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Title: Supplemental Site Characterization Investigation of a Gasoline Release in a Karstic Carbonate Environment

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Key Topic: Innovative Assessment Methods

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Client Name: Metropolitan Nashville Airport Authority

Project Name: MNAA: Supplemental Site Characterization Investigation

Project Location: Nashville, Tennessee

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ABSTRACT

Background/Objectives:

An underground gasoline pipeline was struck and damaged by others during an April 2019 geotechnical drilling operation at the Berry Field Nashville Airport (BNA), releasing an estimated fourteen thousand gallons of gasoline. Within two days of the gasoline release, a petroleum sheen was observed in the western stream bank of McCrory Creek, the primary receptor for the release was approximately 925 feet away. Gasoline migrated to McCrory Creek via a combination of overland and subsurface flow through a karstic carbonate aquifer. Immediately following the release, spill response measures was completed by others, including the recovery of light non-aqueous phase liquid (LNAPL) through five interceptor trenches and nine recovery wells. By March 2020, less than 2,000 gallons of LNAPL and 120,000 gallons of petroleum-impacted water were recovered. The initial site characterization was limited in scope to the area near McCrory Creek and, consequently, the nature and extent of petroleum-impacts to the entire Area of Interest (AOI), which covered an area of approximately 9 acres near the gasoline release, was not well defined. In conjunction with a follow-on litigation action with allegations of a $5 million plus outstanding environmental remediation liabilities, which was delaying a multi-billion dollar airport expansion project, Metropolitan Nashville Airport Authority (MNAA) engaged Ramboll in 2021 to undertake an expedited two-phase, three-month long Supplemental Site Characterization Investigation to better understand the lateral and vertical extent of contamination and to estimate remaining environmental remediation liabilities.

Approach/Activities:

Ramboll employed a two-phase approach to characterize the entire AOI, with an emphasis on the source area near the gasoline release and potential subsurface migration pathways to McCrory Creek and other potential pathways outside the AOI. Phase 1 of the Supplemental Site Characterization Investigation employed surface geophysical methods to identify potential indications of fracturing, faulting, weathering, karst activity and/or other geophysical indications of conditions within the upper bedrock that could lead to preferential pathways for fluid to flow. Geophysical methods employed included electromagnetic terrain conductivity surveys, electrical resistivity imaging tomography, and multichannel analysis of surface waves. The results from the geophysical data identified unique features that guided Phase 2 field activities, which included the installation of 16 soil borings, 14 temporary wells, and one monitoring well. 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. These detailed lithological observations were essential in the development of the Conceptual Site Model (CSM) along with integrating data from literature reviews, existing reports, and from the Supplemental Site Characterization Investigation findings.

Results/Lessons Learned:

Understanding the geologic and hydrogeologic conditions of the karstic carbonate environment underlying the AOI was essential in the development of the CSM. Initial geophysical surveys provided valuable insights into the lateral and vertical variability in the clay overburden and within the upper portions of the limestone bedrock. Rock coring provided sufficient lithological detail to identify an inferred geologic contact between two limestone formations based on changes in color, texture, abundance of brachiopod fossils, and frequency of natural breaks (i.e., bedding planes and/or fractures). A simplified stratigraphic sequence is presented below (top to bottom): (1) clay overburden, (2) lower member of the Carters Formation is a medium- to thick-bedded with abundant dissolution-enlarged openings, and (3) Lebanon Formation is a thin-bedded with thin shale partings and low dissolution-enlarged openings. The gasoline release migrated through the Carters Fm along bedding planes, horizontal/vertical fractures, and dissolution openings. A few notable preferential pathways were identified that likely contributed to the rapid containment transport of petroleum hydrocarbons to McCrory Creek. For example, at one location, an oil/water interface probe was used to measure the water level shortly after a 0.3-foot void was encountered in the Carters Fm. The lead driller and field geologist could 'feel' the metal probe being pulled, indicating the presence of moving water. Based on the findings from this investigation, LNAPL was not present in the groundwater within the AOI, and only very low residual petroleum constituents were detected in groundwater and surface water. Supplemental Site Characterization Investigation activities demonstrated natural source-zone depletion (NSZD) obviated the need for any further active remediation to be performed prior to BNA expansion projects. Only periodic monitoring of the surface water at McCrory Creek was required until the remaining residual petroleum impacts were mitigated through natural in situ degradation processes.

The Aspect of Work that Relates to Sustainability:

Supplement Site Characterization Investigation and Report successfully demonstration to the satisfaction to the Tennessee Department of Environmental Quality (TDEC) that no active remedial measures or further groundwater monitoring was needed, was key to the successful settlement of the outstanding litigation and eliminated the 2019 gasoline spill as an impediment to a multi-billion dollar airport expansion project.