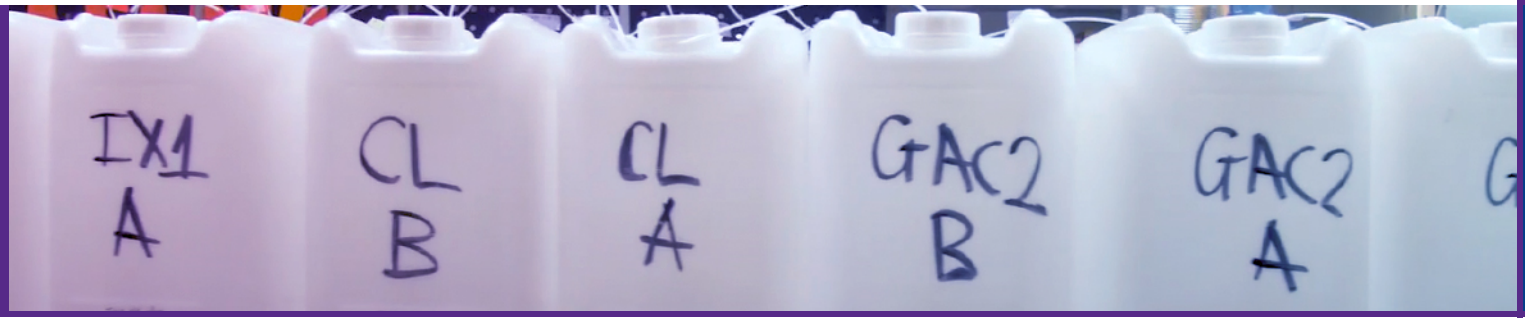
FYI in 45
Breaking Down PFAS

Panelists:
Dora Chiang
Al LeBlanc

Moderated by:
Andrew Beaton

June 27, 2019



CDM Smith

Today's Discussion Will Focus On

- The latest news on PFAS regulations
- Sampling and testing for PFAS
- Options for PFAS treatments and their comparative strengths
- What the latest research into PFAS is uncovering

Our Panel

Dora Chiang, PhD, PE
Remediation Technical Strategy Leader

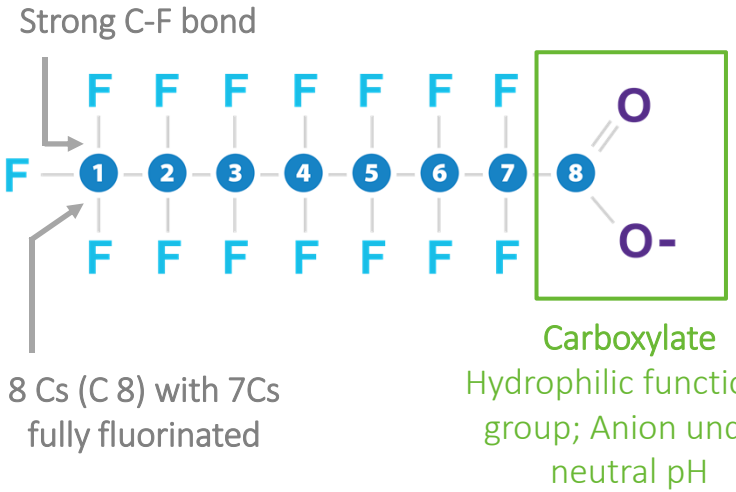
Al LeBlanc, PE, BCEE
Senior Environmental Engineer

“The Forever Chemicals”

Per- and Polyfluoroalkyl Substances (PFAS)

