Communicating and Addressing Risks from PFAS and Other CECs in Potable Reuse

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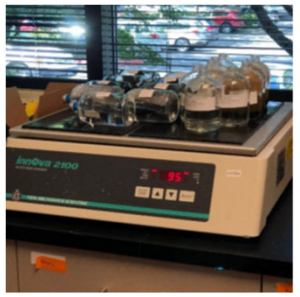
AAEES WORKSHOP - Contaminants of Emerging Concern (CECs) Across the Water Cycle

May 2019

CDM Smith

Presentation Outline

- Types of Contaminants of Emerging Concern (CECs)
- What are PFAS and Why Should We Care About Them?
- Communicating Risks
- Addressing Risks: Example for Treating PFAS/CECs
- Summary





Identify PFAS/CEC Risks

Types of Contaminants of Emerging Concern (CECs)

Evolving Contaminants

Contaminants we have already been dealing with but new information has changed the way we view or have to deal with them (e.g., TCE, Hexavalent Chromium)

Emerging Contaminants

Contaminants that are increasingly being talked about or required or requested to be analyzed (e.g., PFAS, 1,4-dioxane)

New Contaminants

Newly developed or formed chemicals released into the environment (e.g., nanoparticles, artificial sweeteners) or chemicals used for new purposes (e.g., Ethanol, fuel additives)

Examples of CECs (no Fed MCLs)
Perchlorate
Per- and Polyfluoroalkyl Substances
1,4-Dioxane
Pharmaceuticals
DBPs (including NDMA and nitrosamines)
Insecticides, herbicides, fungicides, pesticides, and their degrades
Brominated flame retardants (PBDEs)
Nanomaterials
Sucralose (Splenda)
Algal toxins
Microplastics

No Federal Maximum Contaminant Levels

Why Should We Care About Communicating or Addressing Emerging Contaminants?

- They are likely more prevalent than we think
- Relatively mobile and less biodegradable in the environment
- Threats to the quality of drinking water sources
- 4000+ compounds in PFAS family →Wonderful products, Forever Chemicals → Public fear of unknowns and uncertainties (e.g., drinking water, foods, property values, job security, impact to next generations)
- Increasing regulations at state levels

No Federal Maximum Contaminant Levels

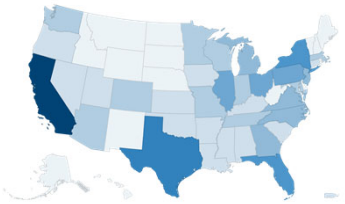
Why Should We Care About Communicating or Addressing Emerging Contaminants?

- They could be re-openers for water treatment system upgrades and complicate facility management
- Emerging contaminants' concentrations may be low but treatment costs are high
- Future potential liabilities (e.g., litigation risk)
- Reputation risk

Scales ad Three Core Elements on CEC *Risk* Evaluation


Global

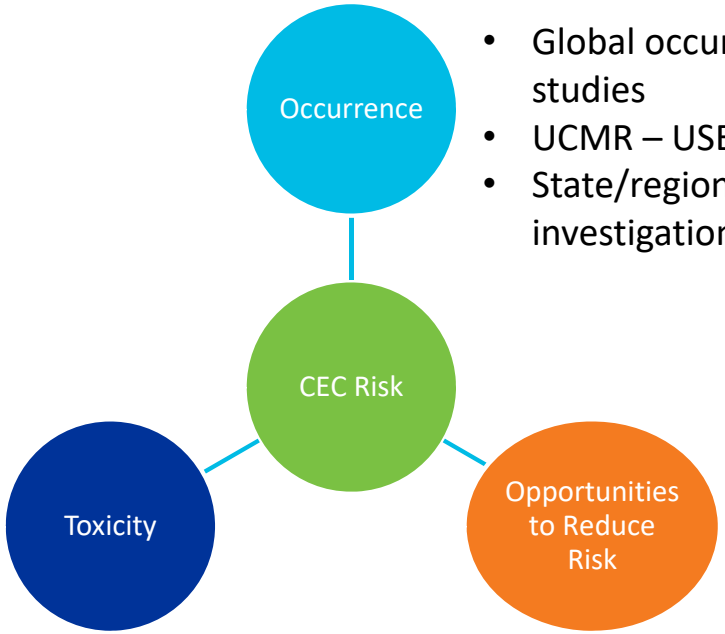

National


State/Regional

City/Communities


Household


Individuals



- Global occurrence researches and studies
- UCMR – USEPA SDWA
- State/regional/site specific level investigation of potential sources

