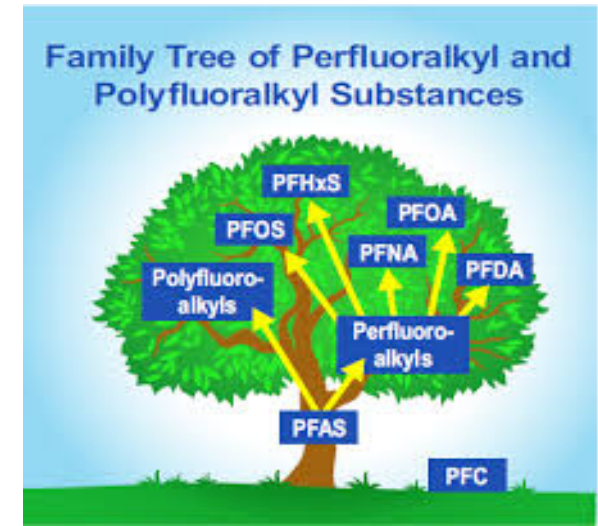


Decision-making and financial implications of PFAS fate and transport in multiple environmental media

Panel Discussion

Battelle Chlorinated Conference
Denver, Colorado

June 3, 2024



Discussion Objectives and Outline

Last year's panel – Implications of Background/Ambient PFAS in the Environment

This panel – Widespread occurrence of PFAS in all environmental media

Key Topics for Today

- How much data is needed for PFAS characterization and decision-making?
 - Dr. Jinxia Liu, McGill University
- How should RPs approach PFAS at a programmatic and site level?
 - Dr. Nicolette Andrzejczyk, NAVFAC-EXWC
- **10-minute Q&A break**
- Can PFAS Remediation Goals achieve risk reduction and/or site closure ?
 - Grant Trigger, RACER Trust
- How do regulators define “success” and exit the process?
 - Rebecca Higgins, AECOM/Formerly MPCA
- Where do we go from here?
 - All + Audience



Panel Members



Usha Vedagiri
WSP-USA

Moderator,

PFAS Consultant
Risk/Liabilities



Jin-Xia Liu

McGill University,
Canada

PFAS Chemistry
Researcher



Nicolette Andrzejczyk

NAVFAC-EXWC, USA

PFAS Site Assessment
Program Management



Grant Trigger

RACER Trust, USA

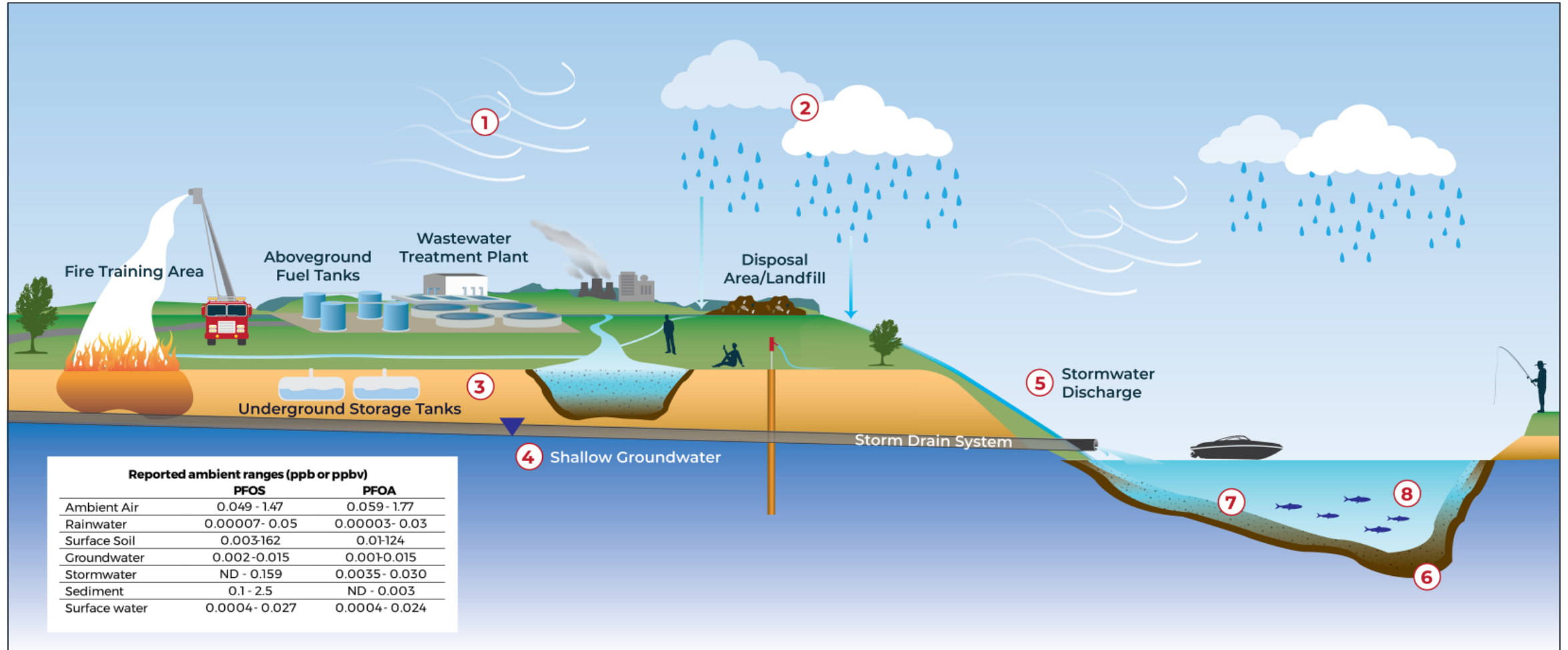
PFAS Site Uses



Rebecca Higgins,
AECOM , Formerly
Minnesota Pollution
Control Authority,
USA

PFAS Regulator/
Consultant

Ambient PFAS Levels in Multiple Environmental Media



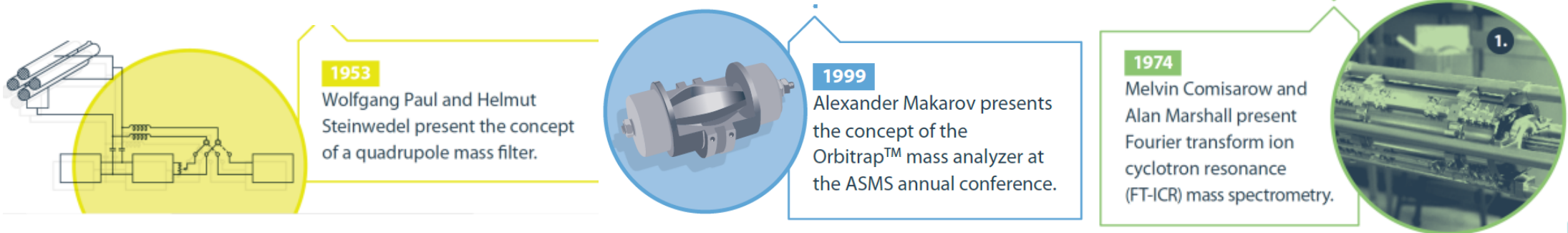
Dr. Jinxia Liu
McGill University, Montréal, Canada

PFAS Environmental Data

How did we get here?

Analytical chemistry and tools have played a big role

- The extent of PFAS contamination is not realized until an analytical technology emerges and is accessible;
- Current US EPA MCLs for PFAS are partly based on the lowest level that laboratories can reliably measure.



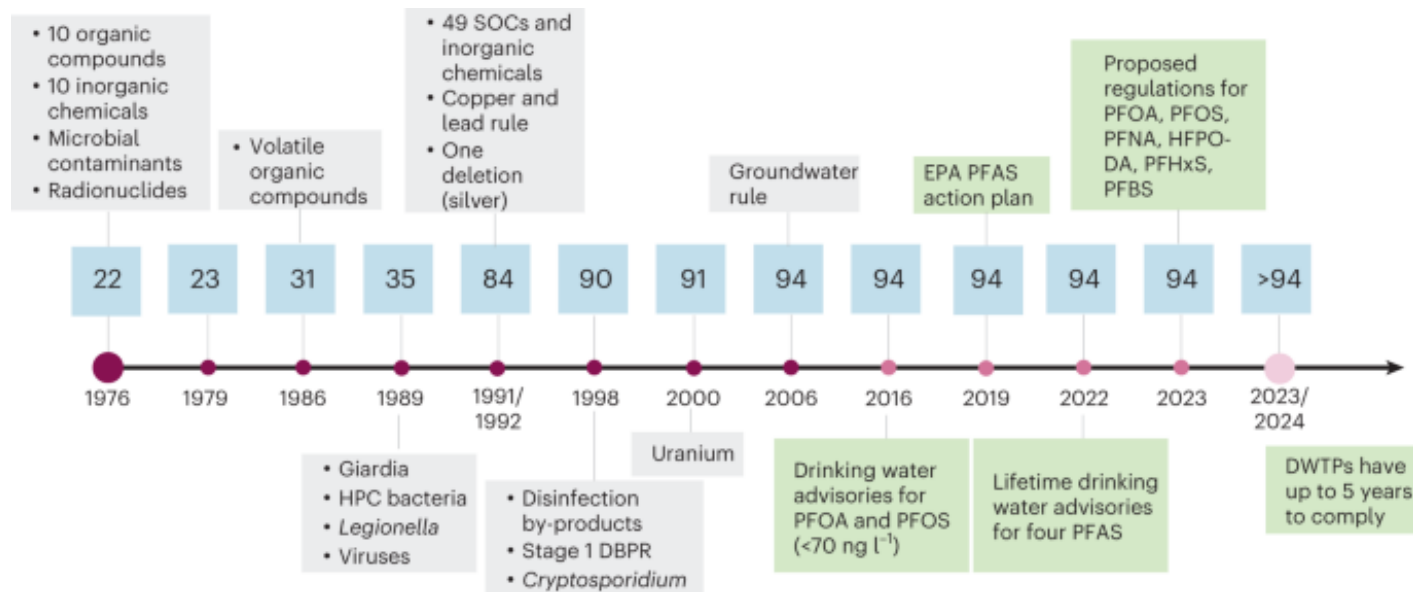
- ^{19}F -Nuclear magnetic resonance spectroscopy (^{19}F -NMR)
 - Particle-induced gamma ray emission (PIGE)
 - Combustion ion chromatography (CIC)
 - Total oxidizable precursor (TOP) assay

