

PFAS in Landfill and Landfill Leachate

PFAS

PER- AND POLYFLUOROALKYL SUBSTANCES



NATIONAL
SOLIDWASTE
BENCHMARKING INITIATIVE

- PFAS Federal Initiative
- Chemistry/Applications
- PFAS in Landfills
 - Groundwater
 - Leachate
- PFAS in WWTP
 - Leachate Treatment
 - Biosolids
- Take-aways

- <https://canadagazette.gc.ca/rp-pr/p1/2021/2021-04-24/html/notice-avis-eng.html>

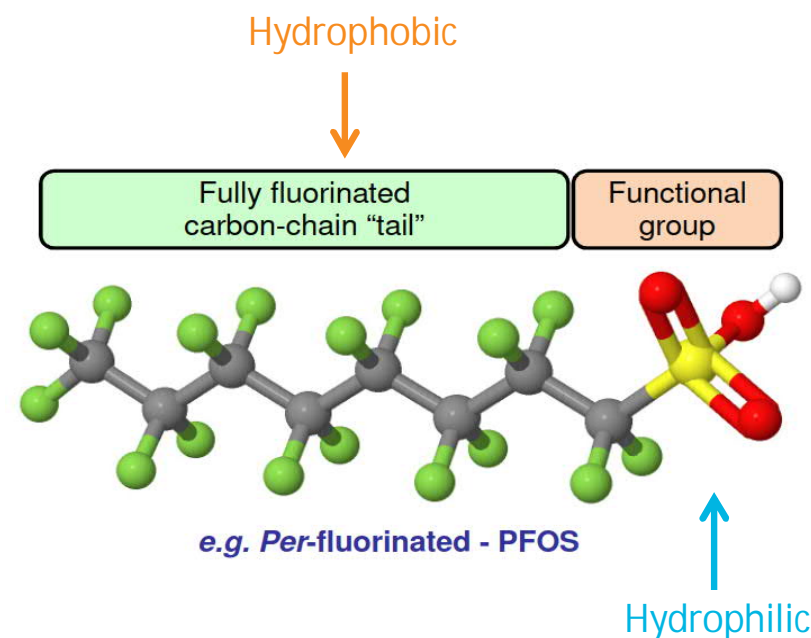
In 2021, the Government of Canada will

- continue to invest in research and monitoring on PFAS;
- collect and examine information on PFAS to inform a class-based approach; and
- review policy developments in other jurisdictions.

In addition, within the next two years, the Government of Canada will publish a State of PFAS Report, which will summarize relevant information on the class of PFAS.

PFAS Chemistry

- Class of synthetic, manmade compounds
 - Carbons bonded with fluorine in place of hydrogen
 - C-F is one of the strongest chemical bonds
 - Many PFAS are resistant to thermal, chemical, and biological degradation
- Main manufacturing processes
 - Electrochemical Fluorination (ECF)
 - Telomerization
- Large group of compounds
 - Polymers
 - Non-Polymers



Well-studied PFAS have demonstrated the following characteristics:

- **They are environmentally persistent and mobile within the environment. .**
- **They have been detected in humans, wildlife, and environmental media worldwide.**
- **They biomagnify in food webs.**
- **They are associated with a range of adverse effects on the environment and effects that may have implications for human health.**

