



Per- and Polyfluoroalkyl Substances (PFAS) Emergent Contaminant Issues in Michigan

John M. Cuthbertson

Dorin Bogdan, PhD

What is an Emerging Contaminant?

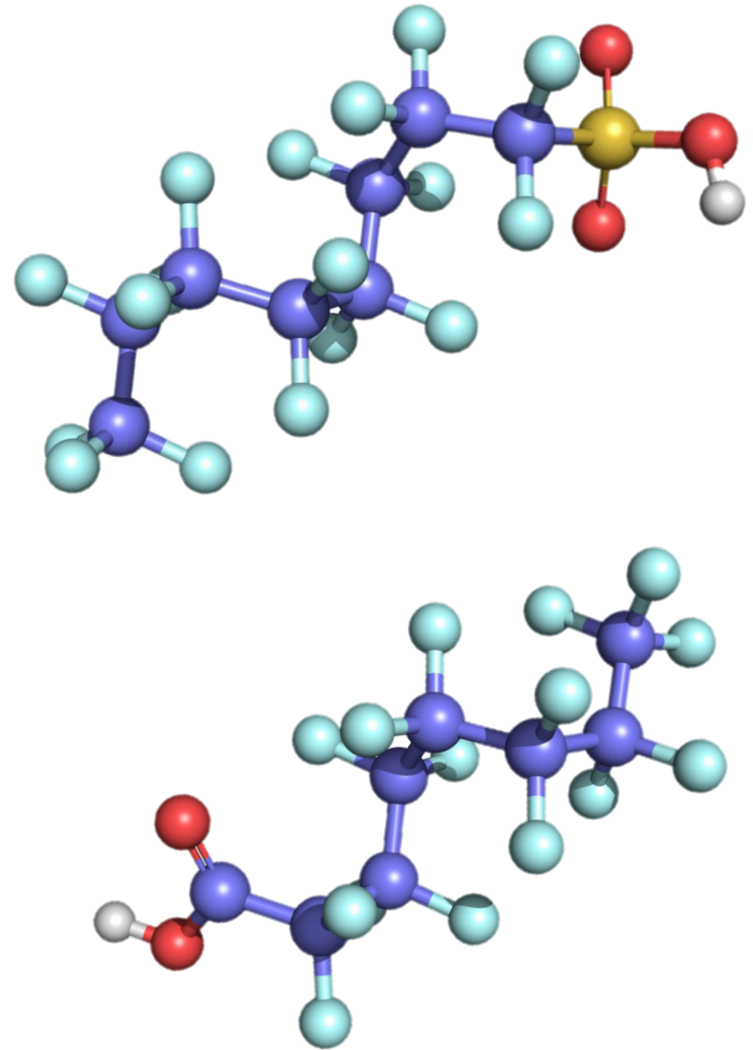
Chemicals and materials that have pathways to enter the environment and present real or potential unacceptable human health or environmental risks...

and either

Do not have peer-reviewed human health standards

or

Standards/regulations are evolving due to new science, detection capabilities or pathways



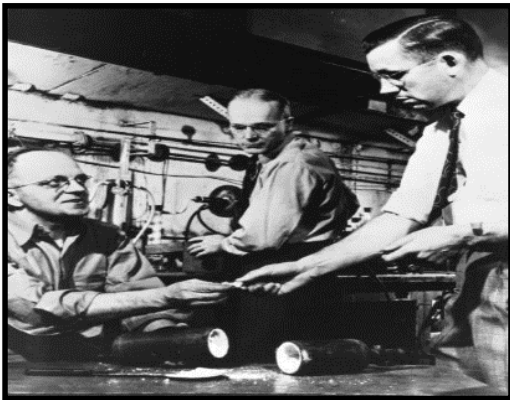
PFAS Development....

