PFAS
Water Treatment Challenges

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What is PFAS?

PFAS or "PFCs"

- FASAs
  - Perfluoroalkane sulfonamides
- PFAAs
  - Perfluoroalkyl Acids
- PFCAs
  - Perfluoroalkylcarboxylic acids
- PFSAs
  - Perfluorinated sulfonic acids

- PFOA
  - Perfluorooctanoic acid
- PFOS
  - Perfluorooctane sulfonic acid

Poly-PFAS

Per- and Polyfluoroalkyl Substances

- Poly-PFAS
What is PFAS?

PFAS exposure may:
- Affect development in children
- Lower pregnancy chance
- Interfere with hormones
- Increase cholesterol levels
- Affect immune system
- Increase risk of cancer

SOURCE: CDC/ATSDR PFAS Health Effects; http://evocra.com.au
## Per-PFAS versus Poly-PFAS

<table>
<thead>
<tr>
<th>Per-PFAS</th>
<th>Poly-PFAS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fully fluorinated</td>
<td>Not fully fluorinated</td>
</tr>
<tr>
<td>Strong C-F bond</td>
<td>Creates a “weak link”</td>
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<tr>
<td>Difficult to degrade</td>
<td>Can be transformed into Per-PFAS</td>
</tr>
<tr>
<td><strong>High</strong> water solubility</td>
<td><strong>Low</strong> water solubility</td>
</tr>
<tr>
<td><strong>Low</strong> volatility</td>
<td><strong>High</strong> volatility</td>
</tr>
<tr>
<td>Transported in surface &amp; groundwater</td>
<td>Transported in atmosphere</td>
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</tbody>
</table>
Emerging Awareness

- Perfluorinated and Polyfluoroalkyl Substances (PFAS)
  - PFOS
  - PFOA
  - PFHxS
  - PFBS
  - PFAS
  - Fluorotelomers
  - All Other PFAS

Common regulatory criteria or health advisories:
- Sum of informal poll (NJ, NH, MN)

Thematic and not proportional. Bottom of triangle indicates additional number of compounds; not a greater quantity by mass, concentration, or frequency of detection.

SOURCE: ITRC's History of Use of Per- and Polyfluoroalkyl Substances (PFAS) – Fact Sheet
# Evaluation of Water Treatment Systems

<table>
<thead>
<tr>
<th></th>
<th>AER</th>
<th>COAG/DAF</th>
<th>COAG/FLOC/SED/G- or M-FIL</th>
<th>MnO₄, O₃, ClO₂, Cl₂, CLM, UV</th>
<th>AIX</th>
<th>GAC</th>
<th>NF</th>
<th>RO</th>
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</thead>
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*Treatment performance is assumed based on PFAA size/charge and/or known removal data of shorter or longer chain homologues.

**Source:** Dickenson and Higgins (2016) Water Research Foundation “Treatment Mitigation Strategies for Poly- and Perfluoroalkyl Substances”
Case Study – Groundwater Treatment

Evaluation of treatment alternatives for impacted groundwater

- **Constituents requiring treatment:**
  - Iron
  - Phosphorus
  - Mercury
  - PFAS

- **Constituents potentially requiring pre-treatment:**
  - Organic carbon (30-50 mg/L)
  - PFAS (total 1 µg/L)

Removal of non-PFAS organics can drive treatment costs and significantly impact unit process selection
Case Study – Treatability Testing

**Design considerations**

- Activated carbon adsorption can vary depending on:
  - PFAS compounds present
  - Dissolved organic carbon
  - Water chemistry (pH, ionic strength)

- Currently performing laboratory tests to develop design and cost information
  - Iron precipitation and solids coagulation
  - Destruction of dissolved organic carbon
  - GAC adsorption rates of PFAS using rapid small column tests
Case Study – Treatment Alternative

<table>
<thead>
<tr>
<th>Mix Tank 1</th>
<th>Mix Tank 2</th>
<th>Settling Basin</th>
<th>Biox</th>
<th>Adsorption</th>
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</thead>
<tbody>
<tr>
<td>Fe precip</td>
<td>Hg precip</td>
<td>Solids removal</td>
<td>Organics reduction</td>
<td>PFAS adsorption</td>
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<tr>
<td></td>
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<td>NH₃ removal</td>
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<td>P removal</td>
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PFAS in the Spotlight

Sept 6 – U.S. House of Representatives congressional hearing
• Draft toxicology profile from June (Agency for Toxic Substances and Disease Registry)
• EPA hopes to release “national management plan” by end of this year

Sept 26 – Senate subcommittee hearing
Questions?

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