PFAS Applications



Aerospace



Apparel



Building and Construction



Chemicals and Pharmaceuticals



Electronics



Oil and Gas



Energy



Healthcare and Hospitals



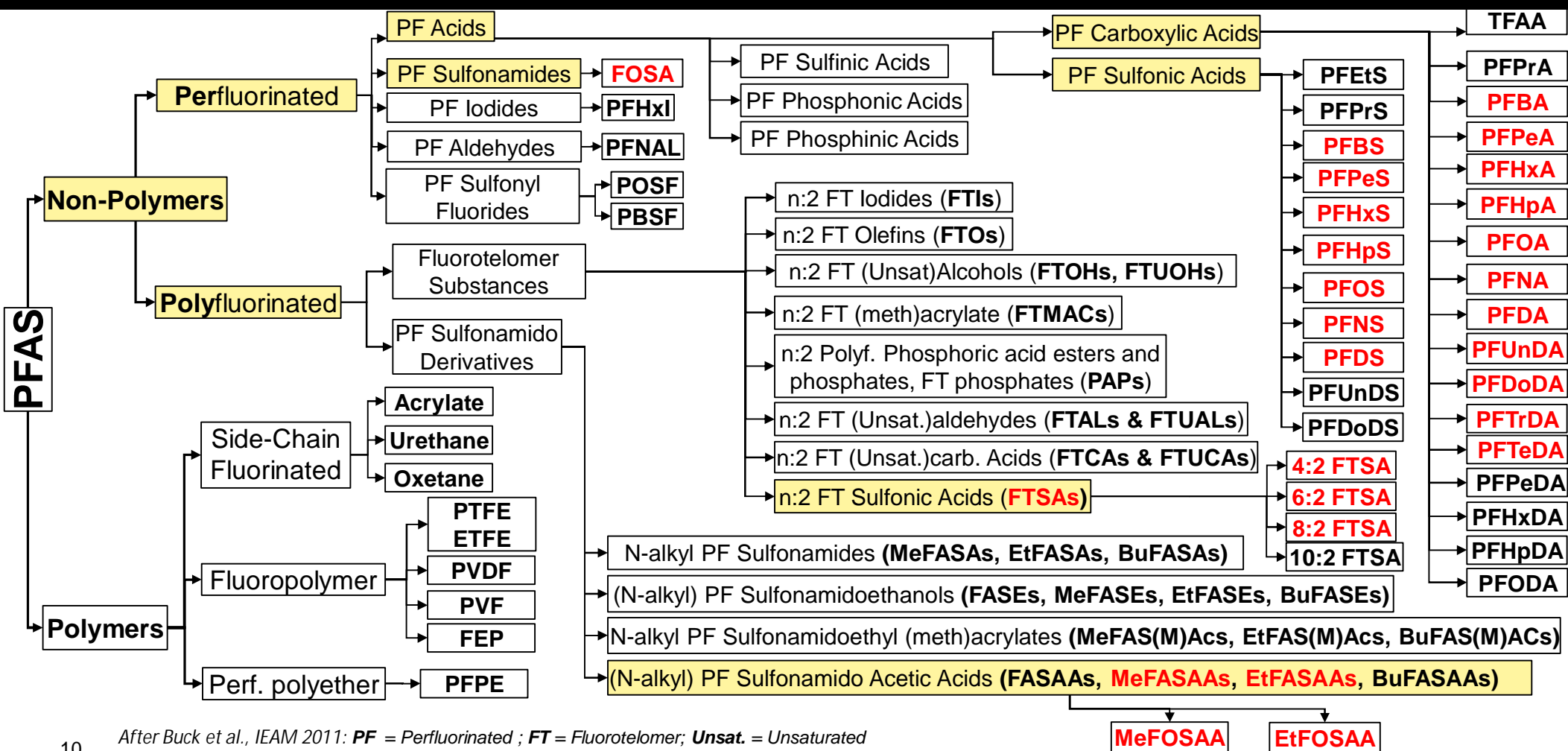
Aqueous Film Forming Foam



Semiconductors

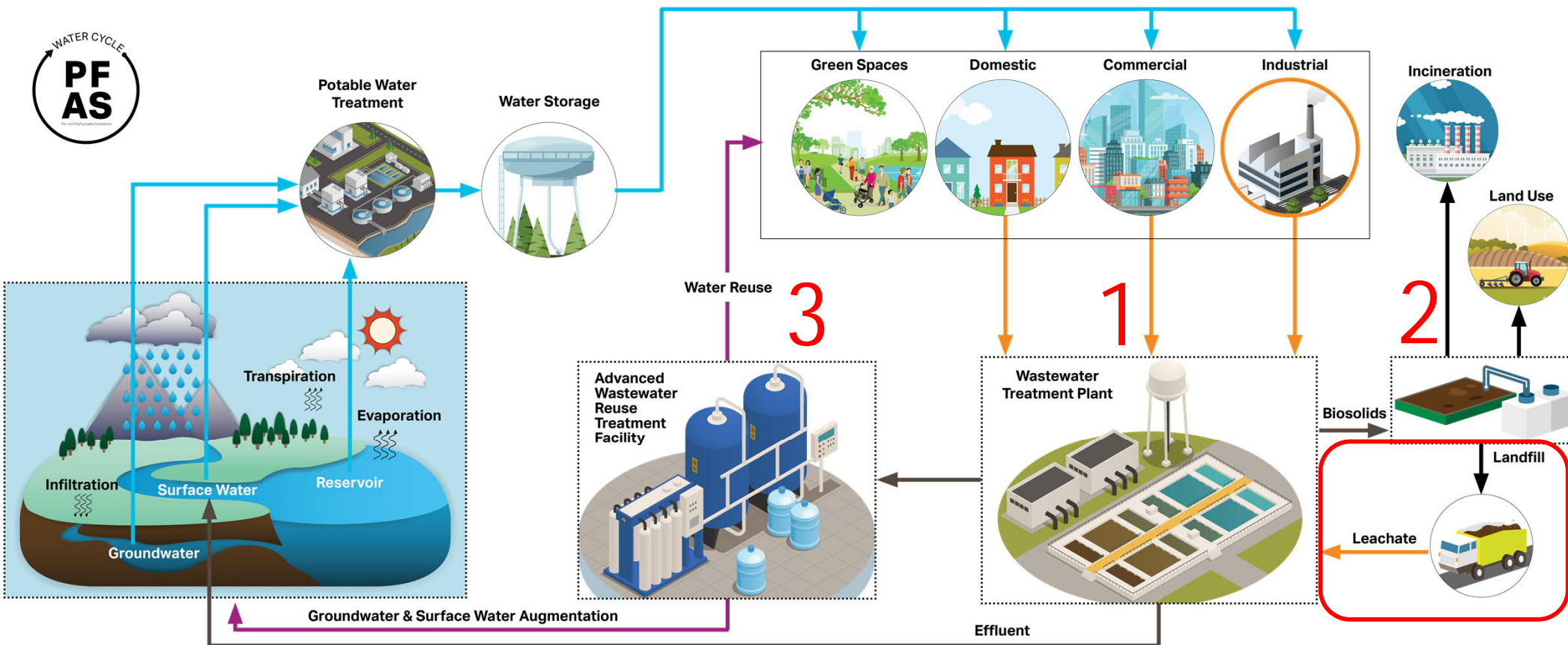
PFAS Family Tree – Minimum 24 PFAS Compounds

