2018 MRN/SWANA Mid-Atlantic Annual Conference

PFAS at Landfills

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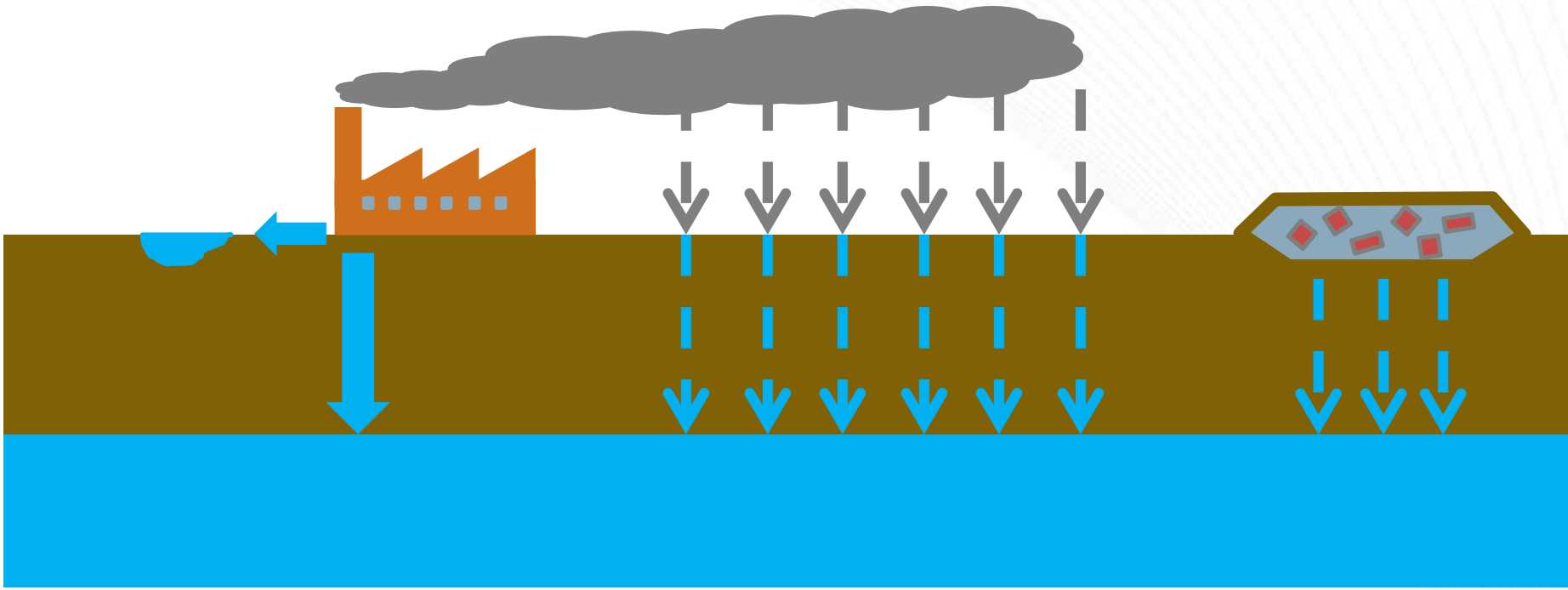
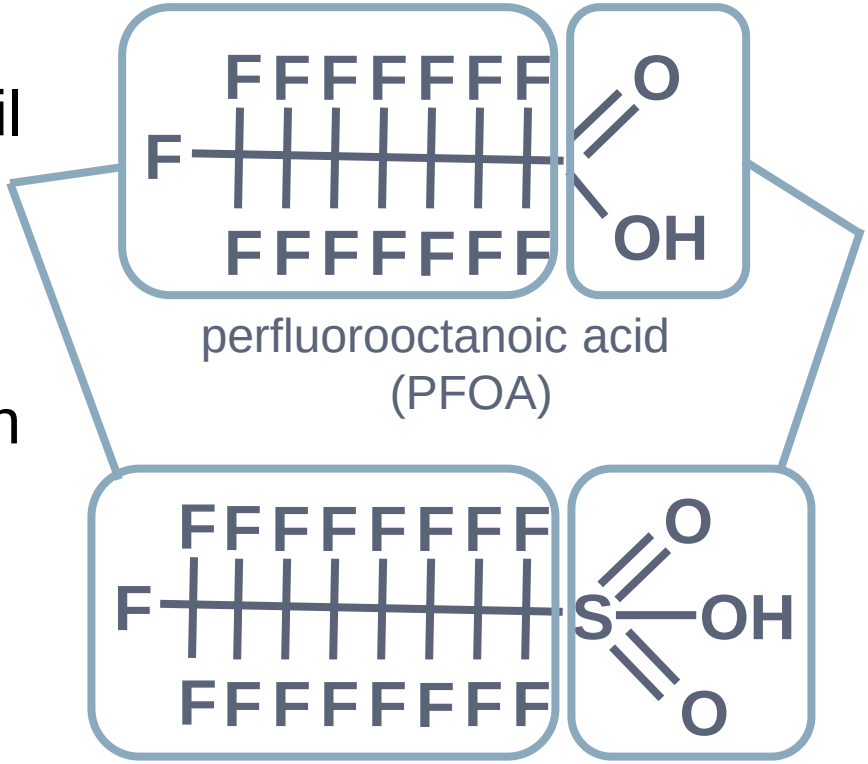


PFAS – THE BASICS

PFAS – The Basics

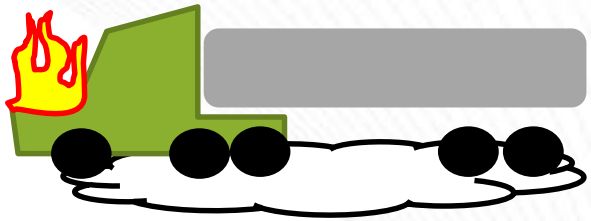
PFAS – Per- and Poly- Fluorinated Alkylated (Fluoroalkyl) Substances; also PFCs – Perfluorinated Compounds)

