COST AND PERFORMANCE REPORT

Pump and Treat and Air Sparging of Contaminated Groundwater at the Gold Coast Superfund Site Miami, Florida

September 1998

Prepared by:

U.S. Environmental Protection Agency
Office of Solid Waste and Emergency Response
Technology Innovation Office

SITE INFORMATION

Identifying Information:

Gold Coast Superfund Site
Miami, Florida

CERCLIS #: FLD071307680

ROD Date: September 11, 1987

Treatment Application:

Type of Action: Remedial

Period of operation: 7/90 - 3/94
(Data collected through February 1996)

Quantity of material treated during application: 80 million gallons of groundwater

Background

Historical Activity that Generated Contamination at the Site: Spent oil and solvent reclamation

Corresponding SIC Code: 4953W
(Miscellaneous Waste Processing)

Waste Management Practice That Contributed to Contamination: Direct discharge of reclamation blowdown to the soil; improper storage of waste

Location: Miami, Florida

Facility Operations: [1,7]

- Gold Coast Oil Corporation operated as a spent oil and solvent recovery facility from 1970 to 1982. Recovery operations at the 2-acre site included distillation of lacquer thinner and mineral spirits. Blowdown from these operations was discharged directly onto the soil.
- In 1980, the FDEP detected soil and groundwater contamination from sampling on-site soil and an on-site well.
- In 1981, the FDEP, DERM, and the EPA conducted soil and groundwater investigations. Soils were found to be contaminated with heavy metals and organics; groundwater was found to be contaminated with VOCs.
- In 1982, facility operations ceased. The remaining hazardous liquid and solid waste was disposed off site by the owners.
- Visibly contaminated soil was excavated from the site in 1982 and disposed off site. After excavation, the remaining soils were tested. According to the Site Closeout Report, no contamination was detected in the remaining soils [8]. Had contamination been detected, the plan was to solidify and stabilize the soils [8].
- From 1982 until 1990, additional remedial investigations were performed. As part of these investigations, 15 monitoring wells were installed at the site.
- In September 1983, the site was placed on the National Priorities List (NPL).

Regulatory Context:

- EPA issued a ROD on September 11, 1987.
- Site activities were conducted under provisions of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA) §121, and the National Contingency Plan (NCP), 40 CFR 300.

Groundwater Remedy Selection: The selected groundwater treatment was extraction of the groundwater followed by treatment using an air stripper, with treated groundwater being re-injected into the upper Biscayne Aquifer.

SITE INFORMATION (CONT.)

Site Logistics/Contacts

Site Lead: EPA

Remedial Project Manager:
Brad Jackson*
U.S. EPA Region 4
3456 Courtland Street, N.E.
Atlanta, Georgia 30365
(404) 562-8975

State Contact:
Marvin Collins
FDEP
Tallahassee, Florida
(850) 488-0190

Treatment System Vendors:
Construction: Simmons Consulting, Inc.
Treatment System Vendor: Lantec
Operations: Simmons Consulting, Inc. and The Baljet Corporation/Edward E. Clark Engineers-Scientists, Inc.

*Indicates primary contact

MATRIX DESCRIPTION

Matrix Identification

Type of Matrix Processed Through the Treatment System: Groundwater

Contaminant Characterization [1,6]

Primary Contaminant Groups: Volatile organic compounds

- The groundwater contaminants of concern at the site were VOCs. The maximum initial concentrations of the VOCs detected at the site were methylene chloride at 100 µg/L; 1,1-DCA at 2,000 µg/L; trans-1,2-DCE at 3,000 µg/L; TCE at 48,000 µg/L; PCE at 100,000 µg/L; and toluene at 545 µg/L.
- The initial areal extent of the contaminant plume was estimated to be 0.87 acres, based on the 1990 plume map prepared by Edward E. Clark Engineers (EEC). Based on a plume thickness of approximately 10 feet, a porosity of 30%, the initial plume volume was estimated for this report at 2,834,700 gallons.
- Figure 1 illustrates the contaminant contours observed prior to remediation and after one year of remediation in 1991. The contaminant plume as observed during sampling events from 1991 to 1993 is illustrated in Figures 2 and 3.
- The initial concentrations of TCE and PCE detected in the groundwater were greater than 1 and 60 percent of TCE and PCE solubilities, respectively, which indicates the likely presence of a dense nonaqueous phase liquid (DNAPL) [10].
- Figures 1, 2, and 3 show the extent of DNAPL presence from 1990 to 1993, based on data from sampling events. The estimated distribution of DNAPL is labeled the DNAPL residual zone. After remediation was completed in 1994, no evidence of residual DNAPL was found. The reduction in plume size and the elimination of residual DNAPL is further discussed in the Performance Data Assessment section of this report.

MATRIX DESCRIPTION (CONT.)