Where are we now?

Published analytical methods

- EPA Method 533: 25 analytes; drinking water
- **EPA Method 1633: 40 analytes; linear and branched isomers; non-potable waters, solids, biota**
- EPA Method SW-8327: 24 analytes; surface/ground/wastewater
- EPA Method 1621: adsorbable organic fluorine (AOF) by CIC
- ASTM D8421: 44 analytes; various non-potable water
- ASTM D8535: 44 analytes; soil, sediment, sludge and biosolids

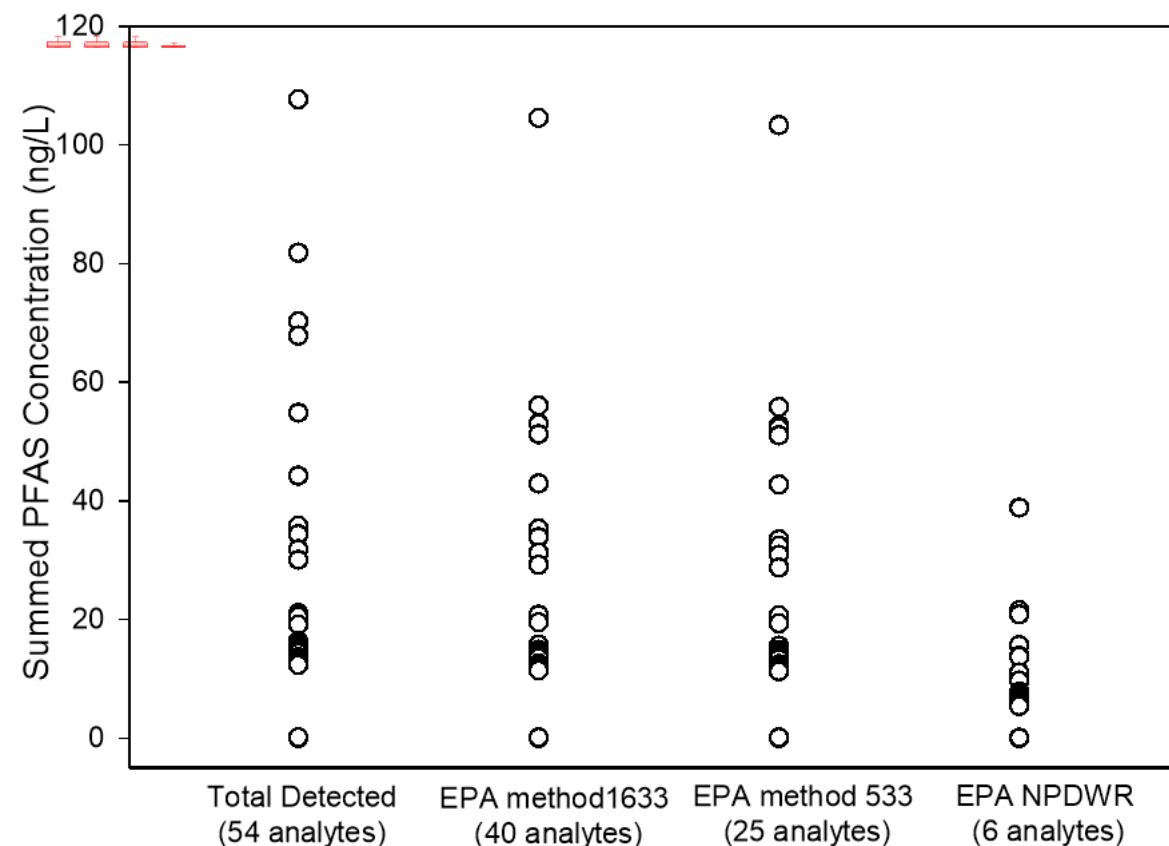
PFAS regulatory compliance in water infrastructure in the US



Where are we now?

PFAS in drinking water: what would be quantified vs regulated?

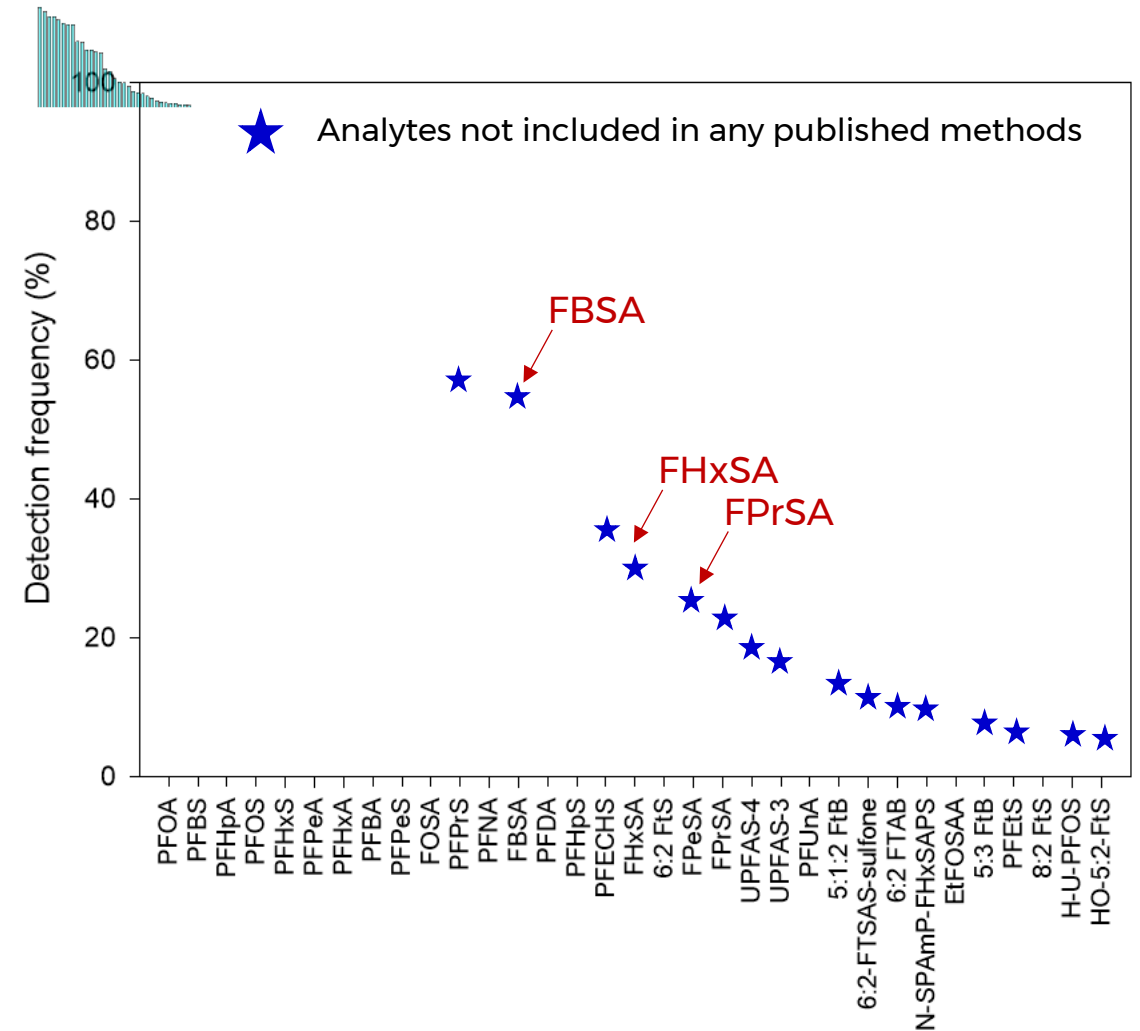
- Dataset for Quebec, Canada including 462 samples
- 54 PFAS were detected (24 classes)
- Compounds detected above 20 ng/L: PFPeA, PFHxA, PFHxS, 6:2 FTSA
- Short-chain sulfonamides (C3-C6) are often detected in tap water, but not covered by published methods



Where are we now?