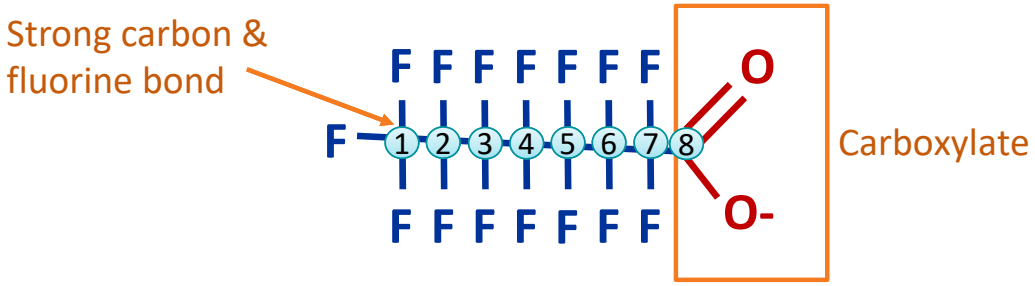
- Adverse effect to human health and the environment
- Data accuracy for risk assessment

- Risk reduction through chemical use and manufacturing policy
- Technologies that can economically and sustainably reduce short and long term risks
- Monitoring and control of discharges from waste management units

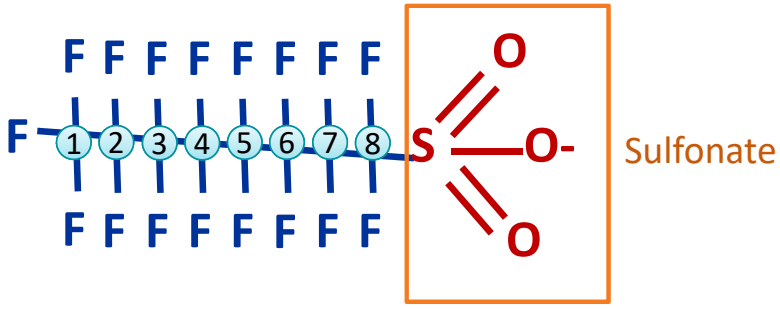
PFOA and PFOS

- Repel water, grease and stains
- C-F is the shortest and strongest bond in chemistry
- Relatively soluble but also sticky
- Chain length (tail) and functional group (head) generally determine PFAS' bioaccumulation and affinity on treatment sorbents

- ***P***er***F***luoro***O***ctanoic ***A***cid (PFOA)



- ***P***er***F***luoro***O***ctane***S***ulfonic Acid (PFOS)



Fire fighting foams

PFAS Sources/Occurrence Under Site Investigation

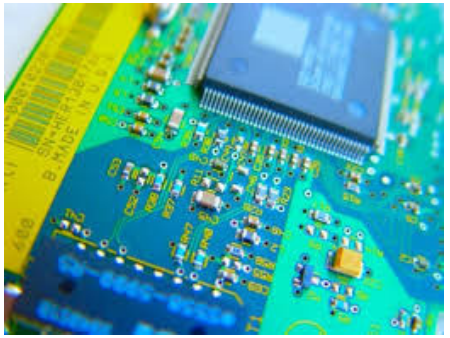
- Facilities using or storing aqueous film forming foams (AFFF), such as DoD installations, airports, oil refineries, fire training facilities, fire stations, etc.
  - Fire fighting / crash sites
  - Fire training areas
  - Foam suppression systems
  - Foam storage areas
  - Fuel tank area with fire protection systems
- Manufacturing emissions
- Chrome plating (PFOS as mist suppressant)
- Landfill leachates
- Wastewater treatment plants
- Biosolids

