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WATER QUALITY Technology Conference
A PFAS Primer for Utilities
Technology Selection and Life-Cycle Cost Impacts

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Agenda

PFAS Background

Regulatory/Legislative Environment

Treatment Considerations

Life-Cycle Cost Impacts

Closing Thoughts
PFAS Background
What are PFAS?

- Per- and Poly-Fluoro Alkyl Substances (PFAS)
- Synthetic chemicals
- Common properties
  - Persistent
  - Bioaccumulative
  - Toxic
- Pervasive
- No enforceable federal drinking water standards
- USEPA lifetime public health advisories for PFOA and PFOS
- States are beginning to establish drinking water standards

PFAS are commonly detected in human and animal populations worldwide and are not readily metabolized
PFAS Structures

There are at least 3,500 compounds in this class with some estimates as high as 8,000.
Applications

Firefighting Foams  Non-stick Cookware  Oil Recovery  Food Packaging

Cosmetics  Paints & Inks  Coatings on Textiles  Medical Devices

Numerous pathways for contamination and human exposure
Common Contamination Routes

- Airports and fire-fighting schools
  - Use of Aqueous Film Forming Foams (AFFF)
- Waste Disposal
  - Runoff
  - Landfill leachate
- Manufacturing
  - Air emissions
  - Wastewater discharges

Drinking water supplies have been widely contaminated by AFFF use and primary manufacturing discharges
PFAS Presence in Drinking Water

Relatively higher MRLs used for UCMR3 – occurrence likely more widespread
Health Effects

• Readily adsorbed (ingestion and inhalation)
• Not metabolized (long half-lives)
• Crosses placenta and into breast milk
• Known adverse effects:
  • Pregnancy complications
  • Developmental issues
  • Liver damage and immune system effects
  • Increased risks of asthma, thyroid disease, infertility
  • Increases in cholesterol (total, LDL)
• Suggestive evidence of additional adverse effects

Lack of health studies on majority of PFAS
Regulatory and Legislative Environment
United States Environmental Protection Agency

- **Lifetime Health Advisory (HA) Levels (May 25, 2016)**
  - PFOA < 70 ng/L
  - PFOS < 70 ng/L
  - Measured individually or in combination

- **EPA PFAS Action Plan – February 14, 2019**
  - Regulatory determination for PFOA and PFOS in 2019
  - Study designation of PFOA and PFOS as CERCLA hazardous substances
  - Develop PFOA and PFOS groundwater cleanup standards
  - Develop oral RfDs for GenX and PFBS

ATSDR toxicology study suggests drinking water limits of 11 ng/L for PFOA and 7 ng/L for PFOS – June 2018
State Regulatory Actions

- 14 States with PFAS Standards and Guidelines
  - Notification levels
  - Interim response levels
  - Action levels
  - Groundwater clean-up standard
  - Drinking water MCLs
  - Health based guidance for water
  - Guidance value
  - Health advisory
  - Drinking water health advisory

Individual and combined levels for PFOA, PFOS, PFNA, PFHxS, PFHpA, PFDA, and GenX at concentrations between 5.1 and 140 ng/L
 Legislative Activity

- Over 20 bills have been introduced in Congress in 2019
  - PFAS Action Act of 2019 (H.R. 535)
  - PFAS Accountability Act (S. 1372, H.R. 2626)

- Three Congressional hearings

- Generally bipartisan support for PFAS legislation

- Letter to Congress from 22 state attorneys general

- 63 bills in 18 states are under consideration (9/2019)

- 22 adopted policies in 14 states (9/2019)

The pace of legislative activity is rapid and the impacts on regulatory activity is uncertain
Treatment Considerations
Treatment Challenges

- **Conditions**
  - Apparent health risks/impacts
  - Customer expectation of 0 ng/L ... NOW!
  - Regulatory uncertainty

- **Risks**
  - Damaged customer perception
  - Incurred costs
  - Litigation

Drinking water providers need to navigate through a rapidly changing PFAS landscape and carefully balance multiple considerations
Universe of PFAS Solutions

- Treatment (localized vs. regionalized)
  - Granular Activated Carbon
  - Ion Exchange
  - Reverse Osmosis
- Purchase treated water
- New water supplies (well or surface)
- Blending

Solutions must consider technical, political, public relations, and regulatory components
Technical Considerations

- Target PFAS compounds
  - Long chain compounds
  - Short chain compounds
  - Sulfonic acids, carboxylic acids, ether carboxylic acids, etc.
  - Others undiscovered, or not measurable

