

Upstream of POTWs: PFAS Composition and Loads from Neighborhood Sewersheds

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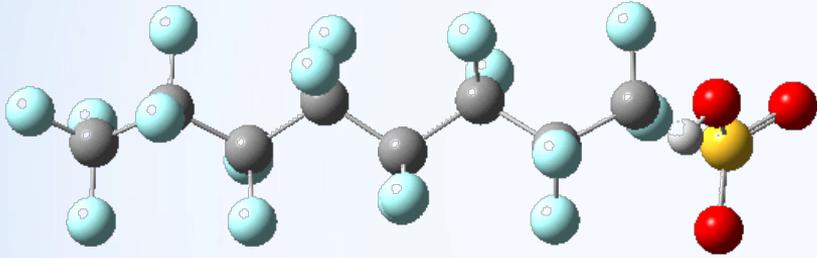
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Per- and Polyfluoroalkyl Substances (PFAS)



Food packaging & paints

Chemistry: Large family of synthetic fluorinated chemicals (C-F bond) >14,000



Nonstick cookware

Fluorine electronegativity (3.98)



Stain resistant furniture



Cosmetics

Strong C-F bond (Bond energy 485 kJ·mol⁻¹)



Firefighting foam

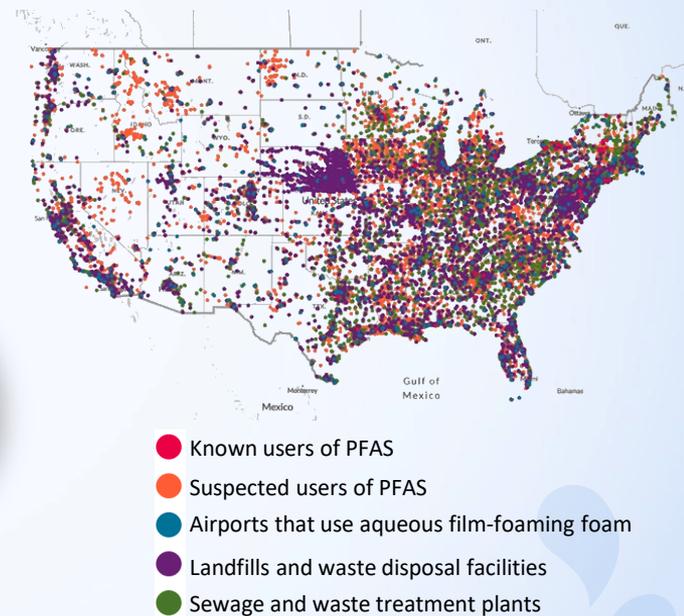
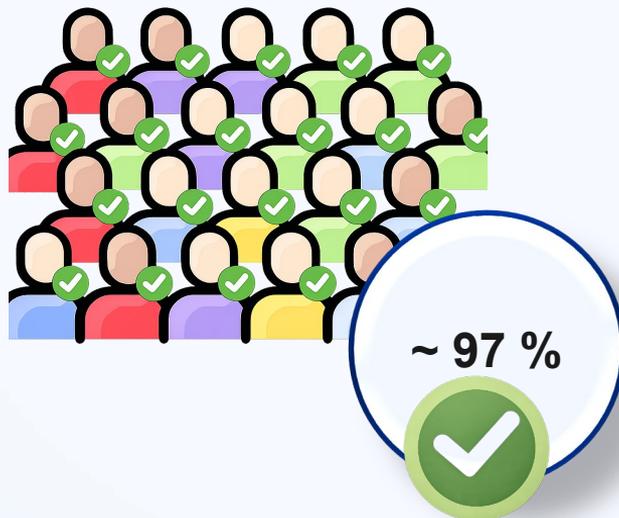
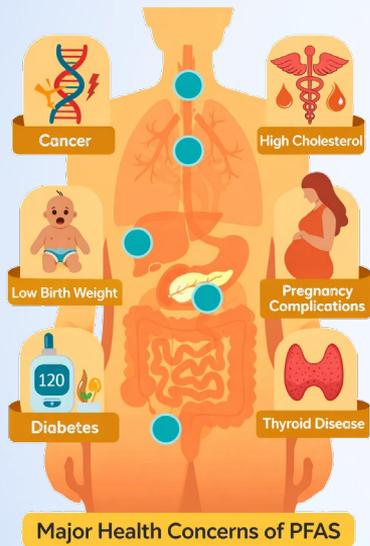