Challenges of Dealing with PFAS and communicating

1. Optimal Risk Management Approach is Unclear
2. Uncertainty Creates a Communication Challenge
3. Multiple Point and Non-Point Sources
4. Regional Groundwater/Water Supply Contaminations
5. Field Sampling Precautions

PFAS in our living environment since 1950s

- Large class of fluorosurfactants (~4000+ compounds) with unique chemical & physical properties that repel water, grease and stains, extremely persistent and mobile in the environment
- Used since 1950s in wide range of consumer and industrial applications



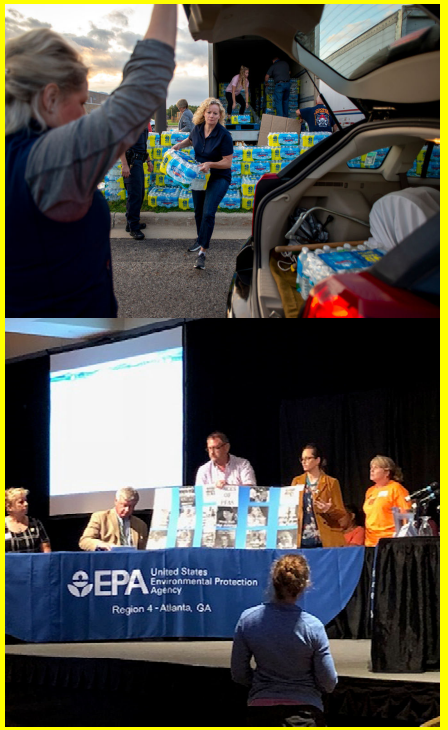
PFAS and Our Health

Scientists are still learning about the health effects of exposures to mixtures of PFAS. Although more research is needed, some studies in people have shown that certain PFAS may:

- Lower a woman's chance of getting pregnant
- Increase the chance of high blood pressure in pregnant women
- Increase the chance of thyroid disease
- Increase cholesterol levels
- Change immune response
- Increase chance of cancer, especially kidney and testicular cancers

