

# Atmospheric Sources, Fate, and Transport of Per- and Poly- fluorinated Alkyl Substances (PFAS)

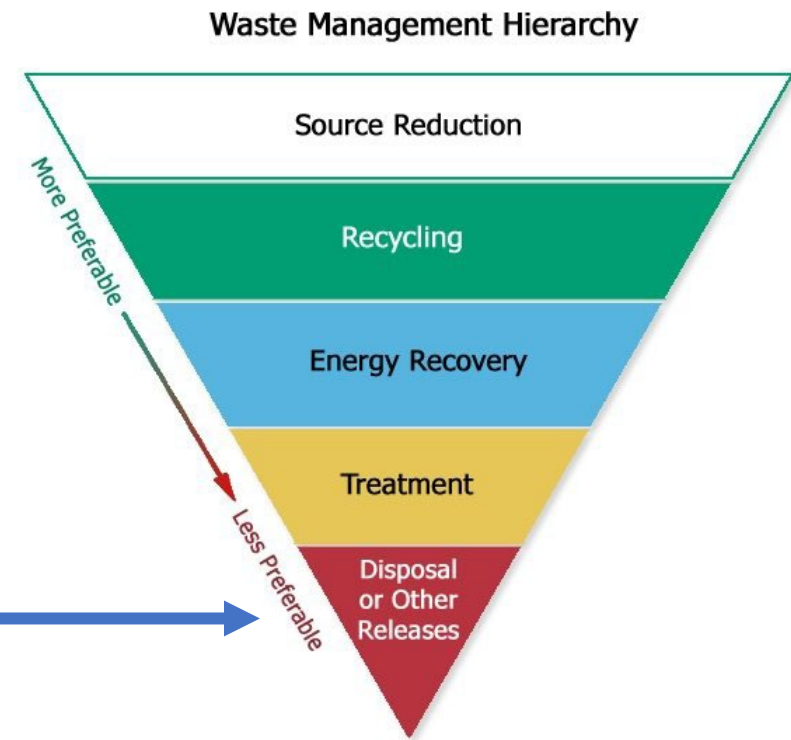
Dr. Andy May

The Ohio State University



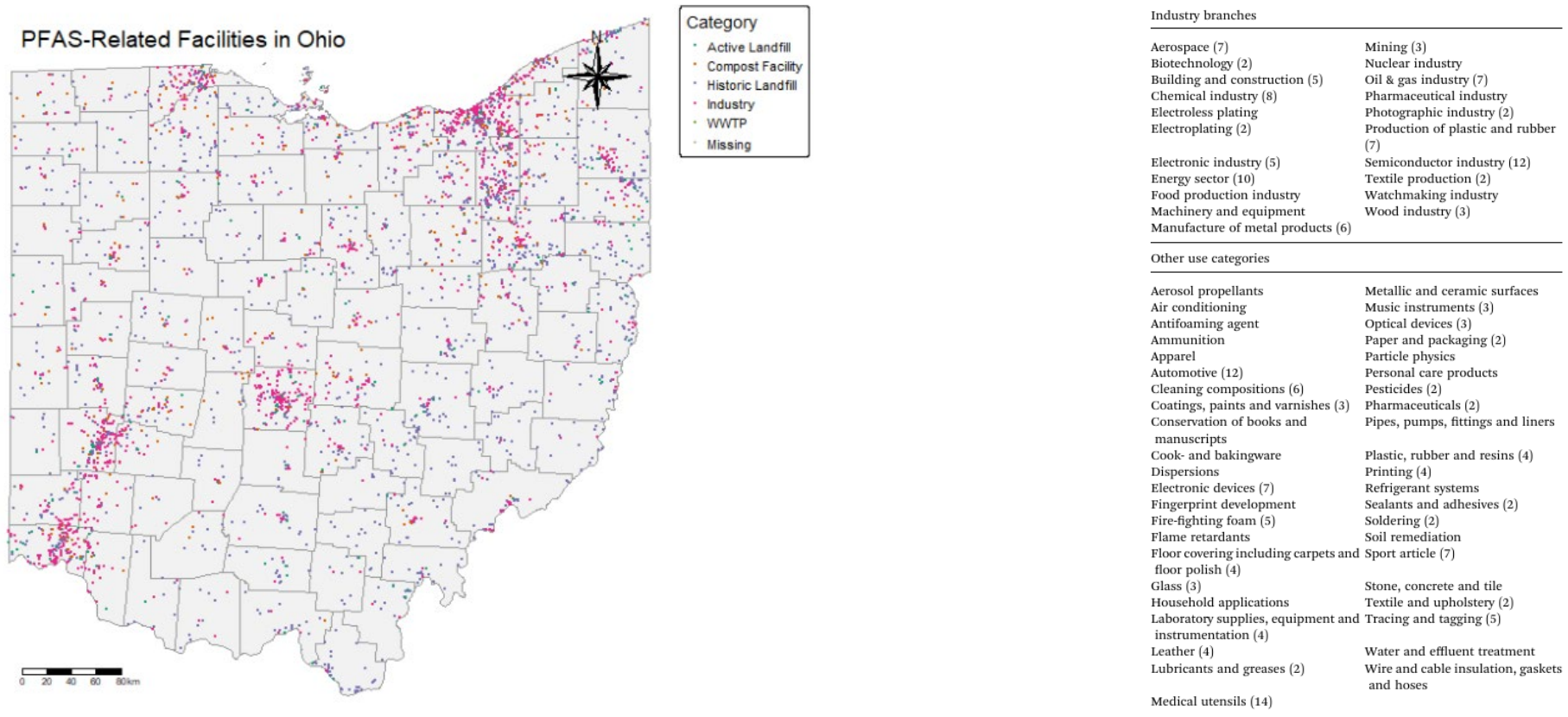
# PFAS represent an environmental – not just water – issue

- This has *become* a water treatment problem
- Its origin is a waste management problem that affects air, water, and soil in the environment



