OXIDATIVE TRANSFORMATION AND MIGRATION OF PFAS PRECURSORS AT A FORMER FIRE PROTECTION TRAINING SITE, ALASKA

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Background/Objectives:

Parsons conducted a remedial investigation at a former Fire Protection Training Area at a site in the interior of Alaska adjacent to the Yukon River. Fire training exercises, including use of aqueous film-forming foam (AFFF), were conducted from the 1950s until 1991. The data suggested ongoing discharge of shorter chain perfluoroalkyl carboxylic and sulfonic acids to groundwater by oxidation of PFAS precursors in soil. This presentation outlines the analyses and evaluations performed to reach that conclusion.

Hydrologic conditions at the site include a very transmissive sand and gravel aquifer, with the water table controlled by water levels in the Yukon River. The water table drops about 8 meters over the course of most of the year (summer through winter) and rises quickly for a few weeks during spring runoff in conjunction with the Yukon River. This has the effect of making contaminant plumes "dive" over time and distance from the source. A second topographic and hydrologic feature is that the site is situated in a local topographic low point. This causes water to pond around the former fire protection training area during snow melt in the spring, to eventually infiltrate once the ground thaws.

Approach/Activities:

Remedial investigation sampling included groundwater samples from nested monitoring wells (14 wells in the spring and 18 wells in the fall), 20 surface soil samples, and 57 subsurface soil samples from 10 boreholes. All media were analyzed for 25 PFAS using QSM 5.3 Table B-15. Total oxidizable precursor (TOP) analysis was also performed on two surface soil, two subsurface soil, and two groundwater samples. Additional samples from all media were collected and analyzed using EPA Method 1633. Results were evaluated using a variety of graphing and analytical techniques including spatial moment analysis to develop a conceptual site model.

Results/Lessons Learned:

Our evaluation resulted in the following conceptual model incorporating precursor oxidation and migration:

- PFAS in surface soil is widespread, but PFAS in vadose zone soils is limited to the area of the topographic low where water ponds in the spring, indicating a migration pathway from surface soil to groundwater.
- TOP analysis shows oxidizable precursors are present in surface soil and subsurface soil (concentrations gradually reducing with depth). While some precursors (e.g., FOSA) were identified by chemical analysis, TOP analysis indicates that 78 to 98 percent of precursors in the samples were not identified.
- Shorter-chain PFAS (e.g., PFHxA) are present in the upgradient well cluster, which is located within the topographic low where water ponds in the spring. PFAS normally associated with AFFF (e.g., PFOS) are also present but at much lower concentrations.
- Spatial moment analysis shows the center of plume mass for shorter chain PFAS are all located at a similar distance and depth from the former fire protection training area. The center of mass for longer-chain PFAS associated with AFFF (e.g., PFOS) are located further from the source and deeper in the aquifer despite having a higher retardation factor than the shorter-chain PFAS. This suggests that the PFOS is the direct result of the historical AFFF use and the shorter-chain PFAS are the result of more recent and probably ongoing release resulting from precursor oxidation.

Evaluation suggests an ongoing discharge of shorter-chain PFAS to groundwater, consistent with

oxidation of precursor compounds in surface soil and transport to groundwater by infiltration from annual ponding events. Addressing these PFAS precursors in soil will be an important component to eliminating PFAS contamination in groundwater.

About The Author

Dr. Edward Heyse PE is an environmental engineer with over 40 years experience supporting environmental remediation efforts. He served on active duty as a bioenvironmental engineer in the US Air Force, and since 2003 works for Parsons supporting projects for government and commercial clients. He develops conceptual site models and optimizes remedial systems/approaches. He is a licensed professional engineer in Florida, Alabama and Colorado and is a Parsons Fellow Emeritus.