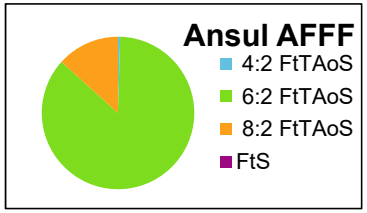
https://www.michigan.gov/pfasresponse/

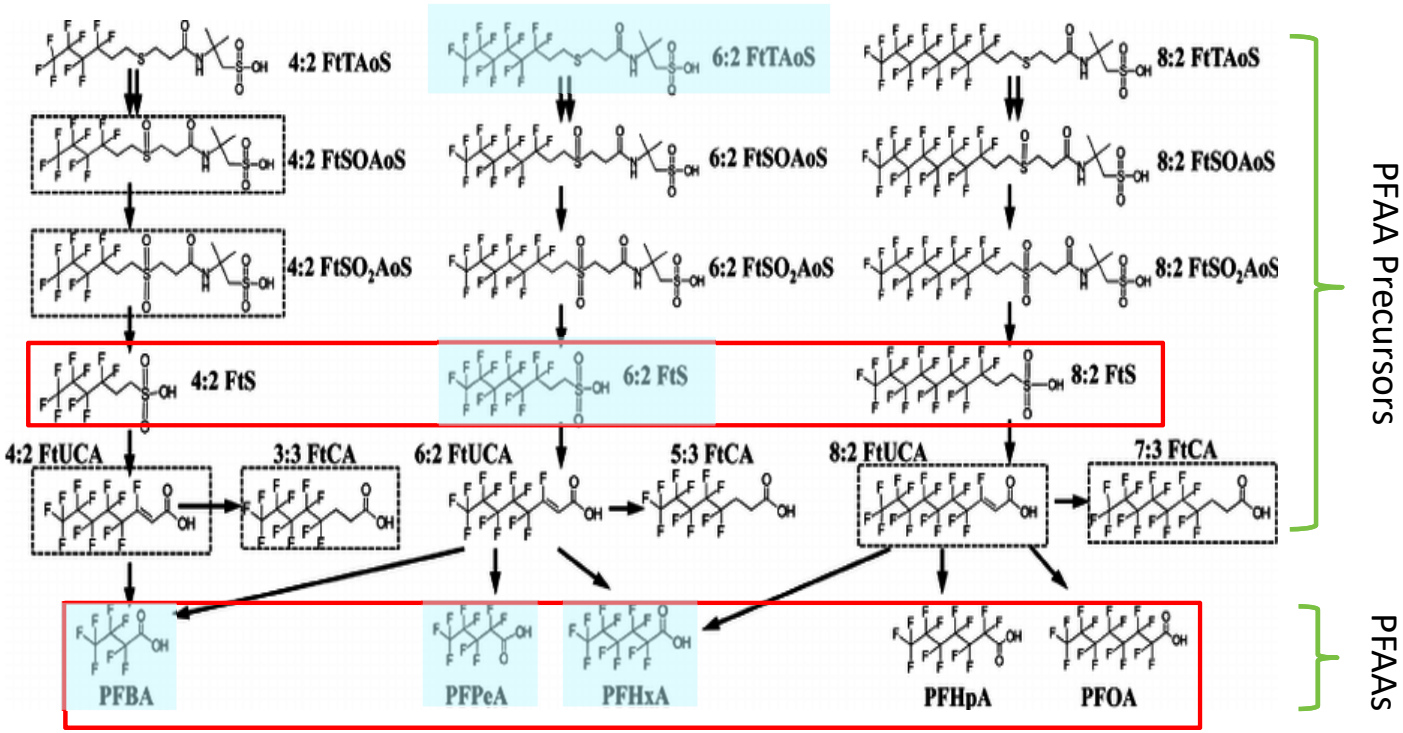
Risk = Hazard + Outrage



Complex Chemistry

What you detected are not quite what you have - Biotransformation of precursors





Can be analyzed using USEPA 537 Mod

Figure 4 of Harding-Marjanovic, et al. 2015

Ref: ITRC PFAS training slides

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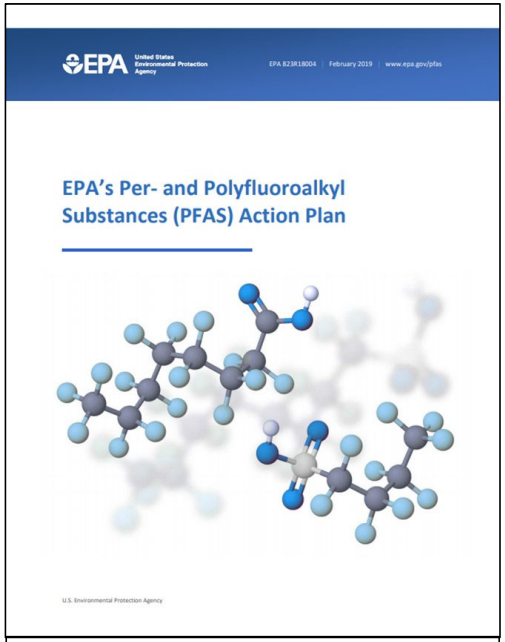
USEPA Regulatory History

- Concerns originated in **1999**
- By **2002** 3M phased out PFOS production
- USEPA OSWER established Health Advisory Levels for PFOS (200 ppt) & PFOA (400 ppt) in **2009**
- USEPA included 6 PFAS in UCMR3 in **2012**
- USEPA revised health advisory levels (PFOS: 70 ng/L and PFOA: 70 ng/L, PFOA+PFOS: 70 ng/L) in **2016**
- USEPA published PFAS Action Plan on Feb 14, **2019**
- On **4/25/19** USEPA published draft screening levels (40 ng/L) and preliminary remediation goals (PRGs, 70 ng/L) for FPSO and PFOA in groundwater that is a current or potential source of drinking water



- Drinking water
- Cleanup
- Toxics
- Research
- Enforcement
- Risk Communications

