COST AND PERFORMANCE REPORT

Steam Enhanced Extraction at the
A.G. Communications Systems Site
Northlake, Illinois

June 2003

SITE INFORMATION

IDENTIFYING INFORMATION

Site Name: A.G. Communications Systems
Location: Northlake, IL
Regulatory Context: State voluntary cleanup
Technology: Steam Enhanced Extraction (SEE)
Scale: Full-scale

TECHNOLOGY APPLICATION [1,2,3]

Period of Operation: September 1995 to November 1999

Type/Quantity of Material Treated during Application: Source zone (saturated and unsaturated) - Estimated 330,000 cubic yards treated

BACKGROUND [1,2]

The A.G. Communications site, located near Chicago, IL, operated as a telecommunications manufacturing facility from the 1950s through the early 1990s when it was sold to a real estate development company. Trichloroethene (TCE) and mineral spirits used in manufacturing operations were stored in underground storage tanks (UST). During the decommissioning of the manufacturing facility, chlorinated solvents, including TCE and cis-1,2-dichloroethene (DCE) and components of mineral spirits, including xylene and benzene, were found in soil and groundwater at the site. The source of the contamination was identified as an area in the vicinity of the former tank farm and beneath the manufacturing facility. Approximately 63,000 tons of contaminated soil were excavated from the former tank farm area and disposed off site.

The site was remediated under the Illinois Environmental Protection Agency (IEPA) voluntary site remediation program (SRP). A SEE system was pilot-tested at the site from January through July 1994. Full-scale SEE operation was performed from September 1995 to November 1999.

CONTACTS

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Not available

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MATRIX DESCRIPTION

MATRIX AND CONTAMINANT IDENTIFICATION [1,2,6]

Type of Media Treated With Technology System: Source zone (saturated and unsaturated)

Primary Contaminant Groups: Chlorinated solvents (TCE, cis-1,2-DCE), and petroleum hydrocarbons (xylene and benzene)

SITE HYDROGEOLOGY AND EXTENT OF CONTAMINATION [1,4]

The geologic strata at the site consists of three till layers overlying dolomite bedrock. The Tinley Till (0-35 ft bgs; hydraulic conductivity of $1x10^{-8}$ cm/sec), overlain by clayey silt fill, consists of dense silty clay with thin discontinuous seams of sand and silt. The Valparaiso Till (36-38 ft bgs; hydraulic conductivity of $2.9x10^{-3}$ cm/sec) consists of a fine to medium grained sand layer which is underlain by a dense, overconsolidated, well sorted laminated silt (38-48 ft bgs; hydraulic conductivity of $9x10^{-8}$ cm/sec). The Lemont Drift (48-65 ft bgs) consists of thick coarse-grained sand and gravel layer underlain by a fine grained dolomite sand and silt with some gravel fragments. Weathered Silurian dolomite is present at 65-75 ft bgs, with Silurian dolomite bedrock present at greater than 75 ft bgs. The depth to groundwater is 38-40 ft bgs.

Contamination was present primarily in the Tinley and Valparaiso Till layers. According to the vendor, TCE and DCE were present as DNAPL, as well as in the dissolved phase. Xylene and benzene were present as LNAPL and in the dissolved phase. The only data available for contaminant concentration prior to treatment was a groundwater TCE concentration of greater than 45,000 ug/L in December 1995.

Table 1 lists the matrix characteristics affecting treatment cost or performance for this application and the values measured for each.

Table 1. Matrix Characteristics [1,4]

Parameter	Value
Soil Classification	Alternating clay and sand till, with intermittent sand and silt layers
Clay Content and/or Particle Size Distribution	0-7 ft below ground surface (bgs) clayey silt 30-40 ft bgs dense silty clay
Depth to Groundwater	38-40 ft bgs

TECHNOLOGY SYSTEM DESCRIPTION

TREATMENT TECHNOLOGY

Steam enhanced extraction

TREATMENT SYSTEM DESCRIPTION AND OPERATION [1,2,3,4]

SEE was tested on a pilot-scale basis at the site from January through July 1994. While details of the pilot-scale system were not provided, the vendor reported that the pilot-scale system was incorporated into the full-scale system. The full-scale system, shown in Figure 1, was operated from September 1995 to November 1999. The system covered an area of about 250,000 ft^2 to a depth of about 50 ft in the former tank farm area and beneath the existing building. The system included shallow vapor extraction wells, shallow and deep steam injection wells, vacuum-enhanced groundwater/vapor extraction wells, deep groundwater extraction wells, and two vacuum extraction units.

