COST AND PERFORMANCE REPORT

Pump and Treat of Contaminated Groundwater
with Containment Wall at the
Solvent Recovery Services of New England, Inc. Superfund Site
Southington, Connecticut

September 1998

EPA

Prepared by:

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

SITE INFORMATION

Identifying Information:

Solvent Recovery Services of New England, Inc. Site
Southington, Connecticut

CERCLIS #: CTD009717604

ROD Date: Scheduled for September 1999

Non-Time Critical Removal Action Memorandum: April 1, 1993

Treatment Application:

Type of Action: Removal

Period of operation: July 19, 1995 - Ongoing (Performance data collected through July 1997; data on volume treated collected through June 1998)

Quantity of groundwater treated during application: 32.5 million gallons through June 30, 1998

Background

Historical Activity that Generated Contamination at the Site: Solvents recovery

Corresponding SIC Code: 7389A (Solvents Recovery)

Waste Management Practice That Contributed to Contamination: Waste lagoons, open pit incineration, incineration residuals handling, drum storage

Facility Operations [1,2,3,7]:

- This case study presents information on Phase 1 of the Non-Time Critical Removal Action (NTCRA) performed at the Solvent Recovery Services of New England, Inc. (SRS) Site. The final RI Report was submitted in June 1998. The Record of Decision (ROD) will be prepared by September 1999.

- The 2.5-acre site is located in a suburban area bordered by commercial, agricultural, and residential properties. Included in the area potentially affected by the SRS plume is the SRS facility operations area, an adjoining property, and the Town of Southington wellfield.

- SRS reclaimed spent industrial solvents for reuse or blending from 1955 until March 1991. Chemicals from site activities and process sludge were disposed of in two on-site unlined lagoons from 1955 until 1967, when they were closed. The lagoon contents were drained and disposed of off site. The lagoons were then backfilled with clean soil.

- For several years thereafter, wastes were burned in an open pit incinerator at the southeastern corner of the operations area, and incinerator ash was used as fill at the facility. Practices used for waste handling, transferring, and storing of spent solvents and fuels in drums and tanks resulted in spills and leaks to the soils.

- From 1980 to 1982, EPA conducted numerous investigations of the SRS site during the evaluation process for the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) National Priorities List (NPL). Further investigations were performed from 1980 through 1990 under the purview of Resource Conservation and Recovery Act (RCRA). The site was placed on the NPL on September 8, 1983.

- In 1983, SRS entered into a Consent Decree with EPA which required changes to solvent handling procedures, spill control measures, paving of the operations area, fire protection measures, and the installation of a system to recover groundwater.

- The groundwater recovery system, named the On-site Interceptor System (OIS), included 25 recovery wells but no monitoring wells. The OIS extracted groundwater, treated it in an air stripper, and discharged it to the Quinnipiac River. EPA reviewed OIS performance in 1993. The OIS was found to be ineffective in preventing off-site migration of contaminated overburden groundwater. The OIS unit was shut down in 1994 when EPA made the decision that NTCRA 1 was needed.

SITE INFORMATION (CONT.)

Background (Cont.)

- SRS disposed of remaining on-site sludges from tanks, concrete dikes, and drums during shutdown cleanup from January 25 to March 26, 1991.

- In 1992, EPA removed PCB-containing sediments from a drainage ditch as part of a Time-Critical Removal Action. From January through February 1994, EPA conducted a Time-Critical Removal Action to dispose of drums, pails, and other containers with residual laboratory chemicals off site.

- The NTCRA 1 Action Memorandum was signed by the Region 1 Regional Administrator on April 1, 1993, and addresses the performance of soil studies and the extraction and treatment of the groundwater in the overburden aquifer to contain the plume.

- On October 4, 1994, EPA entered into an Administrative Order of Consent (AOC) for NTCRA 1 with greater than 1,600 Potentially Responsible Parties (PRPs). A 1994 de minimis settlement reduced the number of active PRPs to 360. NTCRA 1 was the only action addressed in the first AOC. EPA entered into a second AOC for NTCRA 2 and to complete the RI/FS and perform a TI Evaluation with the PRPs on February 6, 1997, with an effective date of five days after signature.

- NTCRA 1 pre-design investigation work was initiated in September 1994, and included installation of four initial recovery wells, four overburden piezometers and four bedrock piezometers. The 100% Design was submitted in December 1994, and construction occurred from February 1995 to July 1995, with system start-up in July 1995. This report addresses only the groundwater activities performed under NTCRA 1.

Regulatory Context:

- Remedial activities in the overburden aquifer are being performed under NTCRA 1, as an interim remedy.

- Site activities are managed under CERCLA, as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA) §121, and the National Contingency Plan (NCP), 40 CFR 300.

Remedy Selection: Groundwater containment is currently being conducted under a two-phase Non-Time Critical Removal Action (NTCRA 1 and NTCRA 2). NTCRA 1 was mandated to minimize migration of contaminated groundwater in the overburden aquifer. NTCRA 2 was mandated to minimize migration of contamination in the bedrock aquifer. Under NTCRA 1, contaminated groundwater is pumped from the overburden aquifer containment system, treated by ultra violet light (UV) oxidation, and discharged to the Quinnipiac River. Containment is also provided by a downgradient sheet pile wall. NTCRA 2 will extend the groundwater extraction system into the bedrock aquifer and will use the same treatment technology [1].

SITE INFORMATION (CONT.)

Site Logistics/Contacts

Site Lead: PRP

Oversight: EPA

Remedial Project Manager:
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Connecticut Department of Environmental Protection
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79 Elm Street
Hartford, CT 06106-5127
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*Indicates primary contacts

Treatment System Vendor(s):
PRP Oversight Contractor: de maximis, Inc.
Bruce Thompson*
PRPs Project Manager
37 Carver Circle
Simsbury, CT 06070
(860) 651-1196

Treatment System Vendor:
NTCRA 1 Design Contractor: Blasland, Bouck, & Lee, Inc. (BBL), Syracuse, NY
NTCRA 1 Construction Contractor: BBL Environmental Services
NTCRA 1 Operations Contractor: Handex of New England

MATRIX DESCRIPTION

Matrix Identification

Type of Matrix Processed Through the Treatment System: Groundwater

Contaminant Characterization [1,3,4,7]

Primary Contaminant Groups: Volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), polychlorinated biphenyls (PCBs), and metals.

- The contaminants of concern at the site include VOCs, SVOCs, PCBs, and metals. Refer to Attachment A for a complete list and range of contaminants detected in the groundwater during sampling in 1991. VOCs are the most prevalent contaminants.

- As shown in Attachment A, sampling events performed in 1991 detected concentrations of trichloroethlene (TCE) at 30,000 µg/L, *cis*-1,2-dichloroethylene (*cis*-1,2-DCE) at 110,000 µg/L, 1,1,1-trichloroethane (1,1,1-TCA) at 78,000 µg/L, as well as other VOCs in the overburden aquifer. The same sampling events detected TCE concentrations of 41,000 µg/L, *cis*-1,2-DCE at 5,300 µg/L, 1,1,1-TCA at 320,000 µg/L, as well as other VOCs in the bedrock aquifer.

- PCBs and metals were also detected at levels of concern. PCBs were detected at concentrations up to 85 µg/L in 1991. Barium (3,510 µg/L), cadmium (76.9 µg/L), chromium (111 µg/L), lead (175 µg/L), and manganese (37,200 µg/L) all had maximum concentrations of concern.

MATRIX DESCRIPTION (CONT.)

Contaminant Characterization (Cont.)

- From 1994 to 1995, Blasland, Bouck, and Lee, Inc. (BBL) constructed the NTCRA 1 system. During construction, dense nonaqueous phase liquid (DNAPL) was found in samples from monitoring wells and in the soil from the bottom of some wells. DNAPL has been visually observed in samples from both aquifers. The DNAPL was analyzed and found to contain primarily TCE, perchloroethylene (PCE), and toluene, with additional VOCs at smaller fractions.