Concerns: Persistence, ubiquity, toxicity, and bioaccumulative



Use: Industrial and consumer products

PFAS – Why they are a concern



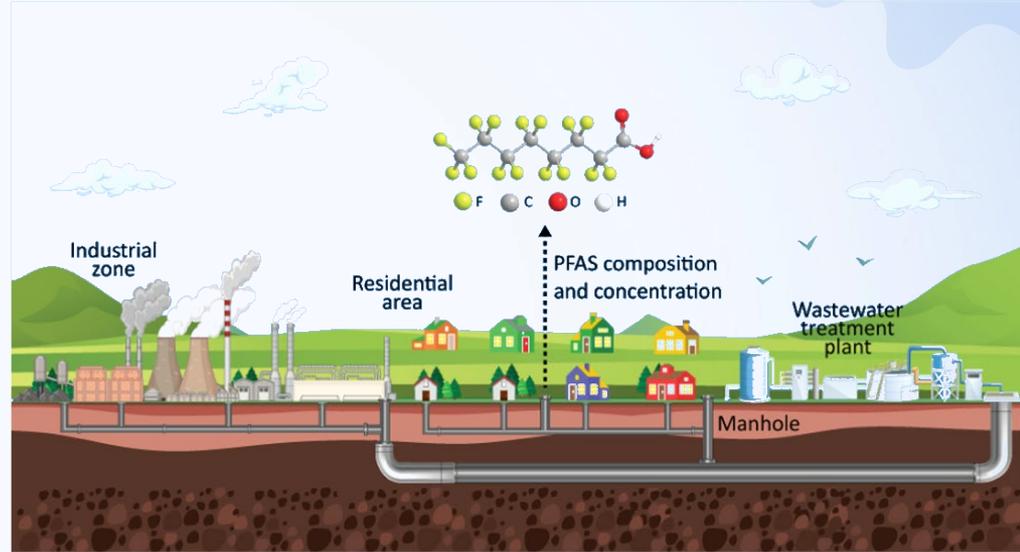
Why POTWs Should Care

- “Receivers” of these persistent “forever chemicals”
- As the EPA and state agencies accelerate regulations, POTWs face significant legal, financial, and operational risks.
- PFAS has been detected in wastewater samples
- PFAS are challenging to treat



Study Objectives

- Determine the temporal variation of PFAS contribution from households
- Quantify neighborhood PFAS concentrations and per-capita loads.
- Compare household wastewater vs local tap water.
- Identify composition patterns and drivers (incl. socioeconomic signal).



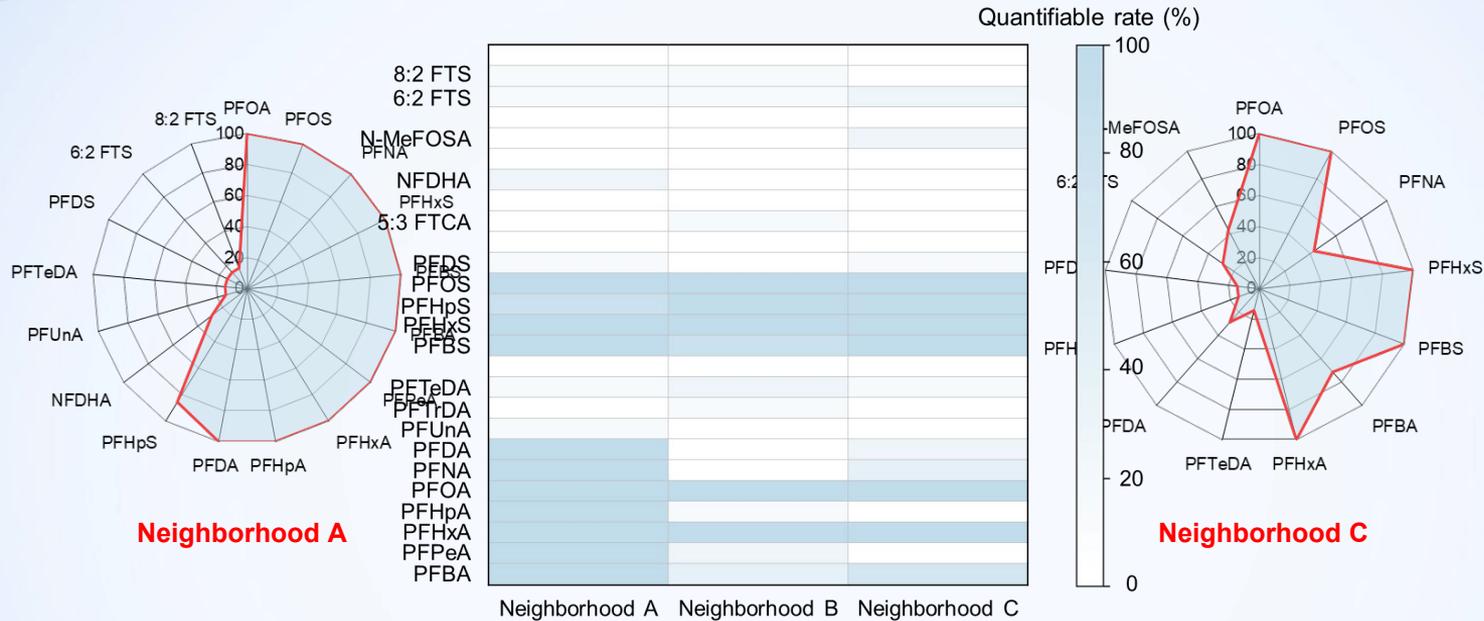
Quantifies the residential baseline upstream of plants to inform pretreatment and compliance planning

