Emerging Contaminants at Brownfields: The Role of Risk Communication

Brownfields Summit 2022: Revitaling New England
May 18, 2022

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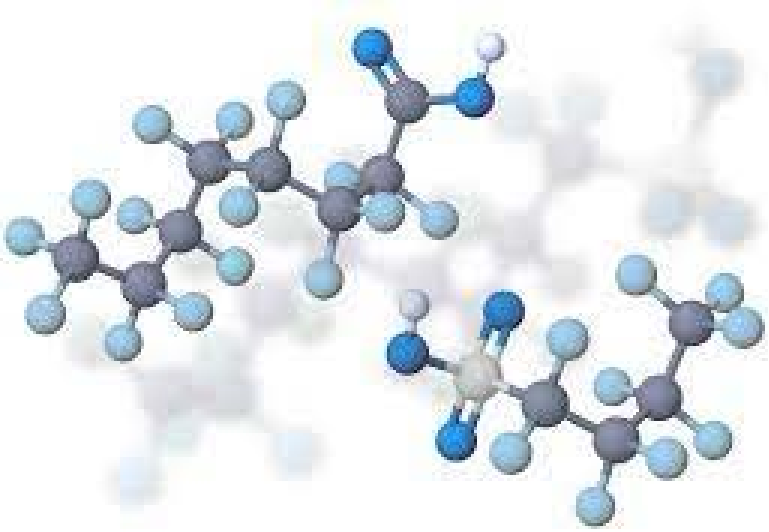
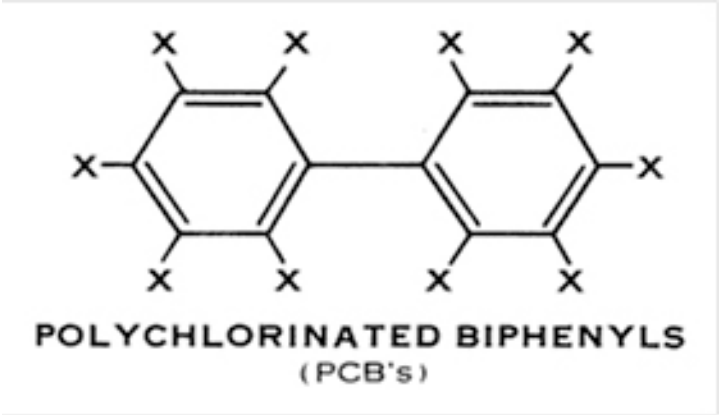
Scope/Outline of Talk

- Risk Communication Background & Perspectives
- PFAS and PCBs Examples for Risk Communication



PFOA PFBS



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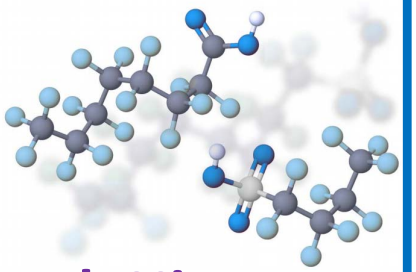
The Devil We Know, Dark Waters, and a Roadmap

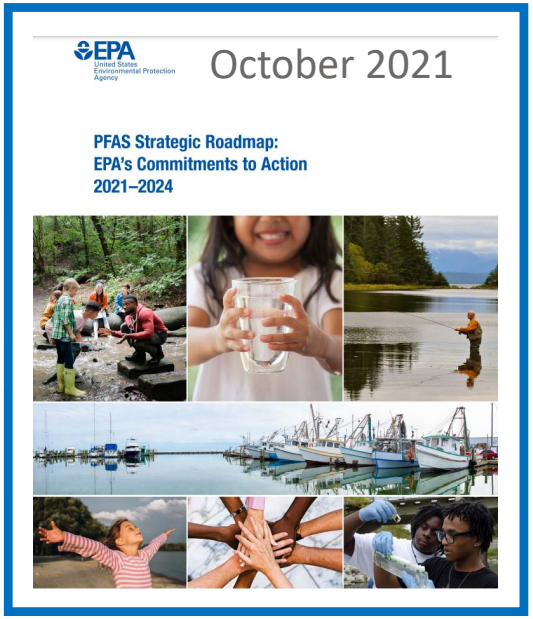
2018 The Devil We Know documentary promo (2:16)
https://www.youtube.com/watch?v=9GNAvYxaIfM

2021 PFAS Last Week Tonight with John Oliver (20 mins)
https://www.youtube.com/watch?v=9W74aeuqsiU

PFAS Action Plan
February 14, 2019

EPA's Per- and Polyfluoroalkyl Substances (PFAS) Action Plan





Google Search Hits

- PFAS – 33,100,000
- Beatles – 192,000,000

NATIONAL LAW REVIEW

Vermont Governor Signs Law Setting Strict PFAS Limits Monday, May 20, 2019

New Hampshire Adopts Aggressive PFAS Drinking Water Bill Friday, July 24, 2020

Massachusetts Finalizes Drinking Water Standard for PFAS Monday, September 28, 2020

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EPA's PFAS Roadmap

Action	Legislation	Proposed/Final Rule	PFAS
Hazardous Substance Designations	CERCLA	Spring 2022/Summer 2023 • 01/10/2022 proposed rule to OMB (90 days?) • 01/14/22 Federal Register notice seeking comment	PFOS & PFOA
Ambient Water Quality Criteria	CWA	Winter 2022 (Aquatic Life) Fall 2024 (Human Health) • 01/18/2022 Tribe Briefing	PFOA & PFOS (benchmarks for other PFAS?)
NPDES Permits Effluent Limitation Guidelines	CWA	Winter 2022 • 09/14/2021 advanced notice of rulemaking	Up to 40 PFAS
Maximum Contaminant Levels	SDWA	Fall 2022/Fall 2023 • SAB meeting 12/16/2021 to 01/07/2022	PFOS & PFOA
Health Advisories		Spring 2022 • 01/18/2022 Tribe Briefing	GenX & PFBS
Toxics Release Inventory	CAA	Spring 2022 (Enhanced) • 01/24/2022 PFBS & 3 additional compounds	176 + 4 PFAS

Ref: *https://www.epa.gov/system/files/documents/2021-10/pfas-roadmap_final-508.pdf*

- EPA's Lifetime Health Advisory of 70 ppt could be lowered ~10,000-fold based on preliminary interpretations of toxicity data
- EPA's Science Advisory Board (SAB) is also considering cancer risk in a similarly conservative manner

Risk Communication - EPA's Perspective

How effective are we at risk communication?