- DNAPL is present in both the overburden and bedrock aquifers. Figures 1, 2, and 3 illustrate the contaminant plume distribution in the upper, middle, and lower layers of the overburden aquifer, respectively, based on November 1996 to February 1997 data. Figures 4 and 5 illustrate the contaminant plume distribution in the shallow and deep layers of the bedrock aquifer, respectively, based on November 1996 to February 1997 data .

- Figures 1, 2, and 3 show that the contaminant plume in the overburden covered the on-site operations area and migrated downgradient east, offsite, to the Quinnipiac River. The 1998 RI data modified the plume delineation shown in Figures 1 and 2, and the northern extent of the plume was decreased.

- Figures 4 and 5 show that the contaminant plume in shallow bedrock covered the operations area and migrated south and east to the Quinnipiac River.

- An estimate of the volume of the plume was not provided in the available reference material. An estimate could not be developed because of the complexity of the hydrogeology at the site. However, the 1998 RI by BBL estimated the volume of actual DNAPL in the aquifer at up to 900,000 gallons. The recovery of DNAPL is discussed in the System Operations section.

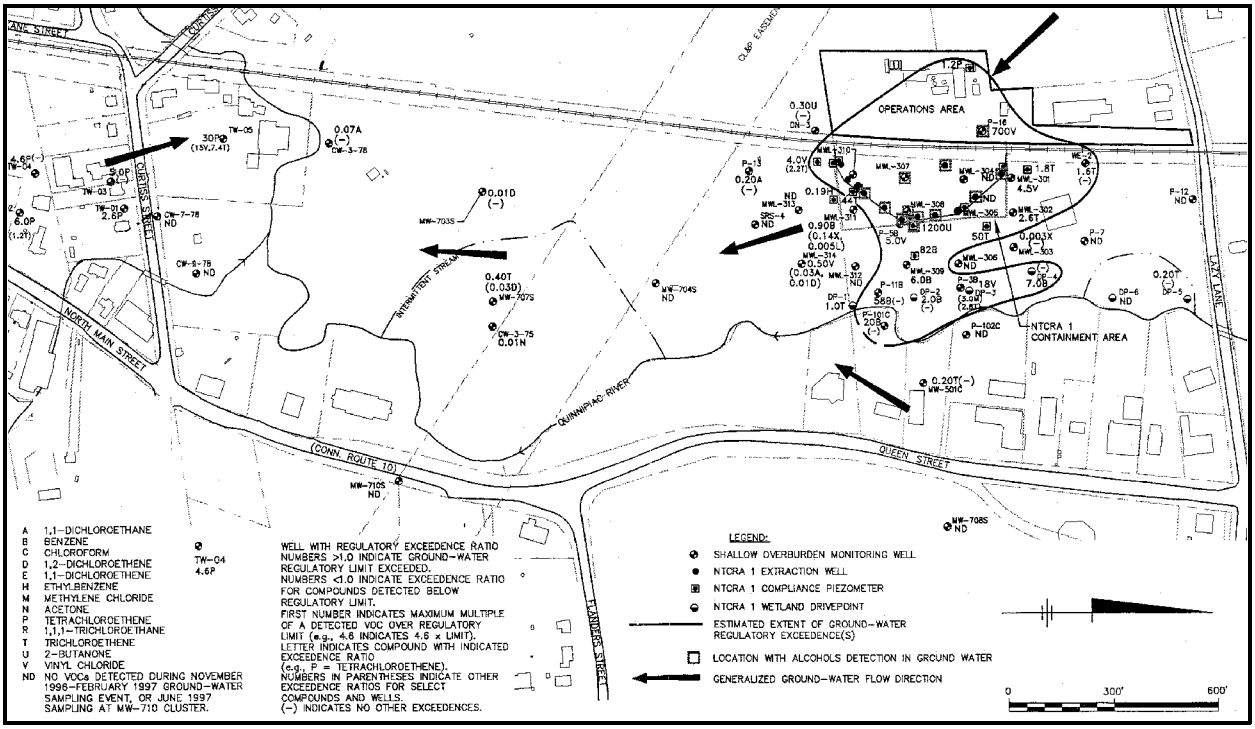

Figure 1. Distribution of Contaminant Plume in Upper Overburden Aquifer Based on November 1996 to February 1997 Sampling Data [3]

MATRIX DESCRIPTION (CONT.)

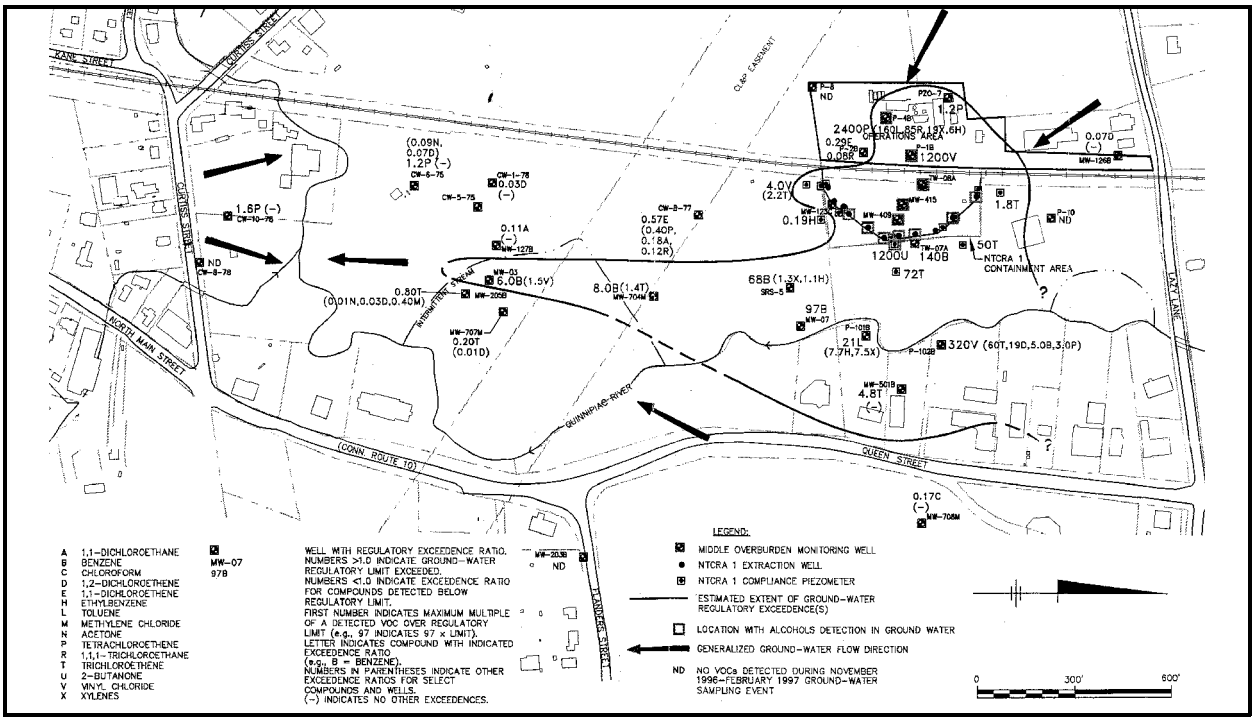

Figure 2. Distribution of Contaminant Plume in Middle Overburden Aquifer Based on November 1996 to February 1997 Sampling Data [3]

