

PFAS at Landfills: Managing Risk and Navigating Rapidly-Evolving Regulations

U.P. Solid Waste Forum

April 25, 2019

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AGENDA

- 1 Introduction to PFAS
- 2 PFAS Health Effects and Regulations
- 3 PFAS Sampling and Laboratory Analysis Considerations
- 4 Landfill Considerations
- 5 Recommended Resources



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What are Per- and Polyfluoroalkyl Substances (PFAS)?

- Large class of chemicals with unique properties
 - Extremely persistent and mobile in the environment
 - Used in a wide variety of products
 - Nearly ubiquitous in nature
 - Found even in remote places



A brief history of PFAS

PFAS	Development Time Period							
	1930s	1940s	1950s	1960s	1970s	1980s	1990s	2000s
PTFE	Invented	Non-Stick Coatings			Waterproof Fabrics			
PFOS		Initial Production	Stain and water resistant products	Firefighting Foam				US Reduction of PFOS, PFOA, PFNA
PFOA		Initial Production	Protective Coatings					
PFNA					Initial Production	Architectural Resins		
Fluorotelomers					Initial Production	Firefighting Foams		Predominant form of firefighting foam
Dominant Process		Electrochemical fluorination						Fluoro-telomerization
	Pre-Invention of Chemistry		Initial chemical synthesis/production			Commercial products introduced and used		

First detection in factory workers



First detection in general population



First detection in environmental samples



2016: USEPA set lifetime health advisory of 70 parts per trillion (ppt) for PFOA and PFOS in drinking water

Source: ITRC



PFAS

Non-polymer

Polymer

Potential Precursors

Perfluorinated

- PFAAs
- PFCAs
- PFSAs
- FASAs

Polyfluorinated

Precursors (or GenX)

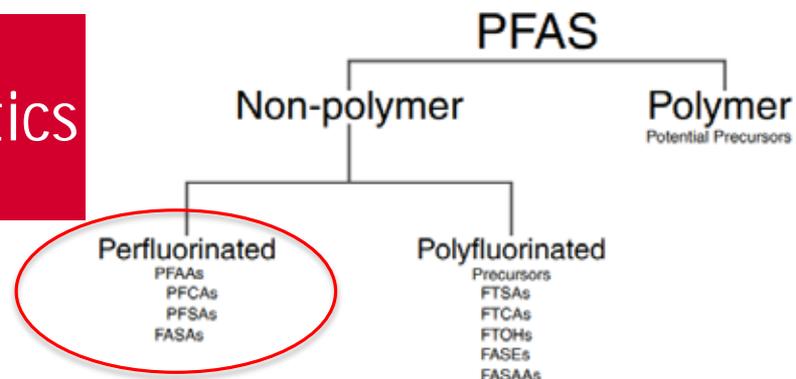
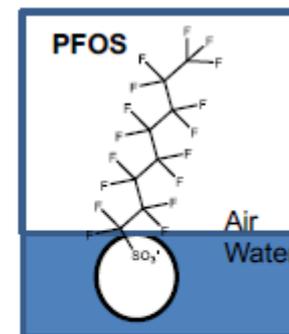
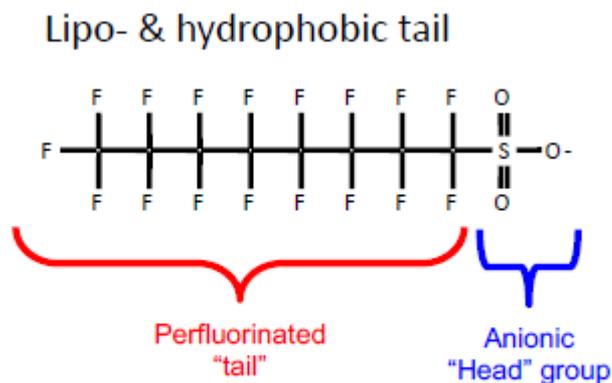
- FTSAs
- FTCAs
- FTOHs
- FASEs
- FASAAs



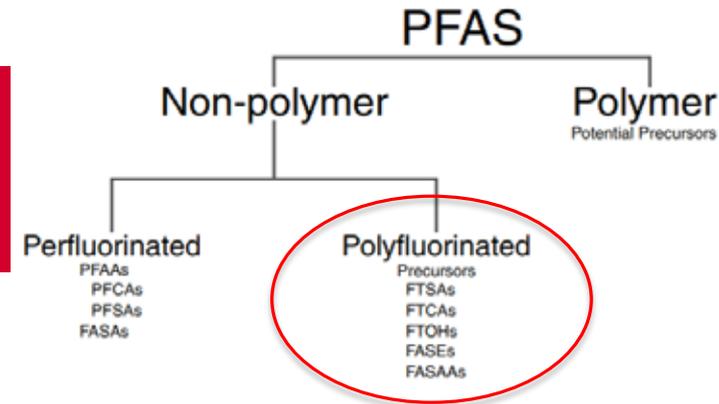
Perfluoroalkyl substance characteristics