PFAS in drinking water: what would be quantified vs regulated?

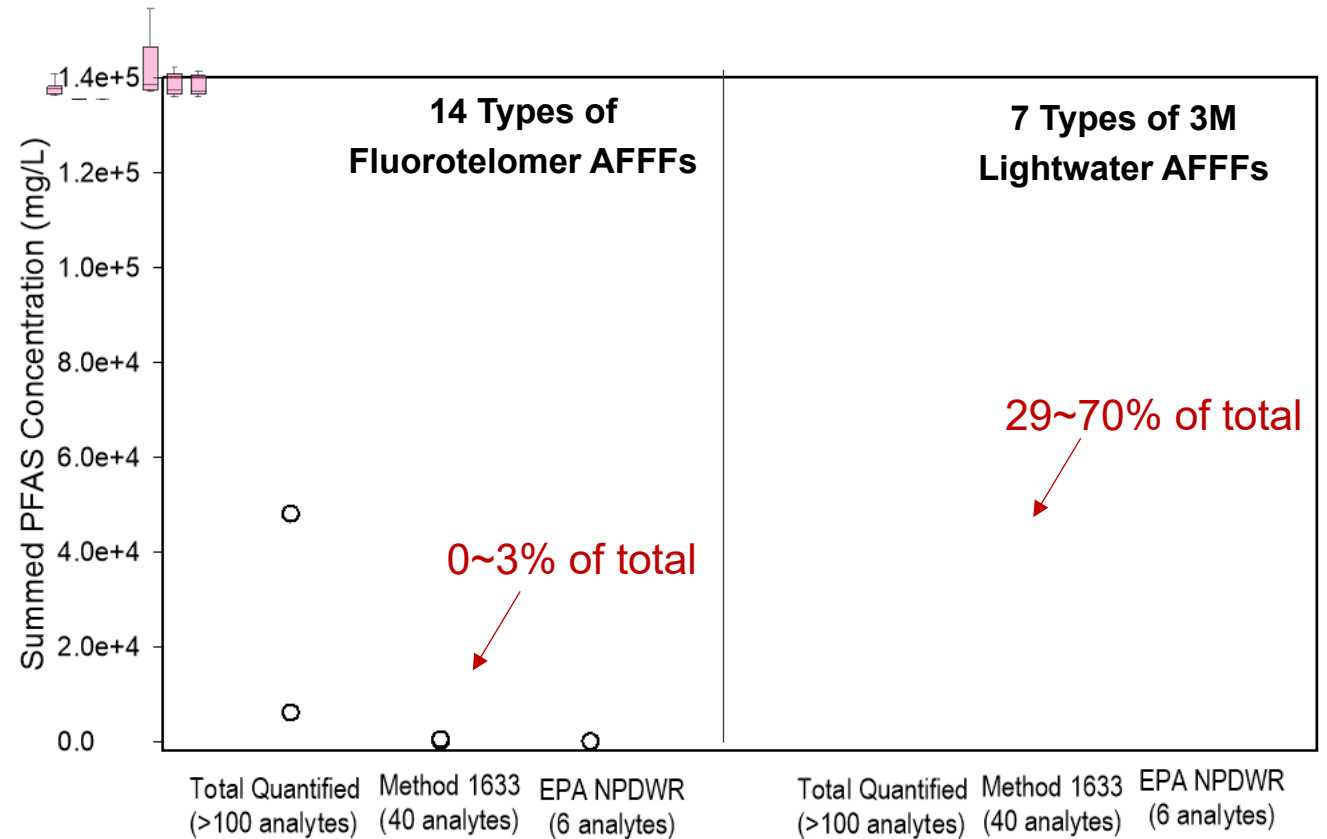
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Where are we now?

PFAS in aqueous film-forming foams (AFFFs): what would be quantified vs regulated?

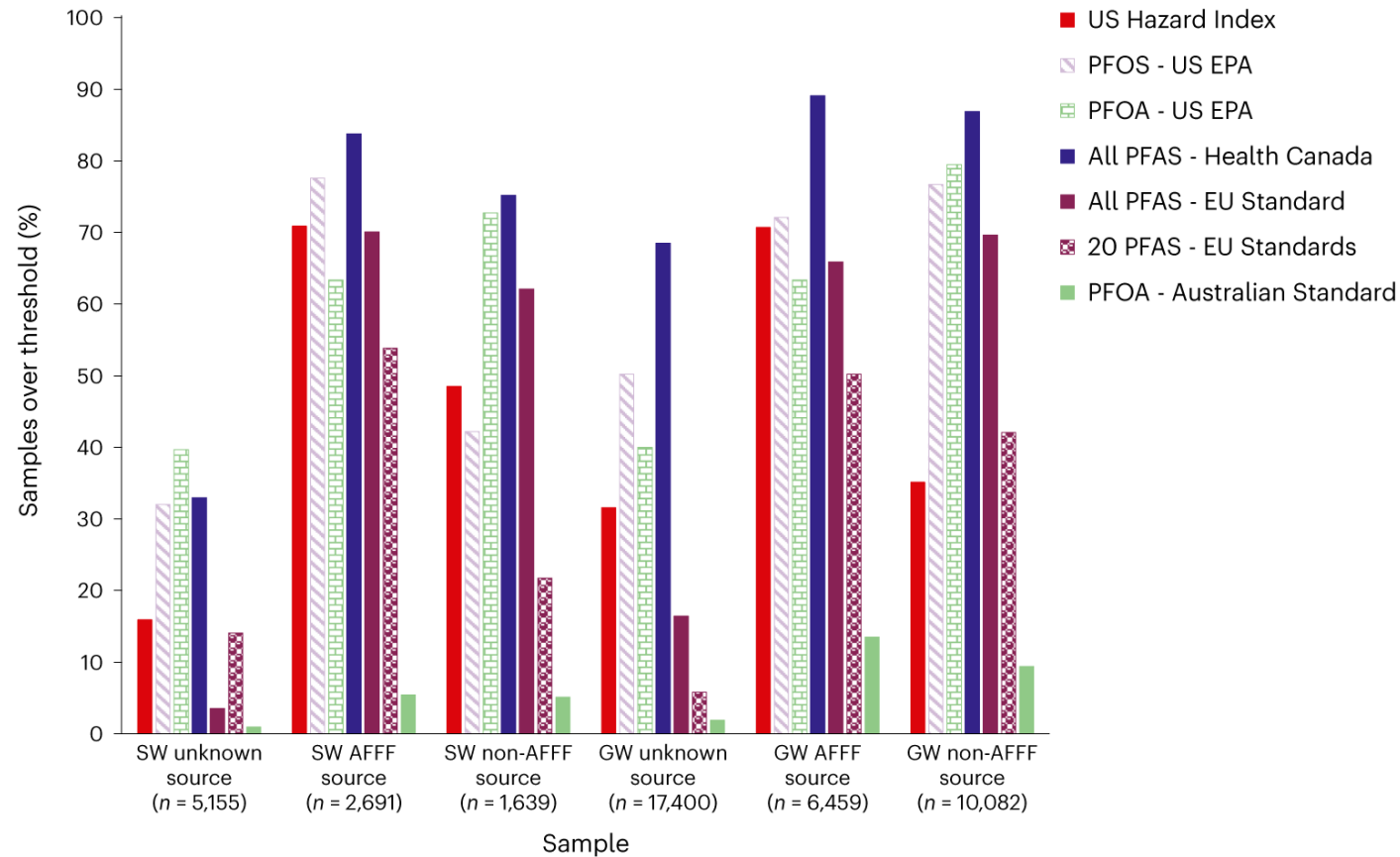
- Published methods have low coverage of types and concentration of PFAS in fluorotelomer AFFFs;
- AFFF transformation in the environment may result in higher percentage of quantifiable PFAS;
- How much published methods can cover PFAS in AFFF-impacted samples?



Where are we now?