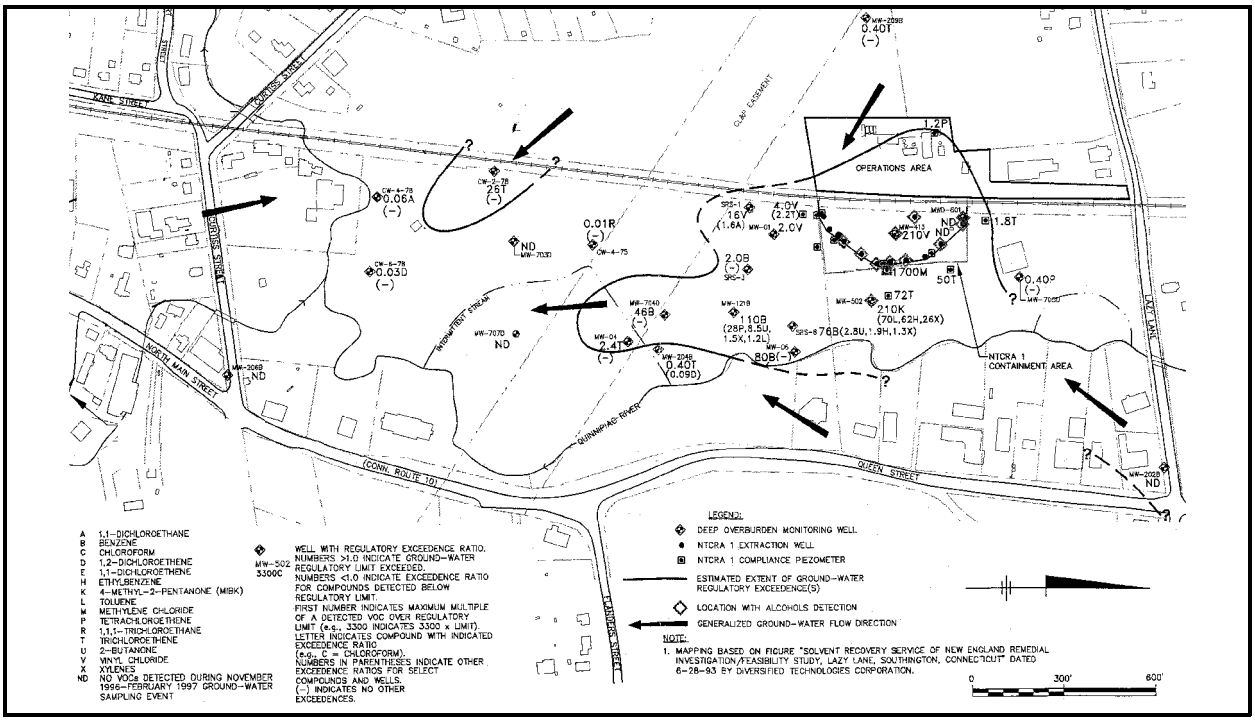

Figure 3. Distribution of Contaminant Plume in Deep Overburden Aquifer Based on November 1996 to February 1997 Sampling Data [3]

MATRIX DESCRIPTION (CONT.)

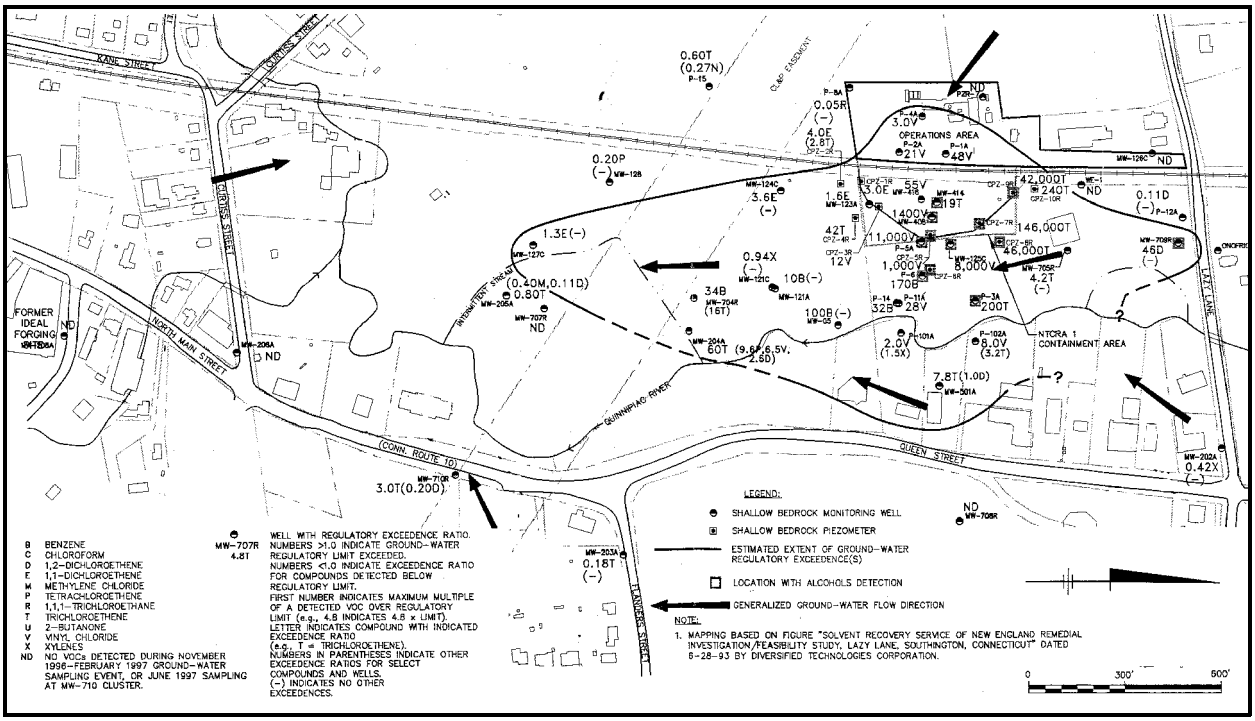

Figure 4. Distribution of Contaminant Plume in Shallow Bedrock Aquifer Based on November 1996 to February 1997 Sampling Data [3]

