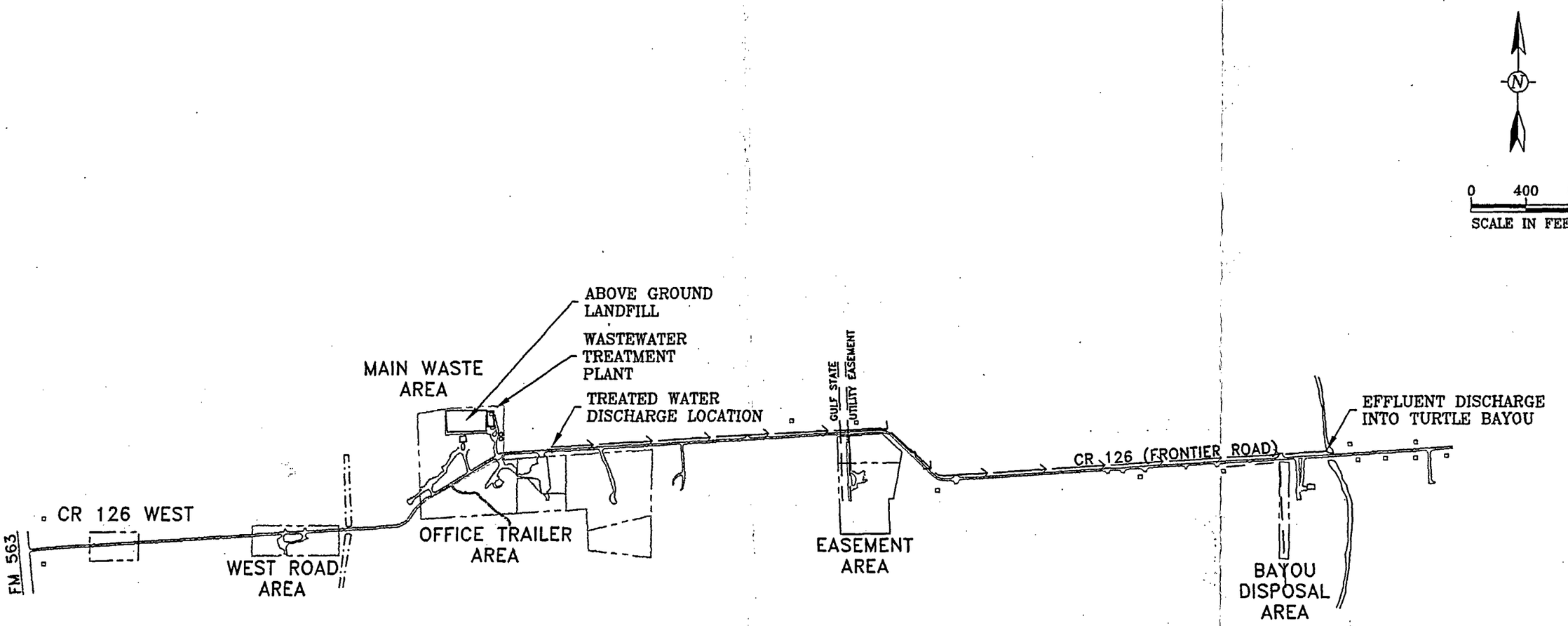
With the enactment of CERCLA in 1980, interest in the site was renewed. In 1982, the Texas Department of Water Resources (TDWR) investigated the site and determined that the site constituted a "discharge or imminent discharge, as well as the creation and maintenance of a nuisance as prohibited by the Texas Administrative Code (TAC) 335.4." In 1984, EPA proposed the site for inclusion on the National Priorities List (NPL). The site was placed on the NPL in 1986.

As an interim measure, warning signs were posted at the site. After limited Superfund monies became available in 1986, a removal action was performed to build a fence. Approximately 2,400 feet of fence were installed from May 12 to May 16, 1986.

TWC and EPA decided to first address contamination along Frontier Park Road (Operable Unit [OU] 1) and conducted a remedial investigation (RI) and feasibility study (FS) from January to November 1986. The RI found that several sections of Frontier Park Road were contaminated with volatile organic compounds (VOCs) (mainly benzene) and polycyclic aromatic hydrocarbons (PAHs) (mainly naphthalene). Approximately 5,900 cubic yards ($yd^3$) of soil contained polynuclear aromatics (PNA) or VOC contamination at levels that exceeded 100 milligrams per kilogram (mg/kg). Potential risk to local residents, particularly those living on the site, was high. Local residents could be exposed to PNA and VOC contamination through multiple routes (direct contact, ingestion, and inhalation).

In June 1988, TWC and EPA initiated the site's second RI/FS, which defined the nature and extent of contamination throughout the rest of the site (Operable Unit [OU] 2). In addition to Frontier Park Road, the RI/FS identified five areas of the nearly 500-acre site as waste disposal areas: the West Road Area (WRA), the Main Waste Area (MWA), the Office Trailer Area (OTA), the Easement Area (EA), and the Bayou Disposal Area (BDA). Figure 2 shows the location of these areas. Soil contamination identified during the second RI/FS included primarily VOCs (benzene up to 7,000 mg/kg) and PAHs (naphthalene up to 6,700 mg/kg). Underlying the contaminated soils, significant contamination in shallow ground water was detected and included primarily VOCs (benzene up to 480 milligrams per liter [mg/L]) and PAHs (naphthalene up to 13,000 mg/L). The shallow ground water zone is located approximately 18 to 30 feet below ground surface (ft bgs). Additionally, small isolated areas of soil contained lead concentrations up to 5,000 mg/kg.

Except for one sampling point in the deeper aquifer, all contaminated ground water was found in the shallow aquifer (upper 17 to 27 feet). The shallow aquifer is not currently being used as a source of drinking water. However, the shallow aquifer could be used as a source of drinking water in the future and is considered a class 2-B aquifer. Contamination in the shallow aquifer was determined to present future potential risks above health-based levels. Therefore, exposure to contaminated ground water was considered the primary risk at OU2.




LEGEND

- WEST ROAD AREA
- MAIN WASTE AREA
- OFFICE TRAILER AREA
- EASEMENT AREA
- BAYOU DISPOSAL AREA
- CR 126 WEST AREA
- RESIDENCES
- EFFLUENT FLOW

PETRO-CHEM SYSTEMS, INC.
(TURTLE BAYOU)
LIBERTY COUNTY, TEXAS

**FIGURE 2**
SITE MAP

PREPARED FOR: EPA

BY: Tetra Tech EM Inc.

## 4.0 REMEDIAL ACTIONS

The following sections discuss the remedies selected, remedy implementation, and system operations.

### 4.1 REMEDY SELECTION

The site was divided into two operable OUs. OU1 addressed contaminated soils at Frontier Park Road. OU2 addressed the rest of the site, including ground water. The first ROD for the site addressed OU1 and was signed on March 27, 1987. The remedial action objectives were to:

- Prevent direct contact with highly contaminated soils, defined as PAHs or total volatiles (TVS) in excess of 100 mg/kg.
- Minimize direct contact with moderately contaminated soils.
- Improve site access for heavy equipment to facilitate remedial investigation sampling, monitoring, and future remedial action.

The remedial actions at OU1 were:

- Excavate contaminated soils to below 100 mg/kg PAHs or 100 mg/kg TVS.
- Temporarily dispose of contaminated soils in an on-site storage facility
- Construct a road over excavated areas and existing roadways.
- Temporarily relocate on-site residents during construction.

The second ROD for the site addressed OU2 and was signed on September 6, 1991. The remedial action objectives were to:

- Prevent current or future exposure to contamination in soil through treatment and/or containment, as well as to reduce the migration of contaminants from soil to ground water.

- Address the principal risk posed by contaminated shallow ground water by returning it to its potential beneficial use and preventing future adverse impacts to lower ground water zones.

On April 30, 1998, EPA issued a ROD amendment for OU2. The amendment modified the 1991 ROD soil cleanup criterion for benzene, narrowed the site boundary from approximately 500 acres to only those contaminated portions of the property (and all suitable property very near to the contamination necessary for implementation of the RD/RA), and expanded the selected remedy for OU2; the remedial objectives remain the same.

OU2 includes the WRA, MWA, OTA, EA and BDA. The above-ground landfill, which is located in the MWA, has been considered a separate entity for treatment purposes. Figure 2 shows the location of these areas, and Tables 2, 3, and 4 list the selected remedy according to area. The selected remedy at OU2 as amended in the 1998 ROD Amendment includes:

- Dismantling the aboveground landfill and (if warranted) remedial action for the potentially contaminated soils underlying the vault.
- Soil vapor extraction—treating contaminated soils by removing volatile organdies from the vadose zone.
- In-situ thermal desorption to treat soil hot spots (characterized by benzene concentrations in excess of 100 mg/kg). This technology is essentially thermally enhanced soil vapor extraction.
- Soil excavation and off-site treatment and/or disposal of hot spots.
- Soil excavation and biotreatment—excavating soil from hot spots followed by on-site ex situ biotreatment.
- Soil washing—treating of contaminated shallow soils in place by cyclic or periodic injection and extraction of a wash solution.
- Aqueous phase soil bioremediation—fresh water, oxygen and nutrients are supplied to affected soils, promoting aerobic degradation by native microorganisms.
- In-situ aquifer bioremediation—nutrients and oxygen are supplied to contaminated ground water.

## TABLE 2

## REMEDIAL COMPONENTS FOR CONTAMINATED SOIL FOR OU2 FROM THE 1998 ROD AMENDMENT

| SOIL REMEDIAL COMPONENTS | West Road Area | Main Waste Area | Above Ground Landfill | Office Trailer Area | Easement Area | Bayou Disposal Area |
|---|---|---|---|---|---|---|
| Soil vapor extraction | 1 | 1 | 1 | 1 | 1 | N/A |
| Bioventing | 2 | 2 | 3 | 2 | 2 | N/A |
| Soil washing | 3 | 3 | 4 | 3 | N/A | N/A |
| Aqueous phase bioremediation | N/A | N/A | 2 | N/A | N/A | N/A |
| Containment | N/A | 4 | N/A | N/A | N/A | 1—Living Cap |
| Storm water management controls | 4 | 5 | 5 | 4 | 3 | 2 |
| Monitored natural attenuation | 5 | 6 | 6 | 5 | 4 | 3 |
| Institutional controls | 6 | 7 | N/A | 6 | 5 | 4 |

Note: The numbering indicates the anticipated application sequence of the remedial component for each area.

N/A Not Applicable

## TABLE 3

### REMEDIAL COMPONENTS FOR SOIL HOT SPOT FOR OU2 FROM THE 1998 ROD AMENDMENT

| Remedial Components Listed in Anticipated Application Sequence |
|---|
| Focused soil vapor extraction |
| Thermal desorption |
| Focused hot spot excavation and on-site biotreatment |
| Focused hot spot excavation and off-site disposal/treatment |
| Containment/infiltration control |

Note: This is the general sequence that will be followed in selecting the most suitable remedial component for any given hot spot.

## TABLE 4

### REMEDIAL COMPONENTS FOR CONTAMINATED GROUND WATER FOR OU2 FROM THE 1998 ROD AMENDMENT

| Ground Water Remedial Components | West Road Area | Main Waste Area | Office Trailer Area | Easement Area |
|---|---|---|---|---|
| In-situ bioremediation | 1 | 1 | 1 | 1 |
| Selected directional containment | 2 | 2 | 2 | 2 |
| Monitored natural attenuation | 3 | 3 | 3 | 3 |
| Institutional controls | 4 | 4 | 4 | 4 |

Note: The numbering indicates the anticipated application sequence of the remedial component for each area.

- Bioventing—provides an aerobic environment through air circulation in contaminated soil, encouraging biodegradation of contaminants by native microorganisms.
- Catalytic thermal destruction of extracted vapors from soil.
- On-site treatment plant to treat extracted ground water.
- Vertical infiltration control by a living cap for the BDA.
- Containment using a traditional synthetic liner cap for the MWA.
- Containment using a living cap which consists of a graded clay cap with selected vegetation (e.g., pine trees) planted and developed so as to minimize infiltration of rain water for the BDA.
- Selected directional containment (such as slurry wall).
- Installation of structures to control and treat surface water runoff.
- Monitored natural attenuation.
- Ground water monitoring.
- Restoration of the site surface when the remedy is complete.
- Institutional controls.

## 4.2 REMEDY IMPLEMENTATION

This section discusses implementation of the remedy at the site, addressing each OU individually.

### 4.2.1 OPERABLE UNIT 1

The first ROD for OU1, signed on March 27, 1987, called for the excavation of highly contaminated soil which was defined as containing PAHs or total volatiles in excess of 100 mg/kg, temporary disposal of highly contaminated soils in an on-site storage facility, construction of a road over excavated areas and existing roadway, and the temporary relocation of on-site residents during construction. The remedial design for OU1 began on June 5, 1987 and was completed on October 30, 1987. Approximately 5,900 $yd^3$ of highly contaminated soils ranging from one to five feet in depth were excavated along the first 1,800 feet of CR 126, and the excavated materials were placed in a temporary, above-ground landfill on-

site (in the MWA). The excavated area was backfilled with clean soil, and the entire length of the road was paved. This work was completed in August 1988.

### 4.2.2 OPERABLE UNIT 2

The 1991 ROD for the site addressed OU2. Soil vapor extraction (SVE) and ground water sparging formed the major components of the selected remedy. Since the Unilateral Administrative Order (UAO) was signed in 1993, the potentially responsible parties (PRPs), Lyondell Chemical Company (previously known as ARCO Chemical Company) and Atlantic Richfield Company, have been working with EPA and the Texas Natural Resource Conservation Commission (TNRCC) to complete the site's RD. The site's RD commenced on September 25, 1992, and ended on May 22, 1998.

In April 1998, EPA issued an amendment to the ROD, which modified some of the remedies outlined in the 1991 ROD. The amendment to the ROD identified in-situ bioremediation as the major remedial treatment component for ground water. The soil remedies were enhanced by identifying additional in-situ soil treatment technologies such as bioventing, thermal desorption, and soil washing, which may be used in combination with SVE to reach remedial goals. The remedy at the BDA was modified from an engineered soil and synthetic liner cap to a living cap consisting of a graded clay cap and selected vegetation.

Sampling and field pilot studies have been used to develop area-specific remedial systems which use combinations of the remedial technologies identified in the ROD Amendment. The systems are designed to be flexible so that they can be redefined in response to sampling data and field conditions. This was shown to be an effective means of addressing varying geologic conditions and area-specific contamination profiles at the site.

On December 8, 1998, the EPA entered into a Consent Decree with Lyondell Chemical Company and Atlantic Richfield Company. The Consent Decree supersedes the provisions of the UAO that address the obligations of Lyondell Chemical Company and Atlantic Richfield Company.

