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Guaranteed Remediation Certainty
Our Word Is Who We Are

Project Example - Remediation of Trichloroethene at an Operating Industrial Manufacturing Facility, Northrop Grumman-Litton Systems, Inc., Springfield, MO

This project included a firm fixed price with our ***standard guarantee*** *for remediation of trichloroethene (TCE) at the Litton Systems site in Springfield, Missouri.*

Figure 1. Site Layout

Client References: Mr. Larry Williams and Mr. Mark Densmore, SECOR (217) 698-7247, lwilliams@secor.com, mdensmore@secor.com.
Contract Terms: Standard firm fixed price guarantee.
TRS Price: $323,000.
Engineer: Mr. Greg Beyke, Vice President of Engineering, TRS, Franklin, TN, (615) 791-5772, gbeyke@thermalrs.com.
Project Superintendent and Construction Manager: Mr. Miles Stumbaugh, Project Manager, TRS, Asheville, NC, (828) 994-0035, mstumbaugh@thermalrs.com.
Geology: Residual clay with variable limestone and chert floaters.
Hydrology: Water table at approximately 6 ft bgs.
Treatment Area, Depth Interval and Volume: approximately 3,900 square feet; average 4 – 22 ft bgs; approximately 3,177 cubic yards.
Beginning Contaminant Concentrations: 325 mg/kg and 8,400 µg/l TCE in soil and groundwater, respectively.
Remedial Goal: Reduce the 90% UCL for TCE in soil to 0.4 mg/kg, a reduction of about 99%.
Goal Achieved: Average 99.96% reduction of TCE in soil and 99.9% reduction of TCE in groundwater.
Date of Project: June 24 to October 18, 2005.

Problems Encountered and Corrective Actions: During drilling and electrode installation, limestone pinnacles were encountered in the subsurface treatment area resulting in several auger refusals. TRS made quick field adjustments to the electrode locations and customized the electrode lengths for various depth intervals to avoid the pinnacles while maintaining proper electrode geometry. No two electrodes were the same depth in the ERH treatment area.

Background

As a subcontractor to SECOR, TRS provided a pilot test remediation of trichloroethene (TCE) in soil using ERH at an operating manufacturing facility located in Missouri.

This project was performed for a firm fixed price based on our standard guarantee that included installing and operating the ERH pilot system until either the remedial goal was achieved or the design energy was applied to the subsurface, whichever occurred first. The initial design energy was 707,000 kW-Hrs and the remedial goal was to reduce the 90% upper confidence limit (UCL) TCE concentrations in soil to 0.4 mg/kg, a reduction of about 99%. Based on a comparison of thirteen pre and seven post ERH soil samples, TCE in soil was reduced by an **average 99.96%.** During drilling activities, some of the electrodes were placed at a shallower depth than originally designed due to refusal. This had a net effect of reducing the total treatment volume by eighteen percent. A revised estimate of the total energy needed to treat the area was 581,861 kW-hrs. The actual energy applied to the subsurface at the time of confirmation sampling was 569,180 kW-hrs and at the end of the project was 607,142 kW-hrs.

Although groundwater remediation was not the principal focus of this pilot test, TRS expected to reduce groundwater concentrations in the treatment region by about 99% also. Based on comparing one pre and post ERH groundwater sample TCE in groundwater was reduced by **99.9%.**

Site Characteristics

Site lithology in the pilot test area consists of residual clay with variable limestone and chert floaters and limestone pinnacles. Groundwater was encountered at about 6 feet bgs.

The initial designated pilot test treatment area covered approximately 4,000 square feet of a parking lot. The average remediation depth interval extended from 4 to 22 feet below ground surface (bgs). The resulting target remediation volume was approximately 2,800 cubic yards.

TCE was the primary contaminant of concern. The maximum beginning concentration of TCE in soil was 325 mg/kg. The goal of the pilot test remediation was to reduce the 90% upper confidence limit (UCL) TCE concentrations in soil to 0.4 mg/kg, a reduction of about 99%.

Prior to the pilot test the client collected soil samples from 13 locations utilizing direct push technology (DPT). Samples were continuously collected to refusal (9-31 feet) and screened for volatile organic compounds (VOC's) with a photoionization detector (PID). The sample at each location with the highest PID reading was submitted for laboratory analysis. After the pilot test was completed, the client selected seven locations from the pre-test sampling that represented the highest TCE concentrations. The client then took a second round of samples adjacent to those seven locations at the depth where the pre-test sample was taken. Figure 2 illustrates the pre and post ERH sample results.