- Fully fluorinated
- Extremely stable
 - Resistant to:
 - Chemicals
 - Heat
 - Water
 - Oils

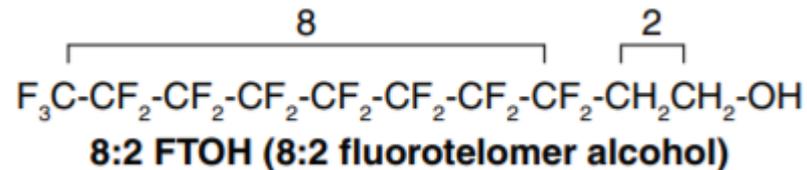
Perfluorooctane sulfonate (PFOS)
 $C_8F_{17}SO_3^-$



Polyfluoroalkyl substance characteristics ("precursors" or "GenX")



- Partially-fluorinated
- Non-fluorine atom (usually H or O) attached to at least one, but not all, of the carbons in the alkane chain
- Creates a "weak link" susceptible to biotic or abiotic degradation (becoming a perfluoroalkyl substance)
- Example:



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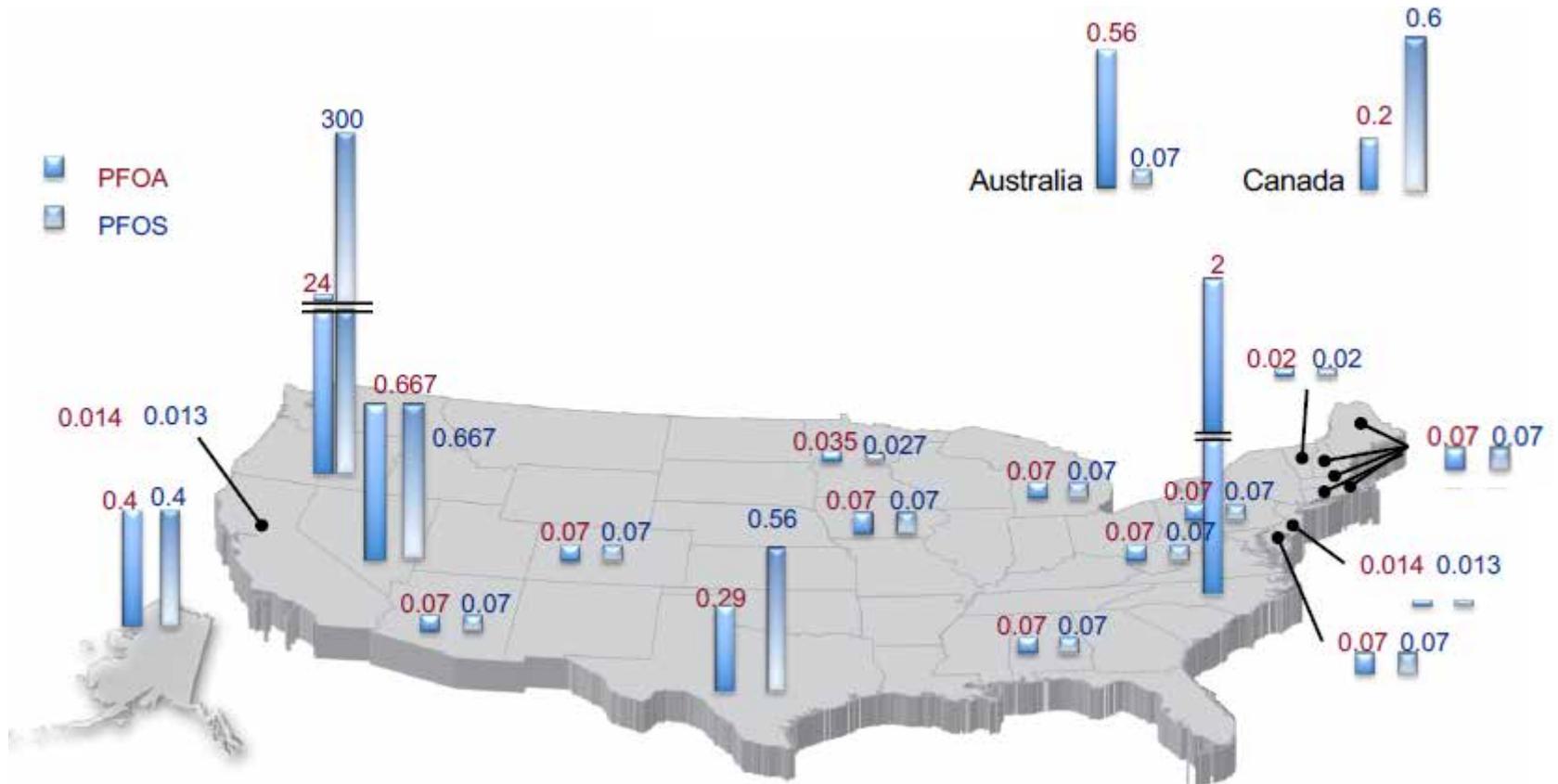
PFAS Health Effects



