

INTRODUCTION TO PFAS

Per- and Polyfluoroalkyl Substances

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RAMBOLL

Bright ideas.
Sustainable change.

Topics

01

What are PFAS?

02

Key federal activities

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Sampling & analysis primer

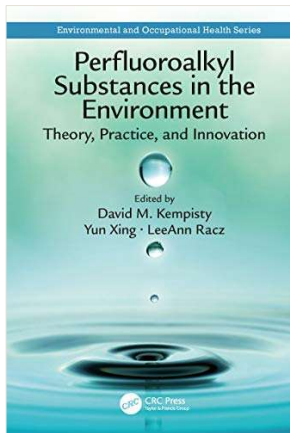
05

Aqueous treatment primer



What are PFAS?

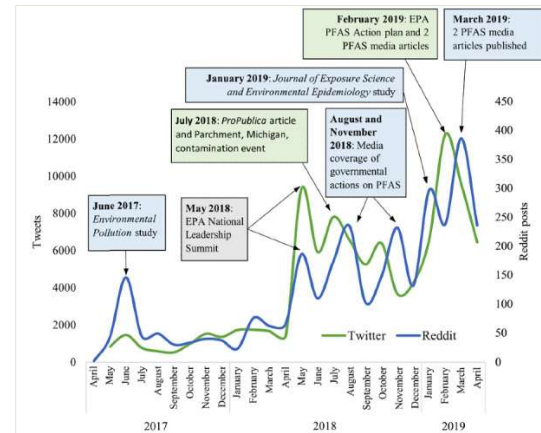
PFAS are among the most significant environmental regulatory developments in the last 40+ years



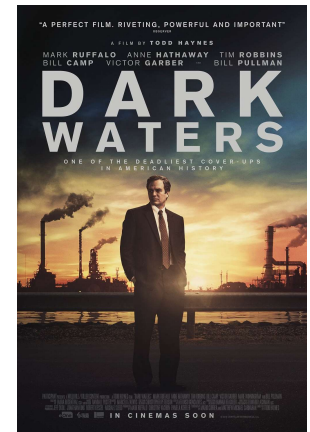
PFAS are
in books



PFAS are in the news



PFAS are in social media

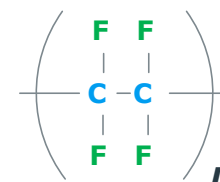


PFAS are in the
movies

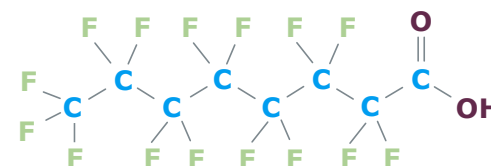
What are PFAS?

- 01 PFAS is a generic term for a large (>10,000) subclass of human-made fluorinated chemicals
- 02 Used in a wide range of industrial and commercial applications, consumer products, and firefighting foams
- 03 Unique because of their ability to repel oil, grease and water
- 04 Exceptionally stable, non-reactive chemicals, resistant to degradation naturally and heat resistant
- 05 Properties/behavior varies dramatically

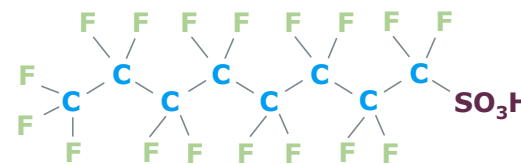
PFOA, PFOS and GenX are probably the most well known PFAS



Perfluoroalkyl moiety ($C_nF_{2n+1}-$)