Fluorocarbon tail
- Strong bonds
- Hydrophobic
- Oleophobic
- Varying length

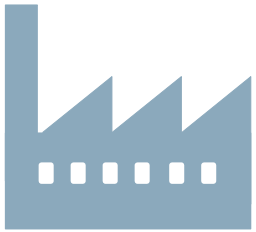


Functional group
- Strong to weak acids
- Hydrophilic

PFAS in the Environment

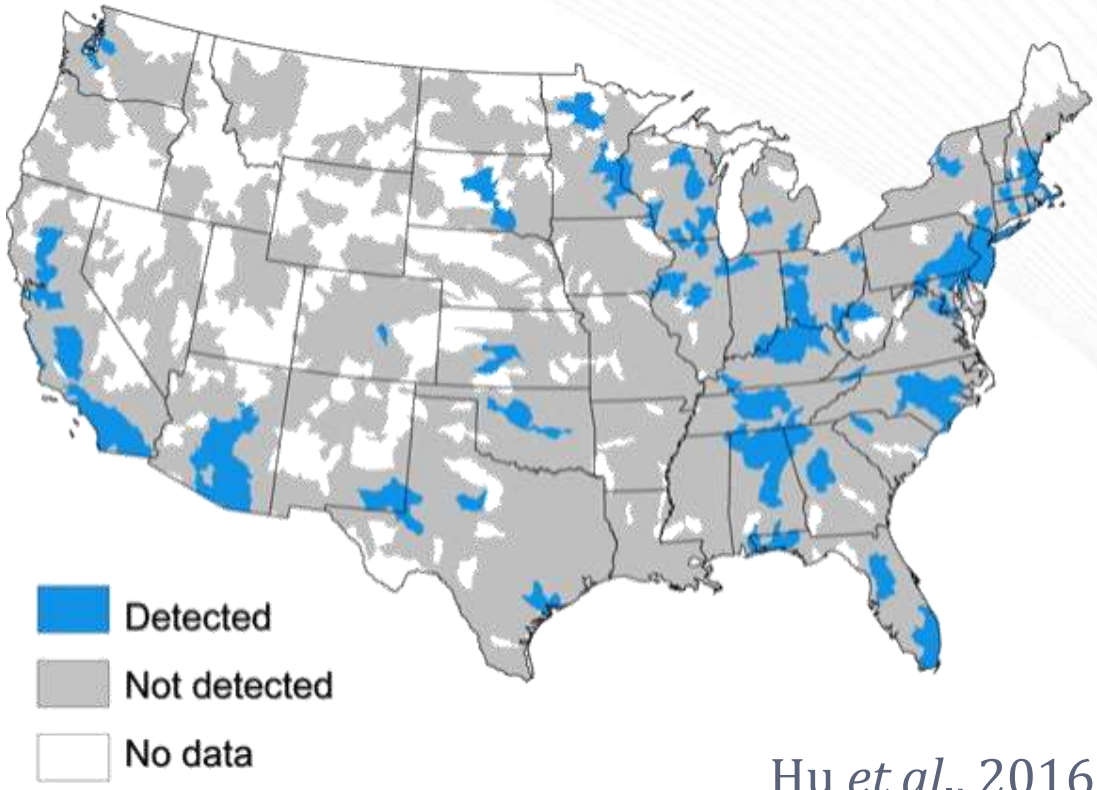


- Entered Commerce in 1940s
- AFFF use for firefighting
- Household products
- Stormwater runoff/street dust
- Industrial/commercial facilities
  - Textile coaters
  - Chromium platers
  - Car washes
- PFAS-containing wastes
  - Landfills
  - Wastewater treatment effluent/biosolids



PFAS Physicochemical Properties

- Soluble in water
- Resistant to degradation
- Low volatility
- Primary transport pathways
  - Air Deposition
  - Groundwater migration
- Primary exposure pathway
  - Ingestion of groundwater



Hu *et al.*, 2016

PFAS HEALTH EFFECTS

PFAS – Health Concerns?

- EPA PFAS Summit held May 22-23, 2018
  - MCL process to be investigated
  - PFOA and PFOS to be made CERCLA hazardous substances
  - Toxicity values for GenX and PFBS by end of summer
- CDC PFAS report has been withheld/delayed
- Australian Expert Health Panel (May 7, 2018)
  - "… there is mostly limited, or in some cases no evidence, that human exposure to PFAS is linked with human disease" and "there is no current evidence that suggests an increase in overall cancer risk"
  - "… even though the evidence for PFAS exposure and links to health effects is very weak and inconsistent, important health effects for individuals exposed to PFAS cannot be ruled out based on the current evidence"

