North Central Texas
Council of Governments

Fighting PFAS Through Regulations and Remedies

NCTCOG Webinar
August 15, 2024

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United States
Environmental Protection
Agency

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

North Central Texas Council of Governments
Environment & Development

www.nctcog.org/WaterResources

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Webinar Procedures

- The webinar is being recorded and will be posted to NCTCOG's website under the green banner called "Webinars" here:

  https://www.nctcog.org/envir/natural-resources/water-resources

- If you submitted a RSVP for this webinar, you will receive an email with the presentation slides, and eventually, a link to the recording. If you did not RSVP and would like these webinar materials, please email aknox@nctcog.org.
- Please keep your microphone on mute until the Question-and-Answer period at the end of each presentation.
- Thank you!

Welcome and Introduction of Speakers

- **PFAS Environmental Concerns and Evolving Regulations-** J. Michael Trapp, Ph.D.
- **PFAS in Wastewater - From Research to Reality**- Samir Mathur, P.E., B.C.E.E.
- **PFAS Exposure Reduction: Findings from the National Academies of Sciences, Engineering, and Medicine Consensus Study, "Guidance on PFAS Exposure, Testing, and Clinical Follow-Up"** - Ned Calonge, M.D., M.P.H.
- Time for Q & A after each presentation

Speaker Introduction

J. Michael Trapp, Ph.D.

National Water Resources Market Lead, Atkins Global

PFAS CONCERNS :

ENVIRONMENTAL CONCERNS, AND EVOLVING REGULATIONS

J. Michael Trapp, Ph.D.,
National Water Resources Market Lead
AtkinsRéalis

Aug 15, 2024


PFAS
Perfluoroalkyl and Polyfluoroalkyl Substances
COSMETICS
FIREFIGHTING FOAM
STAIN RESISTANT FURNITURE
CARPETS
FASTFOOD PACKAGING
WATER RESISTANT CLOTHING
STAIN RESISTANT
PERSONAL CARE
NON-STICK COOKWARE
PESTICIDES
PAINT
PHOTOGRAPHY

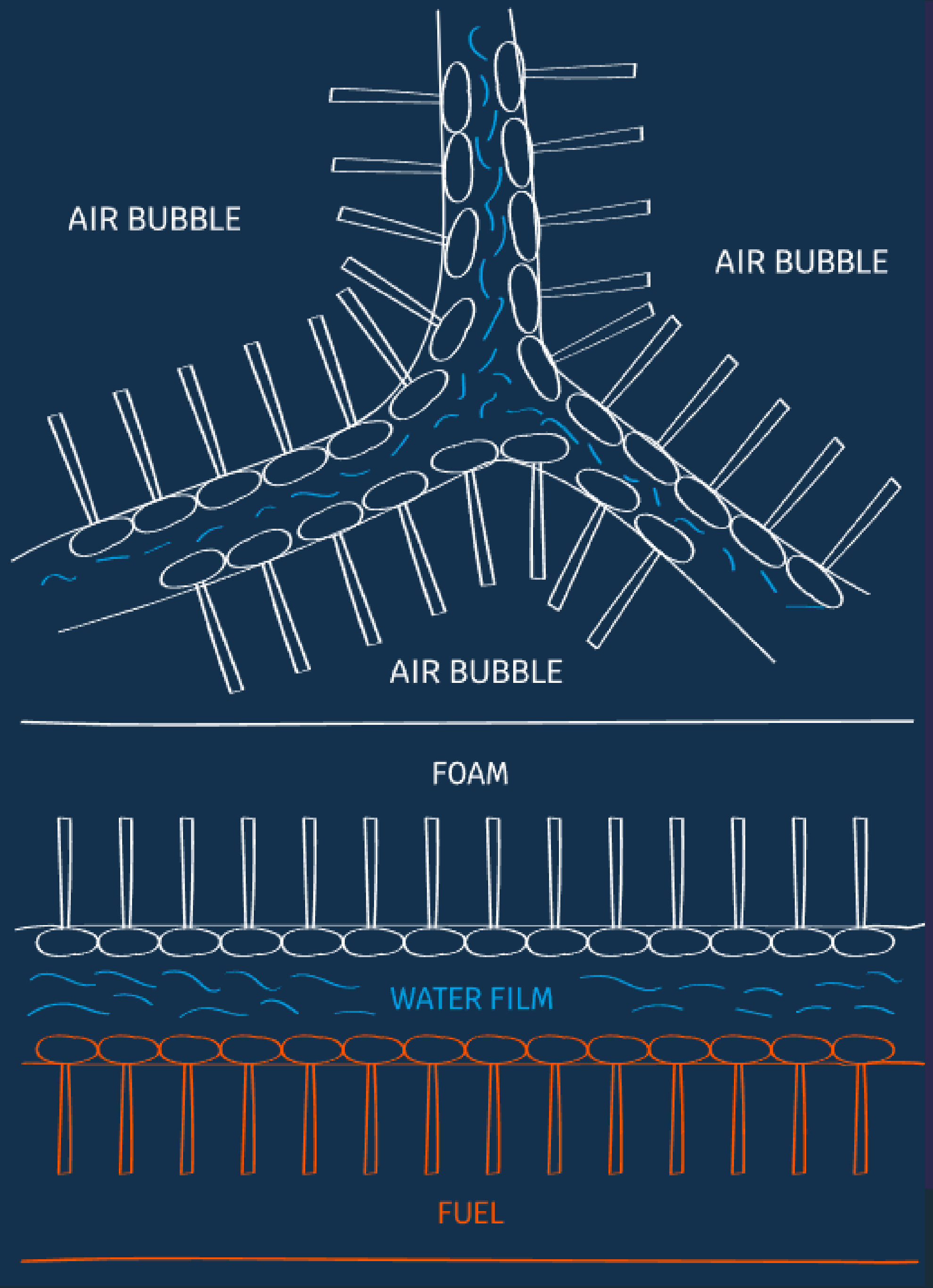
HISTORY OF AFFF AND THE FAA

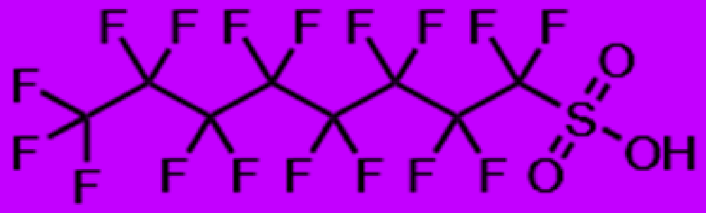
1960s- Originally developed by the US Navy, Aqueous Film-Forming Foam (AFFF) is used to fight liquid-fueled fire, and it is very effective in suppressing fires from jet fuel.

1970s- The Navy, along with the rest of the military extensively used AFFF. More than 90 airports and civilian fire departments also used AFFF.

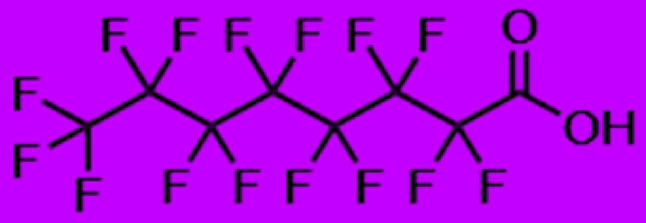
1980s- FAA required airports that provide commercial passenger service to use AFFF.

2022- DOD required to create effective firefighting foams without the use of PFAS.

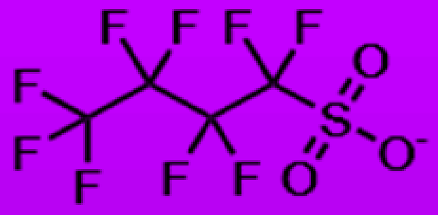




Perfluorooctanesulfonic acid



Perfluorooctanoic acid



Perfluorobutane sulfonate

How PFAS Cycle Through the Environment

A

PFAS, which are unregulated in industrial discharges, enter the environment through air, surface water and groundwater.

B

Nutrient-rich materials that remain after wastewater treatment and testing are used on farms as low-cost fertilizers. Significant contributions to wastewater from nearby industrial sites can lead to elevated PFAS levels in the residual materials that can seep into groundwater if not removed during treatment.

C

Firefighting foams containing PFAS were previously used at airports, military bases and training sites. In some sites, the runoff migrated through soil into surface and groundwater.

D

At older landfill sites, wastewater containing dissolved and suspended materials from contaminated waste may have leached into groundwater or entered surface water.

E

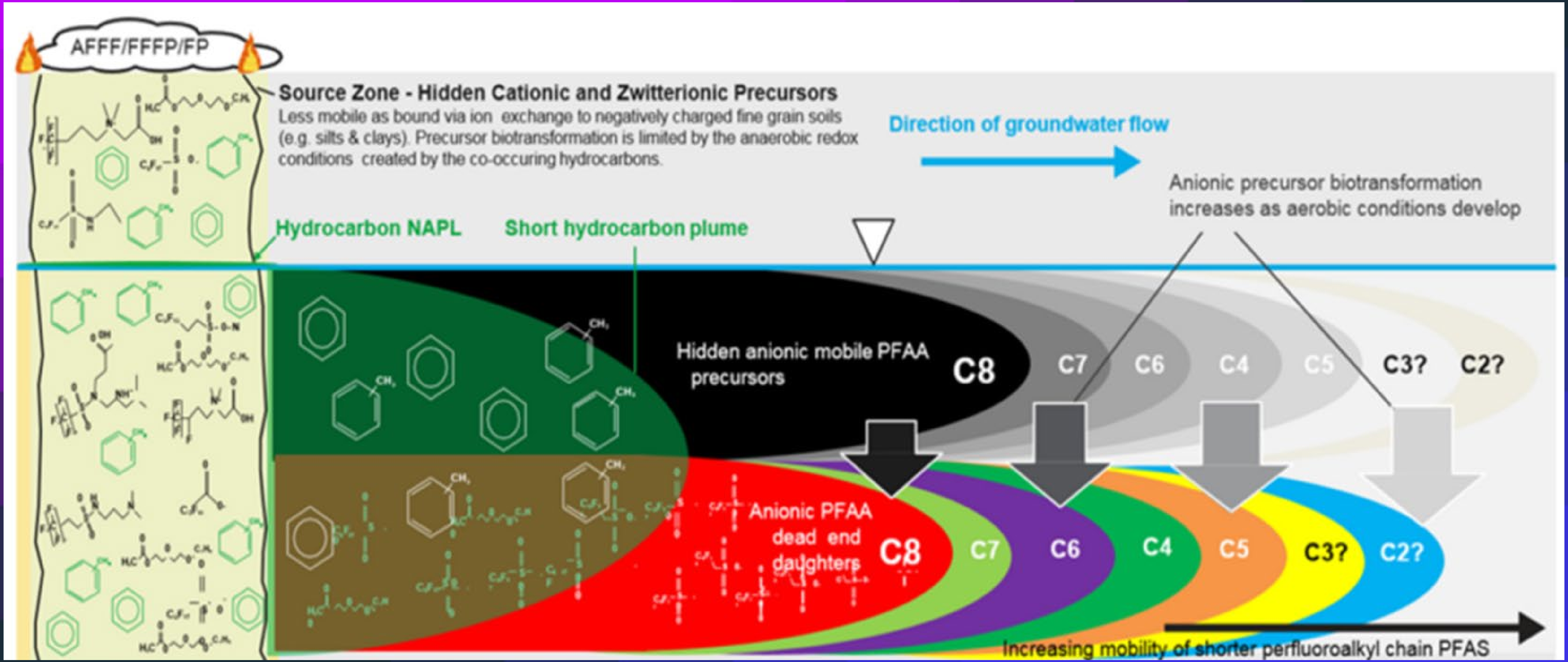
New technologies have enabled recent detection of PFAS in drinking water supplies. Water treatment facilities that hadn't previously known of PFAS in their water supplies are determining the most effective treatments for removal.

F

PFAS were used in common household products such as non-stick cookware, shampoo, food containers and paint. Because they don't easily break down, PFAS can accumulate in the human body and end up in source water and drinking water.

G

Liquid waste that seeps from landfills and wastewater are treated at wastewater plants, but PFAS may remain in the water after treatment and contaminate groundwater.

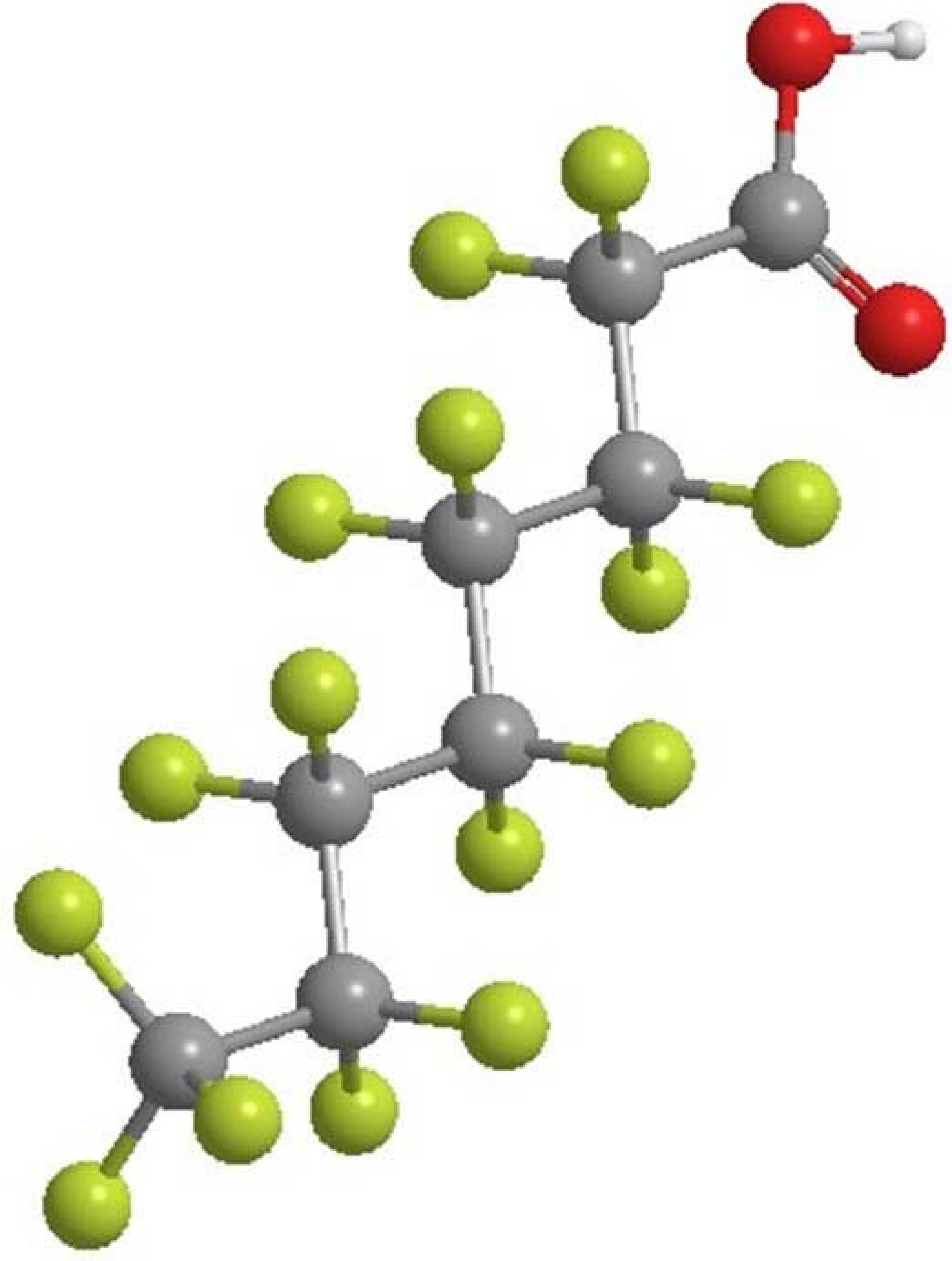

AFFF/FFFP/FP
Source Zone - Hidden Cationic and Zwitterionic Precursors
Less mobile as bound via ion exchange to negatively charged fine grain soils (e.g. silts & clays). Precursor biotransformation is limited by the anaerobic redox conditions created by the co-occuring hydrocarbons.
Direction of groundwater flow
Anionic precursor biotransformation increases as aerobic conditions develop
Hydrocarbon NAPL
Short hydrocarbon plume
Hidden anionic mobile PFAA precursors
C8
C7
C6
C4
C5
C3?
C2?
Anionic PFAA dead end daughters
C8
C7
C6
C4
C5
C3?
C2?
Increasing mobility of shorter perfluoroalkyl chain PFAS

Exposure Sources and Routes

- Occupational exposures
- Placental transfer
- Inhalation
- Ingestion
  - Drinking water from PFAS-contaminated sources
  - Eating food produced near places where PFAS were used or made
  - Eating fish caught from water contaminated by PFAS
  - Eating food from some types of grease-resistant paper or packaging (e.g., popcorn bags, fast food containers, pizza boxes, and wrappers)
  - Swallowing contaminated soil.