AFFFs vs unknown sources: groundwater and surface water

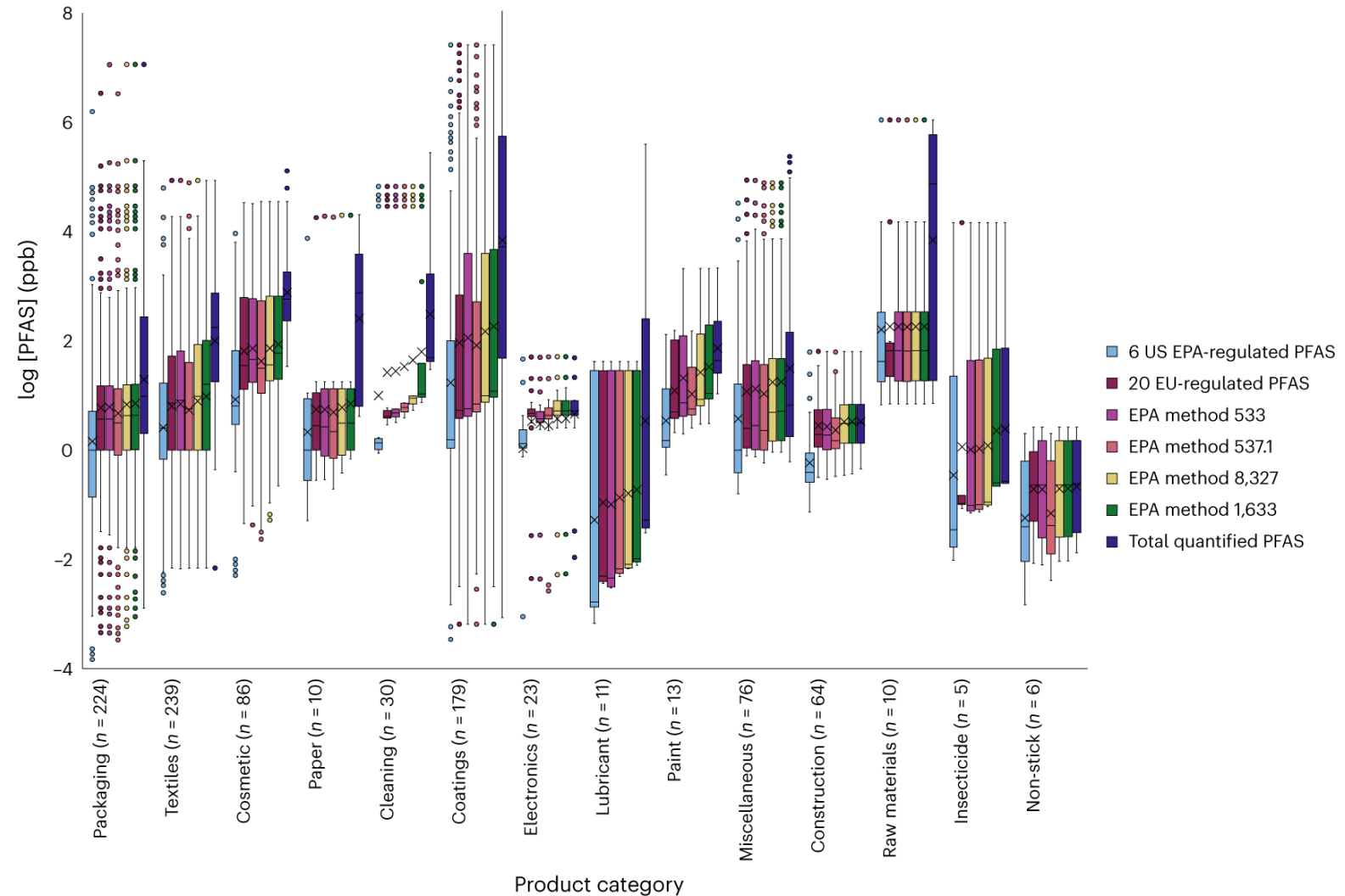
- For groundwater samples with known AFFF contamination, the incidence of exceedance of EPA drinking water regulation was >50%;
- When there was no known source, the incidence of exceedance of these criteria was still elevated (>30%)



Where are we now?

PFAS in consumer and industrial products: what would be quantified vs regulated?

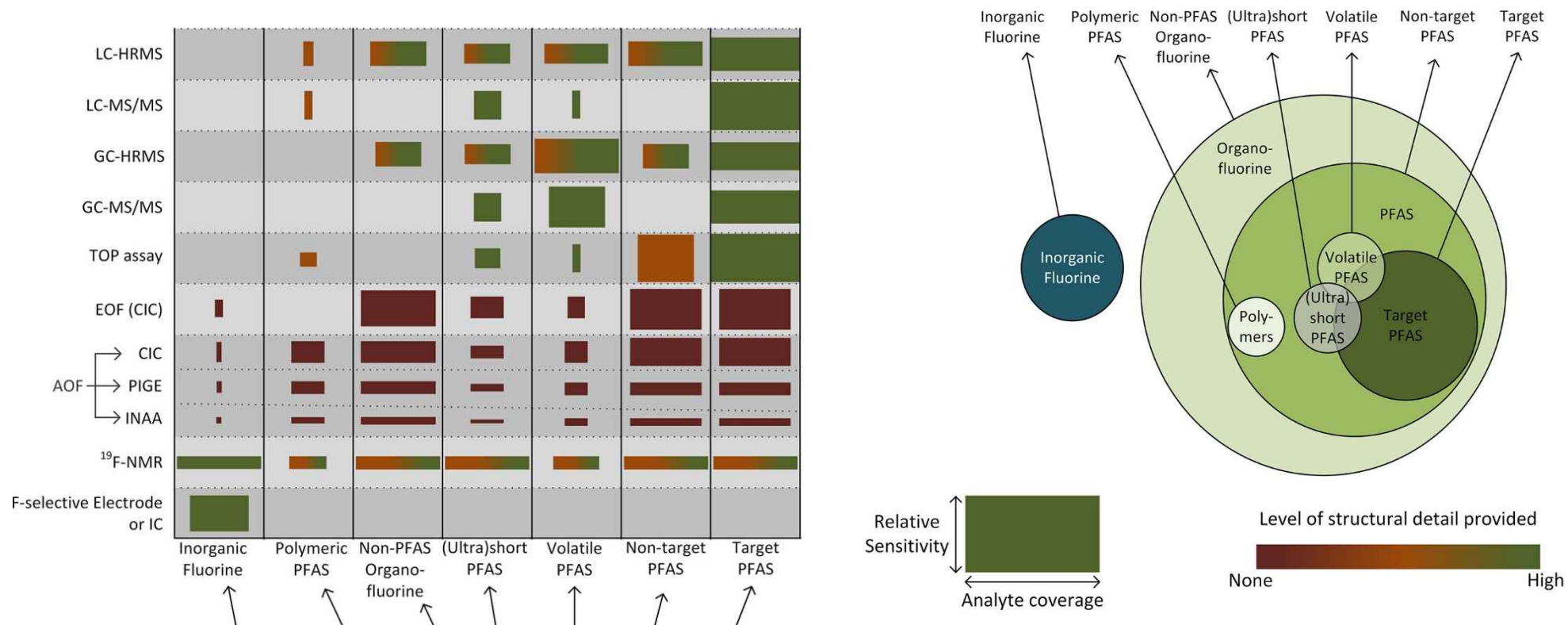
- Analyzing only those analytes in EPA methods to these products would substantially underestimate total embodied PFAS;
- Current regulations have very limited coverage of PFAS detected in products.



Where are we going?

Close the fluorine mass balance

- Analytical tools were proposed for closing the fluorine mass balance in evaluating PFAS destruction technologies.
- What tools have you used or are considering using for investigating environmental fate and transport and performing risk assessment?

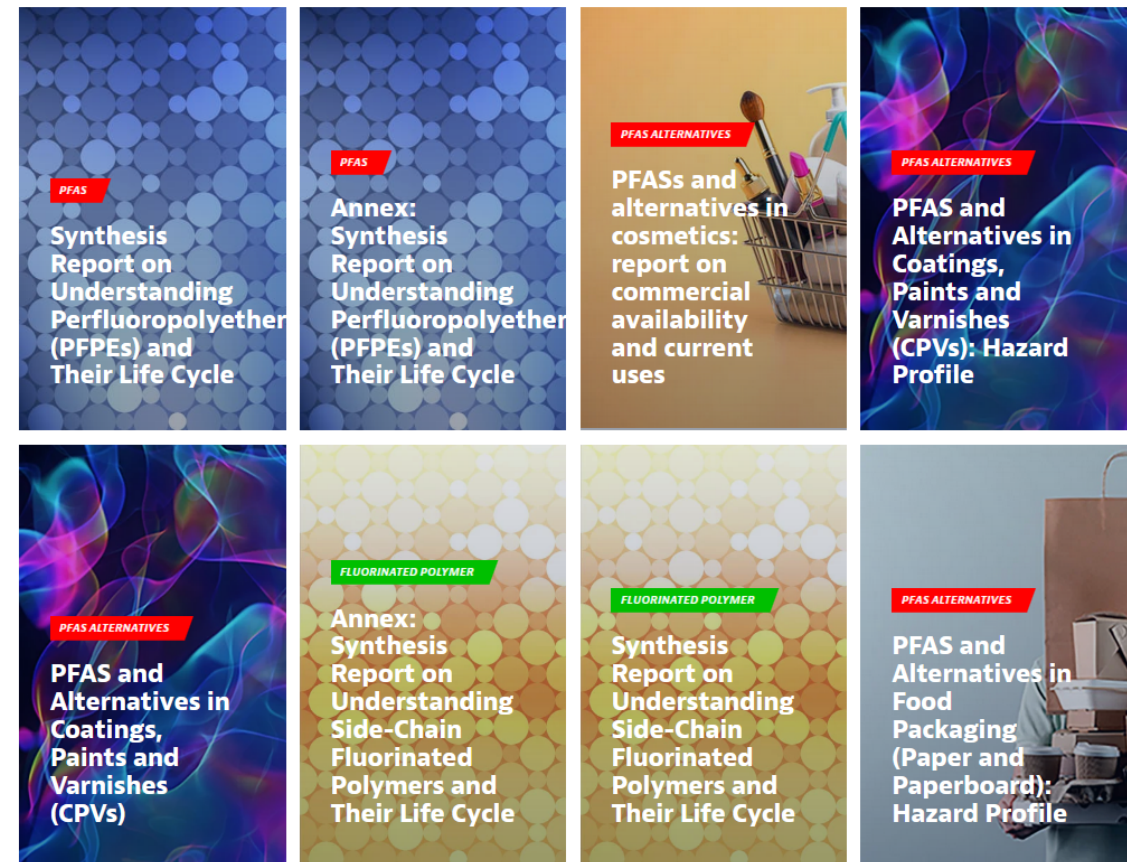


Where are we going?