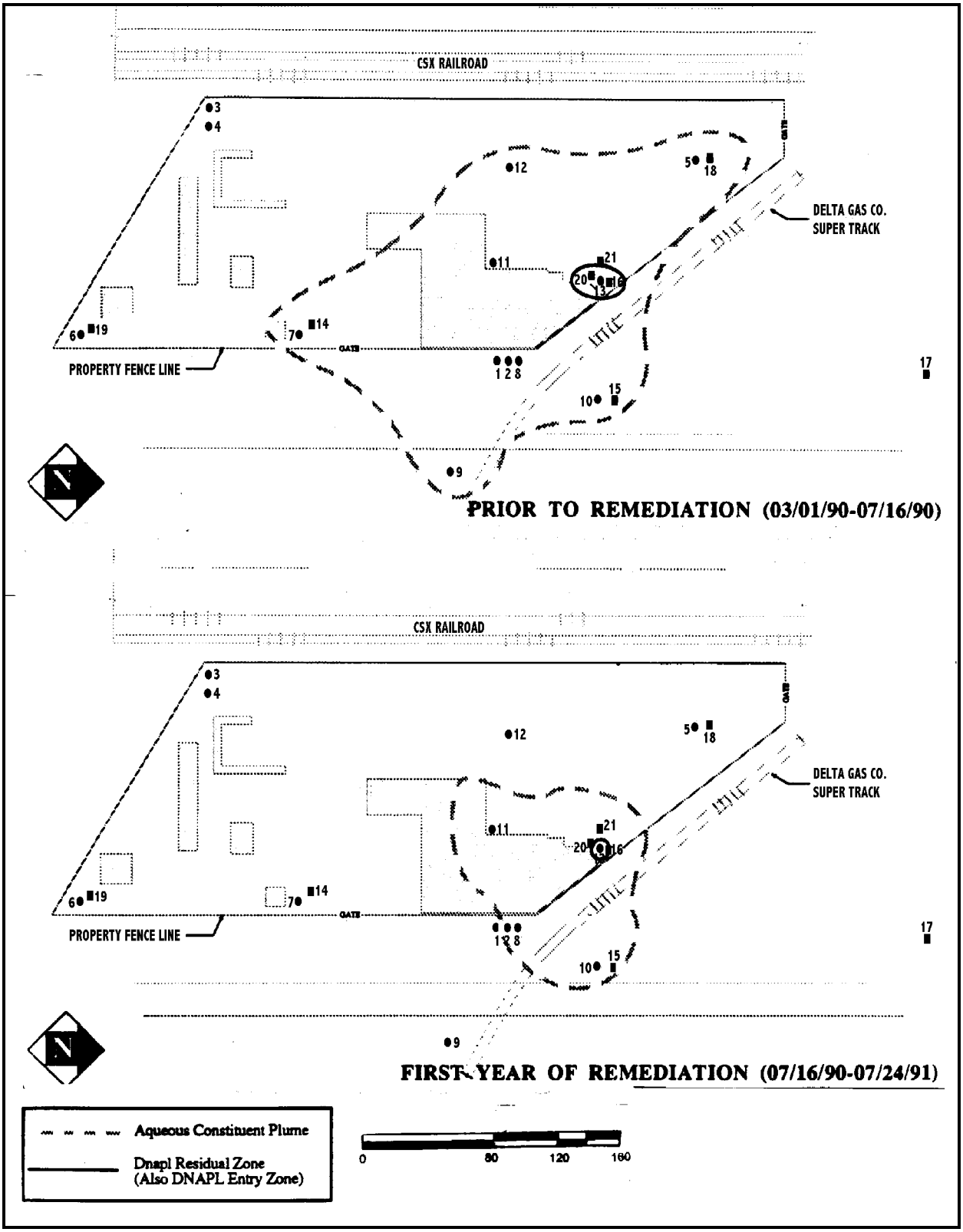

Figure 1. DNAPL and Plume Distribution (1990 - 1991) [7]

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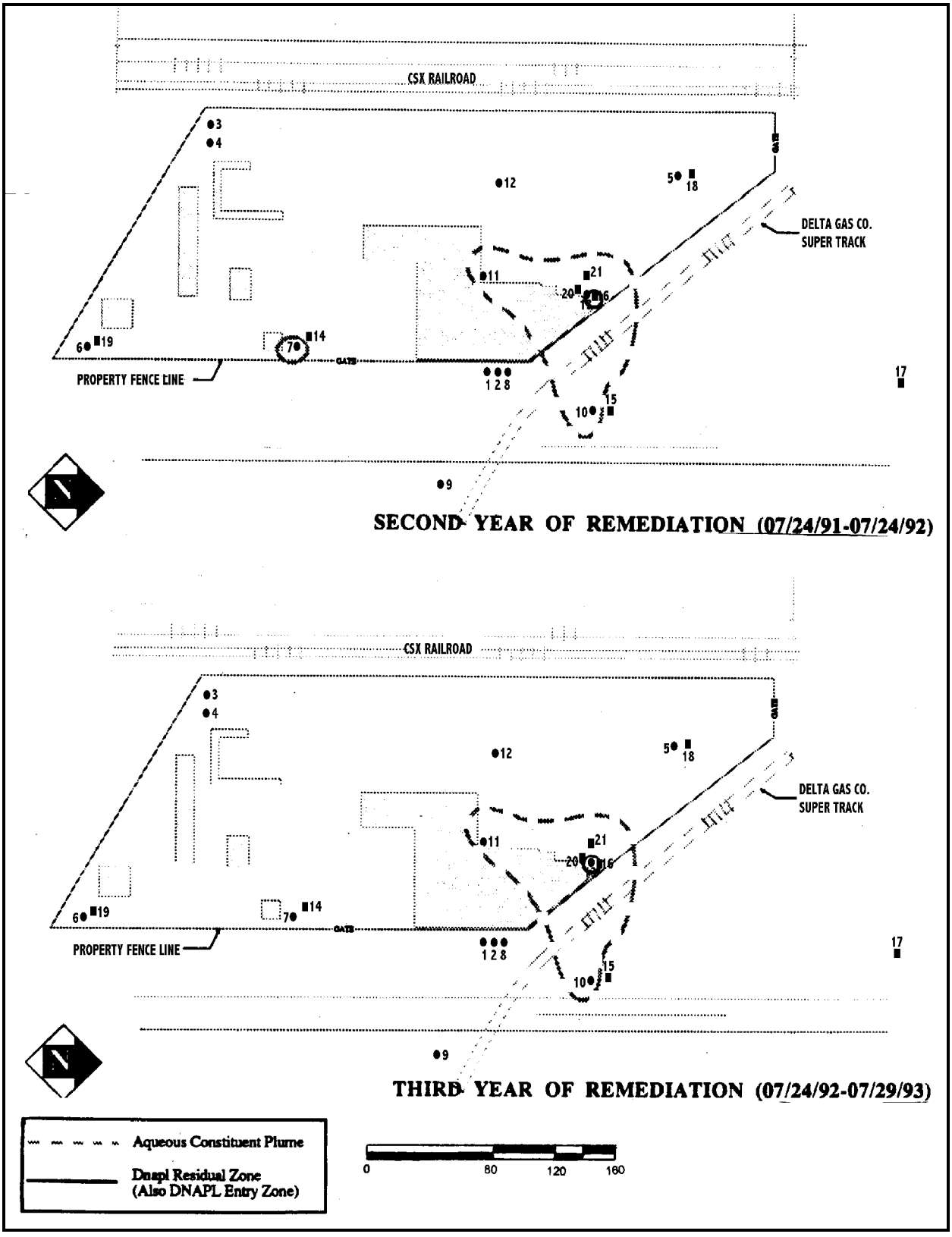