AECOM



PFAS – One Water Perspective

AECOM



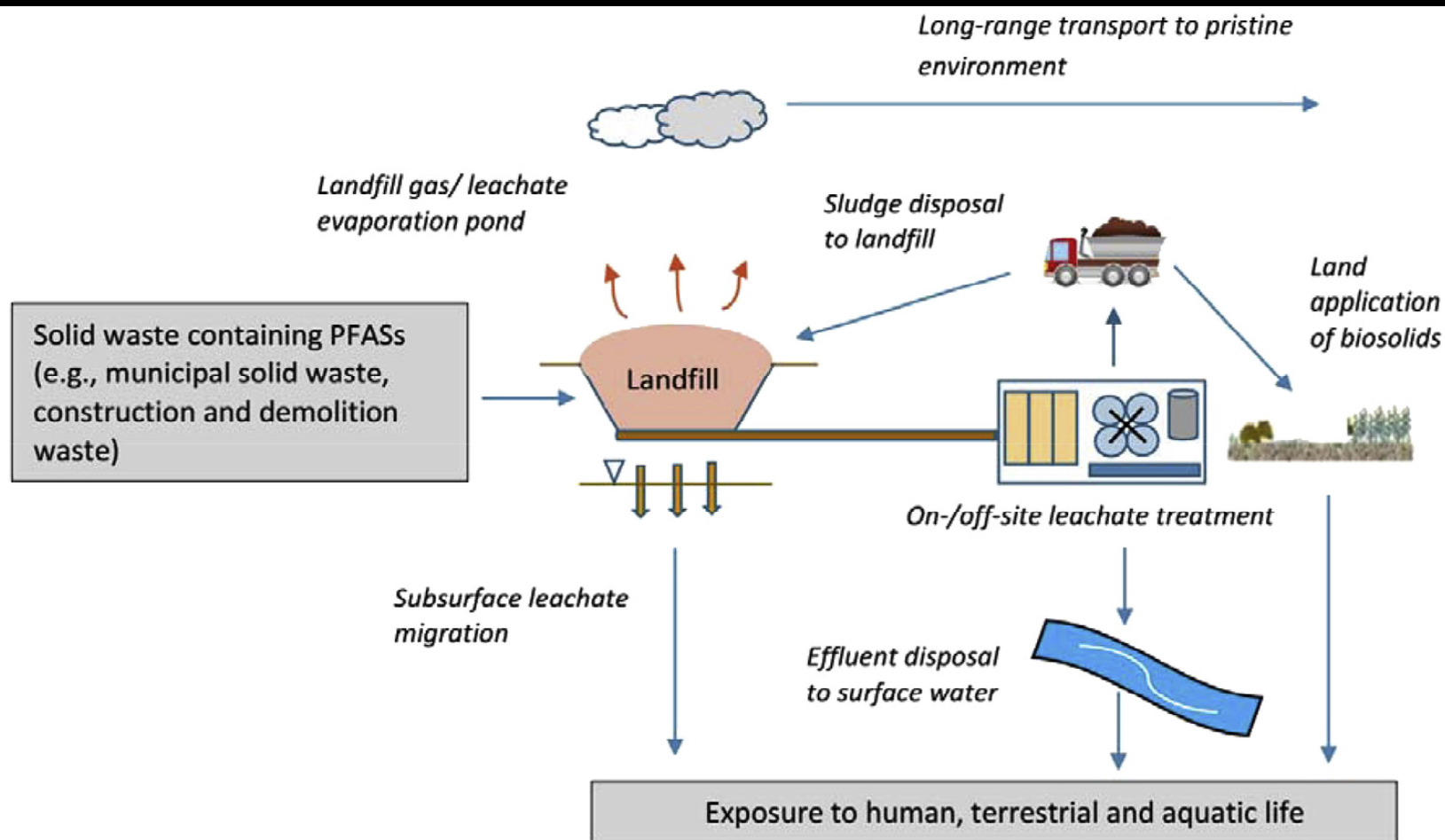
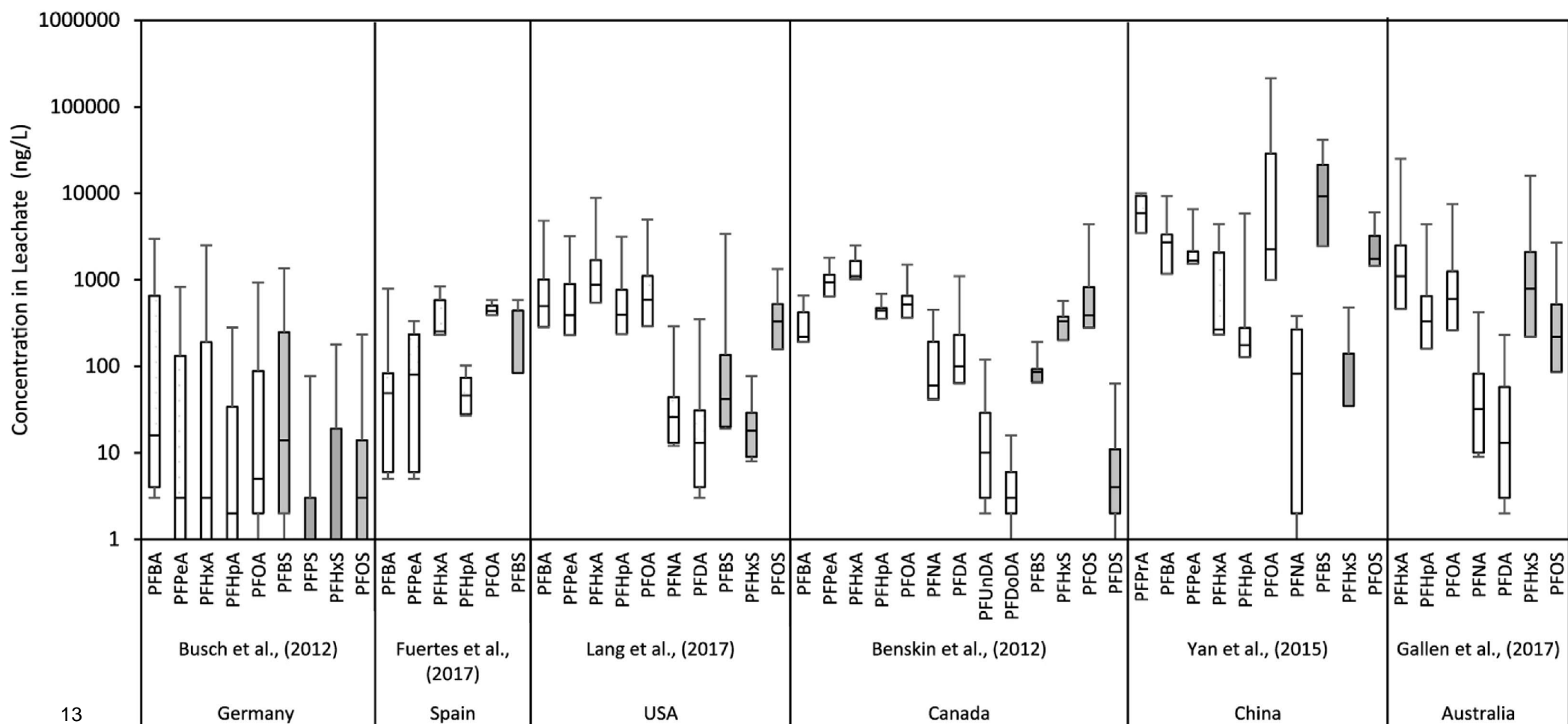