1930's

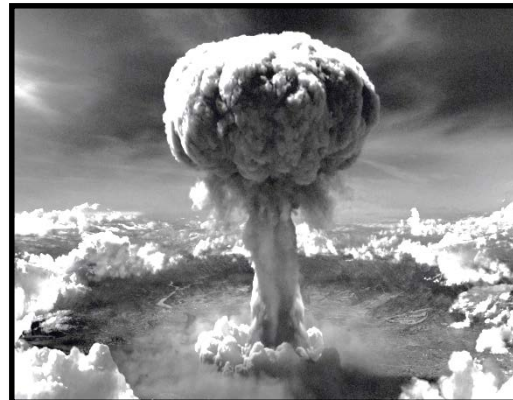
1940's

1950's

1960's



**Teflon accidentally
discovered in 1938**



**Teflon used in the
Manhattan Project for
the development of the
atomic bomb**



**Consumer and industrial
products (Polymers)**



**Aqueous Film Forming
Foam (AFFF) is
developed**

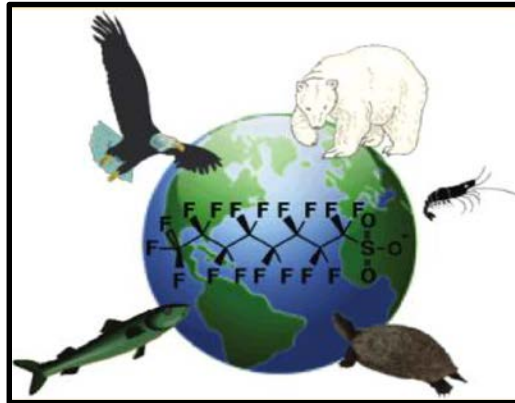
... and Evolution

1970's



**Use of PFAS
significantly expands
in different industries**

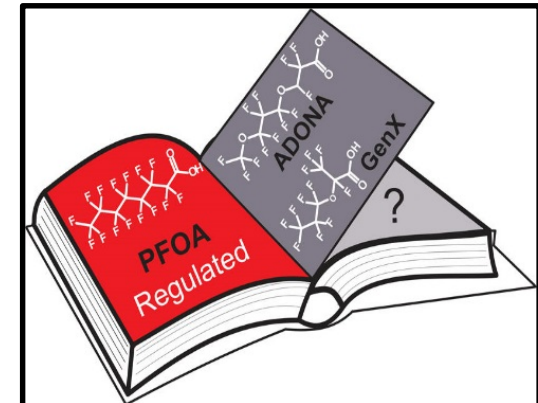
2000's



**Global distribution of certain
PFAS in biota**

Voluntary phase out of products

Current



**Increased public scrutiny
Changing regulatory climate
Lawsuit settlements
Development and use of new PFAS**

Terminology Evolution: PFCs vs. PFAS

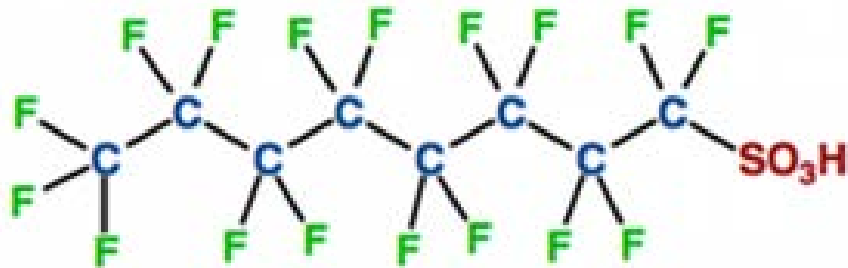
The terminology and classifications of these compounds have evolved

- Perfluorinated Compounds (PFCs) – **Past**
- Per- and Polyfluoroalkyl Substances (PFAS) - **Current**



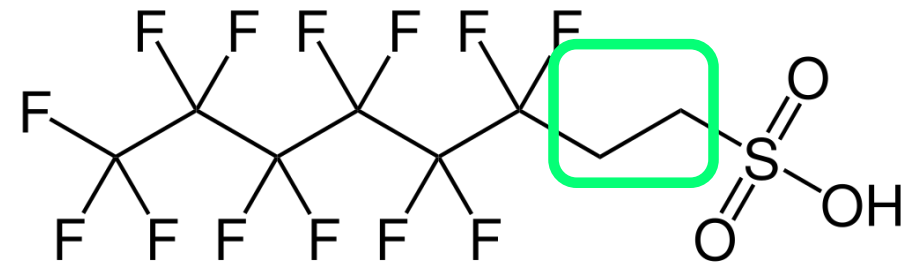
Perfluorinated

All carbon atoms fully fluorinated



Polyfluorinated

Some carbons are not fully fluorinated

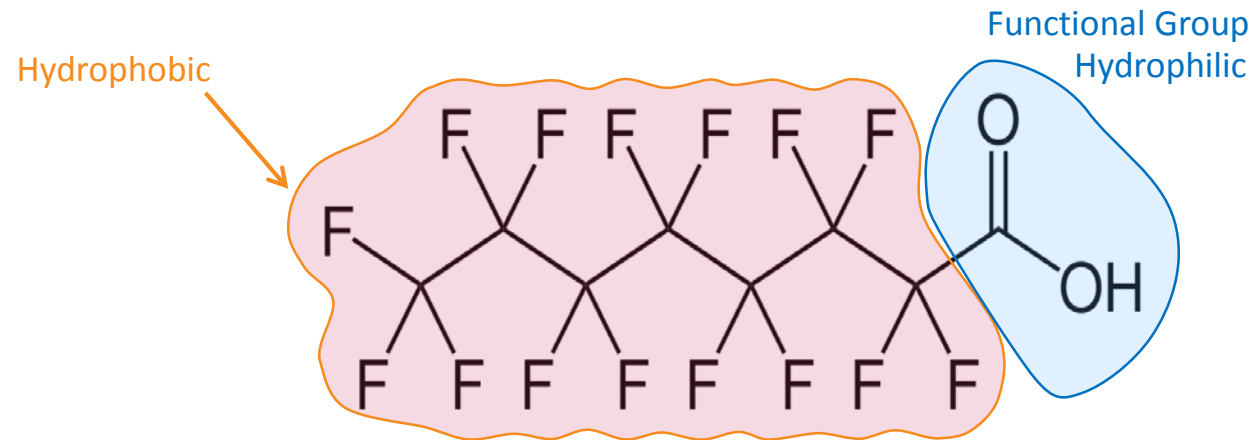


Chemical Properties

“Per” – All of the C-H groups are replaced by C-F

Carbon-fluorine bonds

- Very strong, inert
- Resistant to thermal, chemical, and biological degradation
- Surfactant, reduce surface tension
- Hydrophobic and oleophobic (repel water and oil/fat/grease)