Figure 2. DNAPL and Plume Distribution (1992 - 1993) [7]

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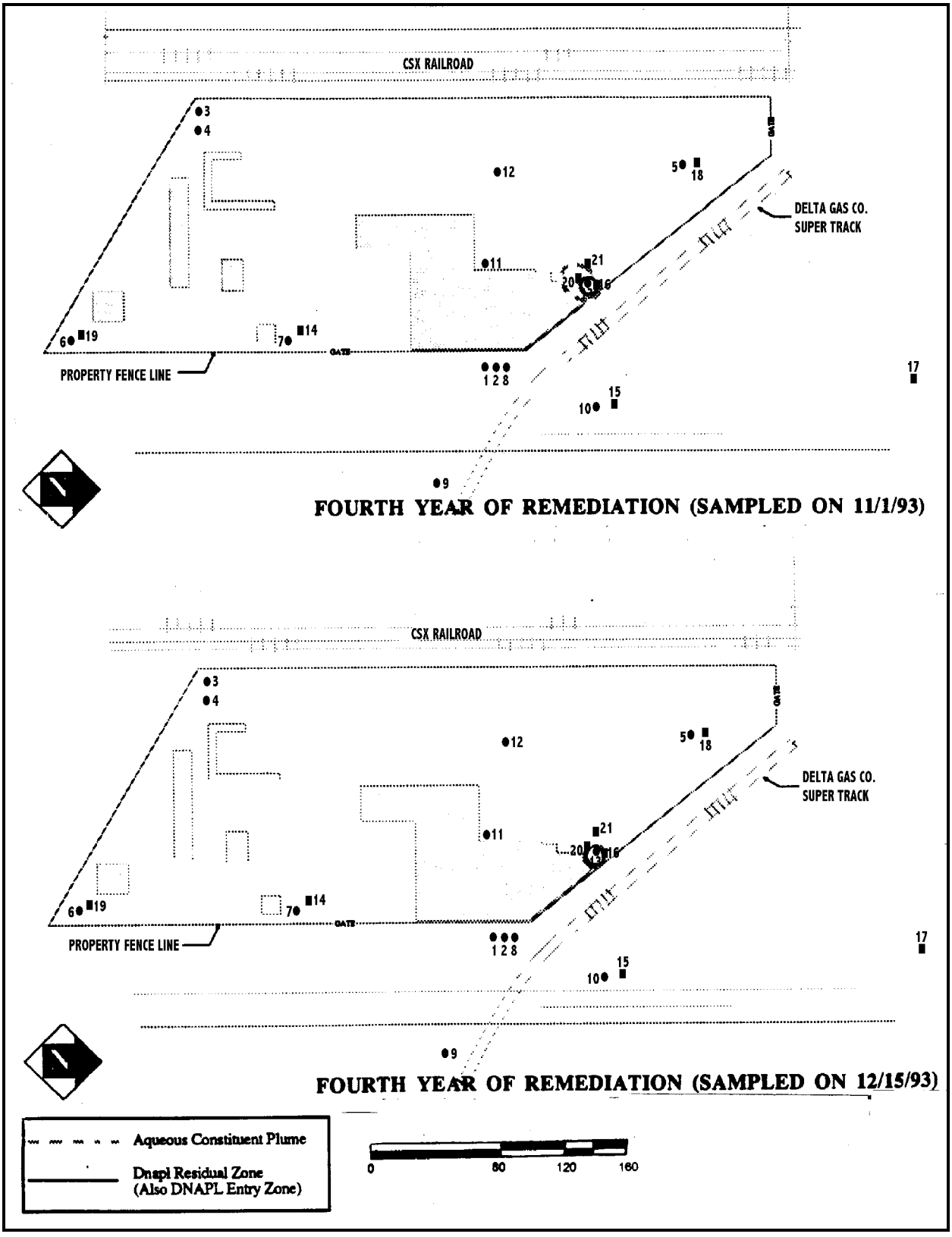


Figure 3. DNAPL and Plume Distribution (1993) [7]

MATRIX DESCRIPTION (CONT.)

