Camp Lejeune, NC

Site 89

Sept '03 – Mar '04

U.S. Navy

Camp Lejeune, NC

SITE BACKGROUND

1,1,2,2 Tetrachloroethane (TECA) and Trichloroethene (TCE) were detected in monitoring wells at Site 89, Camp Lejeune, N.C. Investigations concluded that a separate-phase DNAPL was encountered between 5 and 19 ft bgs. It was assumed to be perched on discontinuous, lower permeability layers. The upper vadose zone was immediately treated with a separate technology; however a more sophisticated approach was required to address the DNAPL problem.

Site 89 was characterized by three hydro-stratigraphic units within the treatment interval of 5 to 26 ft bgs. 1) An undifferentiated formation from grade to around 8-15 ft bgs consisting of fine to medium sand with interbedded silt and clay layers. 2) The Belgrade formation, a discontinuous clay layer (perching layer) that was presumed to have retarded much of the downward migration of DNAPL. The discontinuous Belgrade formation occurs at depths from 8 to 18 ft bgs, and consists of clays, fine silty sand, or silt and was presumed to have retarded downward contaminant migration. 3) The River Bend formation begins at a depth of approximately 18 ft bgs and is distinguished by the presence of calcareous sands, shell fragments, and fossil fragments. The overall hydraulic conductivity of the Castle Hayne aquifer and Belgrade formation are 10^{-3} cm/sec and 10^{-6} cm/sec, respectively. Groundwater is typically found at 3 ft bgs.

APPLICATION

To meet the project objectives, CES deployed the Six Phase Heating™ technology using three-phase electricity delivered to an array of 91 vented electrodes to cover a total of 15,900 ft^2. System heating performance and contaminant migration detection was conducted by monitoring subsurface temperatures and pressures at 15 monitoring wells throughout the treatment area. Seventeen horizontal vapor extraction wells were installed under an impermeable and thermally insulated site cap. To ensure that the River Bend formation did not pressurize due to steam generation during heating, 25 deep vents were also installed to collect steam and hot water along the periphery of the heated volume. To further mitigate lateral and downward migration of DNAPL into the Castle Hayne aquifer, the electrodes were installed with the dual capability of extracting vapors and groundwater for hydraulic control. Therefore, active venting and moderate dual-phase extraction successfully managed subsurface pressures generated by heating.

A vacuum extraction system was used to capture steam and vapors. The contaminated steam was condensed in a heat exchanger and the condensate stored in a Baker tank for sampling and appropriate treatment or disposal.

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The non-condensed vapor, containing most of the contaminant mass, was then be treated by catalytic oxidation (CATOX) with an acid scrubber before discharge to the atmosphere.

RESULTS

Operations began in Mid October, 2003 with targeted energy to the floor and walls of the site. Approximately two months later, active heating began at the core of the site. Energy was balanced to keep the floor and walls at a slightly higher temperature than the core until the bulk of the site reached active steaming temperatures in early February. Project performance data showed that the SPH Technology was able to increase subsurface temperatures in both the soil and groundwater to 100º C or greater and hold the temperatures to these levels until the desired remediation levels were reached. Active heating continued until April 30, 2004 at which time a review of operational data concluded that the objectives of the test had been achieved.

Heating served to dramatically increase the removal rate of VOCs. The contaminant extraction rate increased from an average of 2 lbs/day at the beginning to averages of 200-440 lbs/day in December and January. As heating continued, the concentrations gradually tailed off to a rate of about 10 lbs/day. It was concluded that DNAPL was no longer present and groundwater concentrations exceeded the treatment goals.

Groundwater monitoring throughout the project showed that the average total dissolved VOCs increased from about 1,500 mg/L to over 4,700 mg/L during heating. DNAPL was actually recovered from monitoring wells during sampling events during this period. Following the first 30 days of steaming, the dissolved total VOC concentrations were reduced to 24 mg/L, and at the conclusion of heating, the average total VOC concentrations were 4 mg/L throughout the site. TECA concentrations decreased by 99.99% after 6 months of operations; from an average of 992 mg/L to 0.9 mg/L.

The results of the technology exceeded the clients' expectations and were completed safely without a single health and safety incident.