- **EPA's Definition:** Communication intended to supply audience members with the information they need to make informed, independent judgements about risks to health, safety, and the environment (1)
- EPA's Goal: To provide **meaningful, understandable, and actionable** information to our many audiences

https://www.epa.gov/risk-communication/learn-about-risk-communication

(1) Morgan, Fischoff, Bostrom, Atman. Risk Communication: a Mental Models Approach

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Risk Communication
A Risk Assessor's & Engineer's Perspective

- Risk communication guidance available (e.g., ITRC Toolkit)
- Personal Observations/Opinions
  - We are often not very good at communicating technical concepts
  - We have in some cases abandoned efforts to "talk science"
  - Use of sound bites and oversimplifications is not always useful
  - Process sometimes gets politicized

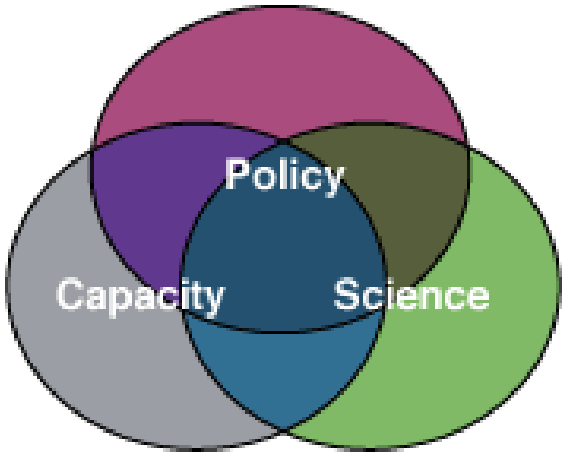
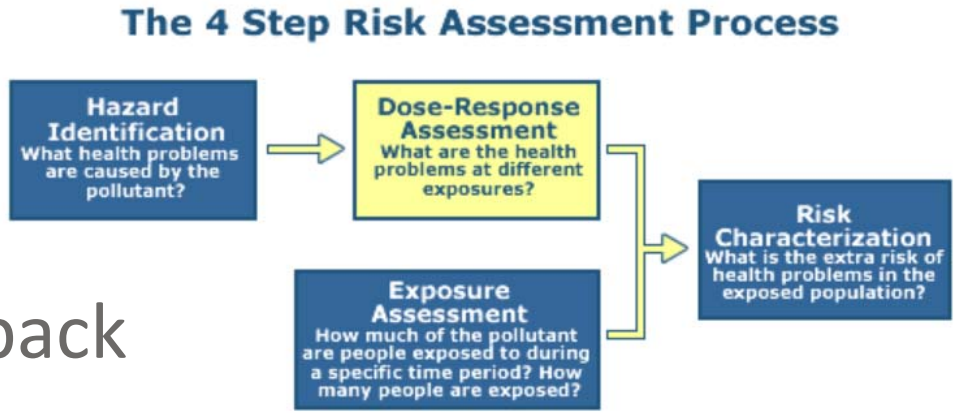


Image from https://www.fda.gov/science-research/science-and-research-special-topics/risk-communication

Risk Assessment Methods



- Origins of risk assessment go back to the 1980s (and earlier)
  - Used terms like “bounding estimates” and “overestimate”
  - Over time guidance standardized methods
- Health risk estimates are intentionally biased high
  - Cancer risks often based on the upper 95th percentile confidence limit of the slope of the dose-response curve
  - Non-cancer reference doses often incorporate multiplicative safety factors
- How are these concepts communicated?

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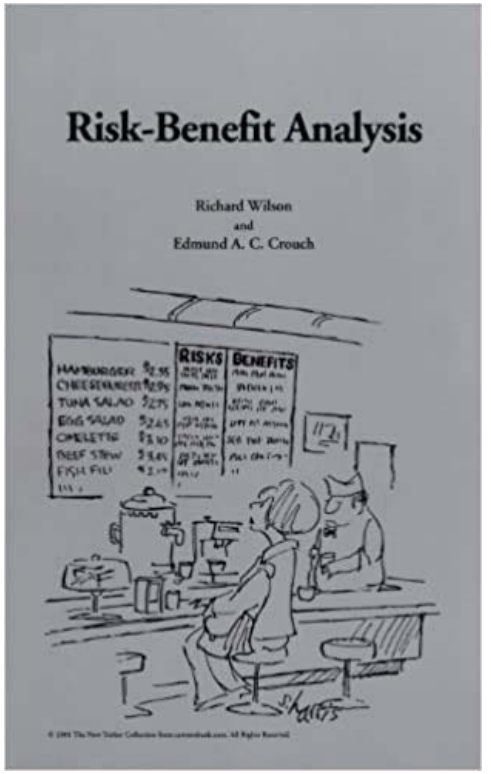
Relative Risk
An Important Concept, But Slippery Slope

- Opinion: Important to emphasize the risk basis of regulatory programs and degree of protectiveness
- Risk of Death from COVID-19
  - ~ 1,000,000 in 330,000,000
  - = 1 in 330
  - = 3×10^{-3}
- Superfund Acceptable Risk Range
  - 1 in 1,000,000 to 1 in 10,000
  - = 1×10^{-6} to 1×10^{-4}
  - 30 to 3,000 times less than COVID-19
- Actuarial risks
  - Developing cancer: males 40.14%, females 38.70% -- 1 in 2.5
  - Dying from cancer: males 21.34%, females 18.33% -- 1 in 5

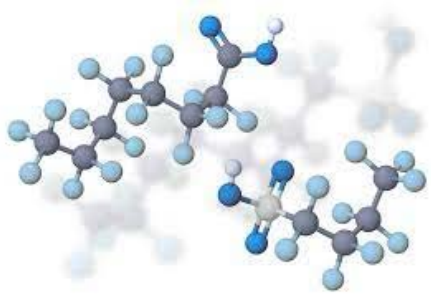


What We Know about Health Effects (EPA 5/9/2022)

Current peer-reviewed scientific studies have shown that exposure to certain levels of PFAS may lead to:

- Reproductive effects such as decreased fertility or increased high blood pressure in pregnant women.
- Developmental effects or delays in children, including low birth weight, accelerated puberty, bone variations, or behavioral changes.
- Increased risk of some cancers, including prostate, kidney, and testicular cancers.
- Reduced ability of the body's immune system to fight infections, including reduced vaccine response.
- Interference with the body's natural hormones.
- Increased cholesterol levels and/or risk of obesity.

- Which PFAS?
- Points of departure?
- Dose-response data?
- Key studies?
- Animal studies v. human epi studies?
- Relevance of animal models?

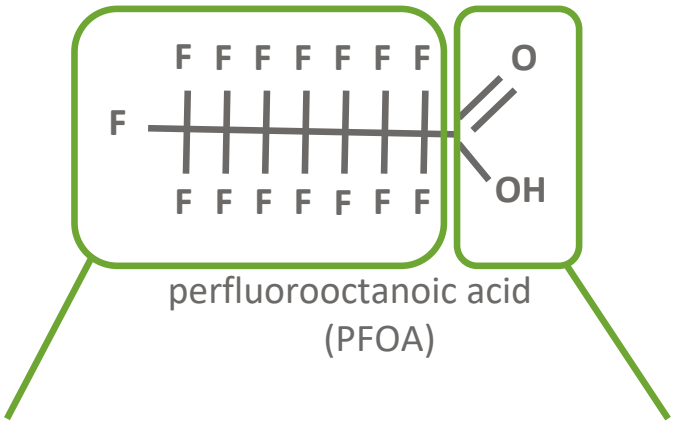


https://www.epa.gov/pfas/our-current-understanding-human-health-and-environmental-risks-pfas

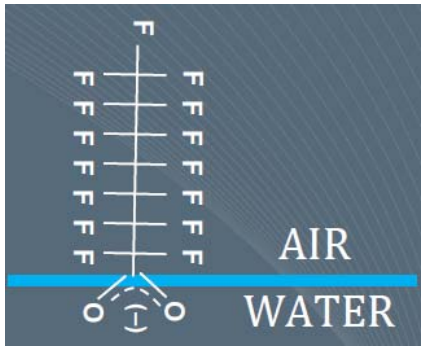
PFAS – A Class of Chemicals

Thousands of PFAS compounds have been identified

They have been used in countless applications thanks to unique and beneficial properties



perfluorooctanoic acid (PFOA)