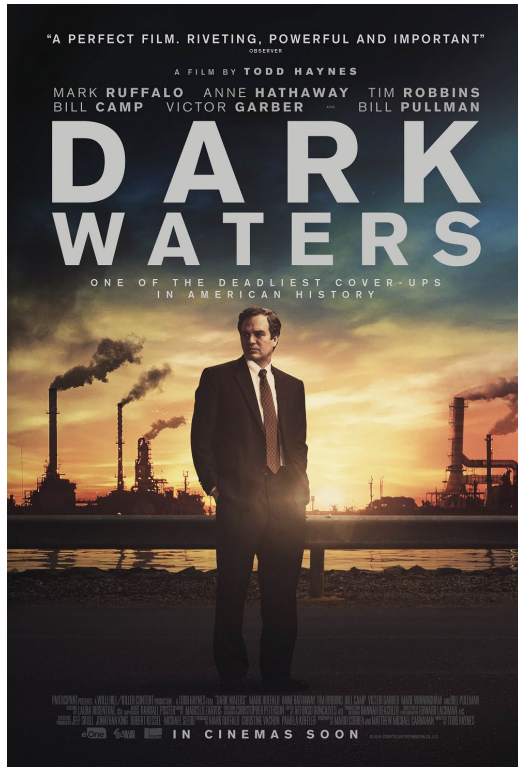


# PFAS use is widespread across industries within Ohio

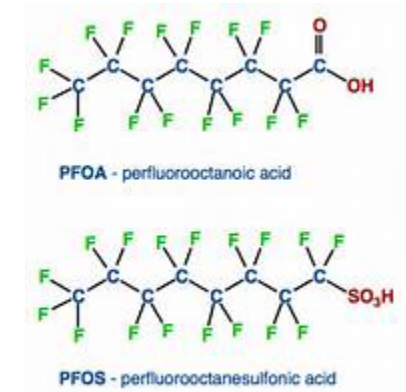
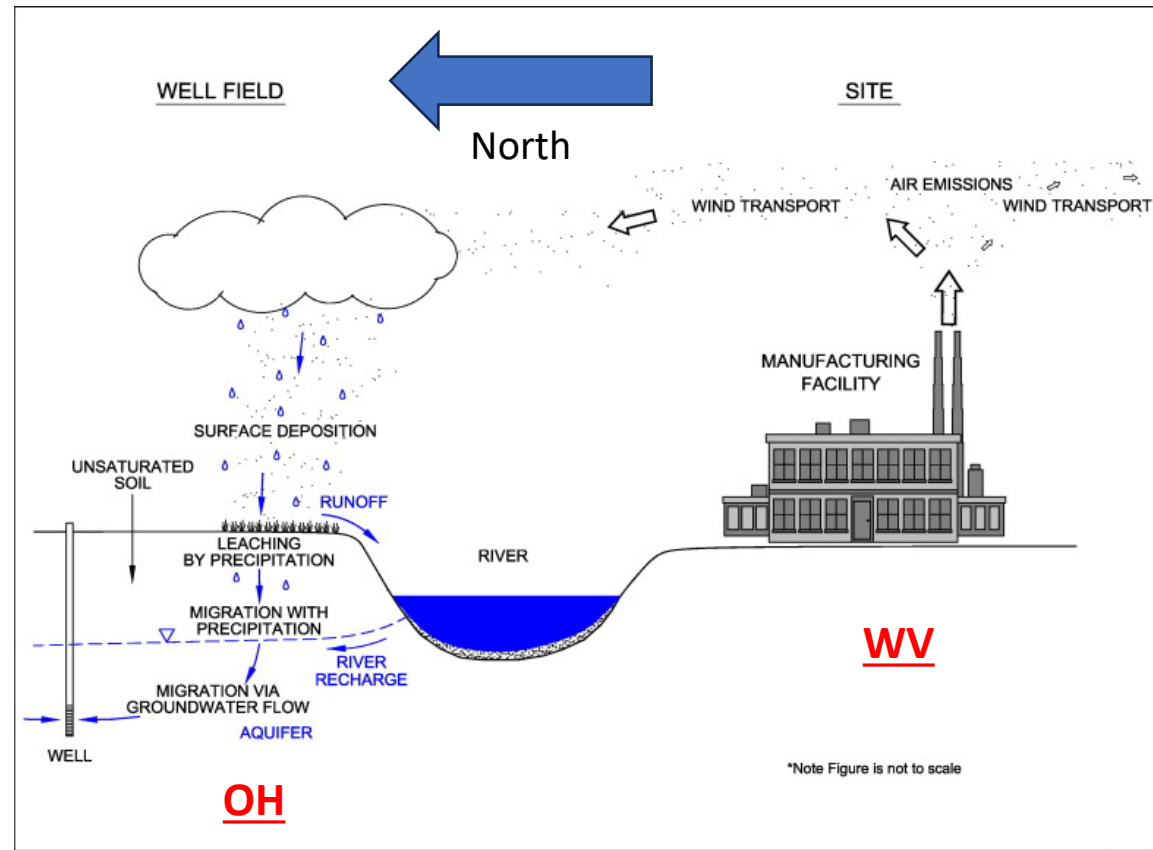