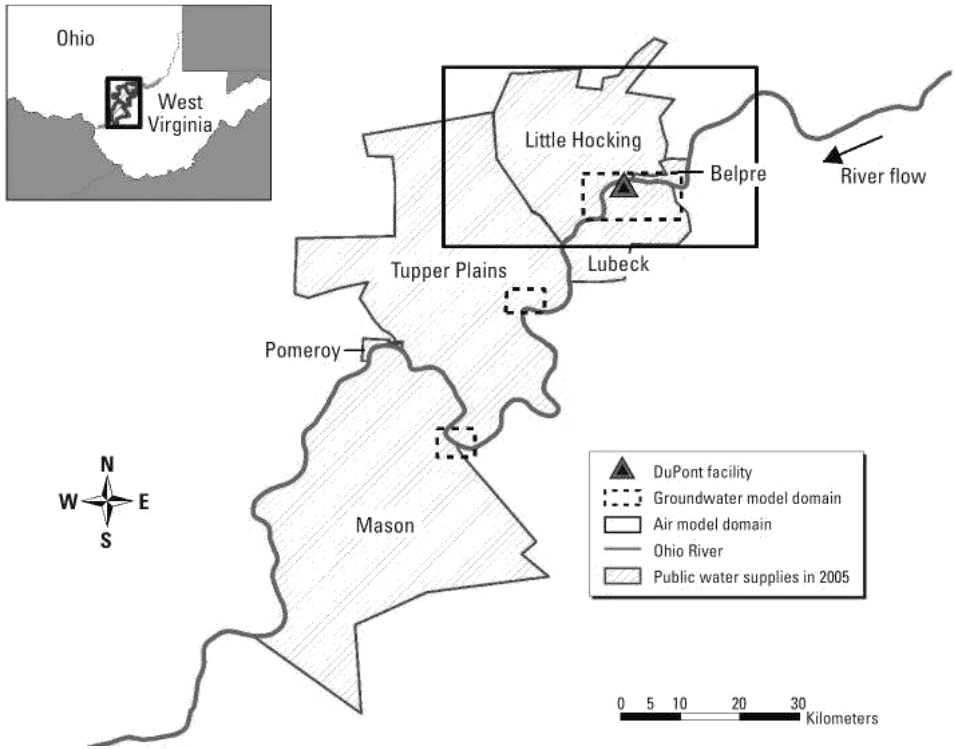
State Groundwater Standards

State	PFOA	PFOS	Notes
Al, CA, CO, DE, FL, NY, RI	70 ng/L	70 ng/L	Adopted EPA HAL
AK, IL	400 ng/L	200 ng/L	
Maine	60 ng/L	100 ng/L	
Massachusetts			PFAS are regulated; Anticipated in 2018
Michigan	70 ng/L	70 ng/L	
Minnesota	35 ng/L	27 ng/L	
New Jersey	40 ng/L	---	Proposed PFOA 14 ng/L; PFNA 10 ng/L
New Hampshire	70 ng/L	70 ng/L	
North Carolina	2,000 ng/L	---	
Texas	290 ng/L	560 ng/L	
Vermont	20 ng/L	20 ng/L	
West Virginia	500 ng/L	---	

C8 Panel Studies

http://www.c8sciencepanel.org/prob_link.html

Dupont Washington Works
Wood County, WV



- Probable links between PFOA exposure and:
  - Diagnosed high cholesterol
  - Ulcerative colitis
  - Thyroid disease
  - Testicular and kidney cancers
  - Pregnancy-induced hypertension
- No correlations with:
  - Birth defects
  - Miscarriages and stillbirths
  - Preterm birth and low birth weight
  - Liver disease
  - 19 other cancers and 11 other non-cancer effects

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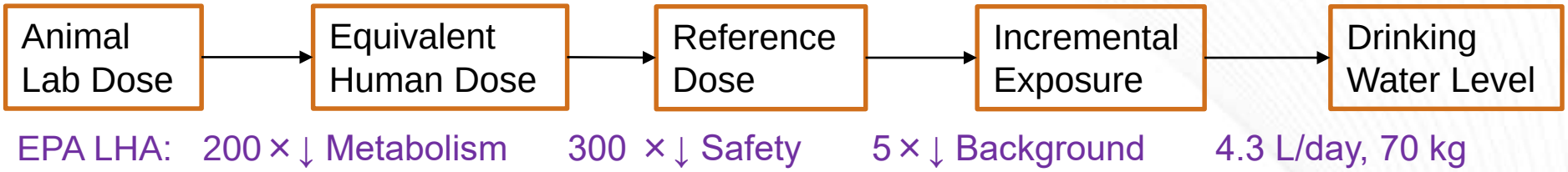
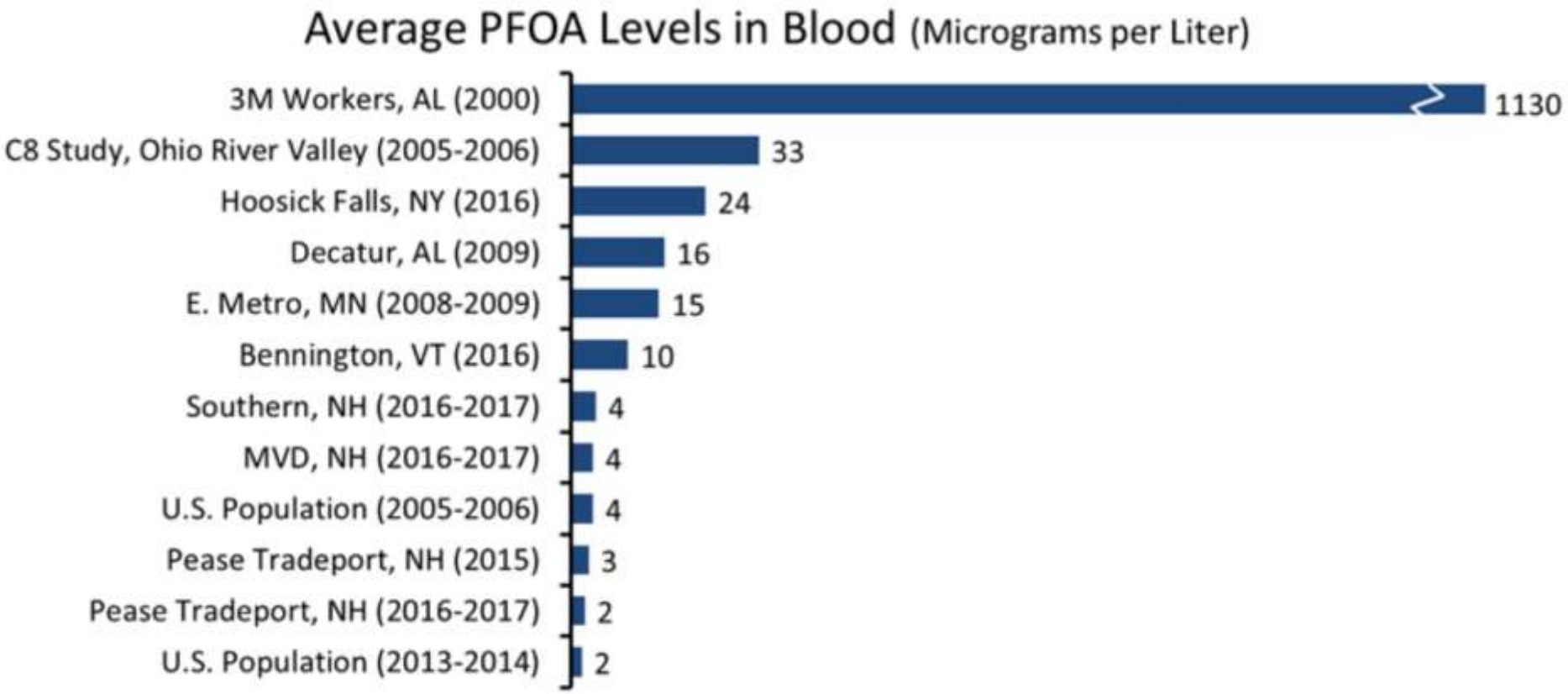
Risk-Based Standards