PFOA – perfluorooctanoic acid

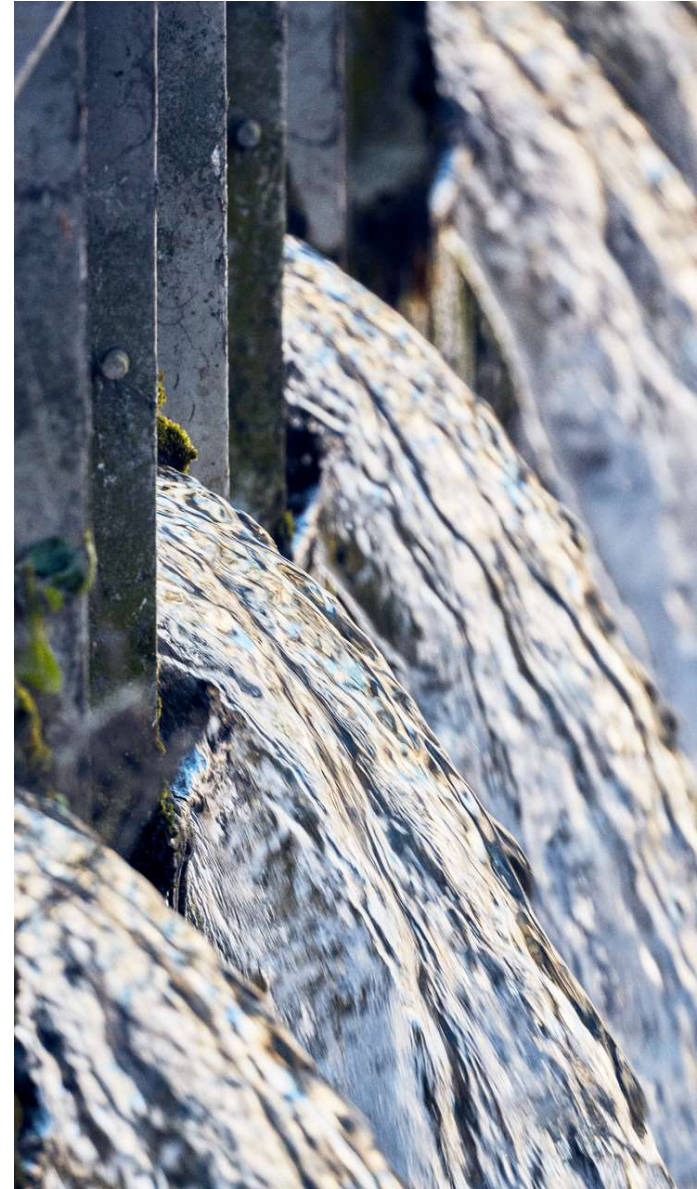


PFOS – perfluorooctane sulfonic acid

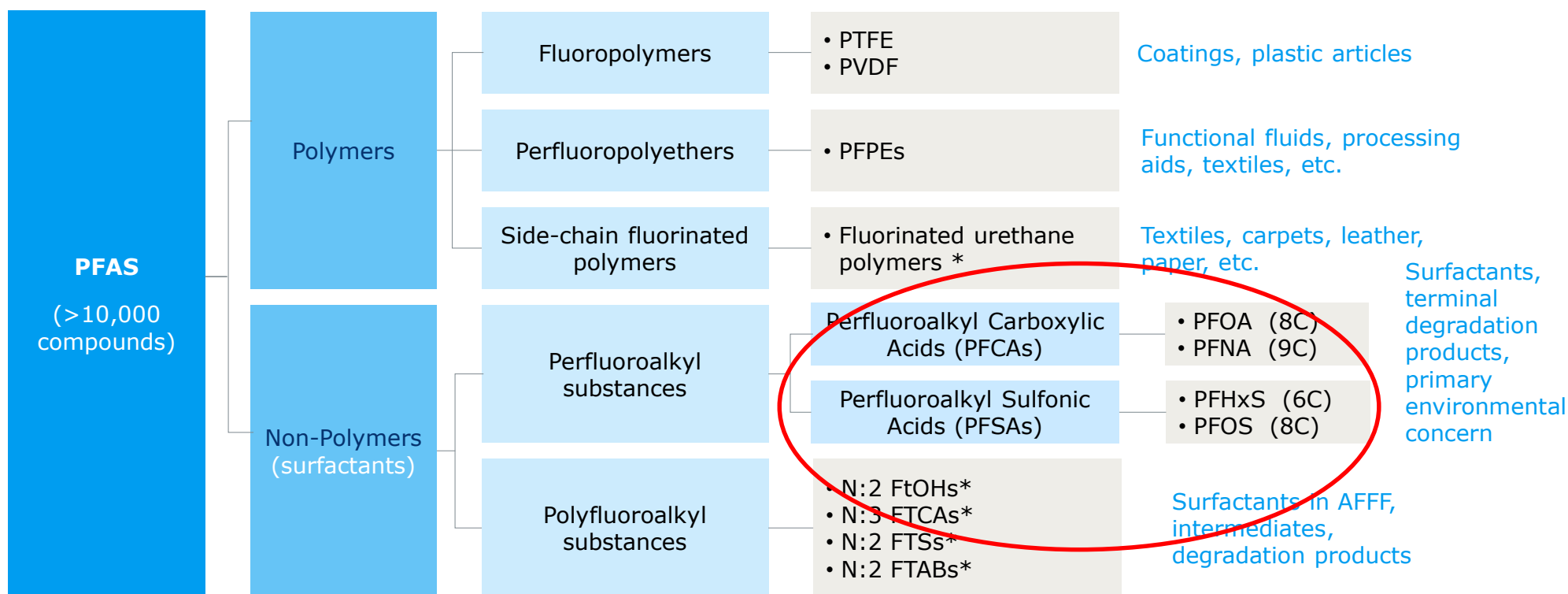
Why the interest in PFAS?

- Ubiquitous in the environment
- Relatively mobile in the environment, moderately soluble
- Potential human toxicity
- Environmentally persistent
- Lengthy and varied history of use
- USEPA has identified more than 10,000 individual PFAS compounds

Many PFAS are classified by regulatory agencies as persistent, bioaccumulative and toxic compounds (PBTs)

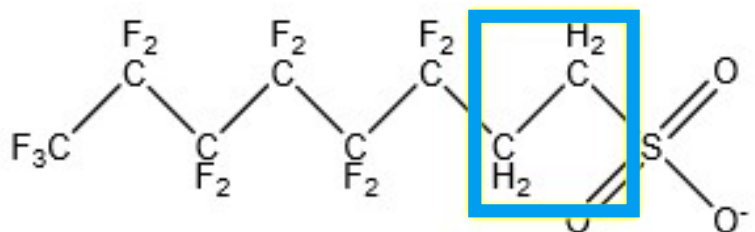


The complex world of PFAS



“Precursor” PFAS can transform to other PFAS

- Thousands of PFAS
- Some break down into the perfluorinated compounds of greatest interest – these are called “precursors”
- Example:



6:2 Fluorotelomer Sulfonate (6:2FtS)

- Concentrations of precursors can be significant (e.g., in most fire fighting foams)
- Many/most precursors are not quantified during current commercial analyses

Is something else present that can transform to the PFAS of interest?

What are some of the many sources of PFAS?