Fluorocarbon tail

- Strong bonds
- Hydrophobic
- Lipophobic
- Varying length
- Branched isomers

Variations

- Chain length
- Fluorine saturation
- Precursors

Functional group

- Strong to weak acids
- Hydrophilic
- Effects chemical properties

Source: *Draft Toxicological Profile for Perfluoroalkyls*, U.S. Department of Health and Human Services, 2018

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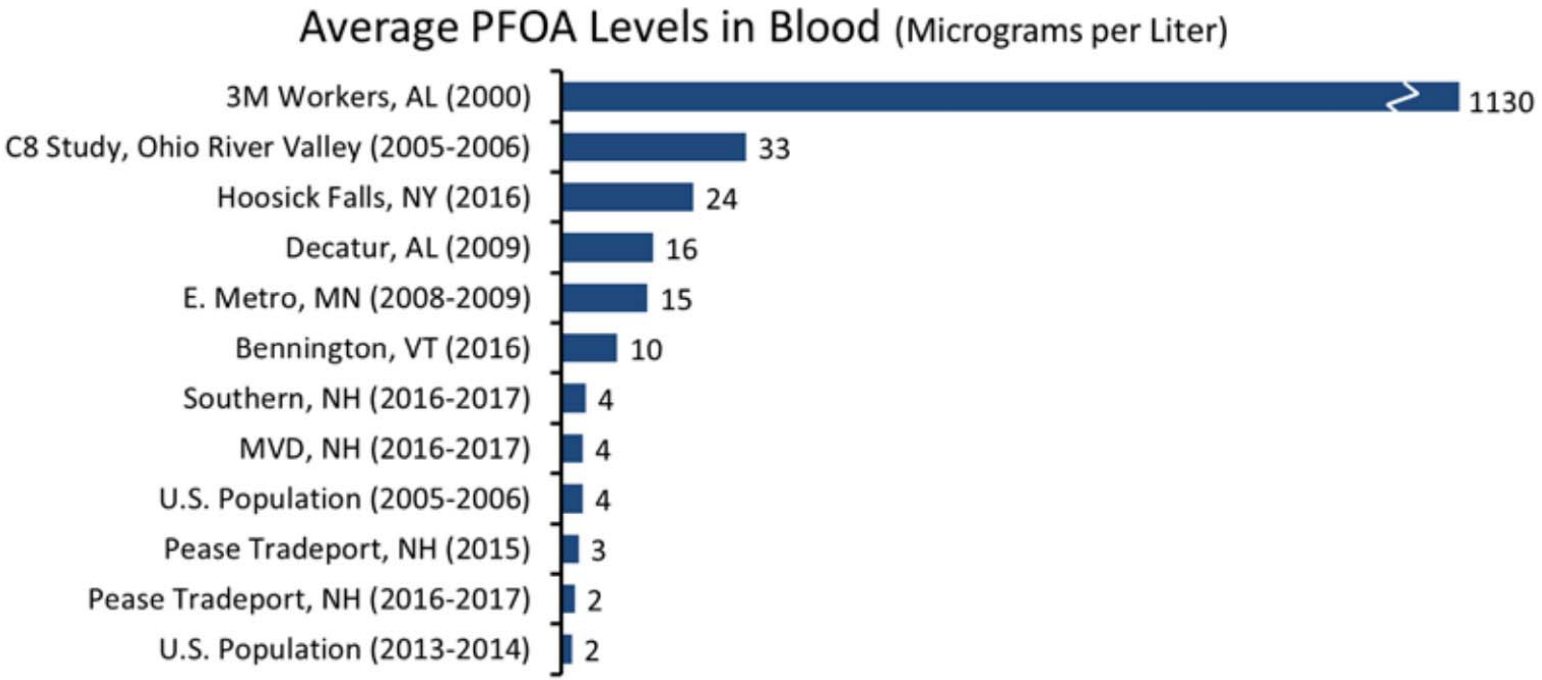
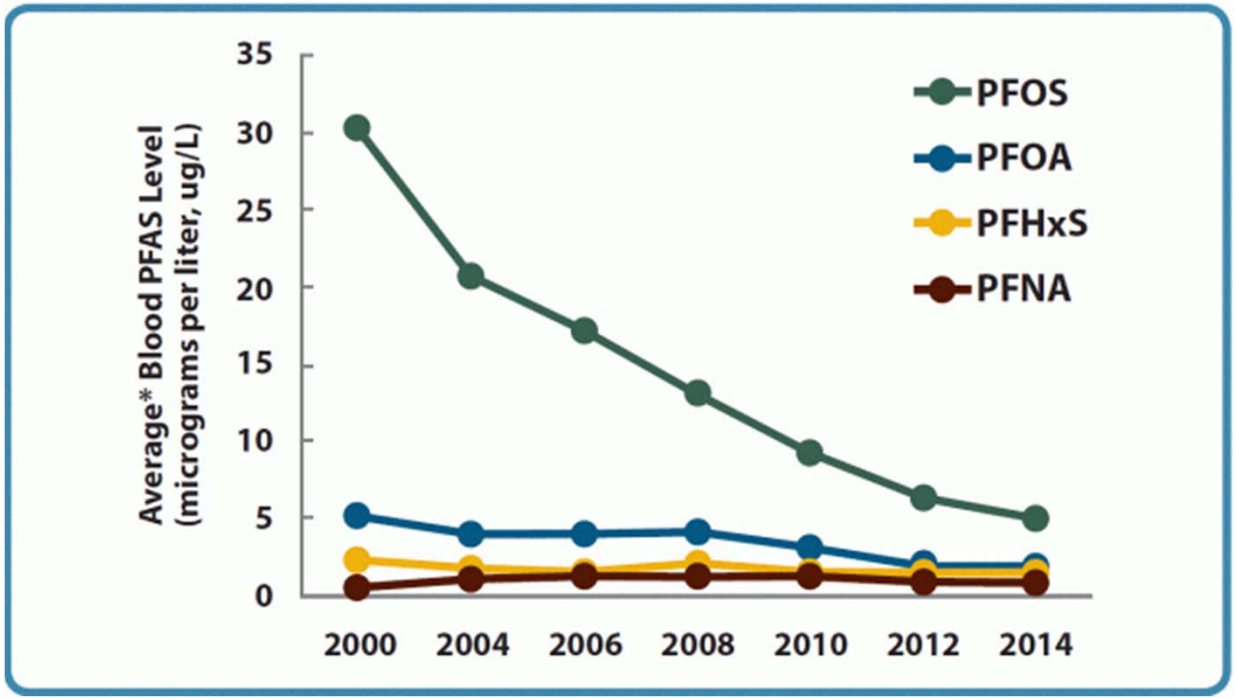
PFOA Levels in Blood (µg/L)



- Exposure to PFOA and PFOS in water elevates levels in blood
- Bioconcentration over time ~100-fold

https://www.dhhs.nh.gov/dphs/pfcs/documents/mvd-pfc-09252017.pdf

PFOA Levels in Blood (µg/L)