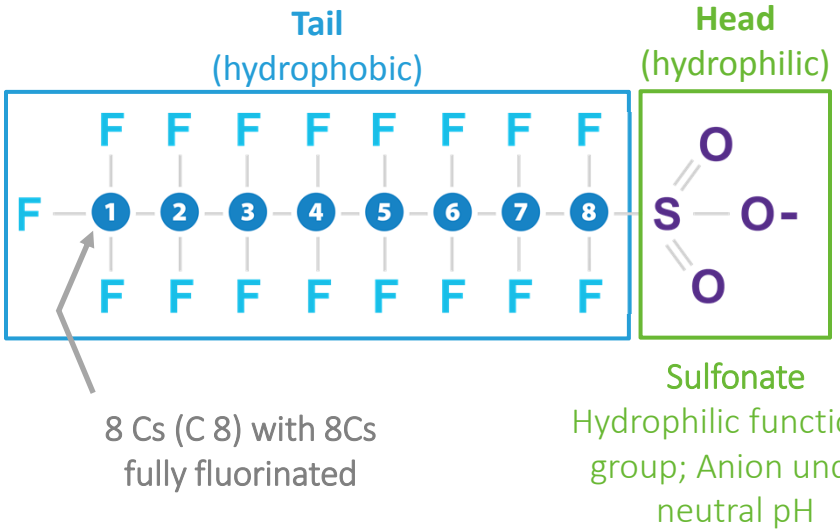
PFOA

Per**F**luoro**O**ctanoic **A**cid

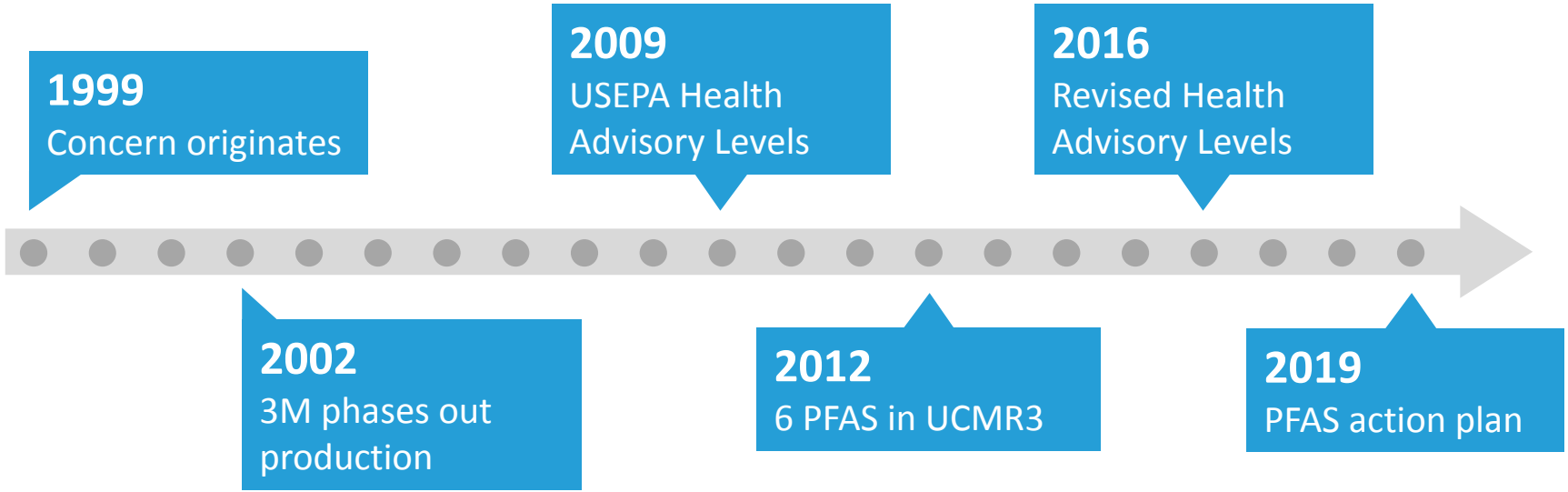


PFOS

Per**F**luoro**O**ctane**S**ulfonic Acid



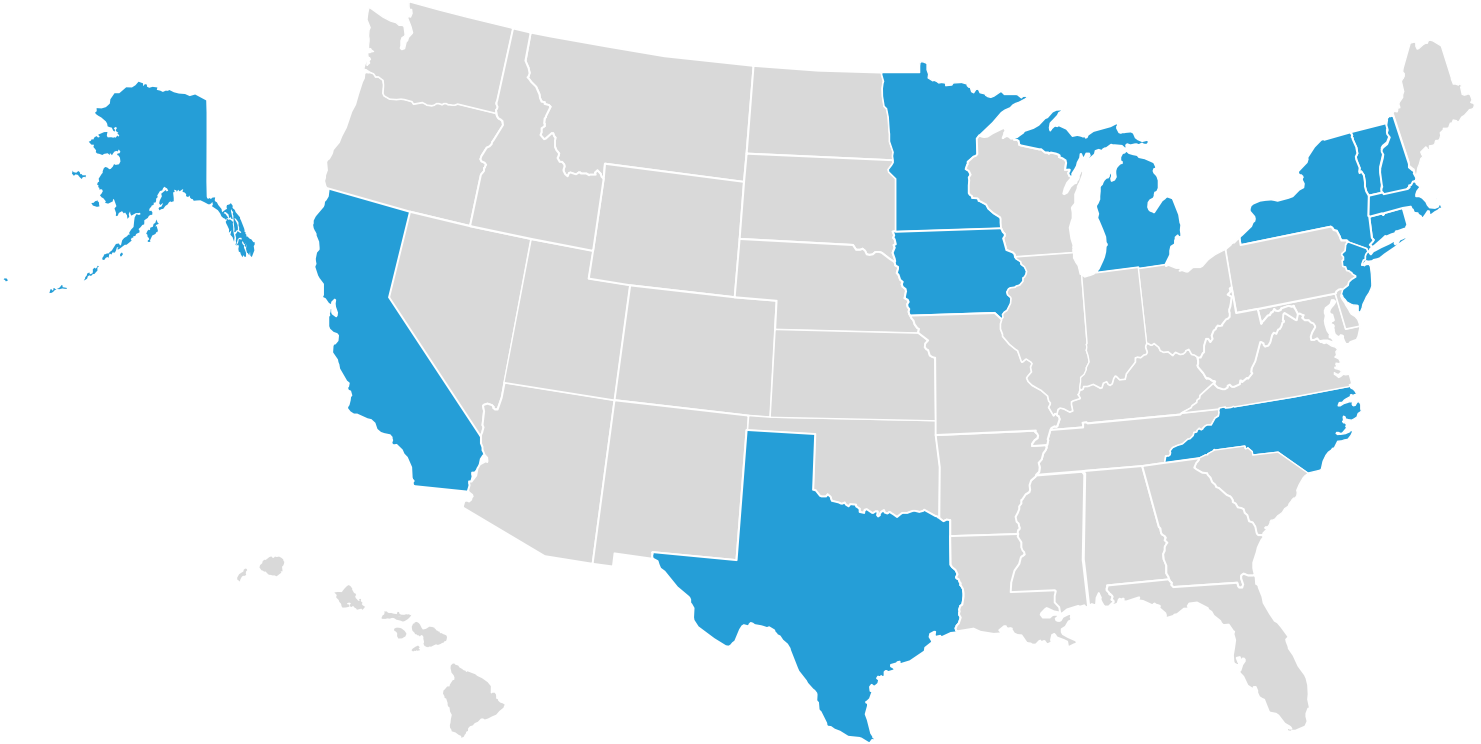
A Growing Crisis



Why Should We Care About PFAS?

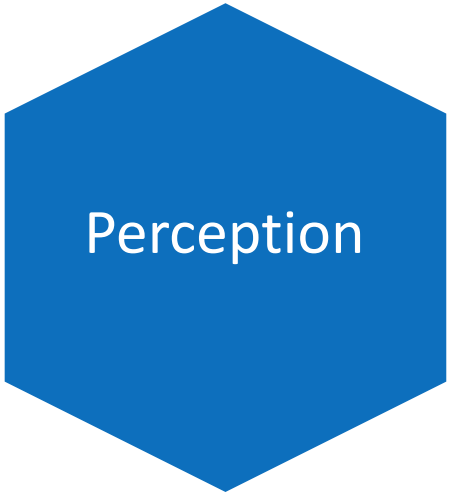
- More prevalent than we think
- Threats to drinking water
- Probable evidence of health risk
- Public fear of unknowns/uncertainties
- Increasing state-level regulations

Increasing State-Level Regulations & Advisories



Successful Risk Communication

Help build **understanding** of risk assessment and management



Help form scientifically valid **perception** of the likely hazards

Allow **participation** in decisions about how risk should be managed

Sampling and Testing for PFAS

Entering into our sources of water via….

Aqueous Film Forming Foam (AFFF)