RESEARCH INDICATES PFAS:

- Alter cholesterol levels
- Disrupt thyroid function
- Harm liver and kidney function
- Alter immune response
- Raise risk of ulcerative colitis
- Harm reproductive health
- Increase the risk of birth defects
- Decrease infant birth weights
- Cause tumors and cancer



REGULATORY RESPONSE

History of Regulations (International)

Stockholm Convention on Persistent Organic Pollutants (POPs) 2004

- 2009 - Eliminate the production and use of PFOS under most circumstance
- 2010 - Ban the use of firefighting foams containing PFOA and removed exemptions for the use of PFOS

History of Regulations (Domestic)

EPA Regulatory Authority

- Toxic Substances Control Act (TSCA),
- Safe Drinking Water Act (SDWA),
- Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA),
- Other regulatory authorities

History of Regulations (Domestic)

2002 - 2 Significant New Use Rules (SNURs) - notification about the manufacture or import

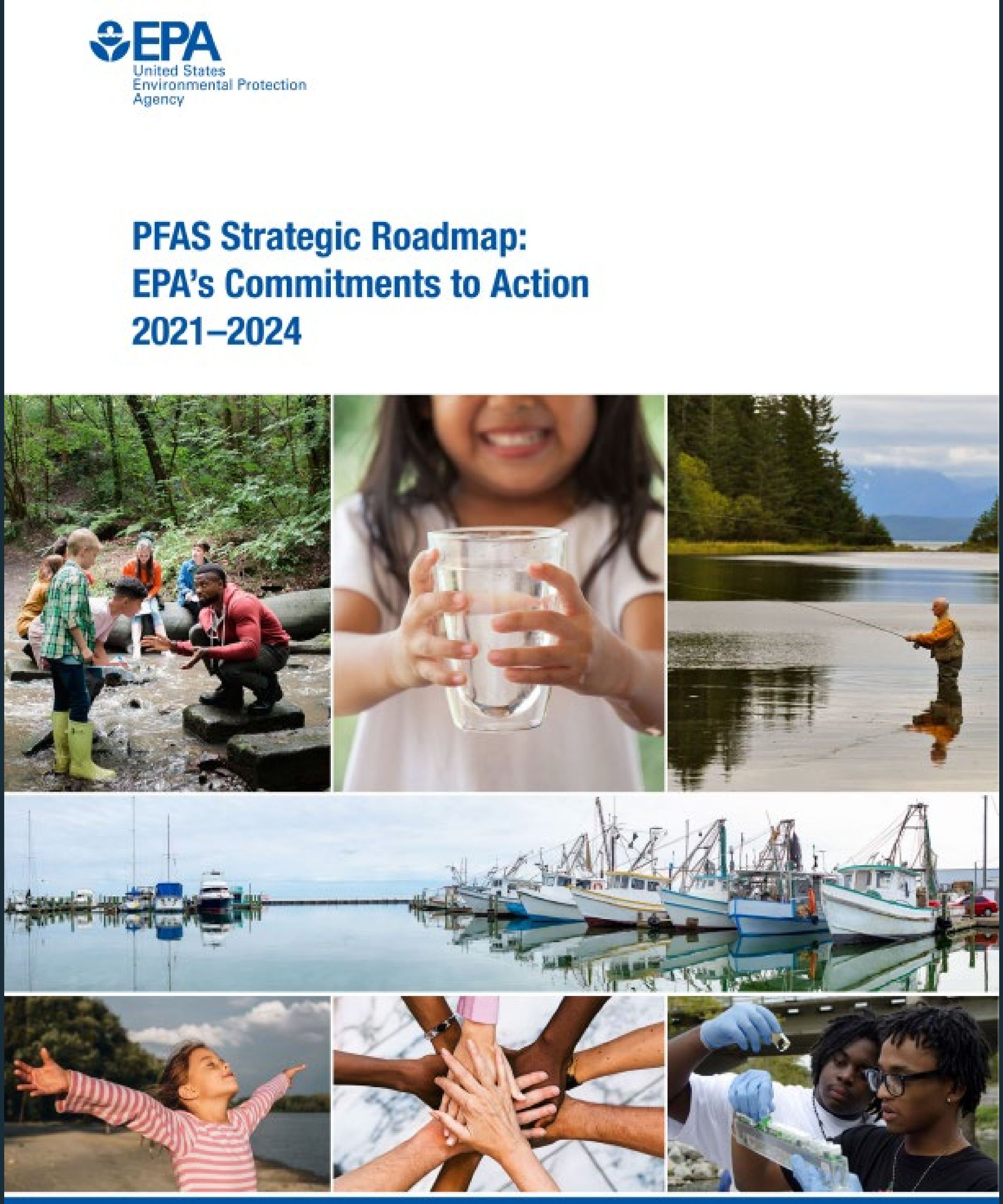
2006 - PFOA Stewardship Program, (95% reduction)

2009 - SDWA provisional health advisories

2013 - UCMR 3 Monitoring Program

2016 - Lifetime drinking water health advisory level of 70 ppt

2018 - Agency for Toxic Substances and Disease Registry's (ATSDR) Toxicological Profile for PFOS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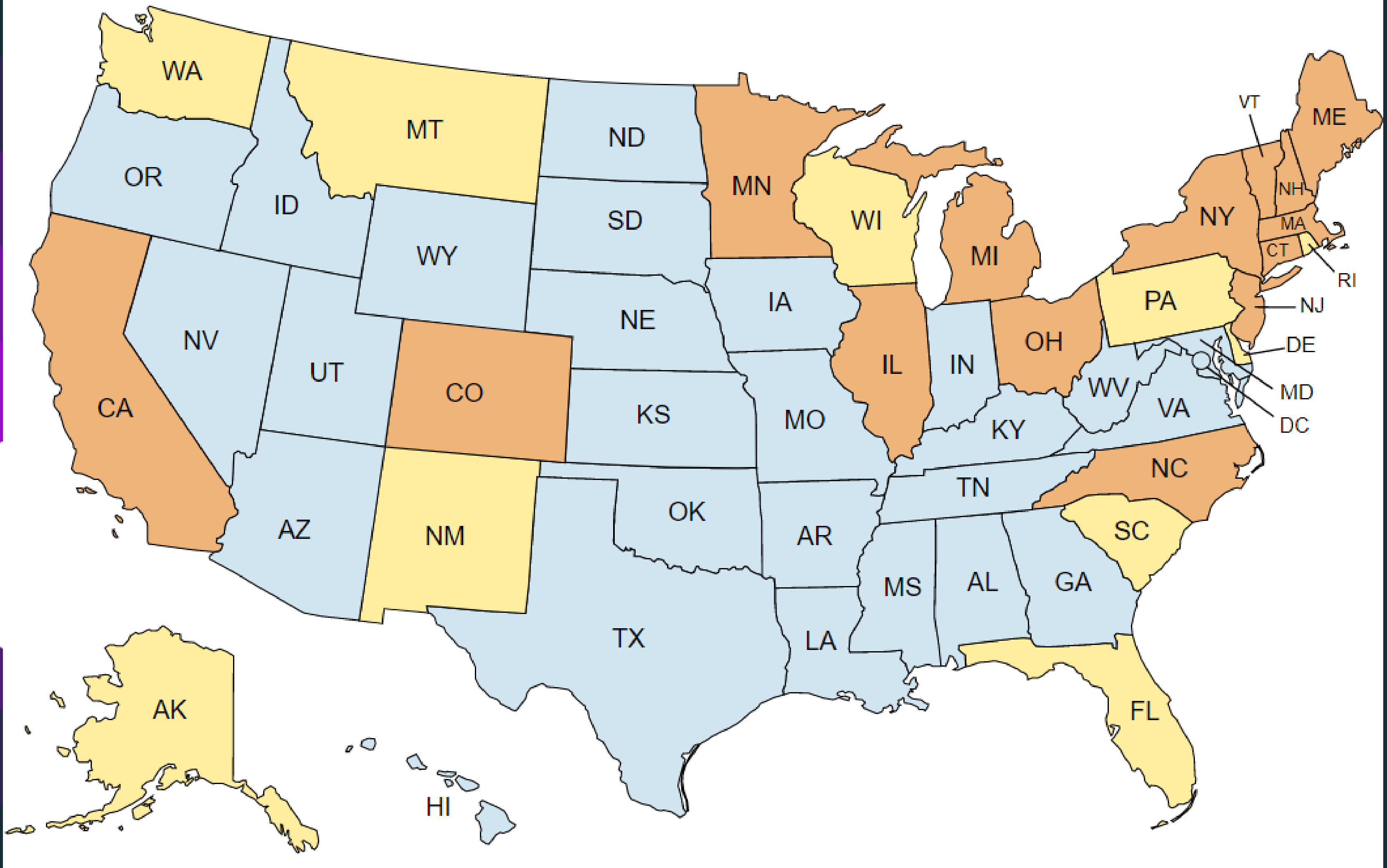
PFAS Strategic Roadmap:
EPA's Commitments to Action
2021–2024

History of Regulations (States)



= no promulgated regulations / no information available
= adopted standard equal to or less stringent than 70 ppt / additional regulation in progress
= adopted standard more stringent than 70 ppt / adopted standard for additional PFAS

United States Environmental Protection Agency

Safe Drinking Water Act

Per- and Polyfluoroalkyl Substances (PFAS)

Final PFAS National Primary Drinking Water Regulation

Compound	Final MCLG	Final MCL (enforceable levels)
PFOA	Zero	4.0 parts per trillion (ppt) (also expressed as ng/L)
PFOS	Zero	4.0 ppt
PFHxS	10 ppt	10 ppt
PFNA	10 ppt	10 ppt
HFPO-DA (commonly known as GenX Chemicals)	10 ppt	10 ppt
Mixtures containing two or more of PFHxS, PFNA, HFPO-DA, and PFBS	1 (unitless) Hazard Index	1 (unitless) Hazard Index

$$HI\ MCL = \left(\frac{[HFPO-DA_{water}]}{[10\ ppt]}\right) + \left(\frac{[PFBS_{water}]}{[2000\ ppt]}\right) + \left(\frac{[PFNA_{water}]}{[10\ ppt]}\right) + \left(\frac{[PFHxS_{water}]}{[10\ ppt]}\right) = 1$$

Implementation Timeframes

Within three years of rule promulgation (2024 – 2027):

- Initial monitoring must be complete

Starting **three years following** rule promulgation (2027 – 2029):

- Results of initial monitoring must be included in Consumer Confidence Reports (i.e., Annual Water Quality Report)
- Regular monitoring for compliance must begin, and results of compliance monitoring must be included in Consumer Confidence Reports
- Public notification for monitoring and testing violations

Starting **five years following** rule promulgation (starting 2029)

- Comply with all Maximum Contaminant Levels (MCLS)
- Public notification for MCL violations

Implications of Regulations

Total Cost Estimates

- APWA estimated $37.1 to $48.3 billion in CI and $2.7 to $3.5 billion in O&M (next 5 years)

PFAS Funding and Technical Assistance

- $9 billion communities impacted by PFAS
- $12 billion in BIL funding general drinking water improvements

PWS Class Action Lawsuit

Federal Class Action MDL

- 3M $12.5 B
- DuPont $1.2 B
- TYCO $750 M
- BASF $312.5M

Deadline Description	Dupont Deadline Date	3M Deadline Date	Tyco Deadline Date	BASF Deadline Date
Deadline to Submit Objections	11/11/2023	11/11/2023	8/24/2024	9/15/2024
Deadline to Submit Requests for Exclusion	12/4/2023	12/11/2023	9/23/2024	10/15/2024
Court's Final Fairness Hearing	12/14/2023	2/2/2024	11/1/2024 at 11:00 AM EST	11/1/2024 at 12:00 PM EST
Deadline to Withdraw Request for Exclusion	3/15/2024	3/15/2024	11/1/2024 at 11:00 AM EST	11/1/2024 at 12:00 PM EST
Phase One Public Water System Settlement Claims Form	**7/26/2024**	**7/26/2024**	**Effective Date + 60 Days**	**TBD**
Phase One Special Needs Claims Form	**8/26/2024**	**8/26/2024**	**PWS Claims Form Deadline + 45 Days**	**TBD**
Phase Two Testing Claims Form	1/1/2026	1/1/2026	N/A	N/A
Phase Two Public Water System Claims Form	6/30/2026	7/31/2026	N/A	N/A
Phase Two Special Needs Claims Form	8/1/2026	8/1/2026	N/A	N/A
Phase One Supplemental Fund Claims Form	12/31/2030	12/31/2030	12/31/2030	TBD
Phase Two Supplemental Fund Claims Form	12/31/2030	12/31/2030	N/A	N/A

https://www.pfaswatersettlement.com

WHERE DOES IT GO FROM HERE?

If you put five lawyers in a room, you will get at least ten opinions on the impacts of recent supreme court decisions on environmental regulations.

-Wayne Rosenbaum, The Environmental Law Group

AtkinsRéalis

Impact of Chevron

LOPER BRIGHT, FINAL RULE INJUNCTIONS, AND MORE – JUST HOW MESSY ARE THINGS GOING TO GET?

AUGUST 6, 2024

NWRA and others challenge EPA's PFAS hazardous substance designation in federal court

NWRA, along with two other groups, want the court to consider whether the EPA incorrectly interpreted regulations and imposed "retroactive liability" when crafting the PFAS hazardous substance rule.