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%	0.061	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

PFOA Levels in Blood (µg/L)



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

- Background levels decreased from 5 µg/l in late 1990s to present 2 µg/l
- Exposure to PFOA in water elevates levels in blood
- Bioconcentration over time ~100-fold

PFAS Health Risks - Summary

- Risk-based standards/guidelines for PFOA and PFOS are protective
- Toxicity of PFOA & PFOS not certain
  - Epidemiological studies and laboratory animal studies have not shown consistent and conclusive findings
  - Cancer incidence studies in NY, NH, and MN not indicative of PFAS effects
  - If PFAS is causing health effects, the effects appear to be subtle
- Reasons for concern
  - PFAS in drinking water elevates PFAS in blood
  - Little data for PFAS other than PFOA and PFOS

PFAS: REGULATORY AND LEGAL CONSIDERATIONS

Regulation of PFAS Under TSCA

- 3M discovered PFAS in the U.S. blood supply in the 1990s, and reported its findings to EPA under the Toxic Substances Control Act (TSCA)
- 2000: 3M voluntarily agreed to phase out production of PFOS (completed in 2002)
- 2006: EPA developed a stewardship program to voluntarily phase out PFOA production in U.S. by 2015; 95% of PFOA phased out by 2010
- EPA issued significant new use rules (SNURs) targeting new uses/imports of PFOA, PFOS, and 275 other PFAS chemicals

U.S. Drinking Water Regulation Timeline

- 2009: EPA issued provisional health advisory levels for PFOA (400 ppt) and PFOS (200 ppt) to protect against short-term exposures
- May 2012: Unregulated Contaminant Monitoring Rule (UCMR) identifies six PFAS for further evaluation and monitoring under the Safe Drinking Water Act (SDWA) including PFOA, PFAS, PFNA, PFHxS, PFHpA, and PFBS
- May 2016: EPA issued new Lifetime Health Advisory levels for PFOA and PFOS in drinking water (70 ppt)

Legal Effect of EPA Health Advisories

- "Health advisories provide information on contaminants that cause human health effects and are known or anticipated to occur in drinking water. EPA's health advisories **are non-enforceable and non-regulatory** and provide technical information to state agencies and other public health officials on health effects, analytical methodologies, and treatment technologies associated with drinking water contamination."

- "EPA is evaluating PFOA and PFOS as drinking water contaminants in accordance with the process required by the Safe Drinking Water Act (SDWA). To regulate a contaminant under the SDWA, EPA must find that it: (1) **may have adverse health effects**; (2) **occurs frequently** (or there is substantial likelihood that it occurs frequently) at levels of public health concern; and (3) there is a **meaningful opportunity for health risk reduction** for people served by public water systems."

EPA's Lifetime Health Advisory Levels

- EPA's lifetime health advisory levels of 70 ppt are highly problematic
  - The levels are "advisory" and not legally enforceable as a health standard, but in the absence of any other guidance, a number of states immediately adopted the levels as enforceable standards
  - Regulating without rulemaking: there was no notice or opportunity for comment from the public
  - EPA levels are much lower than levels set in U.K., Germany, Denmark, the Netherlands, Sweden, and some states that have independently evaluated the PFAS health data

Public Health and the Environment

- 70 ppt standard is a conservative measure and assumes long-term exposure of the most vulnerable populations
- Critically, the standard assumes that the vast majority (80%) of human exposure to PFAS is from sources other than drinking water (exs. diet/indoor air), reducing the amounts acceptable in drinking water
- EPA screening levels, which do not consider background exposure, indicate levels of 325 ppt for PFAS are likely sufficient to protect human health and the environment

Pressure on Municipal Water Providers

- An estimated 6 million municipal water users, supplied by 66 large U.S. water providers are currently receiving drinking water that is above the 70 ppt standard
- An estimated 16 million additional waters users are drinking water with some level of PFAS
- Smaller municipalities and private well owners also likely have drinking water with some level of PFAS
- Municipal water providers are under increasing pressure to provide water to customers with no detectable levels of PFAS
- Some water providers have already brought suit against 3M and fire-fighting foam manufactures; more litigation is likely

Overview of Litigation in the U.S.

- EPA's new standards have unleashed a wave of litigation against the manufacturers of PFAS and some secondary commercial users of PFAS
- Major class action and attorney general lawsuits involving 3M and DowDupont in Ohio/West Virginia, New York, North Carolina, and Minnesota
- Newly-filed litigation in Michigan, Ohio, New York, New Jersey, Pennsylvania, and Alabama
- At least two cases (in Alabama and Michigan) involve alleged releases from landfills brought by the plaintiffs' bar and environmental groups
- Possibility of additional state attorney general actions, class actions, and other actions involving municipal water providers, waste water treatment plants, military facilities, and private well owners
- Plaintiffs firms are recruiting new plaintiffs, going door to door in Michigan, and may be responding to requests for proposal from attorneys general

Wolverine Worldwide Litigation

- As many as 90 cases recently filed against shoe manufacturer Wolverine Worldwide stemming from PFAS releases from landfills
- Other defendants in the litigation include 3M and Waste Management, Inc.
- Wolverine Worldwide used Scotchgard on its products for decades
- CERCLA 106 order from EPA, RCRA lawsuit filed by Michigan Department of Environmental Quality (MDEQ), Class Action litigation

Political Pressure Mounts

- E. Scott Pruitt commits to addressing PFAS during his confirmation hearing as U.S. EPA Administrator
- December 4, 2017: U.S. EPA forms working group to study PFAS and coordinate efforts to regulate the chemicals among agencies and states
- Bipartisan support for health study of PFAS from U.S. military facilities; $7 million in funding authorized under the National Defense Authorization Act
- U.S. Senators in North Carolina, New York, and West Virginia are especially concerned and aggressive regarding PFAS study, regulation, and cleanup

