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Guaranteed Remediation Certainty Our Word Is Who We Are

Project Example - Guaranteed Performance Based Source Area Remediation of Trichloroethene in Soil and Groundwater using ERH, Fort Wayne, Indiana

*This project involves a **guaranteed performance based remediation** of trichloroethene (TCE) at a former steel manufacturing facility located in Fort Wayne, Indiana.*

Client Reference: Mr. Jon Hacker, Fort Wayne Steel Corp., (260) 434-2850

Engineer: Mr. Greg Beyke, vice president of engineering, TRS, Franklin, TN, (615) 791-5772, gbeyke@thermalrs.com.

Project Superintendent: Mr. Chris Blundy, project manager, TRS, Charleston, SC, (843) 225-6018, cblundy@thermalrs.com.

Geology: Primarily muddy glacial till with heaving sands and rocks the size of bowling balls.

Hydrology: Water table at 10-12 ft bgs depending on season.

Treatment Area, Depth Interval and Volume: Treatment area was a total of 12,289 square feet with 3 depth areas; Area A was 8-28 ft bgs, Area B was 8-22 ft bgs, and Area C was 8-34 ft bgs; for a total of 8,800 cubic yards.

Site Constraints: Guaranteed removal of a very high initial TCE mass. Part of the ERH operations below a warehouse. Large bowling ball sized boulders encountered during drilling.

Beginning Contaminant Concentrations: estimated 60,000 lb TCE release; 21,000 mg/kg TCE in soil and 40 mg/L TCE in groundwater.

Period of Performance: July to December 2005.

TRS Total Price: \$435,302; (\$49.5/yd³) per cubic yard.

Contract Terms: Guaranteed performance based fixed price remediation for a 90% reduction in TCE mass in soil and groundwater.



Figure 1. ERH Remediation Areas Outside (top) and Inside (bottom) Building

Background

Thermal Remediation Services, Inc. (TRS) worked as the Electrical Resistance Heating (ERH) subcontractor to Clayton Group Services on this project. This was a guaranteed performance based fixed price remediation of trichloroethene (TCE) in soil and groundwater. The guarantee was based on a 90% reduction in baseline TCE mass in soil and groundwater. TRS guaranteed to operate the ERH system until the contaminant mass reduction goal was met or until the original design energy of 1,588,000 kW-hrs was applied to the subsurface, whichever occurred later. The Indiana Department of

Environmental Management (IDEM) controlled the escrow account that was established to cover the remediation costs. The initial estimate of the mass of TCE released in the remediation area was about 60,000 pounds (lbs) of TCE.

Site Information

The remediation area was subdivided into three areas, each with different treatment depth intervals. Area A was approximately 7,718 square feet with a depth interval of 8 to 28 feet below ground surface (ft bgs). Area B was approximately 2,872 square feet with a depth interval of 8 to 22 ft bgs. Area C was 1,699 square feet with a depth interval of 8 to 34 ft bgs. All three areas combined equal 12,289 square feet with a treatment volume of 8,800 cubic yards. Figure 1 shows the treatment areas outside and inside the building.

Table 1 contains the baseline mass estimate for TCE in soil and groundwater in all three remediation areas (A, B and C) before the ERH remediation.

Table 1.

ESTIMATED TOTAL MASS OF TCE IN SOILS AND GROUNDWATER PRIOR TO REMEDIATION				
The average soil and water concentrations for each area are multiplied by the soil masses and groundwater volumes to determine TCE mass in soil and groundwater.				
Area	Mass of Soil (kg)	Average TCE Soil Concentration (mg/kg)	Total TCE Mass Soil (kg)	Total TCE Mass Soil (lbs)
A	7,904,961	851.0	6,727.1	14,840.0
B	2,108,387	1,311.1	2,764.3	6,098.1
C	2,344,429	5,680.0	13,316.4	29,375.9
Total Soil TCE Mass (All Areas)			22,807.8	50,314.0
Area	Volume of Groundwater (L)	Average Groundwater TCE Concentration (mg/L)	Total TCE Mass Groundwater (kg)	Total TCE Mass Groundwater (lbs)
A	1,782,396	99.9	178.1	392.8
B	345,511	152.6	52.7	116.3
C	422,039	182.0	76.8	169.4
Total Groundwater TCE Mass (All Areas)			307.6	678.6
Total TCE Mass Pre-Remediation (Soil plus GW)			23,115.4	50,992.6