Household/ cooking

- Cookware
- Packaging
- Carpet/fiber protector
- Floor finishing



Apparel/ textiles

- Stain-resistant clothing
- Outdoor gear



Personal care/ healthcare

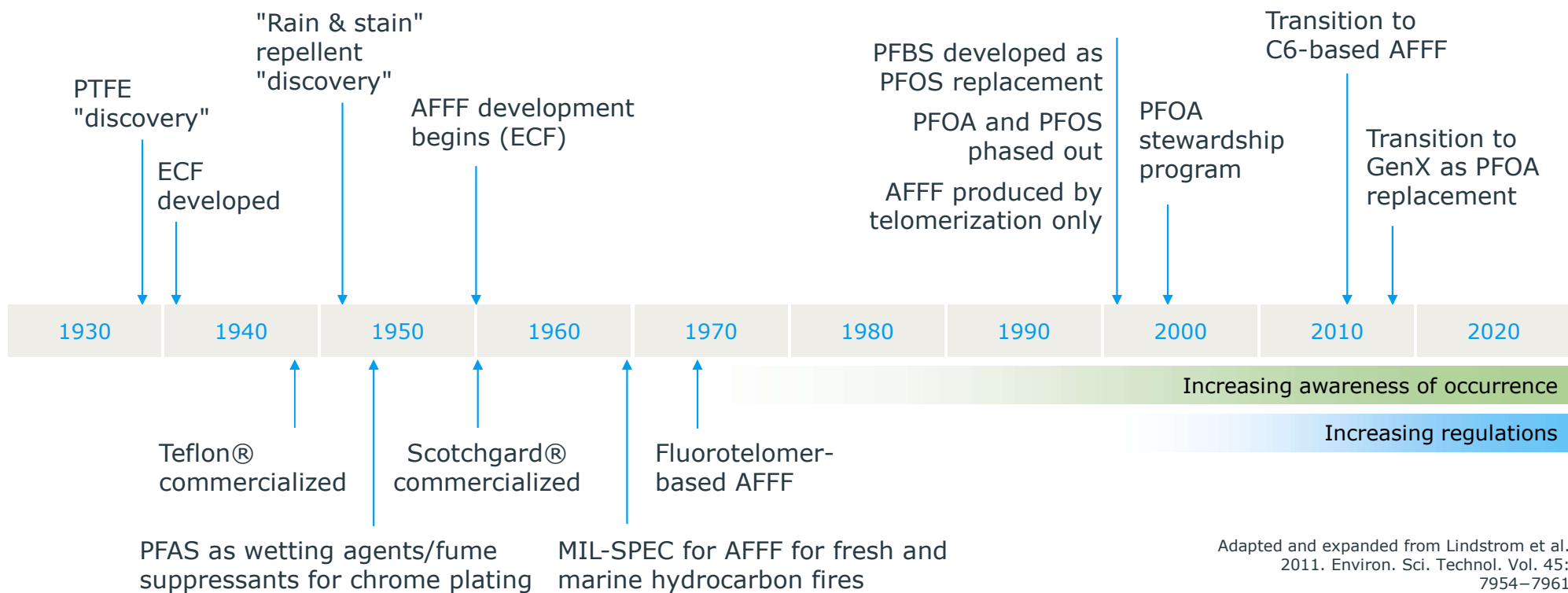
- Eyewear coating
- Cosmetics
- Biomaterials
- Medical devices



Industrial/ specialized

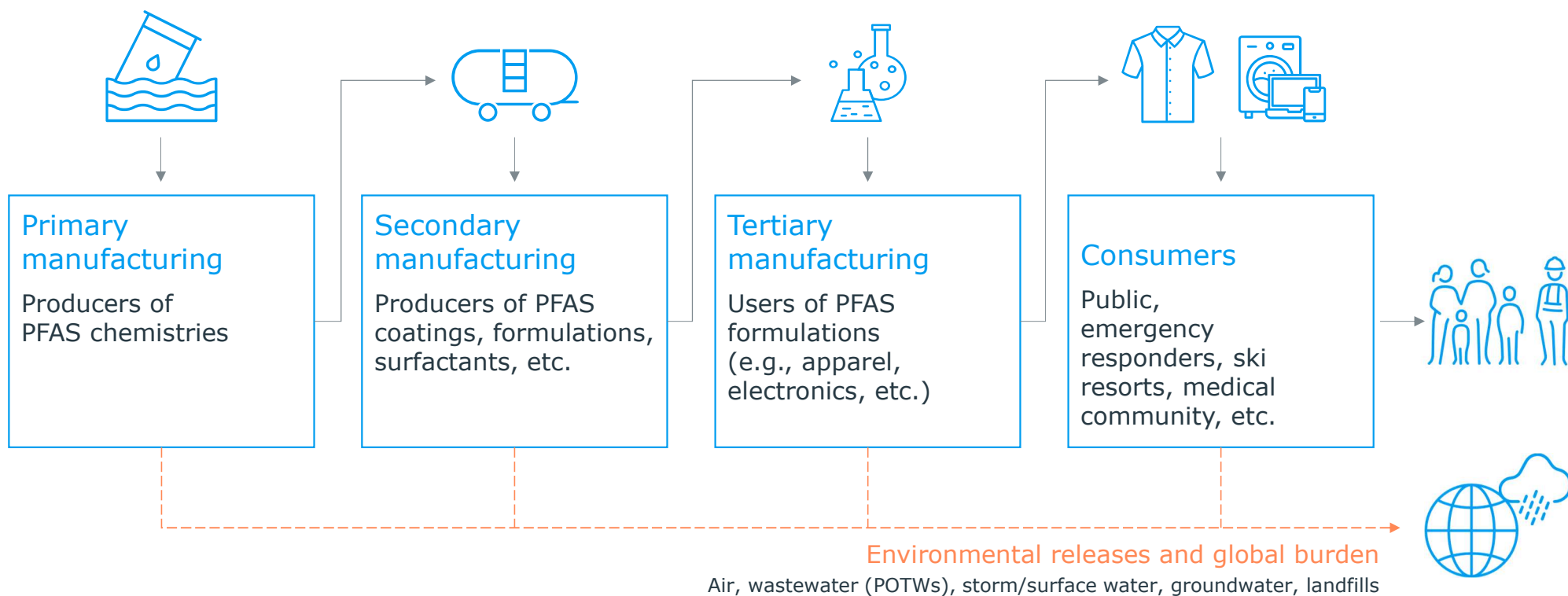
- Firefighting foams
- Chrome plating
- Aviation hydraulic fluids
- Semiconductor
- Coatings/adhesives

