



SIX-PHASE HEATING AND DUAL PHASE VACUUM EXTRACTION REMIEDIATES GASOLINE LNAPL IN CALIFORNIA

CES



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In November 2005 Current Environmental Solutions (CES) was contracted to perform a Six Phase Heating (SPH) / Dual Phase Extraction (DPE) remediation at a former gasoline station site located in the San Francisco Bay area of California. SPH, an aggressive in-situ thermal remediation technique, was selected to rapidly bring closure to this site where other remedial activities had been attempted since 1995. CES began site construction in December 2005, commenced operations in March 2006, and completed the subsurface treatment in November 2006. Post treatment sampling confirmed the clean-up goals had been achieved.

The subsurface soil and groundwater at the site had been impacted with Benzene, Toluene, Ethylbenzene, and total Xylenes (BTEX), and Total Petroleum Hydrocarbons - Gasoline Range Organics (TPH-g) due to the storage and dispensing of automotive gasoline at the former filling station. Former remediation activities, which included partial excavation, soil vapor extraction, air sparging with ozone, and bioremediation were performed at various times over the previous 10 years. However, following these treatments, residual hydrocarbon mass remained trapped in a very low permeability soil zone from 28 to 33 feet below grade surface(bgs).

SPH was deployed by CES for heating the subsurface soil and groundwater in order to liberate the remaining hydrocarbons from the low permeability soil zone through direct volatilization and in-situ steam stripping. Simultaneously, DPE was used for hydraulic control of the groundwater aquifer as well as a mechanism for hydrocarbon mass removal. The site first reached 100 °C temperatures in the treatment zone in early June 2006 after 2.5 months of operations, and the active thermal treatment was completed in September 2006. Additional DPE equipment was mobilized at the end of May 2006 and again in mid September 2006 to further enhance hydrocarbon mass removal. Approximately **44,541** pounds of hydrocarbons were removed from the subsurface during the project.

The treatment goals for the project were:

- 1) Soil: 0.51 mg/Kg (ppm) benzene ; 13 mg/Kg TPH-g
- 2) Groundwater: 200 ug/L (ppb) benzene ; 4,500 ug/L TPHg

Groundwater samples were collected in November 2006. The results from groundwater samples and decreasing extracted hydrocarbon concentrations indicated that the remediation was nearly complete. Closely thereafter, final confirmatory soil sampling was performed by others. All groundwater samples except for one were below the treatment goals. Similarly, all soil samples met the target clean-up goals except for two samples from one location which were well below the target clean-up objective for benzene, but slightly above the target for TPH-g.