Determining the PFAS contribution of residents to municipal wastewater – Final Report[1]

Water UCI

EXECUTIVE SUMMARY

Per- and polyfluoroalkyl substances (PFAS) are widely-used synthetic chemicals having a variety of industrial, commercial and consumer/household uses. They constitute a class of contaminants posing risks to human health due to their persistence, toxicity, and bioaccumulation. The U.S. Environmental Protection Agency (EPA) has determined that PFAS may cause decreased fertility or increased high blood pressure in pregnant women; and affect the development of children, causing low birth weight, bone variations, accelerated puberty, or behavioral changes. Responding to PFAS contaminants detected in water and wastewater systems, state and federal agencies have taken steps to protect humans from these harmful effects including establishing Maximum Contaminant Levels (MCLs) recently set by EPA for PFAS in drinking water.

The goal of this study was to illuminate household contributions to PFAS and to prescribe a methodology for future investigations. While industrial contributions to PFAS are significant, household residences also contribute PFAS to municipal wastewater systems. We investigated the contributions of household residences to PFAS loading in three residential sub-sewersheds located in three Orange County, California cities of varying size and demographic composition. Sampling was performed over 7 consecutive days. A detailed analysis of individual greywater and blackwater samples obtained from 40 households was also undertaken to identify the primary sources of residential wastewater PFAS (see Figure 1).

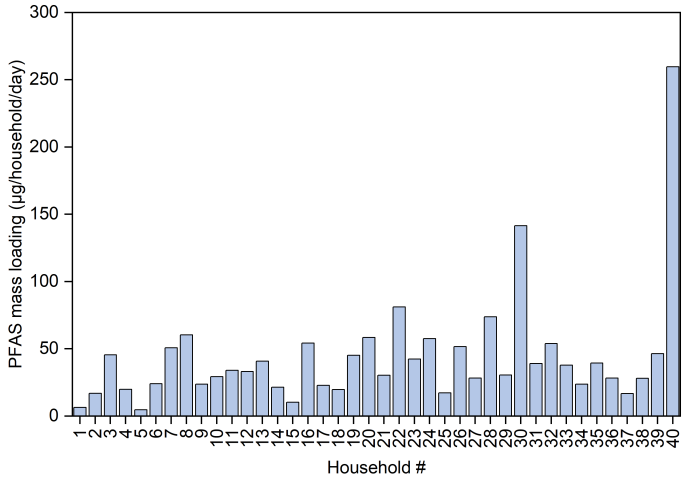

Figure 1. PFAS mass loading per household in µg/household/day

[1]Adeyemi S. Adeleye, Ziwei Han, Omobayo A. Salawu, and Naomi Senehi. 2024. Determining the PFAS contribution of residents to municipal wastewater FINAL REPORT, July

Employing EPA-approved analytical methods, the study found quantities of different PFAS commonly present in consumer products. Among them, perfluorooctanoic acid (PFOA), perfluorooctanesulfonic acid (PFOS), perfluorohexanoic acid (PFHxA), and perfluorohexanesulfonic acid (PFHxS) were consistently observed throughout the sampling period in all three sub-watersheds at levels that can be quantified with accuracy and precision. The total PFAS detected daily over the sampling period ranged from 10.43 to 49.14 ppt, while the range of PFAS mass loading into wastewater across the 40 households was 4.6 – 258.8 µg/household/day.

The top three household activities contributing to PFAS mass loading were laundries (28.3%), showers (23.2%), and urine (23.2%). Among the six PFAS regulated by the EPA in drinking water, PFOA (mainly from urine and laundries) was the contaminant released in largest quantity to sub-sewersheds by households (see Figure 2).