Matrix Characteristics Affecting Treatment Costs or Performance

Hydrogeology [1, 2, 7]:

Two distinct hydrogeologic units have been identified beneath this site.

Unit 1	Biscayne Aquifer	The Biscayne Aquifer is the sole source of drinking water for the area. It lies approximately 5 feet below the ground surface [7]. The upper layers of the aquifer are composed of sand, shell, and unconsolidated limestone. Hard condensed limestone with layers of thick solution-riddled limestone are found in the lowest layers. The Miami Oolite and Fort Thompson formations, which consist of consolidated limestone divided by a layer of hard sand, form the base of the Biscayne Aquifer. At the site, the aquifer ranges in thickness from approximately 100 to 110 feet. Unit 1 is not hydraulically connected to the deep aquifer, Unit 2. Regionally, groundwater flow is to the east with a very low hydraulic gradient. However, groundwater flow is governed locally by the nearby Coral Gables and Tamiami Canals and will change direction depending on canal water levels [2].
Unit 2	Floridan Aquifer	The saline Floridan Aquifer is a deep aquifer separated from the Biscayne Aquifer by the Tamiami and Hawthorne Formations. The Tamiami and Hawthorne formations reach a depth of approximately 700 feet and consist of sand, silt, marl, and clay materials [2]. This aquifer has not been sampled at this site.

Tables 1 and 2 present technical aquifer information and well data, respectively.

Table 1. Technical Aquifer Information [6]

Unit Name	Thickness (ft)	Conductivity (ft/day)	Average Velocity (ft/day)	Flow Direction
Biscayne Aquifer	100 - 110	1,000[a]	2.0	East[b]
Floridan Aquifer	700	NA	NA	NA

[a] As measured by Howard Klein in *Biscayne Aquifer, Southeast Florida:* U.S. Geological Survey Water Resources Investigations Report 78-107.
[b] Groundwater flow direction is governed locally by the nearby Coral Gables and Tamiami Canals and will change direction depending on canal water levels.

TREATMENT SYSTEM DESCRIPTION

Primary Treatment Technology

Pump and treat with air stripping

Supplemental Treatment Technology

None

System Description and Operation

Table 2. Technical Well Data [6]

Well Name	Unit Name	Depth (ft)	Design Yield (gpm)
MW-10	Biscayne Aquifer	15	10
MW-11	Biscayne Aquifer	15	10
MW-13	Biscayne Aquifer	15	10
MW-16	Biscayne Aquifer	30	35
MW-20	Biscayne Aquifer	30	35

System Description [2,3,7]

- The extraction system was a network of five extraction wells, with three wells at depths of 15 feet and two wells at depths of 30 feet. Figure 1 shows the site layout and well locations. Two of the three shallow wells, MW-11 and MW-13, were located in suspected DNAPL source zones along the western edge of the former on-site building. The two deeper wells were located in the same source zone as MW-13. The third shallow monitoring well was located along the eastern, downgradient edge of the plume. Well locations were selected to pump from the most contaminated areas and to contain the plume. The overall average pump rate, based on a 95% operation rate and a total of 80 million gallons extracted, was approximately 44 gpm.
- The treatment system consisted of two air stripping towers in series, two holding tanks, and associated pumps and valves. Each stripping tower was 36 feet high and 3 feet in diameter and packed to a height of 26 feet with IMPAC, a packing material that enhances stripping of VOCs from water.
- Groundwater was pumped through the stripping towers, into the holding tanks, and re-injected into the aquifer through three injection wells.

System Operation [6,7,8]

- Quantity of groundwater pumped from aquifer in gallons:

Year	Volume Pumped (gal)
July 1990-1991	29,736,200
1992	28,560,200
1993	20,297,890
March 1994	1,060,950

TREATMENT SYSTEM DESCRIPTION (CONT.)

System Description and Operation (Cont.)

- From 1990 to 1994, the system was operational 95% of the time. The system was shut down for routine maintenance and during August 1992 as a result of power outages from Hurricane Andrew. The system was not damaged by the hurricane.
- Extraction wells MW-11 and MW-13 were pumped throughout system operation because they were located in suspected source zones. The other extraction wells were pumped sporadically and at lower rates.
- In July 1991, wells MW-11 and MW-13 were enlarged from 2-inch diameter to 4-inch diameter wellpoints to increase extraction rates.
- In February 1992, pumping began from MW-10.
- Because elevated levels of TCE and PCE persisted in MW-11 and MW-13, EPA and the site engineer decided to consider alternative efforts to capture further contamination. The maximum TCE and PCE levels detected during monthly sampling events persisted at levels up to 10 µg/L and 30 µg/L, respectively. (The cleanup goals were 3.0 µg/L for TCE and 0.7 µg/L for PCE.) Hydrogen peroxide was added to MW-11 and MW-13 from March through July 1993. However, the elevated contaminant levels persisted in MW-11 and MW-13, which indicated the likely presence of a subsurface source zone, or DNAPL [7].
- In August 1993, EPA and the site engineer tried another alternative. The extraction system was shut down to increase the amount of TCE and PCE desorbing from aquifer materials into the groundwater. Monitoring continued through the shutdown. The extraction system was restarted in November 1993. The mass flux into the treatment system did not increase, and it was determined the shut-down did not increase contaminant desorption. Maximum concentrations of TCE and PCE persisted at 6 µg/L and 24 µg/L.
- In March 1994, EPA decided to temporarily shut down the extraction system while monitoring continued. Through May 1994, contaminant concentrations had not increased and the groundwater treatment system was officially shut down by the EPA [7].
- In November 1994, soil in the areas of suspected DNAPL contamination was excavated around wells MW-11 and MW-13, as approved by EPA. The excavated soil tested below detection limits for PCE and TCE. The groundwater was sparged using a portable sparger and contaminants were allowed to volatilize in accordance with EPA correspondence. Subsequent testing of the groundwater in the excavations revealed that contaminant levels were below cleanup goals [7].
- Contaminant levels in monitoring wells sampled from February 1995 through April 1995 did not exceed detection limits.
- The wells were decommissioned in April 1995.
- The Close-Out Report was signed by the EPA on February 16, 1996, and the site was deleted from the NPL on August 21, 1996.