PFOS Levels in Blood
National average: 4.3 µg/l
Belmont MI individual: 3200 µg/l

- PFOA background levels decreased from 5 µg/l in late 1990s to present 2 µg/l
- PFOS background levels decreased from 31 µg/l in late 1990s to present 4.3 µg/l

https://www.atsdr.cdc.gov/pfas/pfas-in-population.html

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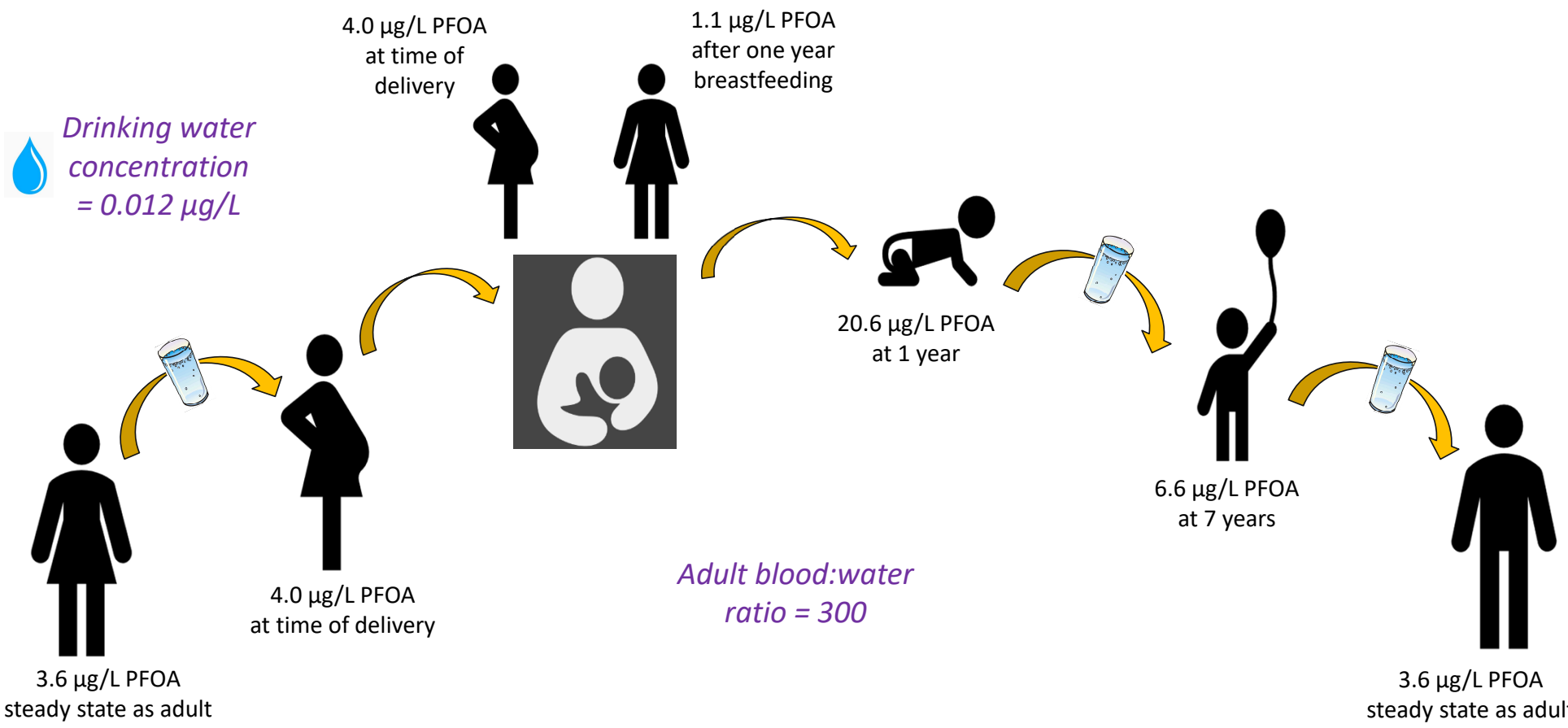
NH Application of Multigenerational Model for PFOA



Model based on Goeden et al. (2018), *J Expo Sci Environ Epidemiol*. 29(2):183-195.

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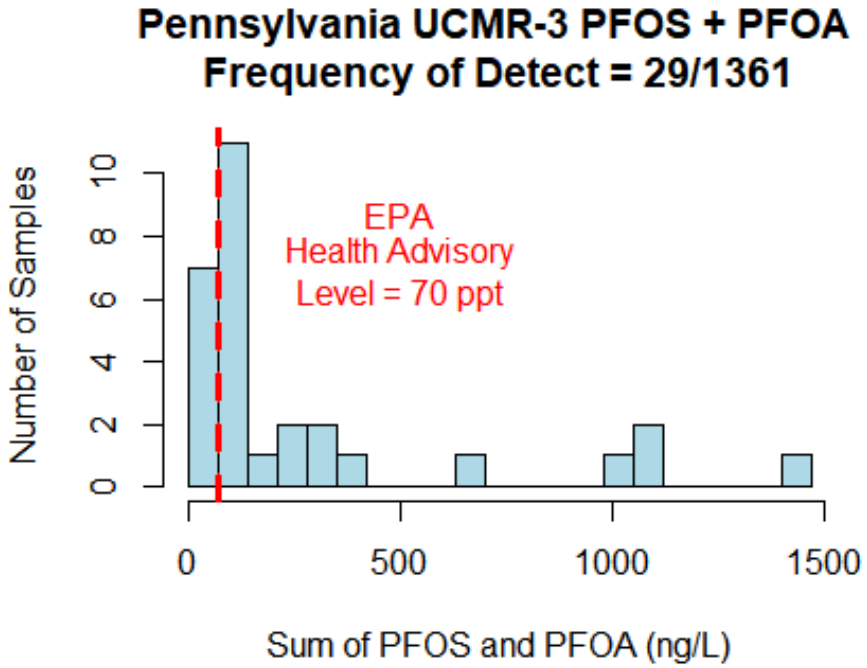
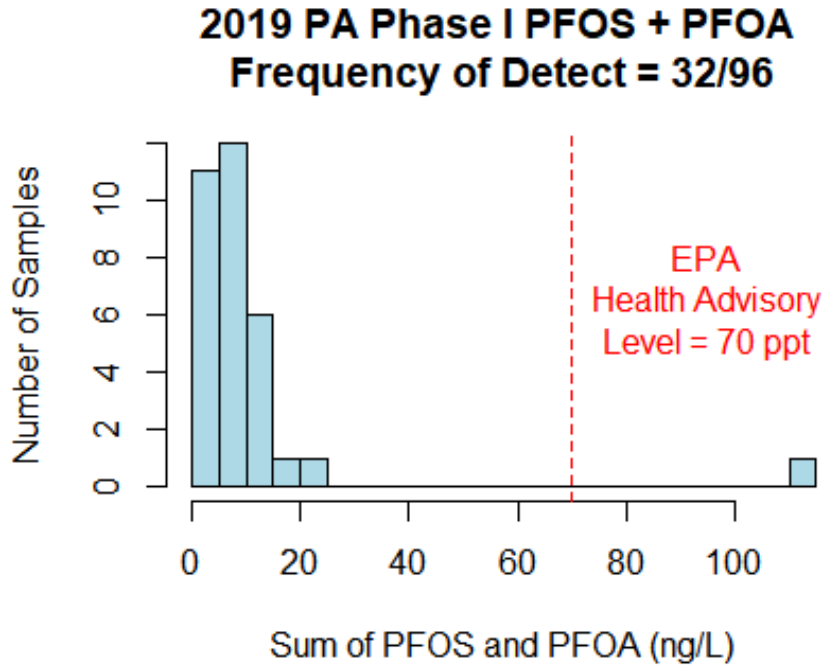
Drinking Water Sampling (PA Data)
Peak Concentrations ↓, Frequency of Detection ↑