Chrome Plating

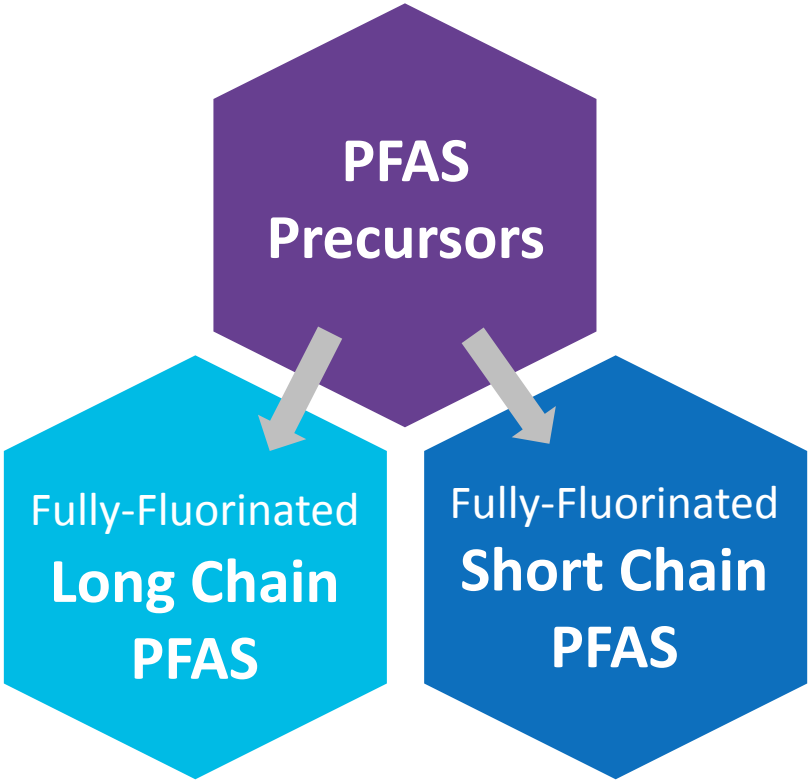
Manufacturing Emissions

Biosolids

Landfills

Wastewater Treatment Plants

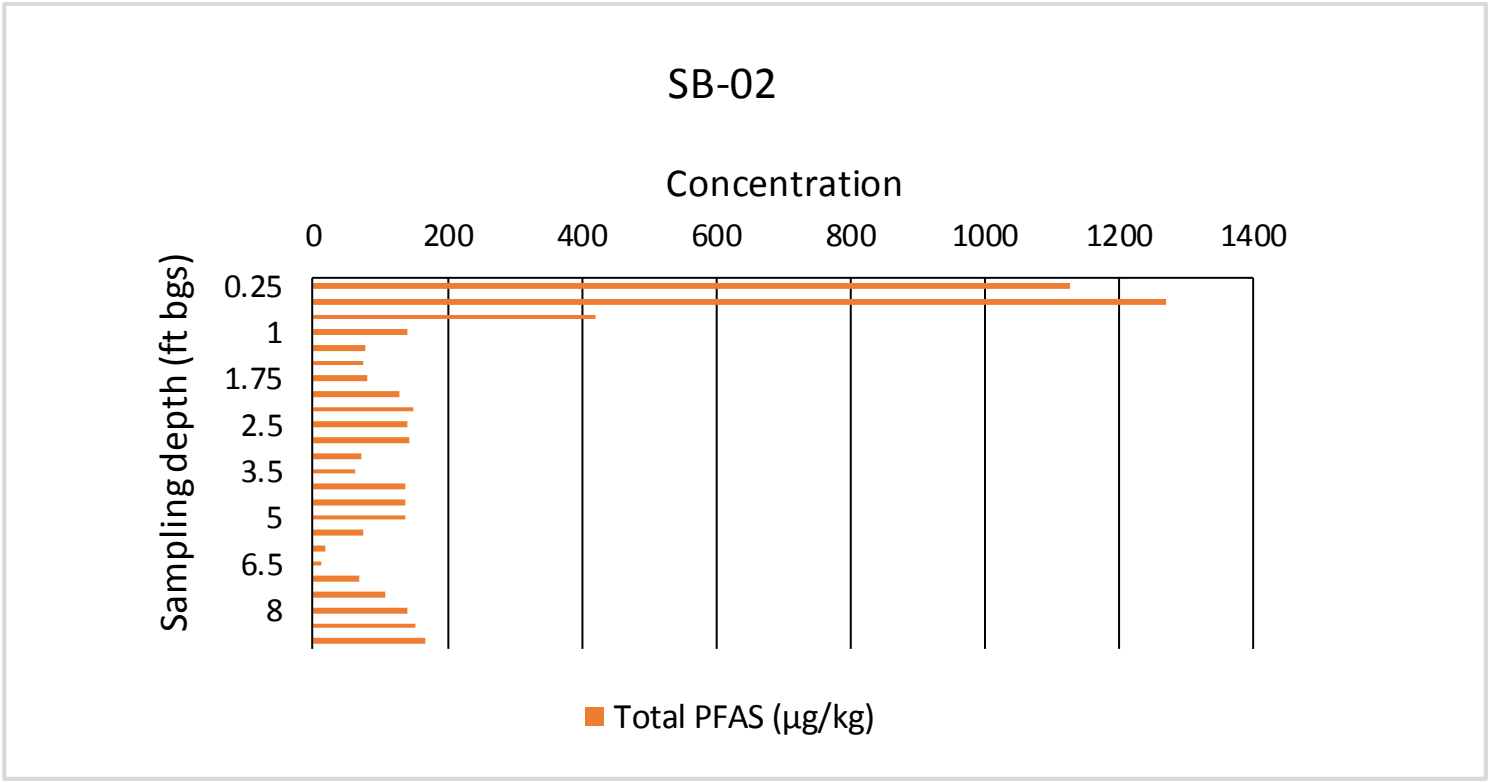
Three Buckets of Concern



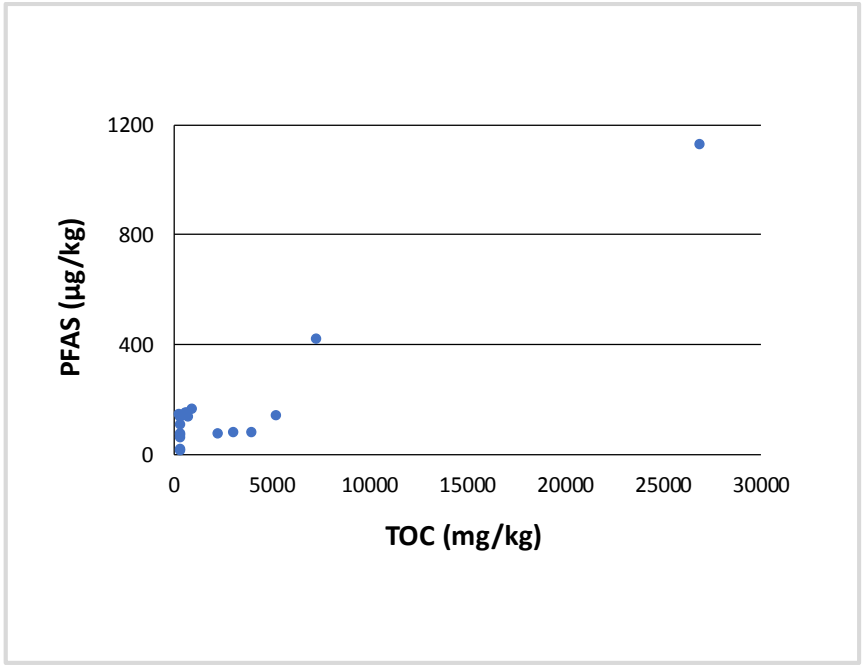
SERDP Project ER18-1204

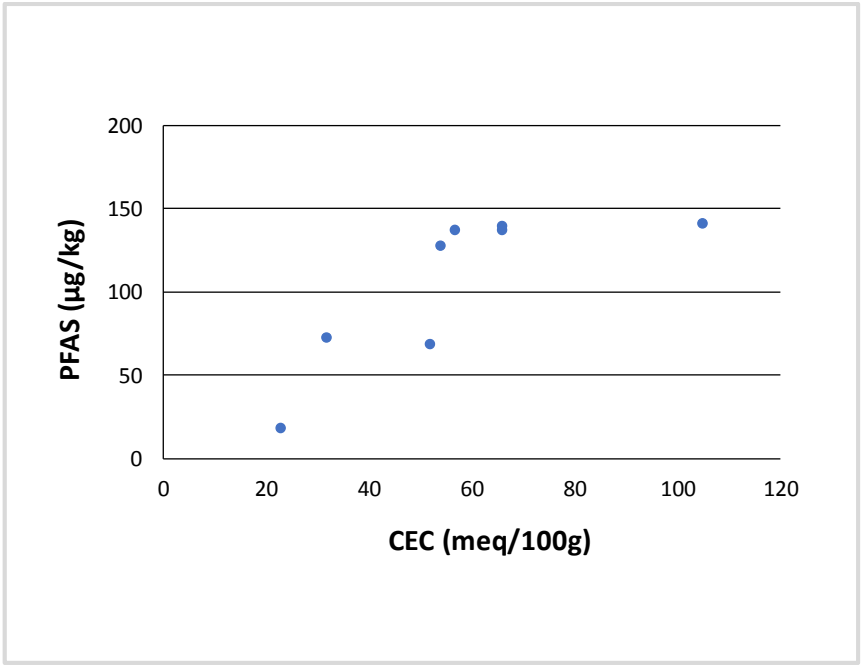
Lakehurst Historic Fire Training Area #1

Preliminary PFAS Results



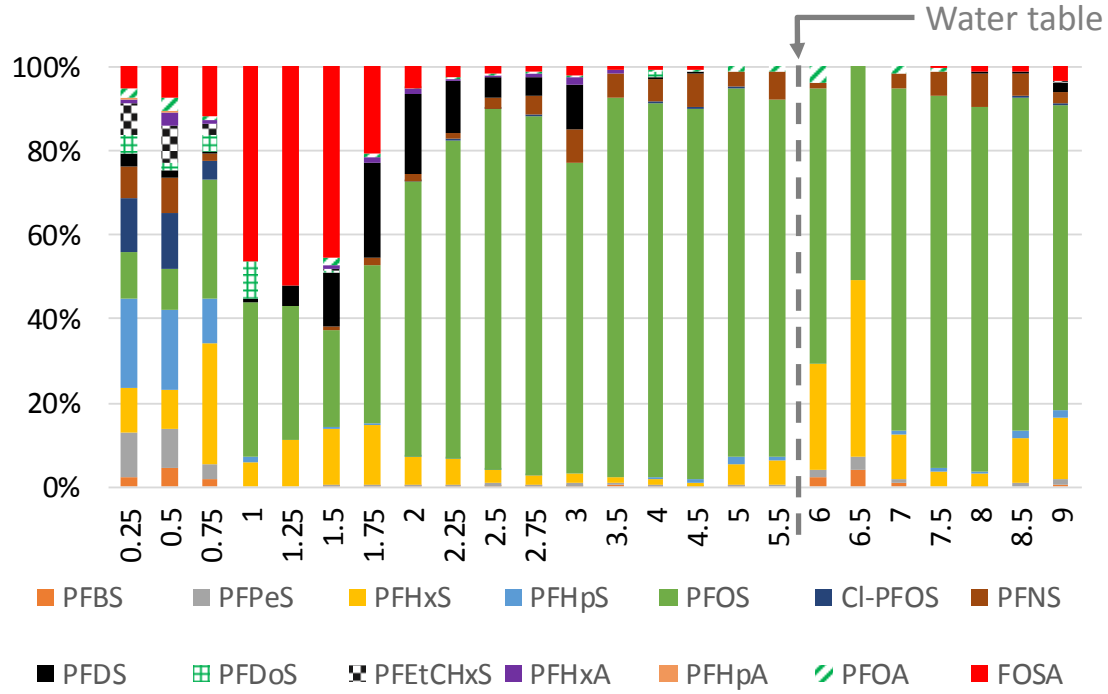
PFAS Distribution Related to Soil Properties