TREATMENT SYSTEM DESCRIPTION (CONT.)

Operating Parameters Affecting Treatment Cost or Performance

Table 3 presents operating parameters affecting cost or performance for this technology.

Table 3. Performance Parameters

Parameter	Value
Average Pump Rate	44 gpm
Remedial Goal (aquifer)	same as performance standards
Performance Standard (effluent)	1,1-DCA 5.0 µg/L trans-1,2-DCE 70.0 µg/L Methylene Chloride 5.0 µg/L PCE 0.7 µg/L Toluene 340.0 µg/L TCE 3.0 µg/L

Note: Average system rate was 44 gallons per minute (gpm), based on a total of 80 million gallons pumped since operations began and a 95% operation rate.

Source: [1,2]

Timeline

Table 4 presents a timeline for this remedial project.

Table 4. Project Timeline

Start Date	End Date	Activity
09/11/87	---	ROD signed
04/89	---	683 tons of soil excavated
01/90	07/15/90	Construction of remedial system
07/90	---	Pump and treat system and quarterly monitoring begun
7/91	---	Wells 11 and 13 enlarged to 4-inch diameter wells to increase effectiveness
2/29/92	---	Pumping from MW-10 begun
10/92	---	Concrete base of MW-10 regrouted after hurricane damage
1/93	---	Contaminant levels persist and alternative efforts to increase contaminant capture considered
3/21/93	---	Hydrogen peroxide injected into wells MW-13 and MW-20
4/8/93	---	Hydrogen peroxide injected into wells MW-13 and MW-20
5/7/93	---	Hydrogen peroxide injected into wells MW-13 and MW-20
7/26/93	---	Hydrogen peroxide injected into wells MW-13 and MW-20
8/1/93	9/1/93	Groundwater extraction system operation ceased for 30-day period in attempt to increase desorption of TCE and PCE from aquifer to groundwater
91/93	11/1/93	Groundwater extraction system operation ceased for 60-day period in attempt to increase desorption of TCE and PCE from the aquifer to groundwater
3/15/94	---	Groundwater extraction system stopped operating to allow aquifer equilibration and pending stability sampling
11/94	2/95	Soil in suspected source areas excavated and backfilled with clean soil. Groundwater in open pits sparged
5/16/94	---	EPA authorizes final shutdown of pump and treat system
5/94	5/95	Aquifer stability sampling continued through quarterly monitoring
5/95	---	Wells abandoned and site officially shut down by EPA

Source: [2,4,6]

TREATMENT SYSTEM PERFORMANCE

Cleanup Goals/Standards

The remedial goal for the site was to reduce concentrations of 1,1-DCA, trans-1,2-DCE, methylene chloride, PCE, toluene, and TCE to levels below the maximum contaminant levels (MCLs) set by the DERM, FDEP, and Primary Drinking Water Standards. The required cleanup levels are listed above in Table 3 and are applied throughout the aquifer, as measured in all on-site monitoring wells [1].

Treatment Performance Goals

- Effluent discharged from the treatment system must meet the remedial goals listed in Table 3 for re-injection [1,2].
- As a secondary goal, the remedial system is designed to create an inward gradient toward the site to contain the plume [2].

Performance Data Assessment [4,5,7,8]

- Groundwater monitoring results indicate that contaminant concentrations have been reduced below treatment goals.
- Performance monitoring results indicate that effluent requirements have been met throughout the operation of the treatment system.
- No contaminants were detected in downgradient monitoring wells during the remedial operations. Based on this information, the plume was contained throughout the remedial action.
- After the first year of operation, the concentrations of all contaminants except for TCE and PCE were reduced to levels below cleanup goals. Elevated levels of TCE and PCE were detected primarily in wells MW-11 and MW-13, in the suspected DNAPL zones.
- During remedial system operations, the contaminant plume was reduced in size, as shown in Figures 1, 2, and 3. Also shown in the figures is the location of the residual DNAPL around wells MW-11 and MW-13. The estimated distribution of DNAPL residual decreased each year from 1990 until 1993. In 1994, sampling events did not indicate the presence of DNAPL.
- The performance measures for the Gold Coast system focused on TCE and PCE because they were the only contaminants remaining to be remediated after July 1991. Figure 4 illustrates PCE and TCE removal from 1991 to 1994.
- Figure 4 shows that from 1991 to 1994, 1,961 pounds of TCE and PCE were removed from the groundwater. The removal curve shows the typical flattening that indicates a reduction in removal efficiency beginning in the first year and continuing through the remaining system operation. In addition, Figure 4 shows that the mass flux rate declined from 3.4 lbs/day during the first year to 0.006 lbs/day in the final year.
- Figure 5 shows the average levels of TCE and PCE detected in groundwater from March 1990 until February 1995. Average contaminant concentrations in the groundwater declined from 176 µg/L of PCE to 8 µg/L of PCE and from 88 µg/L of TCE to 9 µg/L of TCE in the first year. Contaminant levels were elevated primarily in wells MW-11 and MW-13. By May 1991, the average PCE and TCE concentrations had leveled off, illustrating that the pump and treat system was not as effective in decreasing TCE and PCE concentrations.

