

Assessment of PFAS in Soil and Groundwater: New Analytical Technologies for Comprehensive Analysis of PFAS Including Precursors

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Background/Objectives. Poly- and perfluoroalkyl substances (PFAS), including perfluorooctane sulfonate (PFOS) and perfluorooctanoate (PFOA) are commonly elevated in soil and groundwater associated with the use of aqueous film-forming foams (AFFFs). Polyfluorinated compounds, in addition to many other perfluorinated compounds (collectively termed precursors), are biotransformed in the environment to form simpler perfluorinated carboxylates and sulphonates (such as PFOS and PFOA), which are persistent in the environment as they are not susceptible to further biodegradation.

So in addition to PFOS and PFOA there are numerous other “precursor” compounds in AFFF which present an ongoing source of PFOS and PFOA and other perfluorinated sulphonates and carboxylates. PFAS contaminated source zones are often associated with large plumes as the majority of PFAS are anionic and are not retarded significantly in aquifers, however some precursors are cationic and so will bind to soils via ion exchange mechanisms, producing a lesser mobile source mass.

The precursors are not accounted for by the U.S. EPA analytical method 537 (LC-MS/MS). Additional analytical challenges are associated with the required low reporting limits/detection limits to be consistent with The U.S. EPA’s drinking water provisional health advisory of 0.2 µg/L and 0.4 µg/L for PFOS and PFOA, respectively.

This presentation will describe new analytical methods developed to quantify the total concentration of precursors and PFAS in water and soil samples.

Approach/Activities. ARCADIS have implemented the use of multiple analytical methods to quantify the total mass of precursors and qualitatively assess the nature of individual precursors. The new methodologies employed include (1) the total oxidizable precursor (TOP) method (Houtz et al., 2013), (2) particle induced gamma emission (PIGE) spectroscopy and (3) adsorbed organic fluorine (AOF) using combustion ion chromatography, which are all appropriate for use at field sites. The conventional analytical methodology (US EPA method 537) was used for comparison, with further detailed assessment of identical samples being done using LC Q-TOF-MS (time of flight mass spectrometry) which can elucidate the empirical formulae of the precursors present in AFFF present in the soil and groundwater.

Results/Lessons Learned. Soil and groundwater from PFAS contaminated sites as well as soil spiked with characterized AFFF were analyzed by both the conventional, new and detailed analytical methods. The results demonstrate that PFOA and PFOS only account for only a small portion of the PFAS present in some impacted soil and groundwater. This next generation of new PFAS analytical techniques will generate more comprehensive analytical data that will support more robust conceptual site models and improve our understanding of PFAS fate and transport. Accounting for precursors is going to be key for the successful design of remedial systems