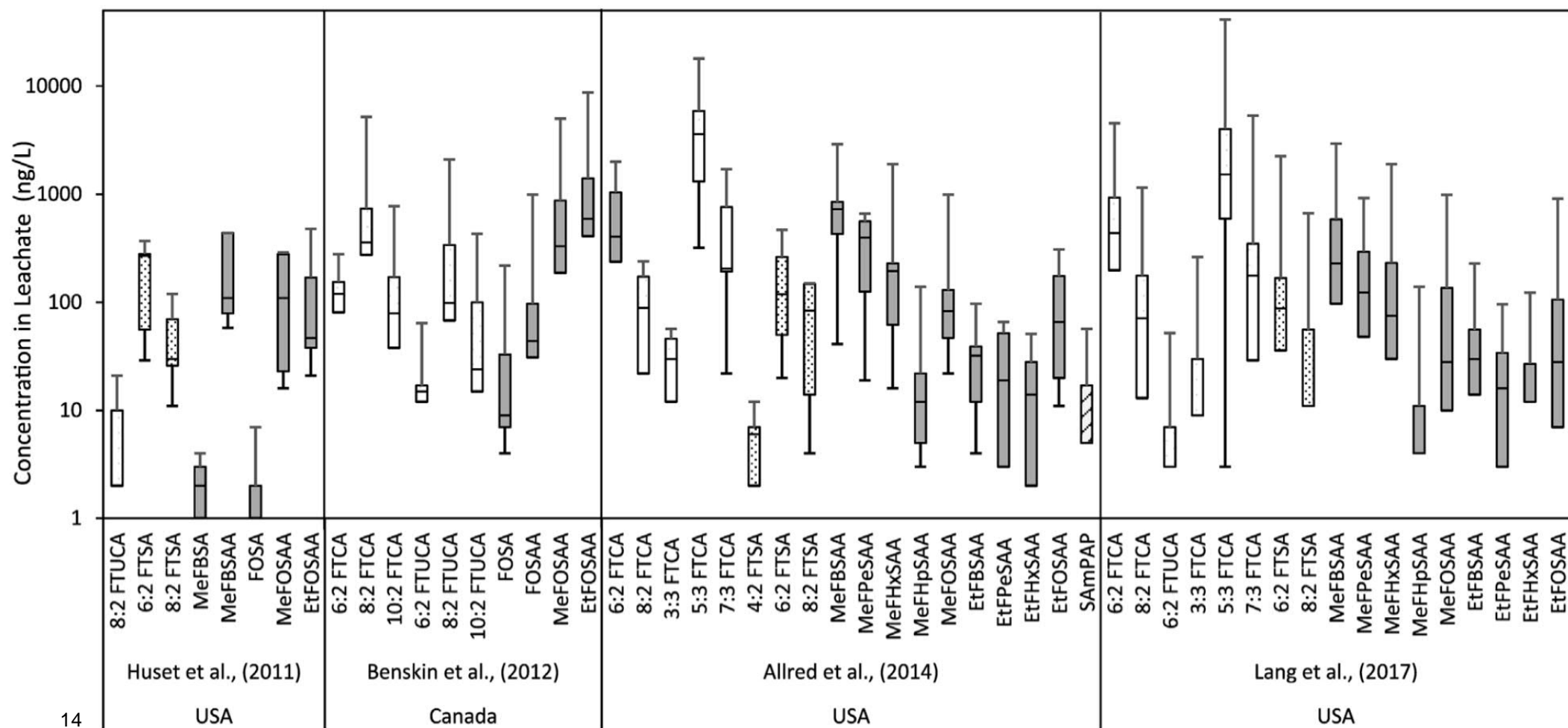


Fig. 1. Environmental pathways of per- and polyfluoroalkyl substances (PFASs) originating from solid wastes.