The total (all three areas combined) estimated TCE mass in soil before ERH was 50,314 pounds (lbs). The total estimated TCE mass in groundwater before ERH was 678.6 lbs. The combined total mass estimate in soil and groundwater before ERH was 50,992.6 lbs.

Installation

Thirty-nine (39) electrodes and co-located vapor recovery wells were installed in 13 inch outside diameter borings on 19.5 foot centers to cover the treatment areas. Two additional electrodes were installed in 6 inch o.d. borings within the former degreaser pit. About 20% of the total treatment area was inside a large warehouse. Figure 2 is a diagram of the electrode layout. The drilling required much longer than normal due to very difficult subsurface conditions. At least 20 auger refusals occurred during the drilling as a result of encountering bowling ball sized boulders.

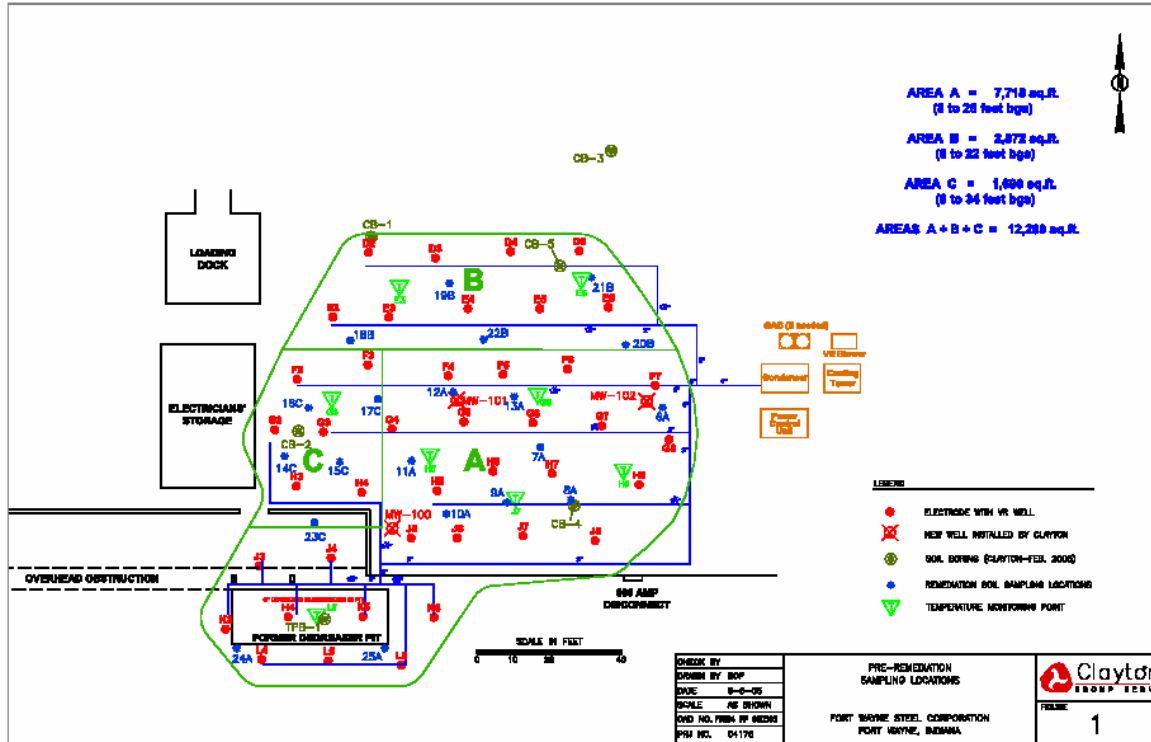


Figure 2. Electrode Layout

TRS mobilized our 950-kW Power Control Unit (PCU), a 15 hp blower, and standard steam condenser and cooling tower from our ERH specialty equipment fleet. The system utilized a 3-phase, 480 volt, 1,200 amp electrical service that was no longer in use inside the building.