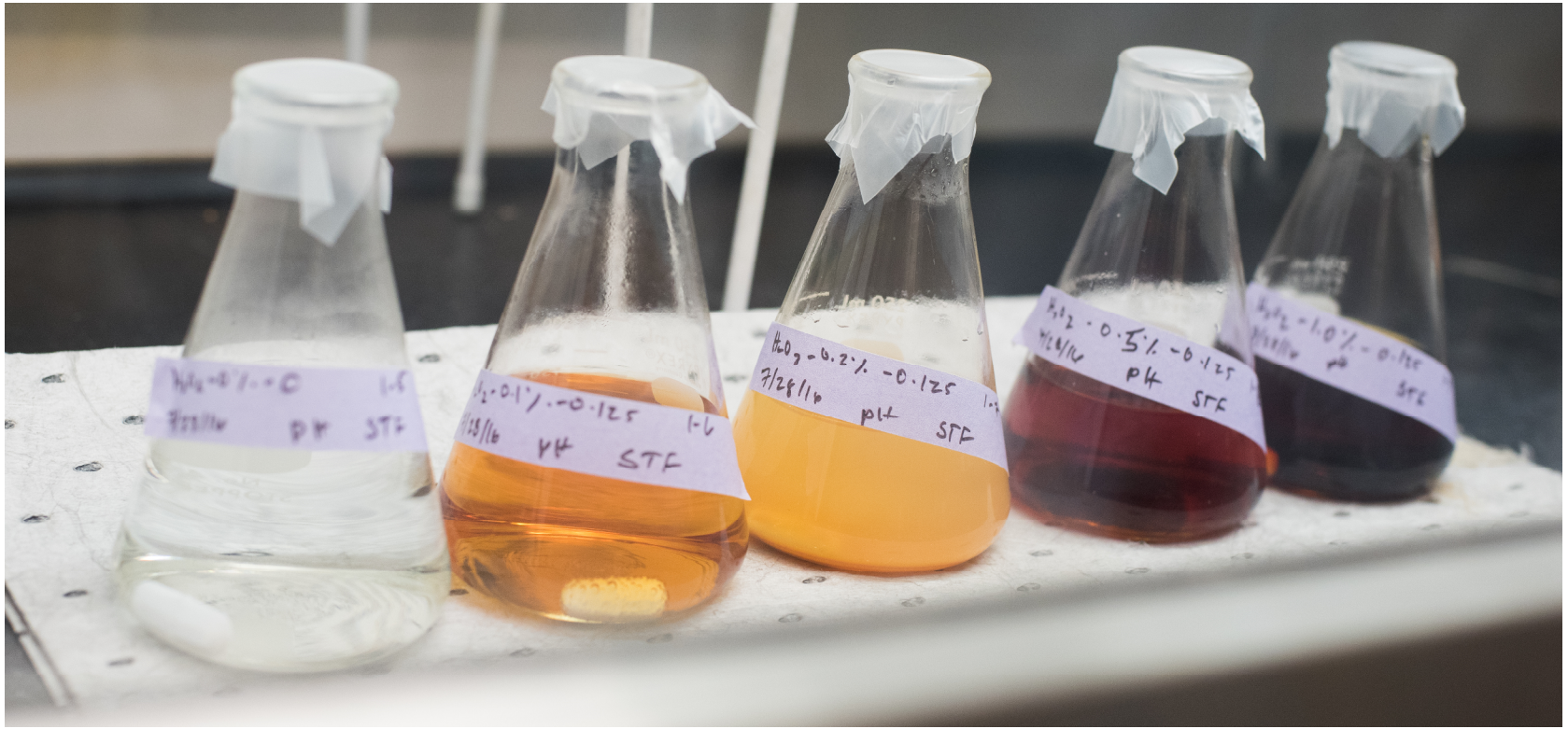
PFAS Composition with Depth

Fluorotelomer & Suspect Analyte Data Not Yet Quantified



- Greater mix of PFAS (esp. short chained) near surface
- FOSA and PFDS comprise a large fraction at intermediate depths
- PFOS dominant in deep vadose zone

Partnerships for Better Sampling & Testing



Upcoming USEPA PFAS-24

SW-846 Method 8327
variation of ASTM 7979-17. Direct aqueous injection (dilution with methanol), that has recently been referred to as a screening method

SW-846 Method 8328
uses isotope dilution and would be applicable to non-potable waters and solids

Table 1. EPA Method Development Analyte List

Analyte Name	Acronym	CAS Number
Perfluorotetradecanoic acid	PFTreA	376-06-7
Perfluorotridecanoic acid	PFTriA	72629-94-8
Perfluorododecanoic acid	PFDoA	307-55-1
Perfluoroundecanoic acid	PFUnA	2058-94-8
Perfluorodecanoic acid	PFDA	335-76-2
Perfluorononanoic acid	PFNA	375-95-1
Perfluorooctanoic acid	PFOA	335-67-1
Perfluoroheptanoic acid	PFHpA	375-85-9
Perfluorohexanoic acid	PFHxA	307-24-4
Perfluoropentanoic acid	PFPeA	2706-90-3
Perfluorobutanoic acid	PFBA	375-22-4
Perfluorodecanesulfonic acid	PFDS	335-77-3
Perfluorononanesulfonic acid	PFNS	68259-12-1
Perfluorooctanesulfonic acid	PFOS	1763-23-1
Perfluoroheptanesulfonic acid	PFHpS	375-92-8
Perfluorohexanesulfonic acid	PFHxS	355-46-4
Perfluorooctanesulfonamide	PFOSA	754-91-6
Fluorotelomer sulfonic acid 8:2	FtS 8:2	39108-34-4
Fluorotelomer sulfonic acid 6:2	FtS 6:2	27619-97-2
Fluorotelomer sulfonic acid 4:2	FtS 4:2	757124-72-4
2-(N-Ethylperfluorooctanesulfonamido)acetic acid	NEtFOSAA	2991-50-6
2-(N-Methylperfluorooctanesulfonamido)acetic acid	NMeFOSAA	2355-31-9

Level of Awareness During PFAS Sampling

Most Important

Items in direct contact of environmental media under investigation:

- sample containers
- sampling parts and equipment
- drilling equipment
- well construction items and materials
- parts and equipment for hydrogeological testing
- in-situ treatment parts and equipment

Important

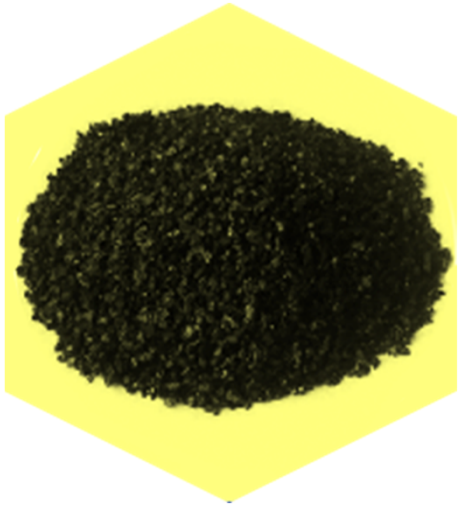
- PPE, personal hygiene that are used by sampling personnel
- Items used in coolers for shipping and transporting PFAS samples

Less Important

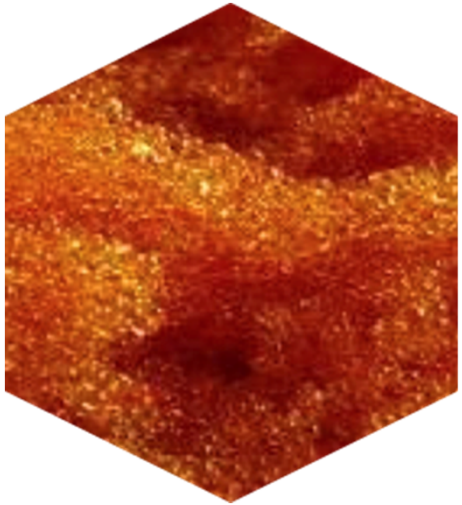
Activities in the staging area away from immediate PFAS investigation area