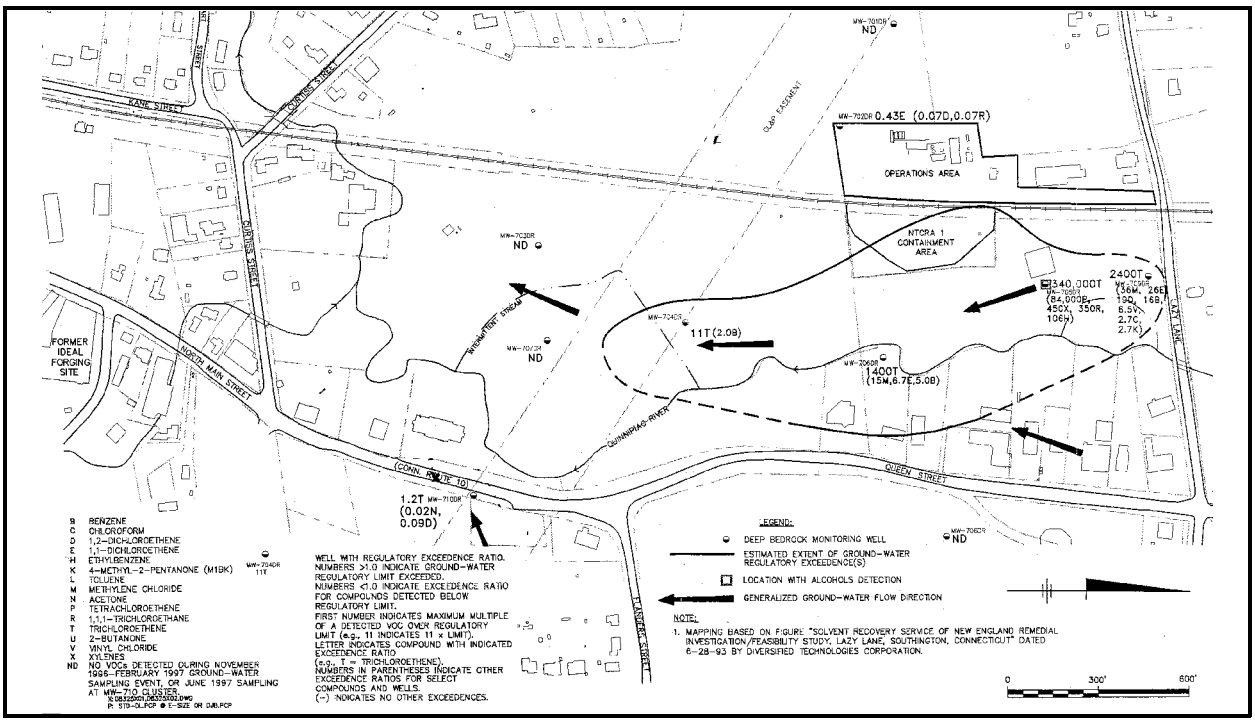

Figure 5. Distribution of Contaminant Plume in Deep Bedrock Aquifer Based on November 1996 to February 1997 Sampling Data [3]

MATRIX DESCRIPTION (CONT.)

Matrix Characteristics Affecting Treatment Costs or Performance

Hydrogeology [3,7]:

The geology of the study region consists of Pleistocene glacial deposits overlying the Upper Triassic New Haven Arkose bedrock ("red bed"). Wisconsin-age glaciation partly eroded and smoothed the bedrock hills, depositing the principle unconsolidated overburden units throughout the region. The hydrogeology at the site is complex. For the purposes of this report, the hydrogeology can be grossly characterized as two units: the overburden and the bedrock. Hydraulic conductivity in both aquifers is heterogeneous and anisotropic. Hydraulic conductivities have been measured to range over three orders of magnitude in the overburden and five orders of magnitude in the bedrock. Regional groundwater flow is towards the Quinnipiac River, from both sides of the river.

Overburden Unit	The overburden unit was divided into three layers for characterization purposes: shallow overburden, middle overburden, and deep overburden. These layers do not necessarily correspond to separate hydrostratigraphic units. The shallow overburden is glacial outwash, a mix of reddish-brown silty sand and gravel interbedded with layers of silt and sorted sand and gravel. The middle overburden is unstratified reddish-brown clay, silt, sand, gravel, cobbles, and boulders, but also includes discontinuous sandy seams. The deep layer is basal till, primarily coarse-grained sand and gravel with cobbles and boulders. In some areas at the site, fill overlies the overburden. The thickness of the overburden unit varies from 10 to 40 feet and decreases towards the river.
Bedrock Unit	The bedrock unit is severely weathered in the top 5 feet and is more competent but still highly fractured and permeable 5 to 30 feet below ground surface. As the bedrock dips towards the river, depth from ground surface to bedrock increases.

Groundwater at the site flows towards the Quinnipiac River from both sides; however, south of the site, the river discharges to the overburden aquifer. This flow pattern implies a circulation common to Connecticut hydrology. The groundwater at the site flows east, but regionally groundwater flow direction varies. The overburden aquifer is a water-bearing unit, but is not used for drinking water because of poor water quality. The bedrock fractures contain groundwater but connectivity of the fractures is undetermined.

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

Table 1. Technical Aquifer Information

Unit Name	Thickness (ft)	Conductivity (ft/day)	Solute Velocity (ft/day)	Flow Direction
Overburden	10 - 40	0.2 - 300[1]	2.3[2]	East[3]
Bedrock	Not Characterized	0.35[1]	Not Available	Not Characterized

[1] Conductivity is highly variable because of heterogeneity and anisotropy. Bedrock hydraulic conductivity is the bulk conductivity

[2] Solute velocities varied from 0.00 ft/day for PCBs and naphthalene to 2.30 ft/day for methanol.

[3] At the site, groundwater flows east. Regionally, groundwater flows to the Quinnipiac River from both sides.

Source: [3]

TREATMENT SYSTEM DESCRIPTION

Primary Treatment Technology

Pump and treat (P&T) with UV oxidation

Supplemental Treatment Technology

Metals precipitation and liquid phase carbon adsorption

System Description and Operation [3,4,7]

Table 2. Technical Well Data

Well Name	Unit Name	Screened Interval (feet below ground surface)
RW-1	Overburden	14.5 - 27
RW-2	Overburden	19 - 31.5
RW-3	Overburden	18 - 28
RW-4	Overburden	9.9 - 21
RW-5	Overburden	10.21 - 20.21
RW-6	Overburden	10.14 - 20.14
RW-7	Overburden	8.58 - 18.58
RW-8	Overburden	11 - 26
RW-9	Overburden	10.81 - 30.81
RW-10	Overburden	8.27 - 33.27
RW-11	Overburden	8.84 - 23.84
RW-12	Overburden	12.5 - 27.5
MWD-601	Overburden	21.4 - 26.4

Source: [1]

System Description

- The groundwater containment system consists of 12 extraction wells and a downgradient steel sheet pile wall that extends to the bedrock.
- The extraction wells are placed according to locations determined by computer modeling, using MODFLOW to optimize containment. MODFLOW showed that because of low hydraulic conductivity, containment could not be achieved by recovery wells alone; therefore, a sheet pile wall was installed.
- The sheet pile wall is shaped in a horseshoe in the downgradient portion of the plume. It is approximately 700 feet long and extends vertically to the bedrock.
- Eleven wells are located along the interior of the sheet pile wall, with one in the center of the containment area. Water is pumped from the wells to a transfer pipe leading to the groundwater treatment system.
- The recovery wells are 8" diameter stainless steel screens, installed into 14" diameter boreholes. Each recovery well incorporated a 2' stainless steel sump at the base of the screen, in anticipation of DNAPL mobilization towards the wells.
- Influent water is pumped through the treatment train illustrated in Figure 6. A metals pretreatment system is the first treatment step. This is primarily a gravity-flow system designed to operate at a flow rate of up to 100 gpm and to remove inorganics (primarily iron and suspended solids). The metals pretreatment system consists of a 10,000-gallon flow equalization tank followed by a 1,000-gallon clarifier feed tank. Caustic soda is added to the clarifier feed tank to adjust the pH from approximately 7.0 to 9.0. Water from the clarifier feed tank flows first to a flash-mix chamber (not shown) where polymer is added; next to a slow-mix chamber (not shown) where flocculation occurs; and then

TREATMENT SYSTEM DESCRIPTION (CONT.)

System Description and Operation (Cont.)

to an inclined-plate clarifier where solids settle out. Effluent from the clarifier flows by gravity to a sand filter and then to a 3,000-gallon oxidation feed tank. Sulfuric acid is added to the oxygen feed tank to reduce the pH from approximately 9.0 to 7.0. The water is then pumped through the UV oxidation treatment system.

- The treated groundwater from the metals pretreatment system is pumped to the enhanced oxidation treatment system, which consists of two independent oxidation chambers. Each is designed to accommodate a flow rate of 50 gpm, for a total flow of 100 gpm. The enhanced oxidation treatment system removes organic compounds using high-powered UV lamps that emit UV radiation through a quartz sleeve into the water stream. Simultaneously, an oxidizing agent, hydrogen peroxide, is added and forms oxidizing radicals that destroy the organic compounds contained in the water.

- The UV oxidation treatment system discharges treated water into a 3,000-gallon granular activated carbon (GAC) feed tank and is pumped through two liquid-phase GAC units connected in a series. Each liquid-phase GAC unit consists of two skid-mounted liquid-phase GAC vessels connected in parallel. The first GAC unit removes organic compounds that may remain in the water following treatment in the enhanced oxidation treatment system. The treated water then flows through a second GAC unit designed to remove any residual peroxide. Treated effluent is discharged to the Quinnipiac River.