PA Phase 1 data: http://files.dep.state.pa.us/Water/DrinkingWater/Perfluorinated%20Chemicals/SamplingResults/PFASPhase1ResultsSummary.pdf

EPA UCMR3 data: https://www.epa.gov/sites/production/files/2017-02/ucmr-3-occurrence-data.zip

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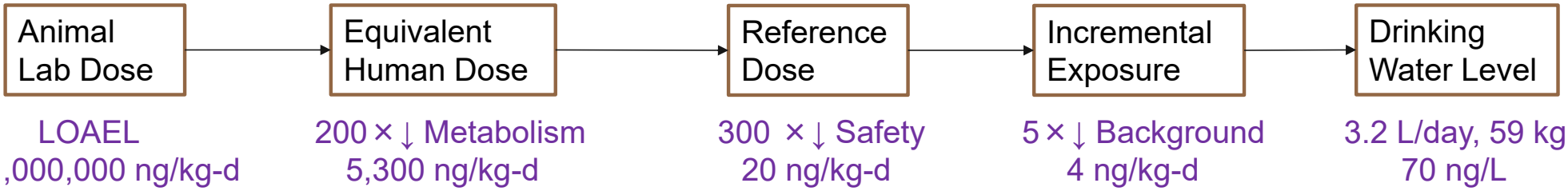
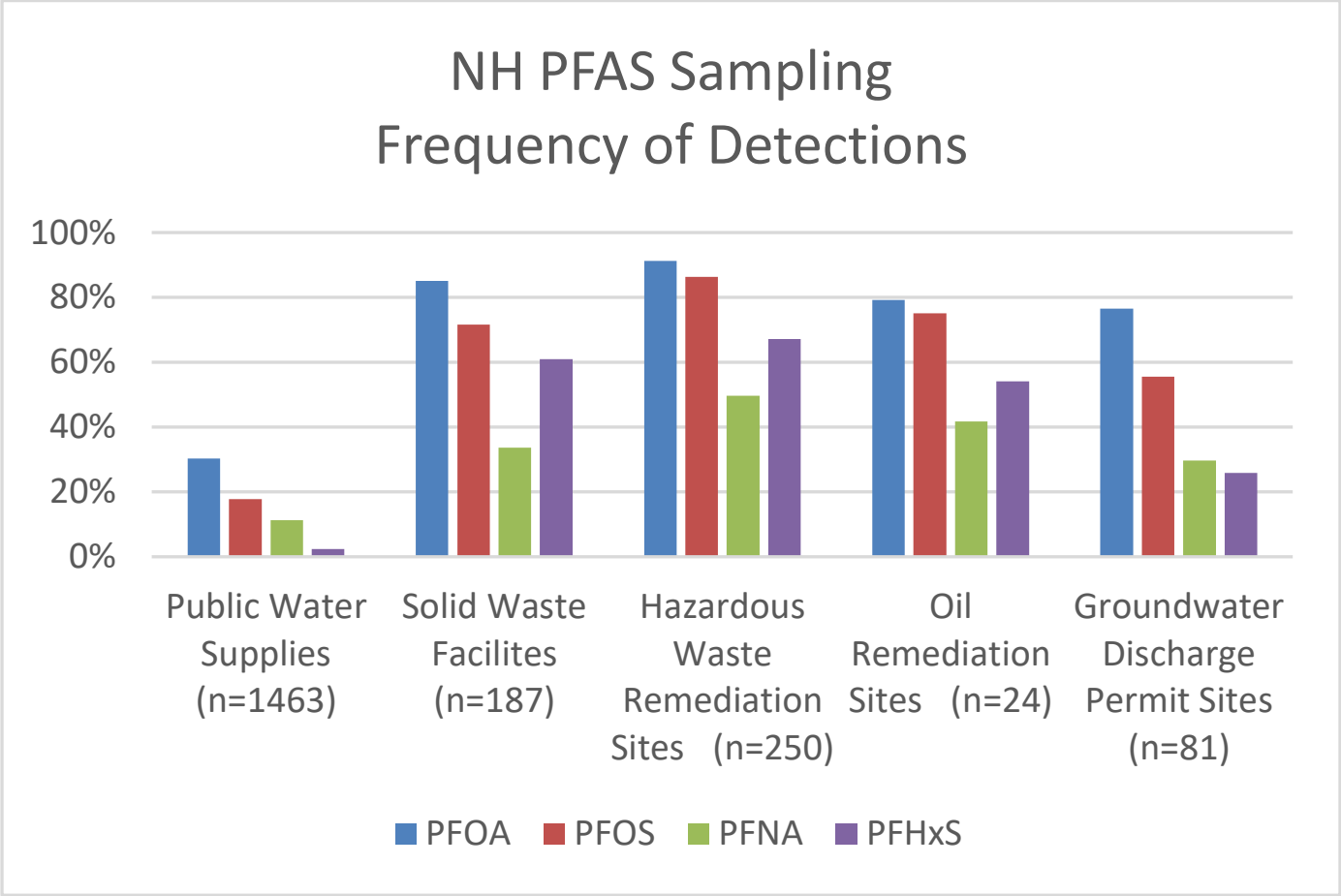
Risk-Based Standards

- Regulators are making different assumptions and interpretations in the face of uncertainty
- Results: Substantial variability and in some cases adoption of very protective assumptions



Regulatory Authority	Receptor	Chemical	Reference Dose (ng/kg-d)	Background Exemption	Exposure Rate (l/kg-d)	Risk-Based Concentration (ng/l = ppt)
U.S. EPA LHA	Nursing mother	PFOA + PFOS	20	80%	0.054	70
VT DOH	Nursing infant	PFOA + PFOS	20	80%	0.175	20
TX CEQ	Small child	PFOA	12	0%	0.041	290
		PFOS	23			560

Likelihood of Finding PFAS in Groundwater Near Sites is High



STATUS REPORT ON THE OCCURRENCE OF PER- AND POLYFLUOROALKYL SUBSTANCES (PFAS) CONTAMINATION IN NEW HAMPSHIRE

This report has been developed to satisfy the requirements of the Laws of New Hampshire January Session of 2018, Chapter 306:2 (HB 1766)