More PFAS will be discovered and detected in the environment

- **High-resolution mass spectrometry for routine analysis**
- **More PFAS compounds**
 - Ultrashort chain
 - Volatile neutral
 - Zwitterionic and cationic
 - Polymeric PFAS: wide range of molecular weights
- **More sample types**
 - Air and vapor phases
 - Spent sorbents; technology-derived waste, concrete, asphalt, etc.
- **Evolving definitions**
 - Some jurisdictions moving to include RCF_3 , RCF_2CF_3 and even $\text{RCF}_2\text{R}'$

Latest publications on Per- and Polyfluoroalkyl Substances



Dr. Nicolette Andrzejczyk
NAVFAC EXWC, San Diego, CA

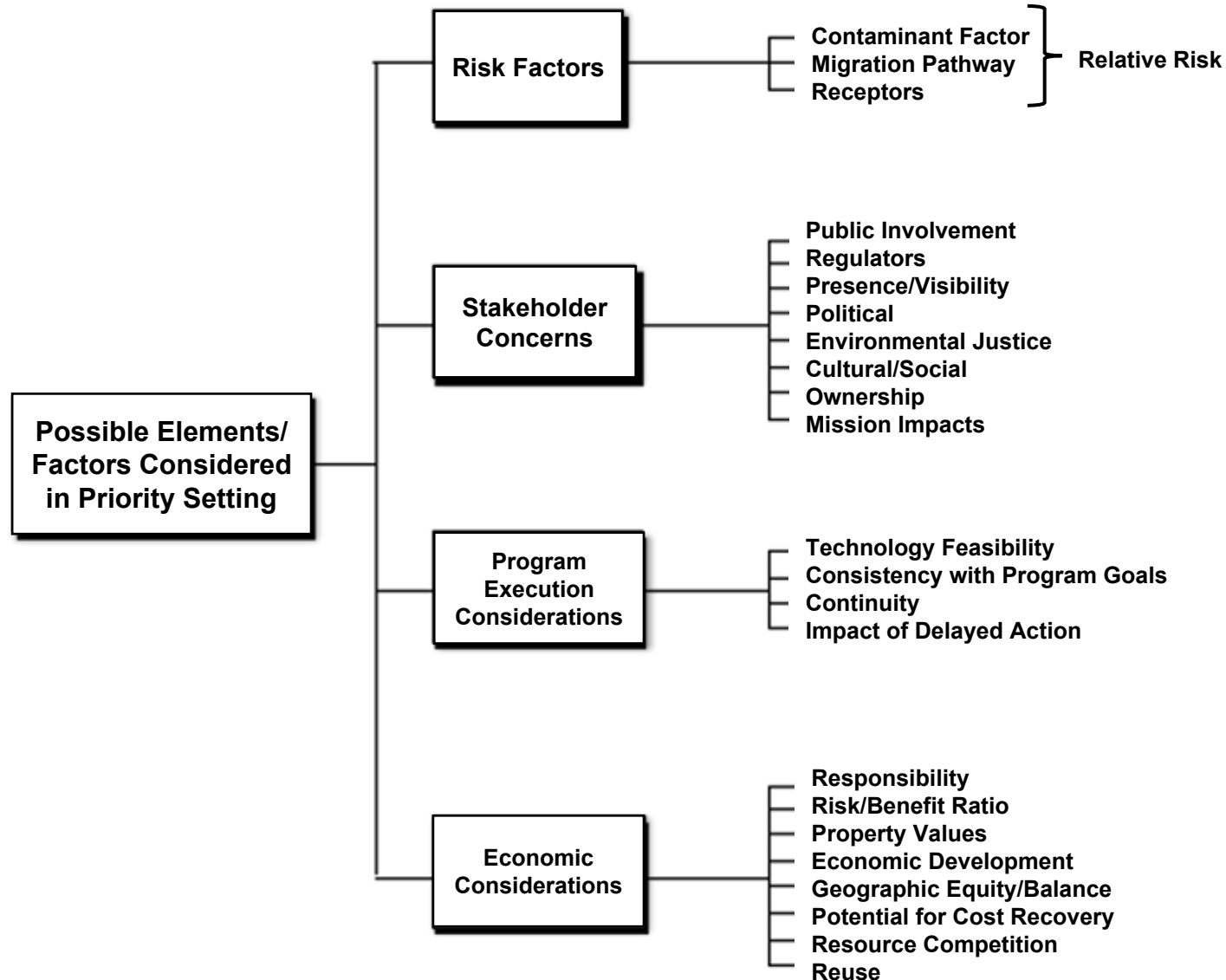
PFAS in Navy Programs

U.S. Navy PFAS Sites Progress

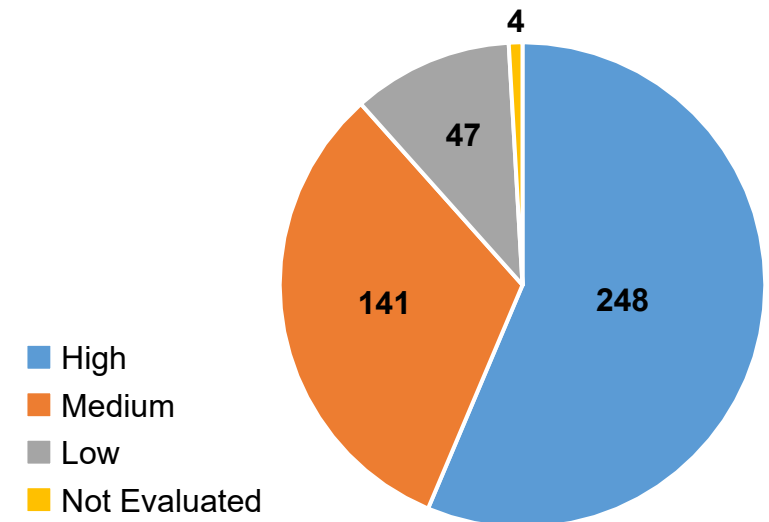
- Preliminary Assessment/Site Inspection (PA/SI) CERCLA phase is complete at approximately 150 U.S. Navy installations
 - Thousands of areas of interest (AOIs) examined during the PA/SI phase
- 440 new/reopened/existing sites with PFAS concerns moving into Remedial Investigation (RI) phase (more coming)
 - Relative risk site evaluation will be used to prioritize sites