Developing Regulations

Biosolids disposal and land application

WWT & landfill effluent standards

Surface water guidance

New PFAS Reporting and Recordkeeping

PFAS in Fluorinated Plastic Containers

PFAS in Cookware

Speaker Introduction

Samir Mathur, P.E., B.C.E.E

Senior Vice President and Water Reclamation Practice Leader– CDM Smith

PFAS in Wastewater – From Research to Reality

Translating PFAS Research for Practitioners

Samir Mathur
CDM Smith

NCTCOG PFAS Seminar

August 15, 2024

CDM Smith

Agenda

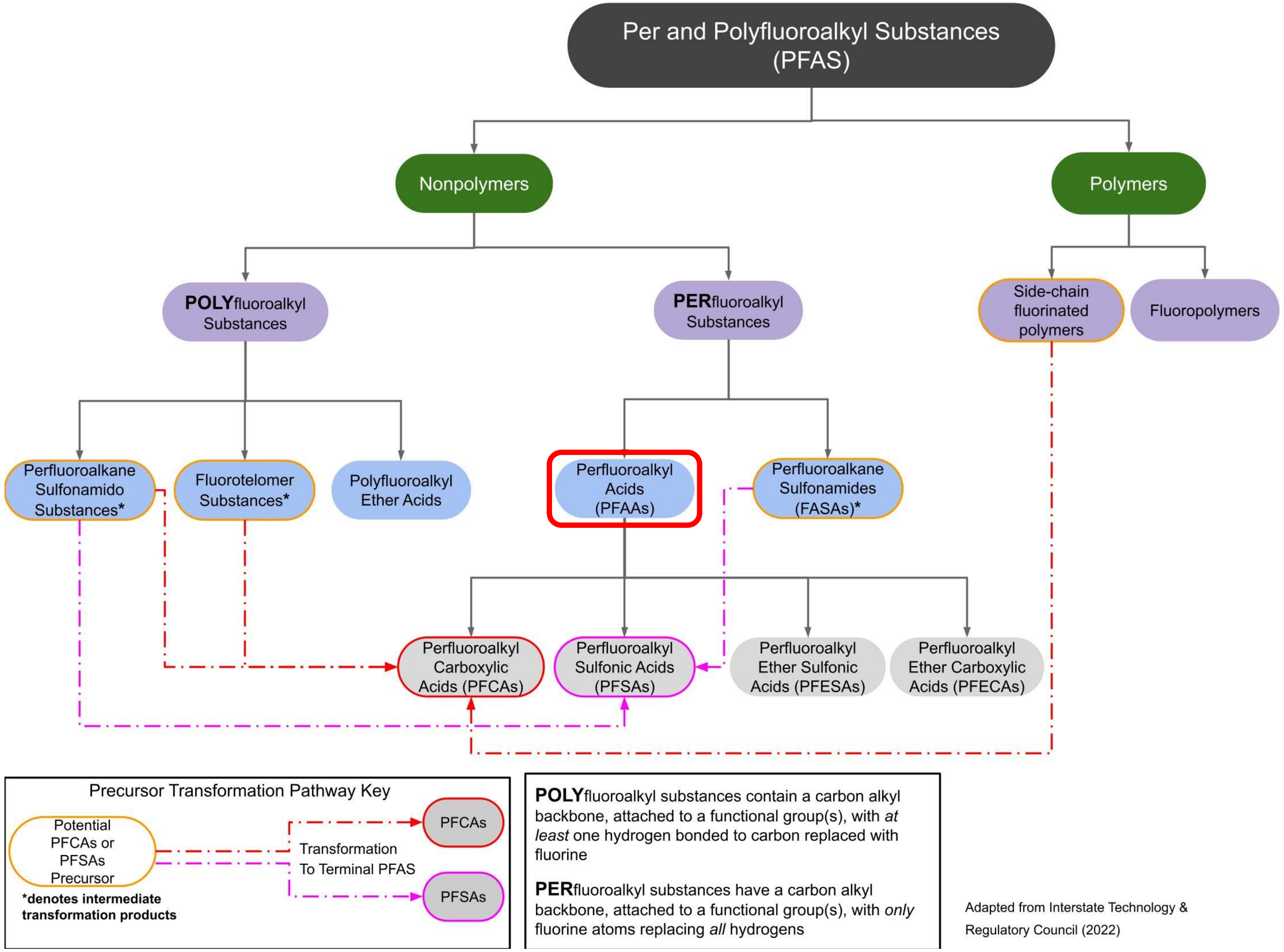
1. **Introduction**
   - Regulatory environment
   - Scientific landscape
   - The importance of linking science and practice
2. **Water Research Foundation (WRF) Projects**
   - WRF 5031. Do I have PFAS in my influent or effluent?
   - WRF 5082. Where is PFAS coming from?
   - WRF 5042. Is there PFAS in my biosolids?
   - WRF 5214. Does PFAS from biosolids reach groundwater?
   - WRF 5212. Does PFAS end up in aerosols, scum, and sidestream?
3. **Conclusion**

PFAS Fundamentals

Long Chain PFAA = PFOS and PFOA (8 or more carbon)

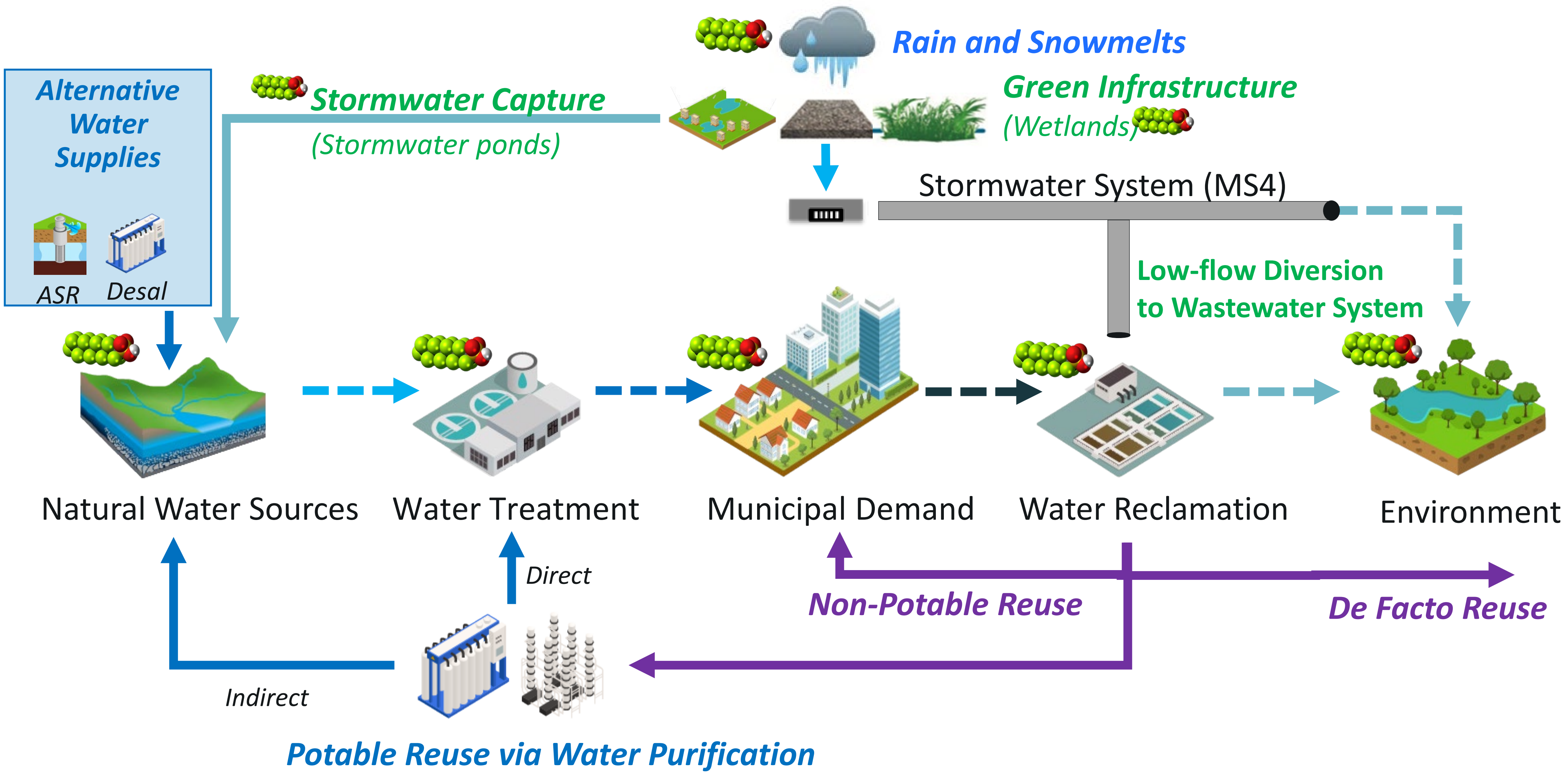
Short chains = GenX C6, 6:2 FTOH (<8 Carbon)

Ultra shorts (2-3 carbon only)



Source: San Francisco Estuary Institute and Aquatic Water Science Center

PFAS is Detected in Every Part of the "One Water" Cycle



Regulations and Actions Differ by State

Federally, US EPA actively conducting risk evaluation of PFOA & PFOS in biosolids

Anticipated completion Q4 2024

Some states require monitoring more PFAS compounds:
California, Colorado, Minnesota, Michigan, New Hampshire, Pennsylvania, New Jersey, Massachusetts

Some states have interim land application limits – Michigan, New York, Connecticut, Vermont (and some Canadian provinces)

Some states banned land application - Maine

EPA PFAS Roadmap for Biosolids

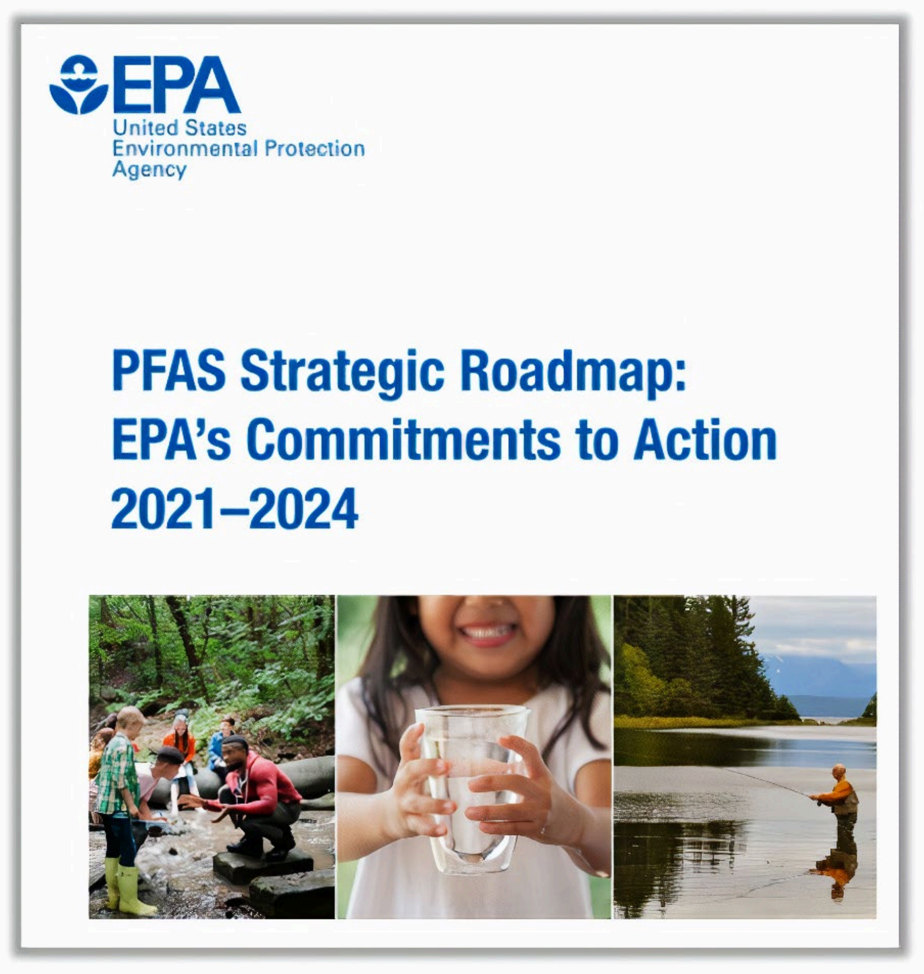
Winter 2024: Completion of the risk assessment for PFOA and PFOS

2025-2026: Anticipated that EPA would issue a Final Rule

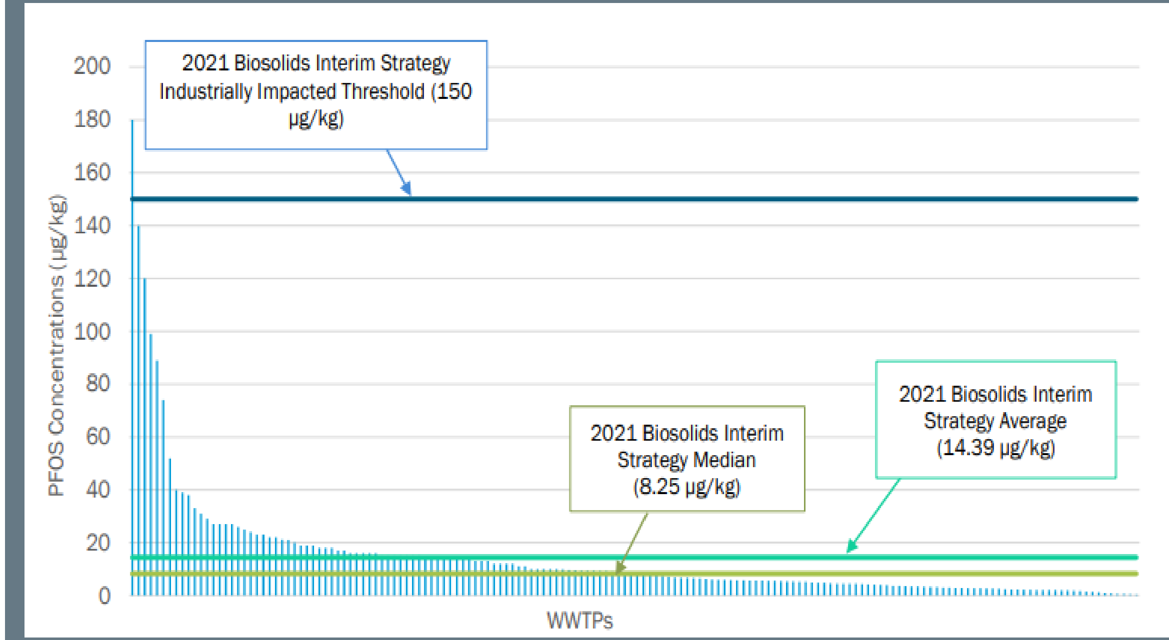
2026-2031: Assuming a 5-year compliance schedule

The risk assessment will serve as the basis for determining whether regulation of PFOA and PFOS in biosolids is appropriate

Interim Guidance on PFAS Destruction and Disposal - Published April 9, 2024 (previously this was used to guide EPA funding)



Michigan EGLE – Biosolids Land Application Interim Strategy



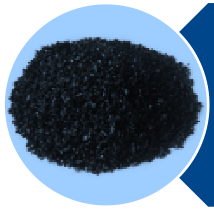
Source: Michigan EGLE: Updated interim strategy, April 2022 (MI EGLE Interim Strategy)

Strategy effective July 1, 2022

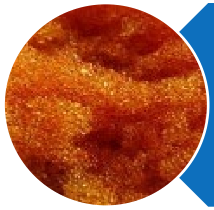
- **PFOS > 125 µg/Kg (ppb)**
  - No land application allowed
  - Investigate source reduction
- **PFOS > 50 µg/Kg (ppb)**
  - Land application allowed
  - Max 1.5 dt/acre
  - Investigate source reduction
- **PFOS < 50 µg/Kg (ppb)**
  - Land application allowed
  - If PFOS > 20 ppb, consider investigating sources

EPA is reportedly adopting this strategy!