- Most studies have focused on PFOA and PFOS
- PFOA and PFOS
 - Animal (documented evidence)
 - Affects liver, immune system, development, endocrine, reproduction
 - Humans (possible negative links)
 - Liver (cholesterol)
 - Immune system (decreased vaccination response, asthma)
 - Development (birth weight)
 - Reproduction (decreased fertility)
 - Cardiovascular system (pregnancy-induced hypertension)
 - Cancer (testicular, kidney)
- No known studies on effects of PFAS bioaccumulation
 - PFAS is known to be attracted to proteins in the human body
 - Bioaccumulation prediction is more complicated than for other contaminants



GROUNDWATER REGULATORY STANDARDS



As of Jan. 2019; does not include all proposed values

Source: ITRC



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PFAS Sampling Considerations



- Main concern is with cross-contamination of PFAS in the sampling environment
 - PFAS are ubiquitous
 - Low (i.e. ppt) standards
 - Much of our typical sampling equipment and items in the sampling environment contain or may contain PFAS
 - Little published research on how certain materials may affect sample results
- Refer to MI EGLE PFAS Sampling Guidance for appropriate and prohibited materials for sampling and personal protection
- **Conservative approach is recommended**
 - When in doubt, collect field, equipment, trip blanks
 - Also advisable to collect sample duplicates



Formally-established PFAS Laboratory Analysis Standards

- EPA Method 537.1 Rev 1.1
 - Drinking water method last updated November 2018
 - Includes 18 PFAS analytes
 - Requires Field Reagent Blank for additional QA/QC
- ISO Method 25101
 - Method for unfiltered samples of drinking water, groundwater, and surface water
 - Used for PFOS and PFOA
- ASTM D7979
 - Used in surface water, sludge, and wastewater for select PFAS
- ASTM D7968
 - Used for perfluorinated substances (not exhaustive PFAS list)
 - “Quick and dirty” method



PFAS Laboratory Analysis to be Established

- **Some labs have “Modified” EPA Method 537**
 - Includes isotope dilution, not typically sanctioned by EPA
 - Used for other media (i.e. groundwater, soil, etc.)
 - Requires Field Reagent Blank for additional QA/QC
- EPA working on additional PFAS methods for release in 2019
 - EPA 8237: non-drinking water, 24 PFAS compounds
 - EPA 8238: non-drinking water/POTW influent/biosolids/soils/DoD sites, 24 PFAS + GenX
 - New drinking water method for shorter chain PFAS outside EPA Method 537 Scope