***NEED TO PRIORITIZE WORK IN RESOURCE
CONSTRAINED ENVIRONMENT***

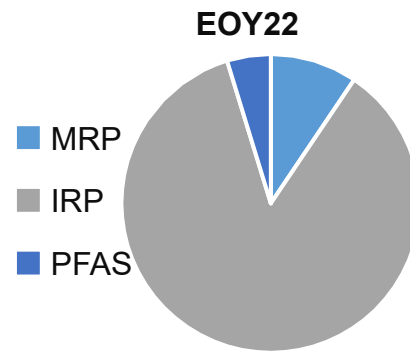
Considerations for Prioritization



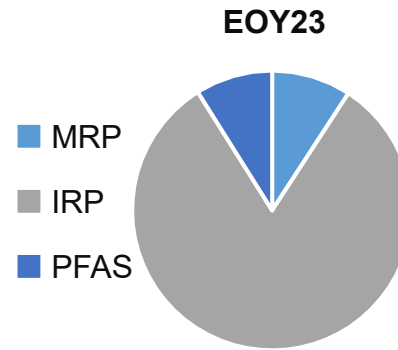
Navy Sites Relative Risk



End-of-Year FY23 PFAS Universe Growth



EOY22 Site Count	
MRP	422
IRP	3,835
PFAS	212
	4,469

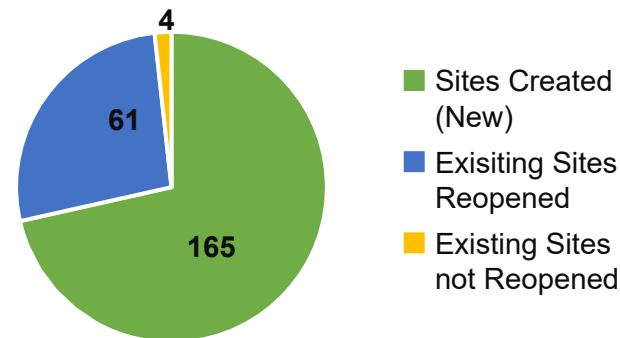


EOY23	New Sites	Count
MRP	2	424
IRP	7	3,778
PFAS	165	440
		4,642

230 Additional PFAS sites in FY23

165 New sites (PFAS)

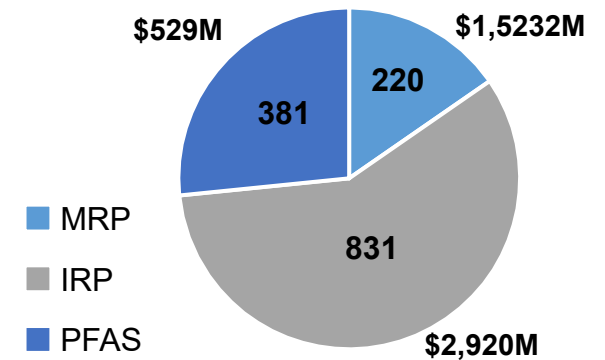
65 Existing sites added PFAS



Cost-to-Complete (CTC)

EOY23	CTC (\$M)	"Active" Sites
MRP	\$1,523	220
IRP	\$2,920	831
PFAS	\$529	381
	\$4,972	1,432

"Active" Sites



Additional PFAS growth expected through FY24

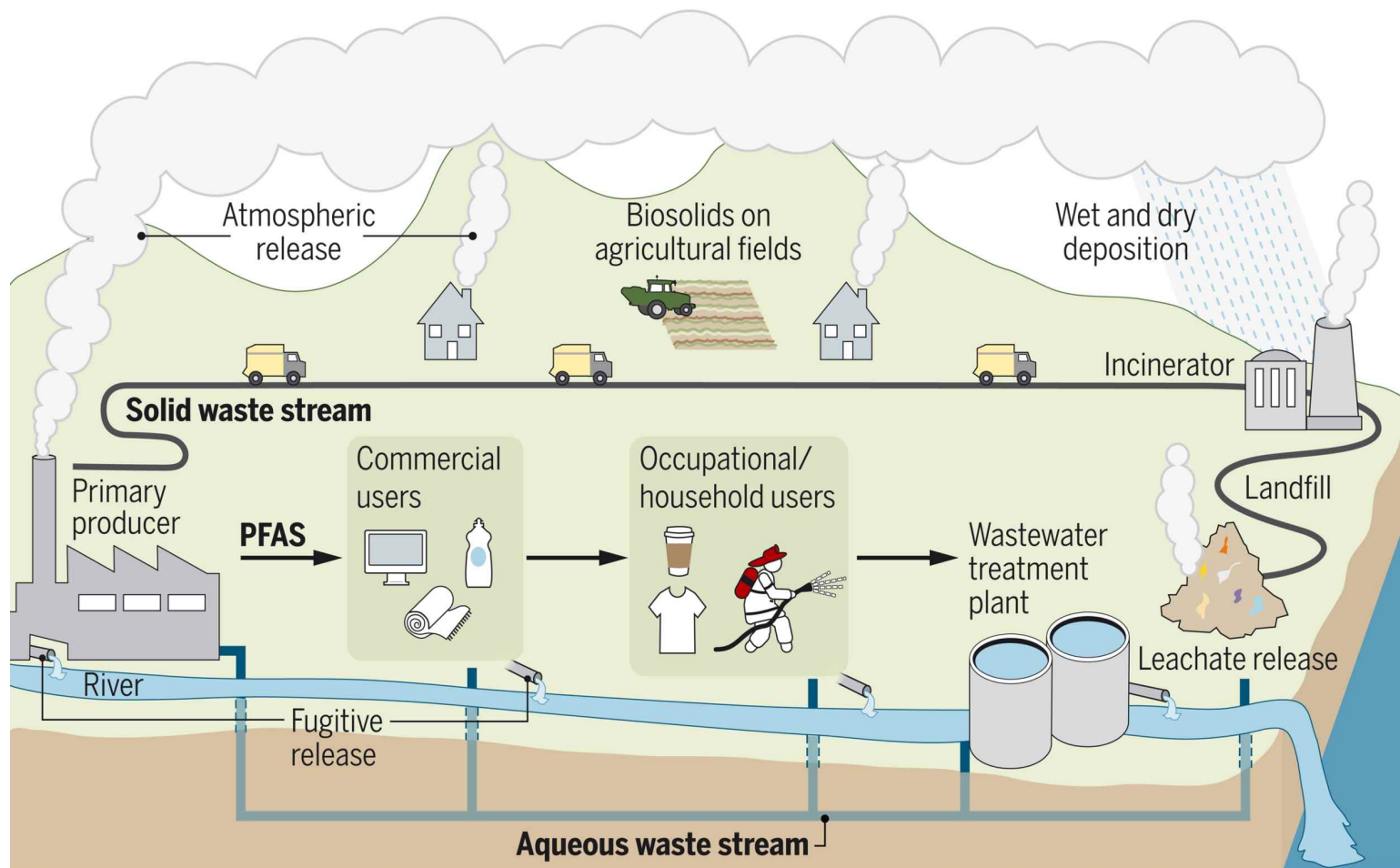
Questions? **10 minutes**



Grant Trigger RACER Trust

PFAS Costs and Relative Risk Management

**ITS EVERYWHERE – WE CAN'T ESCAPE –
WE WILL NEVER BE SAFE FOREVER**



PFAS - PUBLIC IMPACTS AND COSTS

IS RISK MANAGEMENT A SOLUTION?

PANEL DISCUSSION

2024 BATTELLE
CHLORINATED CONFERENCE

DENVER, CO



PFAS IS NOT A PROBLEM –

IF YOU DON'T EAT, DRINK, OR BREATHE



“AN INCONVENIENT TRUTH?”

WHAT IS WORSE THAN PFAS

A WHOLE BUNCH OF THINGS



RIDING IN A CAR

GUN SHOT

DROWNING

CHOKING ON FOOD

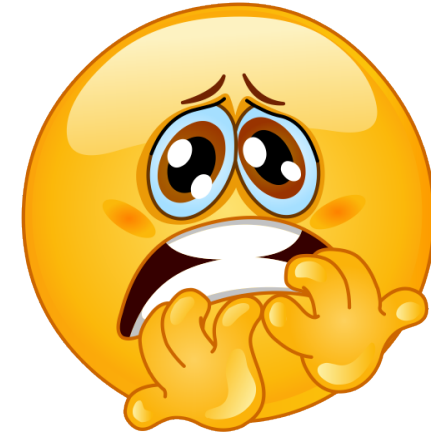
WHAT DOES THE PUBLIC NEED? (WE CREATED A MONSTER UNDER THE BED)

- Honesty/truth
- No fear mongering
- Government that is trusted
- Answers
- To be safe from everything
- **DO WE NEED BETTER ISSUE DEFINITION AND MANAGEMENT???**



NO FEAR MONGERING

- Forever chemicals – a cloud over everything
- Its everywhere – in everything
- Microwave popcorn – how much have I eaten and can I eat anymore?
- Big Mac wrapper – how many have I eaten and can eat anymore?
- Cosmetics – will I wrinkle or go blind?
- Carpet – my kids played on the floor – are they going to get cancer?
- ScotchGuard – can I sit on the couch?
- Dental floss – how much did I use and will I get cancer?
- Contact lenses - will I go blind?
- Doctors can't do anything about it – what can I do?
- Fireman Outerwear – is it a problem – research is not done



PFAS INFO FOR CLINICIANS



- ATSDR 2024 Guidance
- Health effects include increased cholesterol, lower birth weight, lower antibody response to vaccines, kidney and testicular cancer, pregnancy-induced hypertension, preeclampsia
- “PFAS Blood test results do not provide information for treatment or predict future health problems”
- “No approved medical treatments are available to reduce PFAS in the body”
- So “Doctor what am I supposed to do – you tell me I have PFAS in my blood and I can’t avoid exposure forever to PFAS because they are everywhere.....?”