PFAS Summit: May 2018

- May 2018: two-day national summit held in Washington, D.C. to discuss PFAS with state agencies
- Administrator Pruitt is committed to evaluating a federal drinking water standard for PFOA and PFOS; possible regulation of PFOA and PFOS as hazardous substances under CERCLA
  - Numerous regulatory steps requiring several years of rulemaking and public comment
  - Developing more immediate groundwater cleanup recommendations
  - Evaluating toxicity of GenX, a replacement PFAS
- EPA plans to release a PFAS Management Plan by the end of the year; public meetings scheduled this summer in New Hampshire and Michigan

PFAS: Legal Considerations

- **Persistence:** PFAS are durable in the environment and may be discovered decades after their release or disposal
- **Pervasiveness:** PFAS are mobile and spread across the environment; many people have been exposed to multiple sources
- **Narrow manufacturing base in the U.S.:** A small group of companies manufactured nearly all of the PFAS in the United States and will likely be co-defendants in any product liability litigation
- **Overseas PFAS manufacturers and exporters** (2000-present) may be more difficult to track down and bring into litigation
- **State common law** is likely to be the operative law in cases (although state statutory, CWA, and RCRA claims are possible)
- **Jury trials** may be difficult to win given public fear and distrust of chemical manufacturers, and the public's intolerance for any level of contamination in drinking water supplies
- **Severance and bifurcation** may be useful tools if claims go to trial to avoid trial with co-defendants or to separate liability and damages evidence

Potential Legal Defenses

- **Causation**: linking PFAS contamination to a particular source may be difficult in the absence of significant releases from a point source or chemical fingerprinting
- **Injury/Damages**: there is little evidence providing a strong link between exposure to PFAS and cancer; many health studies are statistically weak or contain other methodological flaws and experts relying on these materials may be subject to *Daubert* challenges
- **Statute of Limitations:** state regulatory agencies and private parties may have known about PFAS contamination for decades and failed to preserve their claims
- **Permit shield:** NPDES and RCRA permits may contain language that bars lawsuits for permitted discharges from landfills
- **Indemnification:** landfills and other downstream parties subject to PFAS litigation may have claims for indemnification against primary manufacturers

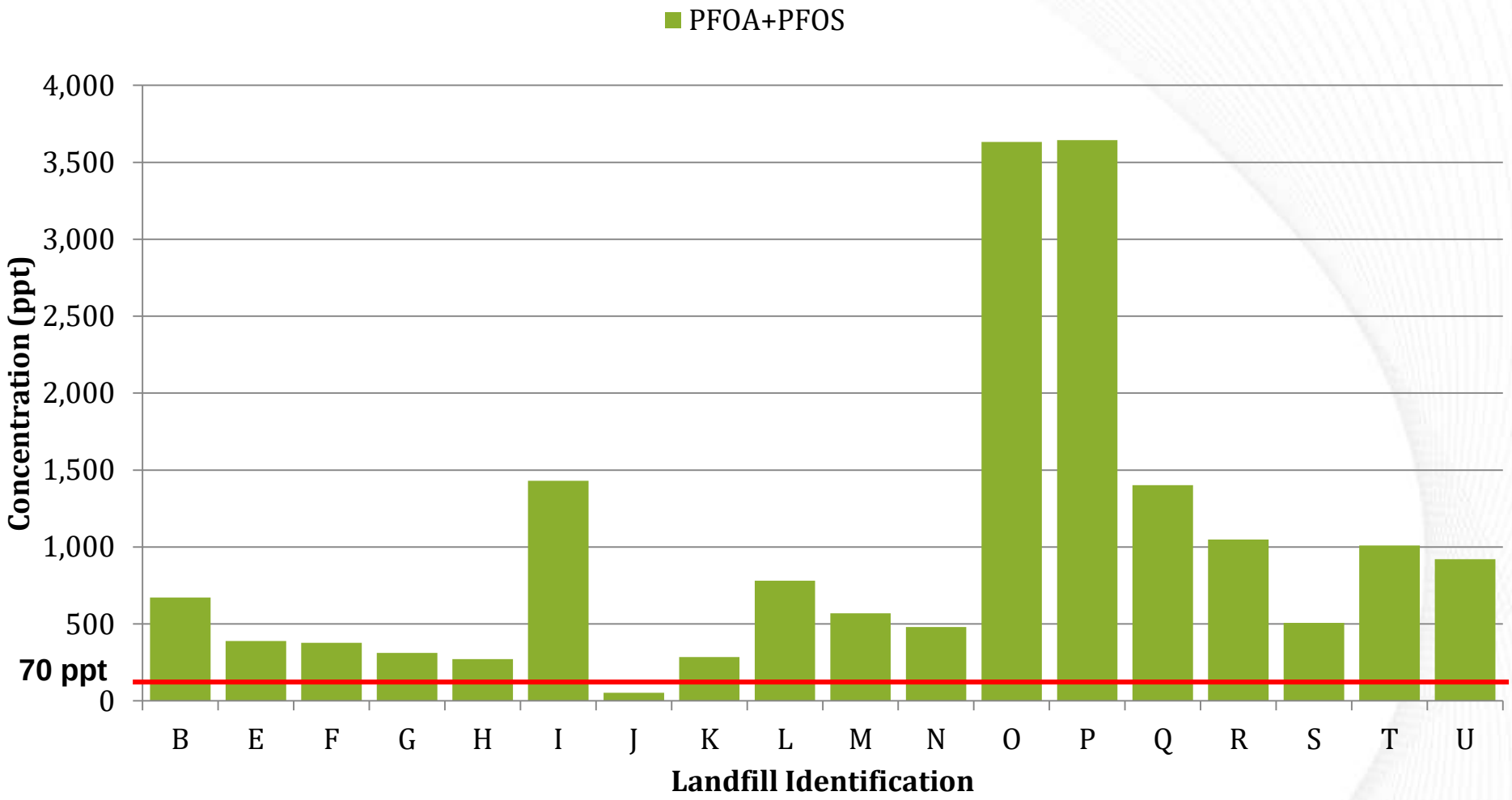
When Will this End?