Most of the on-site construction has been completed as part of the extensive field pilot study. Institutional controls have not been developed. Minor modifications to the area-specific remediation systems are anticipated and may include installation of additional wells and area-specific treatment units. Progress has been made over the past few years in remediating the site. Previously known "hot spots" have been addressed. More hot spots may be encountered and will be addressed. Some areas of the site are being evaluated for monitored natural attenuation. Completion of active remediation at the site is anticipated in the fall of 2002.

Within the past year, a new source area (CR 126 West Area) has been identified; the contaminants of concern are 1,1-dichloroethane, vinyl chloride, and benzene. Characterization of this area is in progress.

Because of the complex nature of the remedial strategy at OU2, it is impractical to provide a chronological discussion of remedy implementation individually for each of the contaminated areas within OU2. The following subsections provide information on whether remedial actions at the site have been consistent with the selected remedy in the 1998 amendment to the ROD.

#### 4.2.2.1 SOIL REMEDY

Soil vapor extraction systems were constructed and have been functioning since July 1998.

Three thermal desorption units are being used to treat hot spots at the site. The first unit began operating in June 1998, the second unit in March 1999, and a third unit in October 1999. Media and process sampling are used to identify areas that could be best addressed by thermal desorption. These units are moved from one area to another, as needed.

Soil from a hot spot in the Easement Area has been excavated and is being remediated by ex-situ on-site bioremediation. Surface water diversion structures have been installed to divert runoff from the treatment area to the on-site water treatment plant.

Soil flushing using surfactants was conducted at a pilot-scale level in the West Road Area. Based on the inconclusive results of the pilot-scale work, this technology has not been used subsequently at the site.

The 1998 amendment to the ROD identified construction of a living cap in the BDA. The purpose of the living cap was to prevent surface water infiltration into the underlying ground water. Previous data from the OU2 RI showed that the ground water in the BDA had benzene contaminant concentrations slightly above the cleanup criteria. The recent results of three quarters of ground water sampling did not show any contamination above the ground water cleanup criteria. Additional rounds of quarterly ground water sampling in the BDA are planned. Based on the sampling results, the need to construct the cap will be reevaluated.

Containment using an engineered soil and synthetic liner cap in the MWA was listed as an anticipated remedial component of the 1998 amendment to the ROD. Based on remedial progress in the Main Waste Area, this technology has not been required.

#### 4.2.2.2 GROUND WATER REMEDY

In-situ bioremediation (ISB) units consisting of ground water extraction and injection systems have been functioning since July 1998. These systems operate by cyclic injection and extraction of nutrient-rich water, which raises and lowers the water table, thereby flushing and aerating the aquifer.

Selected directional containment using a slurry wall, listed as a ground water remedial component in 1998 amendment to the ROD, has not been required.

#### 4.2.2.3 TREATMENT SYSTEMS

A wastewater treatment plant (WTP) and two thermal oxidizers are the primary contaminant treatment systems.

The WTP is located in the MWA and comprises biotreatment towers, a nutrient/inoculation system, aeration basin, mechanical clarifier, effluent basin, carbon filters, and a total organic carbon (TOC) analyzer. Surface water runoff and water produced by all project wells form the influent for the WTP. The treated water is eventually discharged into Turtle Bayou.

Two thermal oxidizers have been used to combust contaminant vapors produced by SVE. Currently one is located in the MWA adjacent to the aboveground landfill, and the other in the EA. Pilot tests concluded that VOC destruction efficiencies for the oxidizers exceeded 99.87 percent and 99.98 percent.

## 4.3 SYSTEM OPERATIONS

System operation requirements include:

- **ISB Operation.** Operate extraction and injection wells in focused areas. Measure, record, and evaluate operating data to optimize system performance. Adjust and calibrate the system as required.

- **SVE Operation.** Operate vapor extraction and air injection systems in focused areas. Measure, record, and evaluate operating data to optimize system performance. Adjust and calibrate the system as required.

- **Bioventing Operation.** Convert SVE or ISB systems to bioventing mode as soon as indicated by progress data. Measure, record, and evaluate operating data to optimize system performance and expedite the transition to natural attenuation. Adjust, calibrate, and refine the system as required.

- **Thermal Desorption Operation.** Operate soil watering systems (i.e., sprinkler irrigation used to prevent soil cracking leading to atmospheric inflow) in conjunction with soil vapor extraction. Measure electric current, potential difference, and electrode temperature.

- **Soil Flushing Operation.** Operate injection wells and pumping wells on a 25 to 35-day cycle to wash affected soils in certain areas with nutrients and oxygen. Measure and record flow rates, dissolved oxygen, and chemical composition.

- **Natural Attenuation.** Turn off ISB and SVE systems and allow natural attenuation to remediate the site. Sample and evaluate the status of affected soil and ground water. Predict progress versus performance standards. Refine the system as required.

- **Process Sampling.** Sample the operational systems as per the sampling and analysis plan (SAP) and the quality assurance project plan (QAPP). Record the process data, evaluate them, and make necessary adjustments to keep process parameters within optimum ranges.

- **Progress Sampling.** Sample soils and ground water in the target remediation areas. Evaluate progress versus performance criteria and operating status.

- **Well Drilling.** Install production wells, injection wells, and monitoring wells as required to optimize the remedial process in a timely, cost-effective, and environmentally sound manner.

- **Focused Construction.** Construct modifications, additions, and refinements to the remediation systems as necessary to optimize progress.

- **Maintenance.** Repair, adjust, calibrate, replace, and revise various components of the remediation systems as necessary to optimize remedial progress. Evaluate the performance of system and components and make appropriate changes to improve performance.

As of July 31, 2000, a total of 69,102,227 gallons of treated water have been discharged from the WTP to Turtle Bayou. The in-situ bioremediation system recorded totals of 71,068,230 gallons of injection water, 138,636 pounds of oxygen, and 55,103 gallons of ammonium nitrate/diammonium phosphate/potassium sulfate blend. The volume of soil vapor extracted by the SVE system to date has been 454,336,140 cubic feet ($ft^3$). The volume of air injected to date has been 5,746,848 $ft^3$. Hazardous wastes shipped off site include 93,500 gallons of ground water, 19,500 pounds of carbon, and 20 $yd^3$ of soil. Nonhazardous waste shipped off site includes 2,138,067 gallons of ground water, 29,050 pounds of carbon, 11,560 $yd^3$ of soil, and 36 $yd^3$ of personal protective equipment.

Each thermal desorption unit is operated in a specific area for 90 to 100 days. The unit is then shut down and relocated to another area where the VOC content in the soil is elevated.

Interviews with site personnel revealed that air injection as a part of soil vapor extraction operations was halted after pilot tests. It was determined that comparable soil vapor extraction removal efficiencies could be achieved without air injection.

All water produced by project wells and run-off from contaminated soils is treated in the on-site treatment plant and released to Turtle Bayou. Biomass (i.e., sludge) from the WTP is applied on the surface of the aboveground landfill to promote vegetative growth.

The organic vapors from the vacuum extraction wells are treated in the thermal oxidizers. The thermal oxidizers are operated continuously with periodic shutdowns for maintenance, at which time the vapor extraction wells are also shut down. ROG maintains records of inlet flows and combustion chamber

temperature. The inlet and outlet are sampled daily to calculate the destruction efficiencies of the oxidizers.

## 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 Petro-Chemical Systems, Inc. site five-year review team included Rick D. Smith, Douglas Czechowski, Chitranjan Christian, and Matt Garcia. The five-year review was conducted in accordance with EPA's Comprehensive Five-Year Review Guidance. 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.

This five-year review for the site consisted of the following activities: (1) a review of relevant documents, (2) a site inspection, and (3) interviews with local government officials, ROG representatives, and site property owners (Appendices B and C). Pursuant to EPA's SOW, O&M costs were not evaluated as part of this review. On June 30, 2000, an open house announcement and fact sheet was mailed to more than 250 local residents and government officials. The open house was conducted at the site on July 11, 2000. In addition, a notice of the forthcoming five-year review appeared in the local newspaper (The Vindicator) on July 9, 2000. The completed five-year review will be mailed to the information repository at the Liberty County Library.

## 6.0 FIVE-YEAR REVIEW FINDINGS

The following sections discuss the findings of the interviews, site inspection, applicable or relevant and appropriate requirements (ARARs) review, and data review.

## 6.1 INTERVIEWS

Interviews were conducted in person or by mail response. Interviews took place during the site visit on June 28, 2000, and during the open house which was attended by 15 local residents on July 11, 2000, from 5 to 7 p.m. Open house and interview summaries are located in Appendix C.

The following persons were interviewed either by mail response or in person as part of the five-year review.

- Mr. Mark Collins, ROG (June 28, 2000)
- Ms. Luda Voskov, TNRCC Project Manager (August 3, 2000)
- Mr. J. L. Sonny Davis, Liberty County (July 11, 2000)
- Mr. John Chaplain, Property Owner (July 11, 2000)
- Mr. George Evans, Property Owner (July 11, 2000)
- Mr. John L. Carrell, Property Owner (July 11, 2000)
- Mr. Ronnie Worthy, Property Owner (July 11, 2000)
- Mr. T. R. Bennett, Property Owner (July 11, 2000)
- Mr. Roger Ray, Property Owner (July 11, 2000)

Mr. Mark Collins, the Operations Manager for ROG on-site, stated that operations are going well at the Petro Chemical Systems, Inc. Site. He also stated that remedial progress is being made at the site.

Ms. Luda Voskov, the TNRCC Remediation Project Manager for the site, stated that remedial activities are underway at the site with aggressive use of the various remedy components in succession. Numerous field pilot studies have shown that a flexible approach is an effective remedial strategy for the site. Ms. Voskov has been consistently involved in EPA monthly meetings, site visits, remedial site activities, and inspections to monitor the progress of remedial actions. All copies of documentation related to on-going remedial activities at the site are sent to the TNRCC project manager for review and comment.

In addition, Ms. Voskov stated that the TNRCC's major concern is that an insufficient number of summary reports illustrate the progress of the remedy for the site and document the trends as contaminant concentrations decrease. Additionally, for the Bayou Disposal Area, TNRCC has not seen any ground water monitoring data and summary reports to confirm direction of groundwater flow for this area of concern.

Mr. J. L "Sonny" Davis, Liberty County, Permits, Building & Septic Subdivisions and Flood Plain Administrator, recommended that a formal notification process be implemented and coordinated with Liberty County to inform new residents moving into the area that the site exists.

Mr. John Chaplain, property owner, stated that Lyondell has been informative, helpful, and pleasant at all times and will always answer questions posed.

Mr. George Evans, property owner, is concerned about the present and future condition of the water wells in the area of the site. Mr. Evans also wanted to know what could be done to improve the drinking water.

Mr. John L. Carrell, property owner, stated that he feels that the site will take longer than originally expected to clean up. He also feels that the site has lowered property values. Mr. Carrell suggested that a quarterly update on the site progress would help keep him informed. He feels that he should be compensated for the monitoring wells that were drilled on his land because it restricts his use.

Mr. Ronnie Worthy, property owner, stated that the water level in his well level has dropped 15 feet, and it has hardened. Mr. Worthy also feels that chemicals are contaminating the water supply, and that housekeeping around the site could be improved. Mr. Worthy feels that a lot of investigation is going on and that the site is not being cleaned up.

Mr. T. R. Bennett, property owner, stated that ROG keeps the site very clean. He also stated that the site has not had any effect on him and that Mark Collins, ROG, and Mr. Dick Sloan, Lyondell, have always cooperated with him at all times.

Mr. Roger Ray, property owner, would like a study conducted on wildlife and domestic animals in the area of the site to evaluate whether the animals are being exposed to the chemicals on-site.

## 6.2 SITE INSPECTION

Tetra Tech conducted the site inspection on June 28, 2000. Mr. Mark Collins, Operations Manager with ROG, attended the inspection and provided information about previous and current remedial operations. A summary of the inspection findings is presented below. Appendix B includes a copy of the site visit report. Exhibit 1 of Appendix B includes site photographs, and Exhibit 2 of Appendix B includes the site inspection checklist.

Ambient conditions during the site inspection consisted of a partly cloudy sky with temperatures in the 90s. Some precipitation had been recorded in the area for several days prior to the inspection. There was no precipitation during the site inspection.

Tetra Tech reviewed operations records for the site, which are kept inside the trailer at the OTA. Also on hand were as-built drawings, maintenance logs, the site health and safety plan, and daily access and security logs. Tetra Tech verified that the Occupational Safety and Health Administration (OSHA) training logs were available and current. Tetra Tech reviewed the discharge permit and one amendment application for the WTP. Air permits for the thermal oxidizers are not required since the units operate within the requirements of TAC 106.4, a standard exemption. All waste manifests for wastes shipped off site are kept at the OTA security office and at 2502 Sheldon Road in Channelview, Texas.

EPA and Tetra Tech representatives walked the site with Mr. Collins and visually examined on-going remedial operations and current site conditions. The operations at the site are designated by area and include the WRA, MWA, OTA, EA, BDA, and CR 126 West Area. The aboveground landfill and the WTP are located in the MWA, and areas of focused remedial operations occur within each of the main areas listed above.

At each area, the review team inspected approximately 35 percent of the monitoring well pads and covers, and extraction and injection well pads, covers, and wellhead plumbing including valves,

regulators, gauges, and manifolds, as applicable. The electrical components and transformers for the three in-situ thermal desorption (ISTD) systems were also inspected. The review team inspected visible sections of the nutrient injection, ground water extraction and injection, and SVE system pipelines, as well as the liquid ring pumps and thermal oxidizers and the aboveground storage tanks for nutrient injection, including the electric pumps and mixing systems. The nonpotable water well and associated systems were also inspected. The review team observed all wells, appurtenances, pipelines, and treatment systems to be operating and functioning properly. The electrical enclosures and panels for the thermal oxidizers, liquid ring pumps, and ISTD systems were marked and appeared to be in good condition. The review team noted the equipment to be properly identified, with sampling ports properly marked and functional. Mr. Collins indicated that total VOC concentrations were measured daily at the influent and effluent ports at the thermal oxidizers.

Minor oil staining was noted on the concrete pads under the liquid ring pumps and on the gravel adjacent to the concrete pad at the MWA. Mr. Collins indicated that any oil spills that occur during pump maintenance are promptly cleaned up. The staining does not appear to represent an environmental concern.

The review team observed a small leak in one of the injection wells along CR 126. Tetra Tech noted algae on the well casing and water pooled around the well. No contaminants are being released to the environment. Some of the ISTD wells along CR 126 are fenced and protected with guard rails, whereas the remaining wells are unprotected. Photocell lights on power poles along CR 126 provide additional security at night.