Prepared by
New Hampshire Department of Environmental Services

Robert R. Scott, Commissioner

June 2021

NEW HAMPSHIRE DEPARTMENT OF Environmental Services

PO Box 95, Concord, NH 03302-0095
www.des.nh.gov

Some sampling bias toward expected sites, but also many surprises

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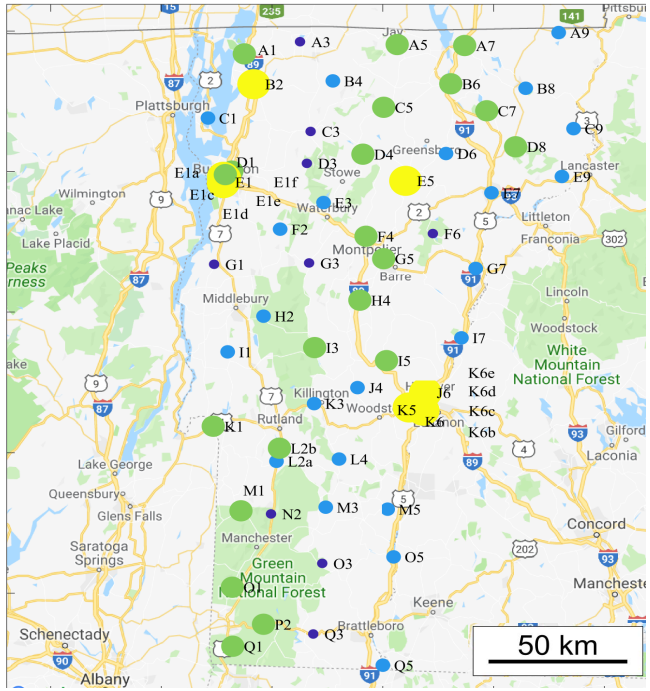
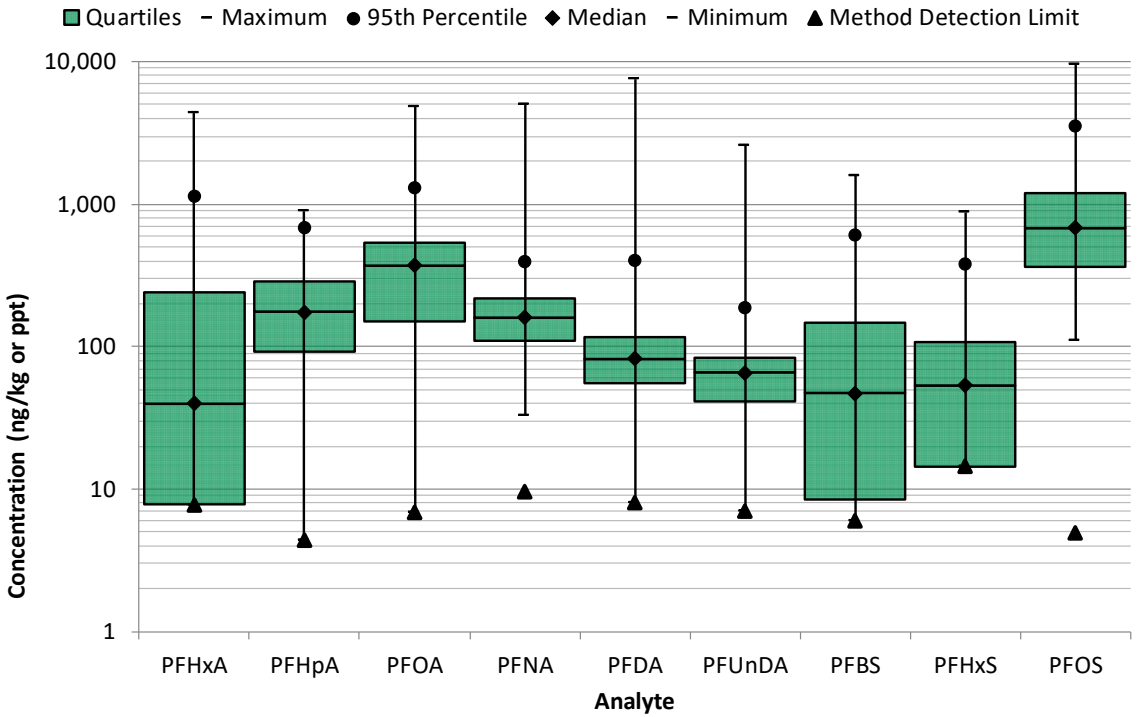
Also Likely to Find PFAS in Soil – VT Background Levels



ΣPFAS (ng/kg)

- >5,000 — 8 locations
- 2,000-5,000 — 23 locations
- 1,000-2,000 — 25 locations
- <1,000 — 10 locations



- Median PFOA = 370 ppt (ng/kg)
- Median PFOS = 680 ppt (ng/kg)

https://anrweb.vt.gov/PubDocs/DEC/PFOA/Soil-Background/PFAS-Background-Vermont-Shallow-Soils-03-24-19.pdf

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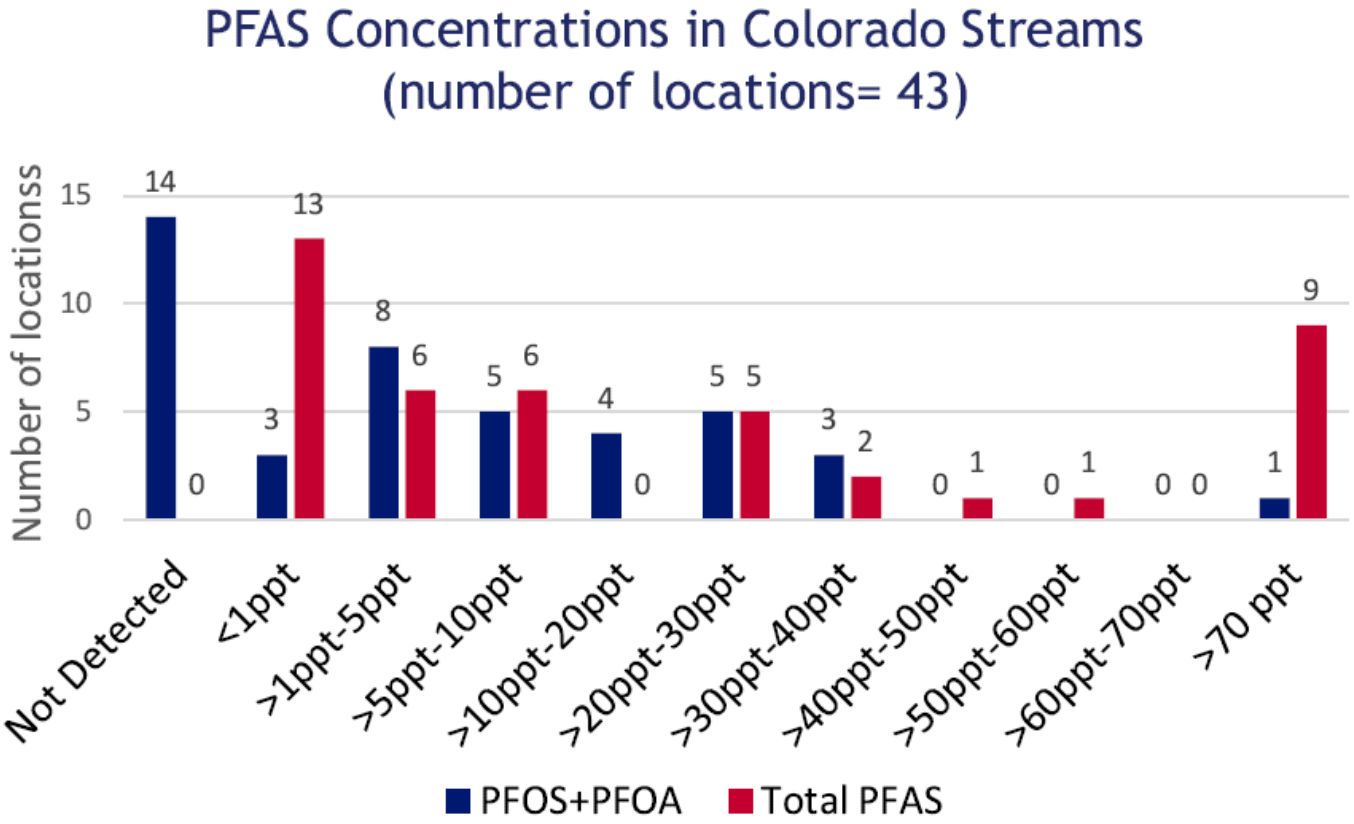
Also Likely to Find PFAS in Surface Water
Colorado DPHE 2020 PFAS Sampling Effort