TREATMENT SYSTEM PERFORMANCE (CONT.)

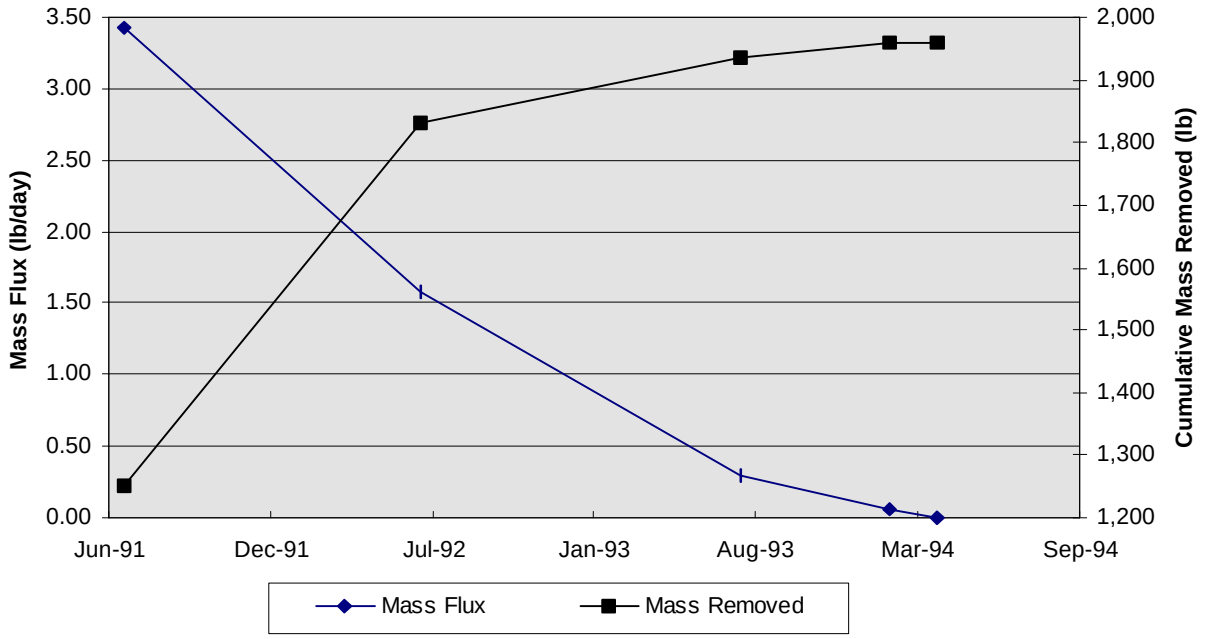


Figure 4. TCE and PCE Mass Flux Rate and Cumulative TCE and PCE Removal (July 1991 to March 1994) [4, 5]

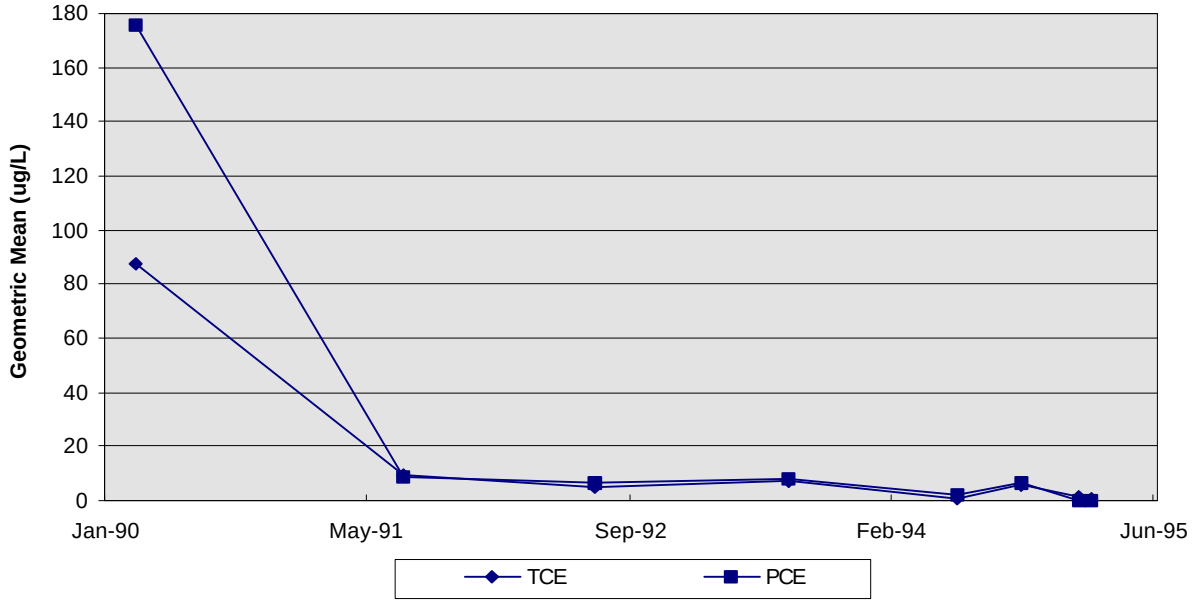


Figure 5. Average TCE and PCE Concentrations in the Groundwater [4, 5]

TREATMENT SYSTEM PERFORMANCE (CONT.)