The WTP is located at the MWA and processes ground water from all remedial systems at the site. Electric submersible pumps extract and pump ground water to the treatment plant though pipelines. Effluent from the plant is continuously monitored for TOC inside a process control laboratory. Measurements for dissolved oxygen (DO) and pH are recorded daily. Air is monitored periodically at the WTP to ensure that no dangerous levels of VOC vapors enter the atmosphere.

The aboveground landfill is located in the MWA. The review team observed a healthy cover of well-kept vegetation. Approximately 4,000 gallons per month of sludge from the treatment plant are mixed with

water and applied to the vegetation using a sprinkler system. Two small areas of patchy vegetation were noted on the west end of the landfill. According to Mr. Collins, ROG recently cut the slope back to allow for mowing, and the vegetation had not completely filled in. Soil erosion was not observed.

ROG recently excavated 1,000 cubic yards of soil from a naphthalene hot spot in the EA and placed it in a treatment area for ex-situ bioremediation. Surface runoff is controlled by a perimeter trench and sump excavated into native soil around the area. A portable (gasoline engine) pump and flexible hoses are used to transfer collected rainwater to a pipeline connection, which then transfers the water to the treatment plant. Air is monitored periodically as discussed in the site's Ambient Air Monitoring Plan (AAMP). The AAMP provides guidance to protect the public from exposure to any potential emissions from remedial action activities. The treatment area and runoff collection system appeared to be properly constructed and well maintained.

At the BDA, the review team noted that ground water is being monitored quarterly. No active remediation is underway at the BDA. Tetra Tech observed broken hinges on the locking well cover at monitoring well MW-59. All remaining wells, covers, and pads that were observed appeared to be secure and in good condition.

At the CR 126 West Area, no remedial activities had been implemented at the time of the site inspection. The area is still being delineated with soil borings and monitoring wells. The Chandler residence and water well are located nearby. All monitoring wells, covers, and pads appeared to be secure and in good condition.

No significant items of concern were observed during the site inspection. With very minor exceptions, all remediation and treatment system components appeared to be in good condition and were well maintained.

The site has access controls, such as fencing and warning signs, in place. Certain areas of focused remediation along CR 126 are fully fenced. The OTA and MWA are partially fenced, and have gates that prevent trespassing from CR 126. Security signs stating "Superfund Remediation Site—Do Not Enter Without Proper Authorization or Protective Equipment" are located on the security fence at the OTA and

MWA. Overall site access is controlled by security personnel who patrol the site at 30-minute intervals 24 hours a day.

The access controls for the site appear to be adequate. However, vehicular traffic along CR 126 presents a potential hazard to wells, appurtenances, and pipelines near the road. In addition, unauthorized access from CR 126 to portions of the site is possible if it is unnoticed by security patrols.

## 6.3 ARAR REVIEW

The September 1991 ROD and April 1998 amendment to the ROD identified many different ARARs and supporting regulations pertaining to the site. Types of ARARs applicable to the site include:

- Federal requirements under RCRA § 3005, 40 CFR 122 pertaining to on-site wastes that qualified as RCRA characteristic hazardous wastes
- Certain local operating permits or licenses
- Federal manifests for transportation under RCRA § 3002 (5), 40 CFR 262
- State hazardous waste manifest laws
- State permits or licenses for transporting hazardous wastes
- Response in a flood plain, Federal Executive Order 11988

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

### 6.3.1 CHEMICAL-SPECIFIC ARARs

Chemical-specific ARARs are health or risk-based numerical values or methodologies that, when applied to site specific conditions, establish the acceptable amount or concentration of a chemical that may be found in or discharged to the ambient environment. If more than one chemical-specific ARAR exists for a chemical of concern (COC), the most stringent level would be identified as an ARAR for the remedial action.

Chemical-specific ARARs for the site include:

- **National Primary Drinking Water Standards.** These standards establish maximum contaminant levels (MCL) for drinking water. Performance standards have not yet been attained. The site is still in the remedial action phase.

- **Land Disposal Restrictions.** RCRA characteristic hazardous waste designations, including land disposal restrictions (LDR), are applicable for certain COCs should they be removed and placed off-site. No additional off-site disposal is anticipated.

- **Ambient Air Quality Standards.** Also listed in the 1991 ROD as chemical-specific ARARs were the National Ambient Air Quality Standards (NAAQS), 40 CFR Part 50, which establish regulations for specific air pollutants. These ARARs continue to apply. Recent air monitoring data collected have shown that thermal oxidizers continuously met effluent criteria and destruction efficiency (as per the March and May 2000 Monthly Status Reports). For lead (identified as a COC for the site), 1.5 micrograms per cubic meter ($\mu g/m^3$) as a quarterly average is the primary and secondary NAAQS. For particulates, 150 $\mu g/m^3$ is the primary and secondary NAAQS for particulate less than 10 microns in size (PM-10). However, neither lead nor particulate monitoring results were reported among the analytical data summarized in the latest available monthly progress reports.

- **Clean Water Act.** Sections of the Clean Water Act, Water Quality Criteria (WQC) and Ambient Water Quality Criteria (AWQC) (40 CFR Part 131), set criteria for water and ambient water quality based on toxicity to human health and toxicity to aquatic organisms. WQCs and AWQCs for site chemicals are ARARs. The Texas Surface Water Quality Standards, or TSWQS (set forth in Title 30 of the TAC, Chapter 307), also apply. With respect to the pertinent site-specific COCs, changes to the TSWQS for lead and benzene were proposed on July 26, 2000. Table 2-6 of the 1998 Amendment to the ROD sets forth discharge limitations for the site. The daily maximum effluent limits for lead (500 micrograms per liter [µg/L] daily average) and benzene (500 µg/L total benzene, toluene, ethyl benzene, and xylene [BTEX]) may need to be re-evaluated to determine whether these limits continue to be protective of Turtle Bayou if the proposed changes to the TSWQS are adopted.

- **Texas Pollutant Discharge Elimination System.** In conjunction with the Clean Water Act requirements listed above, the requirements of the National Pollutant Discharge Elimination System (NPDES) set forth in 40 CFR Part 125, were listed as an ARAR in the 1991 ROD.

### 6.3.2 LOCATION-SPECIFIC ARARs

Location-specific ARARs are restrictions on remedial activities solely based on the location of the remedial activity. 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 1991 ROD and 1998 amendment to the ROD identified some location-specific ARARs pertaining to the site:

- **Flood Plain Management.** Executive Order No. 11988 (40 CFR 6 Appendix A, as part of compliance requirements of the National Environmental Policy Act) dictates that federally funded or authorized actions within the 100-year flood plain avoid, to the maximum extent possible, adverse impacts associated with the development of a flood plain. A facility located in a 100-year flood plain must be designed, constructed, operated, and maintained to prevent wash out of any hazardous waste by a 100-year flood, unless the owner or operator can demonstrate to EPA's satisfaction that waste can be removed before flood waters arrive and that no adverse health hazards are at risk if flooding occurs.

  RCRA requirements for the location of a treatment, storage, or disposal facility in a flood plain (40 CFR 264.18) were noted to apply in the 1991 ROD and in the 1998 amendment to the ROD. At present, Federal Executive Order 11988 requirements are being met, to the extent possible. During recent heavy rainfall (May 20, 2000), the area around Liberty received more than 19 inches of rain within 24 hours. The site was not significantly compromised. The site overall complies with the flood plain management ARARs.

- **Ground Water Restoration.** The State of Texas Rules, Groundwater Protection Act (Title 26 of the Texas Water Code [TWC], or 26 TWC .401-.406) was cited in the 1991 ROD and 1998 amendment to the ROD as a location-specific ARAR. It is applicable because the site's underlying ground water is affected. This rule requires ground water to be restored, if feasible. Ground water has not yet been restored at the site, as remediation is still underway.

### 6.3.3 ACTION-SPECIFIC REQUIREMENTS

Action-specific ARARs are usually technology or activity-based requirements or limitations on actions taken with respect to hazardous wastes. These requirements are triggered by the particular remedial activities that are selected to accomplish a remedy. Since 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.

- **RCRA.** Action-specific guidelines for areas which may be capped as set forth in 40 CFR 264 include the following: (1) conduct and maintain post-closure care for 30 years; (2) maintain the integrity and effectiveness of any final cover, including making repairs to the cover as necessary to correct the effects of settlement, subsidence, erosion, or other events, and preventing run-on and run-off from eroding or otherwise damaging the final cover; (3) maintain and operate a leachate collection system unless leachate is deemed to be no longer a threat to human health and the environment; (4) monitor ground water and adequately maintain the ground water recovery system; (5) develop a written post-closure plan that includes a description of monitoring and maintenance, and the name, address, and telephone number of the person or office to contact about the facility during the post-closure period; and (6) document a description of the planned uses of the property during the post-closure period.

  When the site is prepared to enter the O&M period, an O&M plan will outline the type and frequency of monitoring and maintenance activities to be performed at the site.

- **Fugitive Emissions Monitoring Requirements.** These requirements, specified in TNRCC 30 TAC Chapter 115 (Regulation V), EPA's New Source Performance Standards (40 CFR Part 60), or EPA's National Emission Standards for Hazardous Air Pollutants (40 CFR Part 61), apply, as per the 1998 amendment to the ROD. The Clean Air Act, under the regulatory section on Permitting (40 CFR Part 61), requires permits to discharge pollutants from point sources, area sources, and fugitive emissions. The substantive requirements for a permit are required for discharge. Recent monthly status reports (March and May) indicated that the frequency of ambient air sampling has been reduced, since historical data indicated no potential for exposure downwind and no upwind ambient air influence. Thus, the site complies with this ARAR.

- **Landfill Closure Requirements.** Since hazardous waste will be left on-site, "landfill" closure requirements in 30 TAC Chapter 335 Subchapter E and F are relevant. RCRA regulations that affect landfill closure require the site to be capped, with a final cover designed and constructed to provide long-term protection of human health and the environment by minimizing infiltration of liquids through the capped area and properly maintaining the integrity of the cap over time. Provisions in the 1998 amendment to the ROD allow for a "living cap" (accepted by the TNRCC to meet its requirements) rather than a RCRA (engineered soil and synthetic liner) cap. Should the living cap be built, this requirement will be an ARAR. The Solid Waste Disposal Act, Contingency Plan for Emergency Procedures, Subpart D, was also determined to be applicable in the 1991 ROD since on-site treatment had been selected.

- **Deed Recordation.** Where wastes will remain in place, 30 TAC Chapter 335 Subchapter A (Rule 335.5) requires that the property be deed-recorded. Additional deed recordation

will be required per 30 TAC 335 Subchapter S (Section 335.560 and 335.566). The need for specific institutional controls, such as deed recordation should be evaluated.

- **Air Emissions.** The requirements of 30 TAC Chapter 106 (and specifically, 30 TAC 106.533, formerly TACB Standard Exemption No. 68) are applicable as noted in the 1991 ROD and 1998 amendment to the ROD since vapor extraction and catalytic oxidation are part of the remedy. The exemption states that for soil and ground water stripping, the total emissions of air contaminants (except nitrogen, carbon dioxide, air, oxygen, and water vapor) should not exceed five pounds per hour, and total emissions of petroleum hydrocarbons should not exceed one pound per hour. Benzene emissions must also meet the conditions of 30 TAC 106.262(3) and (4) relating to Facilities Emissions and Distance Limitations, previously known as TNRCC Standard Exemption No. 118. Soil stripping operations must be conducted at least 1,000 feet from any residence or other structure or recreational area not occupied or used solely by the operator of the property on which the operations are conducted. As noted in recent monthly status reports, air emissions are within acceptable limits, and therefore, compliance with this ARAR is being attained.

- **Offsite Disposal.** Off-site disposal of waste will need to comply with EPA's Off-site Rule (40 CFR Part 300.440) and with all current federal and state regulations for transport of waste to the receiving facility. Recent reports (such as the March 2000 monthly status report) indicate that compliance with appropriate disposal regulations as per the Transportation and Disposal Plan is occurring.

- **Contingency Planning.** The Solid Waste Disposal Act, Contingency Plan for Emergency Procedures, Subpart D, is applicable since on-site treatment has been selected. In accordance with the October 28, 1999, Release Prevention/Contingency Plan (RP/CP) for the remedial operation phase, procedures to be used in the event of a major incident are in place, including provisions for an uncontrolled spill or the emission of volatile materials in excess of the established action levels or the reportable quantity as defined by the EPA in 40 CFR 302.4. Thus, the site is in compliance with this ARAR.

- **Containers/Tanks.** The 1991 ROD and 1998 amendment to the ROD indicated that the Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal (TSD) Facilities, Subpart I (Use and Management of Containers), and Subpart J (Tanks) apply. These are ARARs for ground water since the site operations store containers of hazardous waste and use tanks to treat or store hazardous materials. Secondary containment (concrete berms) and lined earthen berms are in place; therefore, the site complies with this ARAR.

- **Injection Control.** The Safe Drinking Water Act, Underground Injection Control Regulations set forth in 40 CFR Parts 144-147 were listed in the 1991 ROD and 1998 amendment to the ROD as applicable if ground water remediation involves injection to enhance remediation. These regulations provide for the protection of underground sources of ground water. Initial phases of the remedial action used limited sulfate

injection to enhance natural attenuation, but injection is not currently used in remedial operations. Therefore, this ARAR is not applicable.

### 6.3.4 TO BE CONSIDERED REQUIREMENTS (TBCs)

Many Federal and State environmental and public health agencies develop criteria, advisories, guidance, and proposed standards that are not legally enforceable but contain information that would be helpful in carrying out, or in determining the level of protectiveness of, selected remedies. In other words, "to be considered" (TBCs) materials are meant to complement the use of ARARs, not to compete with or replace them. The following were identified as TBCs:

- **Archeological Concerns.** A location-specific ARAR, the Archeological and Historic Preservation Act, 16 USC 469, 40 CFR 6301[c], has not been triggered. This ARAR establishes procedures to preserve historical and archeological data that could be destroyed through terrain alteration as a result of federal construction projects or federally licensed activities or programs. No archeological concerns have been discovered at the site.

- **Flood Plain Management and Protection of Wetlands.** Under 44 CFR Part 9, Federal agencies are required to evaluate the potential effects of actions they may take in a flood plain to avoid, to the extent possible, the adverse impacts associated with direct and indirect development of a flood plain. This is applicable since the eastern end of the site is within the 100-year flood plain of the Turtle Bayou tributary.

## 6.4 DATA REVIEW

The lack of a well-defined scale to gauge progress as well as the unavailability of electronic data have limited this review's ability to evaluate progress at this time. For this reason, it is also not possible to confirm a projected completion date for active remediation at OU2. However, the PRP contractor estimates the end of 2002 as a target date for completion of active remediation activities.

In order to assess progress, Tetra Tech conducted a visual inspection of available plume maps. Ground water plume maps in monthly progress reports submitted by Lyondell from June 1999 to May 2000 were reviewed. Benzene was the only COC addressed in these maps. The reports did not contain COC plume maps for soil (although some reports presented soil vapor plumes).