Non-Degradable PFAS in Landfills

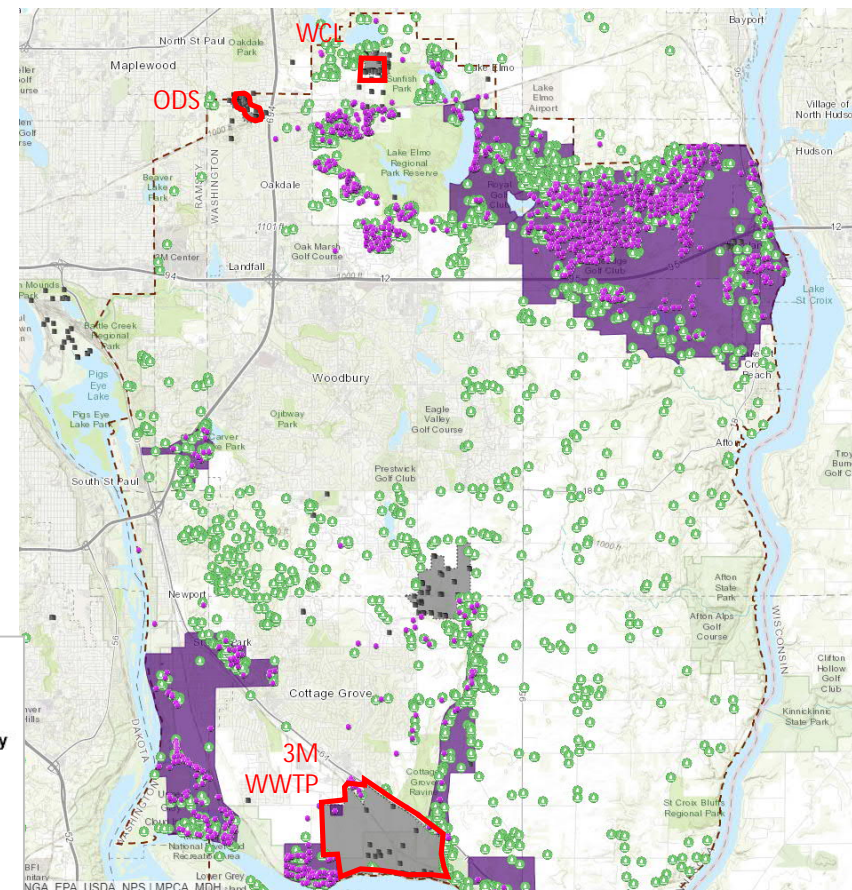
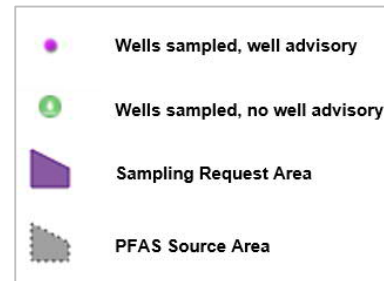


Degradable PFAS in Landfills



PFAS Contamination in Minnesota

- PFAS has been found in the groundwater and surface water of southeastern Minnesota
- sources of contamination include the Oakdale Disposal Site (ODS) and Washington County Landfill (WCL)
- used by 3M to dispose of “water-resistant material” for the manufacture of Scotchguard, Teflon, grease-proof paper, ...
- in 2018, 3M paid \$850M to settle a lawsuit by the Minnesota Attorney General over natural resource damages



MI - IPP PFAS Initiative

AECOM

- February 2018 – 95 WWTPs required to screen Industrial Users
 - Evaluate Industrial Users with potential sources of PFAS
 - Follow-up sampling of probable sources if found
 - Sample WWTP effluent if sources > screening criteria (12 ppt PFOS)
 - Sample WWTP Biosolids if WWTP effluent \geq 50 ppt PFOS
 - Reports submitted 2018-2019