- The equalization tank, clarifier feed tank, flash mix chamber, slow mix chamber, inclined plate clarifier, sludge thickener tank, sludge dewatering press, filter press, sand filter, and oxidation feed tank are all vented to a vapor-phase carbon adsorption treatment system.

- The sludge from the bottom of the clarifier is pumped to a sludge thickener tank and then to a sludge-dewatering filter press. A portion of the sludge from the bottom of the clarifier is recycled back to the flash mix chamber to enhance precipitation and flocculation in the clarifier. The filter press uses the compaction pressure of the sludge pump to dewater sludge into filter cakes consisting of 25 to 60 percent solids. The filter cake is dropped into two collection hoppers and transferred into containers for off-site disposal. Supernatant from the sludge thickener, filtrate from the filter press, backwash from the sand filter, and water collected in the building sump and filter press room sump are directed back to the equalization tank.

- The groundwater levels at the downgradient end of the site are monitored continuously to verify containment. There are 12 monitoring wells just upgradient of the sheet pile wall and 12 monitoring wells downgradient of the sheet pile wall. An inward vertical gradient of 0.3 foot must be maintained between the wells upgradient and downgradient of the wall to demonstrate that containment is being maintained. One pair of wells is equipped with a datalogger, which is programmed to notify site operators by telephone if the 0.3-foot gradient is not maintained.

System Operation

- Approximately 32.5 million gallons of water have been treated from July 1995 to June 30, 1998. From July 1995 through 1997, approximately 21 million gallons of water were treated.

- The site has been operational 100% of the time. As described in System Description, pumping must be continuous to meet the 0.3-foot inward gradient requirement.

TREATMENT SYSTEM DESCRIPTION (CONT.)

System Description and Operation (Cont.)

- The system has a 100 gpm capacity, but has averaged at 20 gpm. The initial MODFLOW modeling predicted the need for a steady-state pumping rate of 20 gpm. The system was designed to treat a higher flow in anticipation of eventual expansion.

- The 0.3-foot inward gradient was lost in one pair of compliance piezometers on June 25-28, 1996. The event lasted less than one day. Failure of a recovery pump caused the temporary loss of containment. Recovery wells are now redeveloped at least once per year, at which time the pump heads are removed and serviced (cleaned).

- In August, January, and February 11, 1998, containment was lost for less than one day due to power outages. In December 1996, containment was lost because of CAC backpressure. All of these losses were quickly mitigated.

- Containment was also lost at one pair of compliance piezometers located in the extreme south end of the system several times in May 1998. Extremely heavy rainfall events, coupled with artesian conditions in the bedrock aquifer and slight fouling in a recovery well pump, caused the loss. The pump head was replaced with a higher capacity unit (16 gpm replaced an 8 gpm head), which restored containment.

- Operations and maintenance efforts depend largely on pump rate and influent contaminant concentrations, because the largest cost is the electrical power required by the UV oxidation system. O&M optimization has focused on energy management, which has included reducing electrical power demand by staggering pump and UV oxidation cycling, changes in electrical rates paid (based on the reduced demands), and tailoring the number of UV bulbs in operation (each bulb "on" accounts for roughly $1,000 per month in power cost). Also, although DNAPL was observed in some wells, no corrosion has been observed in any NTCRA 1 wells. One PVC monitoring well was observed to have been affected by DNAPL, and it was abandoned.

- Recovery wells are surged and redeveloped annually, due to fouling of the well screens. The recovery well pumps are also pulled and cleansed as part of the maintenance procedure. Most of the recovery well level controls need to be cleaned on a weekly basis to remove biological fouling. Routine preventive maintenance (redevelopment) has minimized operational issues.

- According to the PRP oversight contractor, in May 1998, the gravel access road across the NTCRA 1 containment area was relocated to the west of the sheetpile wall and 1,000 poplar trees were planted within the containment area. The PRP oversight contractor stated that this "phytoremediation pilot study" is predicted to achieve the NTCRA 1 containment requirements during the growing season within three to five years, which may allow shut down of the NTCRA 1 system over a portion of each year. No additional information on the pilot study was provided [7].

- In addition, the PRP oversight contractor indicated that, as part of the FS work, the PRPs have contracted with the University of Connecticut to perform a bench-scale treatability study of the potential effectiveness of Fenton's Reagent in treating NTCRA 1 influent. If appropriate, a pilot scale demonstration will be implemented [7].

TREATMENT SYSTEM DESCRIPTION (CONT.)

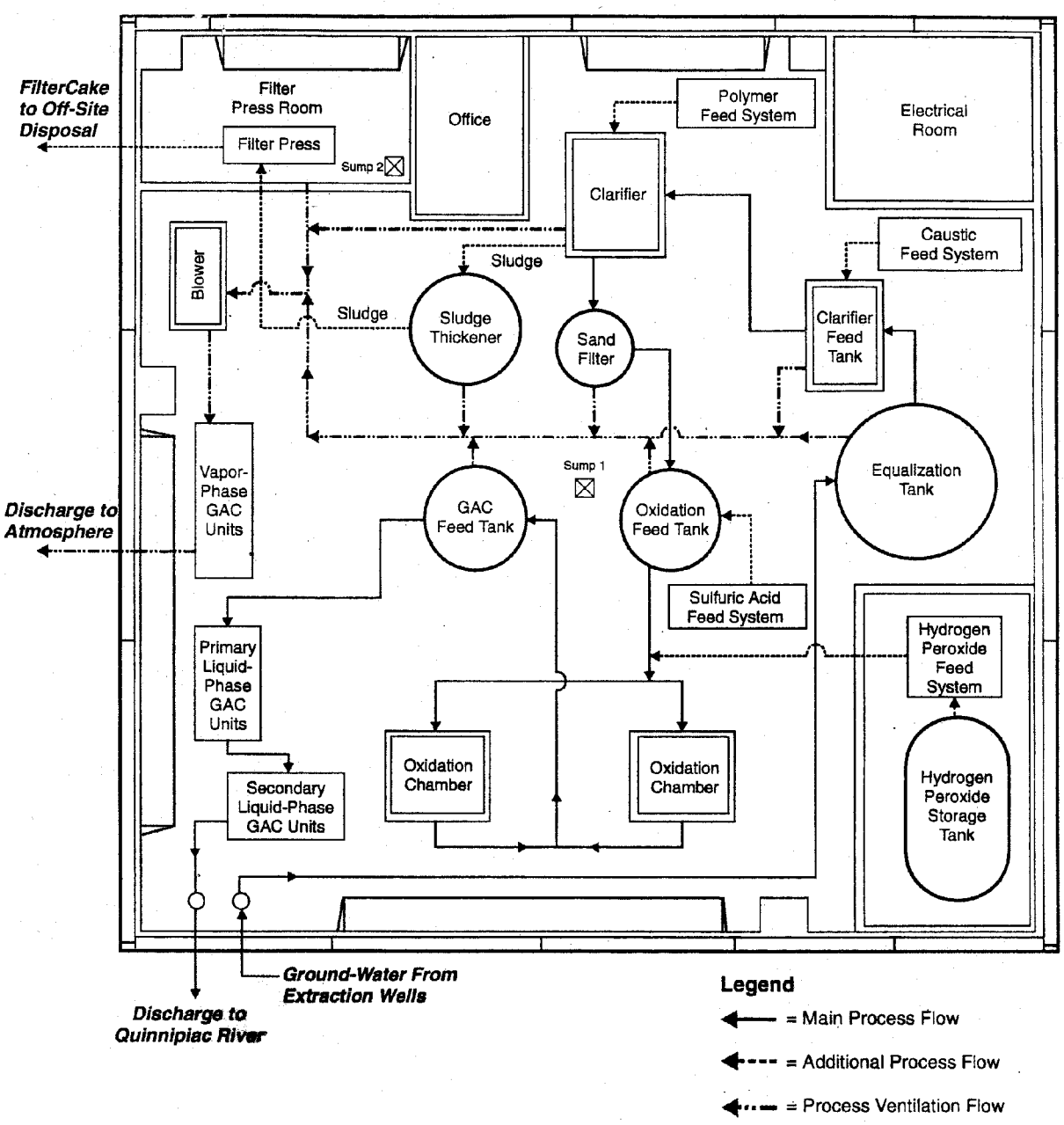

Figure 6. Treatment System Schematic [1]

TREATMENT SYSTEM DESCRIPTION (CONT.)