No Fed MCLs

Health Advisory Levels and MCL Continue to Evolve at State Level

- **USEPA** – Lifetime Health Advisory Levels
  - 70 ppt – PFOA, PFOS, PFOA + PFOS
- **Alaska** action levels for groundwater and surface water
  - 70 ppt – PFOS + PFOA + PFNA + PFHxS + PFHpA
  - 2 ppb – PFBS
- **California** drinking water
  - 13 ppt PFOS – Notification level
  - 14 ppt PFOA – Notification level
  - 70 ppt PFOA, PFOS, PFOA + PFOS- Response level
- **Connecticut and Massachusetts** Screening Criteria
  - 70 ppt – total of PFHxA + PFHpA + PFOA + PFNA + PFOS
- **Michigan** Drinking Water Screening Levels
  - 9 ppt – PFOA
  - 8 ppt – PFOS
  - 9 ppt – PFNA
  - 84 ppt – PFHxS
  - 1,000 – PFBS

(April 2019)

- **Minnesota** Action Levels
  - 35 ppt – PFOA ; 27 ppt – PFOS
- **New Jersey** Drinking Water MCL
  - 13 ppt PFNA – MCL (effective 9/4/2018)
  - 14 ppt PFOA – Proposed MCL
  - 13 ppt PFOS – Proposed MCL
- **New York**
  - 10 ppt-PFOA, PFOS (may be effect in 2019)
- **North Carolina**
  - 140 ppt – GenX
- **NH DES** Proposed MCL and AGQS (Jan 2019)
  - 38 ppt – PFOA
  - 70 ppt – PFOS
  - 70 ppt – PFOA & PFOS (combined)
  - 85 ppt – PFHxS
  - 23 ppt – PFNA
- **Vermont** Drinking Water Standard
  - 20 ppt – PFHxA + PFHpA + PFOA + PFNA + PFOS

PFAS data accuracy is critical to communicate or determine the risks

- USEPA Method 537 determines 14 PFAS in **drinking water** by LC/MS/MS
- EPA 537.1 expands analytes to 18 PFAS in **drinking water** (Nov 2018) to add 4 replacement compounds including GenX
- Commercial laboratories modified EPA 537 or create their own method for quantifying more PFAS (up to 39) and for analyzing PFAS in other environmental matrices. THIS IS NOT A USEPA METHOD!
- Reporting limits generally 1-5 ppt, some labs can report below 1 ppt
- USEPA analytical methods for environmental matrices other than drinking water will be released 2019 and include 24 PFAS

They are pervasive but we know very little about PFAS migration in the environment

Current Top Priority: Protection of Drinking Water Sources

Under study

- State-level surveys on PFAS occurrence from potential PFAS sources
- Source-Pathways- Receptor (Drinking Water Source)
- Groundwater-surface water interface interactions
- Point and non-point sources of PFAS
- PFAS forensics - Different PFAS sources
- Long-term mass discharges of PFAS from source zones
- Productions, behaviors, occurrence and extent of precursors
- Aerobic and anaerobic precursor transformation conditions, rates and pathways

3 Dimensions of Risk Communication

Understand the processes of risk assessment and management

To form scientifically valid **perceptions** of the likely hazards

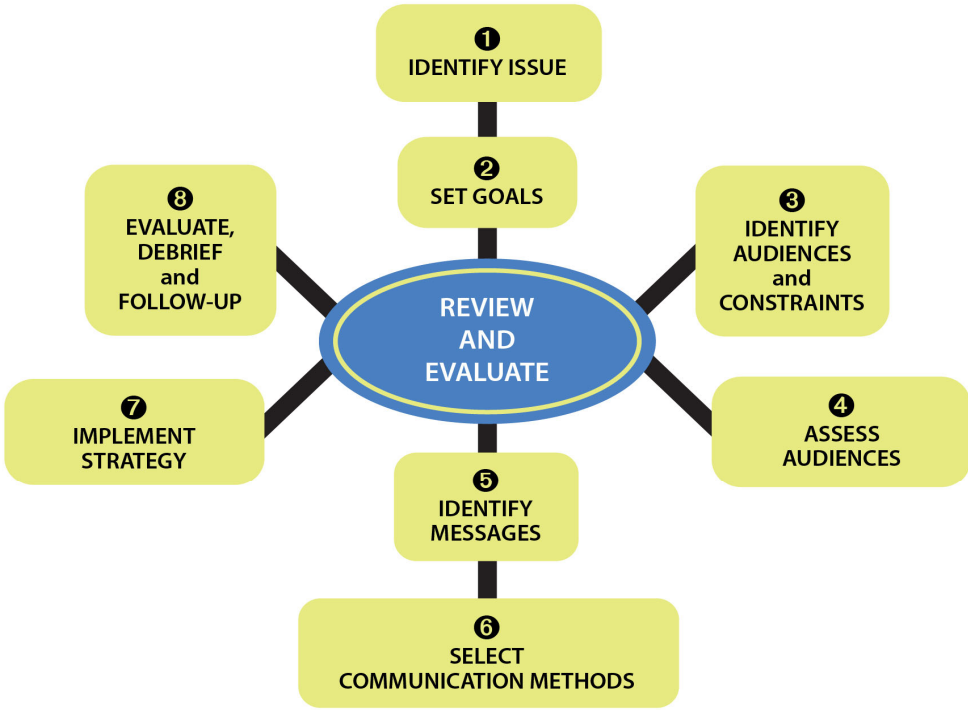
To **participate** in making decisions about how risk should be managed