- 18 PFAS investigated
- At least one PFAS detected in every sample

Images from: https://cdphe.colorado.gov/pfas-projects

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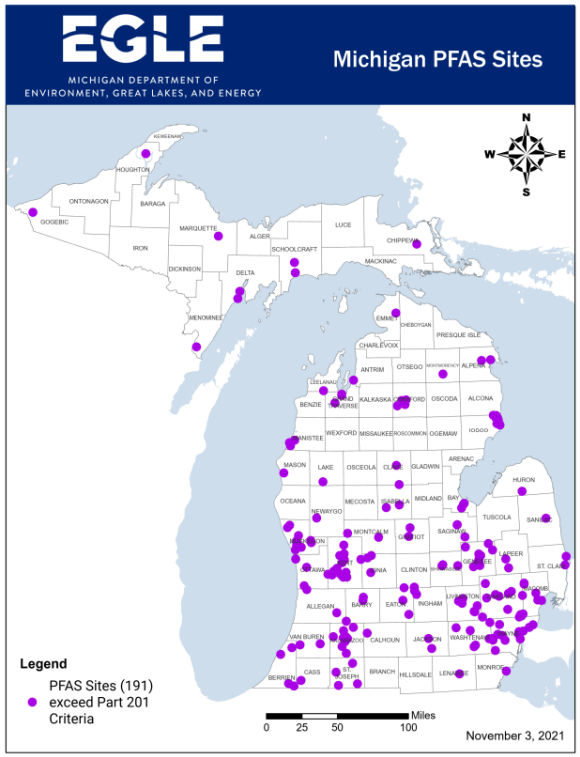
PFAS Issues and Concerns at Brownfield Sites

- Risk perception by stakeholders
- Groundwater typically riskier than soil
  - Drinking water dominates exposure
  - BUT soil can be a source to groundwater
- Institutional controls can restrict exposure on-site
  - Soil disposal options increasing in cost
- Some PFAS are “forever” chemicals – liability?
  - Insurance may cover PFAS, may increase cost
- Phase 1 due diligence – to sample, or not to sample?
  - Requirements ambiguous – regulations are likely
  - PFAS background levels exist in soil – detection likely
  - PFAS is found in groundwater at many types of sites
  - Sources can be off-site – including air deposition impacts



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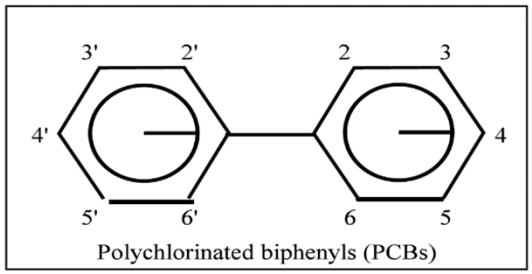
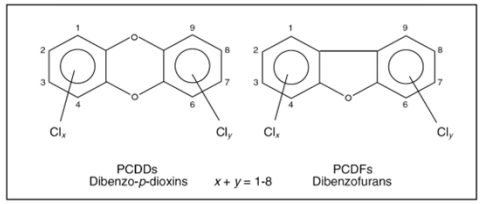
PCB Toxicological Values for Risk Assessment

- Carcinogenic Potencies (kg-day/mg) (EPA IRIS, 1996)
  - High risk/persistence 1 to 2
  - Low risk/persistence 0.3 to 0.4
  - Lowest risk/persistence 0.04 to 0.07
  - 2,3,7,8-TCDD 130,000 (TEQ/co-planar)



Polychlorinated biphenyls (PCBs)

- "Non-cancer" Reference Doses (ng/kg-day) (EPA IRIS, 1994 for Aroclors)
  - Aroclor 1254 20 higher risk
  - Aroclor 1016 70 lower risk
  - 2,3,7,8-TCDD 0.0007 TEQ/co-planar



- Neurological Equivalents Reference Doses (ng/kg-day) (Simon, 2007)
  - Aroclor 1254 8 higher risk
  - Aroclor 1016 70 lower risk

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Indoor Air Screening Levels

EPA's Exposure Levels for Evaluating Polychlorinated Biphenyls (PCBs) in Indoor School Air (ng/m^3)

(https://www.epa.gov/pcbs/exposure-levels-evaluating-polychlorinated-biphenyls-pcbs-indoor-school-air)

Age 1-<2	Age 2-<3	Age 3-<6	Age 6-<12	Age 12-<15	Age 15-<19	Age 19+
100	100	200	300	500	600	500

EPA's Regional Screening Levels (ng/m^3)

(https://www.epa.gov/risk/regional-screening-levels-rsls-generic-tables, TR=1E-06)

	High Risk (dust)	Low Risk (evaporated)	Lowest Risk (99.5% <4 Cl)
Residential	4.9	28	140
Industrial	21	120	610

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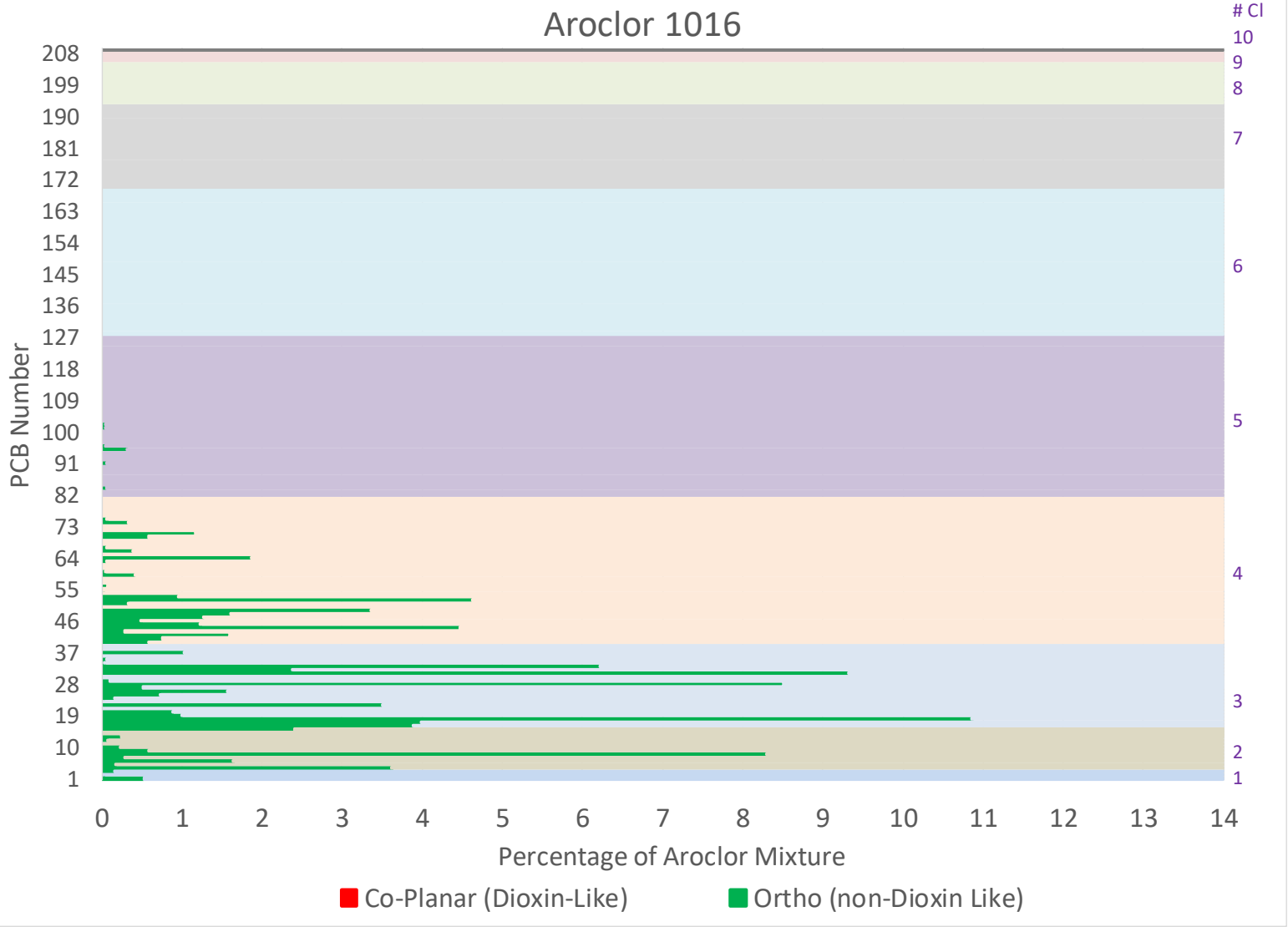