# Early PFAS work developed a conceptual model for industrial air emissions and water contamination

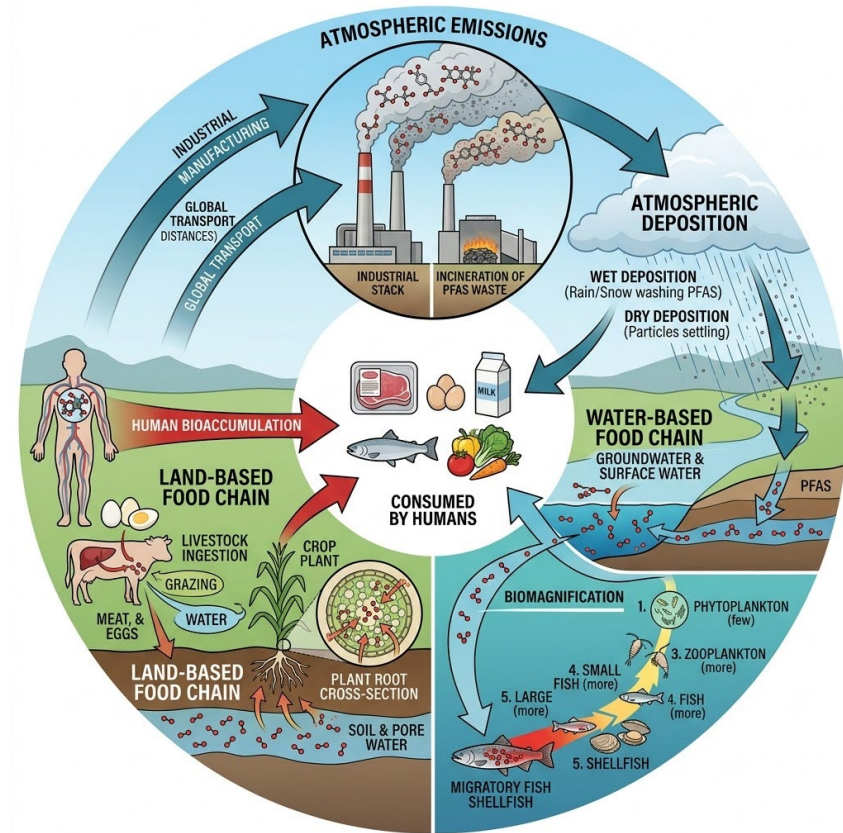


IMDB / Focus Features LLC



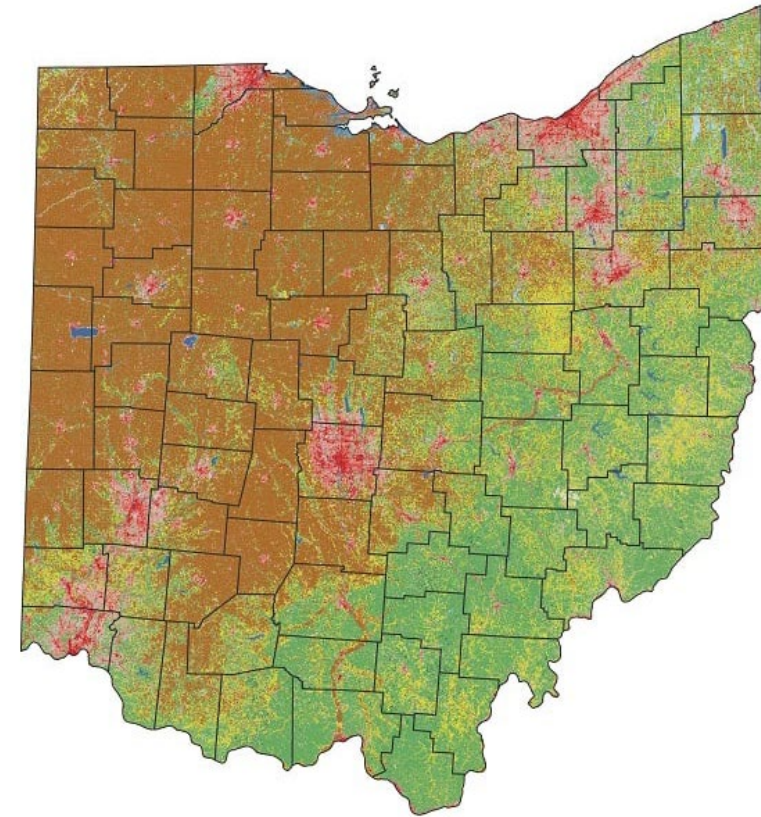
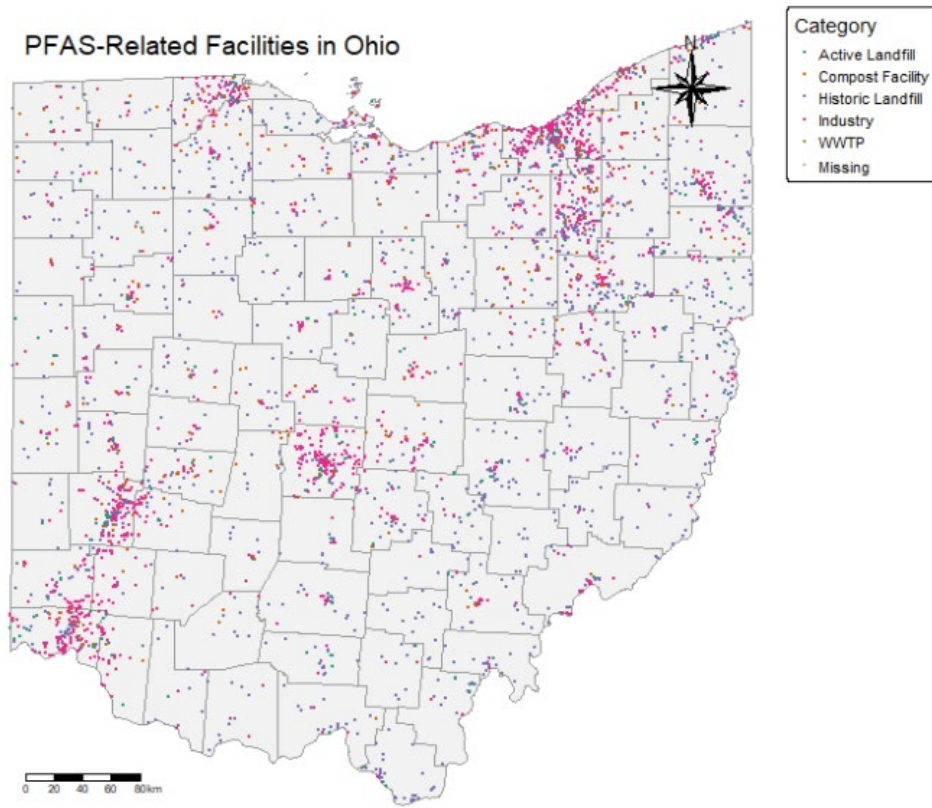
# In the context of food, the issue is broader than drinking water contamination

- Irrigation water → plant uptake
- Soils → plant uptake
- Livestock water and feed
- Biomagnification in aquatic species
- ...





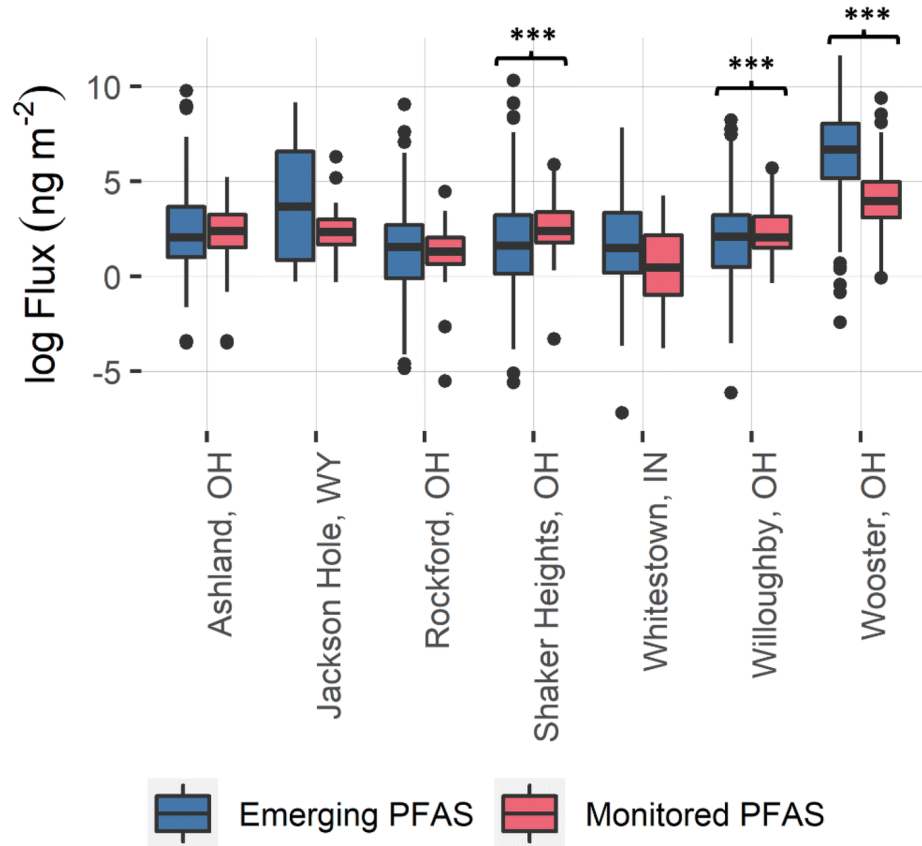
# There are many agricultural lands in Ohio that may be impacted by any PFAS air emissions