- Treated water PFAS concentration

- Other competing contaminants and treatment objectives
  - EDCs and PPCPs
  - NOM and sulfate

- Ultimate disposal of contaminated residuals
Adsorption and Membrane Selective Technologies

Granular activated carbon (GAC) and ion exchange (IX)

Reverse osmosis (RO)
Reverse Osmosis (RO)

Reverse osmosis removes target PFAS compounds by membrane rejection and produces a liquid brine stream (15 to 25 percent of flow) that requires disposal.
Granular Activated Carbon (GAC) and Ion Exchange (IX)

GAC and IX remove target PFAS compounds by adsorption at selective sites

- Competing contaminants – GAC
  - Natural organic matter
  - Organic micro-contaminants
  - Other PFAS compounds

- Competing contaminants – IX
  - Natural organic matter
  - Inorganic macro-contaminants (sulfate)
  - Other PFAS compounds

GAC and IX remove target PFAS compounds by adsorption at selective sites
Target PFAS Compounds – Impact of Structure on Removal – GAC

- Breakthrough order based on
  - Carbon chain length
  - Sulfonate/carboxylic functional group
- Treatment validation/optimization
  - Increasing EBCT reduces GAC replacement frequency
- Adjusting replacement provides flexibility in uncertain regulatory environment

Target PFAS compound(s) determines media replacement frequency
Target PFAS Compounds – Impact of Structure on Removal – IX

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Target PFAS compound(s) determines media replacement frequency
Adsorptive Competition of PFAS Compounds

- Competitive desorption of PFAS
- Chromatographic peaking/roll-off
- Higher PFAS concentration in effluent than in influent during desorption

**Fig. 2 – Breakthrough of PFASs in Utility 20 GAC System.**

Applemann et. al., Water Research, 51, 2014
Adsorbents for PFAS Removal from Drinking Water Supplies

- Granular activated carbon
  - Many products available
  - Removal efficiency varies
  - Pilot testing advisable
  - Mature media disposal
- Ion exchange resin
  - Few products available
  - Removal efficiency varies
  - Pilot testing advisable
  - Media disposal constraints
Pilot Testing Lessons Learned – Evaluate Pre-Treatment Requirements

Pilot Issues – Water quality variability, residuals disposal, pre-treatment, sample analysis, and data management.
Life-Cycle Cost Impacts
Impact of Capacity on Opinion of Probable Capital Cost – GAC

Smaller capacity facilities have higher unit cost ($/gpd) – economies of scale
IX generally has lower capital cost at a given capacity due to higher surface loading rate.
Annual O&M costs for adsorptive processes is driven by bed volumes treated

- Annual media replacement
- Varies with source water quality
- Varies with PFAS compounds and treated water targets
- Varying cost for current products
- Need to consider media handling and disposal
Closing Thoughts
PFAS Treatment Procurement Lessons Learned

3M settlement: key facts
The State of Minnesota and the 3M Company announced an agreement to settle the state’s Natural Resource Damage lawsuit on February 20, 2018. Under the terms of the agreement, 3M will make an $850 million grant to the state to be used for clean drinking water and natural resource projects, and the state’s lawsuit expenses. After legal and other expenses are paid, about $720 million will be invested in drinking water and natural resource projects in the Twin Cities east metropolitan region.

Grant trustees
The grant trustees are the Minnesota Pollution Control Agency (MPCA) and Minnesota Department of Natural Resources (DNR).

Priority one — ensure safe drinking water
The top priority for investing the grant money is to improve the quality and quantity of drinking water in the east metropolitan area. This area includes, but is not limited to, the cities of Afton, Cottage Grove, Lake Elmo, Newport, Oakdale, St. Paul Park, Woodbury and the townships of Grey Cloud Island and West Lakeland.

Funded projects will help provide the region’s 157,000 residents and businesses with clean drinking water to meet current and future needs. Such efforts could include alternative sources of drinking water for cities or private well owners, treating existing contaminated drinking water wells, or connecting homes served by private wells to municipal drinking water systems.

Grant funds could also support the sustainability of drinking water sources with projects such as promoting water conservation or preserving open spaces to help recharge drinking water sources and enhance water quality.

• Understand your procurement process
  • What is included?
  • What is not included?
  • What is required of you?
  • What is the timing of the process?
  • Who can participate in the process?
  • What is required of others that wish to participate in the process?
  • What Regulatory/Settlement approval(s) are required?

Coordination with stakeholders and regulatory agencies is critical
Thank you!

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