Project Abstract

Poly- and perfluoroalkyl substances (PFAS) are persistent and bioaccumulative, and there is mounting evidence for the human toxicity of many of these compounds. The US EPA has issued a drinking water health advisory level for two long-chain PFAS, perfluorooctanoic acid (C8) and perfluorooctane sulfonate (PFOS), at a sum concentration of 70 ng/L. In June of 2018, the Agency for Toxic Substances and Disease Control issued minimal risk levels for public comment, and the corresponding drinking water equivalent levels for PFOA and PFOS would be 11 and 7 ng/L, respectively. Due to regulatory focus on long-chain PFAS, manufacturers have switched to the production and use of short-chain PFAS and fluorinated alternatives, such as perfluoroalkyl ether acids (PFEA). Despite growing regulatory, scientific and public attention, there are still critical knowledge gaps about the selection of treatment approaches for short-chain PFAS, PFEA, and other emerging PFAS. Therefore, the **overarching goal** of the proposed research is to develop a **guidance manual** that allows water treatment professionals to select the most **cost-effective and sustainable treatment options for short-chain PFAS removal**. This guidance manual will take into account the effects of background water matrices and the uncertainties regarding scale-up from bench-scale performance data to field-scale design.

This project will systematically investigate short-chain PFAS removal by readily implementable treatment processes—and to a more limited extent, innovative techniques—in a wide range of background water matrices (groundwater, surface water, treated wastewater) at multiple scales (bench, pilot, full). Specific objectives are to advance the state-of-the-art of short-chain PFAS removal by (1) evaluating conventional and innovative sorbents, (2) identifying essential membrane properties, (3) assessing the impact of background water matrix parameters, (4) comparing pre-treatment options to enhance downstream adsorption, (5) developing scale-up protocols to estimate full-scale sorbent use rates, (6) generating data for residuals management (e.g., treatment of spent ion exchange regenerant by electrochemical oxidation), (7) modeling quantitative structure-property relationships to predict removal by adsorption, anion exchange, and membrane processes, and (8) applying this information towards life-cycle cost and environmental impact models. These models are being developed in a separate, recently funded research project (Department of Defense, ESTCP) that will be conducted by co-PIs Knappe and Bellona.

To address these objectives, we have assembled a diverse team of researchers, engineers and utility representatives with a wealth of research and practical experience related to PFAS treatment. We have support from approximately forty PFAS-impacted utilities as well as sizeable additional cash support from the North Carolina Policy Collaboratory and the Hampton Roads Sanitation District. We will use full-scale sampling campaigns, pilot-scale studies, and lab-scale experimentation to develop information for the guidance manual. We envision a decision support tool that will help water professionals select (1) effective treatment options for short-chain PFAS removal in their unique water matrix and (2) appropriate bench-scale tests to compare sorbents, resins, or membranes. Project outcomes will also include recommendations for the quantitative analysis of short-chain PFAS, including emerging PFEA. Project deliverables will include a concise and accessibly written guidance document for the drinking water community as well as a detailed final report. Results will also be disseminated through presentations at national and regional conferences, AWWA/TWRF webinars, and peer-reviewed publications.