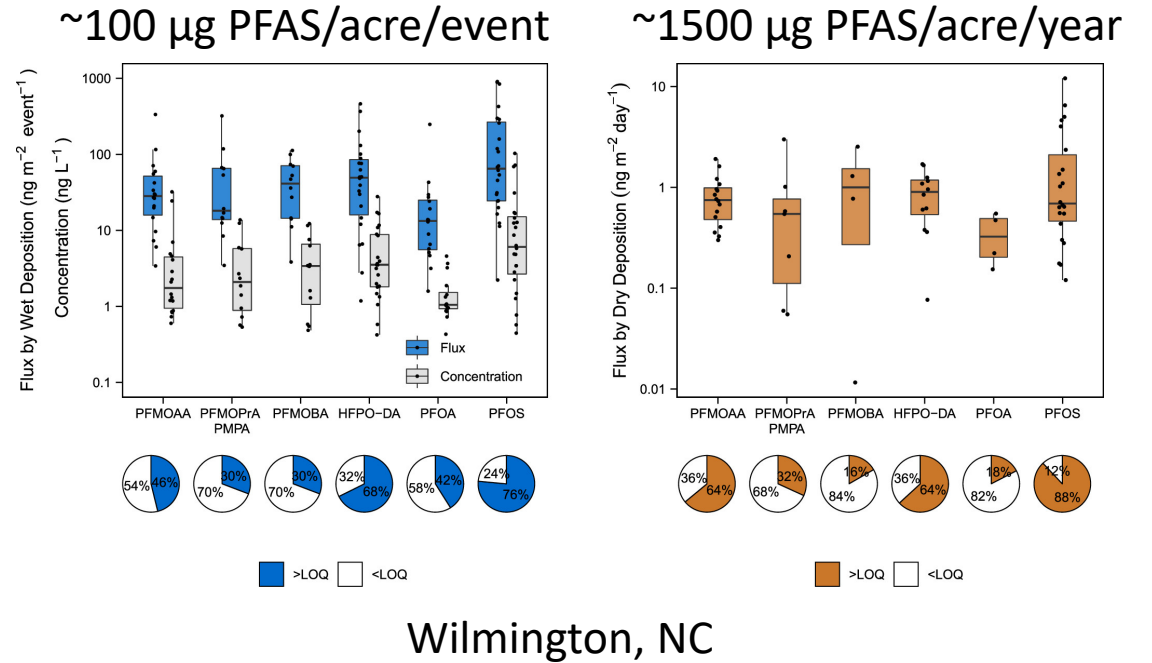
**Key**  
Brown: Cultivated crops  
Green: Forest  
Gold: Hay/pasture  
Red: Developed



# PFAS deposition rates are fairly consistent across locations and species



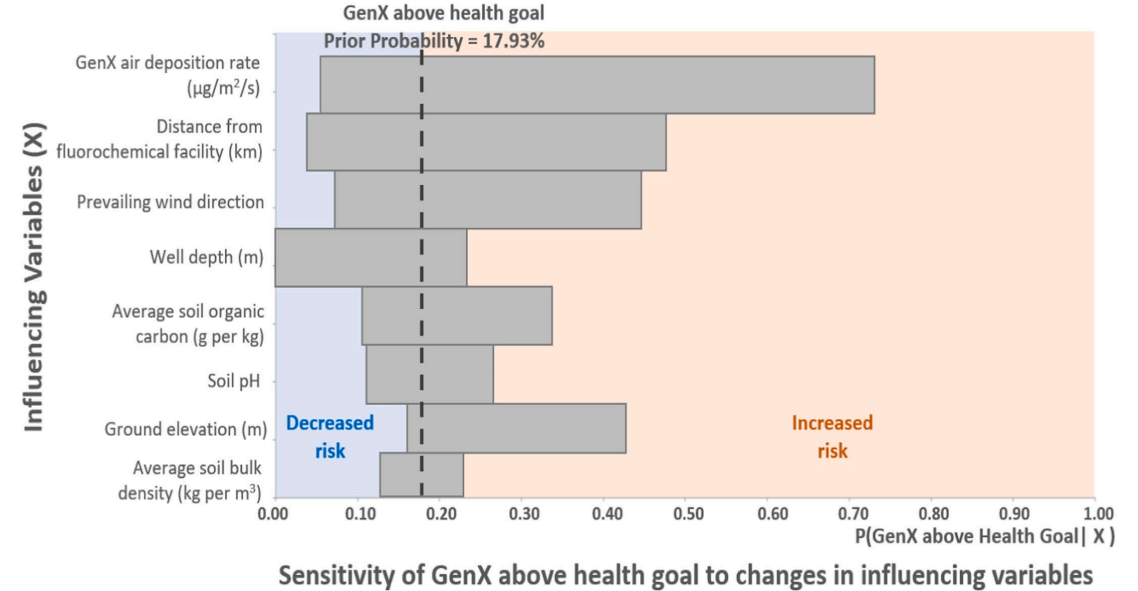
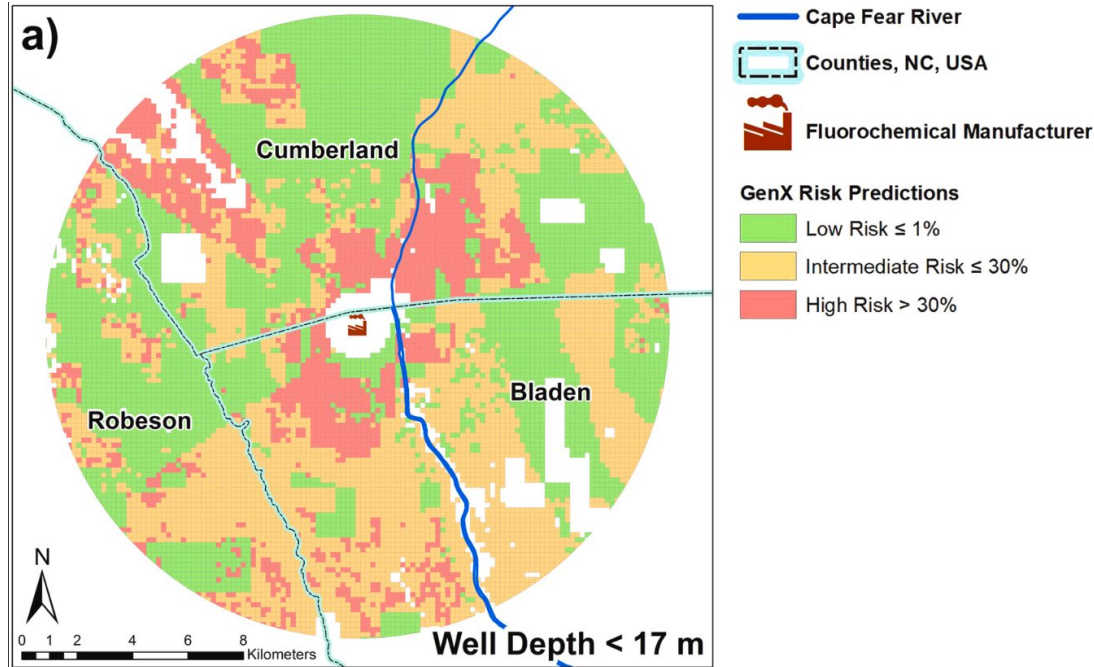
Kim et al. (*Environ. Sci. Proc. Imp.*, 2023)