Proven Treatment Technologies for PFAS Removal



Granular Activated Carbon (GAC)



Anion Exchange (AIX)

NF and RO Membranes

THE Water Research FOUNDATION

Table 2-1. Summary of PFAS removals for various treatment processes.

Compound		Molecular Weight (g/mol)	Aeration	Coagulation/Dissolved Air Flotation	Coagulation/Flocculation/ Sedimentation/Granular Filtration or Microfiltration	Anion Exchange	Granular Activated Carbon Filtration	Nanofiltration	Reverse Osmosis	Permanganate/Ozone/ Hypochlorous/Hypochlorite/ Chloramination/UV photolysis
	PFBA	214	● (assumed)	● (assumed)	●	●	●	■	■	●
	PFPeA	264	●	●	●	●	▼	■	■	●
	PFHxA	314	●	●	●	●	▼	■	■	●
	PFHpA	364	●	●	●	▼	■	■	■	●
	PFOA	414	●	●	●	▼	■	■	■	●
	PFNA	464	●	Unknown	●	■ (assumed)	■ (assumed)	■	■	●
	PFDA	514	●	Unknown	●	■ (assumed)	■ (assumed)	■	■	●
	PFBS	300	●	●	●	▼	■	■	■	●
	PFHxS	400	●	●	●	■	■	■	■	●
	PFOS	500	●	▼	●	■	■	■	■	●
	FOSA	499	Unknown	Unknown	●	Unknown	■ (assumed)	Unknown	■ (assumed)	Unknown
	N-MeFOSAA	571	● (assumed)	Unknown	●	■ (assumed)	■ (assumed)	■ (assumed)	■	Unknown
	N-EtFOSAA	585	●	Unknown	●	■ (assumed)	■ (assumed)	■ (assumed)	■	Unknown

From Dickerson & Higgins, 2016 (WRF, #4322)

● Removal <10% ▼ Removal 10-90% ■ Removal >90% ☐ Unknown ☐ Assumed

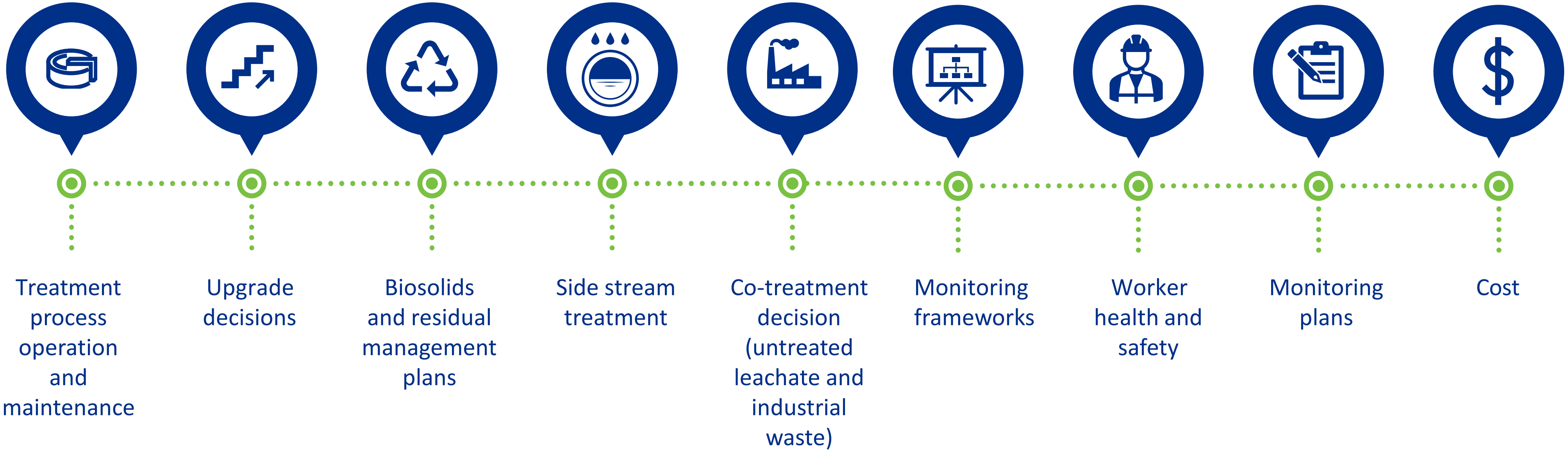
WRF 4322: Treatment Mitigation Strategies for PFCs

Limitations of “Conventional” PFAS Treatment

- High volume of spent media/waste stream requiring waste management
- Significant pretreatment often required to remove competing solutes
- High concentrations of PFAS can lead to inefficient target compound removal
- Overall high costs for removing small mass of contamination (down to trace ppt levels)

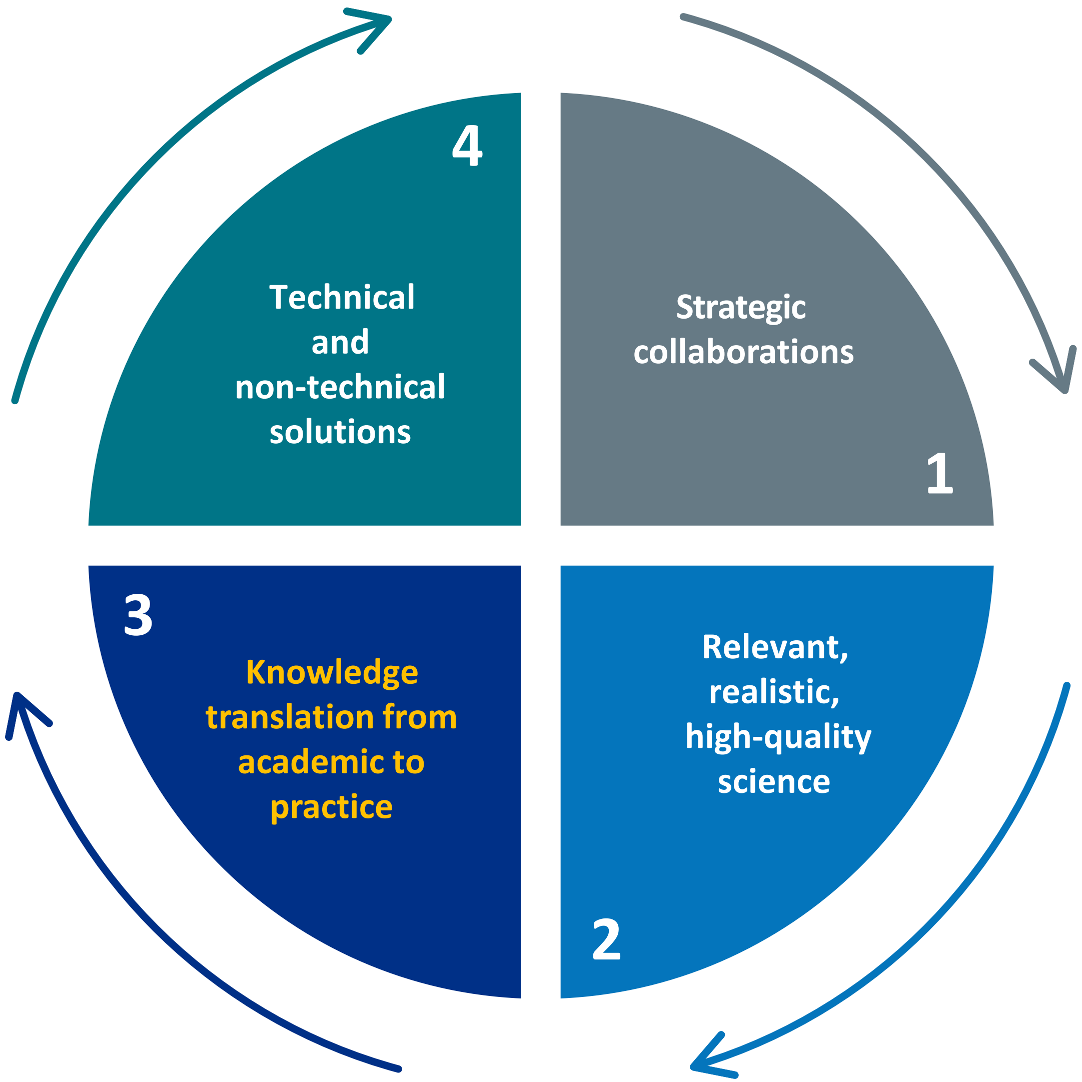
What This Means in Practice

While the primary PFAS focus has been on water supplies in the past, now state regulators and legislators are shifting to wastewater treatment plants (WWTPs) and establishing regulations that could have **significant consequences on how we manage our plants**



Can research results help guide our decision making?

Essential Building Blocks of Successful PFAS Research



WRF 5031: Occurrence of PFAS Compounds in US WWTPs

Do I have PFAS in my influent or effluent?

WRF 5031: Occurrence of PFAS Compounds in US WWTPs (2020-2024)

Main goal:

- To provide utilities with a comprehensive, consistent dataset regarding PFAS occurrence, fate, and mass distribution in liquid, solid, and gaseous phases at WWTPs

Objectives:

- Study occurrence and partitioning of PFAS compounds and their precursors in 38 WWTPs, and their fate in treatment
- Determine the impacts of treatment processes on PFAS fate and partitioning (e.g., aeration)
- Assess PFAS phase behavior and the extent to which these impact PFAS mass flows in WRRFs
- Develop guidelines for PFAS management based on the data reviewed and collected

The Team

Charles Schaefer (CDM Smith, PI)

Dina Drennan (CDM Smith)

Jen Hooper (CDM Smith)

Eric Dickenson (SNWA)

Detlef Knappe (North Carolina State University)

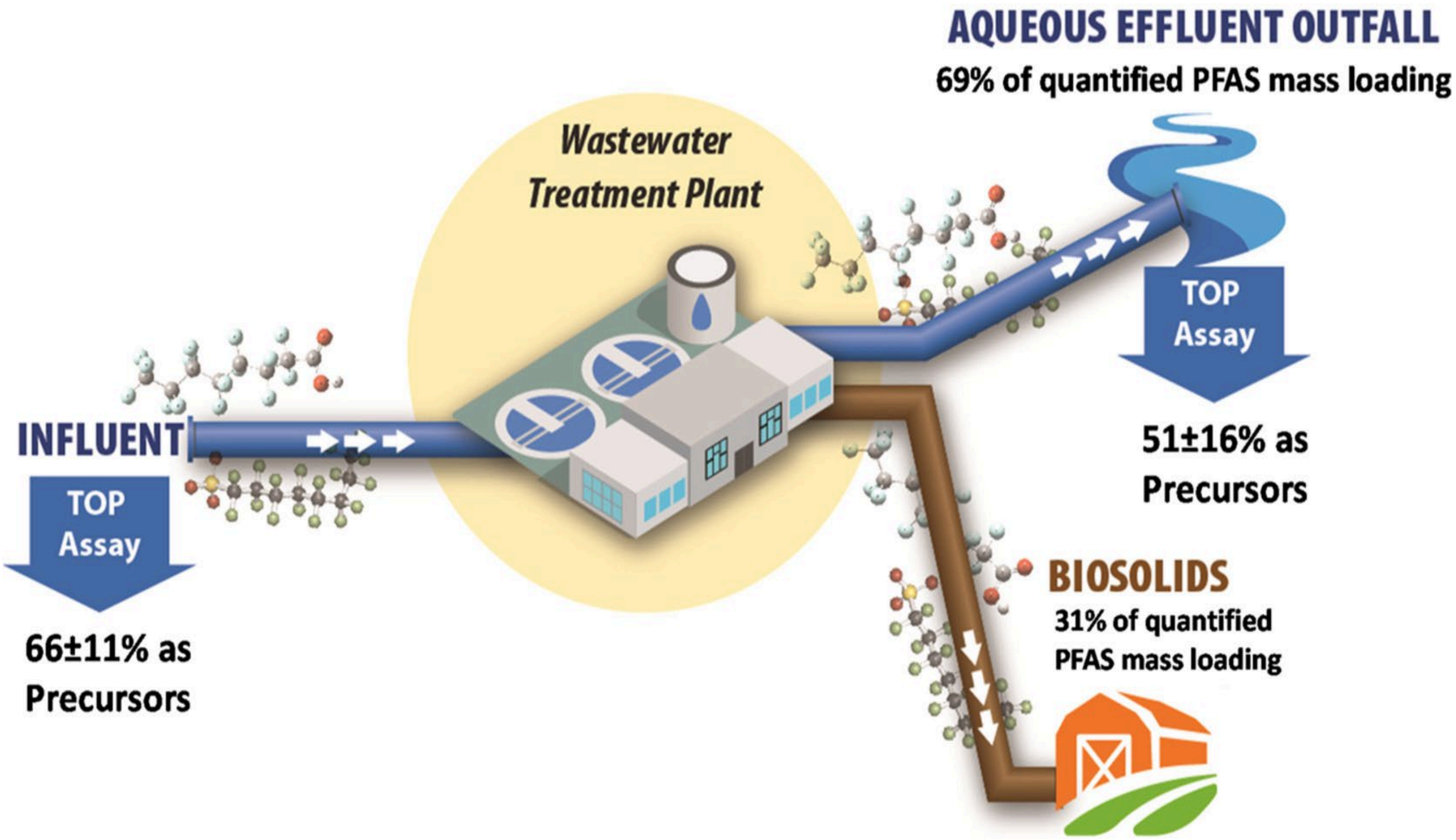
Gaya Ram Mohan (Gwinnett County)

Jennifer Guelfo (Texas Technical University)

WRF 5031: Occurrence of PFAS Compounds in US WWTPs (2020-2024)

Results	Implications
PFAS was detected in the influent, effluent, and biosolids at all the 38 WWTPs sampled	Regulations would impact every utility to varying degrees
Concentrations of PFOA are declining over time in wastewater effluent, but are still at concentrations of concern relative to state regulations	PFOA concentrations may impact direct potable reuse applications and utilities with high levels of de facto reuse
In some WWTPs, the concentrations of PFAS in effluent were higher than those in influent	WWTP biological processes may facilitate precursor transformations to PFAA
Transformation of precursors sustained PFAS release from biosolids	Adapting to new regulation could require significant CAPEX and potentially result in solids handling challenges

WRF 5031: Occurrence of PFAS Compounds in US WWTPs (2020-2024)



WRF 5082: Investigation of Management Strategies to Prevent PFAS from Entering Drinking Water Supplies and Wastewater

Where is PFAS coming from?