- There is political pressure to clean up and/or treat PFAS to levels beyond those protective of human health and the environment
- Litigation of claims involving PFOA and PFOS is maturing; a new wave of litigation is likely to target substitute and replacement PFAS chemicals including GenX
- A negative feedback loop of regulation, media coverage, public fear, and political pressure is feeding PFAS litigation
- MTBE, PCB, and asbestos litigation have continued long after the chemicals ceased being used and initial public interest and regulation waned

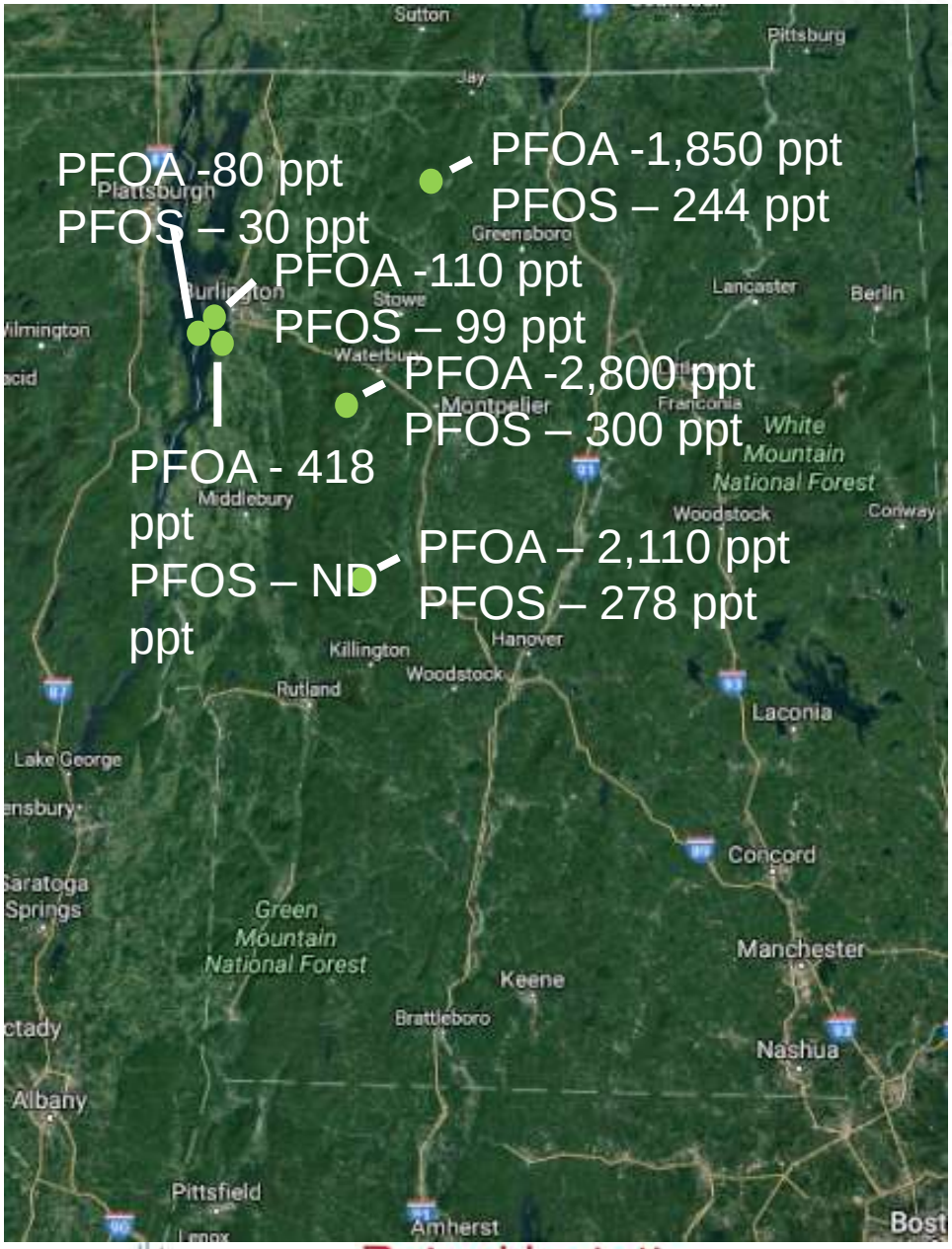
POTENTIAL CONCERNS FOR LANDFILLS

PFAS in Landfill Leachate

Lang et al., Lang J, Allred B, Field J, Levis J, Barlaz M (2017). National Estimate of Per- and Polyfluoroalkyl Substance (PFAS) Release to U.S. Municipal Landfill Leachate. *Environ Sci Technol* **51(4)**:2197-2205.



Landfill Leachate in VT



Landfill Leachate

Two Analytical Methods

- MLA 110
- Modified EPA 537

PFOA
High – 2,800 ppt
Low – 80 ppt

PFOS
High – 300 ppt
Low – Non-detect

*Courtesy of Vermont Department of Environmental Conservation (VTDEC), May 2018

Leachate – What's Next?

- Monitoring/Treatment requirements
  - PFAS
  - Other contaminants
- Future NPDES permit limits for waste water/ stormwater discharge
- WWTPs will look to sources for reductions
  - Restrictions on leachate discharges

VTDEC Landfill Leachate Discharge Guideline Levels*

PFAS Analyte:	Landfill Leachate concentration requiring no restrictions	Landfill Leachate concentration which may require restrictions	Landfill Leachate concentration requiring pretreatment
PFOA	0.120 mg/L (120,000 ppt)	0.120 mg/L to 1.2 mg/L	>1.2 mg/L
PFOS	0.001 mg/L (1,000 ppt)	0.001 mg/L to 0.010 mg/L	>0.010 mg/L

*Courtesy of Vermont Department of Environmental Conservation (VTDEC), May 2018

Groundwater Concerns at Landfills – Data from NH

PFAS Detection Frequency at NH Landfills					
Concentration Bins (ng/L)	**PFOA**	**PFOS**	**PFBA**	**PFPEA**	**PFHPA**
ND - 69	0.67	0.67	0.63	0.70	0.72
70 - 99	0.07	0.10	0.07	0.00	0.14
100 - 999	0.23	0.20	0.30	0.30	0.14
>1,000	0.03	0.03	0.00	0.00	0.00

DF > LHA/AGQS is 0.30 for PFOA/PFOS

PFAS Detection at NH Landfils	**Concentrations (ng/L)**				
	PFOA	**PFOS**	**PFBA**	**PFPEA**	**PFHPA**
Min	0.50	0.44	0.55	1.0	0.89
Max	2200	1560	493	260	410
Mean	12.9	18.0	13.7	14.0	8.0
Median	9.0	17.1	21.7	18.5	10.8

Median is less than 50% of LHA/AGQS for PFOA/PFOS

Groundwater Concerns at Landfills – VT Closed Landfills*

ppt	MSW LF 1	MSW LF 2	MSW LF 3	MSW LF 4	MSW LF 5	MSW LF 6	Paper Sludge LF	C&D LF
Sample Date	10/17	10/17	9/16	9/16	10/16	12/16	10/16	10/16
PFOA	11.3	44.9	8.43	14	2	8.99	18	900
PFOS	ND	37	4.98	5	ND	ND	11	140
TOTAL	11.3	81.9	13.41	19	2	8.99	29	1040

*Courtesy of Vermont Department of Environmental Conservation (VTDEC), May 2018

Groundwater Near Landfills – What's Next?