Monthly progress reports state that ground water plumes are shrinking steadily. A comparison of historical ground water boundaries of plumes depicted on plume maps with current plume boundaries supports this statement. A comparison of plume maps for shallow ground water from the Remedial Operations Plan and the May 2000 monthly progress report shows that concentration distributions for benzene have changed over time to show a greater density in lower-concentration ranges of the plume. This change is an indication of progress. COC concentrations in ground water, however, remain elevated above the cleanup criteria.

Monthly progress reports state that contaminant concentrations in soil generally have achieved cleanup criteria, except in focused "hot spot" areas. These reports also state that progress of the ISB and SVE is consistent with expectations and that thermal desorption has worked well.

The ground water treatment system and thermal oxidizers have been operating in compliance with ARARs.

A review of the HASP and contingency plan indicates that both are in place, are adequate to control risks at the site, and are being properly implemented.

In August 1999, a new source area (CR 126 West Area) was identified. A review of limited analytical data for this area indicated that benzene and 1,1-dichloroethane seem to be the principal contaminants in soil, while vinyl chloride and 1,1-dichloroethane seem to be the principal contaminants in ground water.

In summary, progress is being made, but cleanup criteria for soil and ground water are yet to be achieved.

## 7.0 ASSESSMENT

The following conclusions support the determination that the remedy at the site is expected to be protective of human health and the environment upon completion.

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

- **HASP/Contingency Plan.** Both the HASP and contingency plan are in place, are adequate to control risks, and are being properly implemented.

- **Implementation of Institutional Controls and Other Measures.** Access controls such as fencing and warning signs are in place. Although only parts of the site are fenced, trespassing is prevented by security personnel who patrol the site 24 hours a day. Institutional controls restricting ground water use or land excavation have not been developed.

- **Remedial Action.** The OU2 remedial action is progressing. The selected remedies continue to be effective in removing COCs. The construction of the "living cap" in the Bayou Disposal Area has not commenced. Three rounds of quarterly ground water sampling in the Bayou Disposal Area have occurred. Five additional rounds of quarterly ground water sampling are planned. After each round of ground water sampling, Tetra Tech prepares a trip report documenting the sampling activities conducted. Analytical results of the sampling rounds are provided by the EPA Houston laboratory, which to-date has performed all analyses. At the completion of the eight rounds of sampling, Tetra Tech will prepare for EPA's review and approval a summary ground water monitoring report. The report will consist of the ground water data from the eight sampling rounds, statistical analysis of the data, an evaluation of whether or not the site has met the ground water cleanup standards, and conclusions and recommendations. For the three completed sampling rounds, contaminants of concern were not detected above their respective cleanup criteria. Based on a review of the eight sampling round results, the need to construct the cap will be reevaluated.

- **System Operations/O&M.** System operations procedures are consistent with requirements.

- **Cost of System Operations/O&M.** The total estimated remedial cost of the project is $33,000,000 in EPA and PRP costs. O&M cost analysis was not a part of the SOW for this review.

- **Opportunities for Optimization.** Optimization of the remedial process has been a continuous activity since the start of remedial action. Progress monitoring and subsequent modification of remedial systems to maintain removal efficiencies was included as an operational requirement during the design phase and has been a part of system operations.

- **Early Indicators of Potential Remedy Failure.** No early indicators of potential remedy failure were noted during the review.

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

- **Changes in Standards and To Be Considered Requirements.** Changes to 30 TAC 307.6(c)(8) may need to be evaluated.
- **Changes in Exposure Pathways.** There have been no changes in exposure pathways.
- **Changes in Toxicity and Other Contaminant Characteristics.** The TNRCC's risk calculation, which was used to determine the residential exposure standard for benzene in soils from 0 to 2 feet below ground surface, has changed since the amendment to the ROD set the soil benzene cleanup criteria for 0 to 2 feet below ground surface at 1.33 mg/kg. However, this change does not affect the protectiveness of the remedy.
- **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 after remediation criteria have been achieved.

## 8.0 DEFICIENCIES

Two deficiencies were discovered:

- Lack of institutional controls such as deed restrictions and community notification for construction excavation and well installation in the site area.
- Particulate monitoring results were not reported among analytical data summarized in the latest available monthly reports.

Deficiencies are outlined in Table 5.

TABLE 5

IDENTIFIED DEFICIENCIES

| Deficiencies | Currently Affects Protectiveness (Y/N) |
|---|---|
| **Institutional Controls** | |
| No institutional controls have been developed. | Y |
| **Particulate Monitoring** | |
| Particulate monitoring has not been reported. | N |

## 9.0 RECOMMENDATIONS AND FOLLOW-UP ACTIONS

While not affecting the protectiveness of the remedy at this time, considering the amount of monitoring data generated at this site, it is recommended that an established statistical technique be employed to quantify remedial progress to enable the monitoring data to be presented in more meaningful terms.

To effectively assess the progress of the remedy, it is suggested that consolidated annual reports be submitted analyzing progress in the following ways:

- Trends showing the temporal variation of total amounts of COCs present in all media for each waste area. Tetra Tech has recommended that 3D kriging be employed in estimating the mass of COC present.
- A statistical procedure that incorporates methods of trend analysis and statistical comparison tests should be used to establish concentration trends for COCs in all media addressed and quantify reduction over time.

Institutional controls should be developed to ensure the protectiveness of the remedy in the future.

Particulate monitoring results were not reported among analytical data summarized in the latest available monthly reports. It is recommended that particulates be monitored whenever there are soil moving operations, to ensure compliance with NAAQS.

During the interview portion of the this five-year review, some residents informed EPA that they are concerned about ecological effects that may be linked to contaminants at the site. One resident alleged that boils on deer, tumors on pigs, and multiple liver cancers in domestic dogs have been observed over the past 16 months. These complaints have not been investigated, nor have they been substantiated at this time. To facilitate investigation and documentation of these complaints, additional information should be gathered from the site residents. Water samples from the resident's wells who expressed concerns should be sampled and analyzed for site contaminants. If warranted, surface soil samples may be collected. Subsequent investigatory steps may be taken pending results of the preliminary investigation.

Recommendation and follow-up actions are outlined in Table 6.

## 10.0 PROTECTIVENESS STATEMENTS

The protection of human health and the environment by the remedial actions at OU1 and OU2 is discussed below. Both the HASP and the contingency plan are in place, are adequate to control risks, and are properly implemented.

### 10.1 OPERABLE UNIT 1

The remedy at OU1 is protective of human health and the environment. The objectives of the remedy to prevent direct contact with highly contaminated soils (more than 100 mg/kg total PNAs or 100 mg/kg total VOCs) and minimize direct contact with moderately contaminated soils (between 10 and 100 mg/kg PNAs or 10 and 100 mg/kg total VOCs) were achieved. The remedial action for this OU as described in Remedial Action Report for Frontier Park Road was completed in August 1988. No developments that call into question the protectiveness of the remedy have been reported.

## TABLE 6

## RECOMMENDATIONS AND FOLLOW-UP ACTIONS

| Deficiencies | Recommendations/ Follow-up Actions | Party Responsible | Oversight Agency | Milestone Date | Follow-up Actions: Affects Protectiveness (Y/N) |
|---|---|---|---|---|---|
| Lack of institutional controls | Develop institutional controls | PRP | EPA | | Y |
| Particulate monitoring not reported | Report particulate monitoring | PRP | EPA | | N |
| No definable deficiency | Gather and evaluate additional information (i.e., interviews, property inspection, environmental sampling - e.g., well water) regarding ecological concerns. | EPA | EPA | Unknown | Unknown |

Notes:

EPA U.S. Environmental Protection Agency
PRP Potentially Responsible Party

### 10.2 OPERABLE UNIT 2

The remedy at OU2 is expected to be protective of human health and the environment after cleanup criteria are achieved. Remedial operations are still in progress. The PRP contractor estimates the active remedial action at OU2 will be completed at the end of 2002.

### 10.3 CR 126 WEST AREA

In August 1999, a new source area (CR 126 West Area) was discovered by Remedial Operations Group, Inc. (ROG), the PRP contractor, during a routine sampling event. Contaminant characterization is in progress, and EPA is currently reviewing alternatives to address this area. Because this area was not previously addressed in the 1990 ROD or subsequent 1998 ROD Amendment, it is anticipated that a ROD Amendment may be required to address this area.

## 11.0 NEXT REVIEW

This site requires ongoing five-year reviews. The next review will be conducted within 5 years of the completion of this five-year review report. The completion date is the date of the signature shown on the signature cover attached to the front of the report.

## 12.0 OTHER COMMENTS

Remedial operations at the site appear to be well run.

# APPENDIX A

# DOCUMENTS REVIEWED

(Two Pages)

## DOCUMENTS REVIEWED


Lyondell Chemical Company (Lyondell). 1997. Turtle Bayou Superfund Site, Liberty, Texas, Characterization and Pilot Test Report Extracts. April

Lyondell. 1999a. Turtle Bayou Superfund Site, Liberty, Texas, Construction Report/Certification. April.

Lyondell. 1999b. RCRA Vault Maintenance Plan, Turtle Bayou Project, Liberty County, Texas. June.

Lyondell. 1999c. Turtle Bayou Superfund Site, Liberty, Texas, Remedial Operations Plan. June.

Lyondell. 1999d. Turtle Bayou Superfund Site, Liberty, Texas, Sampling and Analysis Plan. June.

Lyondell. 1999e. Health and Safety Plan, Turtle Bayou Project, Liberty County, Texas. June.

Lyondell. 1999f. Transportation and Disposal Plan, Turtle Bayou Project, Liberty County, Texas. June.

Lyondell. 1999g. Turtle Bayou, June 1999 Monthly Progress Report. Submitted to U.S. Environmental Protection Agency, Region 6, and Texas Natural Resource Conservation Commission. June.

Lyondell. 1999h. Turtle Bayou, July 1999 Monthly Progress Report. Submitted to U.S. Environmental Protection Agency, Region 6, and Texas Natural Resource Conservation Commission. July.

Lyondell. 1999i. Turtle Bayou, August 1999 Monthly Progress Report. Submitted to U.S. Environmental Protection Agency, Region 6, and Texas Natural Resource Conservation Commission. August.

Lyondell. 1999j. Turtle Bayou, September 1999 Monthly Progress Report. Submitted to U.S. Environmental Protection Agency, Region 6, and Texas Natural Resource Conservation Commission. September.

Lyondell. 1999k. Turtle Bayou, October 1999 Monthly Progress Report. Submitted to U.S. Environmental Protection Agency, Region 6, and Texas Natural Resource Conservation Commission. October.

Lyondell. 1999l. Release Prevention/Contingency Plan (RP/CP), Turtle Bayou Project. October 28.

Lyondell. 1999m. Turtle Bayou, November 1999 Monthly Progress Report. Submitted to U.S. Environmental Protection Agency, Region 6, and Texas Natural Resource Conservation Commission. November.

Lyondell. 1999n. Turtle Bayou, December 1999 Monthly Progress Report. Submitted to U.S. Environmental Protection Agency, Region 6, and Texas Natural Resource Conservation Commission. December.

Lyondell. 2000a. Turtle Bayou, January 2000 Monthly Progress Report. Submitted to U.S. Environmental Protection Agency, Region 6, and Texas Natural Resource Conservation Commission. January.

Lyondell. 2000b. Turtle Bayou, February 2000 Monthly Progress Report. Submitted to U.S. Environmental Protection Agency, Region 6, and Texas Natural Resource Conservation Commission. February.

## DOCUMENTS REVIEWED (Continued)


Lyondell. 2000c. Turtle Bayou, March 2000 Monthly Progress Report. Submitted to U.S. Environmental Protection Agency, Region 6, and Texas Natural Resource Conservation Commission. March.

Lyondell. 2000d. Turtle Bayou, March 2000 Monthly Progress Report. Submitted to U.S. Environmental Protection Agency, Region 6, and Texas Natural Resource Conservation Commission. April.

Lyondell. 2000e. Turtle Bayou, May 2000 Monthly Progress Report. Submitted to U.S. Environmental Protection Agency, Region 6, and Texas Natural Resource Conservation Commission. May.

National Oceanic and Atmospheric Administration. 2000. Climate Watch, May 2000. National Climatic Data Center (last update June 9, 2000). Available online at http://www.ncdc.noaa.gov/ol/climate/extremes/2000/may/extremes0500.html.

U.S. Environmental Protection Agency. 1987. CERCLA Record of Decision for Petro-Chemical Systems Inc. (Turtle Bayou) Superfund Site, Liberty, Texas. March.

U.S. Environmental Protection Agency. 1989. Remedial Action Report Frontier Park Road, Petro-Chemical Systems Inc. Site, Liberty, Texas, February.

U.S. Environmental Protection Agency. 1991. CERCLA Record of Decision for Petro-Chemical Systems Inc. (Turtle Bayou) Superfund Site, Liberty, Texas. September.

U.S. Environmental Protection Agency. 1998. CERCLA Record of Decision Amendment for Petro-Chemical Systems Inc. Site, Liberty, Texas, April.

U.S. Environmental Protection Agency. 2000. CERCLIS Hazardous Waste Sites.(last update April 20, 2000). Available online at: http://www.epa.gov/superfund/sites/cursites/c3tx/a0602957.htm.

United States District Court for the Eastern District of Texas Beaumont Division. 1998. Consent Decree as to ARCO Chemical Company and Atlantic Richfield Company. October 27.

