Permanent Removal of Separate Phase Organics in Groundwater

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Background/Objectives. A former bus maintenance facility operated in the 1960s through the 1980s approximately 1,500 feet from the environmentally sensitive Willamette River in the heart of Portland, Oregon. Operations resulted in petroleum soil and groundwater contamination. Soil contamination was addressed solely through property use restrictions. Groundwater remediation began in the early 1990s employing SVE and biosparge systems. Eighteen years of mitigation reduced the most biodegradable portion of petroleum dissolved phase contamination. Mobile dual phase extraction was used intermittently over a decade which did not result in long-term reduction of measured phase separate hydrocarbon (PSH) thickness. The vadose zone was heavily saturated with sequestered petroleum serving as a secondary leaching source for continually accumulating PSH. In 2014, the property was placed under contract making regulatory closure an urgent matter.

The regulator had concurred with a partial risk-based closure with property use restrictions for soil and groundwater (dissolved phase). However, remaining PSH prevented site closure. An approximate 60,000 ft^2 PSH plume was located on the site and under an adjacent State highway right-of-way. PSH ranged from 0.08 to 4.45 feet thick and historically relatively immobile. A novel surfactant based technology was selected to rapidly achieve regulatory closure goals.

Approach/Activities. Three 5-day field events were scheduled approximately 30 days apart. The initial phase focused on desorption of PSH in the vadose zone to eliminate future leaching potential. Concurrently, the groundwater saturated zone was inoculated to exhibit strongly oxidative conditions. Desorption of sequestered PSH required significantly lowering the surface tension, which placed some of the partially soluble petroleum compounds into the dissolved phase. A nonionic surfactant solution bonded with the PSH just under the critical micelle concentration. The desorption resulted in a short term spike of dissolved phase constituents directly under the PSH plume. However, the oxidant inoculations controlled and degraded the additional dissolved phase petroleum. At the end of 5-days of field work, groundwater was monitored for the next 30 days. Groundwater ORP had normalized to pre-treatment conditions within one week. Measured PSH thickness was reduced across the plume to 0.01 to 0.03 feet. Groundwater analysis one month post treatment indicated dissolved phase had been reduced to pre-treatment baseline conditions. This process was repeated for the second phase (5 days of field work) followed by another 30-day monitoring period. At the end of the second phase, PSH was no longer measureable across the plume (<0.01 ft.). A final third polishing phase resulted in no measureable PSH and no visible sheen in any monitor well. Dissolved phase petroleum concentrations were further degraded, below the pre-treatment baseline concentrations.

Results/Lessons Learned. The Oregon Department of Environmental Quality (ODEQ) concurred that remediation goals had been met and all site closure goals were achieved. The site was entered into a post-remedial monitoring period to validate the persistence of achieving the remedial goals. During this period, no measureable PSH was detected or sheen visually identified in any monitor well, the petroleum dissolved phase concentrations remained well below the pre-treatment baseline and declining. Remediation was approved by the ODEQ, moved to public hearing, then closed in time for re-development as an electrical substation.