In Situ Bioremediation of Shallow Dispersed LNAPL Plume Travelling under a Major Highway

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Background/Objectives. A corroded fitting on an unmonitored remote UST fill port for a busy retail petroleum site led to the release of an inestimable amount of gasoline into the subsurface. The release was discovered when heavy seasonal rainfall forced the LNAPL plume above the ground surface. Fuel was observed in the median as well as the far shoulder of the adjacent four-lane highway. The corrective action goals for the site were to remove all measurable LNAPL from the on- and off-site monitoring and recovery well network and reduce dissolved-phase concentrations to site-specific levels.

Approach/Activities. Emergency response activities resulted in the collection of more than 1,200 gallons of product and 20,000 gallons of impacted water. Further investigation revealed an LNAPL plume covering an area of approximately 30,000 square feet with NAPL thickness exceeding 5 feet on the western edge of the plume. After heavy rainfall events, a viscous black tar-like substance was observed seeping from the highway shoulder which was determined to be gasoline product mixing with and dissolving the roadbed. In order to further refine the conceptual site model, a remedial design characterization (RDC) was performed. During the RDC effort 47 soil borings were completed to a depth of up to 16 ft below ground surface, soil was collected every 2 feet or more frequently when hot spots were identified visually or with a PID. Temporary monitoring well clusters were installed in 23 of the completed borings to collect discrete groundwater samples. The remediation technology selected for this site was an activated carbon-based amendment which included calcium sulfate, nitrate, phosphate, ammonia, starch, yeast extract, and magnesium sulfate to assist in the stimulation of a robust biological system. Prior to injection the slurry is inoculated with a blend of aerobic and anaerobic microbes. Phase 1 injections targeted areas identified during the RDC where concentrations of TVPH in soil exceeded 4,000 ppm. Injections were performed from late February 2021 into early April 2021; roughly 75,000 combined pounds of the aforementioned chemicals were installed during this time. An aggressive fluid vapor recovery event (AFVR) was performed approximately 1-month post injection to capture excess LNAPL residing in the monitoring and recovery well network. Phase 2 injections targeted areas where LNAPL was measured after the AFVR event. Injections were performed from January 2022 through March 2022 with the installation of approximately 75,000 combined pounds of amendments and an additional AFVR event.

Results/Lessons Learned. Throughout and immediately following both injection efforts, groundwater gauging data were compiled, groundwater samples were collected and analyzed and soil borings were completed to visually inspect injection progress. Groundwater gauging data showed immediate reductions in LNAPL during both injection events, often followed by a rebound, however, continuous monitoring shows a downward trend in LNAPL levels in 80% of the wells within the injection area. Since completion of the first injection phase, no additional LNAPL has been observed seeping out of the road shoulder. Analytical data for several on site wells show similar trends with 300+ day post-injection samples demonstrating over 70% reduction in benzene and reduction in TVPH below the detection limit in the source area wells.