

## **NAPL Mobility in Sediments: Categorizing NAPL Migration Potential Using a Multiple Lines of Evidence Approach**

**Thomas Daigle** (tdaigle@geiconsultants.com), J. Michael Hawthorne (mhawthorne@geiconsultants.com), Camille Carter (ccarter@geiconsultants.com), Lisa Reyenga (lreyenga@geiconsultants.com), and Bjorn Bjorkman (bbjorkman@geiconsultants.com) (GEI Consultants, Denver, CO, USA)

**Background/Objectives.** Quantifying NAPL mobility in sediments is critical when evaluating remedial alternatives and remediation engineering design. NAPL mobility in sediments cannot readily be evaluated using methods that are typically effective at upland sites. For example, it is not typically practical to install monitoring wells in sediments and perform transmissivity or recoverability testing that would be conventional for upland sites. Little standardized guidance exists to evaluate NAPL mobility in sediment (currently in development with ASTM) and so programs must be developed on a site-specific basis and negotiated with regulatory agencies with jurisdiction. The objective of this presentation is to introduce a case study of a risk-based, site-specific approach to categorize NAPL as residual (immobile), mobile (present, but lacking sufficient saturation or site conditions for lateral or vertical migration), or potentially migrating (present at saturations high enough that may result in lateral or vertical migration). The case study resulted in a regulatory-approved path to characterize NAPL mobility as part of development of site-specific remedial endpoints, remedial design alternatives, and a potentially expedited path to remedial implementation and site closure.

**Approach/Activities.** The case study presents a regulatory-approved approach that is designed in a logical and progressive step-wise fashion with “off ramps” after each step if the NAPL mobility is defined at that point. Thus, it is not necessary to complete the entire process, but only to conduct sufficient analysis to define the NAPL mobility potential. The process begins with field observations of sediment cores, which are then frozen and submitted for a series of laboratory analyses. The laboratory program is set up to be conservative and answer a series of “if-then” questions presented in a flowchart. The laboratory methods include: core photography, water drive testing, pore fluid saturation analysis, and flexible wall permeameter methods. If NAPL is present in fluid eluted during the final flexible wall permeameter test, then it is determined to be mobile with the potential to migrate, and a site-specific hydrogeologic analysis is performed to determine the conditions under which migration may occur either laterally or vertically. A critical evaluation at this point in the process is the location and direction of migration potential and whether those conditions are sufficient for NAPL to migrate beyond its existing extent both laterally and vertically in sediment.

**Results/Lessons Learned.** If NAPL in sediment is determined to be residual (immobile), then isolation and containment may be appropriate remedial actions. If NAPL is determined to be mobile or migrating, then additional remedial actions may be necessary to eliminate the potential for NAPL to migrate beyond its existing extent. If only horizontal migration potential exists, and all such potentially migrating NAPL samples are located within an overall stable NAPL body footprint, then a migrating NAPL body does not exist and no remedy for migrating NAPL is required.