Operating Parameters Affecting Treatment Cost or Performance

One major operating parameter affecting cost or performance for this technology is the flow rate. Values for this and other performance parameters are presented in Table 3.

Table 3: Performance Parameters

Parameter	Value
Average Pump Rate	20 gpm
Performance Standard (Effluent)	See Attachment B
Remedial Goal (Aquifer)	NA*

*NA - This action is a removal action and remedial goals do not apply as discussed in the Cleanup Goals section.
Source: [1,3]

Timeline

A timeline for this remedial project is shown in Table 4.

Table 4: Project Timeline

Start Date	End Date	Activity
1980	1993	RCRA investigations
9/83	---	Site placed on NPL, OIS constructed
1991	---	SRS closed
1991	---	EPA issues UAO which mandates two NTCRAs
1994	---	EPA begins Remedial Investigation
4/95	---	NTCRA 1 written and approved
7/19/95	---	Begin operation of NTCRA1

Source: [1]

TREATMENT SYSTEM PERFORMANCE

Cleanup Goals/Standards

No cleanup goals or standards have been established at this time. A ROD will be finalized in 1999, at which time cleanup standards will be set. The ROD is expected to incorporate a waiver of groundwater standards within the NAPL Zone due to technical impracticability.

Additional Information on Goals

None

Treatment Performance Goals

- The primary goal of the extraction system is to prevent migration of all contaminated overburden groundwater from the operations area of the site.
- The primary goal for the treatment system is to reduce contaminant concentrations in the effluent to the substantive requirement levels Discharge Limits listed in Attachment B, set by the Connecticut Department of Environmental Protection.

TREATMENT SYSTEM PERFORMANCE (CONT.)

Performance Data Assessment [1,3,7]

For the purpose of this analysis, total contaminants includes the contaminants listed in Attachment A. Total VOCs includes those contaminants listed under VOCs in Attachment A.

- Mass removed and influent contaminant concentrations are expressed in terms of total VOCs because the level of total VOCs is high compared with levels of other contaminants. During operation of NTCRA 1, monitoring was performed for VOCs and PCBs. Dioxins and furans are monitored quarterly, with none detected to date.

- As discussed in System Description and Operation, an inward hydraulic gradient of 0.3 feet must be maintained to show hydraulic plume containment. Overall containment has been lost less than four days out of the three years of operation, resulting in a 98% operation rate. Furthermore, water quality sampling data in wells downgradient of the plume have not had increased contaminant levels.

- There are 230 monitoring wells associated with the SRSNE Site, up, down and side gradient of the NTCRA 1 system. These wells were sampled as part of the RI field work, and the data was interpreted to produce the RI plume figures. Wells in the vicinity of the NTCRA 1 system are gauged on a weekly basis. Contaminant levels within the wall have not reduced as DNAPL continues to dissolve into the aqueous phase.

- Influent concentrations of VOCs to the treatment system were 10,000 µg/L in July 1997. Effluent standards have been met throughout system operation. Refer to Attachment B for a list of the most recent effluent monitoring results.

- Influent from the overburden aquifer has been found to have VOC contaminant concentrations ranging from 9,750 to 63,800 µg/L. Figure 7 shows the temporal change in total VOC concentrations in the influent, as calculated by BBL. The average influent concentration from August 1995 through July 1997 has decreased but fluctuations are seen throughout the operation.

- The cumulative mass of dissolved VOCs removed from July 26, 1995 to July 2, 1997 was approximately 4,344 lbs (1,970 kg). Figure 8, also calculated by BBL, illustrates incremental mass removal and cumulative mass removal over time. The incremental removal has fluctuated over the two years of operation, with an average removal rate of 5.95 lb/day (2.7 kg/day).

- Historically, DNAPL has been concentrated in RW-5. Approximately two liters of DNAPL were recovered from RW-5 per week from August 1995 to October 1995. RW-5 is now gauged weekly for DNAPL, but no recovery has occurred since Spring 1996. A total of approximately 20 liters of DNAPL was recovered, which apparently depleted the “pool” intercepted and mobilized by pumping at RW-5.

Performance Data Completeness [1,3,7]

- Performance Data regarding plume containment were provided in the Innovative Technology Data Questionnaire, from EPA Region I. Graphs of performance data in Figures 7 and 8 regarding mass removed and VOC influent concentrations were provided in the RI.

Performance Data Quality

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

TREATMENT SYSTEM PERFORMANCE (CONT.)

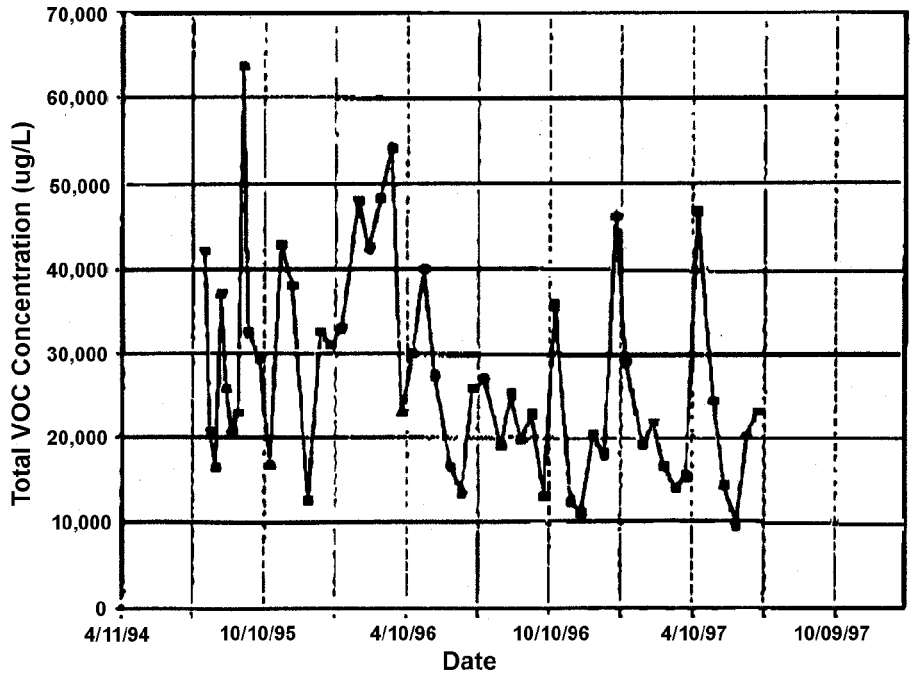

Figure 7. NTCRA 1 Influent Total VOC Concentrations [3]