**APPENDIX B**

**SITE-VISIT REPORT**

**(30 Pages)**

# SITE VISIT REPORT

# PETRO-CHEMICAL SYSTEMS, INC.
# (TURTLE BAYOU)
# 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 28, 2000 |
| Contract No. | : | 68-W6-0037 |
| Prepared By | : | Tetra Tech EM Inc. |
| Telephone No. | : | (214) 754-8765 |
| EPA Work Assignment Manager | : | Mr. Chris Villarreal |
| Telephone | : | (214) 665-6758 |

CONTENTS


| Section | | | Page |
|---|---|---|---|
| ABBREVIATIONS AND ACRONYMS | | | ii |
| 1.0 | INTRODUCTION | | 1 |
| 2.0 | BACKGROUND | | 1 |
| 3.0 | SITE VISIT | | 2 |
| 4.0 | SITE INSPECTION | | 4 |
| | 4.1 | WRA | 4 |
| | 4.2 | MWA | 5 |
| | 4.3 | OTA | 6 |
| | 4.4 | EA | 6 |
| | 4.5 | BDA | 7 |
| | 4.6 | CR126 WEST | 7 |
| 5.0 | ACCESS AND INSTITUTIONAL CONTROLS | | 8 |

Exhibits

| | |
|---|---|
| 1 | PHOTOGRAPHS |
| 2 | SITE CHECKLIST |

## ABBREVIATIONS AND ACRONYMS

| | |
|---|---|
| ARAR | Applicable or relevant and appropriate requirements |
| BDA | Bayou Disposal Area |
| CERCLA | Comprehensive Environmental Response, Compensation, and Liability Act |
| CR | County Road |
| DO | Dissolved oxygen |
| EA | Easement Area |
| EPA | U.S. Environmental Protection Agency |
| FM | Farm to Market |
| ISB | In situ bioremediation |
| ISTD | In situ thermal desorption |
| MWA | Main Waste Area |
| MCL | Maximum contaminant level |
| NPL | National Priorities List |
| O&M | Operation and maintenance |
| OSHA | Occupational Safety and Health Administration |
| OTA | Office Trailer Area |
| OU | Operable Unit |
| PAH | Polycyclic aromatic hydrocarbon |
| PCS | Petro-Chemical Systems, Inc. |
| PRP | Potentially responsible party |
| RI/FS | Remedial investigation/feasibility study |
| RAC | Response Action Contract |
| ROD | Record of decision |
| ROG | Remedial Operations Group, Inc. |
| SVE | Soil vapor extraction |
| TAC | Texas Administrative Code |
| Tetra Tech | Tetra Tech EM Inc. |
| TNRCC | Texas Natural Resource Conservation Commission |
| TOC | Total organic carbon |
| VOC | Volatile organic compound |
| WRA | West Road Area |
| WTP | Water treatment plant |

## 1.0 INTRODUCTION

The Environmental Protection Agency (EPA) and Tetra Tech EM Inc. (Tetra Tech) conducted a site visit 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), and the amended ROD. This report summarizes the results of the site visit at the Petro-Chemical Systems, Inc. (PCS) site in Liberty, Texas.

## 2.0 BACKGROUND

The PCS Superfund site is located in rural Liberty County 15 miles southeast of Liberty, Texas. The site is 6 miles north of Interstate 10 along Farm to Market Road 563 (FM 563), which borders the site to the west. County Road 126 (CR 126—previously identified as Frontier Park Road) provides access to the site from FM 563. The site is sometimes referred to as the Turtle Bayou site.

Unpermitted waste disposal appears to have started in the late 1960s. In 1971, PCS filed an application for a commercial industrial waste disposal permit. The State of Texas withheld approval indefinitely and PCS withdrew the application in 1974. After 1974, the site was subdivided into 5-acre and 15-acre plots and sold for residential development. Residential use of the site has been continuous since 1974, except during previous remedial activity on Frontier Park Road in 1989. Fourteen families currently live on or near to the site. None of them live on any of the identified contaminated areas; however, seven families live adjacent to them.

With the enactment of Comprehensive Environmental Response Liability Act (CRCLA) in 1980, interest in the site was renewed. In 1984, EPA proposed the site for inclusion on the National Priorities List (NPL). The site was placed on the NPL in 1986.

The remedial investigation (RI) and feasibility study (FS) for Frontier Park Road (Operable Unit [OU] 1) was conducted from 1986. The ROD addressing this was signed in 1987. The Remedial Action for OU1 was completed in 1989.

In June 1988, the second RI/FS for the rest of the site (Operable Unit [OU] 2) was conducted. In addition to Frontier Park Road, the RI/FS identified 5 areas of the site as waste disposal areas. These areas are the

West Road Area (WRA), the Main Waste Area (MWA), the Office Trailer Area (OTA), the Easement Area (EA), and the Bayou Disposal Area (BDA). The contaminated media are soil and shallow groundwater. The ROD addressing OU2 was signed in 1991, and amended in 1998. Remedial action for OU2 is still in progress.

## 3.0 SITE VISIT

The site visit was conducted on June 28, 2000. The purpose of the site visit was to (1) obtain information about site remedies, (2) interview the Operations and Maintenance manager, (3) review and verify on-site documents and records, (4) obtain O&M costs, (5) review access and institutional controls, (6) tour the site, and (7) evaluate general site conditions. The objective of the five-year review is to evaluate whether the selected remedies are protective of human health and the environment.

The following were present during the site visit:

- Chris Villarreal, EPA
- Charles David Abshire, EPA
- Rick Smith, Tetra Tech
- Doug Czechowski, Tetra Tech
- Mark Collins, Remedial Operations Group (ROG) Inc.

Before touring the site, Mark Collins, Operations Manager with ROG, discussed history, current investigation activities, current remedial activities, and O&M. The remedial activities at the PCS site include in situ bioremediation (ISB), soil vapor extraction (SVE), ground water extraction, bioventing, in situ thermal desorption (ISTD), soil flushing, and natural attenuation. ROG is also responsible for ongoing process sampling, progress sampling, well drilling, systems construction, on-site laboratory analysis, and maintenance. ROG has installed a total of 127 ground water monitoring wells, 173 injection wells, 171 ground water extraction wells, and 210 SVE (some dual function) wells at the PCS site. Some wells are set up for triple function, where pumping, SVE, or injection can be performed at a single well. ROG has installed three liquid ring pumps (one backup pump on line), two thermal oxidizers, a nutrient storage, mixing and injection system, three electrical transformers for ISTD, and an

activated sludge waste water treatment plant (WTP) at the PCS site. ROG installed a non-potable water well near the OTA to supply water for ground water and nutrient injection systems. Liquid oxygen and nutrients are stored in above ground storage tanks at OTA, and pumped through pipelines to injection wells across the site. An extensive network of surface and subsurface pipelines are in place at the site. No ground water or nutrients are recycled since they are pumped to and processed at the WTP. All treated water is discharged to Turtle Bayou.

Tetra Tech briefly reviewed O&M records for the PCS site, which are kept inside the trailer at the OTA. Also on hand were O&M manuals, as-built drawings, maintenance logs, the site health and safety plan, and daily access and security logs. Tetra Tech verified that the Occupational Safety and Health Administration (OSHA) training logs were available and current. Tetra Tech reviewed the discharge permit and one amendment for the WTP. ROG recently submitted a request to the Texas Natural Resource Conservation Commission (TNRCC) to decrease the effluent sampling frequency at the WTP. Air permits for the thermal oxidizers are not required since the units operate within the requirements of Texas Administrative Code (TAC) 106.4, a standard exemption. All waste manifests for wastes shipped off site are kept at the OTA security office and at 2502 Sheldon Road, Channelview, Texas.

EPA and Tetra Tech representatives walked the site with Mr. Collins and visually examined remedial operations and site conditions. The operations at the site are designated by area. In addition to Frontier Park Road, the five designated areas include the WRA, MWA, OTA, EA, and BDA. A new area designated as CR 126 West was recently discovered. The above ground landfill and the WTP are located in the MWA, and areas of focused remedial operations occur within each of the main areas listed above.

No deficiencies were noted during the site visit. The Potentially Respondsible Party (PRP) representatives with ROG understand the ROD requirements and are diligent in carrying out investigation, remediation, sampling, and O&M activities.

## 4.0 SITE INSPECTION

Tetra Tech conducted the site inspection on June 28, 2000. The following individuals attended the site inspection:

- Chris Villarreal, EPA
- Charles David Abshire, EPA
- Rick Smith, Tetra Tech
- Doug Czechowski, Tetra Tech
- Mark Collins, ROG Inc.

Tetra Tech inspected remedial operations at the WRA, MWA, OTA, EA, BDA, and CR 126 West Area. Findings for each area are presented in this section.

### 4.1 WRA

At the WRA, Tetra Tech inspected the extraction and injection well pads, covers, and wellhead plumbing, including valves, regulators, gauges, and manifolds. Tetra Tech also inspected visible sections of the nutrient injection, ground water extraction and injection, and SVE system pipelines. The electrical components and transformers for the ISTD systems were also inspected. The liquid ring pump, thermal oxidizer, and WTP that service the WRA are located at the MWA. All vacuums are generated at the liquid ring pump and soil vapor is routed to the thermal oxidizer through a network of flexible pipelines. Electric submersible pumps extract and pump ground water to the WTP though pipelines.
All ground water and nutrients are mechanically prepared and mixed at the OTA and pumped to the WRA via pipelines. Tetra Tech observed all wells, appurtenances, pipelines, and treatment systems to be operating and functioning properly. Tetra Tech observed a leaking injection well along CR 126. Algae were noted on the well casing and water was pooled around the well. However, according to Mr. Collins, no contaminants are being released to the environment. Some of the ISTD wells along CR 126 are fenced and protected with guard rails, whereas the remaining wells are unprotected. Photocell lights on power poles provide additional security at night.

## 4.2 MWA

At the MWA, Tetra Tech inspected the extraction and injection well pads, covers, and wellhead plumbing, including valves, regulators, gauges, and manifolds. Tetra Tech also inspected visible sections of the nutrient injection, ground water extraction and injection, and SVE system pipelines. The extraction systems are very similar to what was previously discussed in Section 4.1, since (1) the thermal oxidizer services the MWA, the WRA, and the OTA, and is located at the MWA, (2) the WTP is located at the MWA, and processes ground water from all remedial systems at the PCS site, and (3) all ground water and nutrients are mechanically prepared and mixed at the OTA and transported to the MWA via pipelines.

Tetra Tech observed all wells, appurtenances, pipelines, and treatment systems to be operating and functioning properly. The WTP was noted to be functioning as designed. Effluent from the plant is continuously monitored for total organic carbon (TOC) inside a process control lab. Measurements for dissolved oxygen (DO) and pH are recorded daily. The electrical enclosures and panels for the thermal oxidizer and liquid ring pump were marked and appeared to be in good condition. Tetra Tech noted the equipment to be properly identified, with sampling ports properly marked and functional. Mr. Collins indicated that total VOC concentrations were measured daily at the influent and effluent ports at the thermal oxidizer. Minor oil staining was noted on the concrete pad under the liquid ring pump and on the gravel adjacent to the concrete pad. Mr. Collins indicated that any oil spills that occur during pump maintenance are promptly cleaned up. The staining does not appear to represent an environmental concern.

The aboveground landfill is located in the MWA. Tetra Tech observed the vault to have a healthy cover of well kept vegetation. Approximately 4,000 gallons per month of sludge from the treatment plant are mixed with water and applied to the vegetation using a sprinkler system. Two small areas of patchy vegetation were noted on the west end of the vault. According to Mr. Collins, ROG recently cut the slope back to allow for mowing, and the vegetation had not completely filled in. Erosion of the soils was not observed. Air monitoring is conducted daily at the WTP to ensure that no dangerous levels of VOC vapor enter the atmosphere.

## 4.3 OTA

At the OTA, Tetra Tech inspected the extraction and injection well pads, covers, and wellhead plumbing, including valves, regulators, gauges, and manifolds. Tetra Tech also inspected visible sections of the nutrient injection, ground water extraction and injection, and SVE system pipelines. Tetra Tech inspected the aboveground storage tanks for nutrient injection, including the electric pumps and systems for mixing. The non-potable water well systems were also inspected. The electrical components and transformers for the ISTD system were also inspected.

As discussed in the two previous sections (4.1 & 4.2), (1) the thermal oxidizer services the MWA, the WRA, and the OTA, and is located at the MWA, (2) the WTP is located at the MWA, and processes ground water from all remedial systems at the PCS site including the OTA, and (3) all ground water and nutrients are mechanically prepared and mixed at the OTA and transported to the MWA via pipelines.

Tetra Tech observed the liquid ring pump and all wells, appurtenances, and pipelines to be operating and functioning properly. The nutrient storage tanks, mixing and transfer pumps, and water well were noted to be in good condition and functioning properly. Minor oil staining was noted on the concrete pad under the liquid ring pump. Mr. Collins indicated that any oil spills that occur during pump maintenance are promptly cleaned up. The staining does not appear to represent an environmental concern.

## 4.4 EA

At the EA, Tetra Tech inspected the extraction and injection well pads, covers, and wellhead plumbing, including, valves, regulators, gauges, and manifolds. Tetra Tech also inspected nutrient injection, ground water extraction and injection, and SVE system pipelines. The electrical components and transformers for the ISTD systems were also inspected. A liquid ring pump and thermal oxidizer are located in an open-sided treatment building at the EA, and were also inspected. All vacuums are generated at the liquid ring pump and soil vapor is pulled to the thermal oxidizer through pipelines. Electric submersible pumps extract and pump ground water to the WTP though pipelines laid on the ground surface. The nutrients for injection are stored in aboveground storage tanks at the OTA. All ground water and nutrients are mechanically prepared and mixed and pumped to the EA via pipelines.

Tetra Tech observed all wells, appurtenances, pipelines, and treatment systems to be operating and functioning properly. The electrical enclosures and panels for the thermal oxidizer and liquid ring pump were marked and appeared to be in good condition. Tetra Tech noted the equipment to be properly identified, with sampling ports properly marked and functional. Mr. Collins indicated that total VOC concentrations were measured daily at the influent and effluent ports on the thermal oxidizer.

ROG recently excavated 1,000 cubic yards of soil from a naphthalene hot spot and stored them in a windrow (biopile) for ex situ bioremediation. Surface runoff is controlled by a perimeter trench and sump excavated into the native soil around the biopile. A portable gasoline-powered pump and flexible hoses are used to transfer collected rainwater to a pipeline connection, which then transfers the water to the treatment plant. ROG added potassium permanganate, straw, and nutrients in 2-foot lifts when constructing the biopile, and regularly monitors the moisture content. ROG adds water to the biopile and tills it as needed to enhance bioremediation. Air monitoring is conducted periodically at the biopile to ensure that dangerous levels of VOC vapor do not enter the atmosphere.

### 4.5 BDA

The BDA is currently in the intermediate stages of a quarterly ground water monitoring program; no active remediation is under way. Tetra Tech observed broken hinges on the locking well cover at Monitoring Well-59. All remaining wells, covers, and pads appeared to be secure and in good condition.

### 4.6 CR 126 West

At the CR 126 West Area, no remedial activities had been implemented at the time of the site inspection. The area is still being delineated with soil borings and monitoring wells. The Chandler residence and water well are located nearby. All monitoring wells, covers, and pads appeared to be secure and in good condition.

No significant items of concern were observed during the site inspection. All remediation and treatment system components appeared to be in good condition and were well maintained.

## 5.0 ACCESS AND INSTITUTIONAL CONTROLS

The PCS site has access controls, such as fencing and warning signs, in place. Certain areas of focused remediation along CR 126 are fully fenced. The OTA and MWA are partially fenced, and have gates that prevent trespassing from CR 126. Security signs stating "Superfund Remediation Site—Do Not Enter Without Proper Authorization or Protective Equipment" are located on the security fence at the OTA and MWA. Overall site access is controlled by security personnel who patrol the site 24 hours a day on 30-minute intervals. No known institutional controls restricting ground water use or land excavation are currently in place. An institutional control may be required for ground water at the site. The Chandler residence and water well are locate near the CR 126 Area.