Shimizu et al. (*Environ. Sci. Tech. Letters*, 2021)

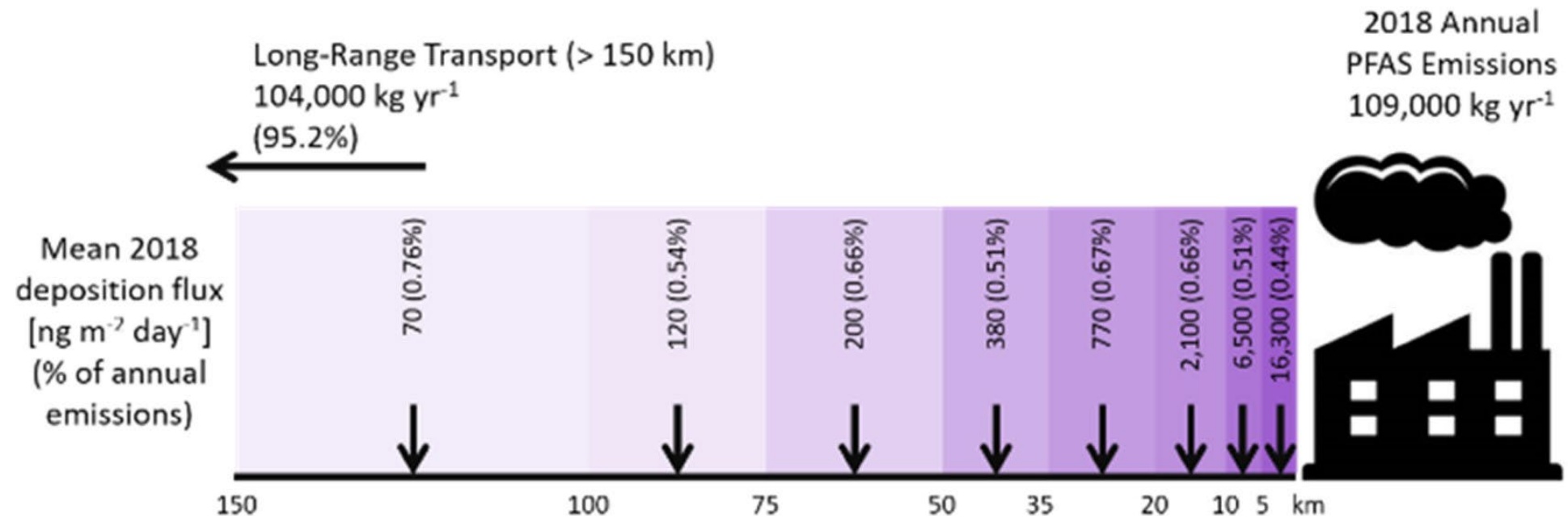


# PFAS deposition rates are the most important contributor to risk of well water contamination



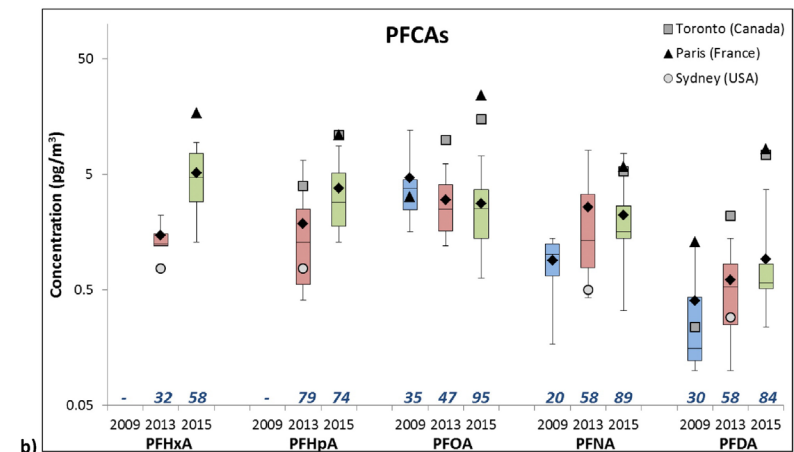
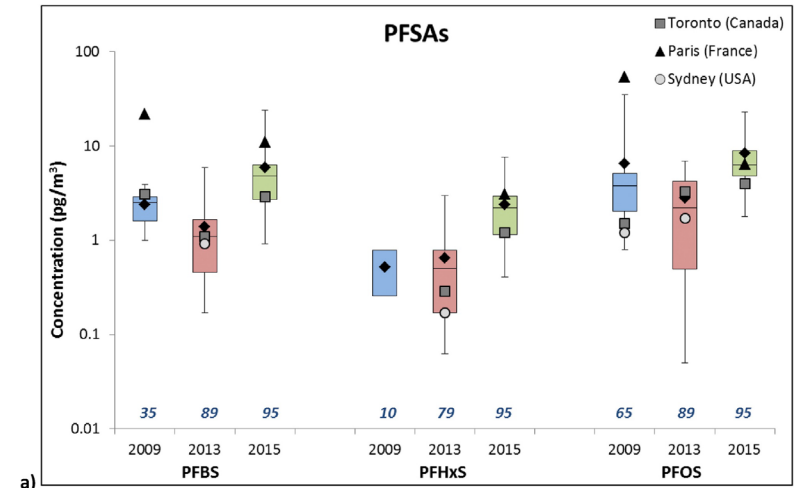
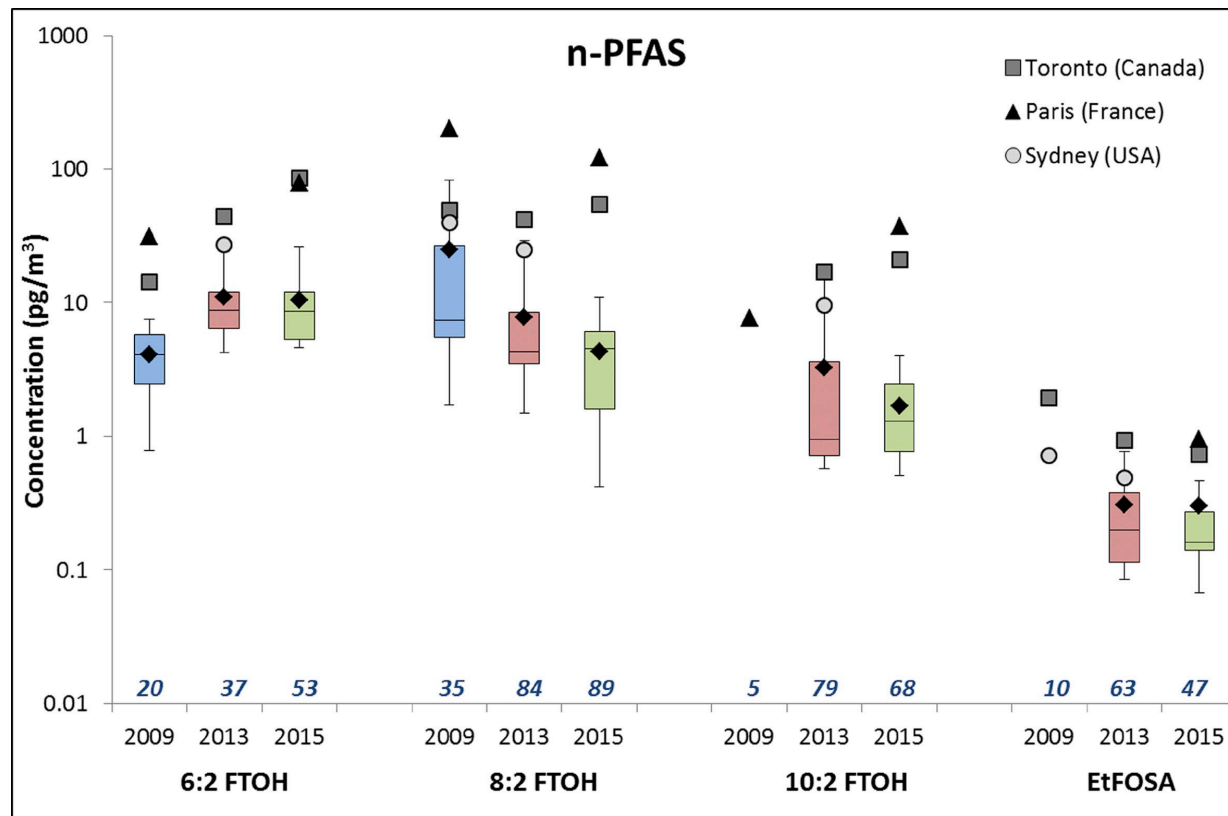