PFAS Chemical Enhancement

1967 – USS Forrestal fire (Protein Foam)



1978 – DC-10 Crash (AFFF – PFAS Foam)



Industrial Use of PFAS



Aerospace



Apparel



Building and Construction



Chemicals and Pharmaceuticals



Electronics



Oil & Gas



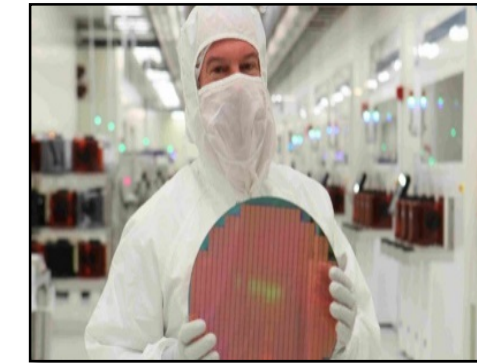
Energy



Healthcare and Hospitals



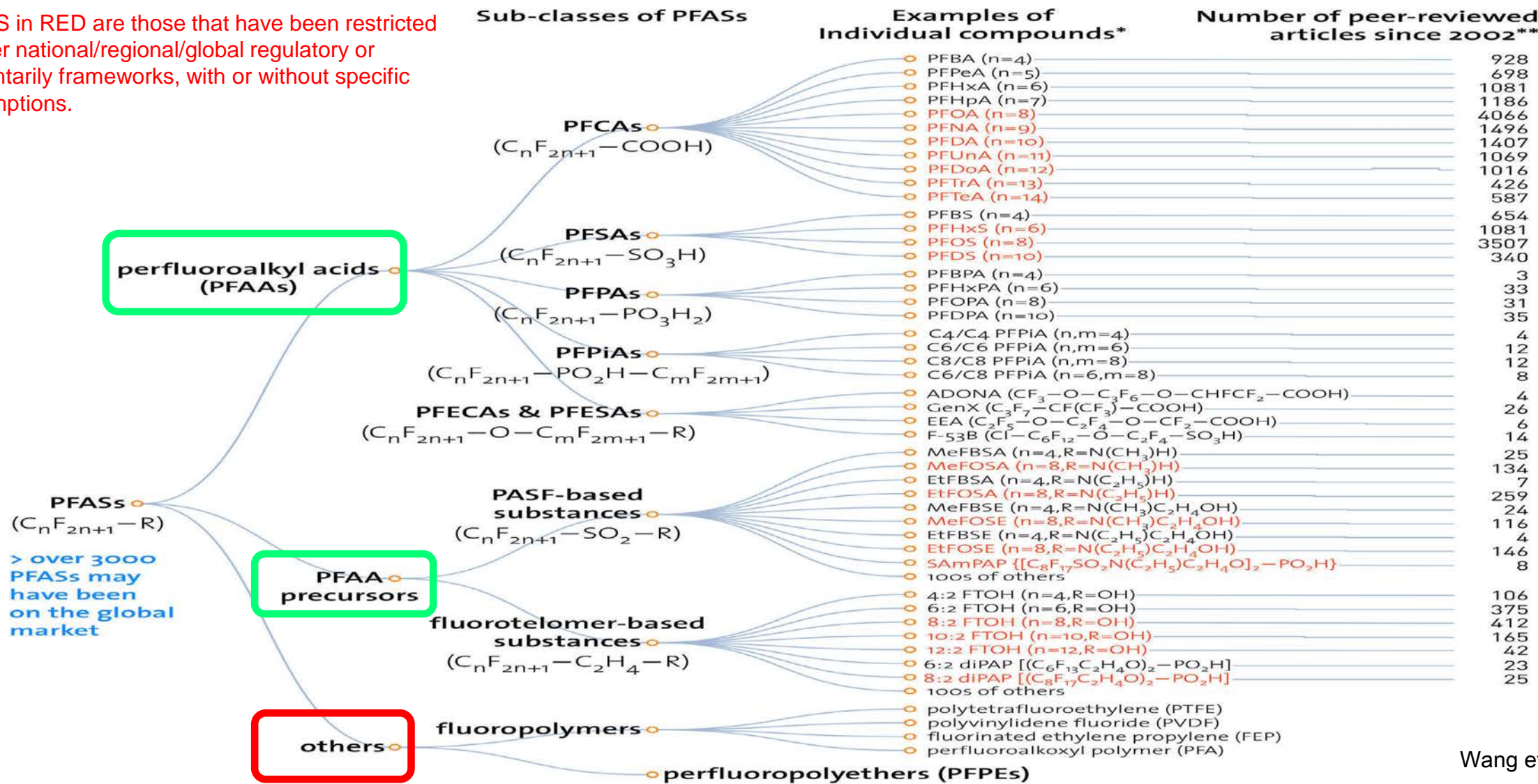
Aqueous Film Forming Foam



Semiconductors

Increased Interest on PFAS

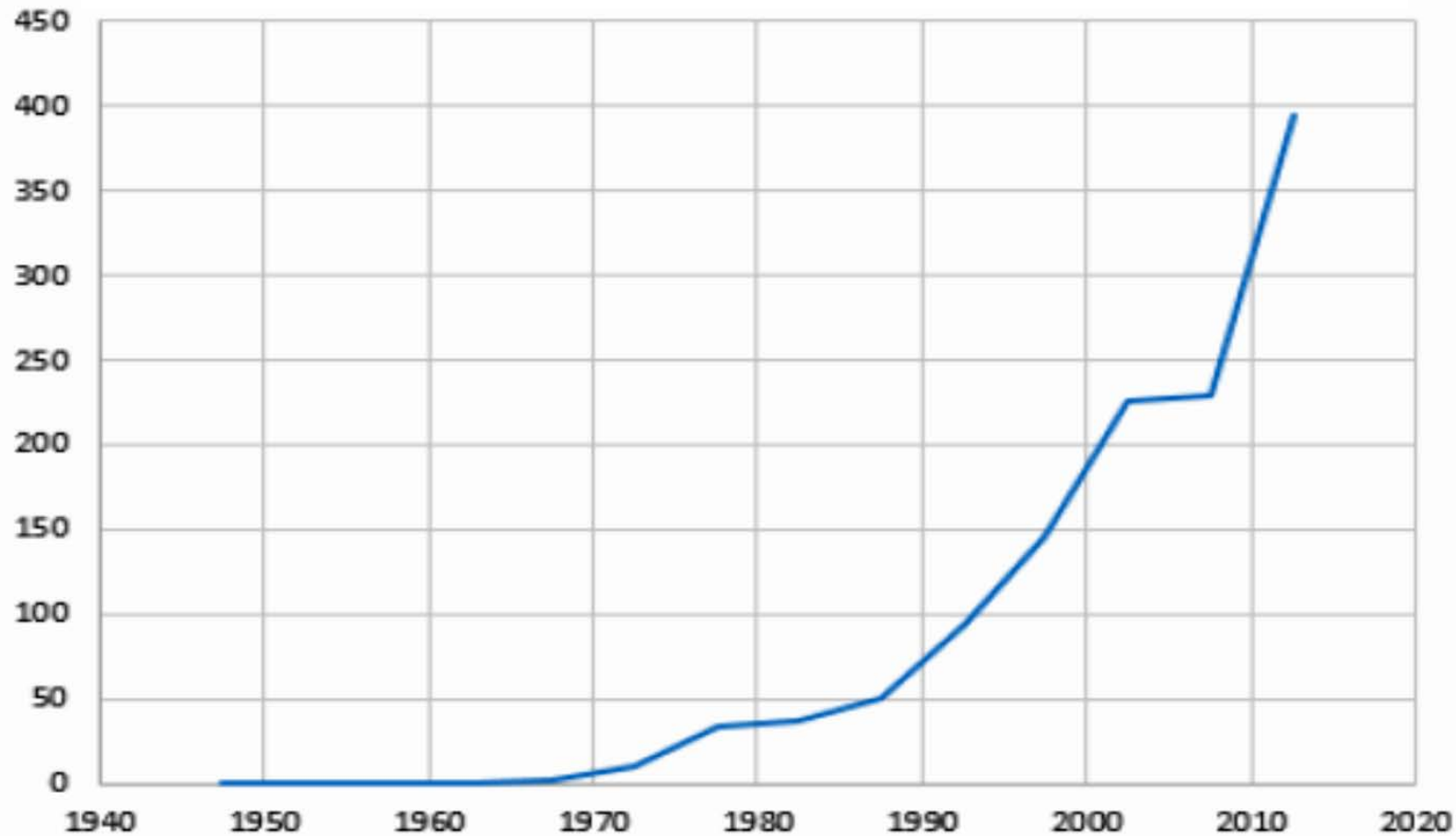
PFAS in RED are those that have been restricted under national/regional/global regulatory or voluntarily frameworks, with or without specific exemptions.



Wang et al., 2017 ES&T

Increased PFAS Applications

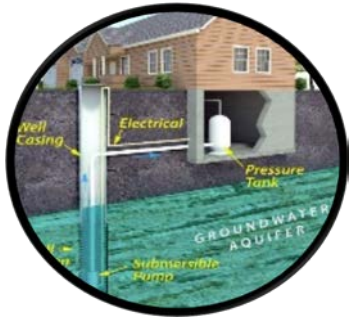
Number of approved patents per month in the USA with “perfluoro” in the patent text



Exposure and Potential Health Effects

Primary human exposure pathways

Drinking Water



Dietary ingestion



Wide range of observed effects:

- Endocrine/thyroid effects
- Changes in cholesterol
- Liver cell effects
- Decreased body and organ weights
- Tumors

Statewide PFAS Investigations in Michigan

2001 SW Sampling

SWQAS Original

MI/DEQ/WB-05/058

MICHIGAN WATER CHEMISTRY MONITORING
Great Lakes Tributaries

2003 Report

2011 State of Knowledge

DEQ

Perfluorinated Compounds in Michigan

Current State of Knowledge and
Recommendations for Future Actions

Prepared by the Toxics Steering Group Perfluorinated Compounds Workgroup

Members:

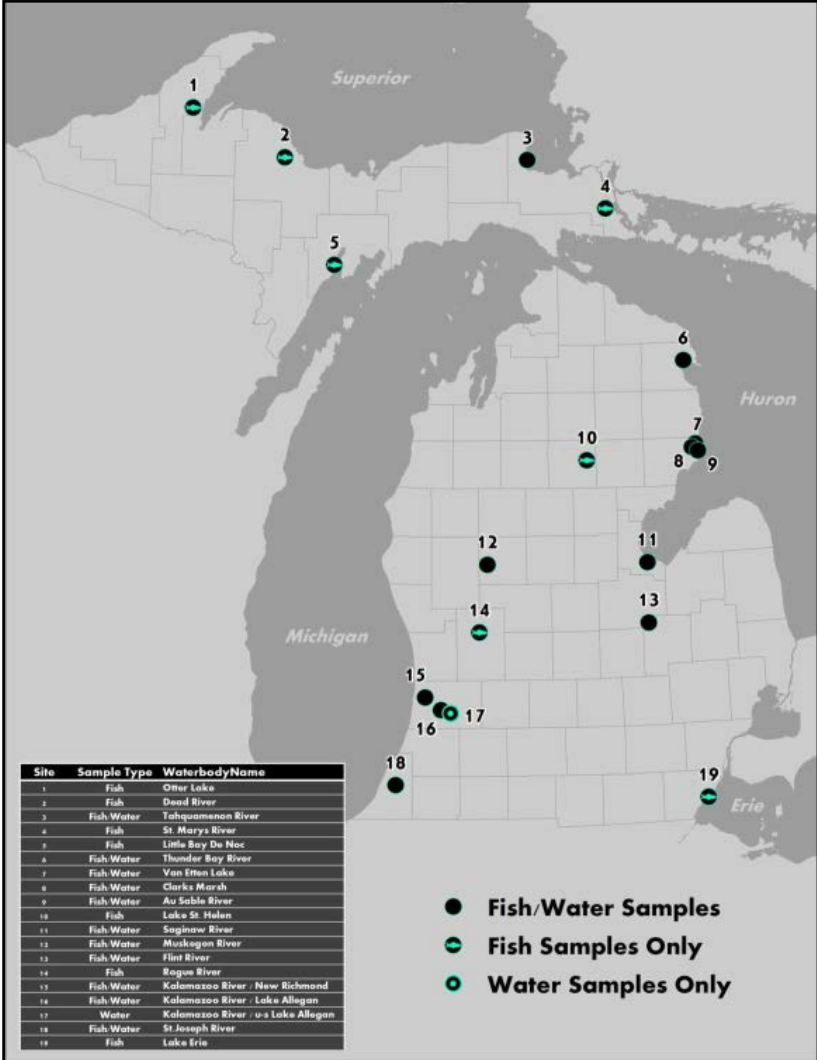
Joy Taylor Morgan, Environmental Quality Specialist, Air Quality Division
Robert Delaney, Geologist, Remediation Division
Mark Henry, Environmental Engineer, Remediation Division
Eric Wildfang, Toxicologist, Remediation Division
Deb Mackenzie-Taylor, Toxicology Specialist, Resource Management Division
Amy Babcock, Toxicologist, Water Resources Division
Michigan Department of Environmental Quality

Christina Bush, Toxicologist
Michigan Department of Community Health

John Buchweitz, Toxicologist
Michigan Department of Agriculture & Rural Development