Operations

Operations began on July 9, 2005. The system design was based on a weekly average power input rate of 375 kW. As a result of having no significant system downtime, the system averaged a power input rate of 463 kW. This allowed us to exceed the project goal, while completing the remediation in less time than was originally anticipated. Table 2, below, compares estimated versus actual data for several project parameters.

Table 2. Estimated vs. Actual Project Parameters

Parameter	Estimated	Actual
Total Energy (kW-hrs)	1,588,000	1,663,351
Power Application Rate (kW)	355	422
Operating Time (days)	186	164
Total VOC Mass Reduction (%)	90.0	93.4

Eight Temperature Monitoring Points (TMPs) with thermocouples at every 5 foot subsurface interval provided continuous temperature readings that were automatically uploaded to our onsite control computer daily. Figure 3 depicts the most recent average subsurface temperature (approximately 90°C) profile through December 15, 2005. The decrease in site temperatures beginning on December 1, 2005 was a result of system optimization that was performed to focus on one small area of the site that required additional energy to reach the mass reduction goal.

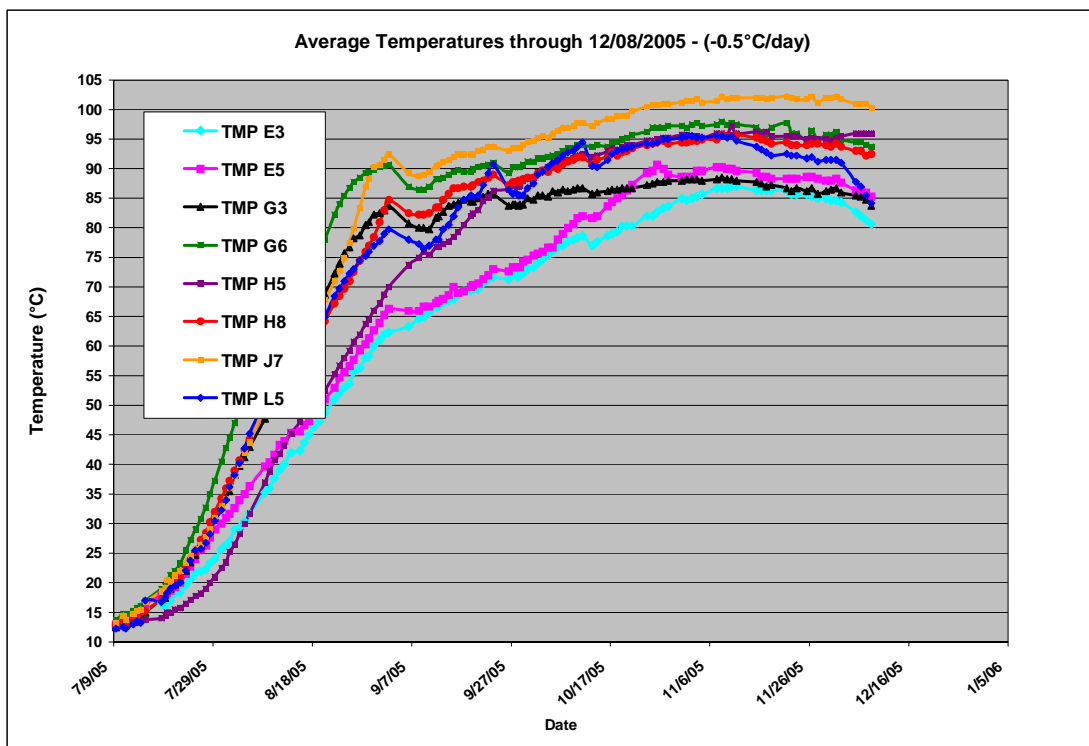


Figure 3. Average Subsurface Temperatures

The ERH system was controlled remotely and checked several times daily, with by-weekly personnel site visits. Since the initial test application of power to the site on July 9, 2005, a total of 1,663,351 kilowatt-hours (kWh) of energy were applied to the subsurface.