Treatment Options

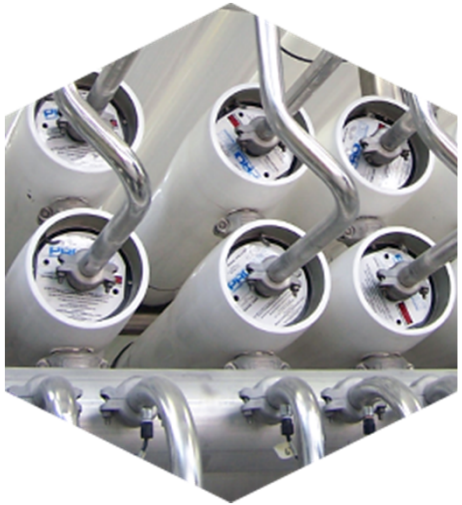
Three Mainstream PFAS Treatment Technologies



Granular Activated Carbon



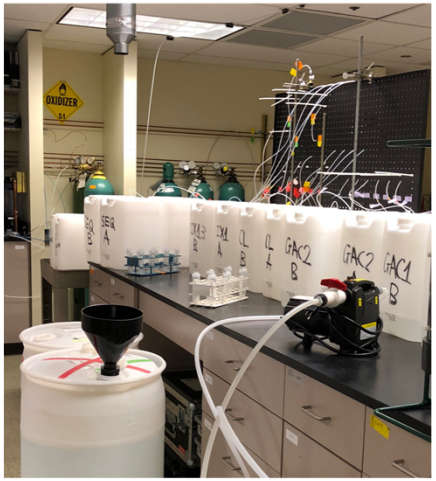
Ion Exchange Resin



Low Pressure Reverse Osmosis Membrane

Getting Smarter with PFAS Technology Selection

Engineering evaluation



Check on PFAS treatability & compatibility with other existing treatment processes

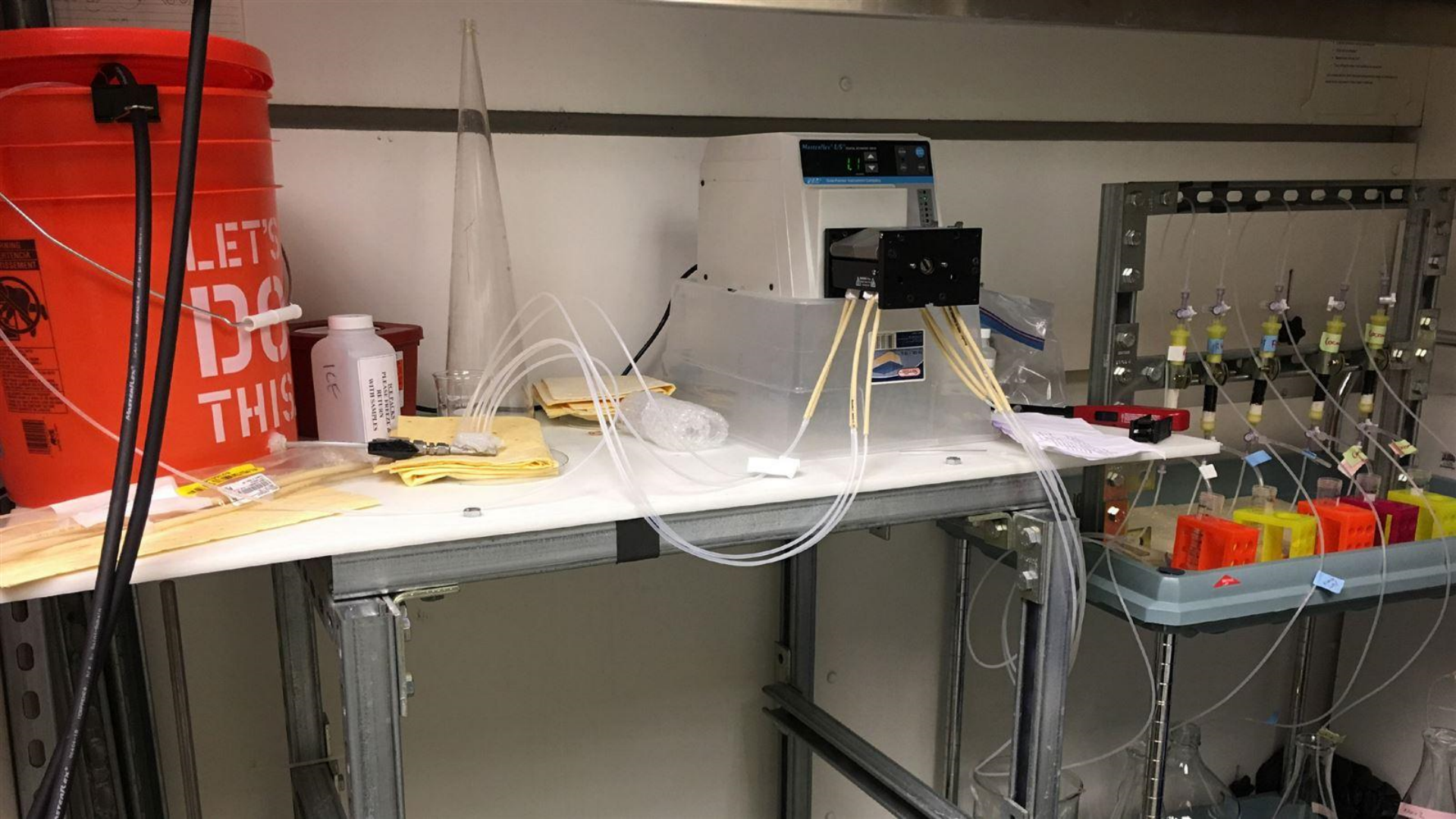
Pilot testing and life cycle assessment

System design, permitting, construction, operation, maintenance, monitoring

GAC

Granular Activated Carbon

Strengths	Considerations
▸ Good track record ▸ Operator/Regulator familiarity ▸ Often effective for removal of long-chain PFAS	▸ Possible competitive adsorption with other compounds present in water



Anion Exchange

Uses synthetic resins with a fixed charge to remove charged contaminant ions

Strengths

- Influent contaminant concentration
- Treatment design (flow rate, resin bead size and material)
- Competing ion concentration
- More effective at removing long-chain compounds

