Fate and Transport of PFAS in a Multi-Stage Groundwater Treatment Plant

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Background/Objectives. Groundwater, surface water and sediment investigations on the Botany Industrial Park (BIP) in Sydney, Australia, in 2016 identified areas on the site that are contaminated with per- and poly-fluoroalkyl substances (PFAS). Investigation of historical operations on the chemical manufacturing site found that the main cause of the PFAS contamination at BIP was firefighting training. During training aqueous film-forming foams (AFFF) – firefighting foam – was sprayed onto the ground. Some of the material soaked into the ground. Since 2004 PFAS-free foams have been used for training (but are not suitable for fighting hydrocarbon fires).

In 2006 a large groundwater pump and treat system was commissioned on the site, primarily to manage groundwater contamination associated with around sixty years of chlorinated solvents manufacturing and storage. Testing in 2016 confirmed that PFAS-contaminated groundwater was being extracted and processed in the groundwater treatment plant (GTP).

Approach/Activities. The pump and treat system comprises three lines of extraction wells, one on and two hydraulically downgradient of the BIP. The GTP consists of several stages of treatment, including air stripping, thermal oxidation and combustion gas quenching and scrubbing, iron removal, activated carbon and biological aerated filter treatment, and multiple stages of filtration including reverse osmosis, to remove almost all man-made and naturally-occurring substances in the extracted groundwater. The resultant high purity treated water is sold to nearby chemical manufacturing plants for use in various process applications. The plant treats around 1.1 to 1.6 million US gallons of groundwater per day.

Initial testing focused on the water in three influent streams to the GTP: the treated water, and two waste water streams discharged to a municipal sewer. A simple mass balance demonstrated that none of the PFAS ended up in the treated water; approximately half was discharged to sewer, and the remaining half was otherwise held up or removed in the unit processes in the GTP. Additional testing has also shown that almost no PFAS are carried into the thermal oxidizer, and none passes through it.

Several solid waste streams from the plant, including residues from biological fouling in the air strippers, sediments in tanks and spent activated carbon, have also been tested for PFAS, with varied results. Most accumulation in the plant seems to be due to settling of sludges.

Results/Lessons Learned. Insights have been gained regarding which unit processes tend to remove certain PFAS from the groundwater. Only small mass losses are observed in most of the aqueous treatment train, with the exception of the final reverse osmosis units that reject 100% of their influent PFAS to sewer. The added data have enabled a review of health and safety management for the plant operators, and characterisation and disposal of the solid wastes.