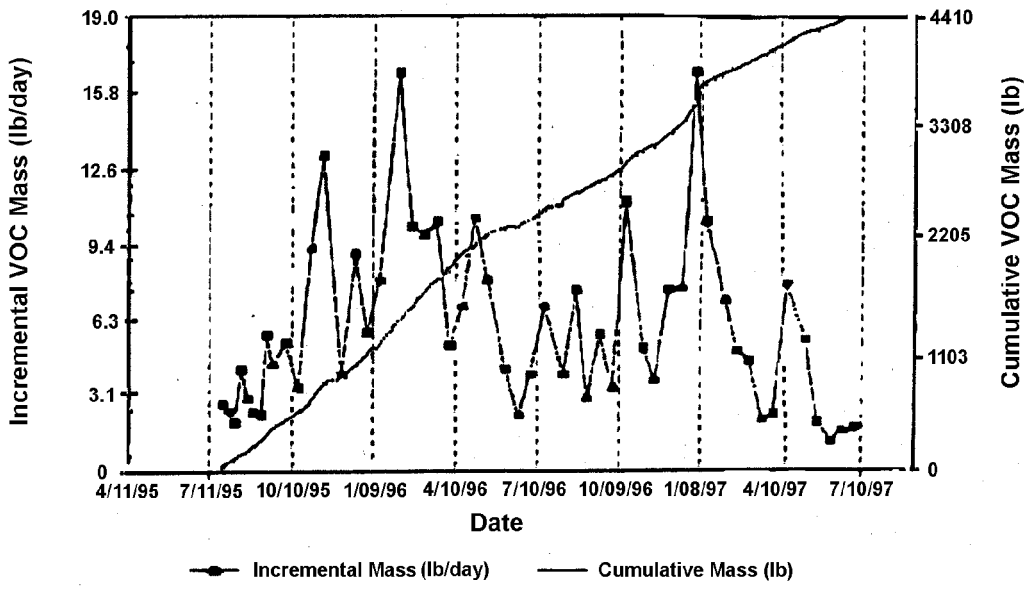

Figure 8. NTCRA 1 Total VOC Mass Removal Summary [3]

TREATMENT SYSTEM COST

Procurement Process

The PRPs contracted with de maximis to manage the remediation and with Handex to operate the system. EPA and the State of Connecticut oversee the site.

Cost Analysis

All costs for remediation at this site are borne by the PRPs.

Capital Costs [1]

Construction Management	$135,200
Deliverables	$17,650
Construction Management	$138,900
Engineering Services	$562,150
Site Work (sheet pile wall, site grading, foundation work)	$1,211,702
Recovery Wells and Piezometers	$254,235
Electrical Work	$330,612
Mechanical Work	$273,900
Prefab Building (80' x 80' building)	$207,185
UV/OX Units	$732,250
Metals Pretreatment System	$388,355
Granular Activated Carbon Systems	$87,450
Total Site Construction	**$4,339,589**

Operating Costs [1]

Start-up	$54,800
Operations & Maintenance (first two months)	$67,930
July 1995 - July 1996	$634,386
July 1996 - July 1997	$460,224
Total O&M	**$1,217,340**

Other Costs [1]

Pre-Design Investigation	$135,400
Design	$21,700
Project Management	$26,200
Bedrock Modeling	$31,400
DNAPL Response Activities	$16,500

Cost Data Quality

Cost data were supplied by the PRP representative, de maximis, Inc. The reported Construction, Design, and Operating Costs provided by de maximis were actual costs incurred.

OBSERVATIONS AND LESSONS LEARNED

- The cost for groundwater treatment at SRS from 1995 to 1997 was $5,556,900 ($4,339,600 in capital costs and $1,217,300 in Operating Costs), which corresponds to $265 per 1,000 gallons treated and $1,280 per lb of contaminant removed (based on 21 million gallons of water treated and 4,344 lbs of contaminants removed through 1997).
- The NTCRA 1 project was designed, approved, and constructed in nine months by eliminating redundant reviews of the design document. The design was written in one step, avoiding the 30%, 60%, 95%, and 100% reviews typically required. The expedited review helped minimize costs [4].
- After two years of operation, the groundwater pump and treat system at SRS has removed approximately 4,300 lbs of VOCs. Effluent standards have been met throughout the system operation.
- Containment has been maintained 98% of the time. Containment has been lost for a total of less than four days. Water quality sampling data from wells downgradient of the plume have not showed an increase in contaminant levels.

OBSERVATIONS AND LESSONS LEARNED (CONT.)

- UV oxidation treatment is effective at treating water contaminated with pure phase contaminants to levels that meet the State of Connecticut standards. The mix of contaminants (VOCs, PCBs, and metals) makes treatment difficult. High (pure-phase) VOC levels would require a large stripper or series of strippers. In addition, several of the influent contaminants (including ketones and alcohols) are not amenable to air-stripping, and the public was sensitive to potential air emissions from air stripping. Unlike GAC, UV oxidation allows treatment of contaminants with no residual solids. In addition, considering the concentrations of contaminants, GAC would have required frequent regeneration. UV oxidation is thus an ideal alternative for treatment when the matrix of contaminants includes high levels of VOCs, in addition to metals and PCBs [1,7].

- DNAPL has been identified at this site. Residual DNAPL acts as a constant source for a dissolved plume to form. DNAPL presence is one cause of fluctuation in total VOC concentrations in the influent. Because of the complex hydrogeology and the DNAPL, a Technical Impracticability (TI) waiver will be applied for [4].

- According to the remedial contractor, DNAPL characterization has been discovered to follow Raoult's Law, with physical data to demonstrate the empirical relation. Mobile DNAPL was found in an overburden well installed during NTCRA 1 construction. Both the DNAPL and supernatant groundwater were sampled and characterized, which allowed effective solubility limits to be empirically demonstrated. The results correlated closely with effective solubility limits predicted using Raoult's Law. DNAPL was also encountered in a bedrock monitoring well installed during the RI. Similar sampling, analysis and correlation was performed. SRS remedial contractors and the PRP representative are finalizing this finding in a future publication [7].

REFERENCES

1. Innovative Technology Questionnaire, Solvent Recovery Service of New England, Inc. Site, Southington, Connecticut, EPA Region 1, undated.

2. Solvents Recovery Service of New England, Superfund Facts Sheet, EPA Region 1, undated.

3. Draft Remedial Investigation, provided by de maximis, Inc. Undated.

4. Correspondence with Mr. Bruce Thompson, de maximis, Inc. December 22, 1997.

5. Non-Time Critical Removal Action No. 1, Ground-water Containment and Treatment System Operations Plan, Solvent Recovery Service of New England, Inc. Superfund Site, Blasland, Bouck & Lee, Inc., June 1995.

6. Correspondence with Mr. John Smaldone, U.S. EPA Region 1, November 11, 1997, December 18, 1997, and December 23, 1997.

7. Comments on draft report provided by Bruce Thompson, de maximis, Inc., July and August 1998.

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, Inc. and Tetra Tech EM Inc. under EPA Contract No. 68-W4-0004.