WRF 5082: Investigation of Management Strategies to Prevent PFAS from Entering Drinking Water Supplies and Wastewater (2021-2024)

Main goal:

- To provide utilities with practical, implementable, and cost-effective guidance on PFAS source evaluation and mitigation

Objectives:

- Collect existing data and utility experiences from a wide range of sources (e.g., case studies, database reviews)
- Fill PFAS source data gaps in wastewater, surface water, and groundwater systems through a combination of sampling and coordination with other ongoing efforts
- Develop guidance to address PFAS sources and points of intervention focusing on practical, implementable solutions

The Team

Eva Steinle – Darling (Carollo, PI)

Jen Hooper (CDM Smith)

Charles Schaefer (CDM Smith)

Eric Dickenson (SNWA)

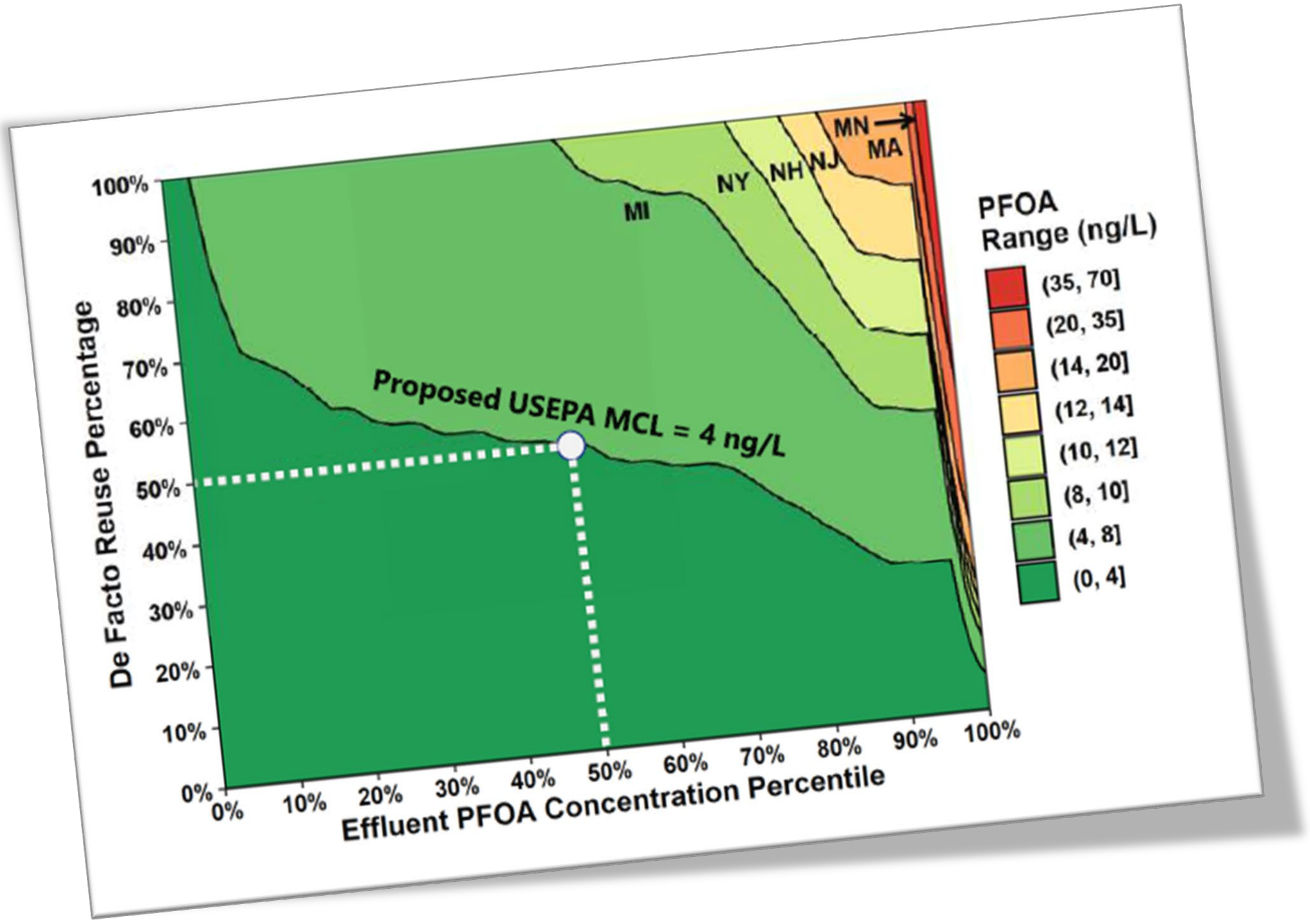
Paul Westerhoff (Arizona State University)

Linda Lee (Purdue University)

Dana Gonzalez (HRSD)

WRF 5082: Investigation of Management Strategies to Prevent PFAS from Entering Drinking Water Supplies and Wastewater

- Major implications to utilities relying on de facto reuse
- Drinking water intake with:
  - Median WW effluent PFOA upstream
  - 50% de facto reuse
  - PFOA ≈ 4 ng/L federal limit
- Sources
  - Data: Schaefer et al. WRF 5031
  - Graph: Eva Steinle-Darling (PI, WRF 5082)



WRF 5082: Investigation of Management Strategies to Prevent PFAS from Entering Drinking Water Supplies and Wastewater (2021-2024)

Results		Implications
Domestic wastewater accounted for half of total measured PFAS in the WWTP influent	→	Source control and industrial pretreatment has limitations in terms of PFAS control because of the domestic baseload
The majority of measured PFAS and at least 48% of individual PFAS entered the Las Vegas Wash through WWTPs	→	WWTPs are not the original PFAS sources but conduits even in the absence of major industrial point sources
PFAS contamination sites show that landfills and electroplating are relatively common point sources of PFAS to groundwater	→	Characterizing PFAS in industrial wastewater can aid decision making

WRF 5042: Assessing PFAS Release from Finished Biosolids

Is there PFAS in my biosolids?

WRF 5042: Assessing PFAS Release from Finished Biosolids (2019-2022)

Main goal:

- To elucidate the processes responsible for PFAS accumulation in biosolids and the leaching of PFAS from biosolids to the environment

Objectives:

- Explain mechanisms and quantify release of PFAS from biosolids batch laboratory desorption tests
- Explain mechanisms and quantify release of PFAS using mesocosm soil leaching experiments conducted outdoors under natural weathering conditions

The Team

Charles Schaefer (CDM Smith, PI)

Dina Drennan (CDM Smith)

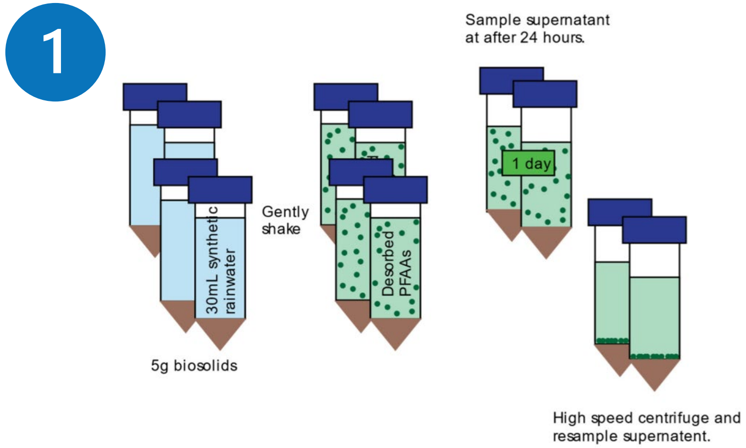
Jen Hooper (CDM Smith)

Linda Lee (Purdue University)

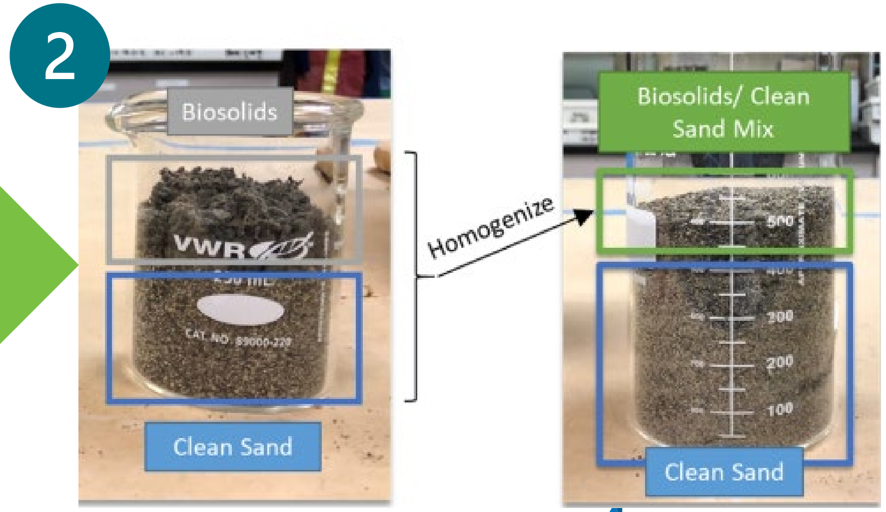
Mahsa Modiri-Gharehveran (Purdue University)

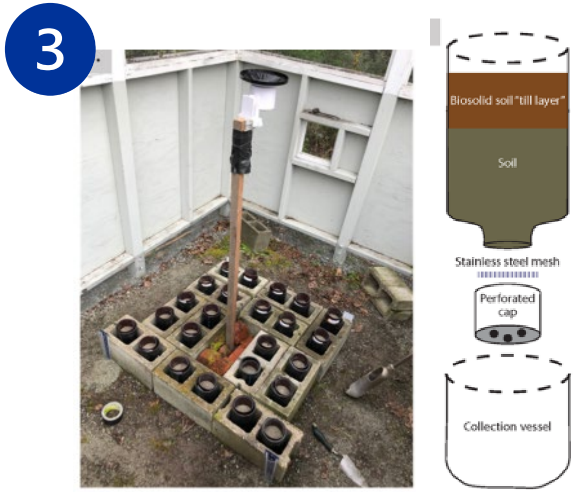
Ned Beecher (NEBRA)

WRF 5042: Assessing PFAS Release from Finished Biosolids (2019-2022)



Bench scale desorption experiments





WRF 5042: Assessing PFAS Release from Finished Biosolids (2019-2022)

Results		Implications
PFAS were present in biosolids samples from seven facilities with concentrations generally within an order of magnitude	→	Regulations would impact all WWTPs to varying degrees since WTTPs could be seen as critical intervention points to remove PFAS
PFAS leaching from biosolids was sustained through 6 months mainly because of precursor transformation and organic content	→	A lot of variables impact when and where you measure PFAS (e.g., sorption, dilution, precursors). Design monitoring programs with experts to ensure the results are meaningful.
Long chain PFAS leached less from biosolids and leaching decreased with greater organic carbon content	→	More short chain PFAS analytical methods are needed.

WRF 5214: Direct In Situ Measurement of PFAS Transformation and Leaching from Land-Applied Biosolids

Does PFAS from biosolids reach groundwater?

WRF 5214: Direct In Situ Measurement of PFAS Transformation and Leaching from Land-Applied Biosolids (2022-2025)

Main goal:

- To measure the transformation, leaching, and migration of poly- and perfluoroalkyl substances (PFAS) through the unsaturated zone from land applied biosolids over an 18-month period

Objectives:

- Measure the transformation and migration of PFAS into soil from land applied biosolids at a location that has not been previously exposed to biosolids and compare it to a location where biosolids have historically been applied
- Evaluate the rate and intensity at which PFAS initially infiltrates the subsurface for both sites
- Provide a direct measure of the in situ natural attenuation capacity of the unsaturated soils

The Team

Charles Schaefer (CDM Smith, PI)

Yida Fang (Haley and Aldridge)

Linda Lee (Purdue University)

WRF 5214: Direct In Situ Measurement of PFAS Transformation and Leaching from Land-Applied Biosolids? (2022-2025)

- Research is still ongoing, but this study would provide critical results from real world environments to describe environmental impacts of biosolids application onto land, which is currently lacking

Results		Implications
Preliminary laboratory results for porewater samples indicate PFAS concentrations at the 2' are 2x those at 4' depth and consist predominately of short chain PFAS	→	Short-chain PFAS are not at steady-state with respect to their vertical migration (at least within the 4-foot interval) possibly reflecting that they are more rapidly flushed through the porewater
Soil characteristics alone do not predict PFAS leaching	→	More work needs to be conducted to inform biosolids application and handling practices to reduce leaching and risk to groundwater contamination

WRF 5212: Enhanced Aeration and Scum Recovery for Physical Removal of PFAS from Wastewater

Does PFAS end up in aerosols, scum, and sidestream?

WRF 5212: Enhanced Aeration and Scum Recovery for Physical Removal of PFAS from Wastewater (2022-2025)

Main goal:

- To use bench- and field-scale testing to verify that enhanced PFAS removal from wastewater can be facilitated during biological aeration

Objectives:

- Examine the occurrence of PFAS in WWTPs foams, aerosols, and dewatering streams to assess the relative contribution of specific unit processes on PFAS phase distribution
- Determine if PFAS surface activity properties can be leveraged for separation and concentration during foam fractionation, like what is already done in leachate treatment
- Identify additional management options for decision makers

The Team

Charles Schaefer (CDM Smith, PI)

Dung Nguyen (CDM Smith)

WRF 5212: Enhanced Aeration and Scum Recovery for Physical Removal of PFAS from Wastewater (2022-2025)

