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Remediation of Poly- and Per-fluoroalkyl Substances: Developing Remediation Technologies for Emerging Challenges

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Background/Objectives. Poly- and per-fluoroalkyl substances (PFAS) comprise a diverse class of contaminants, which include a range of perfluoroalkyl acids (PFAAs) with varying perfluoroalkyl chain lengths: most notably PFOS (perfluorooctane sulfonate) and PFOA (perfluorooctanoic acid). The PFAAs are the “dead end” daughter products resulting from biotransformation of thousands of polyfluorinated precursor compounds, which are present in many commercial products such as class B firefighting foams.

These precursors to PFAAs further complicate the remediation challenges as they are not quantified using standard analytical laboratory methods (US EPA method 537), and the mass of PFAS can be underestimated using conventional analysis. Further, aerobically facilitated biotransformation of the precursors to PFAAs creates an ongoing source of PFAAs. As some precursors are cationic (or cation dominated zwitterions) they are less mobile in aquifer systems, so have the potential to remain in the source area, but precursors will eventually biotransform over time forming PFAAs as daughter products, which seem likely to remain in the ecosystem for thousands of years to come.

Approach/Activities. Innovative and emerging remediation solutions for PFAS include a number of types of technologies to address highly concentrated source zones, mitigate mass flux of impacts to aquifers, or address PFAS in extracted water. The use of granular activated carbon (GAC) will effectively remove a portion of PFAS from groundwater; however, the low binding capacity for PFOS (as compared to hydrocarbons) and the low effective removal of shorter chain PFAAs, render GAC a temporary solution to a perpetual problem. Challenges of more comprehensive PFAS treatment in water are currently addressed using technologies such as reverse osmosis or nano-filtration, but new sorbent media are being developed to remove both long and short chain PFAS. There are new precipitation technologies, sonolytic reactors, foam fractionation technologies, and ion exchange media developed for water treatment. For soils, some sorptive materials to stabilize PFAS are available with others being optimized.

Results/Lessons Learned. The principles underlying the mechanisms by which multiple technologies act will be summarized with comment on where they could be applied or combined to effectively manage PFAS impacted aquifers. Arcadis will present data on easily regenerable sorbent media showing initial promise at removing both long and short chain PFAS including PFBA (perfluorobutanoic acid). Initial data on PFAS removal using ozofractionation and sonolysis will be reviewed. Preliminary results from oxidative approaches to attack PFAAs will be described. For soil treatment, the use of multiple sorbent material to stabilize PFAS will be presented. The presentation will also discuss case studies showing the effective remediation of multiple PFAS impacted site in Europe.