Brief chronology of PFAS

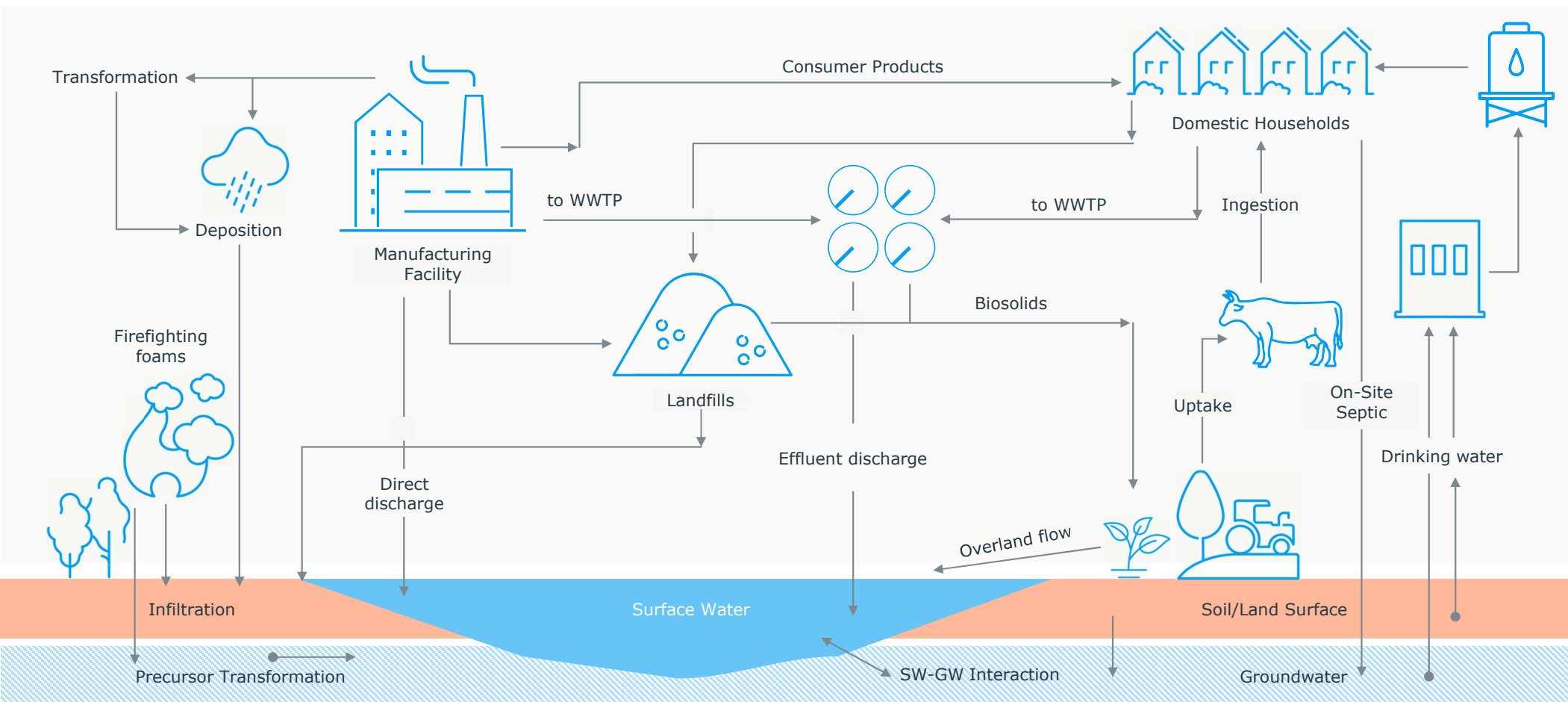


Adapted and expanded from Lindstrom et al.
2011. Environ. Sci. Technol. Vol. 45:
7954–7961

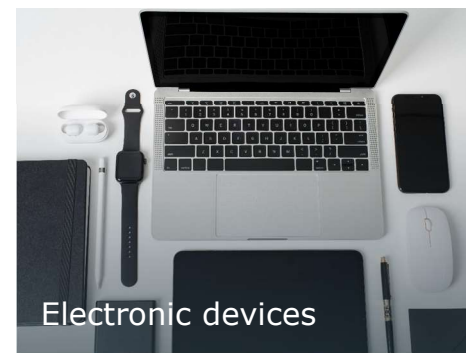
PFAS distribution chain



PFAS distribution in the environment

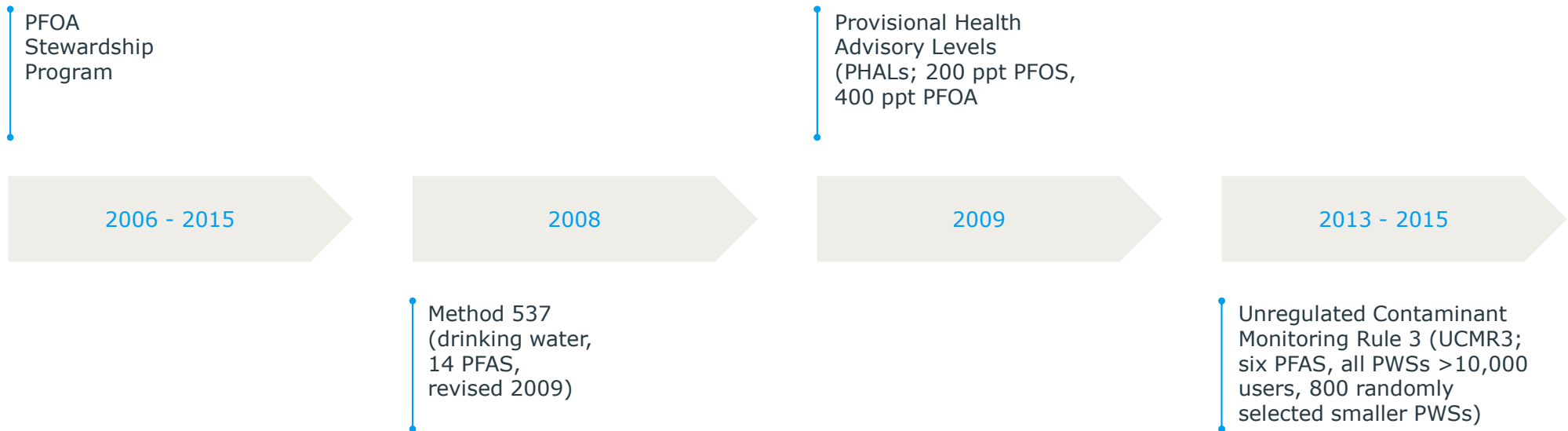


PFAS are everywhere!