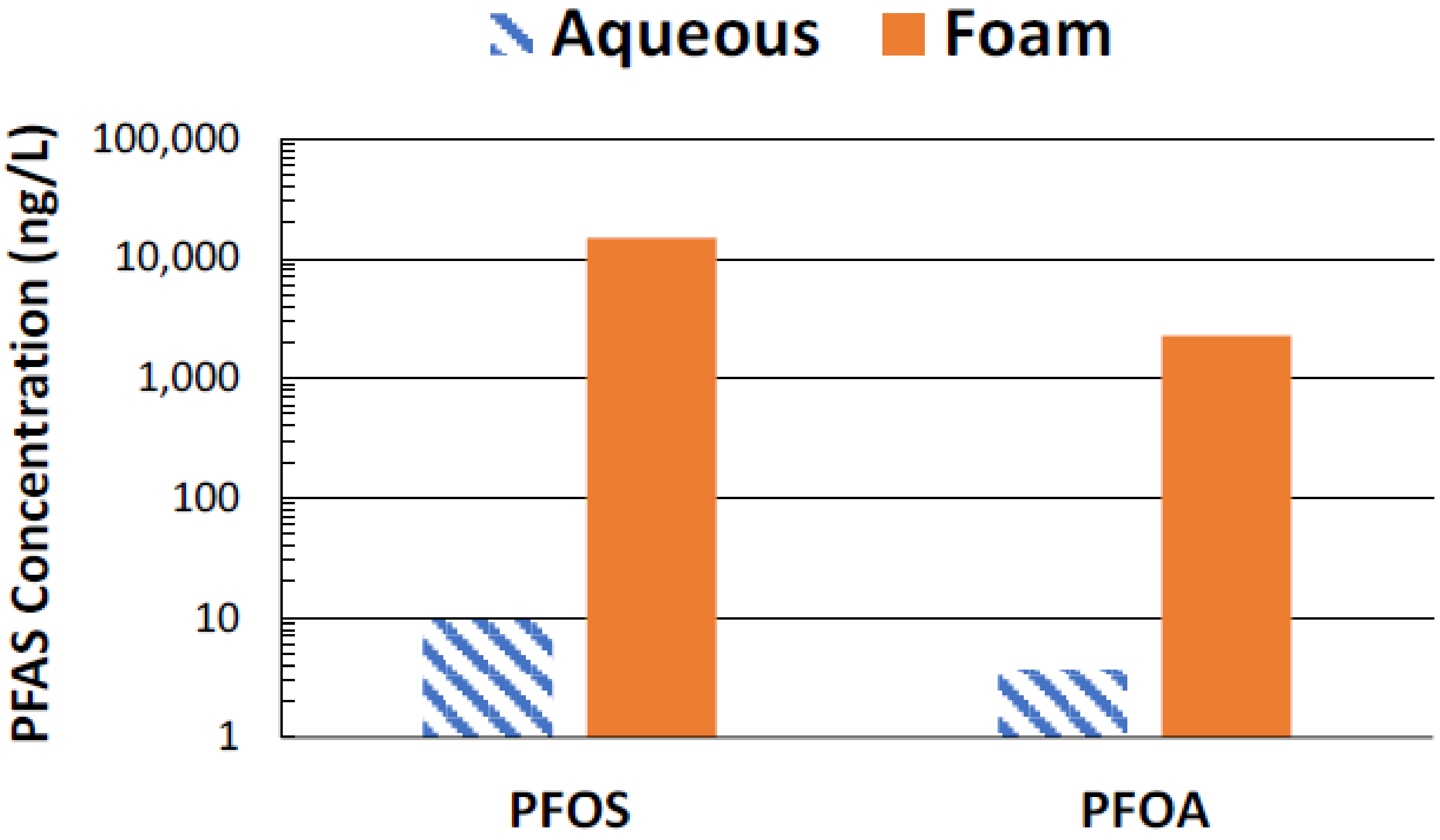
Near surface (2-inch) skimmer

Garrett Screen (mm scale)

Flux Meter

Field Testing

PFAS in Foam vs. Aqueous Phase

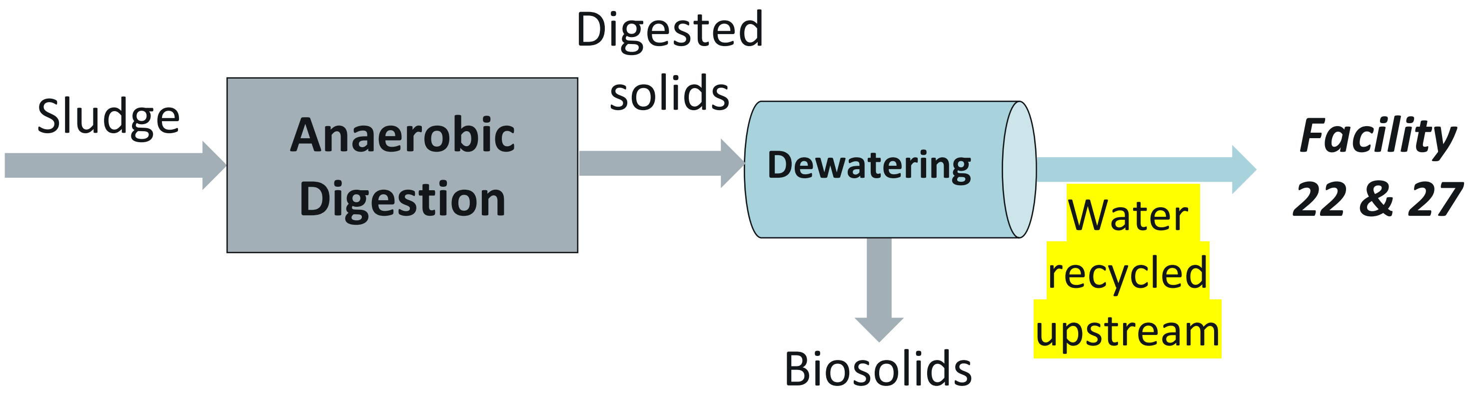


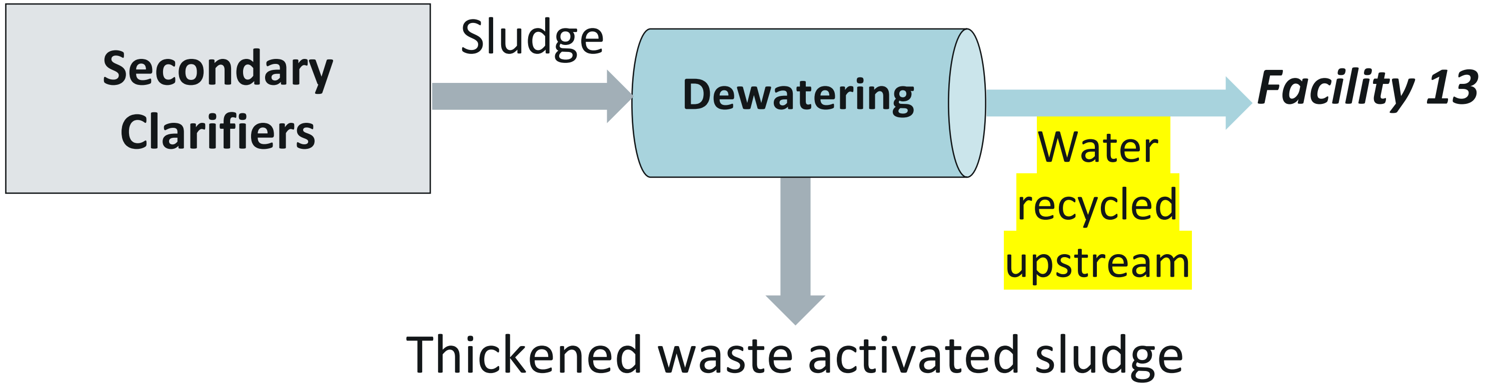
PFOS and PFOA concentrations measured in the aqueous phase and foam/scum during biological aeration.

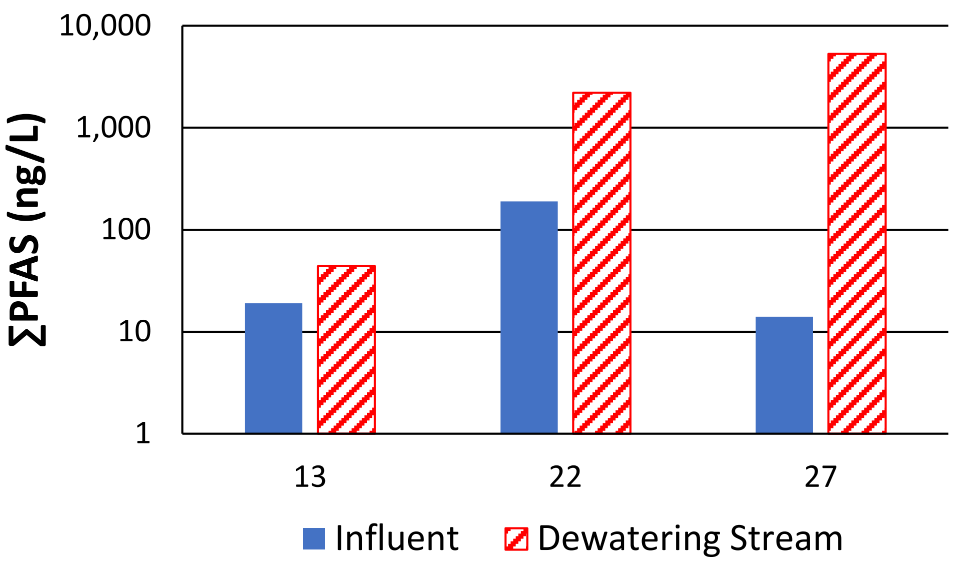
WRF 5031: Solids Dewatering

"PFAS in Foam and Dewatering Streams at Wastewater Treatment Plants"

C.E. Schaefer, J.L. Hooper, L.E. Strom, K. Wu, J.L. Guelfo







WRF 5212: Enhanced Aeration and Scum Recovery for Physical Removal of PFAS from Wastewater (2022-2025)

Results	Implications
Results suggest that foam is substantially enriched with PFAS, and that enrichment increases with increasing perfluorinated chain length	Increasing aeration to increase foaming to allow for PFAS capture is likely to interfere with BNR operation and meeting TN and TP limits, which should remain a WWTP's priority. Sidestream treatment applications may exist
Skimmers, screens and stable foam showed increasing levels of PFOS enrichment at WWTPs tested	When aeration basin sampling, operation and maintenance require contact with foam, remind workers of H&S considerations with PFAS in mind.
At one plant, PFAS in dewatering streams were enriched up to 380x relative to the aqueous influent and represents a significant component of the overall PFAS mass exiting the WWTP	Utilities considering side stream treatment options may want to evaluate the potential effect of selected technologies on PFAS concentration, removal or transformation, if any

Conclusions

Conclusions

- Most papers focus on the regulatory aspects of PFAS or treatment technologies that are currently too cost-prohibitive to implement at WRRFs.
- Using novel science strategically to fill knowledge gaps and guide WRRF O&M provides major opportunities to support the water industry as we face imminent regulations and public scrutiny
- Implementing scientific findings requires collaboration and major efforts from water industry subject matter experts and practitioners to translate academic science into actionable results.
- Utility managers and operators can apply this research to potentially address real-life PFAS issues.

Thank You

To learn more, please reach out to:

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Speaker Introduction

Ned Calonge, M.D., M.P.H.

Associate Dean of Public Health Practice– Colorado School of Public Health

PFAS—Exposure Reduction

Ned Calonge, MD, MPH

Professor of Epidemiology and Associate Dean of Public Health Practice, Colorado School of Public Health

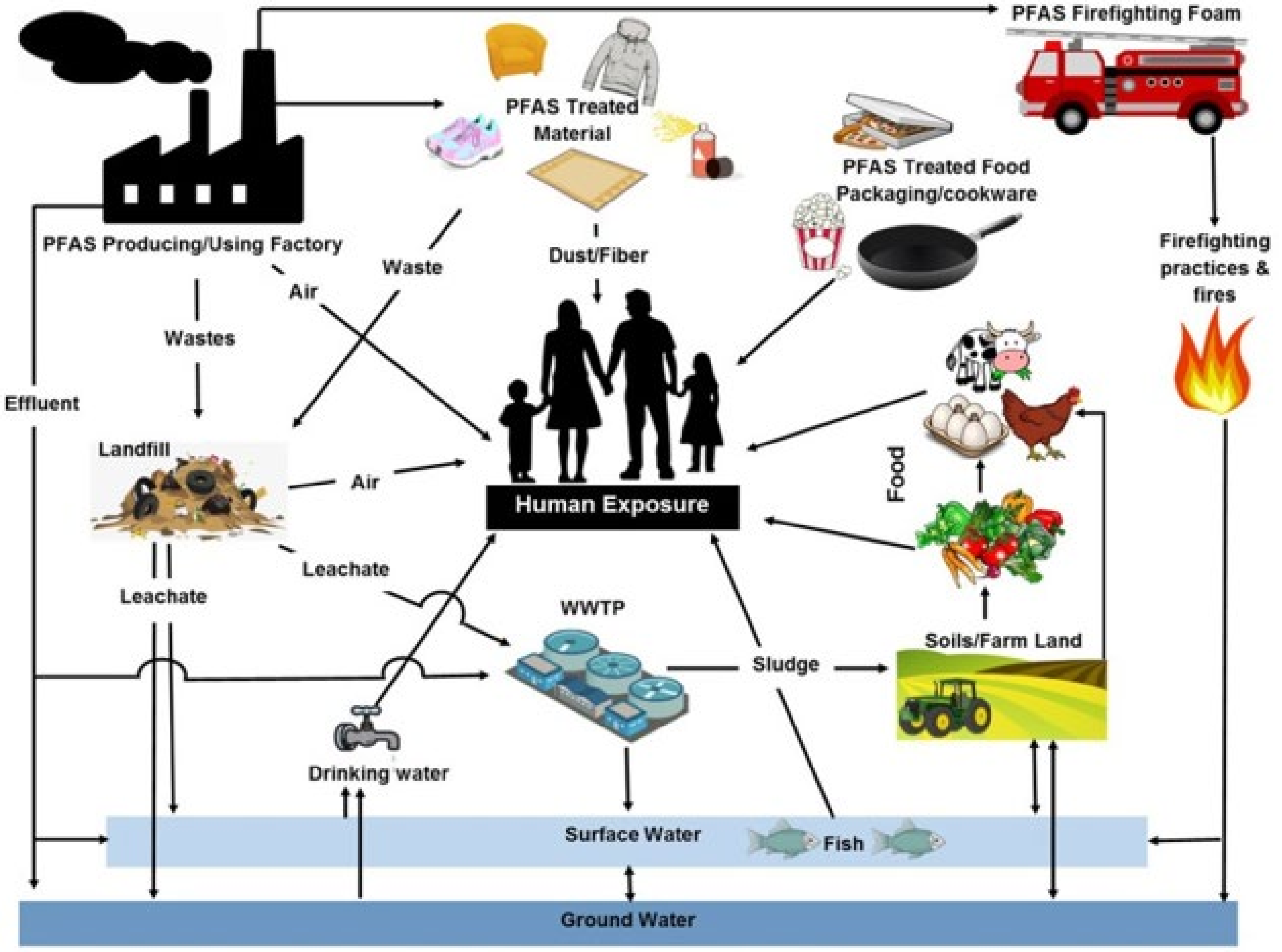
Chair, NASEM Consensus Study on Guidance on PFAS Exposure, Testing and Clinical Follow-Up

About PFAS (Per- and polyfluoroalkyl substances)

- A class of chemicals that includes over 12,000 different compounds
- Used because they repel oil and water, resist heat, and reduce friction
- Used in numerous industrial processes and consumer products since the 1940s
- Are known as “forever chemicals” because they resist degradation, and when they do break down, the chemical products will include another PFAS

Exposure to PFAS

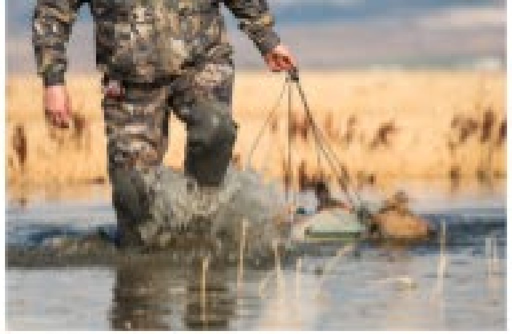
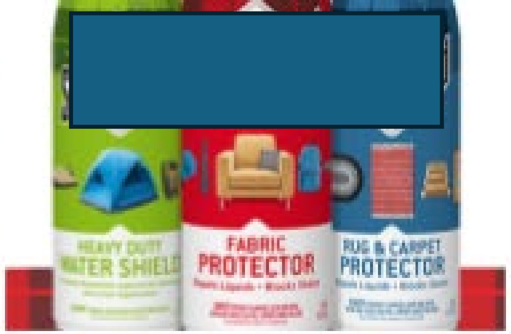
- Drinking water
- Diet
- Dust
- Air
- Consumer products
- Pregnancy and breastfeeding



Human Exposure and sources of PFAS
Image: DWP, adapted from Oliaei et al. 2013.

