Leveraging Warm Water from Source Area Thermal Remedy for Synergistic Biotic and Abiotic Degradation of a Downgradient CVOC Plume

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Background/Objectives. A relatively concentrated CVOC plume exists downgradient from a significant DNAPL source area addressed with an in-situ thermal remedy at an industrial site in New Jersey. We sought to enhance remediation of the downgradient plume by leveraging warm water migrating from the thermal treatment area. The warm water is expected to increase microbial activity and abiotic degradation reaction rates, release organic carbon, and increase desorption of sorbed CVOCs. Modeling results initially suggested that groundwater temperatures may reach 35 to 40°C in the target treatment area, which is at the point that microbial activity can be inhibited; hence we coupled a biotic remedy with an abiotic remedy to ensure continued treatment if microbial activity was inhibited by high temperatures. We injected a solid organic carbon / zero valent iron substrate to enhance biological activity and supply a synergistic abiotic treatment mechanism. The ZVI also provides a less temperature-sensitive treatment mechanism in the event the water becomes too warm for effective microbial activity.

Approach/Activities. The source area thermal remedy was operated from December 2017 through July 2018. Two reactive treatment zones were constructed in accessible areas of the plume (one on each side of a warehouse building), immediately downgradient of the thermal treatment area. A total of 148,500 lbs of Provect-IR was injected as a solid slurry via direct-push into 325 discrete intervals distributed among 57 boring locations over the course of two mobilizations in February and April 2018. Injection targeted a transmissive sand zone identified between approximately 16-50 ft below grade. The depth interval was adjusted between points for the variable depth and thickness of the sand zone. Groundwater temperature was monitored by deploying temperature data loggers in select wells. Biological activity was monitored by deploying Bio-Trap samplers. Overall performance was monitored by collecting samples for analysis of VOCs and redox-sensitive groundwater parameters.

Results/Lessons Learned. Temperature monitoring data confirm little escape of warm groundwater while the thermal system (which included a groundwater extraction component) operated. Six months after shutdown, temperature has increased 3 to 22°C in the downgradient plume area and may have started to plateau. Groundwater samples were collected prior to the thermal remedy and injection, at one and two months after injection (but before thermal shutdown), and at four and seven months after injection (after thermal shutdown). Groundwater conditions are strongly reducing, and microbial activity remains high. The TCE and cis-DCE concentrations are reduced by two to four orders of magnitude in the upgradient treatment barrier and in the deep zone in the downgradient treatment barrier. In the downgradient shallow zone, TCE concentration is reduced by 50% but cis-DCE has increased by nearly 3x, due to either abiotic or biotic degradation; this is attributed to less effective reagent distribution, but degradation is occurring. Temperature and groundwater chemistry monitoring will continue in order to evaluate ongoing progress and to document degradation rates and the contribution of elevated groundwater temperatures.