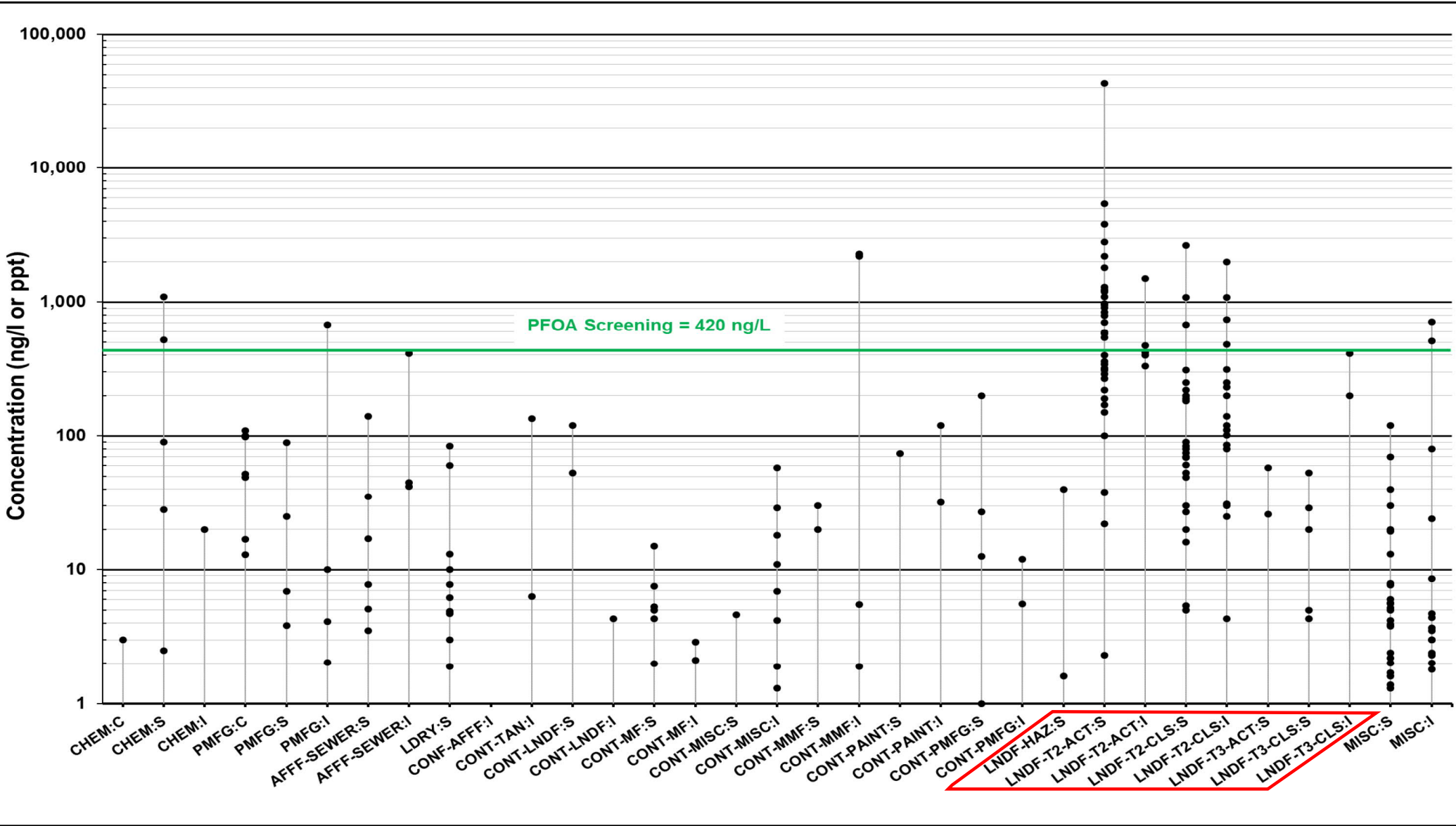


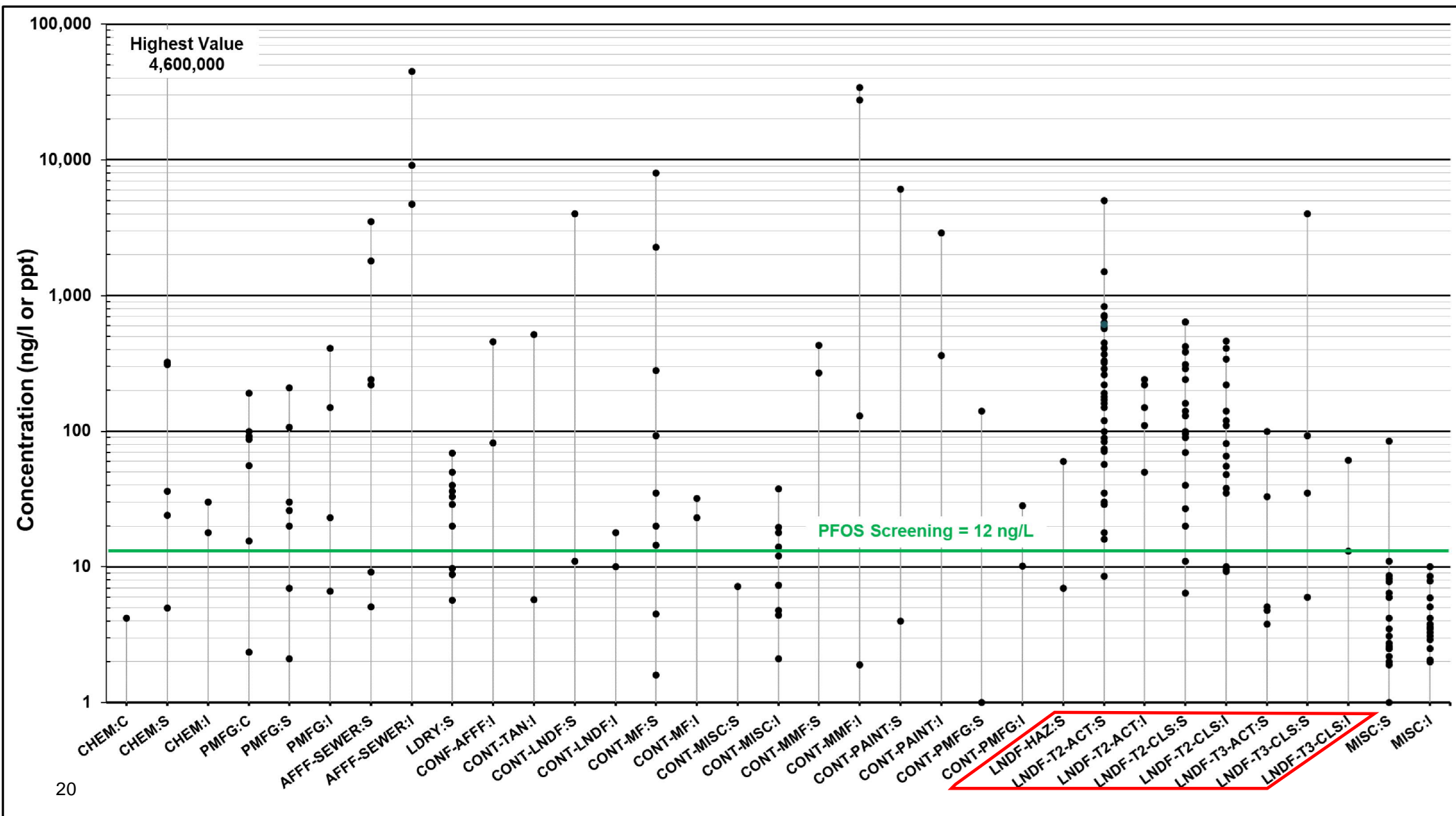
PFAS in Landfills - MI

Table 13. IU and SIU PFAS Summary Results¹

Industry/Category/Type			Graph ID	Total Facilities Sampled	PFOA Number and (%) of Detections	PFOA Minimum (Min) (ng/L)	PFOA Maximum (Max) (ng/L)	PFOS Number and (%) of Detections	PFOS Number and (%) of Sources (>WQS)	PFOS Minimum (Min) (ng/L)	PFOS Maximum (Max) (ng/L)
Landfills											
Hazardous Waste Landfill	SIU	LNDF-HAZ:S		1	1 (100%)	1.6	40	1 (100%)	1 (100%)	7.0	60
Type II Sanitary – Active	SIU	LNDF-T2-ACT:S		22	22 (100%)	2.3	43,425	22 (100%)	22 (100%)	8.5	5,000
	IU	LNDF-T2-ACT:I		3	3 (100%)	330	1,500	3 (100%)	3 (100%)	50	240
Type II Sanitary – Closed	SIU	LNDF-T2-CLS:S		13	13 (100%)	5.0	2,660	12 (92%)	11 (85%)	6.4	641
	IU	LNDF-T2-CLS:I		10	10 (100%)	4.3	2,000	10 (100%)	9 (90%)	9.3	460
Type III Sanitary - Active	SIU	LNDF-T3-ACT:S		3	2 (67%)	26	58	3 (100%)	1 (33%)	3.79	100
Type III Sanitary – Closed	SIU	LNDF-T3-CLS:S		3	3 (100%)	4.3	53	3 (100%)	2 (67%)	6.0	4,000