The 65 steam injection wells were installed in shallow and deep permeable zones. The 39 shallow steam injection wells were screened across the sand layer at the base on the Tinley Till at a depth of 35 ft bgs. The 26 deep steam injection wells were screened across the cobble layer at the base of the Valparaiso Till at a depth of 46 ft bgs. Steam was supplied by a 294 kilowatt series HF Scotch-Box boiler at pressures ranging from 3 to 7 psi. Temperature thermocouples were installed around two of the deep steam injection wells and one shallow steam injection well. During system operation, soil temperatures ranged from 84°F to 140°F, and groundwater temperatures ranged from 68°F to 165°F.

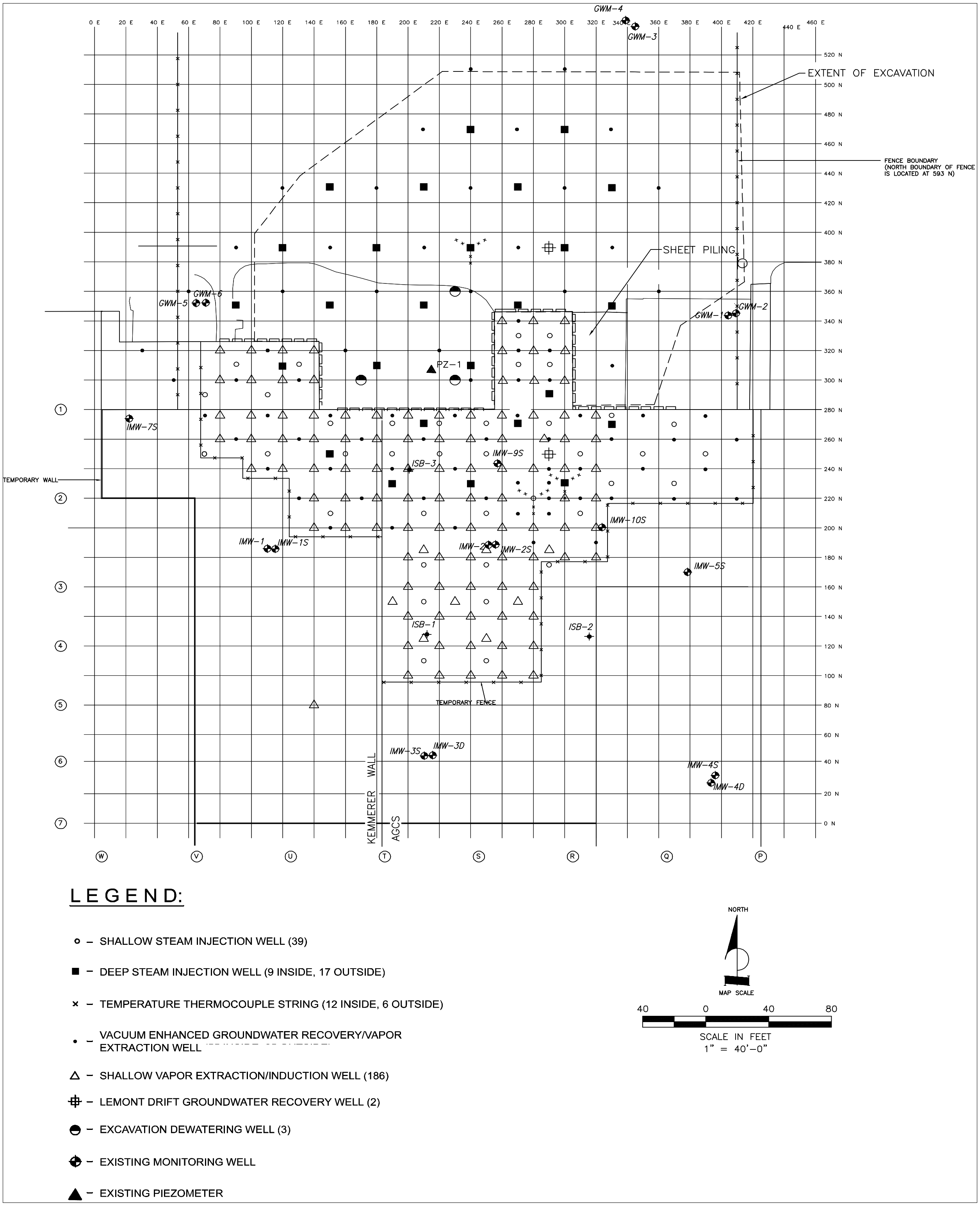
Soil vapor extraction was performed using 186 shallow wells screened in the Tinley Till and the 76 combination groundwater/vapor extraction wells screened across the Tinley and Valparaiso Tills. Two vapor extraction units (VES #1 and VES #2) were operated at 150 to 250 scfm at 7 to 15 inches of mercury. Hydrocarbon emissions from the VES #1 and VES #2 were measured continuously using a TECO® 51 flame ionization detector (FID). The type of treatment used for off-gases was not identified.