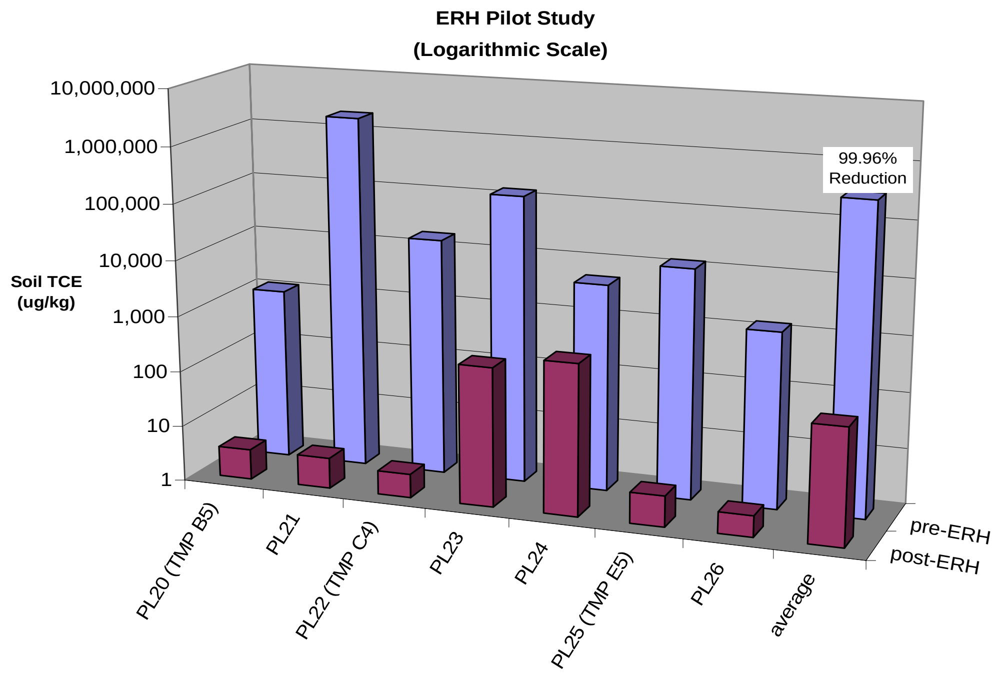

Figure 2. Analytical results

ERH Design Parameters

The ERH pilot system included 18 electrodes in 12-inch outer diameter (o.d.) borings extending to an average total depth of 22-feet bgs or drilling refusal (see Figure 3). The borings were installed using 8¼-inch inner diameter (i.d.) hollow stem auger drilling technique. Each electrode contained a co-located vapor recovery well to capture steam and vapors generated during the ERH application. All electrodes were completed above ground surface. The system also included 13 additional vapor recovery (VR) wells; only one of which was opened, and four Temperature Monitoring Points (TMPs) with thermocouples at five-foot subsurface intervals.

The ERH system was controlled and monitored remotely and checked with bi-weekly personnel site visits.

TRS's ERH specialty equipment provided continuous thermal data collection within the subsurface. Temperature data was collected from four TMPs installed next to the confirmatory boring locations. Each TMP was constructed using ¾-inch chlorinated polyvinyl chloride (CPVC) pipe and each included a TRS-installed thermocouple string that monitored temperatures at 5-foot intervals. All TMPs were completed above ground surface.