Performance Data Assessment (Cont.)

- Figure 6 illustrates the TCE and PCE levels detected in extraction well MW-11 from March 1990 until April 1995. Contaminant levels declined from 89 µg/L of PCE to 13 µg/L of PCE and from 34 µg/L of TCE to 19 µg/L of TCE in the first year of remediation, but levels of contamination above MCLs persisted through 1995.
- Figure 7 illustrates TCE and PCE levels detected in extraction well MW-13 from July 1991 until February 1995. Just as with MW-11, contaminant levels declined from 44,000 to 680 µg/L of PCE and from 1,700 µg/L to 210 µg/L of TCE in the first year of remediation, but levels of contamination above MCLs persisted through 1995. PCE levels fluctuated from below detection limits in June 1994 to 94.9 µg/L in October 1994.

Performance Data Completeness

- For the contaminant concentrations in Figures 5, 6, and 7, annual monitoring data were used. Monthly monitoring data are available from the site contact.
- A geometric mean of contaminant concentrations was used to represent the trend of contaminant concentrations across the site.
- Contaminant mass removal depicted in Figure 4 was determined using analytical results from extraction wells and well extraction flow rate data. Well data on an annual basis were used. The mass removal is, therefore, a best estimate based on available data. Contaminant concentrations in the influent and effluent to and from the treatment system were not available, because all information was archived.

Performance Data Quality

The QA/QC program used throughout the remedial action met the EPA and the FDEP requirements. All monitoring was performed using EPA-approved methods, and the vendor did not note any exceptions to the QA/QC protocols [4].

TREATMENT SYSTEM PERFORMANCE (CONT.)

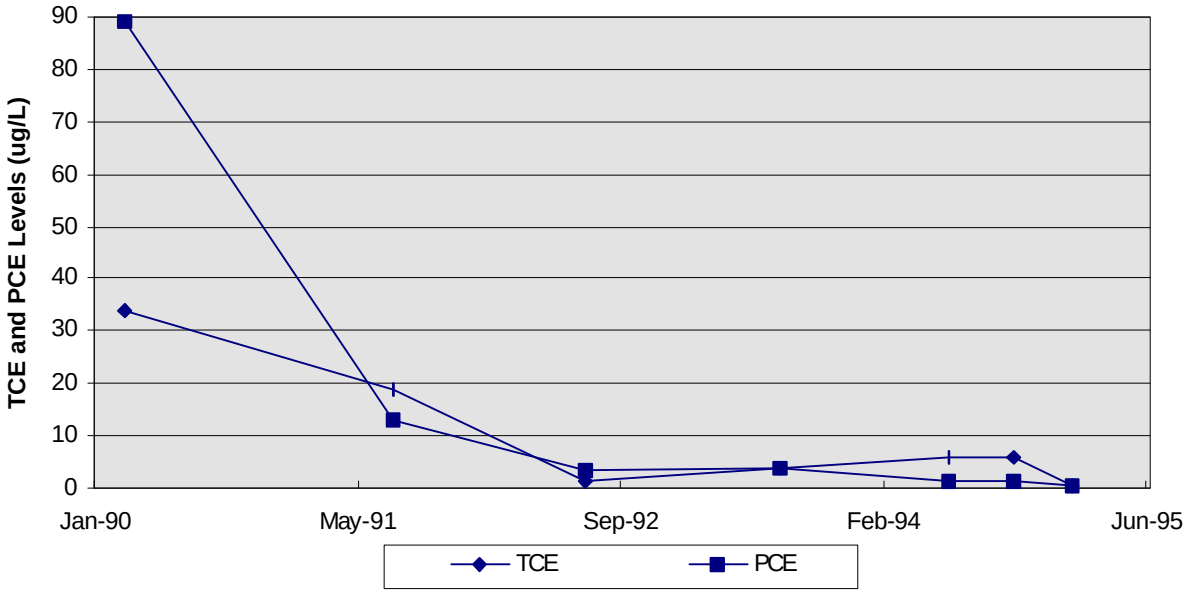
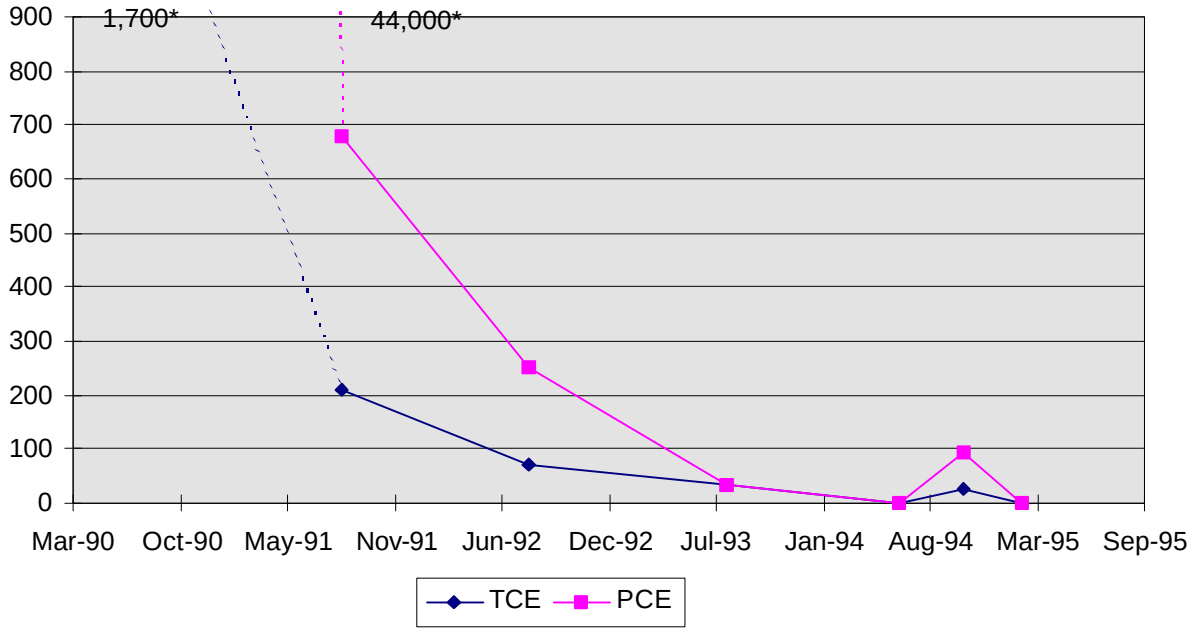


