

Transformation of PFAS Precursors at an Australian Air Force Base: An Ongoing or Artifact Process?

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Background/Objectives. Knowledge regarding the complexity and mechanisms of fate and transport of per- and poly-fluoroalkyl substances (PFAS) in the environment is evolving rapidly. In many instances there is negligible correlation between the findings of published literature, including generic conceptual site models, and 'real world' conditions. This uncertainty is further confounded by theories that the presence and transformation of PFAS precursors into per-fluoroalkyl acids (PFAAs) can complicate the predictions of PFAS migration through the environment. Understanding the fate and transport of PFAS and which factors affect subsurface mobility is critical. To bridge the gap in understanding, an empirical spatial study has been conducted at an Australian Air Force Base (Study Area) to assess the mobility of precursors in the source area and how aerobic conditions at and near a water retention dam may induce the transformation of PFAS precursors, resulting in elevated concentrations of PFAS down gradient of the primary source. This study also evaluates the usefulness of total oxidizable precursor assay (TOPA) on understanding the precursor behaviors.

Approach/Activities. The study area forms part of a larger investigation area (50 km²) across the entire Base and coastal neighboring land. The study area is located on highly permeable sandy soils; a shallow groundwater table with complex migration pathways; dynamic interaction between rainfall, surface water and groundwater; and runoff draining through extensively modified networks to two separate marine environments, containing wetlands and commercial fishing. Off-Base the surface water and groundwater are extensively used for residential and agricultural purposes. Soil, groundwater, surface water and sediment were collected in winter from a north/south transect (direction of groundwater flow) and were analyzed for 28 to 31 different PFAS using a high resolution quadrupole time of flight mass spectrometry (Q-TOF / MS) and liquid chromatography (LC – MS/MS). The same samples were tested using the total oxidizable PFAS (TOP) assay; cations / anions; total organic carbon (TOC); and dissolved organic carbon (DOC). Geochemical parameters including pH, temperature, oxidation-reduction potential, dissolved oxygen and conductivity, were measured for groundwater and surface water. In addition, bench scale column trials have been commenced to further understand transformation factors and whether transformation is an ongoing or artifact process.

Results/Lessons Learned. Results to date have indicated that:

- 27 different PFAS including six PFAS precursors/intermediates were identified in soil in the source area, 19 different PFAS were identified in the groundwater, 10 in the sediment and 12 different PFAS in the surface water.
- After TOPA, perfluoroalkyl carboxylic acids (PFCAs) concentrations in the soil and sediment at the primary source area significantly increased. The PFCA concentration delta before and after TOPA suggest the abundance of PFAS precursors that are not analysable before TOPA. However, the study found very little to no oxidisable precursor mass in groundwater and surface water, suggesting that the precursors are relatively immobile in the soil and sediment of source area. Correlations between geochemical parameters and potential PFAS precursor transformation will be made and the significance between surface water and groundwater interactions will also be discussed.