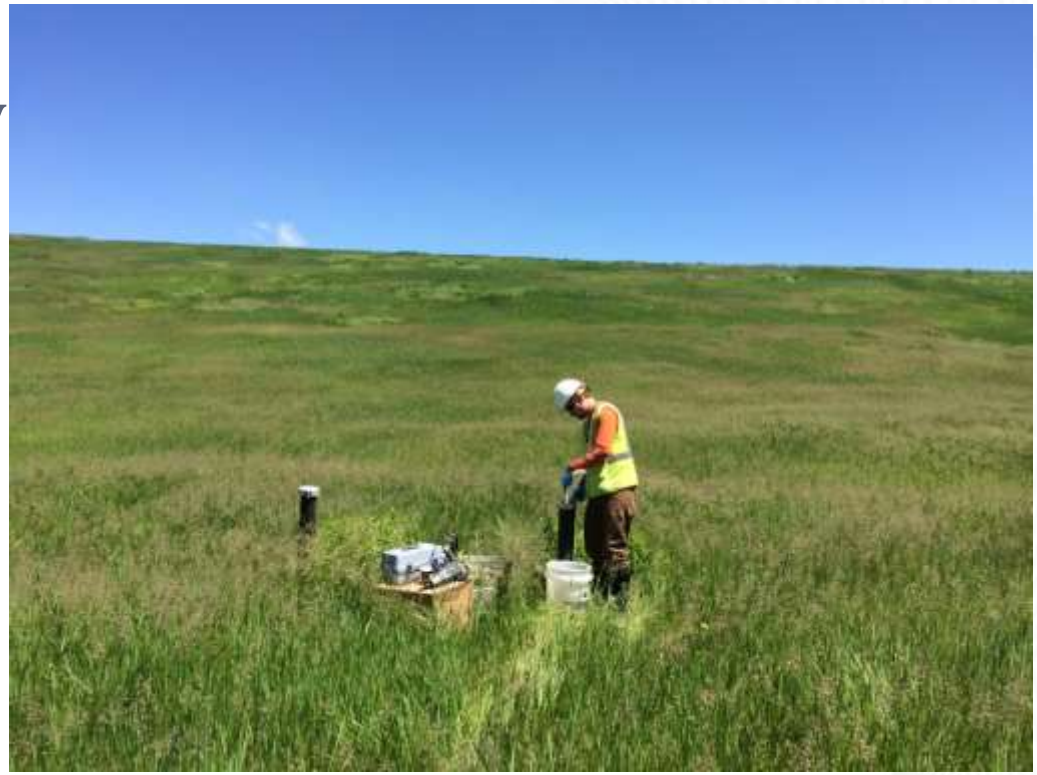
- May 2018 USEPA PFAS Summit Outcomes
  - Consider MCL process, additional advisories, risk-based SW criteria
- New Requirements
  - Release Detection monitoring
  - Legacy release GW monitoring
- Possible Implications
  - Potential for Private Well impacts
  - Potential for remedy requirements/ water line extensions

States Aggressively Regulating – The NH Example

- Oct 2016: PFAS AGQS of 70 ng/L (parts per trillion)
- Nov 2016: Sent notice of required PFAS sampling in 2017/2018
- May 2017: Sent requirements for PFAS sampling at active sites
  - Active/closed landfills
- June 2018 – Anticipated Lower 1,4-dioxane Standard of 0.32 ug/L

States Aggressively Regulating – The NH Example

- Strict sampling protocols for PFAS
- Requirements below PFAS Groundwater Standard (AGQS)



Additional Requirements Imminent

- EPA committed to additional PFAS LHAs and risk-based SW criteria
- NY State requiring sampling at sites for PFAS
- VT considering PFAS sampling requirements
- MA may include up to 5 PFAS (including PFOA and PFOS) in GW standards
- NH required wastewater discharge sample of GenX at a site

PFAS TREATMENT AND REMEDIATION

Leachate Treatment Options

- Sorption
  - Ionic exchange with resins
  - Sorption using GAC
- Destruction using Reverse Osmosis
- Experimental Methods
  - Advanced Oxidation/Reduction
    - Accelerated Remediation Catalysis (ARC)[1]
    - Advanced Reduction Processes (ARP) [2]
    - Non-thermal plasma reduction[2]
    - Advanced oxidation
      - Heat catalyzed persulfate
      - Surface modified nano-ZVI[2]

[1]CEC, SWANApalooza Emerging Contaminants in Landfills Panel, Denver, CO, March 7, 2018
[2]Jacobs, National Waste & Recycling Association PFAS Webinar, May 9, 2018

PFAS Remediation Options

- Primary focus on ex-situ treatment
  - GAC
  - Ionic exchange with resins
  - Reverse osmosis
- Potential for in-situ approaches
  - PRBs using sorptive media
  - Phytoremediation
- Wellhead treatment
  - GAC/Ionic exchange

Additional Resources

- The Interstate Technology Regulatory Council (ITRC) a public-private coalition of stakeholders has published a series of fact sheets on PFAS with updated information http://pfas-1.itrcweb.org
- U.S. EPA's website has information regarding PFAS regulation at https://www.epa.gov/pfas
- If you have questions or comments, you can email Matthew Thurlow at mthurlow@bakerlaw.com; or Russ Abell at rabell@sanbornhead.com or Stephen Zemba at szemba@sanbornhead.com