# The majority of PFAS may undergo long-range transport in the atmosphere



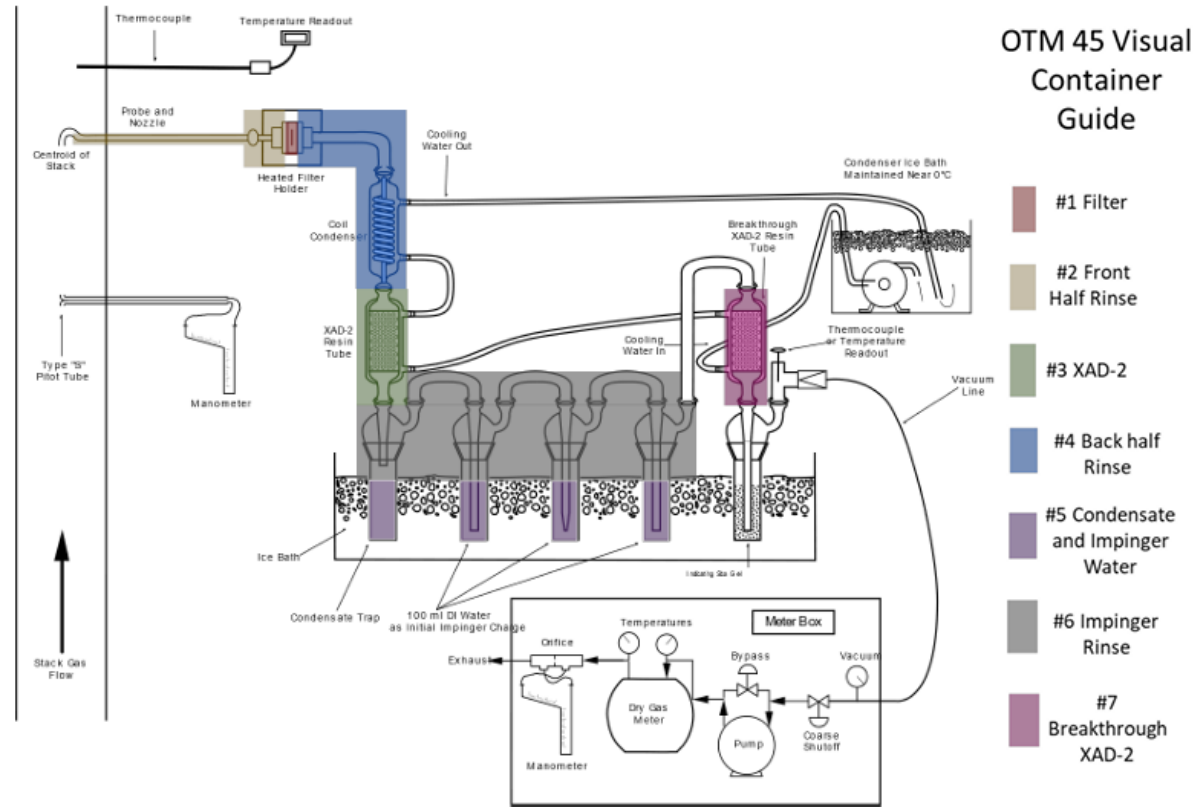


# Background PFAS concentrations are on the order of $\text{pg}/\text{m}^3$



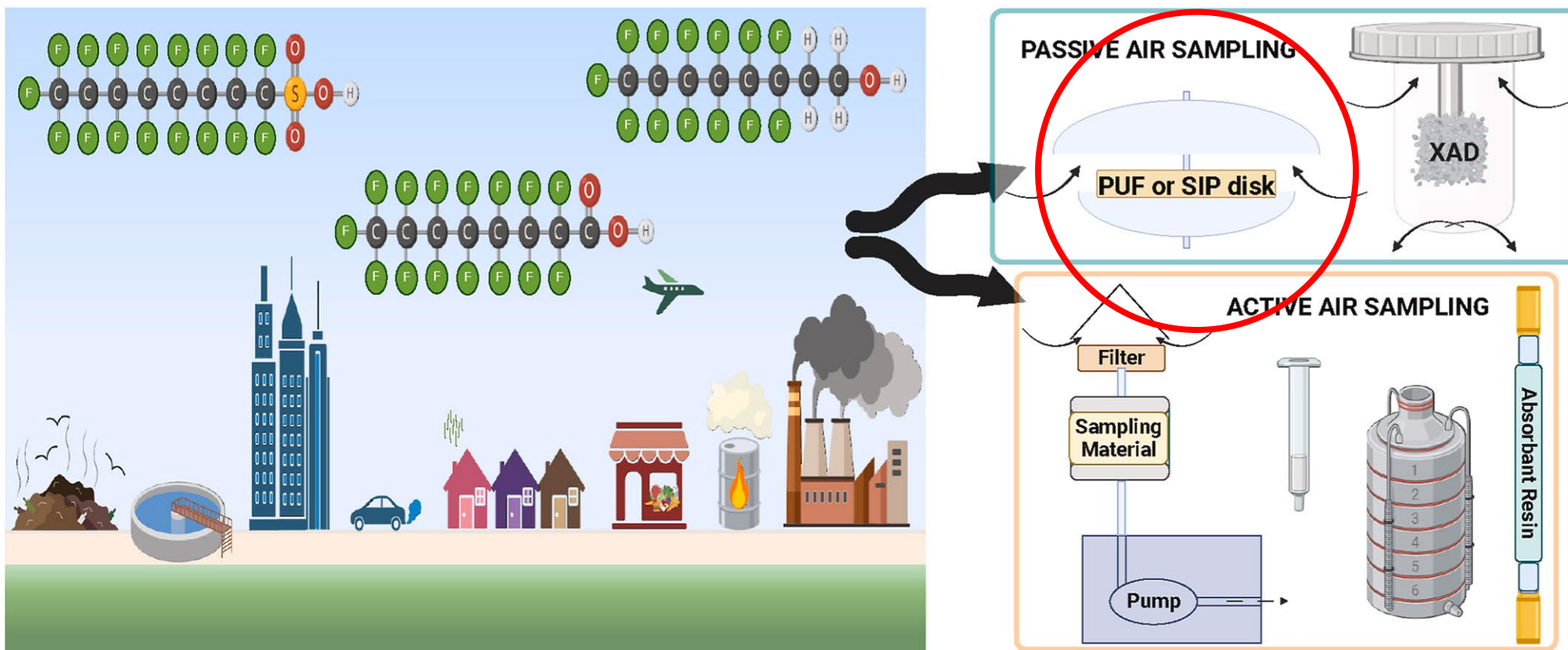


# There is a US EPA method to capture PFAS in air





# Other approaches exist within the atmospheric community





# Various methods exist