The access controls for the PCS site appear to be adequate. However, vehicular traffic along CR 126 presents a potential hazard to wells, appurtenances, and pipelines placed near the road. In addition, unauthorized access from CR 126 to portions of the site is possible, in the event it occurs unnoticed by security patrols.

**EXHIBIT 2**

**SITE CHECKLIST**

**(14 Pages)**

## FIVE-YEAR REVIEW SITE INSPECTION CHECKLIST

Information may be completed by hand and attached to the five-year review report as supporting documentation of site status. "N/A" refers to "not applicable."

### I. SITE INFORMATION

| | |
|---|---|
| **Site Name:** Petro-Chemical Systems, Inc. | **Date of Inspection:** June 28, 2000 |
| **Location and Region:** 6<br>1 mile east of FM 563 on CR 126, Liberty, Texas | **EPA ID:** TXD980873350 |
| **Agency, office, or company leading the five-year review:**<br>EPA Region 6 and Tetra Tech EM Inc. | **Weather/temperature:** 90°, calm, partly cloudy |

Remedy Includes: (Check all that apply)

- ☒ Landfill cover/containment (RCRA vault)
- ☒ Access controls
- ☒ Institutional controls
- ☒ Ground water pump and treatment
- ☒ Surface water collection and treatment
- ☐ Other SVE, ISB, bioventing, soil excavation, soil flushing, ISTD, off-site disposal/treatment, monitored natural attenuation.

**Attachments:** ☐ Inspection team roster attached ☐ Site map attached

### II. INTERVIEWS (Check all that apply)

1. **O&M Site Manager** Mark Collins (Name) — Operations Manager (Title) — June 28, 2000 (Date)

   Interviewed: ☒ at site ☐ at office ☐ by phone Phone no. _____
   Problems, suggestions: ☐ Report attached _____

2. **O&M Staff** N/A (Name) — _____ (Title) — _____ (Date)

   Interviewed: ☐ at site ☐ at office ☐ by phone Phone no. _____
   Problems, suggestions: ☐ Report attached _____

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

Agency _____
Contact _____ _____ _____ _____
Name Title Date Phone no.

Problems, suggestions: ☐ Report attached _____

Agency _____
Contact _____ _____ _____ _____
Name Title Date Phone no.

Problems, suggestions: ☐ Report attached _____

Agency _____
Contact _____ _____ _____ _____
Name Title Date Phone no.

Problems, suggestions: ☐ Report attached _____

Agency _____
Contact _____ _____ _____ _____
Name Title Date Phone no.

Problems, suggestions: ☐ Report attached _____

4. **Other interviews** (optional): ☐ Report attached.

## III. ONSITE DOCUMENTS & RECORDS VERIFIED (Check all that apply)

**1. O&M Documents**

| | | | |
|---|---|---|---|
| ☒ O&M manual | ☒ Readily available | ☒ Up to date | ☐ N/A |
| ☒ As-built drawings | ☒ Readily available | ☒ Up to date | ☐ N/A |
| ☒ Maintenance logs | ☒ Readily available | ☒ Up to date | ☐ N/A |

Remarks _____

**2. Site-Specific Health and Safety Plan** ☒ Readily available ☒ Up to date ☐ N/A

☒ Contingency plan/emergency response plan ☒ Readily available ☒ Up to date ☐ N/A

Remarks _____

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

Remarks Updated May 17, 2000

**4. Permits and Service Agreements**

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

Remarks Not actually a permit for water discharge. Reviewed original agreement dated 2-29-95 and amendment dated 2-23-98. Reviewed amendment request to TNRCC dated 3-2-00.

**5. Gas Generation Records** ☐ Readily available ☐ Up to date ☒ N/A

Remarks _____

**6. Settlement Monument Records** ☐ Readily available ☐ Up to date ☒ N/A

Remarks _____

**7. Ground Water Monitoring Records** ☒ Readily available ☒ Up to date ☐ N/A

Remarks Progress reports were provided prior to inspection.

**8. Leachate Extraction Records** ☐ Readily available ☐ Up to date ☒ N/A

Remarks _____

**9. Discharge Compliance Records**

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

Remarks Observed log in process control lab at Wastewater Treatment Plant.

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

Remarks _____

## IV. O&M COSTS

**1. O&M Organization**

☐ State in-house ☐ Contractor for State
☐ PRP in-house ☒ Contractor for PRP
☐ Other _____

**2. O&M Cost Records** N/A

☐ Readily available ☐ Up to date (costs not provided for legal reasons)
☐ Funding mechanism/agreement in place
Original O&M cost estimate _____ ☐ Breakdown attached

Total annual cost by year for review period, if available

From _____ (Date) to _____ (Date) _____ (Total cost) ☐ Breakdown attached
From _____ (Date) to _____ (Date) _____ (Total cost) ☐ Breakdown attached
From _____ (Date) to _____ (Date) _____ (Total cost) ☐ Breakdown attached
From _____ (Date) to _____ (Date) _____ (Total cost) ☐ Breakdown attached
From _____ (Date) to _____ (Date) _____ (Total cost) ☐ Breakdown attached

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

Describe costs and reasons: _____

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

**A. Fencing**

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

Remarks Some areas of the site are open to CR 126. Site has 24 hour security patrols, 7 days a week.

**B. Other Access Restrictions**

1. **Signs and other security measures** ☐ Location shown on site map ☐ N/A
   Remarks Site has 24-hour security patrol. Warning signs are located throughout the site.

**C. Institutional Controls**

1. **Implementation and enforcement**
   Site conditions imply ICs not properly implemented ☐ Yes ☐ No ☒ N/A
   Site conditions imply ICs not being fully enforced ☐ Yes ☐ No ☒ N/A

   Type of monitoring (e.g., self-reporting, drive by) _____
   Frequency _____
   Responsible party/agency _____
   Contact _____ _____ _____ _____
   Name Title Date Phone no.

   Reporting is up-to-date ☐ Yes ☐ No ☒ N/A
   Reports are verified by the lead agency ☐ Yes ☐ No ☒ N/A

   Specific requirements in deed or decision documents have been met ☐ Yes ☐ No ☒ N/A
   Violations have been reported ☐ Yes ☐ No ☒ N/A
   Other problems or suggestions: ☐ Report attached
   Costs are managed by Schorp Control Services.

2. **Adequacy** ☒ ICs are adequate ☐ ICs are inadequate ☐ N/A
   Remarks The PRP may consider the use of deed restrictions to reduce the placement of shallow water wells in the area. This should be coordinated with Liberty County.

**D. General**

1. **Vandalism/trespassing** ☐ Location shown on site map ☒ No vandalism evident
   Remarks Some pipe was stolen from the site in 1996. A car damaged one well and some piping when it ran off CR 126. No other items reported.

2. **Land use changes onsite** ☒ N/A
   Remarks _____

3. **Land use changes offsite** ☐ N/A
   Remarks Some new residences since 1996. The county contacts Remedial Operations Group prior to issuing any type of permit in the area of the site. This notification is currently done informally.

## VI. GENERAL SITE CONDITIONS

**A. Roads** ☒ Applicable ☐ N/A

1. **Roads damaged** ☐ Location shown on site map ☒ Roads adequate ☐ N/A
   Remarks Roads were repaired by the PRP as recently as June 2000.

**B. Other Site Conditions**

Remarks The RCRA Vault Area is surrounded by a chain-link fence, with a lockable gate. Warning signs (in English and Spanish, in some areas) are located throughout the site and appear in good condition.

## VII. LANDFILL COVERS (RCRA vault) ☒ Applicable ☐ N/A

**A. Landfill Surface**

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

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

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

4. **Holes** ☐ Location shown on site map ☒ Holes not evident
   Areal extent _____ Depth _____
   Remarks _____

5. **Vegetative Cover** ☒ Grass ☒ Cover properly established ☒ No signs of stress
   ☐ Trees/Shrubs (indicate size and locations on a diagram)
   Remarks Two areas on west end were not completely covered with grass. Mr. Collins indicated they adjusted the slope for mowing and the grass had not recovered.

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

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

8. **Wet Areas/Water Damage** ☒ Wet areas/water damage not evident
☐ Wet areas ☐ Location shown on site map ☐ Areal extent _____
☐ Ponding ☐ Location shown on site map ☐ Areal extent _____
☐ Seeps ☐ Location shown on site map ☐ Areal extent _____
☐ Soft subgrade ☐ Location shown on site map ☐ Areal extent _____
Remarks _____

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

B. **Benches** ☐ Applicable ☐ N/A
(Horizontally constructed mounds of earth placed across a steep landfill side slope to interrupt the slope in order to slow down the velocity of surface runoff and intercept and convey the runoff to a lined channel.)

1. **Flows Bypass Bench** ☐ Location shown on site map ☐ N/A or okay
Remarks _____

2. **Bench Breached** ☐ Location shown on site map ☐ N/A or okay
Remarks _____

3. **Bench Overtopped** ☐ Location shown on site map ☐ N/A or okay
Remarks _____

C. **Letdown Channels** ☐ Applicable ☒ N/A
(Channel lined with erosion control mats, riprap, grout bags, or gabions that descend down the steep side slope of the cover and will allow the runoff water collected by the benches to move off of the landfill cover without creating erosion gullies.)

1. **Settlement** ☐ Location shown on site map ☐ No evidence of settlement
Areal extent _____ Depth _____
Remarks _____

2. **Material Degradation** ☐ Location shown on site map ☐ No evidence of degradation
Material type _____ Areal extent _____
Remarks _____

3. **Erosion** ☐ Location shown on site map ☒ No evidence of erosion
Areal extent _____ Depth _____
Remarks _____

4. **Undercutting** ☐ Location shown on site map ☒ No evidence of undercutting
Areal extent _____ Depth _____
Remarks _____

5. **Obstructions** Type _____ ☒ No obstructions
☐ Location shown on site map Areal extent _____
Size _____
Remarks _____

6. **Excessive Vegetative Growth** Type _____
☒ No evidence of excessive growth
☐ Vegetation in channels does not obstruct flow
☐ Location shown on site map Areal extent _____
Remarks _____

**D. Cover Penetrations** ☐ Applicable ☒ N/A

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

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

3. **Monitoring Wells** (within surface area of landfill)
☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition
☐ Evidence of leakage at penetration ☐ Needs O&M ☐ N/A
Remarks _____

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

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

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

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

**2. Gas Collection Wells, Manifolds, and Piping**
☐ Good condition ☐ Needs O&M
Remarks _____

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

**F. Cover Drainage Layer** ☐ Applicable ☐ N/A

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

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

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

**1. Siltation** Areal extent _____ Depth _____ ☐ N/A
☐ Siltation not evident
Remarks _____

**2. Erosion** Areal extent _____ Depth _____
☐ Erosion not evident
Remarks _____

**3. Outlet Works** ☐ Functioning ☐ N/A
Remarks _____

**4. Dam** ☐ Functioning ☐ N/A
Remarks _____

**H. Retaining Walls** ☐ Applicable ☒ N/A

**1. Deformations** ☐ Location shown on site map ☐ Deformation not evident
Horizontal displacement _____ Vertical displacement _____
Rotational displacement _____
Remarks _____

**2. Degradation** ☐ Location shown on site map ☐ Degradation not evident
Remarks _____

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

**1. Siltation** ☐ Location shown on site map ☐ Siltation not evident
Areal extent _____ Depth _____
Remarks Biopile located in the Easement Area has collection trench. No problems observed.

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

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

**4. Discharge Structure** ☒ Functioning ☐ N/A
Remarks Portable pump in place to pump water to Wastewater Treatment Plant.

**VIII. VERTICAL BARRIER WALLS** ☐ Applicable ☒ N/A

**1. Settlement** ☐ Location shown on site map ☐ Settlement not evident
Areal extent _____ ☐ Depth
Remarks _____

**2. Performance Monitoring** Type of monitoring _____
☐ Performance not monitored
Frequency _____ ☐ Evidence of breaching
Head differential _____
Remarks _____

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

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

**1. Pumps, Wellhead Plumbing, and Electrical**

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

Remarks Also includes SVE, nutrient injection, and ISTD.

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

☒ Good condition ☐ Needs O&M

Remarks

**3. Spare Parts and Equipment**

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

Remarks Remedial Operations Group has spare parts available. One liquid ring pump is in place at the Main Waste Area as a backup.

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

**1. Collection Structures, Pumps, and Electrical**

☐ Good condition ☐ Needs O&M

Remarks

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

☐ Good condition ☐ Needs O&M

Remarks

**3. Spare Parts and Equipment**

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

Remarks

Revise caption as follows: "View looking southeast of M W– 59 at the BDA. The Mr. Donnie Taylor residence and water well are visible in the background."

**Tetra Tech Response:**

The caption was revised.

35. **Appendix B - Site Visit Report, Exhibit 1 Photographs, Photograph No. R2P26:**

**EPA Comment:**

Caption under the photograph states: "View looking south toward CR 126 of well cluster showing (left) **50 foot well**; (center) **28 foot well**; and (right) **60 foot well**."

Comment:

Please check your notes regarding the well depths. I believe that the 60 foot well is really a deeper well (e.g., 90 foot).

Revise caption accordingly.

**Tetra Tech Response:**

The well depth was changed to 90 feet.

36. **Appendix B - Site Visit Report, Exhibit 2 Site Checklist, Page 4, Item 3:**

**EPA Comment:**

Under Item 3 (Unanticipated or Unusually High O&M Costs During Review Period, text states: Describe costs and reasons. Costs not provided by PRP and agreed upon by EPA due to potential future litigation.

Delete response.

**Tetra Tech Response:**

The response was deleted.

37. **Appendix B - Site Visit Report, Exhibit 2 Site Checklist, Page 12, Item 1:**

**EPA Comment:**

Under Remarks, text states: "One-billion cubic feet of vapor treated with thermal oxidizers."

**C. Treatment System** ☒ Applicable ☐ N/A

**1. Treatment Train** (Check components that apply)

☐ Metals removal ☐ Oil/water separation ☐ Bioremediation
☐ Air stripping ☐ Carbon adsorbers
☒ Filters Carbon at Wastewater Treatment Plant. Wastewater Treatment Plant is activated sludge plant, 2 bioreactors are present but not used
☐ Additive (e.g., chelation agent, flocculent)
☐ Others
☒ Good condition ☐ Needs O&M
☒ Sampling ports properly marked and functional
☐ Sampling/maintenance log displayed and up to date
☒ Equipment properly identified
☒ Quantity of ground water treated annually 70-million gallons treated to date.
☐ Quantity of surface water treated annually
Remarks A total volume of 454,336,140 cubic feet of vapor treated with thermal oxidizers.

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

☐ N/A ☒ Good condition ☐ Needs O&M
Remarks

**3. Tanks, Vaults, Storage Vessels**

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

**4. Discharge Structure and Appurtenances**

☐ N/A ☒ Good condition ☐ Needs O&M
Remarks Thermal oxidizer stacks and Wastewater Treatment Plant in good condition.