Heightened Sense of Risk to PFAS

Risk Perception	**Amplification: Heightened sense of risk** due to emerging characteristics and physical, social, psychological, demographic factors
Challenge	Persuade stakeholders to **accept** your approach to managing the risk
Solutions	1. Communicate **Transparent CSM**, include uncertainties 2. Secondary risk management **performance metrics** • Source control/ removal • Reduction in contaminant bioavailability/loading • Mitigation of exposure pathways

Communicating the CEC Risks

1. Establish dialogue early and continue through to resolution.
2. Include the community in the decision-making process.
3. Present accessible and clear information.
4. Address uncertainties head on - communicate what is known and what is unknown.
5. Listen, acknowledge, and follow up on specific concerns.
6. Communicate the context for the risk to help audiences decide how to respond.



Source: ITRC PFAS training
Modified from NJDEP 2014

Examples of Community Communication Objectives

Short-Term

- Identify and distribute alternate water source
- Determine extent of impacted population
- Inform and educate local physicians

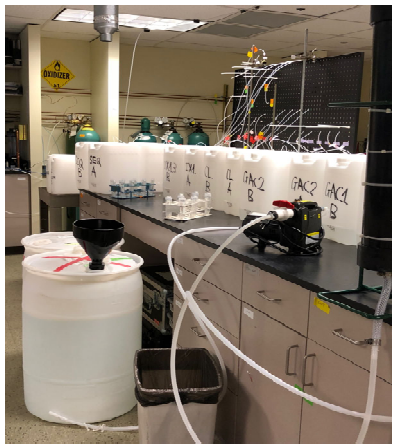
Long-Term

- Identify sensitive populations that need a refined communication strategy
- Educate the community on the basic science of PFAS
- Provide support for review and interpretation of analytical results
- Address unresolved questions and concerns

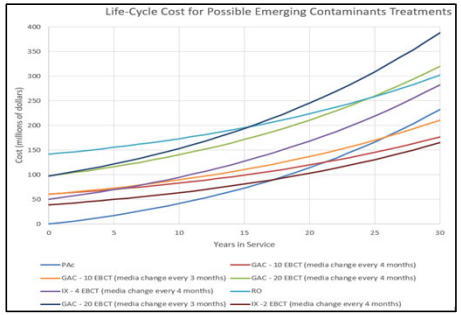
Example of Addressing Risks Through CEC Treatment

We are getting smarter on CEC technology selection

Engineering evaluation
- System upgrades
- New system to remove CEC



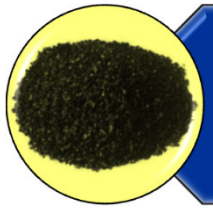
Check on CEC treatability and compatibility with other existing treatment processes



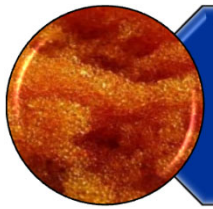
Pilot testing and life cycle assessment

System design, permitting, construction, operation, maintenance, monitoring
→ Life cycle success

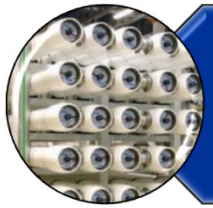
Three Mainstream **PFAS** Treatment Technologies



Granular Activated Carbon (GAC)



Ion Exchange Resin



High Pressure Membrane

Customer Concerns

- Safe water desired
- Who pays, and when?
- Other water supply options?
- Questions on selected technology's adequacy
- Public interest in broader spectrum of PFAS removal
- Operations phase – monitoring
- What is next CEC and can treatment remove all CECs?