EXTRA SLIDES

Examples of PFAS Occurrence

Study/Site	PFOA DF (# detects) > 70 ng/L	PFOS DF (# detects) > 70 ng/L	Number of Sample Locations	Sample Type
UCMR3	0.3% (13)	0.9% (46)	4,920	Public water systems
NH Domestic Private Wells	12.1% (214)	0.7% (12)	1,762	Domestic Wells
Study/Site	**PFOA DF (# detects) > 400 ng/L**	**PFOS DF (# detects) > 200 ng/L**	**Number of Sample Locations**	**Sample Type**
UCMR3	0% (0)	0.4% (19)	4,920	Public Water Systems
NH Domestic Private Wells	0.9% (16)	0.1% (2)	1,762	Domestic Wells

Recent Review of PFAS Toxicity

Klein & Brown (2016)

Some Key Animal Toxicity Studies

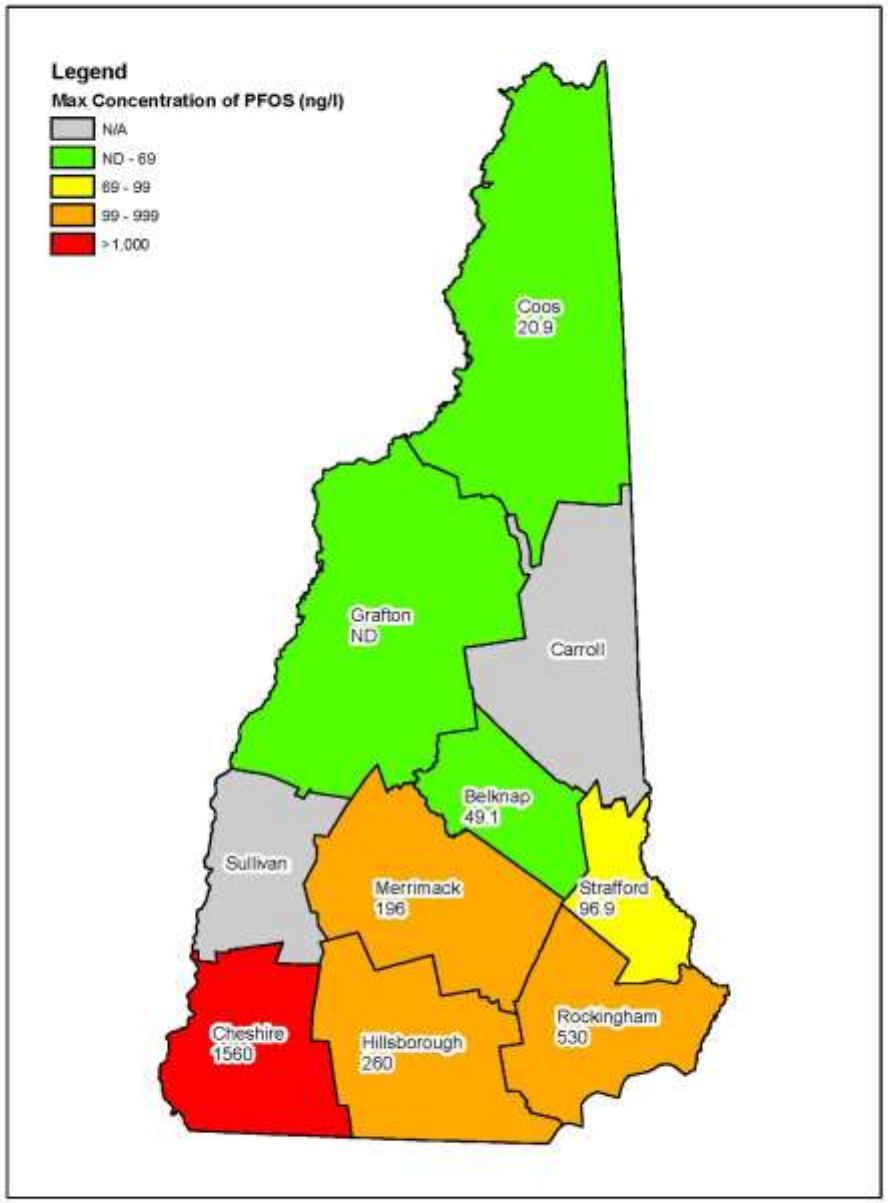
Effect	Investigators	Animal	Notes
Delayed phalanges ossification and hastened puberty in offspring	Lau et al. (2006)	Mice	LOAEL; Basis of EPA's 70 ppt health advisory
Testicular cancer	Butenhoff et al. (2012)	Rats	Leydig cell tumors – human relevance unclear
Increased liver weight in offspring	Quist et al. (2015)	Mice	Signs of chronic stress into adulthood
Mammary gland development in offspring	Tucker et al. (2015)	Mice	Human relevance unclear

Other Health Studies

- February 2018: Minnesota Dept. of Health concludes there is no link to cancer rates or cancer mortality from exposure to PFAS (including PFOA and PFOS)
- April 2012: C8 Panel in mid-Ohio Valley: "[W]e conclude that there is a probable link between exposure to C8 [also known as PFOA] and testicular cancer and kidney cancer but not any of the other cancers that were considered."
- July 2016: IARC Monograph on PFOA
  - "The evidence for cancer of the testis was considered credible and unlikely to be explained by bias and confounding, however, the estimate was based on small numbers."
  - "The evidence for cancer of the kidney was considered credible; however, chance, bias, and confounding could not be ruled out with reasonable confidence."
  - "There is limited evidence in humans for the carcinogenicity of perfluorooctanoic acid (PFOA). . . . Perfluorooctanoic acid (PFOA) is possibly carcinogenic to humans (Group 2B)."

Spatial Distribution: PFOS at Landfills in NH

County	Max PFOS in ng/L
Belknap	49
Carroll	NA
Cheshire	1,560
Coos	21
Grafton	ND
Hillsboro	260
Rockingham	530
Strafford	97
Sullivan	NA



Spatial Distribution: PFOA at Landfills in NH

County	Max PFOA in ng/L
Belknap	177
Carroll	NA
Cheshire	139
Coos	204
Grafton	54
Hillsboro	2,200
Rockingham	850
Strafford	210
Sullivan	NA