Field-Scale Evaluation of Biosparging at a CERCLA Site to Deplete Groundwater Contaminants from Creosote and Achieve Remedial Action Objectives

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Background/Objectives. Aerobic biooxidation of dissolved-phase petroleum hydrocarbons occurs naturally or via engineered application of in situ biosparging when microbes utilize hydrocarbons as electron donors in the presence of oxygen as the primary electron acceptor. In situ biosparging is a proven, effective remediation technology to enhance aerobic biooxidation of dissolved hydrocarbons typically observed in groundwater at creosote sites. In addition, rapid aerobic biooxidation of dissolved hydrocarbons increases dissolution of groundwater contaminants from creosote and changes the creosote composition by depleting the soluble fraction.

A NAPL depletion model that includes a Raoult's Law solubility model was developed to evaluate the ability to effectively weather groundwater contaminants from creosote and meet groundwater criteria using biosparging. The Raoult's Law solubility model is developed from a method that includes laboratory analysis of the creosote composition and water from creosote-water equilibrium studies to estimate the average molecular weight of the creosote. The NAPL depletion model is also used to estimate the time required to deplete groundwater contaminants from the creosote and meet groundwater cleanup standards.

Approach/Activities. The feasibility of biosparging to effectively deplete groundwater contaminants from creosotes has been evaluated at two sites in the Unites States. Although data from treatability studies combined with NAPL depletion modeling indicate biosparging is expected to achieve remedial action objectives (RAOs), the duration of field studies at creosote sites have been limited to focus on supporting evaluations of biosparging in CERCLA feasibility studies. Thus, a two-phased treatability study is being performed at a Superfund Site in Minnesota to collect data at the field scale to evaluate the effectiveness and implementability of biosparging to permanently decrease concentrations of groundwater contaminants and achieve RAOs. Phase 1 of the biosparge study was performed from September 2020 to April 2021 to collect data that supported design of a much larger biosparge system. Operation of Phase 2, planned for startup in fall 2022, will treat the largest creosote source area with portions that extend to 103 ft below ground surface. Phase 2 is planned to operate for several years to allow collection of data to evaluate long-term performance and ability to achieve RAOs.

Results/Lessons Learned. Phase 1 of the treatability study achieved its objectives and supported design and implementation of Phase 2. Laboratory analysis of soil, groundwater, and creosote was used to evaluate biosparging performance to date and provide baseline data for ongoing evaluations of long-term performance. The baseline composition of creosote inferred from lab results for soil samples is similar to lab-measured compositions of creosote obtained from wells. During the initial operation period of the study (Phase 1), the mass and mass fraction of VOCs in creosote decreased by 23% and 15%, respectively, which was greater than for PAHs (the mass and mass fraction of naphthalene in the creosote decreased by 14% and 4%). Biosparging in the limited treatment area of Phase 1 continued after completion of the Phase 1 study (April 2021) and during Phase 2 planning to provide additional data on further

changes to creosote composition that was used to build and calibrate a creosote depletion model for the site.