Expedited Geophysical and Drilling Site Characterization of a Karstic Gasoline Release Site to Develop a Coherent Conceptual Site Model

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Background/Objectives. An underground gasoline pipeline was struck during a 2019 geotechnical drilling operation at a central US airport site, releasing an estimated 14,000 gallons of gasoline. Within two days of the gasoline release, a petroleum sheen was observed in a stream located approximately 925 feet east of the release. Gasoline migrated to the stream via a combination of overland and subsurface flow through a karstic carbonate aquifer. Immediately following the release, spill response measures were completed by others, including recovery of approximately 2,000 gallons of light non-aqueous phase liquid (LNAPL) through interceptor trenches and recovery wells. In 2019 a site characterization was performed by others focusing on the area near the stream. Subsequent litigation actions in part over alleged outstanding environmental remediation liabilities caused a delay to the airport's expansion plans.

Approach/Activities. Ramboll was engaged in 2021 to undertake an expedited three-phase, three-month long Site Investigation to develop a reliable conceptual site model (CSM) that could be used to resolve future outstanding remediation requirements. First, a suite of surface geophysical methods (electromagnetic terrain conductivity surveys, electrical resistivity imaging tomography, and multichannel analysis of surface waves) were employed to identify potential indications of fracturing, faulting, weathering, karst activity and/or other geophysical features indicative of preferential flow pathways. Second, guided by the results of the geophysical findings, a suite of drilling methods (direct push, air rotary, and rock coring) was employed to drill and install 16 soil borings, 14 temporary wells, and one permanent monitoring well. The boring locations were primarily drilled using direct push technology through the overburden and rock coring through the limestone bedrock via a track-mounted Geoprobe 3230DT drill rig. Rock coring provided a greater level of lithologic detail compared to other drilling techniques (i.e., sonic), which accurately identified petroleum-impacted fracture zones, dissolution features (cavities, voids, horizontal/vertical fractures) and water-bearing fracture zones. Lastly, groundwater and surface water samples were collected for off-site laboratory analysis.

Results/Lessons Learned. The expedited geophysical, drilling, and sampling actions generated data, when integrated together, provided for a coherent understanding of site geology, hydrogeology, and contaminant distribution in a karstic carbonate environment and enabled development of a coherent CSM. The geophysical surveys provided valuable insights into where to best site boreholes that intersect preferential flow pathways. The rock coring provided lithological detail regarding the upper unconfined carbonate hydro-stratigraphic unit and lower semi-confined hydro-stratigraphic unit. LNAPL migrated through the upper unconfined carbonate unit along bedding planes, horizontal/vertical fractures, and dissolution openings. Preferential pathways were identified that likely contributed to the rapid containment transport of petroleum hydrocarbons to the nearby stream. At one location, an oil/water interface probe was pulled sideways from water moving through a 0.3-foot void. Finally, LNAPL was not observed anywhere within the subsurface, source area soils were documented to have minimal residual benzene, ethylbenzene, toluene, and xylene (BETX) concentrations, and the July 2021 BETX groundwater concentrations had decreased by an order of magnitude since the April 2019 release. Accordingly, with the effective demonstration of natural flushing and natural source-zone depletion (NSZD), Ramboll was able to demonstrate to the state's satisfaction that

no active remediation was necessary, the outstanding litigation matter was settled, and the airport is proceeding with their expansion plans.