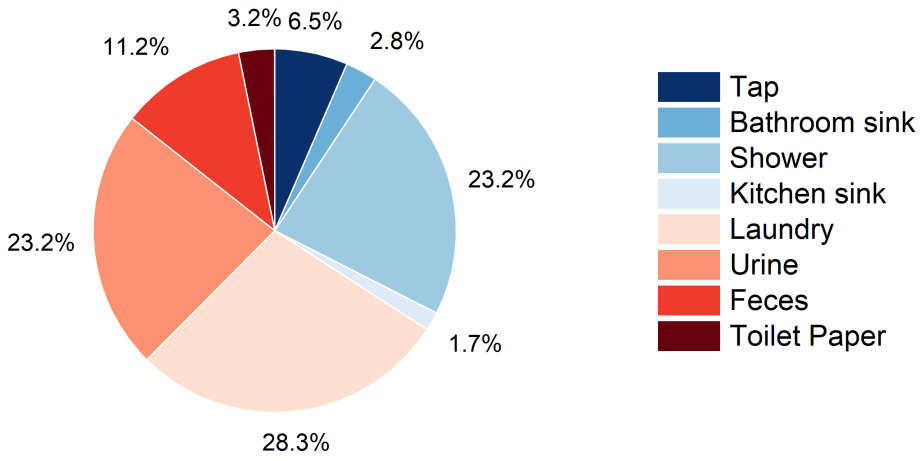

Figure 2. A summary of the mass contributions of different household activities/wastes to the PFAS in residential wastewater

* The plot is based on integrating wastewater and toilet paper data obtained from 40 households.

We offer three conclusions based on our research. These are: (1) eliminating PFAS in industrial discharges will not completely remove PFAS from municipal wastewater. Methods to eliminate the PFAS content of consumer products must be adopted in order to eliminate PFAS from municipal wastewater; (2) portable devices that remove PFAS from wastewater (e.g., via adsorption) can decrease PFAS in wastewater discharge from residences, particularly if they target laundry and shower wastewater, which account for 52% of all the PFAS in residential wastewater; and (3) future studies should focus on PFAS precursors in residential wastewater, abundant in consumer products, that were not targeted in this study.

The study is significant for three reasons. First, the presence of PFAS in wastewater and sludge/biosolids is a challenge for municipal systems that employ wastewater reuse methods. Future regulations will likely limit PFAS in treated wastewater, requiring wastewater treatment plants (WWTPs) to take action to lower PFAS concentrations.

Second, while previous studies have revealed the presence of PFAS in several household products, including cosmetics and cleaning products, determining the composition and concentrations of PFAS that will ultimately end up in household wastewater is challenging due to limited knowledge of all household PFAS sources, a lack of standardized methods for investigating PFAS in household products, and wide variation in product use.

Lastly, while investigating PFAS contribution by industry is relatively straightforward, as wastewater samples can be collected from their effluent points and analyzed, a similar analysis is far more difficult for household residential dischargers. In addition, WWTPs rarely have the regulatory authority to limit PFAS loading in household wastewater. As a result, PFAS in residential wastewater will continue to contribute a baseline in influent to WWTPs having domestic dischargers. Future research is needed to evaluate the ability of WWTPs to meet future PFAS regulations and address the impact of wastewater PFAS on water reuse. In addition to enhanced tracking of all PFAS sources— industrial, commercial, and residential, it is essential to determine households' PFAS contribution and how it varies according to socioeconomic status (see Figure 3).

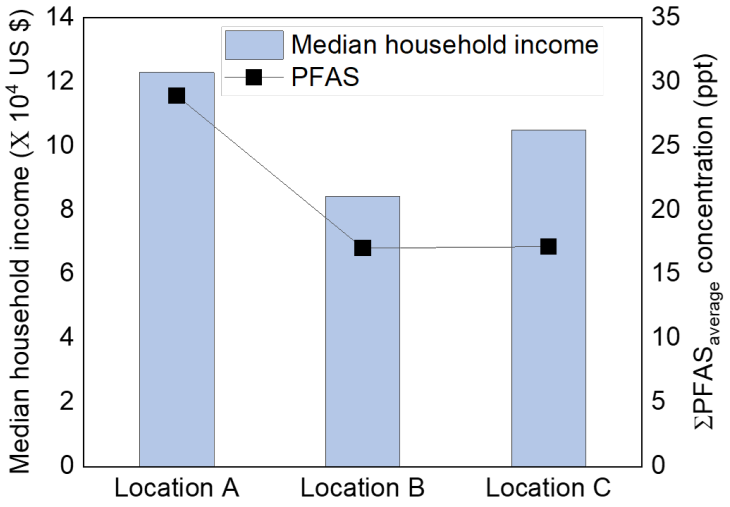

Figure 3. Median household income and average total PFAS concentration for Locations A, B, and C