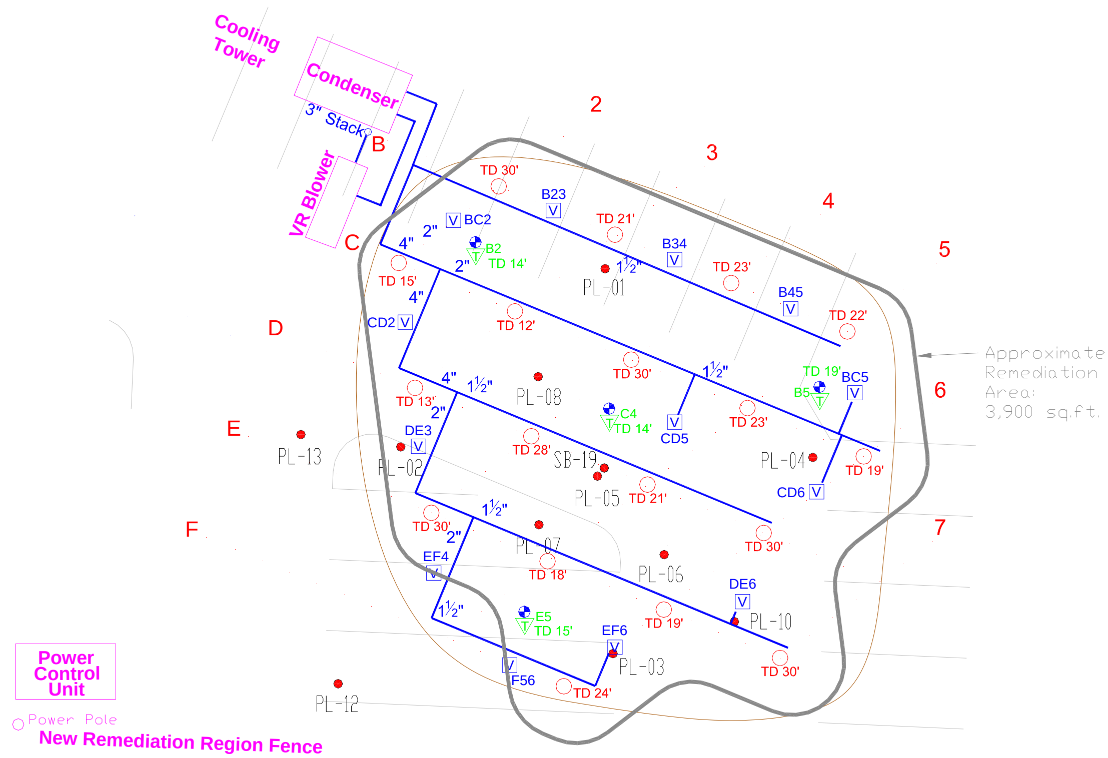

Figure 3. ERH Plot Plan

Results

Power was applied to the subsurface at an average of 222 kilowatts, resulting in a total energy application of 607,142 kW-hrs over the life of the project, between startup on June 24, 2005 and final shutdown on October 18, 2005.

Subsurface temperatures increased to the boiling point of TCE at depth in contact with water (approximately 77°C) within about 25 days. ERH operations continued for another 90 days and concluded on October 18, 2005. Figure 4 illustrates the average subsurface temperature vs. time for the duration of the ERH application.

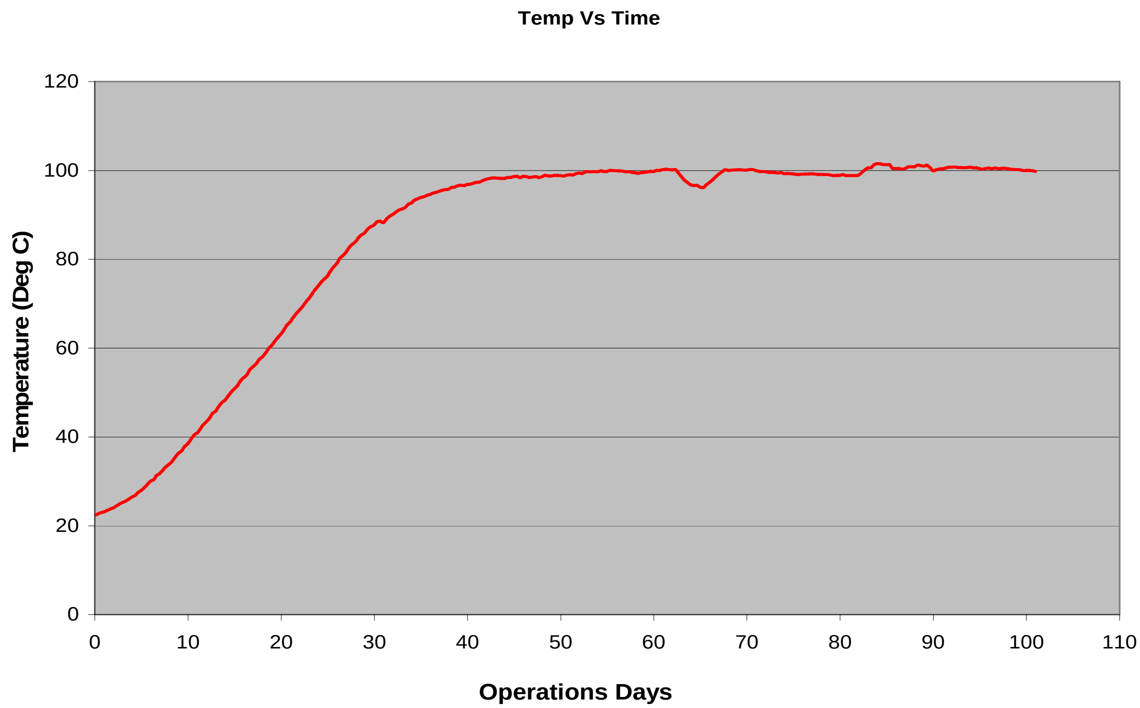

Figure 4. Average Site Temperature

TRS achieved an average 99.96% reduction in TCE concentrations in soil (see Figure 2) during approximately 105 days of ERH operations.

