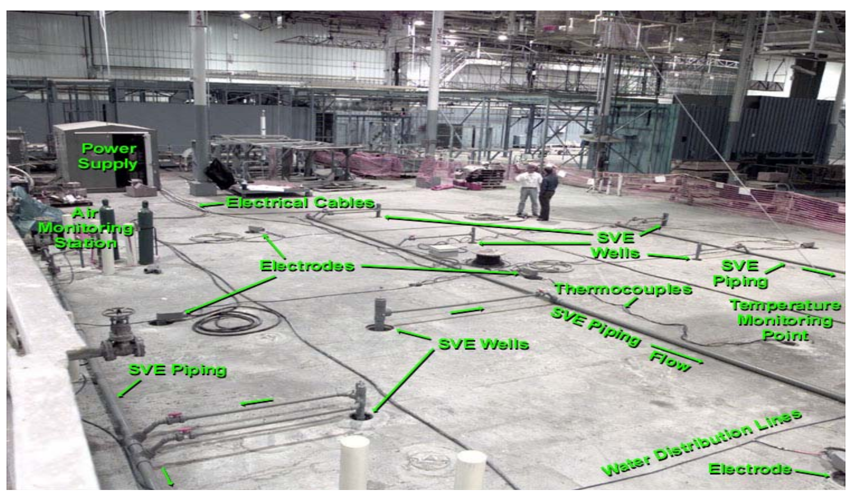
CURRENT ENVIRONMENTAL SOLUTIONS

Six Phase Heating Remediation of TCE DNAPL Under An Active Industrial Plant US Air Force, Plant 4 Ft. Worth, TX

SITE

Six Phase Heating was conducted by CES at Air Force Plant 4 Building 181 where F-16 fighter jets are manufactured. The test objectives were to evaluate the effectiveness and safety of Six-Phase Heating (SPH) beneath an existing structure a at this active military aircraft manufacturing facility. The primary source of subsurface TCE contamination was from leaking degreaser tanks had released a reported 20,000 gallons of the product. Site investigations found that the releases of TCE had resulted in contamination of the vadose zone and groundwater including DNAPL.

The lithology consisted of heterogeneous fine-grained alluvium with varying amounts of clay, sand, and silt underlain by a saturated silty clay unit. Beneath this formation was limestone and/or shale bedrock. Groundwater was encountered between 25-30 ft below grade (bg), and the bedrock was encountered at approximately 35 ft bg.



The peak TCE concentrations were >900 mg/L in the saturated zone and >2700 mg/kg in the vadose zone. Performance objectives were 11.5 mg/l in the groundwater and 11.5 mg/kg in the soil, representing >99% and >98% cleanup for groundwater and soil, respectively.

TECHNOLOGY

After reviewing the relative merits of SPH, steam injection, and radio frequency heating, SPH was the overwhelming choice by the USAF. SPH uses conventional polyphase electricity to resistively heat the soil and groundwater to the boiling point of water. This increases the volatility of contaminants, which improves the effects of vacuum extraction. The heat also initiates VOC degradation through various pathways. Once steam is generated in situ, it acts as a carrier gas which strips out contaminants from the soil or groundwater. The steam is collected from the subsurface by a soil vapor extraction process, and treated aboveground by conventional means such as activated carbon or catalytic oxidization.

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APPLICATION The SPH System was designed to treat a circular area of 3,120 sq ft within the 35-ft interval between the building floor and the underlying limestone bedrock. Seven electrodes were used in a hexagonal pattern at 20 ft spacing. Steam, VOCs, and soil gas were collected through SVE wells installed within the array. Condensed steam was collected and treated with an air stripper. Non-condensed vapors were treated with an existing treatment system that included a catalytic oxidizer and scrubber.

RESULTS The first 30 days of SPH operations resulted in a 40 fold increase in TCE vapor concentrations from a baseline of 40 mg/m^3 to 1,855 mg/m^3 on day 36. The maximum TCE extraction rate was 11.7 lb/day , and approximately 330 lb of TCE were extracted during the 88 day test**.**

Groundwater samples were collected before, during, and after the remediation from 10 DNAPL tracer test wells. Results proved that SPH had reduced TCE concentrations in the groundwater to below the 10 mg/l performance objective. The mean concentration in groundwater fell from 73.4 to 3.6 mg/l. Soil samples showed reduction to <1 mg/kg.

The mean chloride concentration in groundwater doubled during the heating with an average increase of 75 mg/l. The increase in chloride concentration was attributed to reductive dechlorination of the TCE, and this phenomena may have contributed significantly to the reduction of TCE concentrations at the site.

Because the technology met the treatment objectives in a safe manner and was cost-effective compared to other alternatives, the SPH coverage was enlarged to remediate the entire 0.5 acre source area.

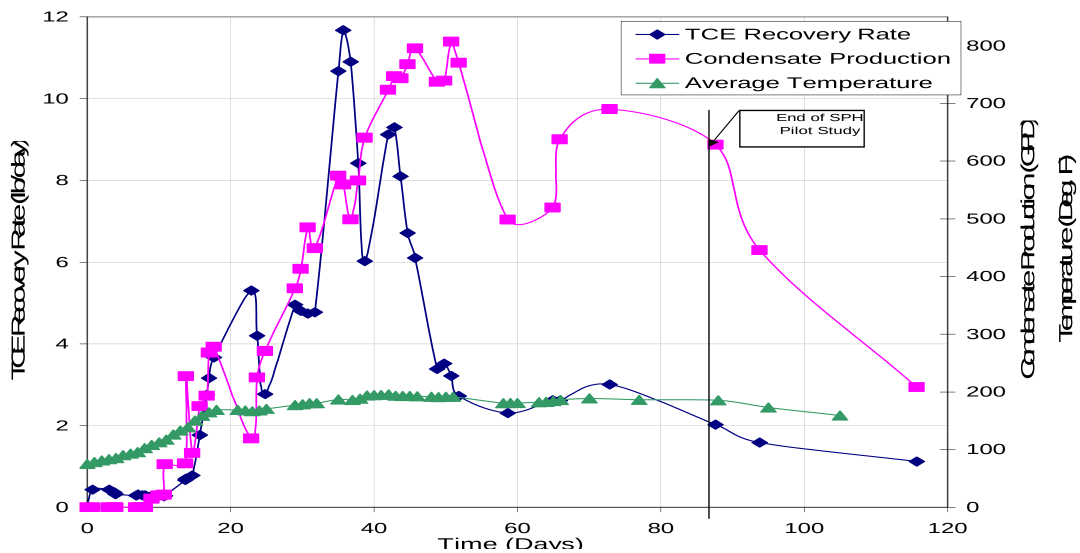

Figure 1. Site Operating Data

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