PCB Congener	2,3,7,8-TCDD TEF
77	0.0001
81	0.0003
105	0.00003
114	0.00003
118	0.00003
123	0.00003
126	0.1
156	0.00003
157	0.00003
167	0.00003
169	0.03
170	0
180	0
189	0.00003

Composition data from ATSDR (2000) Toxicity Profile for PCBs

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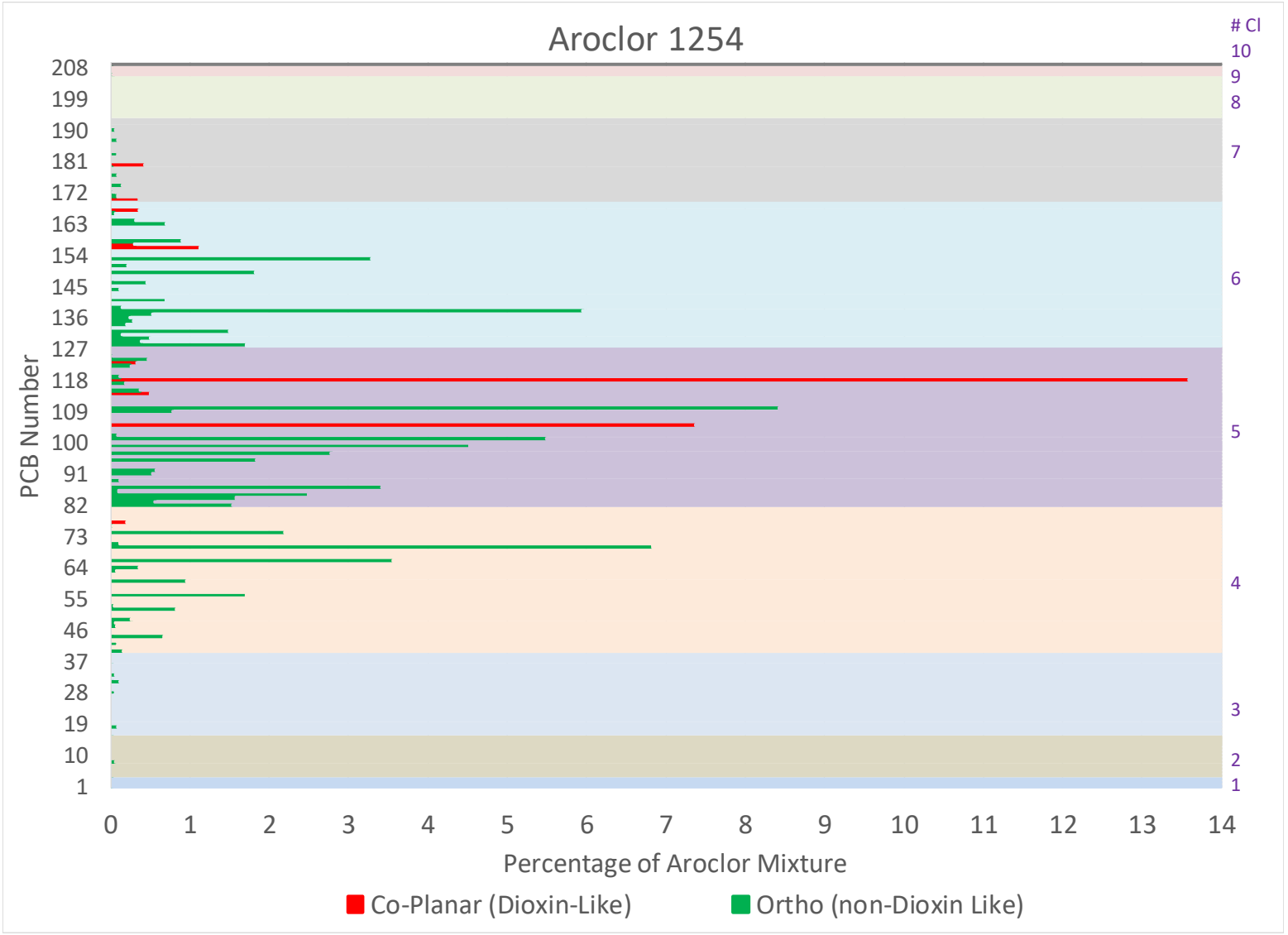

PCB Congener	2,3,7,8-TCDD TEF
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Composition data from ATSDR (2000) Toxicity Profile for PCBs

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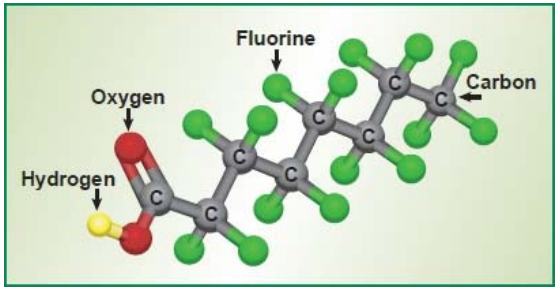
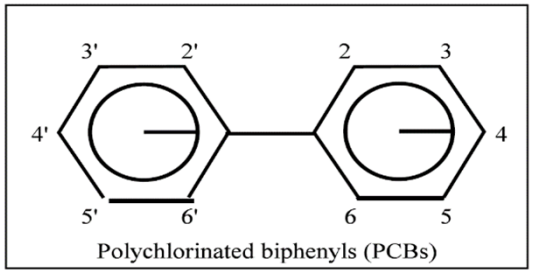
Thank you for your attention!

Questions ?





Also please write or call with any off-line questions

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With thanks to the NH Department of Environmental Services and Numerous Sanborn Head colleagues