• Study design & sampling

- Composite raw wastewater samples were collected daily for 7 days per site
 - 66 grab samples (150 mL each) over 24 h
- 500 mL of sample was collected for PFAS analysis in LC-MS/MS
- Extraction and analysis done according to EPA 1633 method



ΣPFAS Across Neighborhoods (7-day composites)

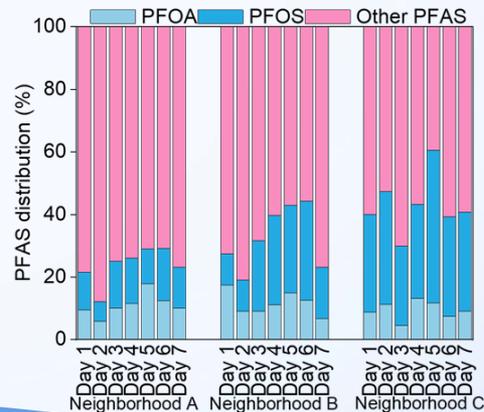


- Quantifiable frequency: PFHxA, PFOA, PFHxS, PFOS in 100% of samples;
- Confirms a persistent residential baseline

$$\text{Quantifiable frequency} = \frac{\text{Number of days analyte} > \text{LOQ}}{7} \times 100\%$$

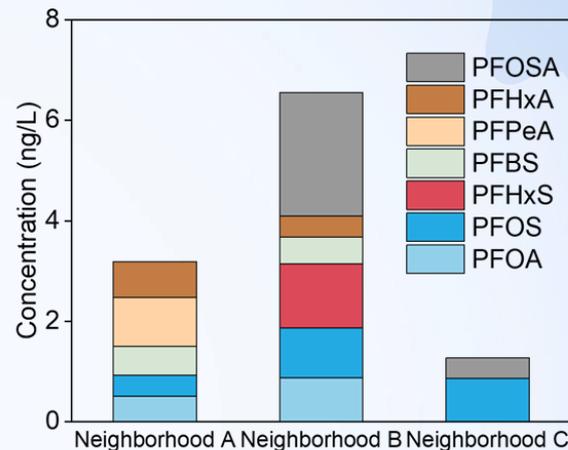
PFAS Composition: the 100% hitters

- Short-chain species drive the baseline
- Range: **10.4 – 49.1 ng/L**
- Between-site differences; occasional daily spikes
- **Composition similar**; magnitude differs (legacy PFOS/PFOA still material)
- **PFOS + PFOA = 12 – 61% of Σ PFAS**