Key federal activities

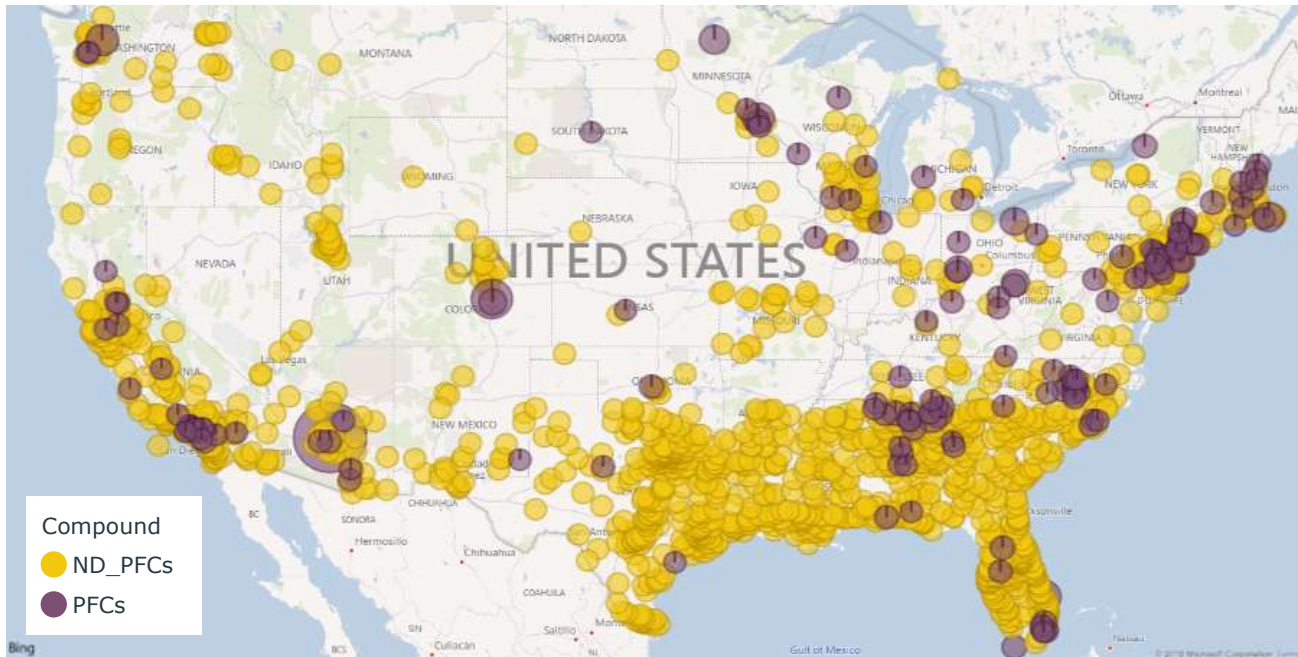
Key federal activities



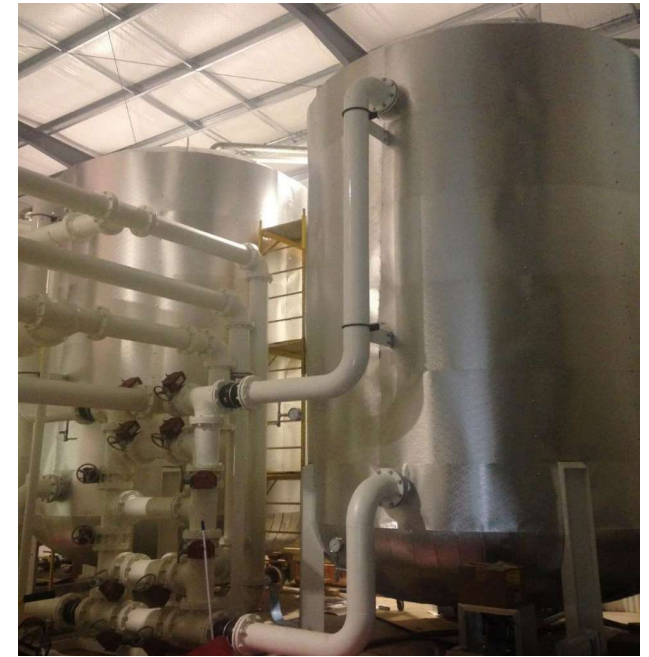
PFAS in drinking water

UCMR3 data 2013-2015 for six PFAS in public supplies

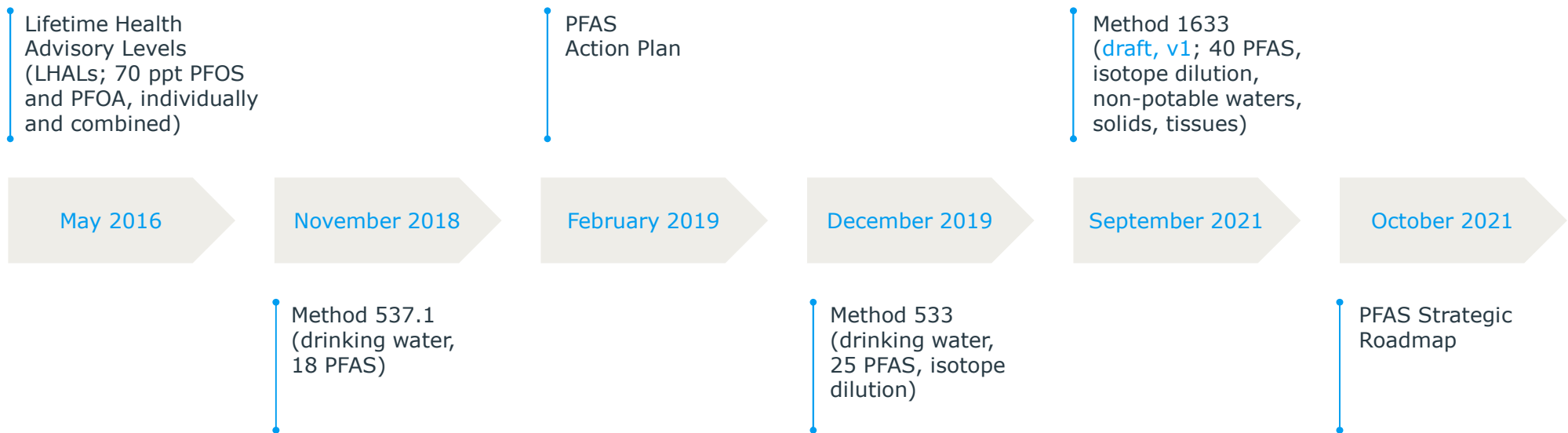
Average of all drinking water samples from public water systems per zip code