Case Study to Remove PFAS and Other CECs

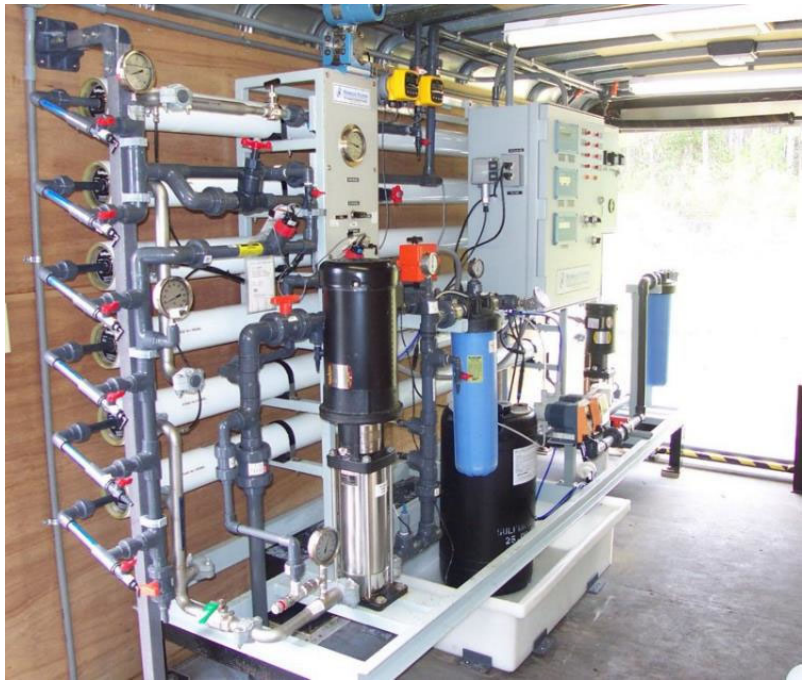
List of PFAS and CEC

- Per-and Poly-fluoroalkyl Substances (PFAS)
- GenX
- PFMOAA, PFMOPrA, PFMOBA, PFO2HxA, etc.
- Other identified PFAS compounds
- Additional unidentified PFAS

- 1,4-Dioxane
- Pharmaceuticals and Personal Care Products (PPCPs)
- Endocrine Disrupting Compounds (EDCs)
- Pesticides and Herbicides
- NDMA, Brominated DBPs
- Other identified compounds
- Additional compounds not yet identified

Low Pressure Reverse Osmosis

- Surface water as drinking water source
  - 35 mgd
  - PFAS
  - GenX
  - CECs
  - LPRO pilot tested
- Pilot-tested by CDM Smith
- Residuals Discharge Evaluation and Permitting
- Energy Considerations



Low Pressure Reverse Osmosis Technology Selection

Provides best protection against unidentified contaminants and spills/spikes in the Cape Fear River

Parameter	Filtered Water Concentration	RO Treated Water	Calculated Removal %
Gen X	7 – 12 ng/L	ND	--
Nafion Byproduct 1 & 2	ND	ND	--
PFMOAA	320 – 750 ng/L	ND – 11 ng/L	98%+
PFO2HxA	12 – 26 ng/L	ND	--
PFHxA	19 – 20 ng/L	ND	--
PFPeA	16 - 17 ng/L	ND	
PFOS + PFOA	26 ng/L	ND	--
Sum (45) of PFAS Tested	423 – 892 ng/L	ND – 11 ng/L	--