	IU	LNDF-T3-CLS:I		1	1 (100%)	200	410	1 (100%)	1 (100%)	13	61
Miscellaneous Sources											
SIU			MISC:S	73	27 (37%)	1.3	120	19 (26%)	1 (1%)	0.98	85
IU			MISC:I	50	15 (30%)	1.8	710	16 (32%)	0 (0%)	2	10

¹Units are in nanograms per liter (ng/L) or parts per trillion (ppt)





PFAS Removal Across Tertiary and Advanced Treatment

Type	Process	PFAS Removal Efficacy
Physical – filtration	Granular media	Low
	MF/UF	Low
	Reverse Osmosis (RO)	High
Physical – adsorption	Granular Activated Carbon (GAC)	High
Chemical	Chlorine	Low
	Chloramine	Low
	Ozone & ozone-peroxide	Low
Irradiation	UV disinfection	Low
	UV-AOP	Low
Hybrid	Biologically Active Carbon (BAC)	Moderate
	Soil-Aquifer Treatment (SAT)	TBD - Site-Specific
Ion exchange	Ion Exchange (IX)	High

Biosolids Treatment Considerations for PFAS

- Heat drying and composting increased perfluoroalkyl acid (PFAA) concentrations
- Only dilution from blending with non-PFAS material decreased PFAA concentrations