Although groundwater remediation was not the principal focus of the project, TRS expected TCE concentrations in groundwater to also be reduced by 99%. TRS achieved a 99.9% reduction in TCE concentrations in groundwater (see Table 1).

Table 1. Groundwater Results

TCE Concentrations in Groundwater			
Location	**Pre-ERH (µg/l)**	**Post-ERH (µg/l)**	**% Reduction**
PS-SB01	8,400	10	99.9

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Dissolved Organic Carbon in Groundwater

During this project, TRS developed the first data set in the environmental remediation industry to help explain the effects of heat during ERH on the dissolved organic carbon content in groundwater. TRS sampled groundwater before and after ERH to analyze the effects of heat on the dissolved organic carbon content in groundwater. Figure 5 illustrates the results of the before and after sampling.

Following ERH, the dissolved organic carbon in groundwater was 41 times higher than before ERH. This is an important development because it further substantiates that ERH creates favorable conditions for enhanced biodegradation by increasing the dissolved organic carbon content in groundwater making it more bio-available for the indigenous microbial community.

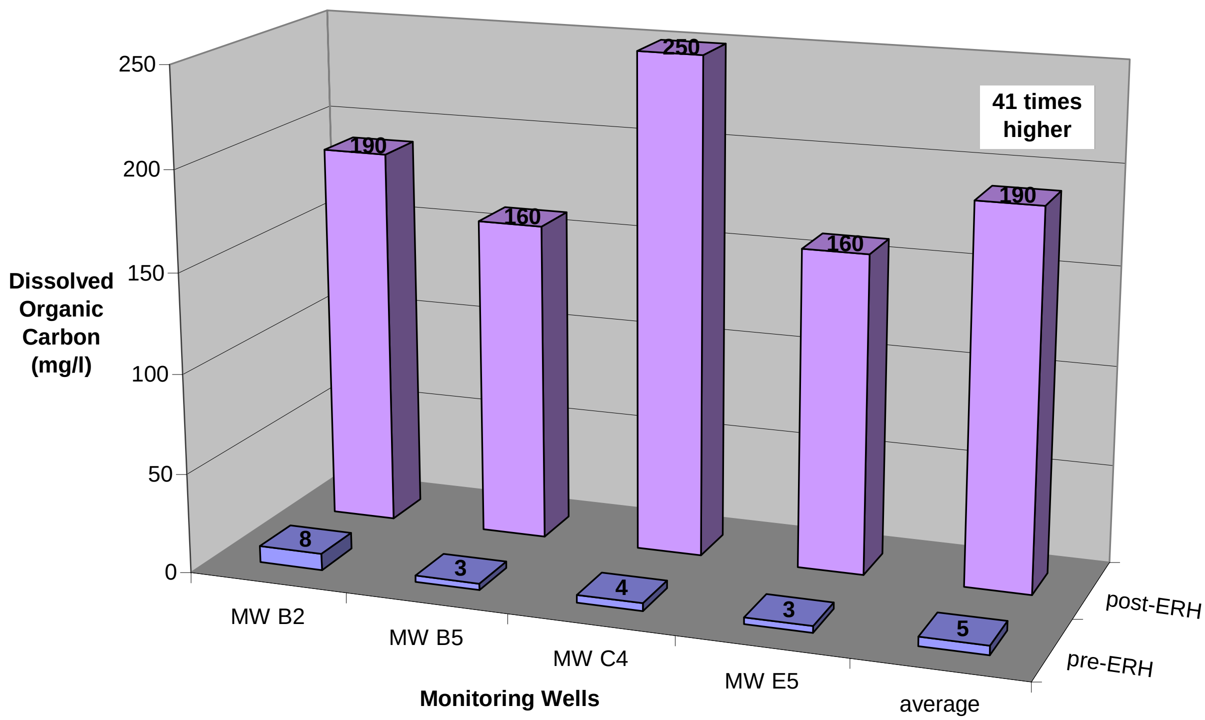

Figure 5. Effect of ERH on Dissolved Organic Carbon in Groundwater