Enhancing Biodegradation of LNAPL with Bioventing

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Background/Objectives. Light nonaqueous-phase liquid (LNAPL) associated with historical fuel releases are present in the subsurface at many environmental sites. Research on natural source zone depletion (NSZD) rates at petroleum-affected sites has demonstrated that the rate of natural LNAPL depletion is typically significant; on the order of hundreds to thousands of gallons of LNAPL per acre, per year. Both academic and industry research studies and measurements made by practitioners have shown that the rate of LNAPL mass depletion by NSZD is often greater than what can be or has been achieved through active LNAPL recovery efforts. These finding suggest that bioventing may be an effective and sustainable technology to enhance biodegradation rates and deplete LNAPL source mass.

Conceptual models of NSZD show that the soil gas above the LNAPL/air interface is rich in methane and depleted of oxygen. These observations indicate that there is anaerobic zone in the vadose zone that typically coincides with a portion of the LNAPL smear zone. Inducing oxygen flow into these methane-rich zones through bioventing is a viable approach to accelerate biodegradation.

Bioventing is not a novel technology; bioventing and bioventing rate testing has existed since the 1990's. While the remediation science has not changed, the conceptual model for LNAPL biological depletion and the petroleum hydrocarbon biodegradation signal observed in biovent field tests and full-scale operation have changed markedly since the 1990's. A technology that was once considered applicable only to TPH in soils have been successful in removing mass from NAPL.

Approach/Activities. The presentation will discuss how bioventing has been traditionally applied and how the conceptual model for NSZD has changed our thinking on source zone biodegradation. A case study demonstrating mass reduction, compositional change, and sustainability considerations will be presented. Petroleum removal rates via bioventing are compared to hydraulic recovery performance and baseline NSZD rates. The mechanisms responsible for the performance of bioventing, NSZD, and hydraulic recovery under various site conditions are discussed.

Results/Lessons Learned. Bioventing is a potentially cost-effective remedy to alternative remedial technologies that not only degrades the mobile fraction but also the residual fraction of LNAPL. Commonly-used LNAPL remedial technologies can be effective in the early stages of remediation. However, remedial efficiency declines exponentially over time and performance ultimately reaches a point where continued operation no longer provides meaningful reduction in contaminant mass or potential risk to receptors. Bioventing is a sustainable remedial technology that can match or exceed mass recovery achieved by LNAPL hydraulic recovery and modify the LNAPL composition.