**5. Treatment Building(s)**

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

**6. Monitoring Wells** (Pump and treatment remedy)

☒ Properly secured/locked ☒ Functioning ☒ Routinely sampled ☒ Good condition
☐ All required wells located ☐ Needs O&M ☐ N/A
Remarks This also includes SVE, injection, and ISTD wells. Not all wells were located due to time constraints. There are approximately 556 well locations.

**D. Monitored Natural Attenuation**

**1. Monitoring Wells** (Natural attenuation remedy)

☒ Properly secured/locked ☒ Functioning ☒ Routinely sampled ☒ Good condition
☐ All required wells located ☐ Needs O&M ☐ N/A
Remarks Not all wells were located. (see above)

## X. OTHER REMEDIES

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

## XI. OVERALL OBSERVATIONS

### A. Implementation of the Remedy

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

Remedial goals were to improve site access; prevent direct contact with highly contaminated soils (greater than 100 ppm total PAHs or total VOC); minimize direct exposure to moderately contaminated soils; reduce benzene concentration in soil to levels specified in the 1998 ROD Amendment. Progress has been made in remediating the site. Efforts are being made to ensure human health and the environment are protected. Site remediation is expected to continue for at least 2 more years.

### B. Adequacy of O&M

Describe issues and observations related to the implementation and scope of O&M procedures. In particular, discuss their relationship to the current and long-term protectiveness of the remedy.

O&M scope and procedures appeared properly implemented, and are expected to maintain the protectiveness of the remedy both currently and in the future.

| C. Early Indicators of Potential Remedy Failure |
| --- |
| Describe issues and observations such as unexpected changes in the cost or scope of O&M or a high frequency of unscheduled repairs, that suggest that the protectiveness of the remedy may be compromised in the future.<br>None. |
| **D. Opportunities for Optimization** |
| Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy.<br>None. |

# APPENDIX C

## INTERVIEW AND OPEN HOUSE SUMMARY FORMS

(12 Pages)

| PETRO-CHEMICAL SYSTEMS, INC. SUPERFUND SITE SURVEY | |
|---|---|
| Site Name: Petro-Chemical Systems, Inc. Superfund Site | |
| Subject: 5-Year Review Local Authority Survey | |
| EPA Work Assignment No.: 034-FRFE-0681 | |
| Date: Not provided | |

| Contact Made By: | | |
|---|---|---|
| Name: Chris Villarreal | Title: Remedial Project Manager | Organization: EPA |
| Telephone No.: (214) 665-6758<br>E-Mail: villarreal.chris@epa.gov | Street Address: U.S. EPA 1455 Ross Avenue, Suite 1200<br>City, State, Zip: Dallas, Texas 75202 | |

| Individual Contacted: | | |
|---|---|---|
| Name: Luda Voskov | Title: Project Manager | Organization: TNRCC |
| Telephone No.: (512) 239-6368<br>E-Mail Address: lvoskov@tnrcc.state.tx.us | Street Address: MC-143, P.O. Box 13087<br>City, State, Zip: Austin, Texas 78711-3087 | |

**Survey Questions**

Please direct questions or comments regarding this survey to Chris Villarreal (at the address listed above).

1. What is your impression of the project (general sentiment)?
   The site remedial activities are underway with aggressive use of the various remedy components in succession. Numerous field pilot studies have shown that a flexible approach is effective remedial strategy for the site. The ROD amendment (1998) included a calculated site-specific Residential Soil-to-Groundwater Cross-media Protection Concentration for benzene using the Seasonal Soil Compartment Model (SESOIL). Although the modeled concentrations are higher than the Residential Soil-to-Groundwater Cross-Media Protection Concentration for benzene under RRS No. 2, the TNRCC anticipates that the substantive requirements of RRS No. 2 will be attained using, when necessary, multiple remedy components.

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.
   The TNRCC project manager was consistently involved in the EPA monthly meetings, site visits and remedial site activities inspections in order to monitor the remedial actions progress. All copies of documentation related to on-going remedial activities at the site were sent to the TNRCC project manager for review and comments.

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.
   During the time period from March 1999 until recently, when I was a project manager, no complaints, violations, or other incidents related to the site requiring a response from my office.

4. Do you feel well informed about the site's activities and progress?
   The TNRCC project manager was always informed about the site's activities and progress.

| PETRO-CHEMICAL SYSTEMS, INC. SUPERFUND SITE SURVEY | |
|---|---|
| Site Name: Petro-Chemical Systems, Inc. Superfund Site | EPA Work Assignment No.: 034-FRFE-0681 |
| Subject: 5-Year Review Background Information Survey | Date: Not provided |

**Survey Questions (Cont.)**

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

   No changes, in relation to the site remedies. We reviewed the 1991 ROD Site Contaminant Cleanup Levels and the revised benzene soil remediation criteria for the Petro-Chemical Site. The revised benzene soil remediation criteria were compared to the Texas Risk Reduction Program Tier 1 PCLs (total soil combined) and the groundwater cleanup levels were compared to the revised Std 2 GW-Res and TRPP res. groundwater PCLs. The groundwater and cleanup levels are acceptable under TRRP.

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

   The site has been in compliance with permitting and reporting requirements during 1999-present time period.

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

   The TNRCC's major concern is that there is an insufficient number of summary reports which can illustrate the remedy progress for the site and show the trends in the contaminants concentration decrease. Additionally, for the Bayou Disposal area, TNRCC has not seen any groundwater monitoring data and summary reports which can confirm the groundwater direction for this area of concern.

| PETRO-CHEMICAL SYSTEMS, INC. SUPERFUND SITE SURVEY | |
|---|---|
| **Site Name:** Petro-Chemical Systems, Inc. Superfund Site | |
| **Subject:** 5-Year Review Background Information Survey | |
| **EPA Work Assignment No.:** 034-FRFE-06ZZ | |
| **Date:** 7/5/00 | |

| **Contact Made By:** | | |
|---|---|---|
| **Name:** Chris Villarreal | **Title:** Remedial Project Manager | **Organization:** EPA |
| **Telephone No.:** (214) 665-6758<br>**E-Mail:** villarreal.chris@epa.gov | **Street Address:** U.S. EPA 1455 Ross Avenue, Suite 1200<br>**City, State, Zip:** Dallas, Texas 75202 | |

| **Individual Contacted:** | | |
|---|---|---|
| **Name:** Mr. John L. Carrell | **Title:** Land Owner | **Organization:** NA |
| **Telephone No.:** (986) 336-8848<br>**E-Mail Address:** | **Street Address:** HCR2 Box 1070<br>**City, State, Zip:** Liberty, TX 77575 | |

**Survey Questions**

Please direct questions or comments regarding this survey to Chris Villarreal (at the address listed above).

1. Would you like to be interviewed at the Open House on July 11, 2000?
   Yes.

2. What is your impression of the project (general sentiment)?
   The clean-up will take longer than originally projected.

3. What effect have site operations had on the surrounding community?
   Lowered property values.

4. Are you aware of any community concerns regarding the site or its operation and administration? If so, please give details.
   No.

5. 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.
   No.

6. Do you feel well informed about the site's activities and progress?
   No, a quarterly update would be appreciated.

7. Do you have any comments, suggestions, or recommendations regarding the site's management or operation?
   I feel like I should be compensated for the test wells drilled on my land, which restricts my use of that portion of my land.

Please mail responses by July 10, 2000 in the enclosed envelope to Matt Garcia at Tetra Tech EM Inc., 350 N. St. Paul St., Suite 2600, Dallas, TX 75201

# PETRO-CHEMICAL SYSTEMS, INC. SUPERFUND SITE SURVEY

| | |
|---|---|
| **Site Name:** Petro-Chemical Systems, Inc. Superfund Site | |
| **Subject:** 5-Year Review Background Information Survey | |
| **EPA Work Assignment No.:** 034-FRFE-06ZZ | |
| **Date:** 7/5/00 | |

**Contact Made By:**

| | | |
|---|---|---|
| **Name:** Chris Villarreal | **Title:** Remedial Project Manager | **Organization:** EPA |
| **Telephone No.:** (214) 665-6758<br>**E-Mail:** villarreal.chris@epa.gov | **Street Address:** U.S. EPA 1455 Ross Avenue, Suite 1200<br>**City, State, Zip:** Dallas, Texas 75202 | |

**Individual Contacted:**

| | | |
|---|---|---|
| **Name:** Ronnie Worthy | **Title:** Land Owner | **Organization:** NA |
| **Telephone No.:** (936) 336-3654<br>**E-Mail Address:** | **Street Address:** 396 CR 126<br>**City, State, Zip:** Liberty, TX 77575 | |

**Survey Questions**

Please direct questions or comments regarding this survey to Chris Villarreal (at the address listed above).

1. Would you like to be interviewed at the Open House on July 11, 2000?
   No response provided.

2. What is your impression of the project (general sentiment)?
   Pumping chemical in ground to clean up water contaminants in water supply.

3. What effect have site operations had on the surrounding community?
   My water well, water level dropped 15' and hardened.

4. Are you aware of any community concerns regarding the site or its operation and administration? If so, please give details.
   Chemicals contaminating water supply. I also don't like the rundown appearance of equipment and poor housekeeping.

5. 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.
   None.

6. Do you feel well informed about the site's activities and progress?
   No.

7. Do you have any comments, suggestions, or recommendations regarding the site's management or operation?
   The operation seems to be just drilling lots of wells but not getting anywhere on clean up or finish. Every year or month even they drill more wells and put up more danger signs.

Please mail responses by July 10, 2000 in the enclosed envelope to Matt Garcia at Tetra Tech EM Inc., 350 N. St. Paul St., Suite 2600, Dallas, TX 75201

# PETRO-CHEMICAL SYSTEMS, INC. SUPERFUND SITE SURVEY

| | |
|---|---|
| **Site Name:** Petro-Chemical Systems, Inc. Superfund Site | |
| **Subject:** 5-Year Review Background Information Survey | |
| **EPA Work Assignment No.:** 034-FRFE-06ZZ | |
| **Date:** 7/8/00 | |

**Contact Made By:**

| | | |
|---|---|---|
| **Name:** Chris Villarreal | **Title:** Remedial Project Manager | **Organization:** EPA |
| **Telephone No.:** (214) 665-6758<br>**E-Mail:** villarreal.chris@epa.gov | **Street Address:** U.S. EPA 1455 Ross Avenue, Suite 1200<br>**City, State, Zip:** Dallas, Texas 75202 | |

**Individual Contacted:**

| | | |
|---|---|---|
| **Name:** T.R. Bennett | **Title:** Home Owner | **Organization:** NA |
| **Telephone No.:** (936) 334-0786<br>**E-Mail Address:** | **Street Address:** HC2 Box 107T<br>**City, State, Zip:** Liberty, TX 77575 | |

**Survey Questions**

Please direct questions or comments regarding this survey to Chris Villarreal (at the address listed above).

1. Would you like to be interviewed at the Open House on July 11, 2000?
   No.

2. What is your impression of the project (general sentiment)?
   ROG keeps a very clean operations site.

3. What effect have site operations had on the surrounding community?
   I'm not sure about the rest of the community, but it has not had any effect on us. ROG has always gone out of their way to accommodate us.

4. Are you aware of any community concerns regarding the site or its operation and administration? If so, please give details.
   No.

5. 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.
   Yes, at the office complex I was told that someone stole some of their equipment one time.

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

7. Do you have any comments, suggestions, or recommendations regarding the site's management or operation?
   Yes. Dick Sloan and Mark Collins have always gone out of their way to help us with any problems we have had, even those not related to the project. They are very good neighbors. All of the employees are always friendly and don't hesitate to lend a hand to help.

Please mail responses by July 10, 2000 in the enclosed envelope to Matt Garcia at Tetra Tech EM Inc., 350 N. St. Paul St., Suite 2600, Dallas, TX 75201

# PETRO-CHEMICAL SYSTEMS, INC. SUPERFUND SITE SURVEY

**Site Name:** Petro-Chemical Systems, Inc. Superfund Site

**Subject:** 5-Year Review Background Information Survey

**EPA Work Assignment No.:** 034-FRFE-06ZZ

**Date:** 7/5/00

**Contact Made By:**

| Name: Chris Villarreal | Title: Remedial Project Manager | Organization: EPA |
|---|---|---|
| Telephone No.: (214) 665-6758<br>E-Mail: villarreal.chris@epa.gov | Street Address: U.S. EPA 1455 Ross Avenue, Suite 1200<br>City, State, Zip: Dallas, Texas 75202 | |

**Individual Contacted:**

| Name: Mr. Roger Ray | Title: Home Owner | Organization: NA |
|---|---|---|
| Telephone No.: (936) 336-3018<br>E-Mail Address: rayhenryjunk@aol.com | Street Address: 2230 Co. Rd. 126<br>City, State, Zip: Liberty, TX 77575 | |

**Survey Questions**

Please direct questions or comments regarding this survey to Chris Villarreal (at the address listed above).

1. Would you like to be interviewed at the Open House on July 11, 2000?
   No response provided

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

3. What effect have site operations had on the surrounding community?
   No response provided

4. Are you aware of any community concerns regarding the site or its operation and administration? If so, please give details.
   None that are concrete. Mostly rumors.

5. 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.
   No.

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

7. Do you have any comments, suggestions, or recommendations regarding the site's management or operation?
   I would like a survey of wildlife and domestic animals carried out to see if some of these chemicals have affected any of them.

Please mail responses by July 10, 2000 in the enclosed envelope to Matt Garcia at Tetra Tech EM Inc., 350 N. St. Paul St., Suite 2600, Dallas, TX 75201

# PETRO-CHEMICAL SYSTEMS, INC. SUPERFUND SITE SURVEY

| | |
|---|---|
| **Site Name:** Petro-Chemical Systems, Inc. Superfund Site | |
| **Subject:** 5-Year Review Background Information Survey | |
| **EPA Work Assignment No.:** 034-FRFE-06ZZ | |
| **Date:** 7/11/00 | |

**Contact Made By:**

| | | |
|---|---|---|
| **Name:** Chris Villarreal | **Title:** Remedial Project Manager | **Organization:** EPA |
| **Telephone No.:** (214) 665-6758<br>**E-Mail:** villarreal.chris@epa.gov | **Street Address:** U.S. EPA 1455 Ross Avenue, Suite 1200<br>**City, State, Zip:** Dallas, Texas 75202 | |

**Individual Contacted:**

| | | |
|---|---|---|
| **Name:** Mr. James Davis | **Title:** | **Organization:** NA |
| **Telephone No.:**<br>**E-Mail Address:** | **Street Address:**<br>**City, State, Zip:** | |

**Survey Questions**

Please direct questions or comments regarding this survey to Chris Villarreal (at the address listed above).