Route of exposure: Consumer products

- PFAS are used in thousands of products (e.g., products containing water; stain-resistant clothing; and personal care products, such as sunscreen, makeup, and dental floss).
- PFAS are also used in such products as paint, textiles, firefighting foam, electroplating material, ammunition, climbing ropes, guitar strings, artificial turf, and soil remediation products
- The extent to which use of products contributes to human exposures is unknown, however, because the relative contribution of PFAS exposures from sources other than food or water is not well characterized
- The presence of PFAS in everyday consumer products may be an important source of exposure for the general population, but this likely varies greatly by individual

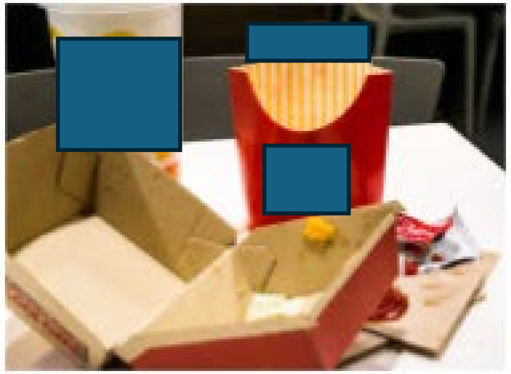



FABRIC
PROTECTOR
RUG & CARPET
PROTECTOR

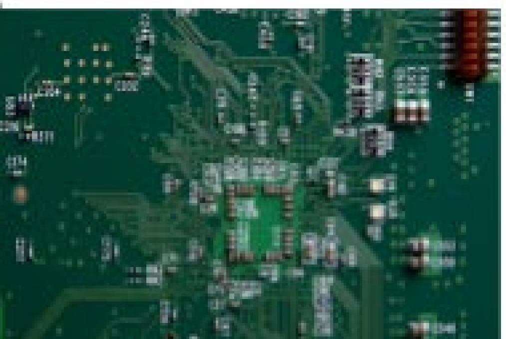




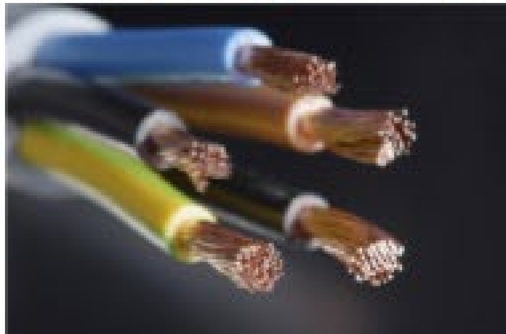










Route of exposure: Occupational

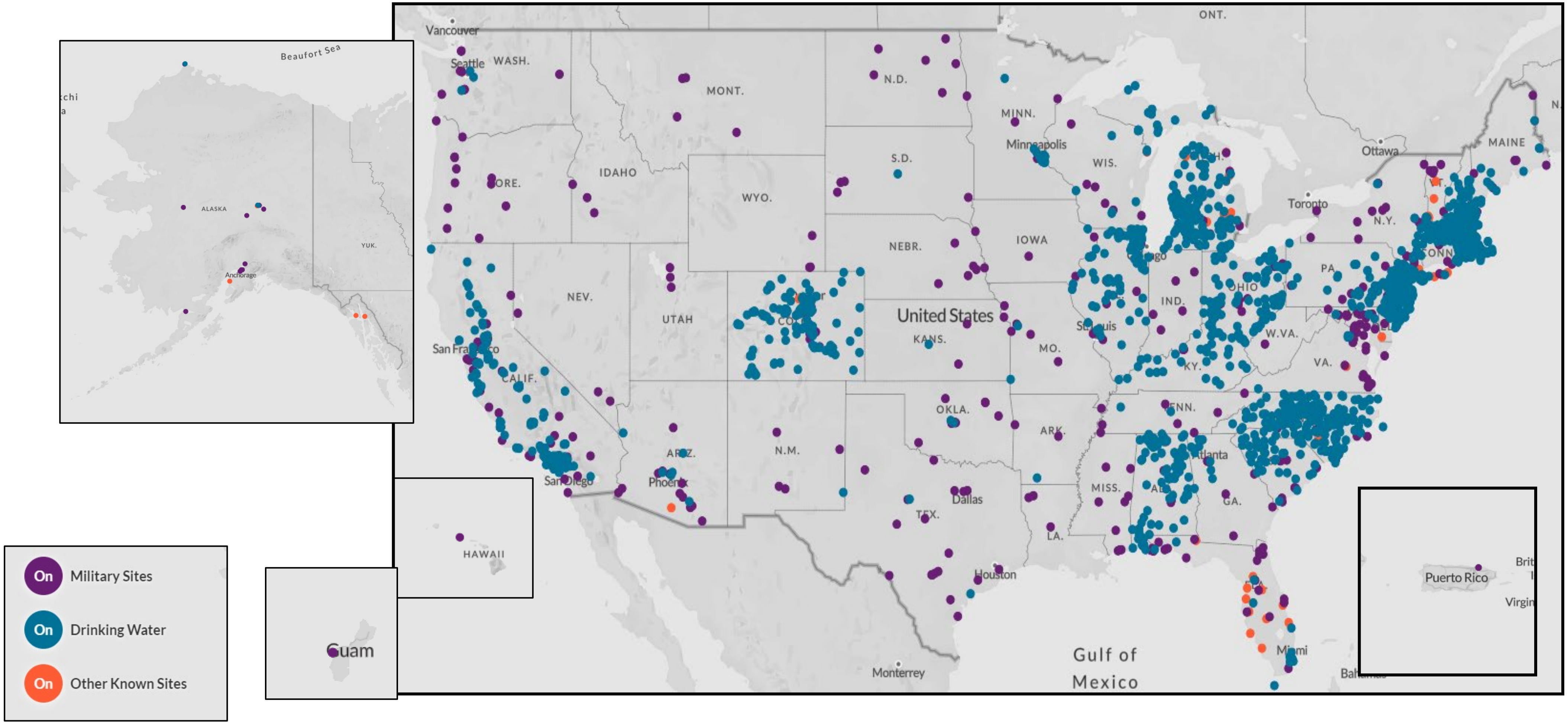
- Specific sources of exposure include jobs in fluorochemical manufacturing facilities or where PFAS-containing products, such as textiles or food contact materials, are made
- Other jobs with a known increased risk of exposure to PFAS include:
  - Electroplating
  - Painting
  - Carpet installation and treatment
  - Serving as a military or civilian firefighter
    - PFAS-containing foams
    - PFAS-impregnated gear
  - Jobs that require prolonged work with ski wax
  - Food workers and others in the hospitality industry who may have elevated exposure since they handle PFAS-containing food packaging as part of their job duties

Route of exposure: ingestion

- Ingestion is the most well-studied route of exposure in nonoccupational settings
- Ingestion of PFAS can occur through:
  - drinking contaminated water
  - eating contaminated seafood
  - consuming other contaminated foods, such as vegetables, game, or dairy products

PFAS Water Contamination

Estimated in 2,854 sites in 50 states and two territories



Source: Environmental Working Group, October 2021

Routes of exposure: ingestion

- Diet appears to be a major pathway of exposure, but there is little information on PFAS in commercial foods commonly consumed in the United States
- The U.S. Food and Drug Administration (FDA) has released PFAS data for certain foods that could be used to model source contributions to PFAS intake in future studies
- FDA data for produce, meat, dairy, and grain products are based on a small sample size, and the results “cannot be used to draw definitive conclusions about the levels of PFAS in the general food supply.”
- Residual PFOA in food packaging (used to greaseproof food-containing paper products) is another potential route of exposure; polyfluoroalkyl phosphoric acids in food packaging can also be metabolized in the body to PFOA

Route of exposure: ingestion

- PFAS are often used in cookware and in materials that came in contact with food, such as microwave popcorn bags or packaging used for fast foods or processed foods
- Exposure can also occur through accidental ingestion of PFAS-containing dusts

Route of exposure: ingestion

- Estimates of how much PFAS exposure comes from diet in adults vary widely, (from 16–99 percent for PFOA to 66–100 percent for PFOS); no estimates are available for individual food products.
- For dust, the estimates are 1–11 percent for PFOA and 1–15 percent for PFOS
- For PFOA, the dominant routes are thought to be oral exposure resulting from consumption of fish and seafood, drinking water, and ingestion of dust
- For PFOS, the dominant routes are thought to be ingestion of food and water, ingestion of dust, and hand-to-mouth transfer from treated carpets

Route of exposure: ingestion

- PFAS cross the placenta, and PFAS from the mother’s body burden can be passed on to her developing fetus
- Maternal transfer of PFAS can also occur through breastfeeding

Breast milk

- Breastfeeding has been shown to contribute significantly to children's serum levels of some PFAS, with serum levels of PFAS increased 8−11 percent per week of exclusive breastfeeding
- Excess PFAS levels have been measured in breast milk especially in communities impacted by PFAS contamination
- Whether lactational exposure to PFAS can have adverse health effects in children has not been well studied to date
- Formula feeding can also lead to PFAS exposure through either contaminated formula or formula reconstituted with contaminated drinking water

Route of exposure: inhalation and skin

- Inhalation and transdermal exposures are less well studied
- Inhalation of PFAS is well-documented in occupational settings that use aerosolized PFAS
- Volatile PFAS have been detected indoors and inhalation near factory emissions and incinerators contributes to exposures in nearby communities
- There are as yet no data formally evaluating inhalation from showering in contaminated water

Exposure reduction

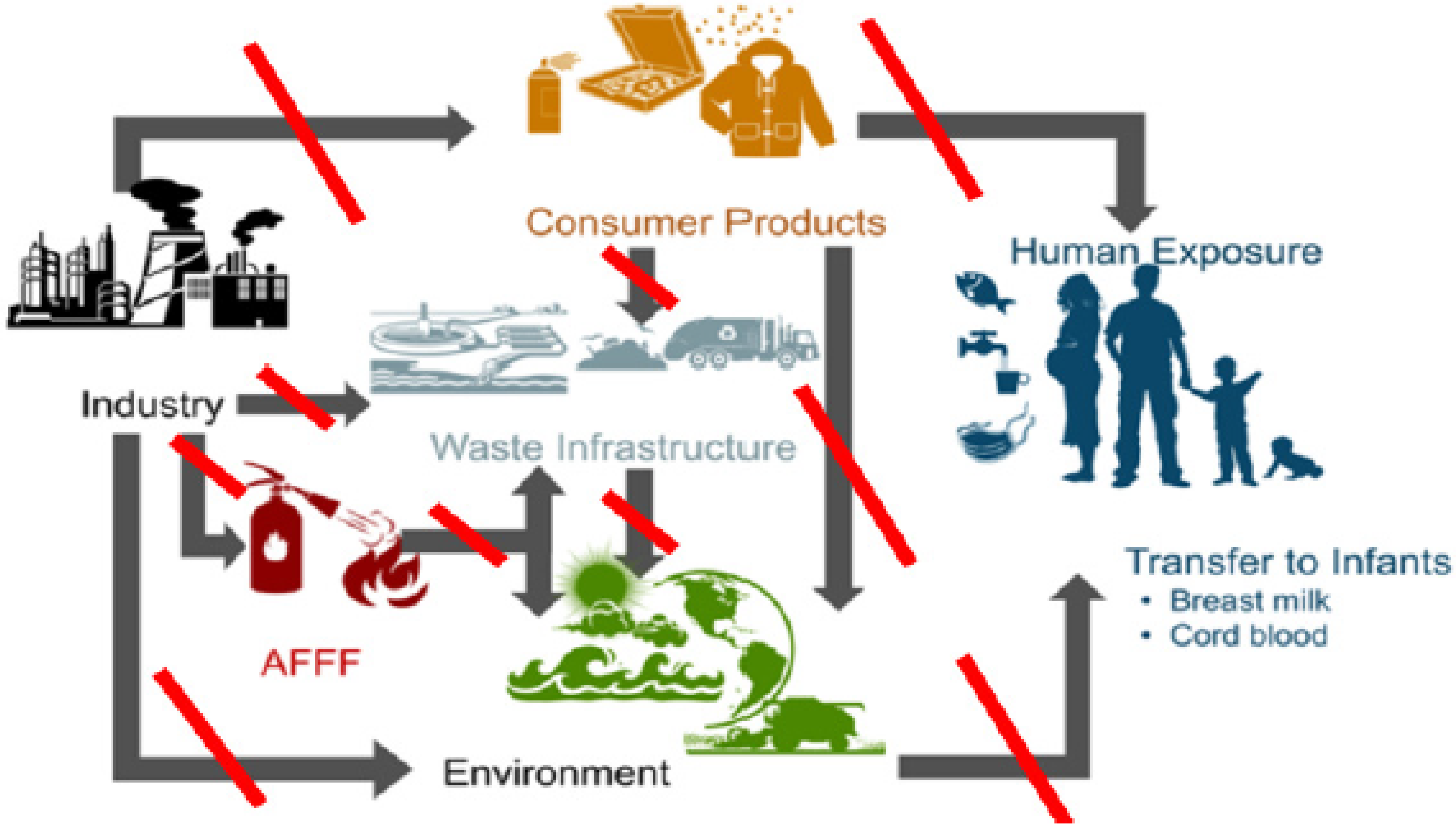


FIGURE 4-1 Conceptual model for PFAS exposure reduction.
NOTE: Red lines indicate a break in the pathway that could reduce human exposure.
SOURCE: Adapted from Sunderland et al., 2019.

Evidence base for exposure reduction

- The available literature is limited in presenting recommendations for effective behavior modifications to reduce internal levels of PFAS
- In places with water contamination, individuals can reduce their exposure through use of water filtration
- In places without PFAS water contamination or workplace exposure, diet is believed to be the primary exposure route, but there is limited information with which to recommend dietary interventions
- No intervention study has examined exposure reduction and its impact on serum concentrations, likely in part because to fully show effectiveness for an intervention, it would have to be conducted over a long enough time to account for the long half-lives of PFAS

Occupational exposure reduction

- Occupational exposures to PFAS may be much higher than community exposures
- In accordance with the hierarchy of controls, methods for reducing workplace exposure can include:
  - replacing the chemical with a less hazardous one
  - engineering controls, such as ventilation to reduce inhalation of the chemical
  - administrative controls, such as rotating operations to reduce the amount of time an individual worker is around a chemical
  - personal-level controls, such as personal protective equipment, including gloves and masks.

