A Mass Balance Approach to Resolving the Stability of LNAPL Bodies

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Abstract. Petroleum hydrocarbons are considered light nonaqueous phase liquids (LNAPLs) and have been released into the environment through many industrial processes. Concern has arisen about the potential contamination of the ground water, vapor plume development, as well as the migration of these bodies. Velocity measurements made on continuous LNAPL bodies have resulted in non-zero values. Interpretation of these velocities has come into question. Generally they are measured internal to the LNAPL body and extrapolated to the edges of the pools. However, movement and/or expansion of many of these pools have not been visually observed. An explanation for this is that these velocities are a result of losses to the pool. A proof-of-concept sand tank study was conducted to determine if these losses can control the stability of free-phase LNAPL pools. Methyl tert-butyl ether (MTBE) was injected into a sand. Five known injection rates and two injection locations were evaluated. The MTBE body initially expanded relatively quickly, the expansion slowed then stopped for all of the injection systems. Analytical models were then developed, following a mass balance approach, to aid in the explanation of this phenomenon. One dimensional, radial, and oblong solutions were obtained for both the extent of a pool and fluxes throughout the continuous LNAPL body. From the proof-of-concept study and the mass balance models it appears that losses do play an integral role in the stability of LNAPL bodies in the subsurface.