ATTACHMENT A
CONTAMINANTS DETECTED IN THE GROUNDWATER DURING 1991 SAMPLING

VOLATILE ORGANIC COMPOUNDS	CONCENTRATION				Connecticut Department of Health Safe Drinking Water Standards (ug/l)
	OVERBURDEN GW		BEDROCK GW		
	MIN ug/l	MAX ug/l	MIN ug/l	MAX ug/l	
Methylene Chloride					
Vinyl Chloride	360 J S,F	620 J S,F	8 J S,F	110 J S,F	2
Chloroethane		1100 J		2 J	
Acetone	R	R	R	R	
2-Butanone (MEK)	R	R	R	R	1,000
1,1-Dichloroethene	320 J S,F	15,000 J	190 J S,F	2,300 J S,F	7
1,1-Dichloroethane	290 J	5500 J	94.5 J	940 J	
trans-1,2-dichloroethene				0.8 J	
cis-1,2-Dichloroethene	2,500 J F	110,000 J F	275 J F	5,300 J F	
1,2-Dichloroethane		940 J S,F		1.3 J S	1
1,1,1-Trichloroethane	24,000 J	78,000 J	17,000 J	320,000 J	200
Carbon Tetrachloride	290 J S,F	9,100 J S,F	69.5 J S,F	2,000 J S,F	5
1,2-Dichloropropane				0.7 J	5
Trichloroethene	26,000 J	30,000 J	14 J S,F	41,000 J	5
1,1,2-Trichloroethane				4.7 J	
Benzene		610 J S,F		1.9 J S	1
4-Methyl-2-pentanone (MIBK)		22,000 J	22.5	2,100 J	
trans-1,3-Dichloropropene				390 J S	10
Tetrachloroethene		2,000 J S,F	4.6 J	6,400 J S,F	5
1,1,1,2-Tetrachloroethane				1.8 J	
Toluene		81,000 J		150,000 J	1,000
Ethylbenzene	870 J F	60,000 J F	51 J	740 J F	
Styrene		49,000 J F	9.7 J		
Xylene (total)				43.5 J	
Isopropylbenzene		1,200 J		1 J	
a-propylbenzene				0.8 J	
1,3,5-Trimethylbenzene				1 J	
1,2,4-Trimethylbenzene		950 J	2.6 J	710 J	

Notes:
(+) = The sample was averaged with its field duplicate
J = Value is estimated
R = Value was rejected
S = Exceeds Connecticut DHS Standards
F = Exceeds Federal MCLs
MEK = Methyl Ethyl Ketone
MIBK = Methyl Isobutyl Ketone
Shading denotes exceeds Federal MCLs

ATTACHMENT A (Continued)
CONTAMINANTS DETECTED IN THE GROUNDWATER DURING 1991 SAMPLING
(Page 2)

SEMIVOLATILE ORGANIC COMPOUNDS	CONCENTRATION				Connecticut Department of Health Safe Drinking Water Standards (ug/l)
	OVERBURDEN GW		BEDROCK GW		
	MIN ug/l	MAX ug/l	MIN ug/l	MAX ug/l	
Phenol	22	4,200		14	
1,3-Dichlorobenzene				2 J	
1,4-Dichlorobenzene				10	75
1,2-Dichlorobenzene		30			
2-Methylphenol	14	83	12	16	
4-Methylphenol	14	100	4 J	13	
Isophorone		8 J	2 J	9 J	
2,4-Dimethylphenol	7 J	11		2 J	
Naphthalene	3 J	44	2 J	3 J	
4-Chloro-3-Methylphenol		16			
2-Methylnaphthalene		3 J			
Dimethyl Phthalate	2 J	17			
Phenanthrene		10 J			
DI-N-Butylphthalate	1 J	52 J		3 J	
Butylbenzylphthalate	9 J	63 J			
Bis(2-ethyl hexyl)phthlate		11,000			
Di-N-Octylphthalate		26 J			

PESTICIDES/PCB COMPOUNDS	OVERBURDEN GW		BEDROCK GW		Treatment Performance Standards (CT DHS) STDS (ug/l)
	MIN ug/l	MAX ug/l	MIN ug/l	MAX ug/l	
Aroclor 1254				13 S,F	1
Aroclor 1260		85 S,F			1

Notes: (+) = The sample was averaged with its field duplicate
J = Value is estimated
Shading denotes exceeds Federal MCLs

S = Exceeds Connecticut DHS Standards
F = Exceeds Federal MCLs

Source: [1]

ATTACHMENT A (Continued)
CONTAMINANTS DETECTED IN THE GROUNDWATER DURING 1991 SAMPLING
(Page 3)

METALS	CONCENTRATION					Connecticut Department of Health Safe Drinking Water Standards (ug/l)
	OVERBURDEN GW			BEDROCK GW		
	FILT. SAMP. (ug/l)	MIN ug/l	MAX ug/l	MIN ug/l	MAX ug/l	
Aluminum	35.6	12,200	51,700	906	91,300	
Arsenic	2.0 J	5.0	21.0	4.0 J	8.0 J	50
Barium	280	604	3,510 J	106	2,690 J	1,000
Beryllium		1.1 J	5.4 J	1.9 J	8.54 J	
Cadmium		2.6 J	76.9 S,F		4.25 J	5
Calcium	65,100	37,100	349,000	41,850 J	140,000	
Chromium		51.2 S	111 S,F	114 J S,F	176 S, F	50
Cobalt	52.4	19.6	140	10.4	267.5 J	
Copper	10.4	44.1 J	324	5.6	1,460 J	1,000
Iron	7,350	39,100	84,400	1,930	99,850 J	
Lead		28.0 J	175 S,F	5.3	50.0 J S,F	15
Magnesium	3,360	9,540	25,700	1,490	33,400	
Manganese	6,720 S	7,610 S	37,200 S	45.5	4,000 J	5,000
Mercury			0.35 J			2
Nickel		32.4 J	84.3	101	102.2 J	
Potassium		5,940	14,000 J	12,465 J	19,600 J	
Sodium	12,600	10,100	105,000 J	6,320	16,910 J	20,000
Vanadium		38.1 J	114	32.8	152	
Zinc	47.6 J	66.2	151	393 J	893	

Notes: (+) = The sample was averaged with its field duplicate
J = Value is estimated
R = Value was rejected

S = Exceeds Connecticut DHS Standards
F = Exceeds Federal MCLs
Shading denotes exceeds Federal MCLs

Source: [1]

ATTACHMENT B
EFFLUENT STANDARDS SET BY THE CONNECTICUT DEPARTMENT OF HEALTH

Parameter	Substantive Requirement Discharge Limit (mg/L)	Most Recent Effluent Concentration (6/17/98) (mg/L)
A. ORGANIC PARAMETERS		
Volatile Organic Compounds		
Trichloroethene	0.973	<0.002 JB
Tetrachloroethene	0.106	<0.005
Toluene	4.0	0.022
Ethylbenzene	1.0	0.003 J
Xylenes, Total	0.50	0.003 J
Vinyl chloride	4.50	0.27
1,1-Dichloroethene	0.06	0.007
Tetrahydrofuran	0.50	0.14 J
1,2-Dichloroethene*	5.0	0.915
1,2-Dichloroethane	0.25	0.008
1,1,1-Trichloroethane	4.0	0.12
1,1,2-Trichloroethane	0.25	<0.005
Methylene chloride	15.0	0.230 B
Styrene	0.50	<0.005
Alcohols		
Ethanol	20.0	<5
Methanol	30.0	<5
2-Butanol (sec-Butanol)	10.0	<5
2-Propanol (Isopropanol)	10.0	<5
Ketones		
Acetone	35.0	N/A
2-Butanone (Methyl Ethyl Ketone)	10.0	N/A
4-Methyl-2-pentanone (Methyl Isobutyl Ketone)	2.0	N/A
B. INORGANIC PARAMETERS		
Metals		
Copper, Total	15.8 g/day	1.98
Iron, Total	5.0	1.68
Lead, Total	3.2 g/day	0.4
Nickel, Total	0.5	<0.040
Zinc, Total	40.3 g/day	1.99
Other		
Total Suspended Solids (TSS)	30.0	<4.0
Peroxide	1.0	0
pH (SU)	1.0	0
Dioxins/Furans	NL	NS
Total PCBs	NL	NS

NOTES:
mg/L = Milligrams per liter unless otherwise noted.
SU = standard units
J = denotes an estimated value less than the Laboratory's Practical Quantitation Level
B = parameter detected in the laboratory method blank
NL = no limited specified
NS = not sampled (total PCBs analysis required monthly; dioxin/furan analysis required quarterly)
ND = parameter not detected at analytical method detection limit
* = 1,2-Dichloroethene represents cis and trans 1,2-Dichloroethene
N/A = As of July 6, 1998 the results for these analytes had not been provided by Katahdin Analytical Services