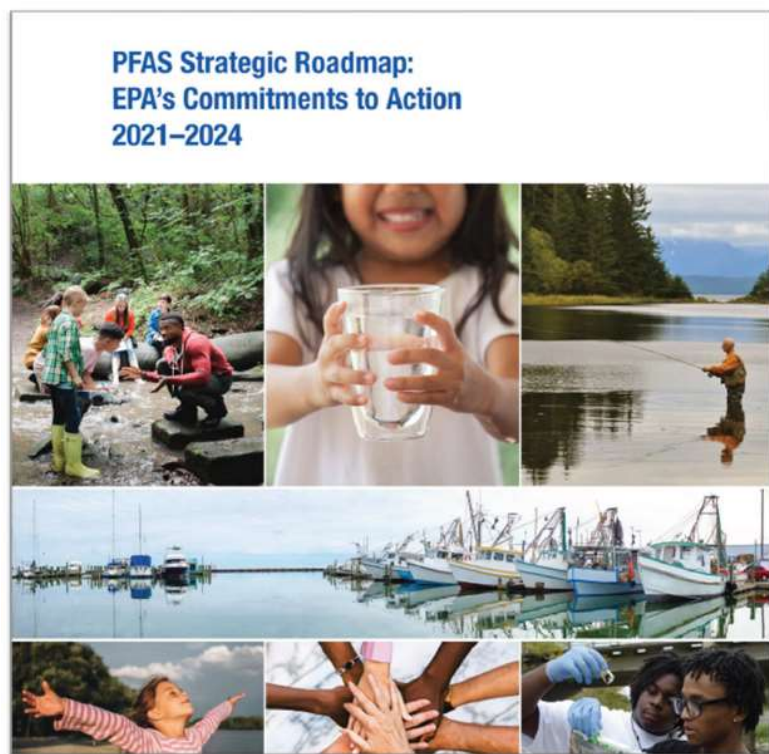
PFOA/PFOS treatment system for 5 MGD municipal supply



Key federal activities (cont'd)



USEPA's PFAS strategic roadmap

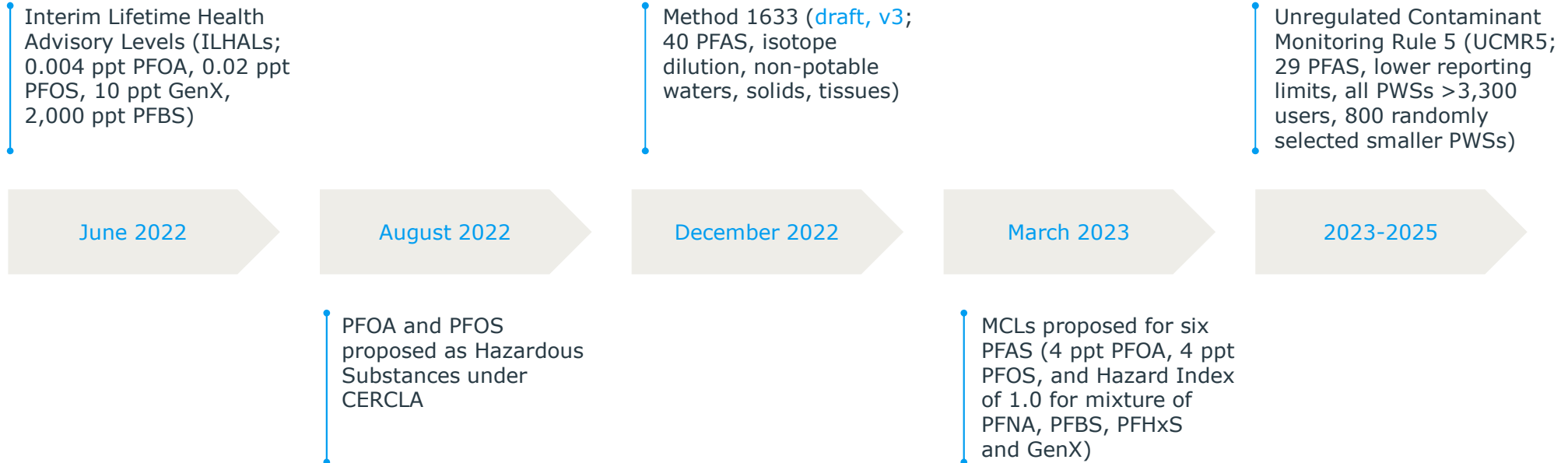


USEPA's approach to tackling PFAS: Principles

PFAS contamination poses unique challenges, and USEPA must use every tool in its tool box; USEPA's approach is centered around the following principles:

- Consider the lifecycle of PFAS
- Get upstream of the problem
- Hold polluters accountable
- Ensure science-based decision-making
- Prioritize protection of disadvantaged communities

Key federal activities (cont'd)



Key NYSDEC activities

Key NYSDEC activities

- Aftermath of Village of Hoosick Falls
- February 2016 – Water Quality Rapid Response Team formed (with NYSDOH)
- April 2016 – Emergency regulations under Part 597 (subsequently finalized)
 - Designated PFOA and PFOS as Hazardous Substances (RQ = 1 pound)
 - Restricted storage, training, and use of fire fighting foams
- Surveyed >1,750 fire departments, airports and petroleum storage facilities
- Information requests sent to >150 industrial facilities
- April 2017 – \$2.5B Clean Water Infrastructure Act signed by Gov. Cuomo
- April 2017 – New York State Drinking Water Quality Council established

Key NYSDEC activities (cont'd)