Groundwater extraction was performed using the 76 combination groundwater/vapor extraction wells screened across the Tinley and Valparaiso Tills, the two deep groundwater extraction wells screened in the Lemont Drift, and one excavation dewatering well. Groundwater was extracted at a rate ranging from 15 to 30 gpm with the groundwater/vapor extraction wells operated at a total flow rate of 4 to 6 gpm and the two deep groundwater extraction wells operated at a flow rate of 10 to 11 gpm per well.

Extracted groundwater was treated using a stainless steel shallow tray air stripper equipped with a 900 cubic meter/minute blower followed by treatment using two 1,000 lb activated carbon vessels, and then discharged under the facility's NPDES permit. Groundwater discharge averaged 500,000 gallons per month.

In addition to SEE, chemical oxidant flushing using chlorine dioxide ($Cl0_2$) was performed in recalcitrant source areas. ClO_2 flushing was used to oxidize soil mineral surfaces and modify pH and redox conditions. According to the vendor, this approach was used to enhance TCE partitioning from soil for removal through the groundwater/vapor extraction wells, and redox levels of -100 to -200 mV were achieved. No additional information about the timing, extent, or effectiveness of the ClO_2 flushing was provided.

Figure 1. Remediation System Layout [1]



TIMELINE [1,5]

- April 1992 — Excavation and off site disposal of soil from former UST area
- January to July 1994 — Pilot test conducted
- Sept 1995 to Nov 1999 — Full scale system operation performed
- May 2002 — Remedial Action Completion Report submitted to Illinois EPA; under review by IEPA

TECHNOLOGY SYSTEM PERFORMANCE

PERFORMANCE OBJECTIVES [1,2]

The remediation was conducted under the IEPA Voluntary SRP. The remedial objective was to obtain IEPA approved closure under Tiered Approach to Corrective Action guidelines. The proposed closure strategy was to use site-specific parameters to calculate a first order degradation constant and demonstrate that there are no on-site or off-site receptors at risk from volatile organic hydrocarbons in soil or groundwater.

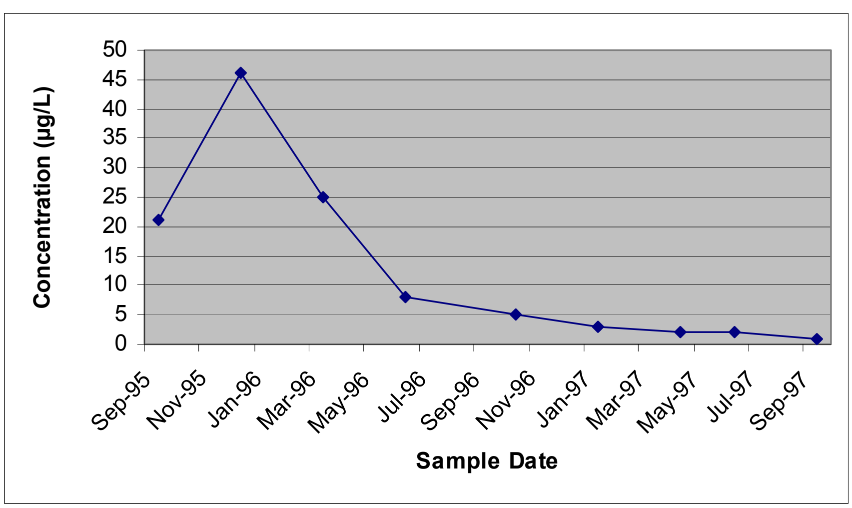
TREATMENT PERFORMANCE [1,2,3,5]