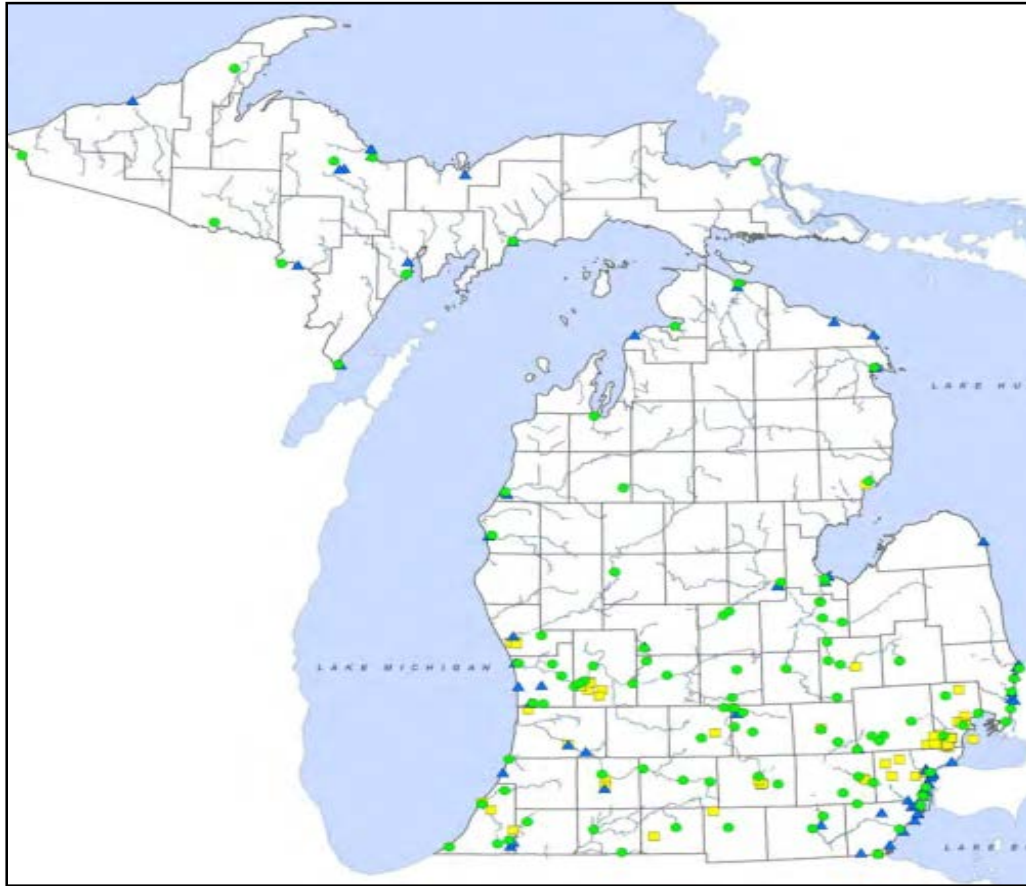
September 1, 2011

2010-2014 SW & Fish Sampling



Potential PFAS Discharges in Michigan

Surface Water



Groundwater



Regulatory Climate



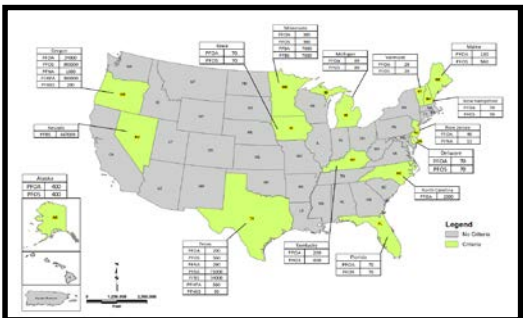
1930's - 2000

- No regulatory or environmental concerns



2001 - 2009

- Initial environmental concerns documented
- US EPA Provisional Health Advisory (HA)
(PFOA = 400 ppt, PFOS = 200 ppt)



2010 - 2017

- Individual states developing criteria
- US EPA Lifetime HA
(PFOA, PFOS, or PFOA + PFOS = 70 ppt)

PFAS News in Michigan

Elevated Levels of Industrial Chemicals Found in Flint River

State regulators say they've detected elevated levels of a group of toxic chemicals in the Flint River and its tributaries that apparently came from an industrial facility in the eastern Michigan city of Lapeer.

Oct. 4, 2017, at 6:49 p.m.



Toxic chemicals pollute drinking water near old tannery dump

Updated on October 9, 2017 at 1:00 PM, Posted on August 30, 2017 at 8:00 AM

DEQ doubles size of Grayling water investigation area

Updated on September 20, 2017 at 2:55 PM, Posted on September 20, 2017 at 2:40 PM

Regulatory Direction

Initial

- PFAS manufacturers

Current

- Department of Defense (AFFF)

Next?

- Other AFFF users?
- Landfills, WWTPs?
- End user manufacturers?