- May 2017 – NYSDEC begins requiring existing remedial sites to sample groundwater for PFAS, and to include PFAS in investigations for new remedial sites
- Summer 2017 – NYSDEC begins evaluating/prioritizing closed landfills
- November 2018 – NYSDEC using screening levels for groundwater PFAS results
 - 70 ppt for PFOA and PFOS (individually and combined; USEPA's LHALs)
 - 100 ppt any single other PFAS
 - 500 ppt sum of other PFAS
- February 2019 – NYSDEC revises guidance document to require PFAS analysis of imported fill at remedial sites
- January 2020 – NYSDEC revises guidance document to adopt 10 ppt as screening level for PFOA and PFOS (DWQC's recommended MCLs) and apply to surface water as well as groundwater
- October 2020 – NYSDEC revises guidance document to include criteria for soil

Key NYSDEC activities (cont'd)

- October 2021 – TOGS 1.1.1 addendum [proposed](#) with guidance values for PFOA and PFOS
 - Class GA and GSA groundwaters – 6.7 ppt PFOS, 2.7 ppt PFOA
 - Surface waters – Various criteria depending on Class
- December 2021 – Changes to Part 375 [proposed](#), including addition of Soil Cleanup Objectives (SCOs) for PFOA and PFOS
 - Public comments accepted through April 2022
 - Not yet finalized
- March 2023 – TOGS 1.1.1 addendum finalized (no changes)

Sampling & analysis primer

Dominant USEPA analytical methods

- Method 537 (November 2008)
 - SDWA method, drinking water, 14 PFAS
- Method 537, Revision 1 / Version 1.1 (September 2009)
 - SDWA method, drinking water, 14 PFAS
- Method 537.1 (November 2018)
 - SDWA method, drinking water, 18 PFAS
- Method 533 (December 2019)
 - SDWA method, drinking water, 25 PFAS, isotope dilution

Modified by numerous labs to quantify more PFAS, at lower detection limits, in non-potable media, with isotope dilution

~ \$200-\$250

- Method 1633, [draft, v3](#) (December 2022)
 - CWA method, non-potable waters, solids and tissues, 40 PFAS, isotope dilution

Currently being requested by NYSDEC

~ \$350-\$400

Sampling procedures are very important

- Use appropriate containers from the laboratory
- Use "PFAS free" equipment and materials
- Use "PFAS free" water to decontaminate re-usable equipment
- Don new nitrile gloves before each sample
- Pay attention to clothing, cosmetics, etc.
- Properly preserve samples to $\leq 60^{\circ}\text{C}$ using bagged ice

Table 1. Summary of Prohibited and Acceptable Items for PFAA Sampling

Prohibited	Acceptable
Field Equipment	
Teflon® containing materials	High density polyethylene (HDPE), stainless steel or polypropylene materials
Low density polyethylene (LDPE) materials	Acetate liners
	Silicon tubing
waterproof paper and waterproof labels	Loose non-waterproof paper and non-waterproof sample labels
rs, or spiral hard cover notebooks	Aluminum field clipboards or with Masonite harples®
	Pens
	Wet ice
Field Clothing and PPE	
synthetic water resistant, ated clothing, clothing	Well-laundered clothing made of natural fibers (preferable cotton)
g fabric softener	No fabric softener
ex™ or treated with water-	Boots made with polyurethane and PVC
	Laundered cotton clothing
ers, hand cream, or other related onal leaning/showering routine on }	Sunscreens - Alba Organics Natural Sunscreen, Yes To Cucumbers, Aubrey Organics, Jason Natural Sun Block, Kiss My Face, and baby sunscreens that are "chemical free", "toxin free" or "natural"
es except as noted on right	Insect Repellents - Jason Natural Quit Bugging Me, Repel Lemon Eucalyptus Insect repellent, Herbal Armor, California Baby Natural Bug Spray, Baby Ganics Sunscreen and insect repellent - Avon Skin So Soft Bug Guard Plus - SPF 30 Lotion
Sample Containers	
	HDPE or polypropylene
	Unlined polypropylene caps
Rain Events	
rain gear	Wet weather gear made of polyurethane and PVC only; field tents that are only touched or moved prior to and following sampling activities
Equipment Decontamination	
well	Alconox® and/or Liquinox®
tested public water supply	Potable water from tested (and PFAA free) public drinking water supply
Food Considerations	
exceptions noted on right	Bottled water and hydration fluids (i.e., Gatorade® and Powerade®) to be brought and consumed only in the staging areas
Vehicle Considerations	
and mats may contain PFAAs	Avoid utilizing areas inside vehicle as sample staging areas.

PFAS SAMPLING CHECKLIST

Site Name: _____ Task: _____
 Weather (temp/precip): _____ Date: _____

Field Clothing and PPE:

☐ No clothing or boots containing Gore-Tex™
☐ No clothing or boots treated with water-resistant spray
☐ Safety boots made from polyurethane and PVC
☐ No materials containing Tyvek®
☐ Field crew has not used fabric softener on clothing
☐ Field crew has not used cosmetics, moisturizers, hand cream, or other related products this morning
☐ Field crew has not applied unauthorized sunscreen or insect repellent

Field Equipment:

☐ No Teflon® or LDPE containing materials
☐ All sample materials made from stainless steel, HDPE, acetate, silicon, or polypropylene
☐ No waterproof field books, waterproof paper or waterproof bottle labels, waterproof markers/Sharpies®
☐ No plastic clipboards, binders, or spiral hard cover notebooks
☐ No Post-it Notes®

☐ Coolers filled with regular ice only; no chemical (blue) ice packs in possession

Sample Containers:

☐ Sample containers made of HDPE or polypropylene
☐ Caps are unlined and made of HDPE or polypropylene

Wet Weather (as applicable):

☐ Wet weather gear made of polyurethane and PVC only

Equipment Decontamination:

☐ "PFAS-free" water on-site for decontamination of sample equipment; no other water sources to be used
☐ Alconox® and Liquinox® to be used as decontamination cleaning agents

Food Considerations:

☐ No food or drink on-site with exception of bottled water and/or hydration drinks (i.e., Gatorade® and Powerade®) that is available for consumption only in the staging area

Vehicle Considerations:

☐ Avoid utilizing areas inside vehicle as sample staging areas

If any applicable boxes cannot be checked, the field team leader shall describe the deviations below and work with field personnel to address issues prior to commencement of that day's work. If possible, materials identified as potentially containing PFAS (i.e., Tyvek® coveralls, spare equipment) should be relocated to a separate area of the site as far away as possible from the sampling location(s) and containerized if practicable. To assist in the assessment of QC data, the field team leader should document the presence of such items, their location, whether they have been containerized, and, if containerized, what type of container.