Treatment performance data are available for contaminant concentrations from September 1995 to September 1997, and total mass removal through November 1999. Treatment progress was monitored in terms of the reduction in TCE and DCE concentrations in groundwater and the total mass of hydrocarbons removed. Hydrocarbon mass removal was calculated based on the FID readings from the air stripper and the two vapor extraction units. The FID readings included the mass of chlorinated solvents (TCE, DCE) and petroleum hydrocarbons (xylenes, benzene).

Concentration Data

Quarterly groundwater sampling was performed for the 76 combination groundwater/vapor extraction wells. Figure 2 shows that the average groundwater concentrations for TCE was reduced from approximately 20,000 μg/L to <1,000 μg/L over the period from September 1995 to September 1997.

Figure 2. Average Groundwater Concentrations of TCE Over Time (Sept 95 - Sept 97) [1]



In addition, groundwater concentration data were available for TCE and cis-1,2-DCE for 17 wells for the period from December 1995 to October 1997. As shown in Table 2, TCE concentrations were reduced in 16 of the 17 wells between December 1995 and October 1997, with most wells showing a reduction of >90%. As of October 1997, TCE concentrations ranged from 28 µg/L to 10,526 µg/L. During this time, DCE concentrations were reduced in 14 of the 17 wells, with about half the wells showing a reduction of >90%. As of October 1997, DCE concentrations ranged from below detection levels to 122 µ/L.

Table 2. Concentrations of TCE and cis 1,2-DCE in Groundwater (µg/L) [1]

Well Location	TCE			Cis 1,2-DCE		
	Dec-1995	Oct-1997	% Reduction Dec 95 to Oct 97	Dec-1995	Oct-1997	% Reduction Dec 95 to Oct 97
200n230e	94,166	74	>99%	2,311	0	>99%
220n210e	3,007	212	93%	1	17	+1600%
220n250e	337	28	92%	29	0	>99%
240n190e	431,318	2,890	99%	168	101	40%
260n250e	161	33	80%	11	7	36%
276n110e	7,615	342	96%	74	0	>99%
276n230e	1,336,589	4,488	>99%	437	80	82%
276n270e	164,764	140	>99%	478	0	>99%
276n310e	190,527	4,700	98%	467	4	99%
300n270e	46,743	1,941	96%	1	10	+900%
300n290e	189,610	1,466	99%	456	13	97%
320n110e	352,639	39	>99%	47	0	>99%
320n220e	266	599	+125%	22	34	+55%
320n290e	341,207	10,526	97%	259	73	72%
340n270e	75,213	270	>99%	228	0	>99%
360n180e	86	28	67%	33	14	58%
360n240e	954	497	48%	423	122	71%

Mass Removal Data

Table 3 provides a summary of the mass of hydrocarbons (including TCE and DCE) removed from the air stripper and two vapor extraction units during the period from August 1995 to January 1998 (29 months). The table shows that the total hydrocarbon removal was approximately 26,000 lbs (11,700 kg) and that the monthly hydrocarbon removal ranged from about 240 lbs (111 kg) to 1,550 lbs (706 kg). Approximately two-thirds of the contaminant mass was removed as vapor from the two VES units. The vendor reported that as of November 1999, more than 33,000 lbs of hydrocarbons had been removed from soil vapor and groundwater. The mass of TCE and DCE removed during this time was not reported separately from the total mass of hydrocarbons removed.