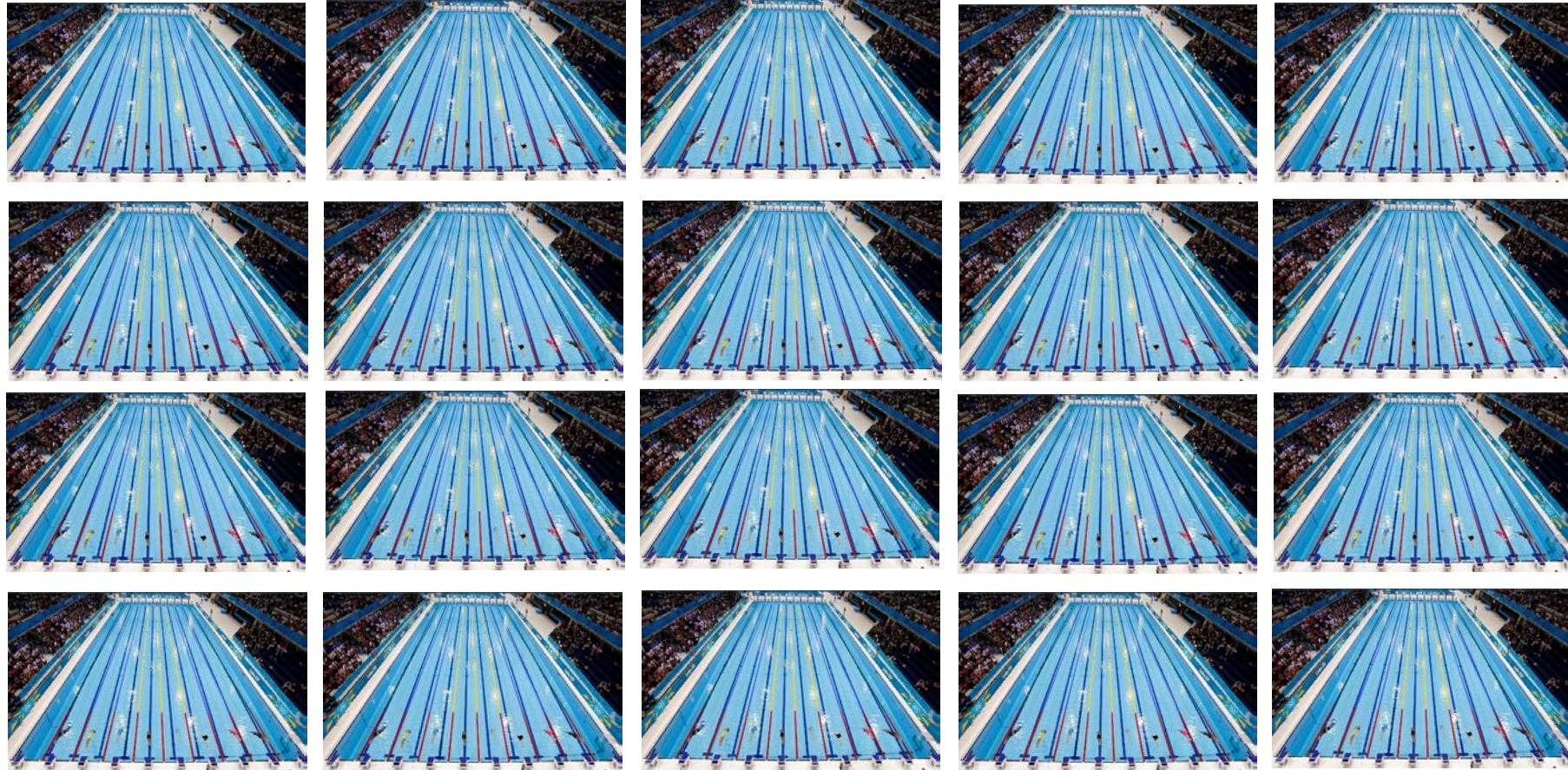
Proposed Michigan Part 201 Criteria

	Residential Drinking Water	Non-Residential Drinking Water	Groundwater-Surface Water Interface
PFOA	70 89	70 280	12,000
PFOS	70 80	70 660	12

Units : Water = ng/L (ppt)

