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Aqueous Film-Forming Foam (AFFF) Effects on Microbial Function Explained in Terms of Perfluoroalkyl Substance (PFAS) Constituents

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Background/Objectives. Perfluoroalkyl substances (PFAS) are strictly manmade compounds found in a multitude of environmental systems as a result of use in many industrial and consumer products. Aqueous film-forming foams (AFFFs) contain high concentrations of PFAS mixtures. Areas contaminated with AFFF, such as firefighting training areas can contain elevated concentrations of PFAS as well as other pollutants, called cocontaminants. While biologic effects of single PFAS have been studied, the effects of PFAS mixtures and PFAS cocontaminant mixtures are unknown. Moreover, the effect of PFAS on microorganisms is not well known; nevertheless, we rely on microorganisms in locations containing elevated PFAS concentrations to perform certain functions such as waste and contaminant degradation. A few studies have shown evidence of altered permeability in biological membranes upon exposure to PFAS. Modified membrane permeability in microorganisms could increase their susceptibility to cocontaminants and affect their ability to function. The goal of this study is to examine the effect of PFAS and AFFF on microbial community function. Communities will be exposed to AFFF as well as PFAS combinations to decipher active ingredients in AFFF.

Approach/Activities. The effects of PFAS on microorganisms were studied at the laboratory scale. The study focused on the consequences of AFFF and PFAS exposure in a microbial community. AFFF as well as different PFAS were tested to determine the active ingredients in AFFF as well as the roles that the number of carbon atoms and functional group serve. To study this, wastewater anaerobic digester communities were exposed to PFAS and a cocontaminant (2,4-dichlorophenol) and then methane production and cocontaminant degradation were measured. The effect of the sorption of the cocontaminant, 2,4-dichlorophenol, was examined as well.

Results/Lessons Learned. Preliminary results show that PFAS and AFFF can alter toxicity and inhibit degradation of 2,4-dichlorophenol. Additionally, it was determined that PFOS is the dominant ingredient in AFFF when looking at the toxicity effect of 2,4-dichlorophenol, however, no PFAS accurately modeled cocontaminant degradation inhibition. Results also show that only PFOS changed the toxicity of 2,4-dichlorophenol, however, this is dependent on PFOS toxicity. Multiple PFAS were shown to inhibit the degradation of 2,4-dichlorophenol. The ability of the PFAS to inhibit degradation was dependent on PFAS properties (i.e., carbon number and functional group). PFAS were also shown to change sorption of 2,4-dichlorophenol to sludge.