Results

The IDEM air emissions permit required a maximum release of 20,000 lbs of VOCs regardless of the rate of removal. The contaminant mass removal rate spiked from 400 lbs/day to 1,200 lbs/day in late August, 2005 (see Figure 4). The system was taken offline over the Labor Day weekend to prevent exceeding the vapor emissions limit. Following the holiday weekend, two 2,000 lb granular activated carbon (GAC) vessels were installed for vapor treatment, in series with an additional two vessels on standby. At the completion of the ERH application, an estimated 24,348 lbs of total VOCs had been recovered in about 164 days of operations.

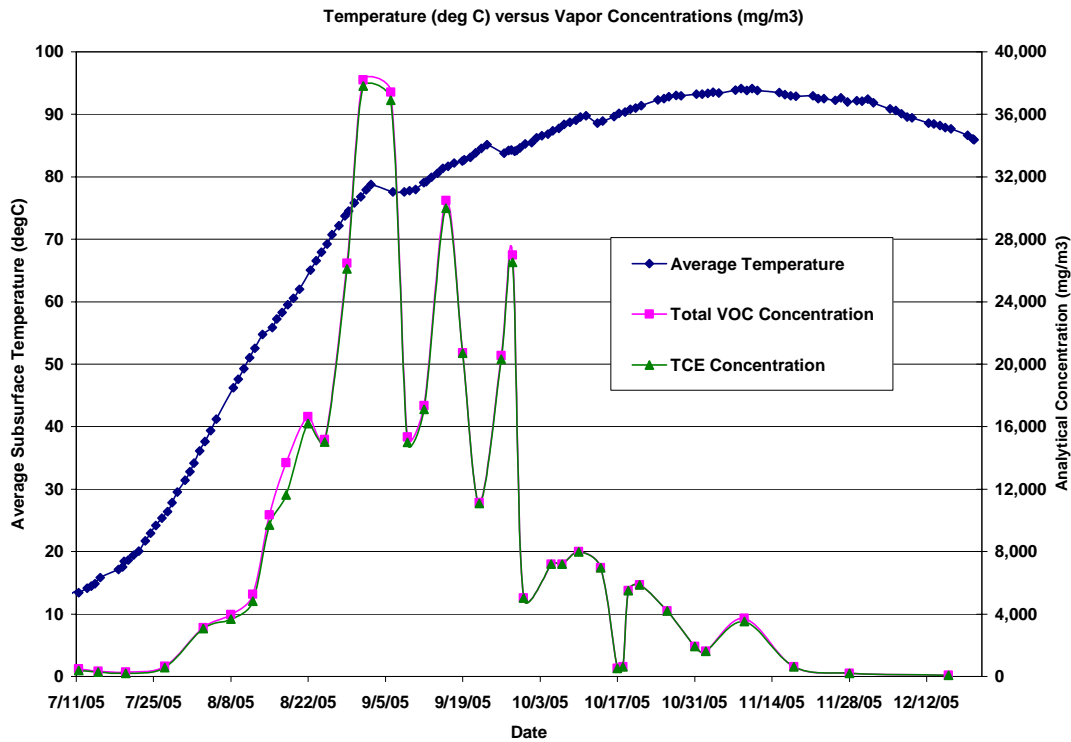


Figure 4. Temperature vs. Vapor Concentration During ERH

Table 3, below, contains the resulting TCE mass data for soil and groundwater after the ERH remediation for all three areas. Total TCE mass in soil (all three areas combined) after ERH was 3,153.3 lbs. Total TCE mass in groundwater after ERH was 216.5 lbs. The total combined remaining TCE mass in soil and groundwater after the ERH remediation

was 3,369.8 lbs. The ERH remediation exceeded the remedial goal (90% reduction in total TCE mass) and achieved a 93.4% reduction in the total TCE mass.