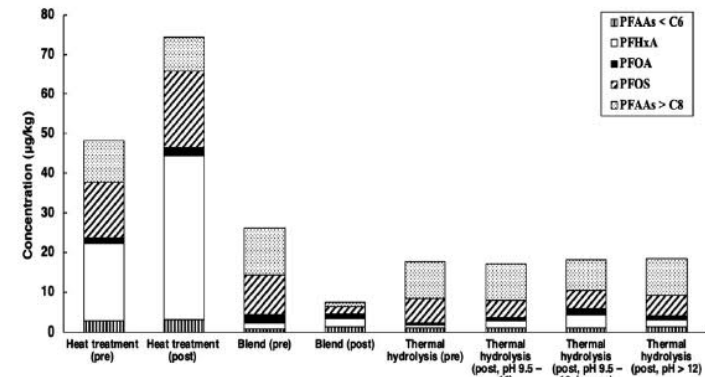
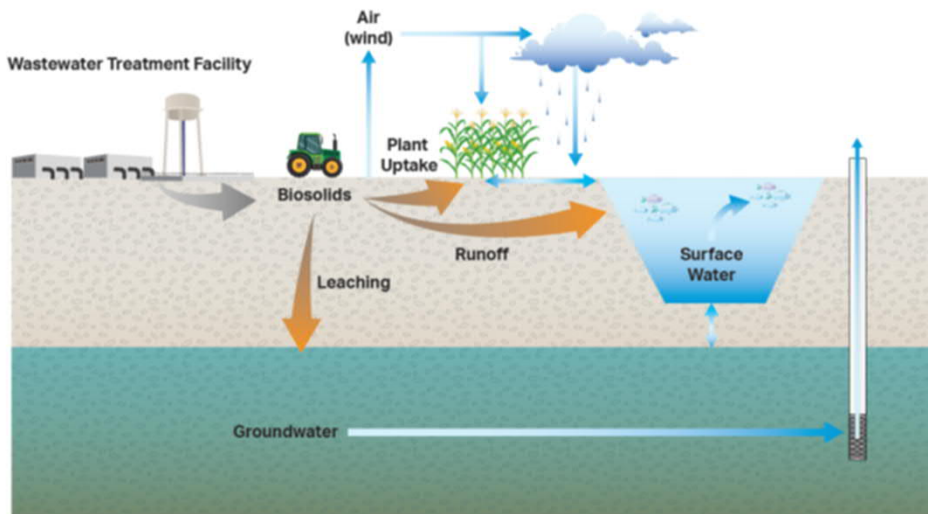
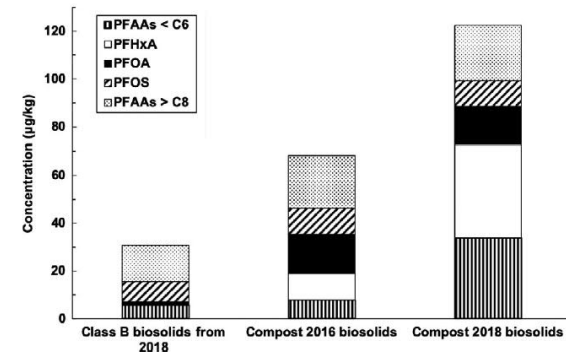


Figure 1. PFAA loads (µg/kg, dry wt.) for the <2 mm particle size fraction of the samples. Pre: before post-treatment process (the Class A or B biosolids) and post: after post-treatment process. PFAAs <C6 include PFBA and PFBS, and PFAAs >C8 include PFNA, PFDA, PFUdA, PFDoA, PFTeDA, and PFTeDA.



Per- and polyfluoroalkyl substances in commercially available biosolid-based products: The effect of treatment processes

Rooney Kim Lazzano,^{1,2,*} Chloé de Perre,¹ Michael L. Mashtare,^{1,2,3} Linda S. Lee^{1,2,3}

Treatment Challenge: Biosolids

- Wastewater treatment concentrates some PFAS compounds in sludge
- Traditional solids stabilization processes do not reduce PFAS
- Landfilling of biosolids
 - Not sustainable
 - Leachate concerns
- Incineration – destruction or transfer from solids phase to gas phase?
- **Result** - PFAS compounds still reside in the environment (landfill / emissions / leachate)



PERSISTENT POLLUTANTS

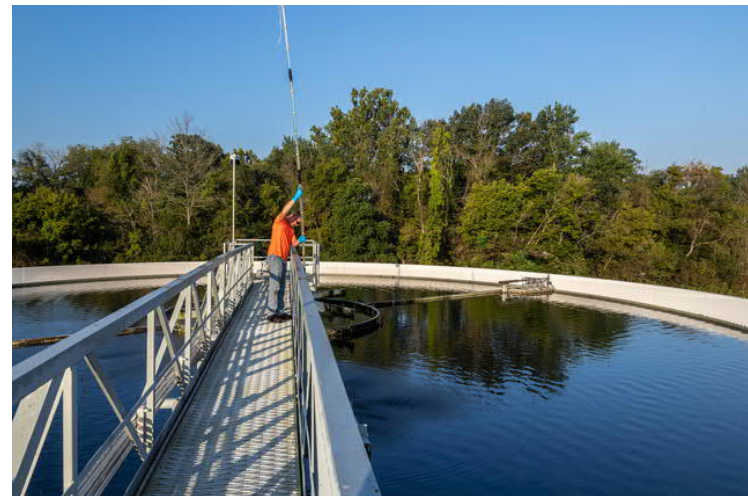
Incineration may spread, not break down PFAS

Preliminary data show soil and water near New York facility are contaminated

by Cheryl Hughes
APRIL 27, 2020

Take Away Points

- Federal Government is studying PFAS, which may lead to regulation as a contaminant of concern
- PFAS detected at landfills
- Potential for landfill managers to include PFAS monitoring in budgets
- Potential for landfill managers to include leachate management and treatment evaluation as due diligence or upon release of Federal Government PFAS report



PFAS

PER- AND POLYFLUOROALKYL SUBSTANCES

QUESTIONS

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