Dealing with Part Per Trillion Levels

**1 ppt = 1 drop (0.05 mL)
in 20 Olympic
Swimming Pools**



Note: 1 Olympic Pool = 660,000 gallons

Challenges

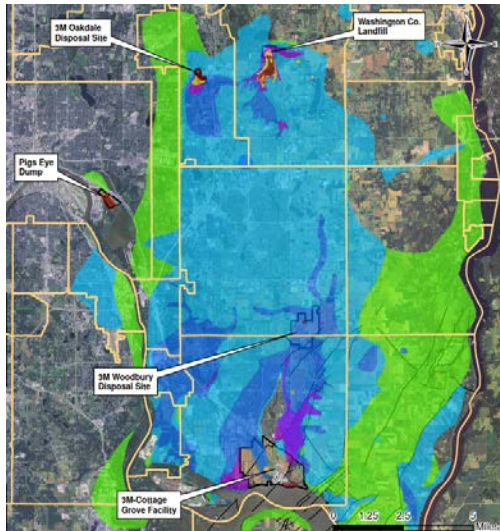
Analytical

- Methodology
- Detection limits
- Cost \$
- Turnaround times



Sampling

- Stringent SOPs
- Cross contamination
- Decon water



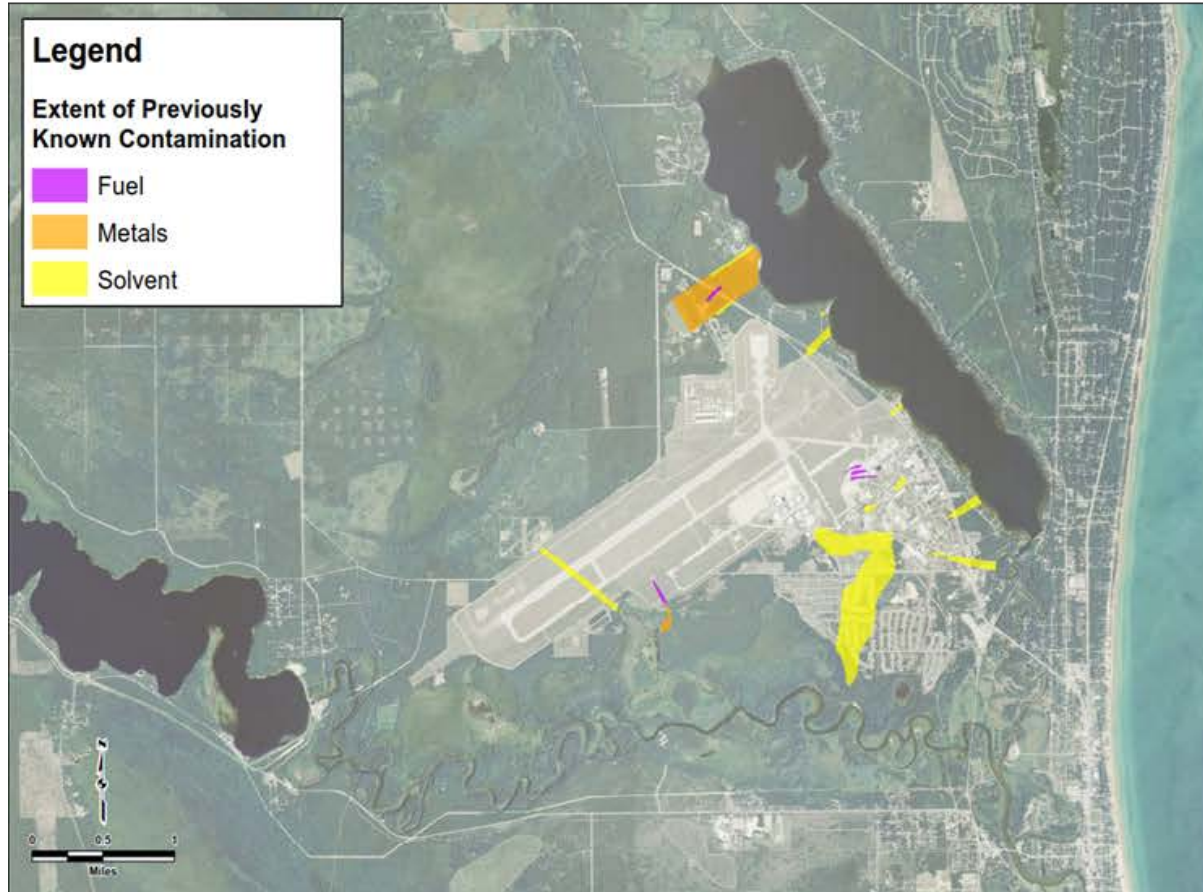
Investigation / Remediation

- Potential sources
- Widespread
- Treatment options
- Potential re-opener

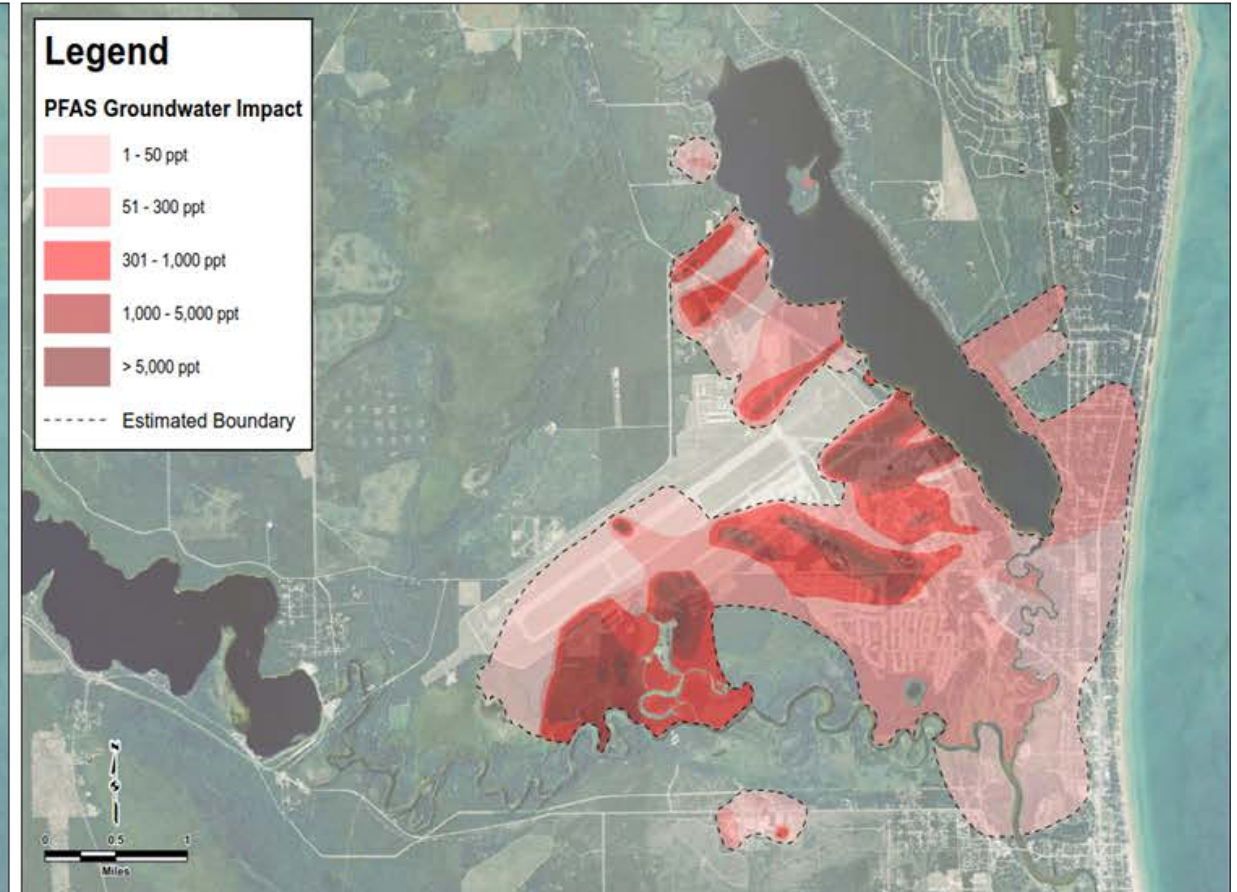


Potential Re-Opener

Extent of Non-PFAS Impact



Extent of PFAS Impact



Key Take Away Points

Unlike contaminants we're familiar with

- Widespread / mobile
- Potential health risks
- Difficult to remediate

Evolving Quickly

- Regulations, policy, laboratory analysis, toxicity, fate & transport, treatment technologies are evolving quickly

Other Considerations

- Media / Residents / Public perception





Thank You!

John M. Cuthbertson
Midwest PFAS Practice Lead

- Grand Rapids, MI
- (616) 481-4009
- john.cuthbertson@aecom.com

Dorin Bogdan, PhD
PFAS Technical Practice Group Leader

- Grand Rapids, MI
- (616) 516-5995
- dorin.bogdan@aecom.com