

# PERFLUORINATED ALKYL SUBSTANCES (PFAS): AN OVERVIEW

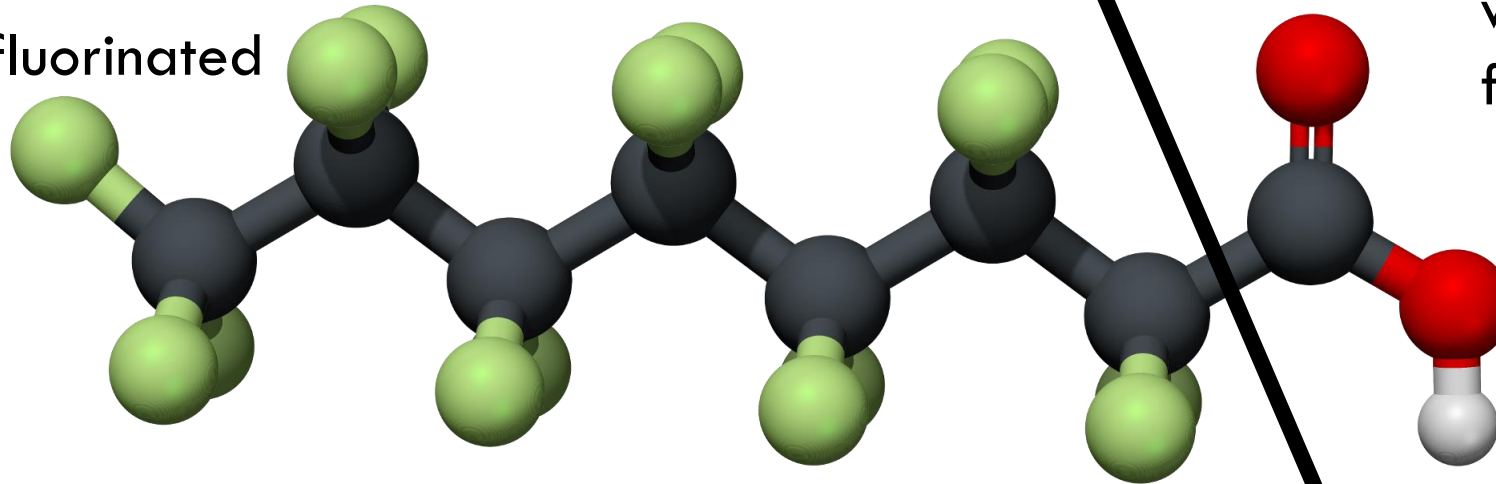
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# WHAT ARE PFAS?

- **Hydrophobic** fluorinated carbon chain
- Full/partial carbon
- Per/polyfluorinated



**Hydrophilic**  
variable  
functional group

Lowers surface tension and enhances spreading • High chemical and thermal stability (C-F bonds) • Very useful compounds •

