An Innovative Air Sparging Approach for Treatment of BTEX and VOCs

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Background/Objectives: Air sparging was one of the first remedial technologies – since its initial implementation, the technology has been used at numerous remediation sites, including over 80 Superfund sites, and is considered a well-documented and proven remedial technology. However, over the years, advancements in the design and implementation of the technology have been made to further enhance treatment efficiency and effectiveness. These advancements include more sophisticated mass-transfer and pneumatic modeling tools, modifiable implementation methodologies, and even real-time remote monitoring and manipulation of system operating parameters. Through the use of such advancements, a full-scale air sparging remedial system for a site in northern New Jersey was designed, and is currently being operated, to address extensive volatile organic compound (VOC), semi-volatile organic compound (SVOC), and pharmaceutical impacts at a former manufacturing facility. A former lagoon used for dumping, the site is riddled with contamination, as well as an extremely complex glacial lithology – a unique air sparing remedial strategy was developed and implemented to realize groundwater concentration reductions of benzene (primary constituent) as high as four orders of magnitude in only the first year of the system operation.

Approach/Activities: Among the complications associated with the various contaminants and highly glacial lithology of the site, was a sporadic network of semi-confining layers identified throughout the site at varying depths, as well as a shallow and relatively low permeable vadose zone. With these site-specific constraints in mind, a full-scale air sparge system was designed to address the source of contamination, as well as prevent further downgradient migration of the contaminant plume into a nearby stream. Extensive pre-design pilot testing activities, in-situ air stripping mass-transfer modeling, and two-dimensional (2D) subsurface pneumatic modeling were essential in the design of the required air sparging system. Such tools provided a basis for the required number of air sparging and vapor collection wells, their respective performance specifications (i.e., flow rate and pressure/vacuum relationship), and ultimately the required process equipment sizing. The mass-transfer model, calibrated with actual air stripping data from numerous previous air sparging operations, provided a basis for the air to water ratios (i.e., air flow rate) required to effectively remediate the medley of different contaminants present on site. Similarly, the 2D pneumatic model, MDFIT™, confirmed the relatively lower permeability nature of the vadose zone. Site-specific innovations to the well-known air sparging technology included, chimney wells to facilitate subsurface air flow and relieve potential pressure build up due to the presence of semi-confining layers, a high permeability 3-foot cap which both provided a media for effective vapor collection and artificially lowered the site water table to reduce the potential for water entrainment within the system, and a pulsing air sparge scheme to further reduce the potential for pressure build up in the subsurface and enhance contaminant stripping via groundwater mixing.

Results/Lessons Learned: Since the initiation of the system operations in June 2016, the total cumulative VOC mass removed via the vapor collection system is estimated to be approximately 60 pounds. Benzene, used to delineate the target treatment area when developing the remedial strategy, has seen concentration reductions as much as four orders of magnitude (e.g., 12,000 micrograms per liter [µg/L] to 9.2 µg/L) within the treatment area.

Although, fluctuations in concentrations are to be expected in the early years of the system operation, the system’s unique design features allow for flexible system operation, which can be optimized as the remediation advances and groundwater conditions change over time. This presentation will present the site-specific constraints, as well as the unique design elements, and demonstrate how these design elements resulted in an innovative air sparging remedial strategy.