Figure 6. TCE and PCE Concentrations Detected in MW-11 [4, 5]



* Concentrations detected during March 1990
** MCLs not shown because of scale limitations

Figure 7. TCE and PCE Concentrations Detected in MW-13 [4, 5]

TREATMENT SYSTEM COST

Procurement Process

The group of responsible parties contracted with a private consulting firm to construct and operate the remedial system, under the oversight of EPA.

Cost Analysis

All costs for investigation, design, construction, and operation of the treatment system at this site were borne by the group of responsible parties.

Capital Costs [9]

Remedial Construction	
Startup	$14,700
Analytical Costs	$8,220
Tower and Packing	$77,110
Tower Installation	$6,350
Well Installation	$36,855
Construction Management	$105,770
Total Construction	$**249,005**

Operating Costs [9]

Operation and Maintenance	$196,050
Utilities	$19,820
Analyses	$36,950
Pump Replacement	$10,060
Periodic Maintenance	$182,440
Cumulative Operating Expenses	$**445,320**

Other Costs [9]

Remedial Design	$183,290

Cost Data Quality

Actual capital and operation and maintenance cost data are available from the responsible parties for this application.

Decommissioning costs were not available. No other costs were incurred that affected cost by greater than 10%.

OBSERVATIONS AND LESSONS LEARNED

- Actual costs for the pump-and-treat application at Gold Coast were approximately $694,325 ($249,005 in capital costs and $445,320 in annual operation and maintenance costs), not including design costs, which corresponds to $354 per pound of contaminants removed and $9 per 1,000 gallons of groundwater treated.
- The cleanup standards were met at this site within approximately four years [8]. Within the first year of operation, the contaminant levels at the site had been reduced below cleanup goals with the exception of TCE and PCE. Only two monitoring wells were found to have consistently elevated levels of TCE and PCE. Extraction was then focused in the area of the two wells [6]. This optimization of extraction well management allowed cleanup to focus on the problem areas.

OBSERVATIONS AND LESSONS LEARNED (CONT.)

- When pump-and-treat did not quickly reduce the concentrations of TCE and PCE in the groundwater, two alternative actions were evaluated - hydrogen peroxide injection and stopping extraction for three months to allow contaminants to desorb from aquifer materials. However, these actions did not reduce the levels of TCE and PCE, indicating they were not as effective as sparging in quickly removing persistent volatile organics from the groundwater given relatively simple hydrogeology [6].

- The pattern of persistent and fluctuating contaminant levels observed in MW-11 and MW-13 was indicative of a possible subsurface source area or DNAPL presence. Cleanup was not achieved until soil in the areas suspected to contain DNAPL was excavated and the groundwater sparged. Because the soil tested clean, it is likely that the source of the persistent elevated TCE and PCE levels was removed through sparging. The excavation likely helped volatilize contaminants from the groundwater to the open air.

- The porous limestone at the site allowed groundwater to be extracted without clogging the wells and enabled easier installation of wells. Deep wells installed in bedrock or harder subsurface environments could have increased cost [6].

REFERENCES

1. Record of Decision, U.S. EPA, September 11, 1987.
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3. Well Installation Plan, EEC, May 1989.
4. Monthly Reports, through Clark Engineers-Scientists, November 1991 through May 1995.
5. Technical Impracticability Evaluation for Further Groundwater Restoration, The Baljet Corporation, February 24, 1994.
6. Five-Year Review, U.S. EPA, November 1994.
7. Site Close-out Report, Edward E. Clark Engineers-Scientists, Inc. January 18, 1995.
8. Gold Coast Close Out Report, U.S. EPA, February 1996.
9. Correspondence with Mr. Larry Kirsch and Mr. Al Simmons, previous site contacts.
10. Dense Nonaqueous Phase Liquids, Halin, Scott G. and J.W. Weaver. U.S. EPA, March 1991.
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Analysis Preparation

This case study was prepared for the U.S. Environmental Protection Agency's Office of Solid Waste and Emergency Response, Technology Innovation Office. Assistance was provided by Eastern Research Group and Tetra Tech EM Inc. under EPA Contract No. 68-W4-0004.