Considerations

- May require approval for PFAS application
- Quench residual oxidant in water
- Mitigate potential corrosion control impacts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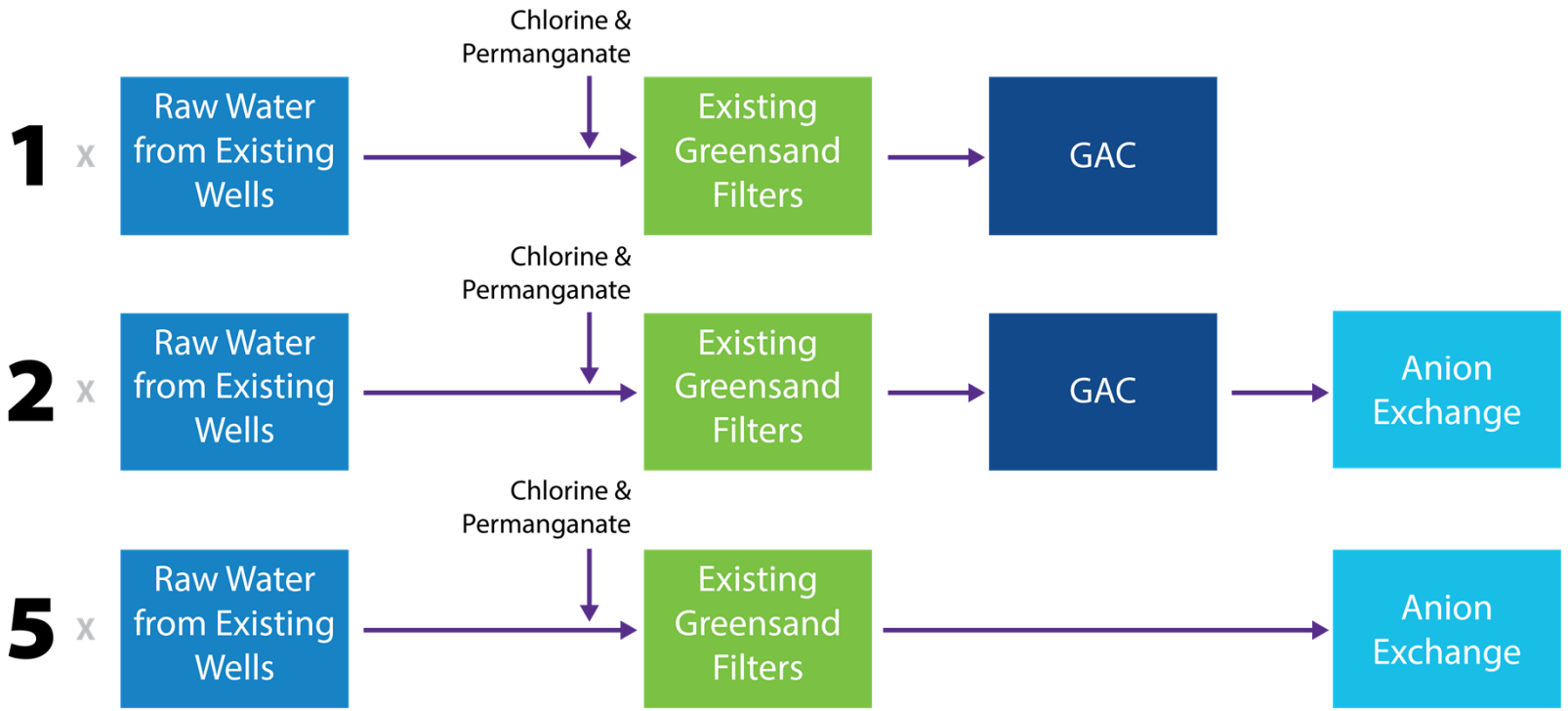
Bench Scale Testing: **GAC versus AIX**



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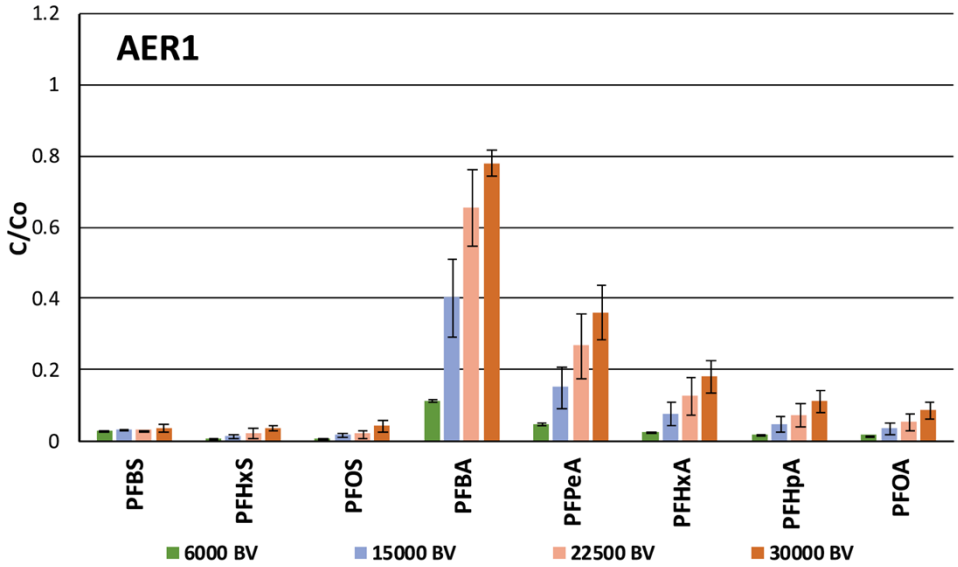
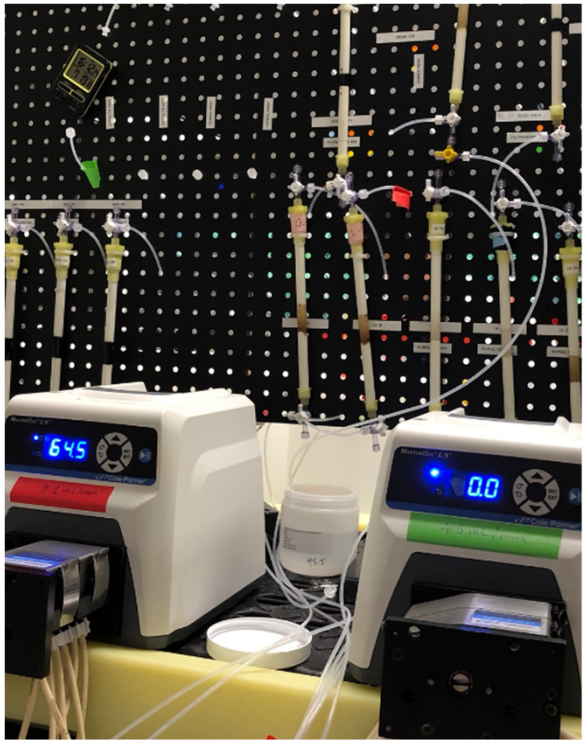
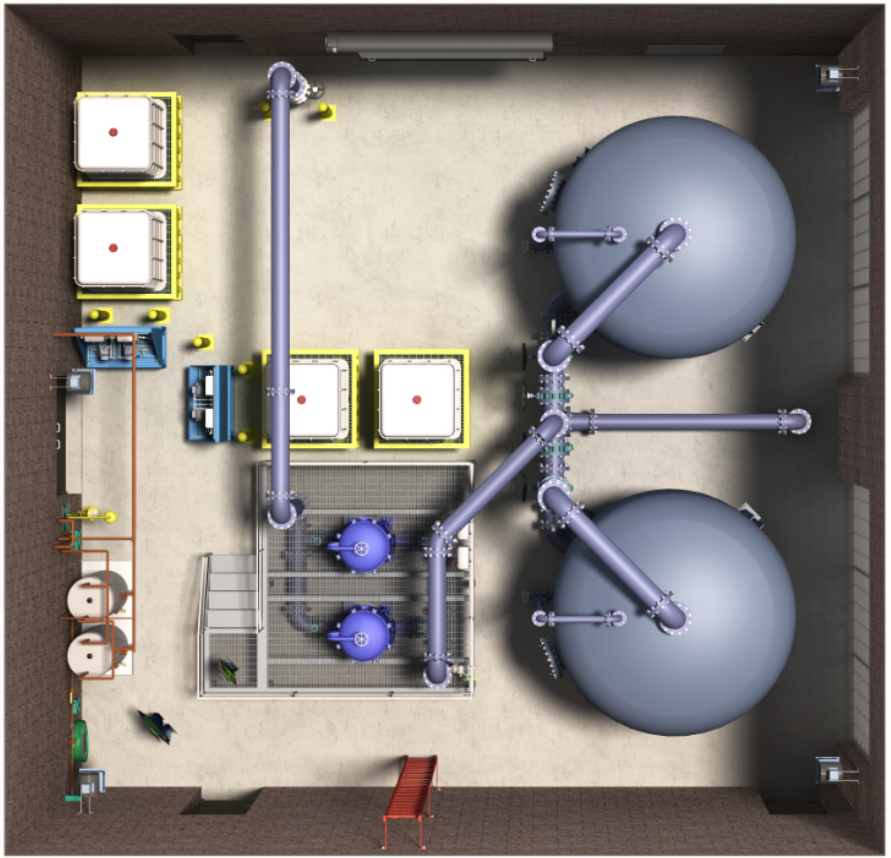




Schaefer, C.E. et al., *Industrial & Engineering Chemistry Research,* **2019,** *58* (22), 9701-9706



Membrane Technology

Relevant membrane tech includes low-pressure reverse osmosis and nanofiltration

Strength	Considerations
▸ Demonstrated significant removal of all PFAS compounds and other emerging contaminants ▸ Removal of PFAS with wide range of molecular weights	▸ Capital and operating costs ▸ Rejected concentrate discharge/management