for quantifying PFAS

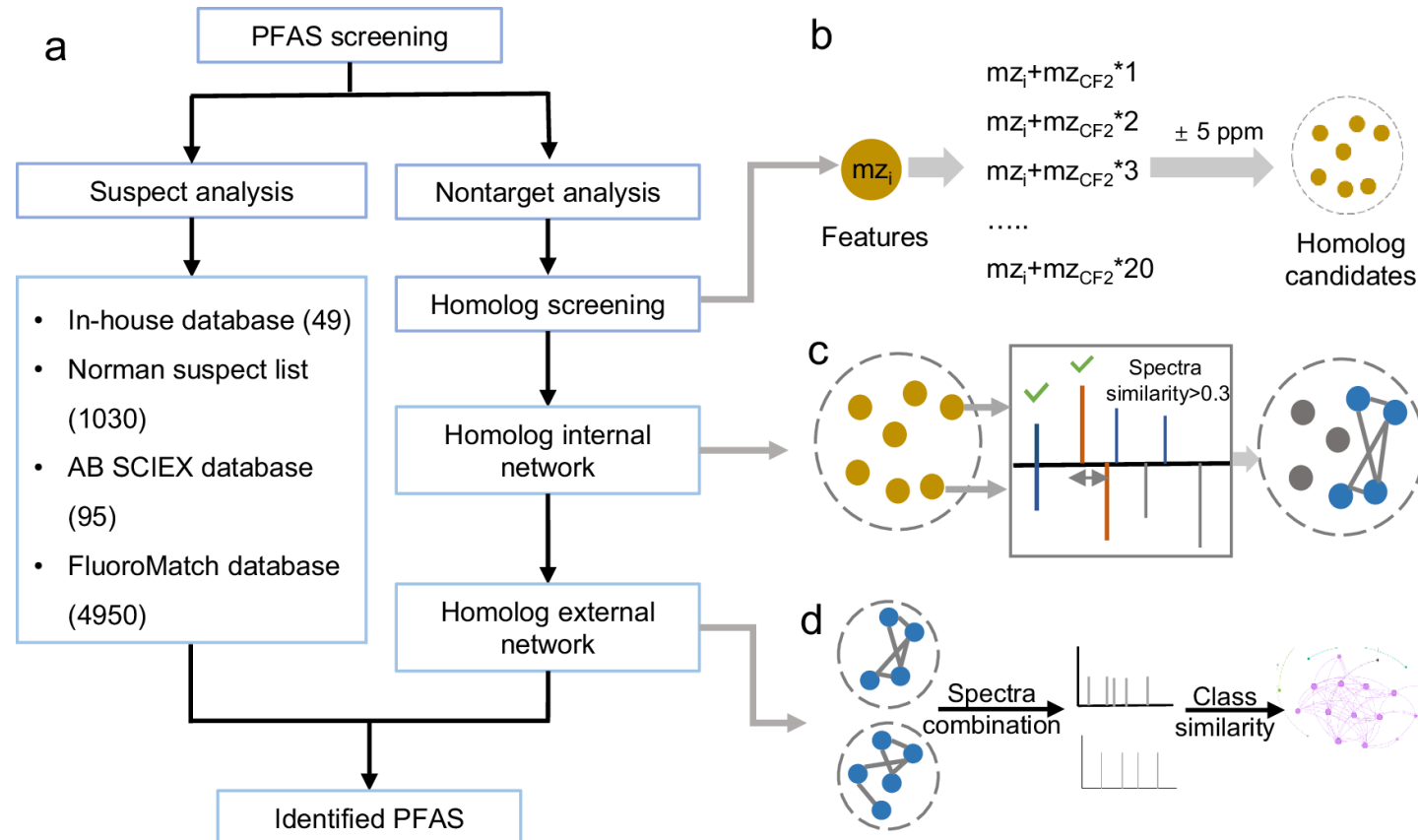
- Combustion ion chromatography – total organic fluorine
- Gas chromatography-mass spectrometry – volatile neutral PFAS
- Liquid chromatography-mass spectrometry – mainly ionic PFAS
- With traditional MS methods, we can only detect what we know – and there are >10,000 to millions of PFAS depending on how these are defined