Drinking water

- Contamination of drinking water with PFAS is a widespread problem in the United States, and the extent of the contamination has not been completely characterized
- If PFAS are in drinking water, switching to another source of water with lower PFAS concentrations will reduce exposure.
- Both municipal and private sources of drinking water (e.g., private wells) can be contaminated with PFAS as a result of fluorochemical manufacturing, use of firefighting foams, or discharge of landfill leachate to drinking water sources
- In April 2024, the EPA passed a rule setting limits for certain PFAS in municipal drinking water

Food advisories

- To date, 11 states have developed or are in the process of developing advisory guidelines offer guidance on limiting the quantity of consumption of fish, wildlife, and other food products to protect human health from exposure to PFAS.
- These advisories are state-specific and range from do not eat (e.g., fish or deer in Michigan with PFOS concentrations over 300 parts per billion) to no need to limit consumption (e.g., New Jersey fish with more than 0.56 nanograms per gram of PFOS)
- The Environmental Council of the States (ECOS) has compiled information from participating states on state PFAS standards, advisories, and guidance values (www.ecos.com)

Breast feeding

- Given the increased exposures observed in breastfed versus formula-fed infants, it is not clear whether the benefits of breastfeeding outweigh the risks to the child among lactating persons with very high levels of PFAS exposure.
- Guidance to breastfeed remains the best feeding advice for most infants given the many benefits of breastfeeding for both mothers and babies.
- Even though PFAS exposures have been occurring for many years, research has consistently shown benefits of breastfeeding, providing confidence in the traditional guidance, although a more in-depth understanding of this exposure route is warranted to inform protection of such a vulnerable population.

NASEM 2022 Consensus Study Recommendations – Exposure Reduction

Recommendation 4-1: Clinicians advising patients on PFAS exposure reduction should begin with a conversation aimed at first determining how they might be exposed to PFAS (sometimes called an environmental exposure assessment) and what exposures they are interested in reducing. This exposure assessment should include questions about current occupational exposures to PFAS (such as work with fluorochemicals or firefighting) and exposures to PFAS through the environment. Known environmental exposures to PFAS include living in a community with PFAS-contaminated drinking water, living near industries that use fluorochemicals, serving in the military, and consuming fish and game from areas with known or potential contamination.

Recommendation 4-2: If patients may be exposed occupationally, such as by working with fluorochemicals or as a firefighter, clinicians should consult with occupational health and safety professionals knowledgeable about the workplace practices to determine the most feasible ways to reduce that exposure.

Recommendations – Exposure Reduction

Recommendation 4-3: Clinicians should advise patients with elevated PFAS in their drinking water that they can filter their water to reduce their exposure. Drinking water filters are rated by NSF International, an independent organization that develops public health standards for products. The NSF database can be searched online for PFOA to find filters that reduce the PFAS in drinking water included in the committee's charge. Individuals who cannot filter their water can use another source of water for drinking.

Recommendation 4-4: In areas with known PFAS contamination, clinicians should advise patients that PFAS can be present in fish, wildlife, meat, and dairy products and direct them to any local consumption advisories.

Recommendation 4-5: Clinicians should direct patients interested in learning more about PFAS to authoritative sources of information on how PFAS exposure occurs and what mitigating actions they can take. Authoritative sources include the Pediatric Environmental Health Specialty Units (PEHSUs), the Agency for Toxic Substances and Disease Registry (ATSDR), and the U.S. Environmental Protection Agency (EPA).

Recommendations – Exposure Reduction

Recommendation 4-6: When clinicians are counseling parents of infants on PFAS exposure, they should discuss infant feeding and steps that can be taken to lower sources of PFAS exposure. The benefits of breastfeeding are well known; the American Academy of Pediatrics, the American Academy of Family Physicians, and the American College of Obstetricians and Gynecologists support and recommend breastfeeding for infants, with rare exceptions. Clinicians should explain that PFAS can pass through breast milk from a mother to her baby. PFAS may also be present in other foods, such as the water used to reconstitute formula and infant food, and potentially in packaged formula and baby food. It is not yet clear what types and levels of exposure to PFAS are of concern for child health and development.

Recommendation 4-7: Federal environmental health agencies should conduct research to evaluate PFAS transfer to and concentrations in breast milk and formula to generate data that can help parents and clinicians make shared, informed decisions about breastfeeding.

Blood Levels are decreasing with time

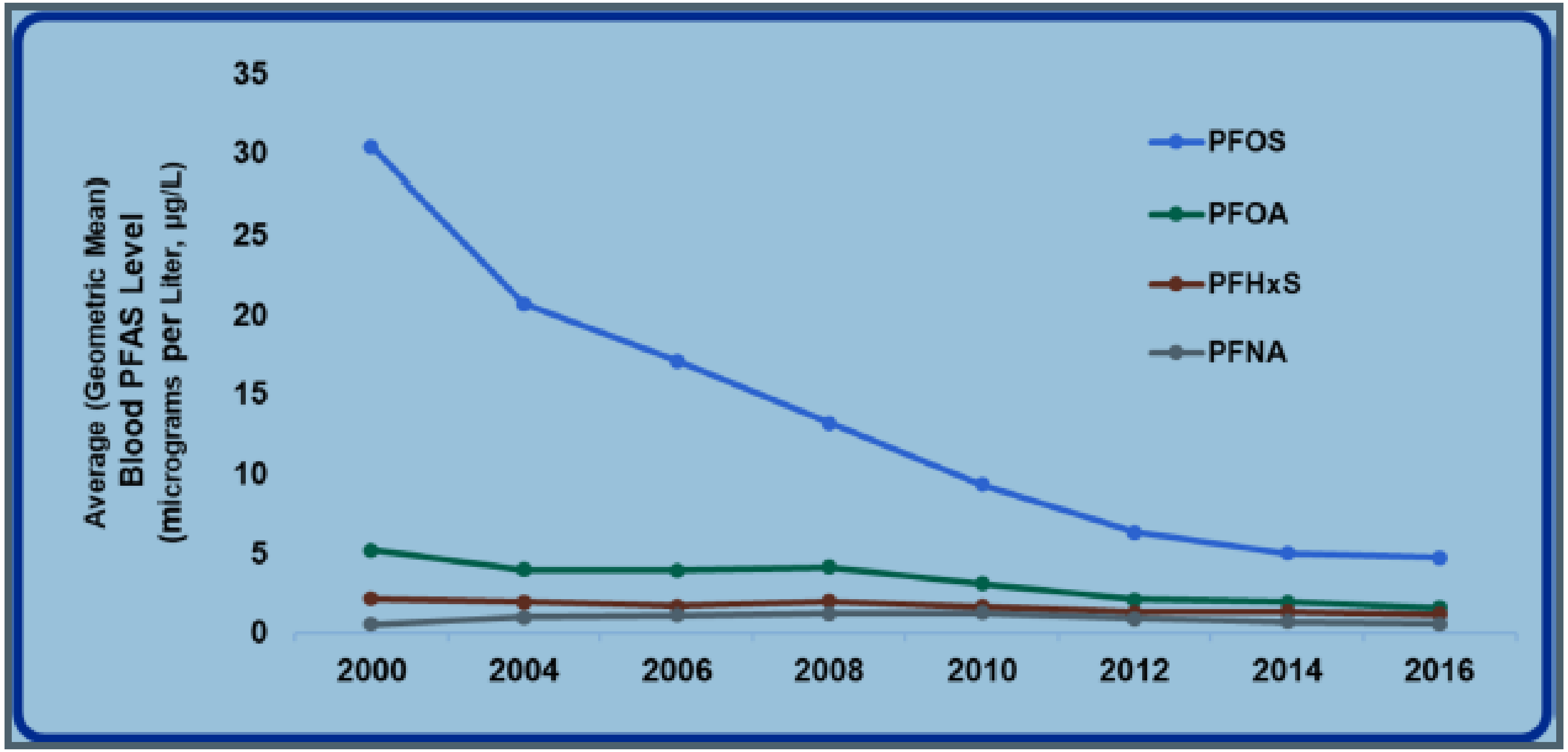


FIGURE 4-2 Blood (serum) levels of PFAS, United States, 2000–2016.
NOTE: Average = geometric mean.
SOURCE: Patrick N. Breysse's presentation to the committee on February 4, 2021. DATA SOURCE: Centers for Disease Control and Prevention. Fourth Report on Human Exposure to Environmental Chemicals, Updated Tables, (January, 2019). Atlanta, GA: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention.

Resources for exposure reduction

- PFAS-REACH (Research, Education, and Action for Community Health) is a project funded by the National Institute of Environmental Health Sciences to develop guidance materials and data interpretation tools for use by communities impacted by PFAS-contaminated drinking water.
- The project is led by Silent Spring, Northeastern University, and Michigan State University, with collaboration from community partner organizations that include Testing for Pease, Massachusetts Breast Cancer Coalition, and Community Action Works.
- The project's online resource center, PFAS Exchange, provides factsheets and interactive maps; a factsheet on how to reduce one's exposure is most relevant to the discussion in this chapter.

Resources for exposure reduction

- The Environmental Working Group (EWG) is a national non-profit included as a data source in the PFAS Project Lab
- The EWG site (www.ewg.org) provides an interactive map that "serves to show the extent of PFAS water contamination as documented by states, the department of defense and EWG's testing," providing the locations of industrial and military sites with known PFAS contamination
- Additionally, the EWG provides a guide for avoiding exposure to PFAS chemicals similar to those in the PFAS-REACH factsheet
- The EWG has developed several consumer guides providing information on the chemicals (not just PFAS) present in a variety of commercial products, including sunscreen, cosmetics, personal care and beauty products, bug repellants, and household cleaners, among others

PFAS-REACH recommendations

In your personal life:

- ✓ Avoid stain-resistant carpets and upholstery, as well as stain-resistant treatments and waterproofing sprays.
- ✓ Avoid products with the ingredient PTFE or other "fluoro" ingredients listed on the label.
- ✓ Choose cookware made of cast iron, stainless steel, glass, or enamel instead of Teflon.
- ✓ Filter your drinking water with an activated carbon or reverse osmosis filtration system.
- ✓ Eat more fresh foods to avoid take-out containers and other food packaging.
- ✓ Avoid microwave popcorn and greasy foods wrapped in paper.
- ✓ Look for nylon or silk dental floss that is uncoated or coated in natural wax.

In your community:

- ✓ Tell retailers and manufacturers you want products made without PFAS.
- ✓ Urge your local water utility to test for PFAS.
- ✓ Ask your state legislators to set up a statewide water and blood testing program.
- ✓ Encourage your state to follow the lead of other states in creating more health protective drinking water limits.
- ✓ Ask your elected officials to support restrictions on PFAS in consumer products and remediation of contaminated sites.
- ✓ Find out about local groups working to protect water quality by visiting:

www.pfas-exchange.org

FIGURE 4-4 Recommendations for reducing PFAS exposure available through the PFAS Exchange.
SOURCE: PFAS-REACH project.

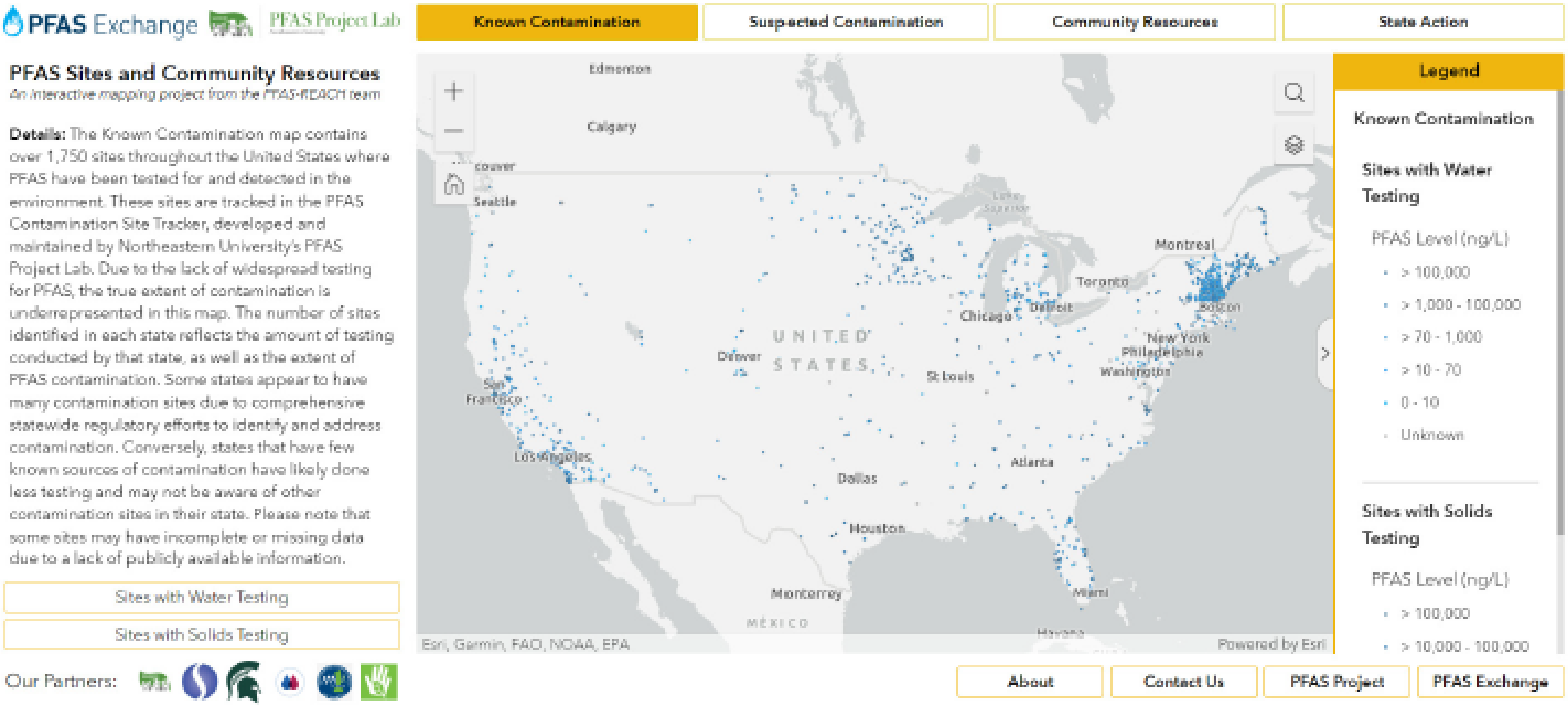


FIGURE 4-5 PFAS Project Lab map showing PFAS contamination sites in the continental United States.
SOURCE: Social Science Environmental Health Research Institute (SSEHRI).
https://experience.arcgis.com/experience/12412ab41b3141598e0bb48523a7c940 (accessed May 25, 2022).

Closing thoughts

- At this time, it not possible to eliminate all sources of PFAS exposure
- There are some sources people can try to limit if they desire and have the resources to do so
- If patients are resource-limited, it is most important that if PFAS contamination of their water is known or suspected, they use water filtration or another source of water for drinking that is lower in PFAS
- Individuals should reference reliable sources of information on PFAS, such as ATSDR, the U.S. Environmental Protection Agency, and state and local departments of public health so they can obtain accurate and up-to-date information

Questions?

Webinar Feedback

- Please provide your feedback on today's webinar in this 4-question survey. Thank you!

Provide Webinar Feedback Here

Wrap-Up

If you submitted a RSVP for this webinar, you will receive an email with the presentation slides and a subsequent email with a link to the recording.

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North Central Texas Council of Governments

Thank you for attending!

NCTCOG Webinar
August 15, 2024

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North Central Texas Council of Governments
Environment & Development
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