Brunswick County, NC
© BSLRed

Low Pressure RO Technology Selection

for 35 MGD Facilities

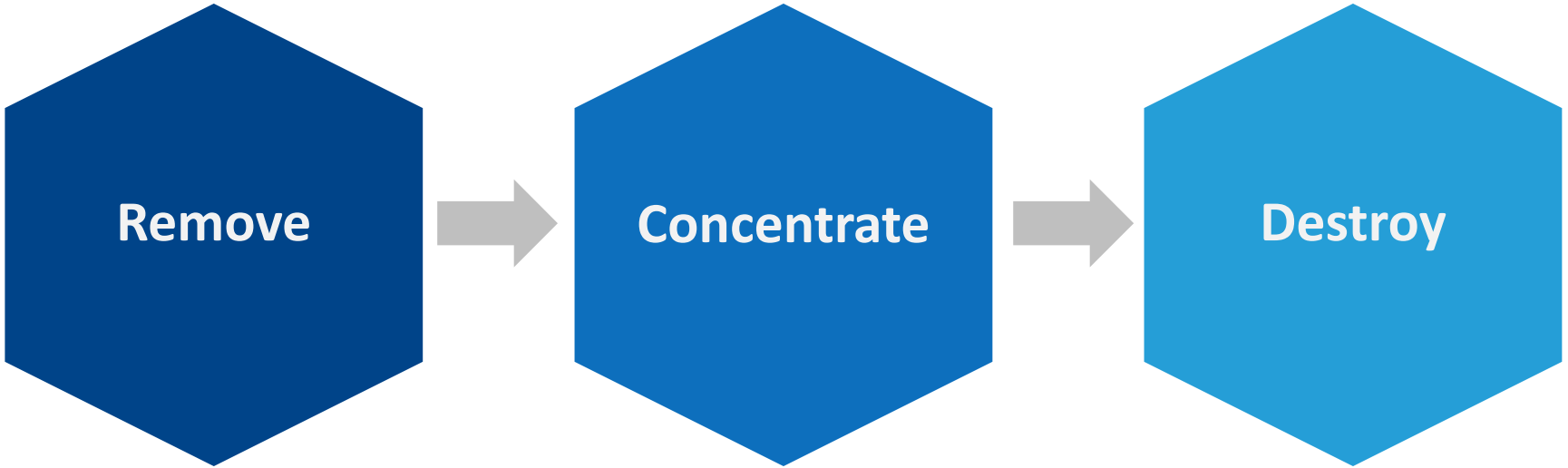
Parameter	Filtered Water Concentration	RO Treated Water	Calculated Removal %
Gen X	7-12 ng/L	ND	--
Nafion Byproduct 1 & 2	ND	ND	--
PFMOAA	320 - 750 ng/L	ND – 11 ng/L	98%+
PFO2HxA	12 – 26 ng/L	ND	--
PFHxA	19 – 20 ng/L	ND	--
PFPeA	16 – 17 ng/L	ND	
PFOS + PFOA	26 ng/L	ND	--
Sum (45) of PFAS Tested	423 –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

Lessons Learned

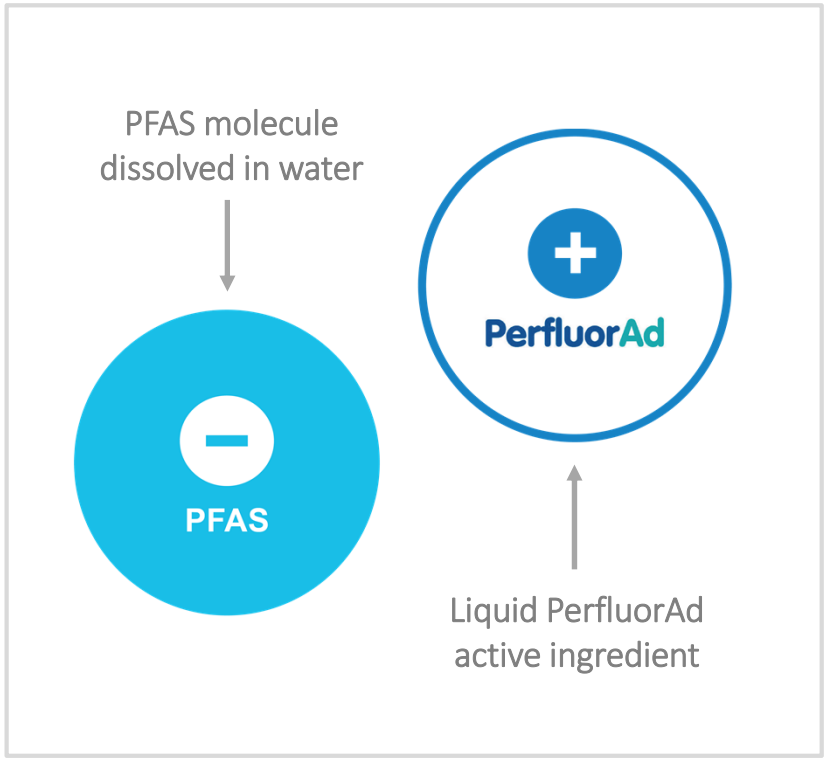
1. Engage a well-rounded project team
2. Life cycle assessment is critical
3. One technology does not fit all

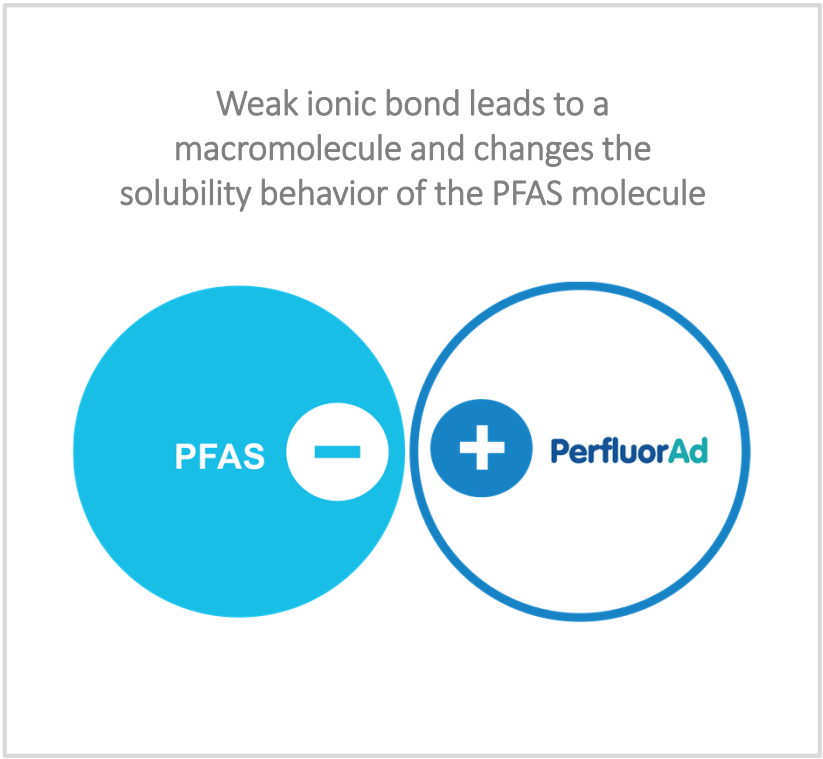

The Latest Research

Innovation Direction



PerfluorAd (Cornelsen)