Parameter	Filtered Water Concentration	RO Treated Water	Calculated Removal %
1,4-Dioxane (industrial chemical)	3.2 µg/L	0.2 µg/L	94%
Carbamazepine (seizure medicine)	13 ng/L	ND	--
Atrazine (herbicide)	58 ng/L	ND	--
Cotinine (metabolite of nicotine)	15 ng/L	ND	--
DEET (insect repellant)	44 ng/L	ND	--
Simazine (herbicide)	57 ng/L	ND	--
Tris (1,3 dichloro-2-propyl)phosphate (pesticide, flame retardant)	120 ng/L	ND	--

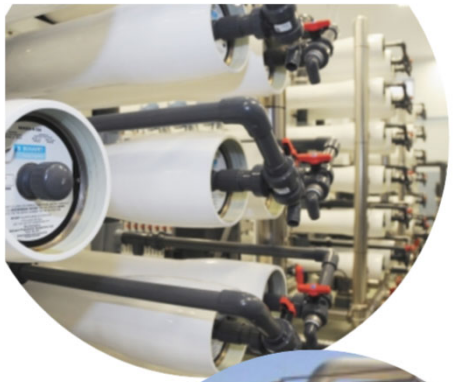
Economic Comparison of Advanced Treatment Options

	Low Pressure Reverse Osmosis (LPRO)	Ozone/BAF - GAC	GAC/IX/UV-AOP
Total Capital Costs	$ 99 M	$ 99 M	$ 84 M
25-yr Present Worth of Annual Costs	$ 59 M	$ 95 M	$ 93 M
Total 25-yr NPW (Capital + Annual O&M)	$ 158 M	$ 194 M	$ 177 M

- Capital and O&M costs based on removal of >90% of each target contaminant

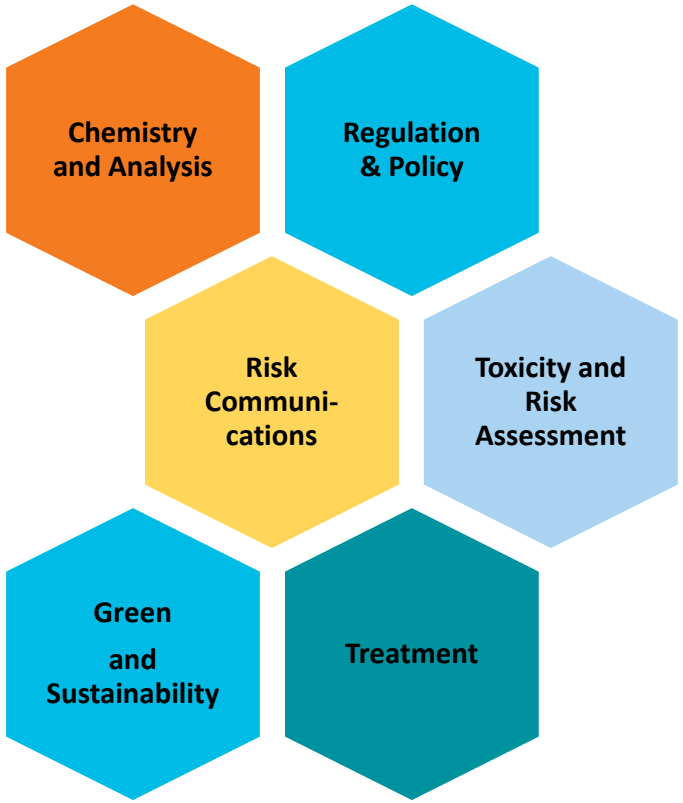
CEC Treatment

- CEC treatment in drinking water is a young practice: Do not generalize or assume. Be wary of citing other treatment results on other waters. Consider site specific water chemistry!
- Pre-design study is needed to help
  - Technology and media selection
  - Identify pre-treatment need
  - Identify issues (e.g., precursor transformation)
  - Identify optimization approach and methods
- Know Thy Constraints – sewer, power, wetlands, fire flow, and more
- Regulations are evolving and the public is focusing on PFAS



Summary

- Regulation and policy evolving quickly – better safe than sorry
- Analytical techniques advanced to better characterize extent of impact
- Ongoing arguments on toxicity effects
- Protection of drinking water resources as top priority
- Consider CECs when going through treatment process selection or evaluating potential future liabilities
- New space created for innovation



Contact Us!

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