PFAS Chemicals*	PFOA	PFOS	GenX	PFBS	PFHxS	PFNA
Parts per trillion (ppt)						
New 2024 Action Levels	4.0	4.0	10	2,000**	10	10
Previous 2020 Ohio Action Levels	>70 single or combined with PFOS	>70 single or combined with PFOA	>700	>140,000	>140	>21

\*PFOA (Perfluorooctanoic Acid), PFOS (perfluorooctane Sulfonate), GenX (HFPO dimer acid), PFBS (perfluorobutanesulfonic acid), PFHxS (perfluorohexane sulfonic acid), and PFNA (perfluorononanoic acid).

\*\*Health Based Water Reference Concentration (U.S. EPA 2023)

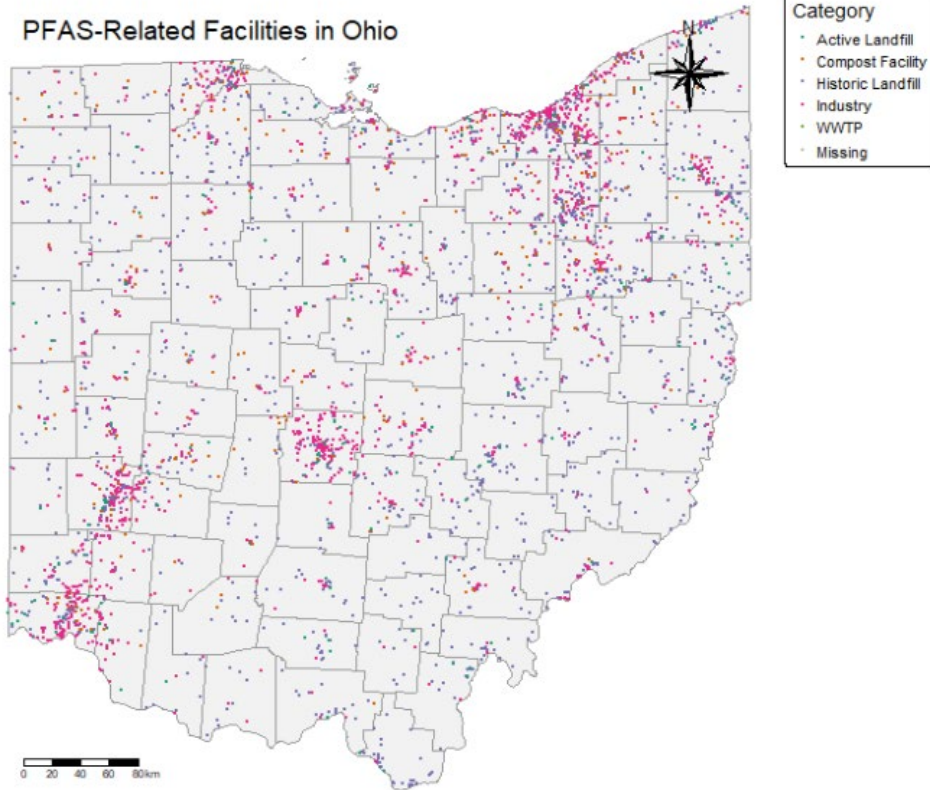
# Identifying unknown PFAS is complex





# We still lack a complete understanding of which PFAS are emitted from what sources

PFAS-Related Facilities in Ohio



Industry branches

Aerospace (7)	Mining (3)
Biotechnology (2)	Nuclear industry
Building and construction (5)	Oil & gas industry (7)
Chemical industry (8)	Pharmaceutical industry
Electroless plating	Photographic industry (2)
Electroplating (2)	Production of plastic and rubber (7)
Electronic industry (5)	Semiconductor industry (12)
Energy sector (10)	Textile production (2)
Food production industry	Watchmaking industry
Machinery and equipment	Wood industry (3)
Manufacture of metal products (6)	

Other use categories

Aerosol propellants	Metallic and ceramic surfaces
Air conditioning	Music instruments (3)
Antifoaming agent	Optical devices (3)
Ammunition	Paper and packaging (2)
Apparel	Particle physics
Automotive (12)	Personal care products
Cleaning compositions (6)	Pesticides (2)
Coatings, paints and varnishes (3)	Pharmaceuticals (2)
Conservation of books and manuscripts	Pipes, pumps, fittings and liners
Cook- and bakeware	Plastic, rubber and resins (4)
Dispersions	Printing (4)
Electronic devices (7)	Refrigerant systems
Fingerprint development	Sealants and adhesives (2)
Fire-fighting foam (5)	Soldering (2)
Flame retardants	Soil remediation
Floor covering including carpets and floor polish (4)	Sport article (7)
Glass (3)	Stone, concrete and tile
Household applications	Textile and upholstery (2)
Laboratory supplies, equipment and instrumentation (4)	Tracing and tagging (5)
Leather (4)	Water and effluent treatment
Lubricants and greases (2)	Wire and cable insulation, gaskets and hoses
Medical utensils (14)	



# Thank you!

Andy May

[may.561@osu.edu](mailto:may.561@osu.edu)