Table 3. Hydrocarbon Removal Totals [1]

Month	Air Stripper Discharge (kg)	VES #1 (kg)	VES#2 (kg)	Monthly Total (kg)
Aug 95	0.0	0.0	222.39	222.39
Sep 95	147.92	64.28	152.59	364.79
Oct 95	110.36	114.17	198.58	423.10
Nov 95	82.62	319.67	190.22	592.51
Dec 95	113.55	247.21	185.78	546.54
Jan 96	139.62	193.09	228.65	561.36
Feb 96	101.78	107.53	106.65	315.96
Mar 96	131.29	400.42	160.92	692.63
Apr 96	181.89	331.48	133.60	646.97
May 96	262.76	298.28	145.42	706.46
Jun 96	255.22	128.59	109.89	463.69
Jul 96	122.83	243.84	72.92	439.59
Aug 96	118.74	202.34	119.80	440.89
Sep 96	127.49	114.43	90.68	332.61
Oct 96	145.63	107.65	98.21	351.50
Nov 96	97.75	128.64	104.07	330.45
Dec 96	86.75	148.49	93.15	328.39
Jan 97	81.57	131.12	82.77	295.46
Feb 97	72.22	71.41	42.96	186.59
Mar 97	87.19	144.67	105.72	337.58
Apr 97	89.57	161.97	86.36	337.90
May 97	98.59	136.17	68.44	303.20
Jun 97	69.95	60.57	44.58	175.11
Jul 97	50.26	28.41	32.67	111.35
Aug 97	132.18	41.75	204.29	378.23
Sep 97	126.55	40.81	164.82	332.18
Oct 97	94.99	87.66	182.30	364.94
Nov 97	224.39	243.76	35.10	503.25
Dec 97	84.58	213.63	46.02	344.24

Table 3. Hydrocarbon Removal Totals [1] (continued)

Month	Air Stripper Discharge (kg)	VES #1 (kg)	VES#2 (kg)	Monthly Total (kg)
Jan 98	90.98	121.15	87.67	299.80
TOTALS:	**3,499.23**	**4,633.20**	**3,597.25**	**11,729.68**

As of November 1999, more than 55,000 ft^2 of the remediation area had been approved for closure by IEPA. The Remedial Action Completion Report was submitted to IEPA in May 2002, with a decision on site closure expected in October 2002. According to the vendor, based on the site-specific first order degradation constant, the calculated groundwater concentrations at the point of compliance (property boundary) met Class I remediation objectives. Where the soil concentrations beneath the building exceeded the soil remediation objectives, a theoretical groundwater concentration leached from the soil was calculated and, along with the site specific degradation constant, was shown to meet the Class I remediation objectives at the point of compliance. No analytical data were provided to support these calculated values.

COST OF THE TECHNOLOGY SYSTEM

COST DATA [2]

The vendor reported that the actual cost for the application was $4.9 million and $13 to 15 per cubic yard treated, including the cost of the pilot test, system design and installation, five years of operation and maintenance, and negotiations with IEPA. A further breakdown of costs was not provided.

OBSERVATIONS AND LESSONS LEARNED

OBSERVATIONS AND LESSONS LEARNED [1,2,4]

The use of steam enhanced extraction removed an estimated 33,000 lbs of hydrocarbons from the soil and groundwater at the site and reduced TCE and DCE concentrations by more than 90%. According to the vendor, this application demonstrated that SEE is effective in a heterogenous clay till.

In August 1997, the vendor performed an experiment to evaluate the cycling of steam injection to improve the rate of hydrocarbon removal (analogous to the oil industry practice of using steam for enhanced oil recovery). Results indicated a dramatic increase in hydrocarbon removal following steam shutdown, and the vendor is currently evaluating appropriate frequencies for the steam cycle.

REFERENCES

1. Adams, Timothy V., Smith, Gregory J. "DNAPL/LNAPL Remediation in Clay Till Using Steam Enhanced Extraction." Battelle Conference Proceedings. Not Dated.

2. ENSR, Case Study: Northlake, IL Site, "DNAPL Remediation in Heterogeneous Clay Till Using Steam-Enhanced Groundwater and Vapor Extraction." Not Dated.

3. ENSR, Statement of Qualifications. "DNAPL Remediation in Clay Till Using Steam-Enhanced Groundwater and Vapor Extraction". Not Dated.

4. ENSR, Power Point Presentation: "DNAPL/LNAPL Remediation in Clay Till Using Steam-Enhanced Groundwater and Vapor Extraction". Not Dated.

5. Tim Adams, ENSR. E-mail correspondence about A.G. Communications, North Lake, IL. September 18, 2002.