1. Would you like to be interviewed at the Open House on July 11, 2000?
   No response provided

2. What is your impression of the project (general sentiment)?
   No response provided

3. What effect have site operations had on the surrounding community?
   No response provided

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

5. 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.
   No.

6. Do you feel well informed about the site's activities and progress?
   No.

7. Do you have any comments, suggestions, or recommendations regarding the site's management or operation?
   No response provided

Please mail responses by July 10, 2000 in the enclosed envelope to Matt Garcia at Tetra Tech EM Inc., 350 N. St. Paul St., Suite 2600, Dallas, TX 75201

| PETRO-CHEMICAL SYSTEMS, INC. SUPERFUND SITE SURVEY | | |
|---|---|---|
| **Site Name:** Petro-Chemical Systems, Inc. Superfund Site | | |
| **Subject:** 5-Year Review Background Information Survey | | |
| **EPA Work Assignment No.:** 034-FRFE-06ZZ | | |
| **Date:** 7/6/00 | | |
| **Contact Made By:** | | |
| **Name:** Chris Villarreal | **Title:** Remedial Project Manager | **Organization:** EPA |
| **Telephone No.:** (214) 665-6758<br>**E-Mail:** villarreal.chris@epa.gov | **Street Address:** U.S. EPA 1455 Ross Avenue, Suite 1200<br>**City, State, Zip:** Dallas, Texas 75202 | |
| **Individual Contacted:** | | |
| **Name:** Not Provided | **Title:** NA | **Organization:** NA |
| **Telephone No.:**<br>**E-Mail Address:** | **Street Address:**<br>**City, State, Zip:** | |

**Survey Questions**

Please direct questions or comments regarding this survey to Chris Villarreal (at the address listed above).

1. Would you like to be interviewed at the Open House on July 11, 2000?
   No.

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

3. What effect have site operations had on the surrounding community?
   No complaints.

4. Are you aware of any community concerns regarding the site or its operation and administration? If so, please give details.
   None.

5. Are you aware of any events, incidents, or activities at the site such as vandalism, trepassing, or emergency responses from local authorities? If so, please give details.
   No.

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

7. Do you have any comments, suggestions, or recommendations regarding the site's management or operation?
   No.

Please mail responses by July 10, 2000 in the enclosed envelope to Matt Garcia at Tetra Tech EM Inc., 350 N. St. Paul St., Suite 2600, Dallas, TX 75201

| OPEN HOUSE SUMMARY OF CONVERSATION | |
|---|---|
| **Site Name:** Petro-Chemical Systems, Inc. Superfund Site | **EPA Work Assignment No.:** 034-FRFE-06ZZ |
| **Time:** 5:00 p.m. - 7:00 p.m. | **Date:** July 11, 2000 |

**Meeting Conducted By:**

| **Name:** | **Title:** | **Organization:** |
|---|---|---|
| Chris Villarreal<br>Matt Garcia | Remedial Project Manager<br>Project Manager | U.S. Environmental Protection Agency (EPA)<br>Tetra Tech EM Inc. (Tetra Tech) |

The meeting was called to order by Mr. Chris Villarreal who opened the meeting by informing the attendees that a five-year review was currently being conducted by the EPA to determine if the remedy selected for the site was still protective of human health and the environment. The following individuals attended the open house which took place on site in the Office Trailer Area in the main office:

| Attendee | Affiliation |
|---|---|
| Mr. Chris Villarreal | EPA Remedial Project Manager |
| Mr. Matt Garcia | Tetra Tech Project Manager |
| Mr. Dick Sloan | Lyondell |
| Mr. Mark Collins | ROG |
| Mr. Rob Jaros | ROG |
| Mr. Ron Jansen | ROG |
| Mr. James L. "Sonny" Davis | Liberty County Permits: Building & Septic Subdivisions and Flood Plain Management |
| Mr. Roger Ray | Property Owner |
| Mr. George Evans and wife | Property Owners |
| Mrs. Misty Kaderli and children | Property Owner |
| Mr. Donnie Smith | Property owner |
| Mr. William J. Starr | No Response |
| Mr. John Chaplain and wife | Property Owners |
| Mr. Frank Cassillas and wife | Property Owners |
| Mr. John L. Carrell | Property Owner |
| Mr. T. R. Bennett | No Response |

Mr. Roger Ray stated that he has chickens that will not hatch and has had several dogs that have died of cancer. Mr. Ray stated that he had a healthy dog that died from cancer after he had lived near the site for 16 months; Mr. Ray lives on the north side of CR 126. In response to Mr. Ray's statement, Mr. Dick Sloan stated that while benzene tends to cause brain and pancreas cancer, there is no benzene in the soil. Mr. Ray feels that the flooding carries the contaminants from the site and deposits them on their properties. Mr. Chris Villarreal stated that limited surface soil contaminants exist around the site and that it is mostly subsurface contamination. Mr. Ray feels that the bridge on CR 126 is contributing to the flooding of properties.

- Mr. Sloan stated to Mr. Ray that flooding should be addressed by the county.
- Mr. Sloan also informed them that CR 126 is not owned by Lyondell; Mr. Sonny Davis, Liberty County, felt it was not a county road (ownership). The county does maintain CR 126 east of the Turtle Bayou crossing.
- Mr. Ray also feels that the rice and cattle farmers located upstream may be contributing to the lack of drainage in Turtle Bayou.

## OPEN HOUSE SUMMARY OF CONVERSATION (Continued)

Mr. Sloan provided a brief history of the site from inception to current date to Mrs. Misty Kaderli. Mrs. Kaderli stated her well water "smells nasty."

Mr. Sloan stated that they will monitor ground water after the cleanup of the site for another 30 years.

Mr. Sloan stated that wells on site are an average of 28 feet below ground surface.

Mr. Davis requested that Lyondell (test) his water well. Mr. Davis stated that he has not drank the water in his water well since his first wife died in the 1970s of cancer. Mr. Villarreal agreed see if there are results from the EPA 1990 sampling event for Mr. Davis' well.

Mr. Sloan offered to sample anyone's well upon request. Mr. George Evans stated that a pit is rumored to have been on Mr. Donnie Taylor's property. (Mr. Donnie Taylor is a resident, and was not present at the meeting.)

Mrs. Kaderli stated that her well smelled like chlorine. She will inform Lyondell the next time it has an odor.

Mr. Sloan suggested the water wells should be sampled twice per year for contaminants.

Residents stated that there is a lot of concern related to chemical exposure to the animals in the area.

Mr. Ray stated that he has seen wild animals (deer) with sores on their bodies, and feels that there should be a study conducted on the domestic and wild animals in the area.

Mr. John Chaplin stated that his well water was fine and tasted very good. His well water is tested quarterly by Lyondell.

Mr. John Carrell stated that his water well is more than 200 feet below ground surface.

Mr. Donnie Smith inquired as to the current status of the new CR126 West Area.

Mr. Sloan stated that the CR126 West Area was west of Mr. Smith's well and Mr. Carrell's well test results were clean. Mr. Sloan stated that ground water migrated in the area of the site from the north, northwest to the southeast at about 5 feet per year.

Mr. Sloan offered to place wells on Mr. Smith's property perimeter to verify that contaminants do not exist and offered to install deep wells if needed.

Mr. George Evans stated that water wells in the area on the site side have deteriorated in quality over the last 3 years. Residents complained of a very strong sulfur smell in the water. Mr. Evans stated that the water is red at times when he uses it at his residence.

Mr. Frank Cassillas who lives across from MW11 stated that his water is in good condition with no problems. His well is 20 years old.

## OPEN HOUSE SUMMARY OF CONVERSATION (Continued)

Mr. Carrell discussed the issue of CR126 West Area. He asked how long this clean-up will take? Mr. Sloan also discussed liability of the site with Mr. Carrell.

Mr. Ray is concerned about the deep wells on the properties located directly across from Mr. Taylor's property; the water has a strong smell.

Mr. Evans feels that the wells in the area are basically not useable on the side (south) of the site. Mr. Evans' property is located across from Mr. Ray's property.

Mr. Evans and Mr. Ray's major complaint is that the bridge on CR126 causes flooding; the culvert is lower than the water level. The culvert should be cleaned and the bayou dredged to the south of the bridge.

Mr. Evans stated that Lyondell is very helpful to the local residents.

Mr. Ray provided the name of Dr. Meyers, who was the veterinarian who performed an autopsy on his boxer (Casey) who died of cancer of the liver.

Mrs. Kaderli requested a list of contaminants. Dick Sloan responded with benzene and 1,2,3-DCA from petroleum production.

Mr. Davis is interested in setting up a "site notification process" to new residents for new construction of septic tank permits for new homes, mobile homes, or any new dwelling. No excavation or water well permits are currently required by the county for the site. Electrical permits are issued by the county for any new residence. This could serve as a notification vehicle.

Mr. Davis suggested that an information packet which identifies contacts/potential issues at the site, be provided to new residents in the area. Residents would sign a receipt/form to show delivery of the notice by the county.

Mr. John Chaplain stated that Lyondell has been nothing short of extremely informative, helpful, and pleasant; the company is always willing to answer questions or respond to a possible problem.

Mr. Evans is mostly concerned about the present and future condition of the water wells used by residents in the immediate areas of the project. Mr. Evans also wants to know what can be done to improve the condition of the water.

The residents feel that the evening hours are a good time to have a public meeting in the future, on site.

At 6:50 p.m., Mr. Matt Garcia of Tetra Tech presented the following summary of issues identified at the meeting:

- Concerns were raised about exposure of chemicals to domestic and wildlife animals; a request was made for a study to be conducted.
- The residents feel that flooding carries contaminants to other properties around the site.
- The culvert is not designed correctly and adds to the flooding in the area.

## OPEN HOUSE SUMMARY OF CONVERSATION (Continued)

- Water wells in the area, especially on the south side, are not useable or have many problems.
- Mr. Davis requested that the EPA 1990 water well sampling results be provided to him.
- Mrs. Kaderli is concerned about the chlorine smell in her water; she will meet with Lyondell.
- Mr. Smith has concerns about possible impact to his property; Lyondell plans to coordinate with him.
- Mr. John Carrell has concerns about the CR126 West Area and how it affects the use of his property.
- Discussion about a possible public meeting in October (preferably on a Tuesday or Thursday, from 5 to 7 p.m.).
- Water well sample results will be provided in writing by Lyondell as requested by residents.

**APPENDIX D**

**FACT SHEET**

**(One Page)**

# TURTLE BAYOU SUPERFUND SITE UPDATE
# EPA 5-Year Review and Open House

**July 2000**

**What is in this Fact Sheet?**

- Site Background
- Status of Cleanup
- EPA 5-Year Review
- Cleanup Progress and Planned Completion
- Open House
- Additional Information

## Site Background

The Turtle Bayou Site (also known as the Petro-Chemical System, Inc. Site) is located in Liberty County, Texas, approximately 12 miles south of Liberty, Texas, and 55 miles east-northeast of Houston, Texas. The Turtle Bayou Site is located along Country Road (CR) 126 (formerly Frontier Park Road). Prior to 1970, the disposal of waste materials began on CR 126 and at several locations along CR 126; these locations have been identified and targeted for environmental cleanup. Specifically, the disposal areas are referred to as (from west to east along CR 126): (1) West Road Area, (2) Main Waste Area, (3) Office Trailer Area, (4) Easement Area, and (5) Bayou Disposal Area. Within the last year, an area located between the West Road Area and Farm to Market Road 563 has also been identified as having subsurface contamination. This area is referred to as CR 126 West and is currently being investigated.

Since the late 1980s, the U.S. Environmental Protection Agency (EPA) has conducted numerous studies to determine the type and amount of waste materials present in the soils and ground water at the Turtle Bayou Site. Initial studies focused on the access roadway (CR 126), while more recent studies have taken a closer look at the specific disposal locations. Cleanup activities are currently underway. As the cleanup activities are conducted, more specific information will be made available to help EPA pinpoint areas where elevated chemical levels are present.

## Status of Cleanup

Each of the five disposal areas has varying levels of waste material concentrations in soil and ground water, as well as varying physical characteristics. As a result of these variations, EPA has selected different cleanup methods, and in some cases a combination of cleanup methods, to best address the specific conditions at each disposal area.

Pursuant to a December 27, 1998, Consent Decree, the work at the site is currently being conducted by the following Potential Responsible Parties (PRPs): Lyondell (formerly ARCO Chemical Company) and Atlantic Richfield Company. The PRPs, under the oversight of the EPA and the Texas Natural Resource Conservation Commission (TNRCC), have designed and constructed the cleanup methods (or systems) for the site. Cleanup systems have been in place and operating since mid-1997 with no major operational or maintenance issues.

## EPA 5-Year Review

The purpose of a 5-year review is to determine whether the remedy at a site is protective of human health and the environment. Where a site has remedial actions that are still under construction, a 5-year review should confirm that immediate threats have been addressed and that the remedy will be protective when complete.

## Cleanup Progress and Planned Completion

Cleanup progress is measured by regularly analyzing soil and ground water samples. Significant cleanup progress has been made at the site. EPA has established soil and ground water cleanup goals for the site. As the cleanup goals are met, portions of the cleanup systems that are no longer needed are discontinued. EPA expects to complete ongoing cleanup activities in the Fall of 2002.

## Open House

An open house will be held at the Turtle Bayou site on July 11, 2000. The meeting will take place at the site office trailer from 5:00 p.m. to 7:00 p.m. The purpose of the meeting is to give the public a chance to ask questions and gain a better understanding of the activities occurring at the site. The meeting will be hosted by EPA and those parties responsible for cleaning up the site.

**Additional Information**

For additional information, please call or write:

Chris Villareal
Remedial Project Manager
U.S. EPA (6H-ET)
1445 Ross Avenue
Dallas, Texas 75202-2733
(214) 665-6758

Documents related to the site are available at:

Liberty Public Library
1710 Sam Houston
Liberty, TX 77575
(409) 336-8901
Monday - Thursday 9:00 a.m. - 6:00 p.m.
Friday 1:00 p.m. - 5:00 p.m.
Saturday 10:00 a.m. - 4:00 p.m.

U.S. EPA, Region 6
7th Floor Reception Area
1445 Ross Avenue
Dallas, Texas 75202-2733
Toll Free 1-800-533-3508
Monday - Friday 8 a.m. - 5 p.m.

TNRCC Library
Building A, Room 102
12100 Park 35 Circle
Austin, Texas 78711-3087
(512) 239-0020

Media inquiries should be directed to Dave Barry, Regional 6 Press Officer, at (214) 665-2200.

EPA
U.S Environmental Protection Agency
Region 6 (6SF AP)
1445 Ross Avenue
Dallas, Texas 75202-2733

First-Class Mail
Postage and Fees
Paid
EPA Permit
No. G-35

TURTLE BAYOU SUPERFUND SITE