FLINT WATER CRISIS – FLINT LIVES MATTER



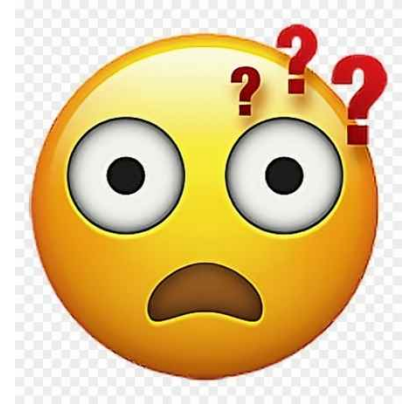
- Lead in water supply (2014) – Professor Edwards stated “The levels that we have seen in Flint are some of the worst that I have seen in more than 25 years working in the field”
- Issue lasted 18 months before source of water was changed.
- At the peak of the water crisis 4.9% of children exceeded CDC “level of concern” (5 micrograms per deciliter) an increase from 2,2% the year before the crisis began - The state average was 3.5% in 2014.
- In 2015 the Mayor of Flint (a psychologist) wrote: “This damage to children is irreversible and can cause effects to a child’s IQ...”
- Studies reported locally on May 14, 2024, - Researchers have found no evidence that lead exposure is the cause of lower learning performance by children in Flint schools. The same Professor Edwards described why students in Flint perform below expectations - its “the “nocebo effect” (like placebo) – when the community tells its children they will perform below standards – the students assume they cannot learn.
- IS THE FEAR OF PFAS WE HAVE CREATED - WORSE THAN THE POSSIBLE HARM FROM PFAS?????

FEAR MONGERING



- In a 2018 Washington Post op-ed Joseph Allen (Harvard Professor in School of Public Health) determined to draw attention to PFAS called them “forever chemicals” because that described their “key feature”
- Now the rest of us are burdened by the pressure to deal with forever chemicals in a public and political minefield driven by the desperation to find ways to track, capture and destroy what we have been told is a forever problem to standards driven to an unachievable level – a task doomed to fail
- What can we say to the public? We are trying but we are doomed to fail? Or not sure when but as soon as science catches up with the politics, policies and regulations

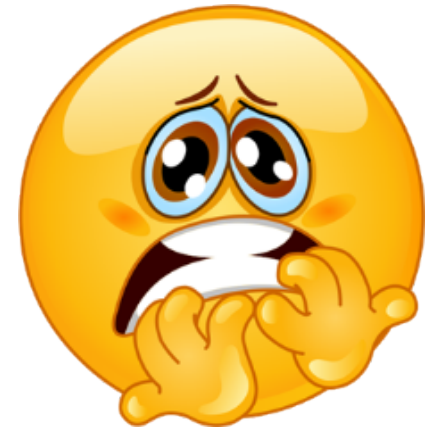
RISK MANAGEMENT MIGHT BE THE ANSWER



- What is the benefit to society of risk standard of 1 in 100,000 or 1 in 1 million?
- What value to society comes from setting environmental standards at 1 in 100,000?
- What is the cost of miss applying the fundamental principles of sound risk management?
- **Define and Implement the most effective action to achieve real risk reduction**

LIFETIME ODDS OF DEATH (NATIONAL SAFETY COUNCIL 2021)

■ Heart disease	1 in 6
■ Cancer	1 in 7
■ Gun shot	1 in 89
■ Motor vehicle accident (MI - 1,123 in 2022)	1 in 93
■ Fall	1 in 98
■ Drowning	1 in 1,006
■ Fire or Smoke	1 in 1,287
■ Choking on Food	1 in 2,659
■ Sunstroke	1 in 4,655
■ Sharp objects	1 in 25,960
■ Hornet, wasp, bee sting	1 in 54,516

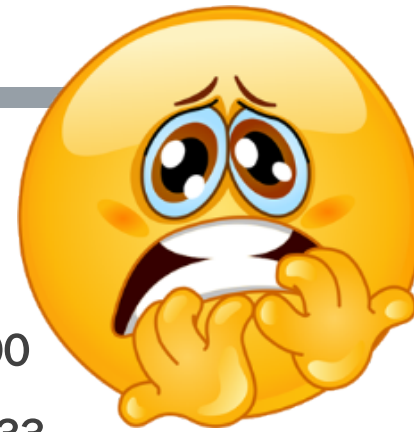


EPA BACKGROUND FOR MCL OF 4 PPT (5 PFAS)



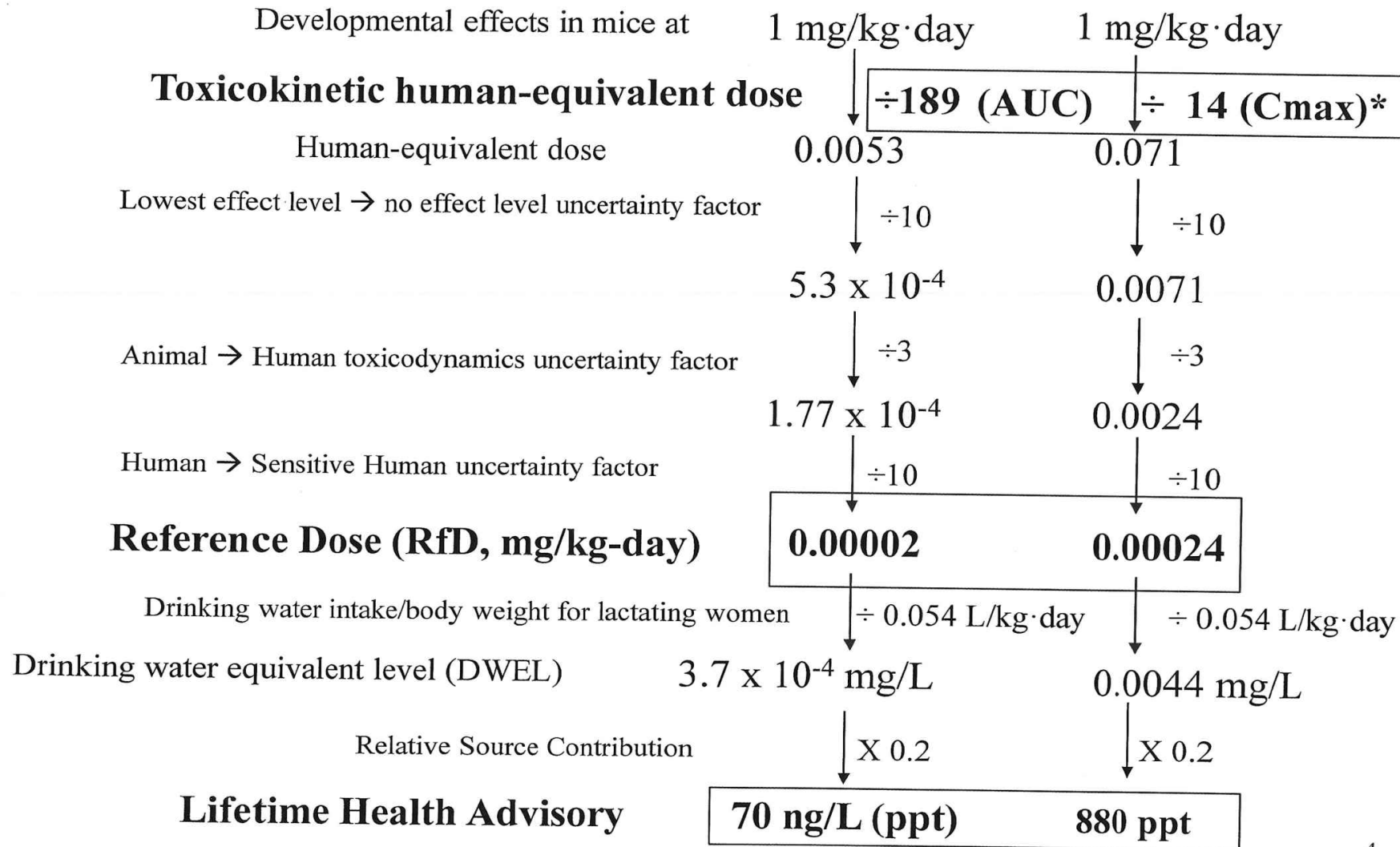
- On April 10, 2024, EPA announced new MCLs for 5 PFAS and stated: “Over many years, this action will prevent thousands of deaths and reduce tens of thousands of serious illnesses that would be attributable to long-term exposure to these PFAS.”
- EPA also stated: “This action that will reduce PFAS exposure for approximately 100 million people.....”
- At a cost of \$1.5 billion a year
- EPA estimated 8,600 deaths would be avoided - in other words 8,600 per 100,000,000 or 86 per 1,000,000 or 1 in 11,627
- However, isolating 3,700 deaths avoided due to “Cardiovascular Effects” – yields 1 in 27,027
- Over 70 years that would cost \$1.05 trillion or about \$1.5 billion per person life saved.
- But will it ??????????????????