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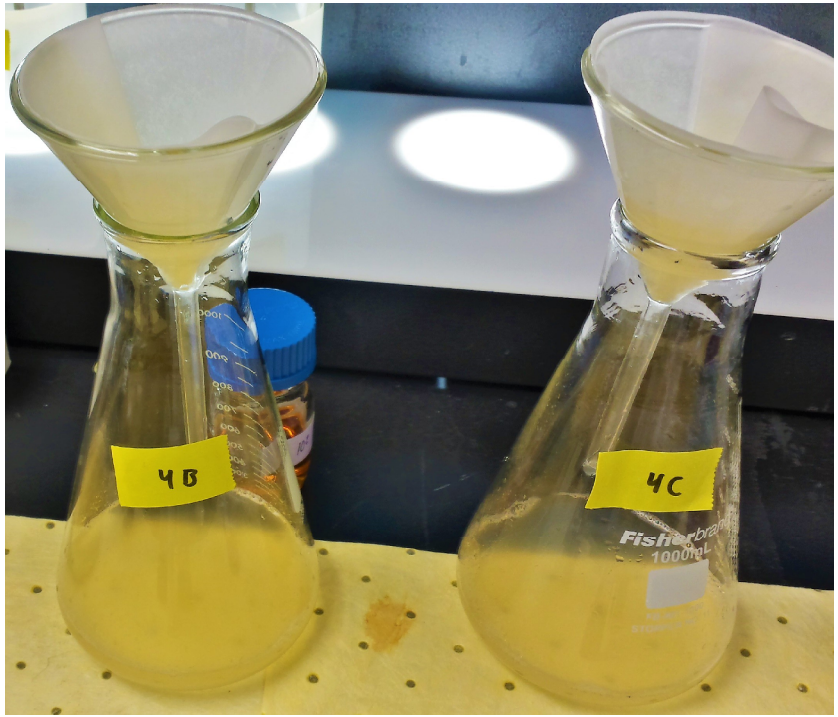
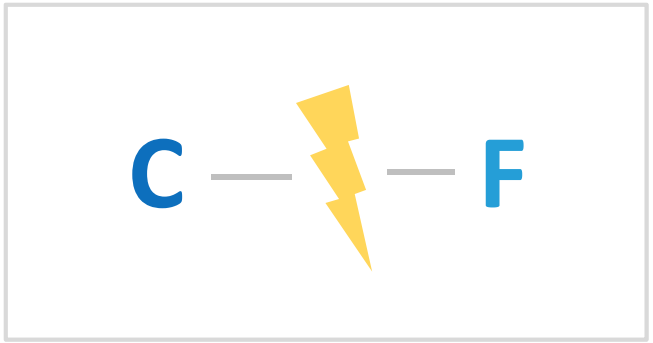


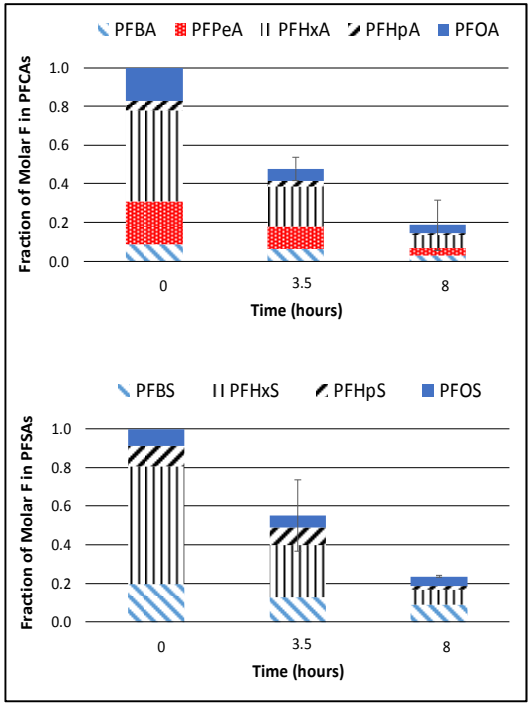
PFAS Destruction

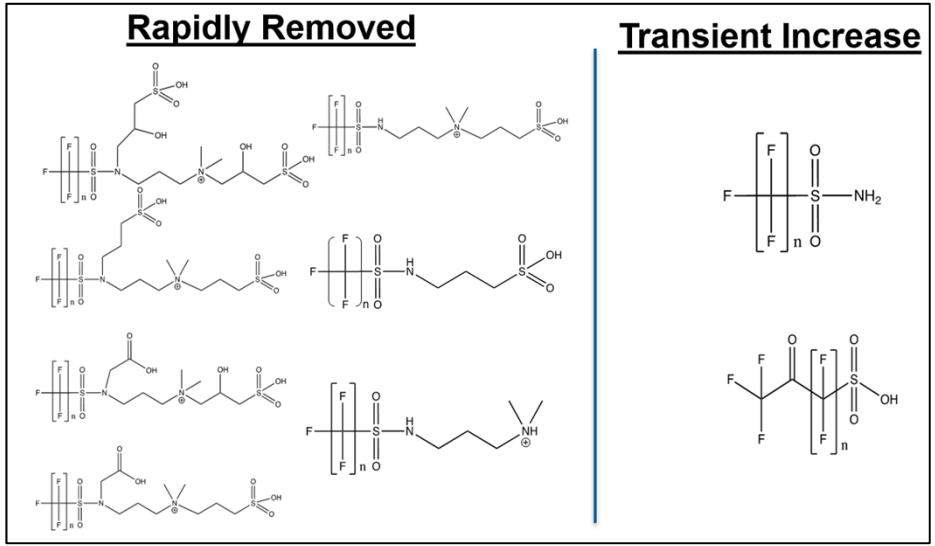
- Electrochemical
- Reductive Defluorination
- Thermal (Plasma)
- Ultrasound



Validating PFAS Destruction Technology

Electrochemical Oxidation of PFAS in AFFF impacted GW, Schaefer et al., ES&T, 2018





Priorities

1. Assess exposure pathways to prioritize mitigation strategy
2. Remove PFAS mass in the source area, if present
3. Consider use of low fluorine or fluorine free alternatives early
4. Bench or pilot testing as standard operating procedure
5. Develop communication tools

Final Thoughts

Contact Information

Panelists

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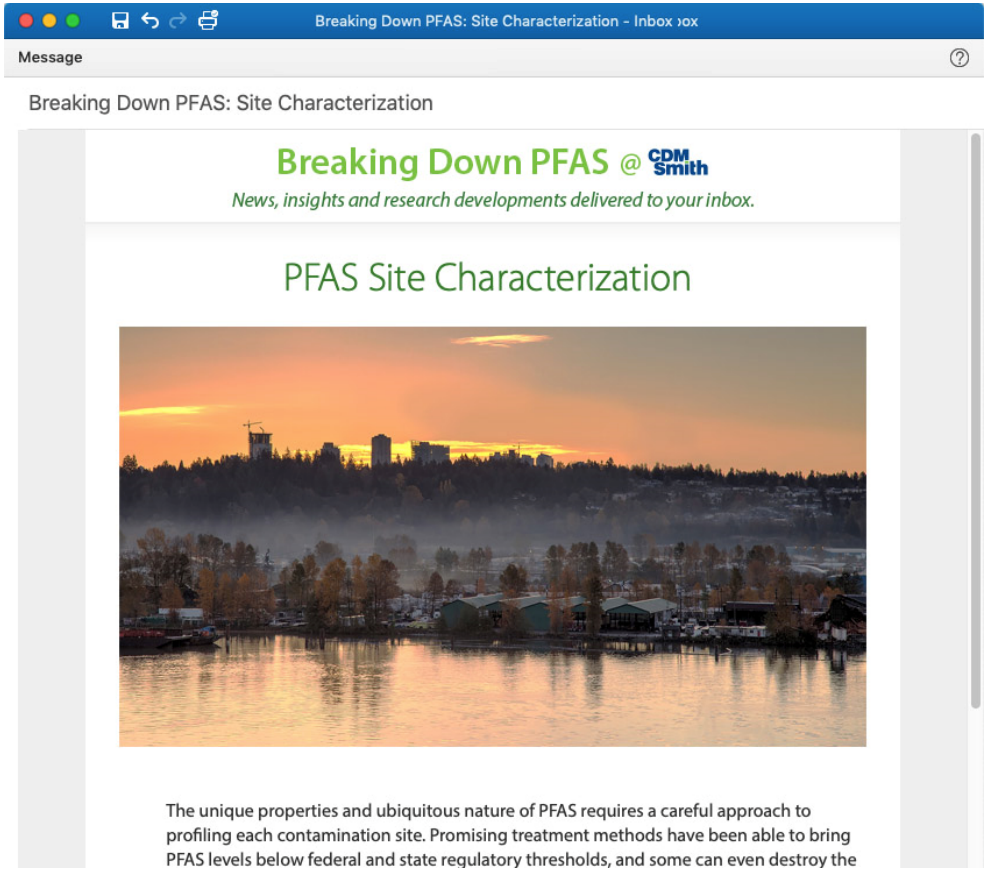

Thank You