Immediate Benefits from HRSC Techniques for Three PFAS Investigations

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Background/Objectives. While the environmental market has matured and many of the large groundwater plumes have been brought under control, remediation optimization through HRSC has been required for many recalcitrant sites. Matrix back-diffusion and preferential groundwater flow paths (i.e., 80 percent of the mass transports through 20 percent of the aquifer) that have extended the assumed remediation timeframes and these residual sources and/or contaminant migration pathways are of the scale that have necessitated HRSC to answer the data gaps that previous investigations created or may have missed. With the emerging per- and polyfluoroalkyl substances (PFAS) contaminant class, there are many questions on plume fate/transport due to low attenuation/differential mobility of the PFAS compounds, environmental mediated biotransformation rates, and source strength/leaching potential from soil to groundwater. While the questions will be answered through site/remedial investigation (RI), the lessons learned for HRSC used late in the site life-cycle can also be collected at the onset of the investigations to 1) develop more robust conceptual site models (CSM) for fate/transport analysis and 2) expedite the investigation while reducing overall total site life-cycle costs through optimized remediation planning. This presentation provides three case studies where adaptive investigation phasing utilizing HRSC has been incorporated at active PFAS RI sites across the US with immediate benefits realized by the project stakeholders.

Approach/Activities. HRSC Case Study No. 1 includes the hydraulic profiling tool (HPT) combined with vertical aquifer profiling in the Missouri River floodplain where generally fining upward point bar and braided fluvial deposits, sometimes in paleo bedrock channels are present that can create preferential flow paths. PFAS mass flux assessments were also performed to identify the preferential flow paths toward the river. To refine the locations for the HRSC borings, an Environmental Sequence Stratigraphy (ESS) based CSM was developed and was iteratively refined with the HRSC results. HRSC Case Study No. 2 included HPT/VAP with mass flux assessments in a glacial depositional environment but also included high-density/rapid turn-around time soil sampling in the previously unidentified source areas based on rapid HPT/VAP results. HRSC Case Study No. 3 includes high density soil sampling in identified source areas in alluvial material over basalt bedrock with co-located soil leaching samples via the synthetic precipitation leaching procedure (SPLP) to assess the potential areal mass flux from soil to groundwater considering the soil matrix chemistry/characteristics.

Results/Lessons Learned. HRSC Case Study No. 1, based on an ESS based CSM, identified and validated a preferential flow path for PFAS associated with a filled paleo channel deposit associated with the historic course of the Missouri River that was not previously identified during the previous investigations. Through the use of ESS analysis and HRSC sampling, limited additional permanent delineation monitoring wells were required. HRSC Case Study No. 2 identified new soil sources areas for PFAS through use of rapid turn-around time VAP sampling and stakeholder discussion. These source areas were confirmed by high density and rapid turn around-time soil sampling using fixed based laboratory PFAS “screening”. Additionally, through use of HRSC, the team validated that the groundwater flow was direction is generally approximately 45 degrees different from what was previously depicted in other environmental investigations using a combination of ground surface elevations from digital elevation models and water table occurrence in the HPT logs. This saved the project team time and resources associated with installing groundwater monitoring wells for groundwater flow direction

determination. The soil data associated with HRSC Case Study No. 3 has been collected and will be processed by March 2023 to assess the areal mass flux to groundwater from likely five source areas. The anticipated benefits from HRSC from these projects include reducing RI timeframes by over 50% and reducing permanent monitoring wells by over 60%.