LIFETIME ODDS OF DEATH (NATIONAL SAFETY COUNCIL 2021)

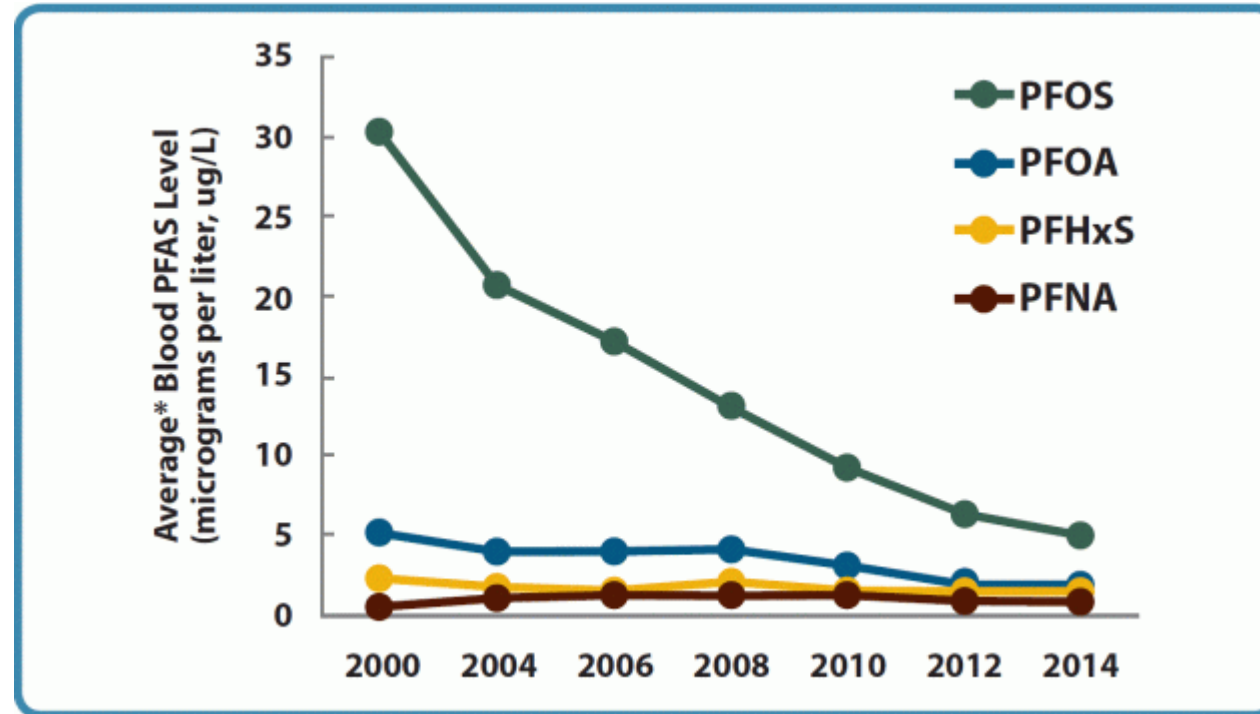


		100,000,000	8600
■ Heart disease	1 in 6	16,666,667	1,433
■ Cancer	1 in 7	14,285,714	1,228
■ Gun shot	1 in 89	1,123,595	97
■ Motor vehicle accident (MI - 1,123 in 2022)	1 in 93	1,075,268	92
■ Fall	1 in 98		
■ Drowning	1 in 1,006		
■ Fire or Smoke	1 in 1,287		
■ Choking on Food	1 in 2,659		
■ Sunstroke	1 in 4,655		
■ Sharp objects	1 in 25,960		
■ Hornet, wasp, bee sting	1 in 54,516		

EPA (2016) Versus Guideline (EPA, 1991, as per Dourson et al., 2019*) Health Advisory for PFOA



BLOOD LEVELS OF THE MOST COMMON PFAS IN PEOPLE IN THE UNITED STATES FROM 2000-2014

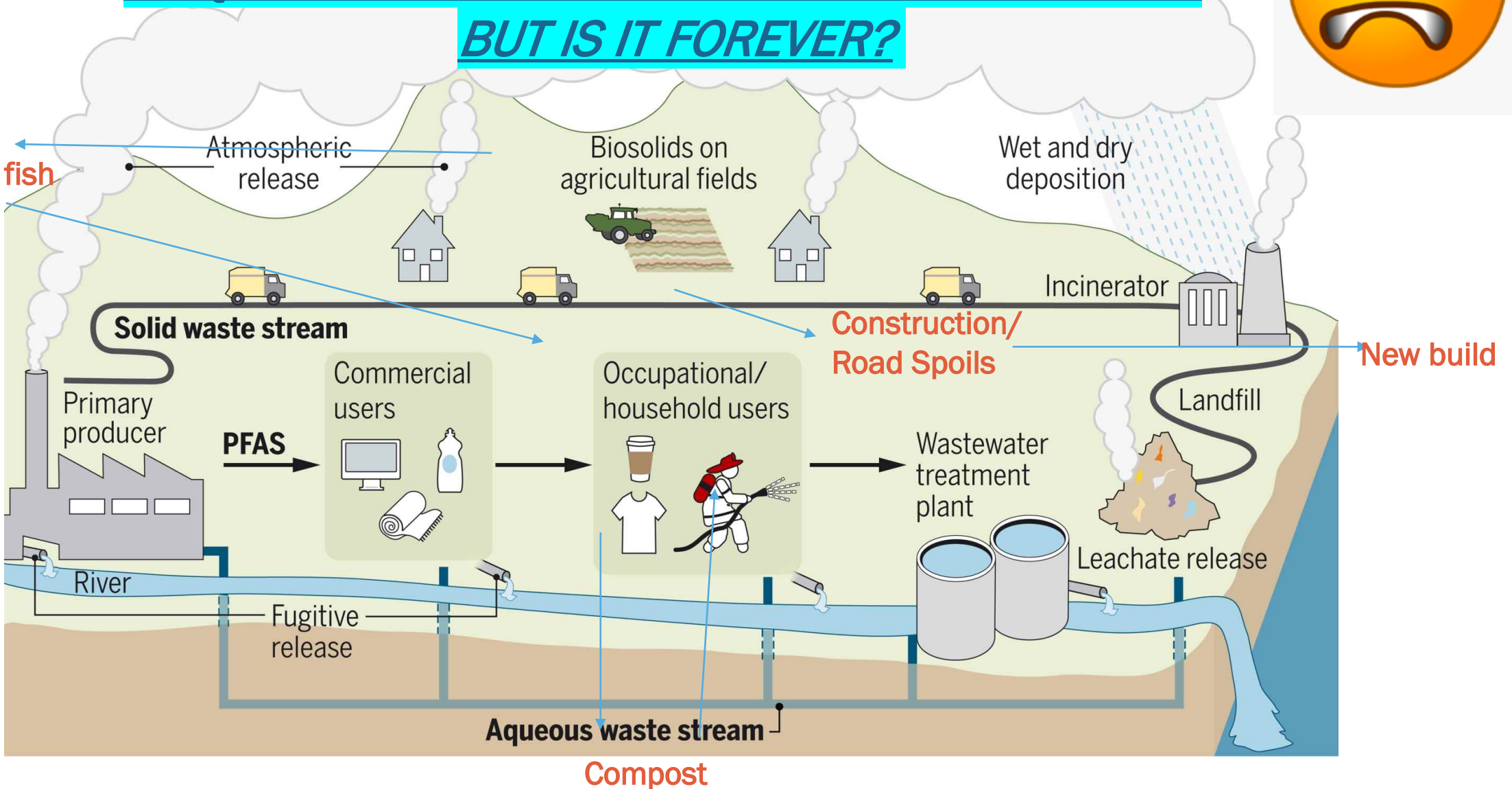


<https://www.atsdr.cdc.gov/pfas/health-effects/us-population.html>

UBIQUITOUS NATURE OF PFAS - ITS EVERYWHERE **BUT IS IT FOREVER?**



Plants,
animals, fish



RISK MANAGEMENT

- Do not mislead the public by claiming its worse than it is?
- Put estimated risk in perspective – would you and your partner ride in same car to the airport and fly on different flights?
- Do not mislabel just for effect
- Maybe we do not know enough yet – that is an honest answer
- Pick actions that actually produce real risk reduction relative to the investment – use limited resources wisely
- Recognize diminishing returns on investments and stop when it is prudent to do so

Rebecca Higgins
AECOM, Formerly Minnesota Pollution Control Agency

PFAS Regulatory Perspectives

Cost Perspectives Objectives, Externalities, Technology and Regulations

Discerning Factors for Site Management with Cost Perspectives

Regulations & Site Scale

Age and speciation of release

Hydrogeologic sensitivity

Human and ecological receptor risk management

Fiscal dexterity

Externalities

Generational scale lifecycles

Building short- and long-term trust

Emerging technology acceptance

PFAS Remediation Sector Maturation

Forecast through 2040: Advanced Definition of Mixtures and Mixtures Risk Assessment, Established Public Health Management Policies, Mature Technologies Applications Implemented at Full-Scale, Removals/Reuse Policy Accommodations, Non-Fluorine Formulation Alternatives

~2015 – Today: Regulatory Drivers, Bench-to-Commercial Scale Waste Destruction Technologies, Volume Challenges, Financial and Secondary/Tertiary Impact Funding Assistance, Product Bans, Replacement Chemistries, Legislative/Local Government Education & Funding Requests, Responsible Party Designations

Management of “Safe”

Artificial Intelligence

Homeland Security

Climate Change

Planetary Travel

THANK YOU!

Rebecca A. Higgins, PG
rebecca.higgins@aecom.com

Conclusions and Path Forward

- More data?
- More money?
- More choices?
- Higher risks?
- Incremental progress?

Questions? Comments?



Thank you



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