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PFAS in Landfills

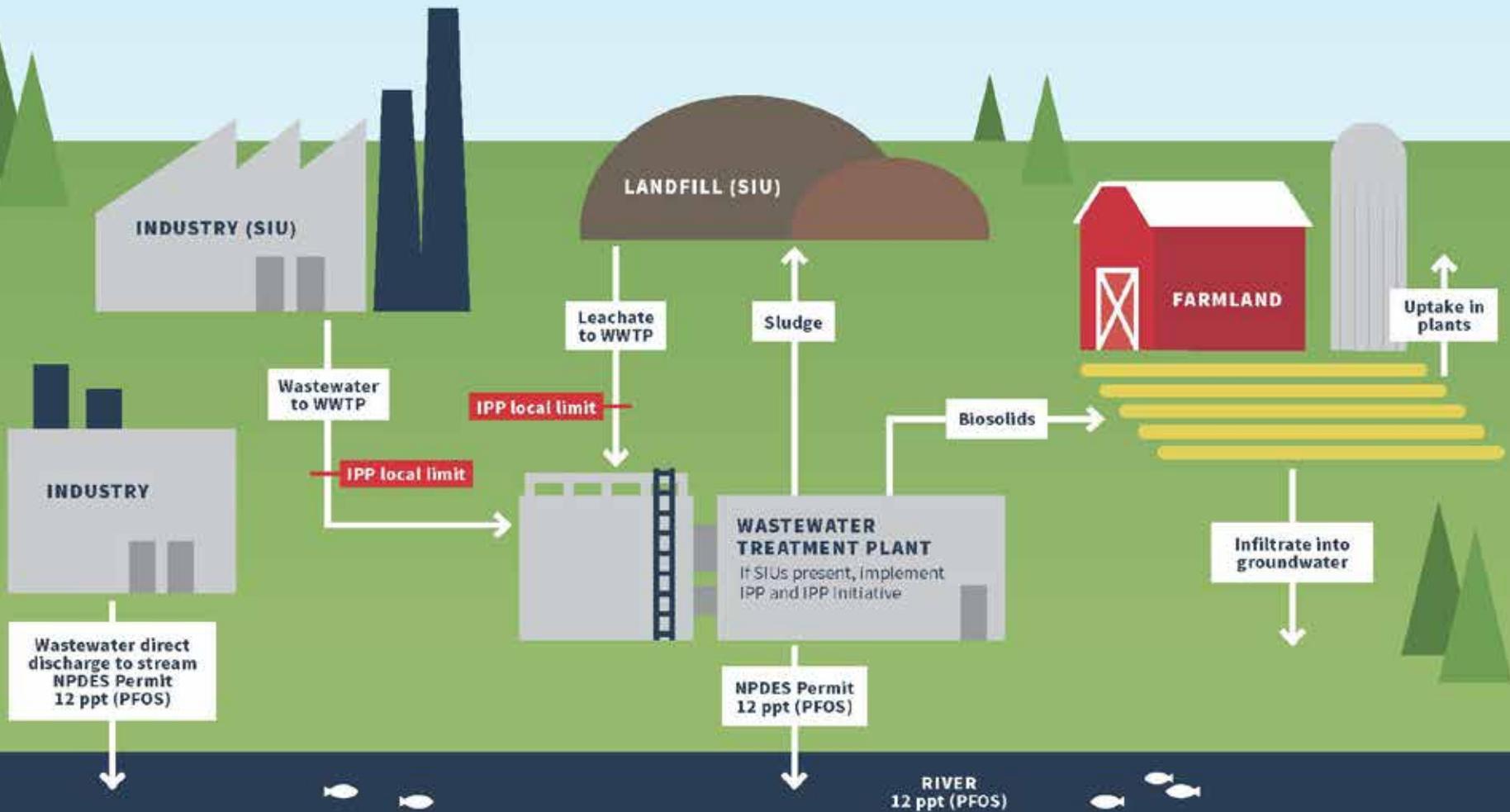


- Sources
 - PFAS-impacted industrial waste
 - Sewage sludge from wastewater treatment facilities
 - Waste from site mitigation
 - PFAS-bearing consumer wastes
 - Any industrial, commercial, and consumer products landfilled since the 1950s
- PFAS composition and concentration
 - Shorter-chain PFAS tends to dominate
 - Concentration depends on type of landfill, waste stream accepted, and local industries



PFAS Water Cycle

IPP = Industrial Pretreatment Program
SIU = Significant Industrial User
NPDES = National Pollutant Discharge Elimination System
PPT = Parts Per Trillion
WWTP = Wastewater Treatment Plant



Source: Michigan EGLE, September 2018



Landfill Considerations



- Lined or unlined?
 - Impacts are harder to control in an unlined landfill
- What material is used for daily cover or alternate daily cover?
 - Sludge, sludge-derived products, shredded automotive parts, spray-on foams may contain PFAS
- How is the leachate processed?
 - WWTP is common, but WWTP technologies are generally ineffective at treating PFAS or might exacerbate the issue
- Age of waste?
 - PFAS will be released at slow but steady rates (i.e. decades) following initial placement
 - May take PFAS several years to reach leachate



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Recommended Resources and References



- ITRC Fact Sheets on PFAS
 - Great for PFAS background, evolving technologies, sampling and analysis, etc.
 - Regulations fact sheet is updated every 6 weeks
- MI EGLE PFAS Sampling Guidance
 - Great for allowable sampling and analysis practices
- MI EGLE PFAS Website
- Free webinars
- USEPA PFAS Website
- Qualified environmental professionals



Uncertainties and Evolving Policies

- Toxicity and risk assessment
- Regulations
- Sampling techniques
- Analysis procedures
- Fate and transport
- Treatment
 - Especially when multiple contaminants are present
 - Long term efficacy



Thank you!

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Consulting
Engineers and
Scientists

Questions?

wastewater field waste Guidance
Concentration Shorter-chain recommended
products since MDEQ
items sampling
sludge-derived treatment PFAS-bearing commercial affect
spray-on Sources ineffective local Much
rates industrial Sewage materials
leachate wastes technologies landfilled stream
daily facilities cover Sludge
standards Any processed ppt Age years generally
approach tends PFAS automotive steady
Low dominate released several
issue used material composition blanks protection
collect results typical type published Lined site
ubiquitous reach WWTP following
exacerbate landfill GenX PFAS-impacted
personal equipment mitigation
Refer concern environment certain
accepted unlined foams
sample placement
research shredded prohibited Conservative
treating initial slow
appropriate consumer
cross-contamination