Table 3. Post-ERH Contaminant Mass

ESTIMATED TOTAL MASS OF TCE IN SOILS AND GROUNDWATER AFTER REMEDIATION				
The average soil and water concentrations for each area are multiplied by the soil masses and groundwater volumes to determine TCE mass in soil and groundwater.				
Area	Mass of Soil (kg)	Average TCE Soil Concentration (mg/kg)	Total TCE Mass Soil (kg)	Total TCE Mass Soil (lbs)
A	7,904,961	91.4	722.7	1,594.4
B	2,108,387	34.8	73.3	161.7
C	2,344,429	270.2	633.4	1,397.2
Total Soil TCE Mass (All Areas)			1,429.4	3,153.3
Area	Volume of Groundwater (L)	Average Groundwater TCE Concentration (mg/L)	Total TCE Mass Groundwater (kg)	Total TCE Mass Groundwater (lbs)
A	1,782,396	30.6	54.6	120.4
B	345,511	27.5	9.5	21.0
C	422,039	80.7	34.1	75.1
Total Groundwater TCE Mass (All Areas)			98.2	216.5
Total TCE Mass Post-Remediation (Soil plus GW)			1,527.6	3,369.8

Figure 5 shows the results of the TCE mass (lbs) in soil (left) and groundwater (right) in all three areas and the total of the combined areas before and after ERH. A sample event was performed at about 75% completion to gauge the project status and identify areas that had achieved the reduction guarantee and were subsequently taken offline. The energy saved from those areas was put to better use heating the areas that had not yet met the reduction guarantee. As of December 15, 2005 the guarantee was achieved and on December 20, 2005 the ERH system was shutdown.

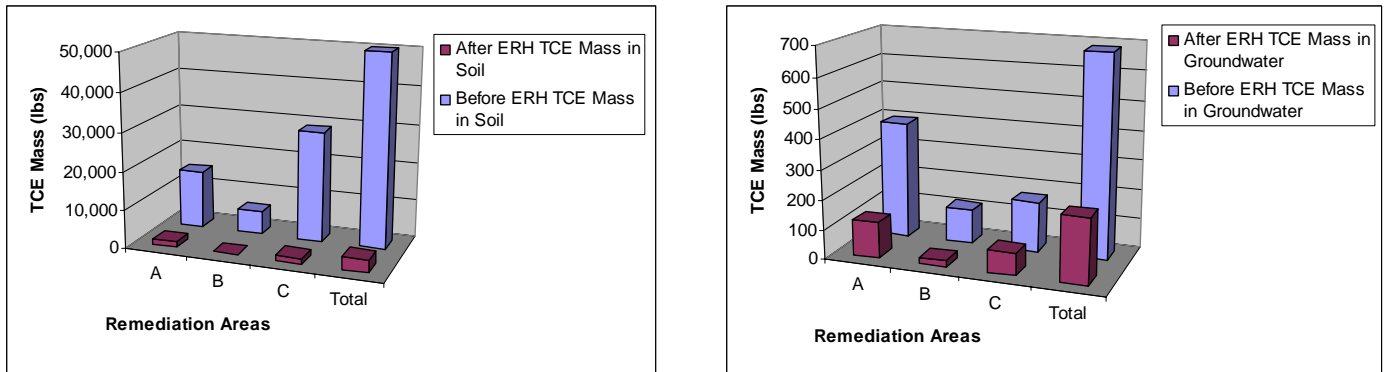


Figure 5. TCE Mass (lbs) in Soil (left) and Groundwater (right) Before and After ERH

Figure 6 compares TCE mass before and after the ERH remediation. The TCE mass estimate before ERH was 50,993 pounds. Following ERH, the TCE mass remaining in the treatment area was 3,370 pounds. The guaranteed goal was a 90% mass reduction of TCE. TRS exceeded the guarantee goal and produced a 93% reduction in TCE mass during six months of operations.

