A Pilot-Scale GAC Filtration Study to Assess Breakthroughs of PFAAs and Precursors

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Background/Objectives. Granular activated carbon (GAC) treatment for per- and polyfluoroalkyl substances (PFAS), including perfluorooctanoic acid (PFOA) and perfluorooctane sulfonate (PFOS), impacted water is currently a presumptive remedy in the United States. However, recent studies suggest GAC may not be effective for short chain PFAS and precursors, which can result in some PFAS discharging back into the environment. The Air Force Civil Engineer Center (AFCEC) Broad Agency Announcement (BAA) program funded a pilot-scale field demonstration project to monitor and assess breakthrough of 11 perfluoroalkyl acids (PFAAs) and 43 precursors. Additionally, Total Oxidizable Precursors (TOP) assay was used to estimate the removal of some missing precursors (i.e., precursors that are non-identifiable and non-analyzable using standard LC/MS/MS procedures). Findings provided site remediation managers with justification for frequent GAC changeouts, and design considerations for GAC filtration and alternative remediation systems (i.e., remediation systems need to address PFAS, rather than solely PFOS and PFOA).

Approach/Activities. Since 2015, a full-scale GAC filtration system has been operated at Wurtsmith Air Force Base (WAFB) to treat PFAS-impacted groundwater extracted from a former fire training area. WAFB was selected as the BAA pilot demonstration site because the groundwater quality has been well characterized and the full-scale system has experienced more frequent GAC changeouts than expected. The pilot treatment system was an exact scale-down version of the full-scale system. One lead vessel and one lag vessel were connected sequentially and received the split groundwater flow that fed into the full-scale GAC system. The pilot study was conducted from November 2016 through August 2017 without changeout of GAC vessels allowing a long-term monitoring of PFAS breakthroughs. Water samples were collected from four sampling ports on a weekly basis for the analysis of 54 PFAS. Selected samples were also analyzed for TOP assay.

Results/Lessons Learned. Eighteen out of 54 PFAS were frequently detected. The total PFAS concentrations in the influent ranged from 20 to 25 nM and 30 to 40 nM before and after the TOP assay, respectively. During the TOP assay process, significant amount of precursors were oxidized and transformed into perfluoroalkyl carboxylates (particularly perfluorohexanoic acid [PFHxA]). PFHxA increased approximately 10-15 nM after TOP assay. For the samples collected from the lead vessel, short chain perfluoroalkyl acids (PFAAs) breakthrough faster than long chain, perfluoroalkyl carboxylates breakthrough faster than sulfonates. Among the detectable precursors, 6:2-Fluortelomersulfonate (6:2-FTS) broke through first while perfluorooctane sulfonamide (FOSA) showed very minimum breakthrough after 10 months of GAC operation. The pilot study demonstrates the need of high resolution characterization of PFAS in the influent. The current analytical method cannot fully identify or quantify PFAA precursors in the influent; however, TOP assay provides indirect information about the presence of other precursors. And these precursors can be as high as 30% based on the site specific data. This is the first field study that comprehensively assesses the breakthroughs of a wide range of PFAS from a GAC treatment system.