Describe any deviation(s) and the action/outcome and document the presence of any potential PFAS-containing materials:

Field Team Leader Name: _____
 Field Team Leader Signature: _____ Time: _____

QA/QC samples

Methods blanks (MBs)

- Prepared and analyzed by the laboratory
- Check on the lab's "PFAS free" water

Field reagent blanks (FRBs)

- Use "PFAS free" water sent by the lab
- Check on potential for sample contamination by air, clothing, cosmetics, etc.

Equipment blanks (EBs)

- Samples of "PFAS free" water poured over/through sampling equipment
- Check on potential for contamination from sampling equipment and sample handling

Duplicates (Dups)

- Check on the reproducibility of the lab results

Matrix spike/matrix spike duplicates (MS/MSDs)

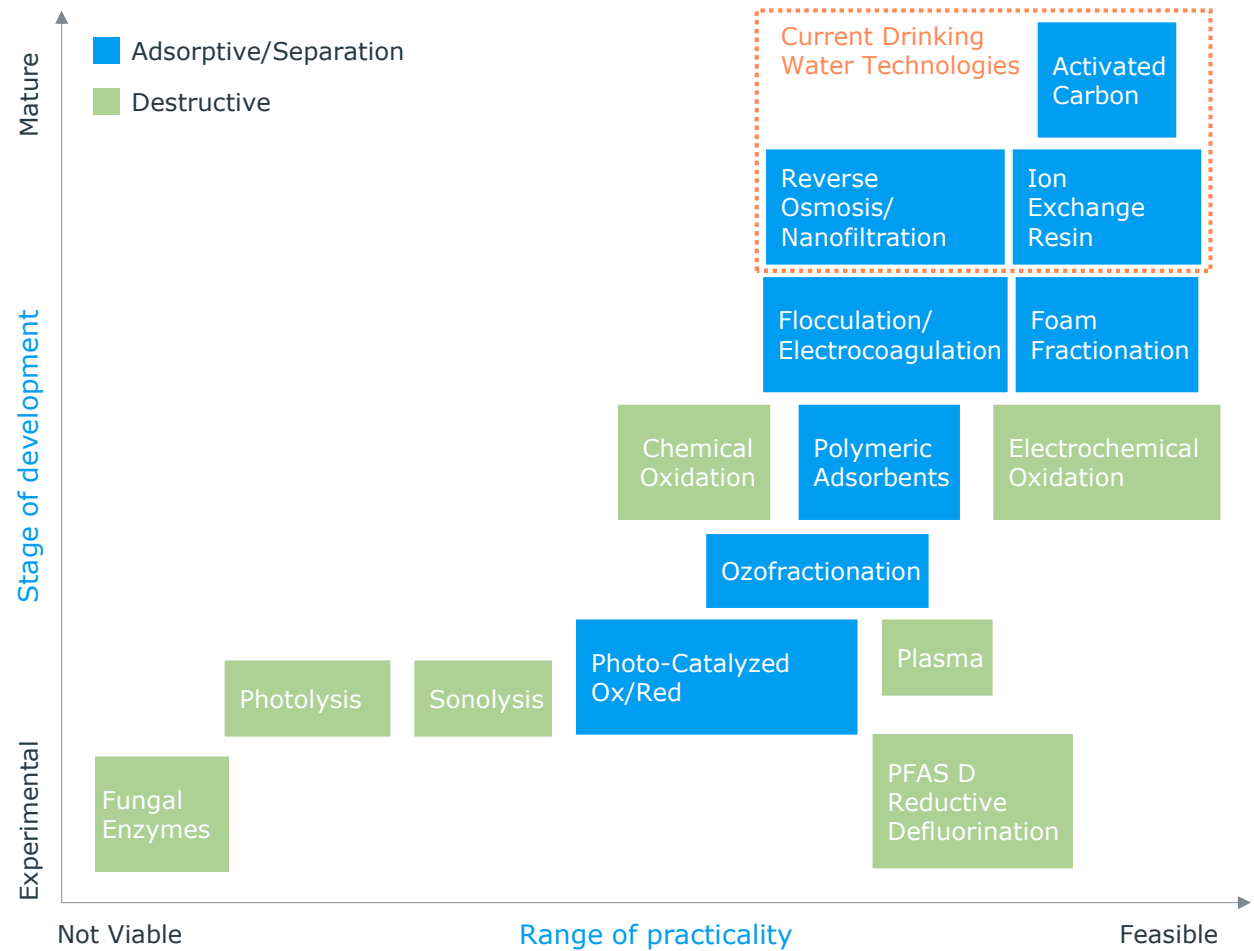
- Assess potential matrix interference

Field QC samples are good practice and are required if data validation is going to be performed



Aqueous treatment primer

Aqueous treatment technologies



Granular activated carbon (GAC)

Mature			●
Experimental			
	Not Yet	Feasible	

Adsorption of molecules to charged surfaces through van der Waals forces



Photo courtesy of Calgon Carbon Corporation, 2018

- Currently the most common treatment technology
 - According to USEPA, "Activated carbon treatment is the most studied treatment for PFAS removal"
- Capable of 90 to >99% removal efficiency
- Treatment efficiency is dependent on type of PFAS, terminal functional group, molecular weight, etc.
- High TOC, TSS, TDS impact effectiveness
- Subject to back-desorption – by displacement of PFAS compounds by organics with stronger affinities, or by lower influent concentrations (reverse concentration gradient)
- Precursor compounds can transform within the vessels
- Spent carbon requires offsite disposal or reactivation

Thank you!



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