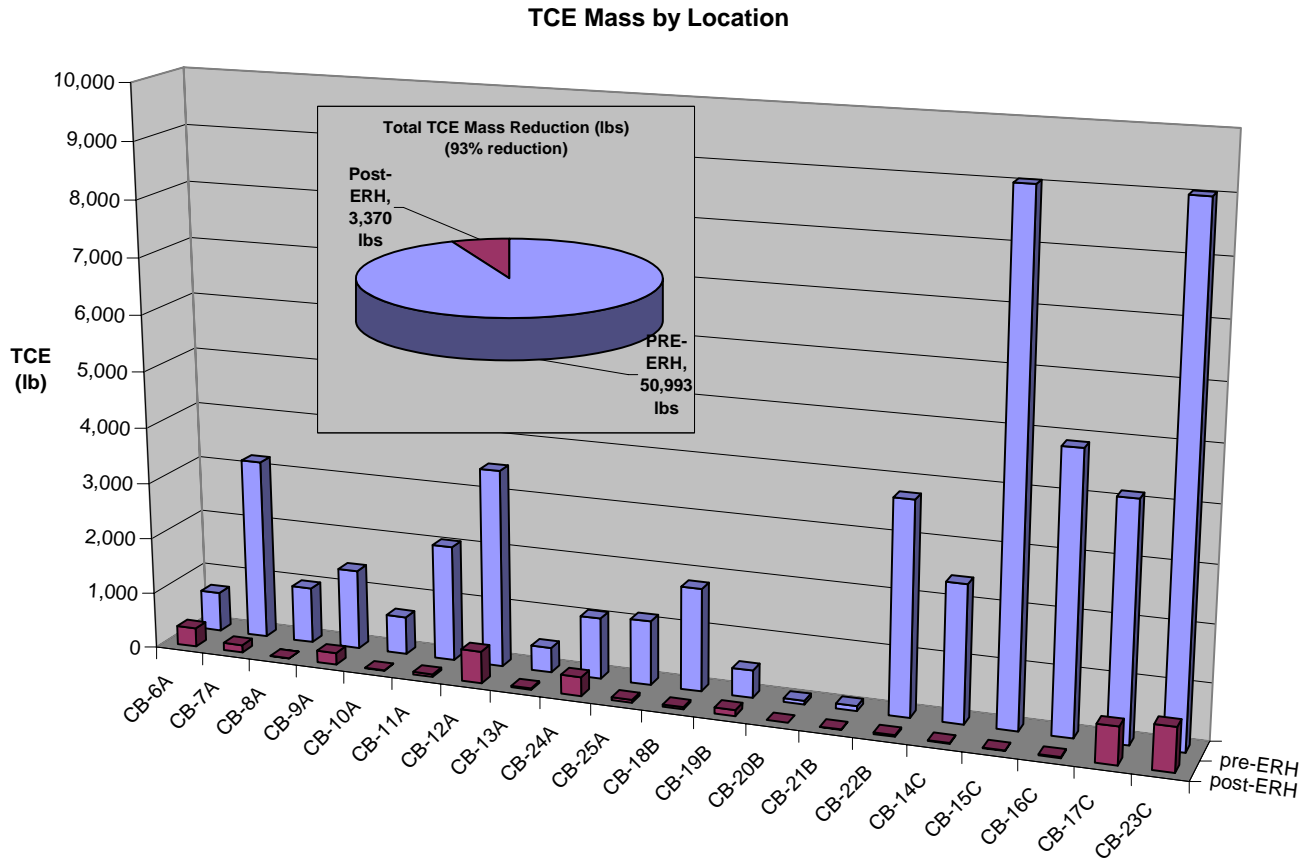


Figure 6. TCE Mass Before and After ERH