LNAPL Transmissivity, NSZD and Incidental Bioventing Characterization for Evaluation of an LNAPL Recovery Program

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Background/Objectives. Recent industry guidance has described possible endpoints for LNAPL recovery and the use of NSZD for post-conventional LNAPL residual remediation. However, the data needs and analysis for transition from conventional recovery to residual LNAPL management have not been thoroughly established. This presentation will report a site characterization approach that considers NSZD mechanisms early in the remedy, as well as quantification of “incidental bioventing” that is achieved by operation of an LNAPL recovery system. The characterization allows for a more expansive assessment of LNAPL recovery operations such that the endpoints can be set on more than one metric (e.g., LNAPL transmissivity).

Approach/Activities. The subject site is an active facility where LNAPL body and dissolved-phase plume stability are remedy objectives. LNAPL recovery is conducted by “enhanced skimming” whereby total fluids extraction pump intakes are set to near the LNAPL-water interface in each well. LNAPL recovery rates have been tracked monthly since 2011, and LNAPL transmissivities have been estimated by “snap-shot” baildown events in 2011, 2014, and 2016. To supplement these conventional LNAPL program data sets, a baseline NSZD characterization effort was conducted in 2016. Monitoring tools included: 1) CO_2 efflux measurements by dynamic closed chamber (DCC), 2) subsurface temperature measurements, 3) vadose zone gas profiling, and 4) groundwater geochemical testing, and 5) Bio-Traps™. Together, these tools provide information on NSZD in both the dissolved and vapor phases, and evidence of enhanced aerobic biodegradation in the vadose zone (incidental bioventing) that occurs during LNAPL recovery operations.

Results/Lessons Learned. Maximum LNAPL transmissivity across the study area decreased from 81 f^{t2}/day to 3.2 ft^2/day in the 2011 to 2016 timeframe, consistent with observed decreased LNAPL recovery rates. LNAPL:water extraction ratios for this timeframe also decreased. The LNAPL recovery rates for individual wells convert to a range of approximately 10 g TPH m^{-2} day^{-1} to greater than 700 g TPH m^{-2} day^{-1} (set to like units for comparison with NSZD). NSZD within the saturated zone is dominated by anaerobic sulfate reduction at a rate of approximately 0.06 g TPH m^{-2} day^{-1}. Within the vadose zone, NSZD occurs by volatilization, followed by subsequent methanogenesis and aerobic biodegradation, with rates ranging from approximately 3 to 20 g TPH m^{-2} day^{-1}. The highest CO_2 effluxes were measured adjacent to pumping wells, and decreased when pumping was temporarily suspended. Subsurface temperature and vapor profiles corroborated an interpretation that pneumatic pump exhaust through the well screen was causing incidental bioventing. Overall, the results suggest that the LNAPL recovery program is approaching a transition point for which NSZD rates might surpass LNAPL recovery rates. At that time, the system operations may be adjusted to optimize the bioventing attenuation mechanism, serving as a “bridge” between conventional LNAPL recovery and eventual shutdown of the system for residual LNAPL management.