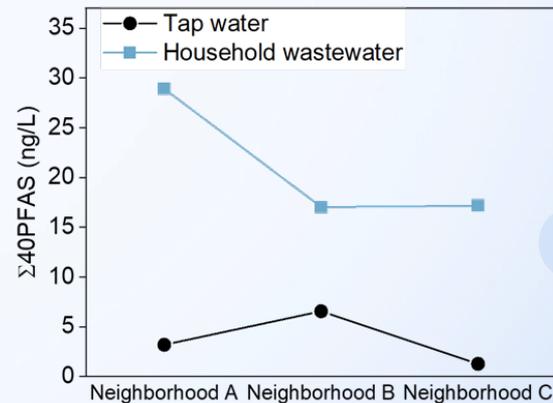


PFAS in tap water vs. household wastewater

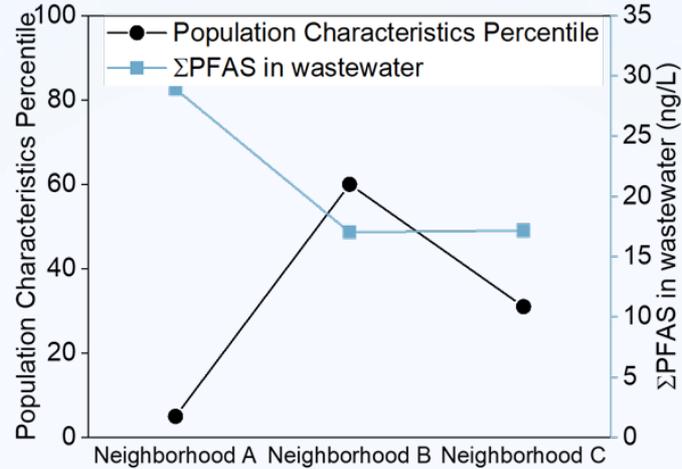
- **1.6 – 8.1×** higher in household wastewater vs tap
- PFAS concentration 0.4 – 2.5 ng/L (12 – 63 %)
- Same analyte list & reporting limits
- Confirms **household introduction upstream**



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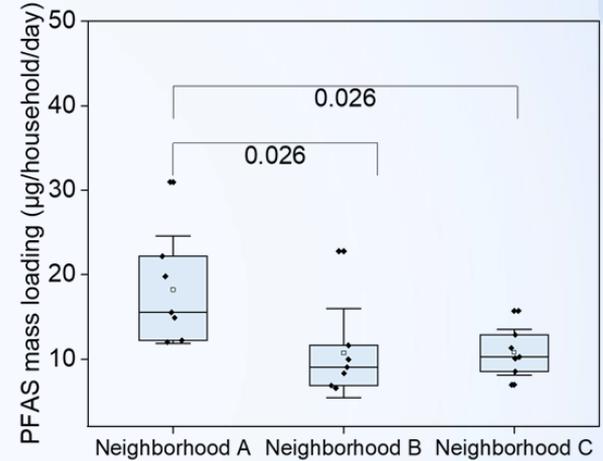
Residential wastewater PFAS and socio-economic status



- **Higher-income areas → higher per-capita PFAS loads**
- Likely drivers: **consumer product usage & purchasing patterns**
- **Caveats:** limited N; potential confounders (household size, water use)

Residential Load to POTWs

- **6.6 – 31 $\mu\text{g}/\text{household}/\text{day}$**
- **2.3–10.7 $\mu\text{g}/\text{person}/\text{day}$** (2.89 persons per household)
- Legacy PFOS/PFOA remain material
- Sets a **baseline** relevant to compliance & reuse



Summary

- Residential “baseline” PFAS enters sewers regardless of industrial inputs.
- Detected in 100% of samples for key PFAS (PFHxA, PFHxS, PFOA, PFOS).
- Levels exceed tap water ($\approx 1.6\text{--}8.1\times$), impacting influent quality.
- Legacy PFOS/PFOA still a large fraction \rightarrow compliance risk.
- Implications for meeting PFAS-specific limits and water reuse programs.
- Upstream data informs pretreatment, source control, and outreach.

Interpretation for pretreatment

- **Non-zero residential baseline** enters plants regardless of industrial users.
- Mix of **short-chain (mobile)** and **legacy** PFAS → different removal/ breakthrough behavior (earlier for short-chain).
- **Industrial pretreatment alone won't zero out influent**; household inputs persist.
- **Headworks concentrations set the floor** for what effluent limits are realistically achievable.

Limits

- **Scope:** three sub-sewersheds, one 7-day window → limited generalizability.
- **Attribution:** household products not directly identified; correlations only.
- **Method:** target list only; MDL/blank constraints for ultrashorts.
- **Temporal:** no seasonal variability captured.



Thanks

Do you have any questions?

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Determination of household wastewater PFAS composition and concentrations via neighborhood sampling

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