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No Further Action: A Case Study on High Resolution Site Characterization and Bioremediation in a Fractured Bedrock Setting

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Background/Objectives. Past operations at a truck stop operated in Richmond, KY resulted in multiple gasoline releases to the subsurface. Over a period of 20 years, site investigation activities have revealed a 320 feet long dissolved BTEX plume within the fractured bedrock beneath the site. The subsurface lithology at the site consists of a thin, approximately one to three feet thick clay overburden, underlain by Upper Ordovician Calloway Creek Limestone, Garrard Siltstone, and Clays Ferry Formation. Monitoring wells at the site were installed with screened intervals varying from 10 feet to 40 feet in length, and screened across multiple formations. Groundwater samples collected from nested wells indicate the presence of dissolved benzene in both the shallow and deep wells at various locations throughout the plume.

Approach/Activities. A bedrock remedial design characterization (RDC) utilizing multiple geophysical investigative techniques and high resolution field data collection were conducted to determine the transport mechanism of the dissolved BTEX plume and determine the effectiveness of the chosen in-situ technology. The RDC and pilot test included four key components: 1) a 2-dimensional electrical resistivity imaging survey (2-D ERI) to identify new borehole locations within the plume, 2) borehole geophysical logging to delineate the vertical extent, orientation, and aperture size of the bedding planes and fractures, 3) discrete groundwater sampling from identified fractures/bedding planes using a custom designed straddle packer assembly with an eighteen inch sample interval, and 4) high resolution water level monitoring of the surrounding well network during air rotary drilling and pilot injection test using pressure transducers to define the horizontal connectivity between existing monitoring wells and the vertical connection between formations.
Based on the data collected from the RDC and pilot test, a clear picture of the subsurface lithology and structural features was obtained. Multiple weathered zones were identified from the 2-D ERI where the additional boreholes were installed, and the borehole geophysical logging identified the horizontal bedding planes that were targeted in the discrete groundwater sampling and pilot injection test. The data collected from the discrete groundwater sampling, provided information to assist in injection location and remediation product loading. The product selected for the pilot test was Remediation Products Inc.'s BOS 200® based on the proven success displayed controlling the back diffusion of petroleum contaminants in fine-grained soils. The BOS 200® was injected via high pressure/high flow injections using Well Improvement Company's specialized pump and straddle packer system. Data collected from the pressure transducers during the pilot injection test demonstrated the radius of influence of the 150-gallon injections, ranged from 45-70 feet at the deeper injection intervals (deeper than 13 feet), and 20-30 feet in the shallower intervals (less than 10 feet).

Results/Lessons Learned. Post pilot test groundwater sampling results show the targeted monitoring well with historical benzene concentrations greater than 6 mg/L, below laboratory detection limits of 0.001 mg/L for seven consecutive quarters. Using the data collected from the pilot test, a full-scale injection was implemented in April 2014. The full scale BOS 200® injection was successfully placed in the identified zones of contamination throughout the plume,

intersecting all impacted monitoring wells, with three consecutive quarterly sampling results exhibiting results below the target remediation goals. Based on the post-injections groundwater results from the pilot test and full-scale injection, a No Further Action letter was issued in February 2015.