Variations

- Length
- Linear/branched

# NAMING CONVENTIONS: ACRONYMS GALORE

PFSA<sub>s</sub>

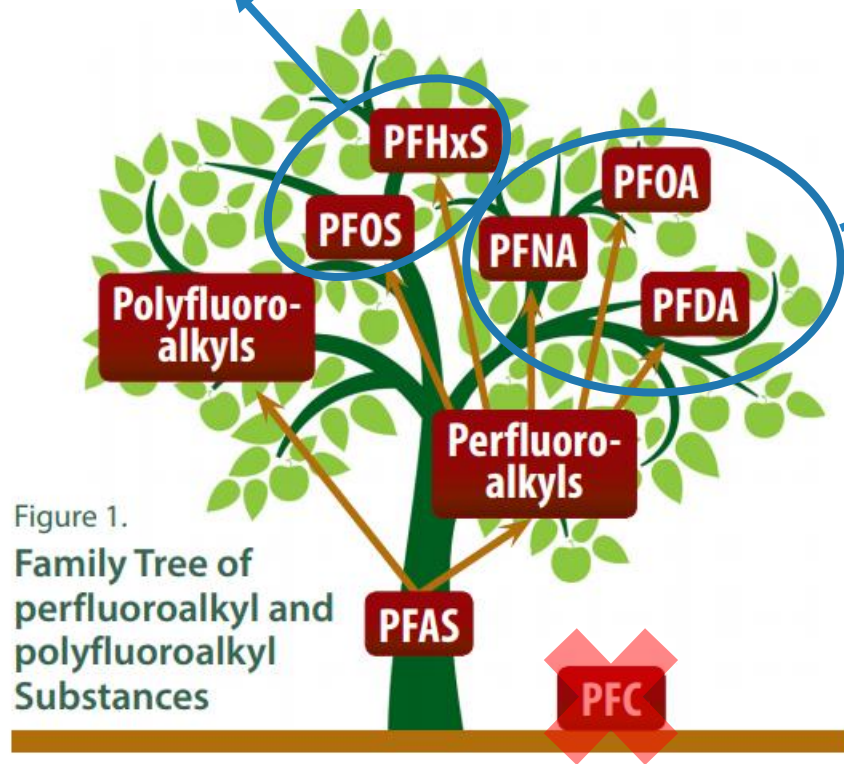


Figure 1.  
Family Tree of  
perfluoroalkyl and  
polyfluoroalkyl  
Substances

PFCAs

FOSEs

PFECAs

FOSAs

FTSAs

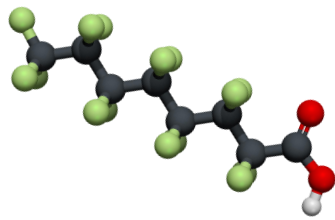
PFESAs

FTOHs

Source: ATSDR

# A BRIEF HISTORY OF PFAS

1940s	1950s	1960s	1970s	1980s	1990s	2000s
Initial production of PFOS and PFOA begins for use in nonstick coatings	Use of PFOA in stain and water resistant coatings	PFOA used in creation of AFFFs	Waterproof fabrics are popularized, initial production of PFNA and fluorotelomers begins	PFNA used for architectural resins, fluorotelomers are used in firefighting foams		U.S. begins to reduce production of PFOA and PFOS, main production method changes from ECF to telomerization



## WHY ARE WE SUDDENLY CONCERNED ABOUT PFAS?

OCCURRENCE: PFAS IN THE BLOOD AND URINE OF PEOPLE: **NOW MORE WIDESPREAD IN WATER THAN THOUGHT**

NUMEROUS EXPOSURES: PFAS ARE USED IN HUNDREDS OF PRODUCTS, FOUND IN DRINKING WATER AND ENVIRONMENTAL CONTAMINATION

GROWING NUMBERS: MORE THAN 4,700 PFAS EXIST AND MORE ARE BEING CREATED

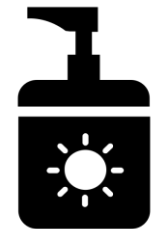
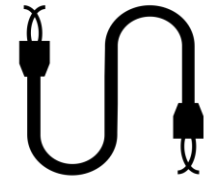
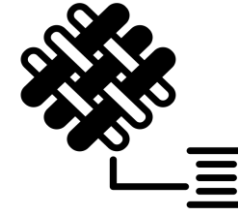
PERSISTENT: PFAS REMAIN IN THE ENVIRONMENT FOR AN UNKNOWN AMOUNT OF TIME AND MAY TAKE YEARS TO LEAVE THE BODY.

BIOACCUMULATION: DIFFERENT PFAS CHEMICALS MAY ENTER THE FOOD CHAIN IN VARIOUS WAYS, GRADUALLY ACCUMULATING AND REMAINING IN A BODY OVER TIME—A PROCESS DUE TO MORE INTAKE THAN EXCRETION OF THE CHEMICALS.

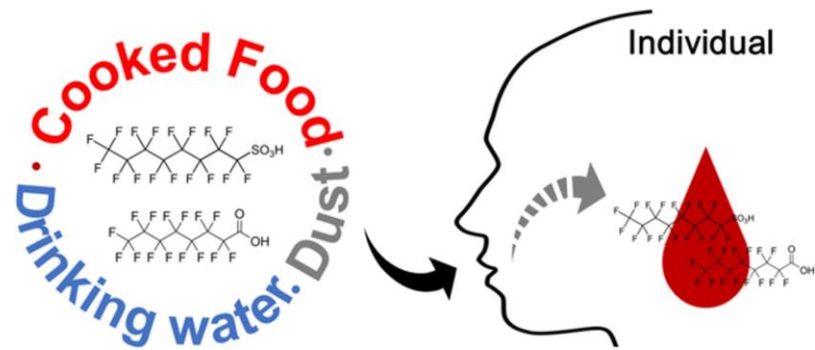
**HEALTH IMPACTS: NEW STUDIES REVEAL POTENTIAL DEVELOPMENTAL HEALTH IMPACTS AT 12 PPT – LOWER THAN PREVIOUSLY THOUGHT**

# WHERE ARE THEY USED?

- WATER AND OIL REPELLENCE
  - TEXTILES
  - PAPER PRODUCTS
  - PACKAGING
  - CARPETS
  - LEATHER
- EMULSIFIERS IN FLUOROPOLYMER PRODUCTION
  - NONSTICK COOKWARE COATINGS
  - CLOTHING MEMBRANES
  - PERSONAL CARE PRODUCTS
  - FIRE/CHEMICAL RESISTANT TUBING
  - ELECTRICAL WIRE CASING
- AQUEOUS FILM-FORMING FOAMS



# HOW ARE PEOPLE EXPOSED



How can I be exposed to

- Drinking contaminated municipal water or private well water
- Eating fish caught from water contaminated
- Swallowing contaminated dust or soil
- Eating food that was packaged with PFAS
- Using consumer products such as non-stick cookware, stain resistant carpeting, and water repellent clothing. (ASTDR)

- WATER

- NEAR CONTAMINATED SITES WHERE HIGH CONCENTRATIONS (MG/LMG/L RANGE) DRINKING WATER CAN ACCOUNT FOR UP TO 75% OF TOTAL PFAS EXPOSURE
- AWAY FROM POINT SOURCES, DRINKING WATER PFAS CONCENTRATIONS APPROXIMATELY 1,000-FOLD LOWER

Hu et al. 2019 references  
Kim et al. 2019

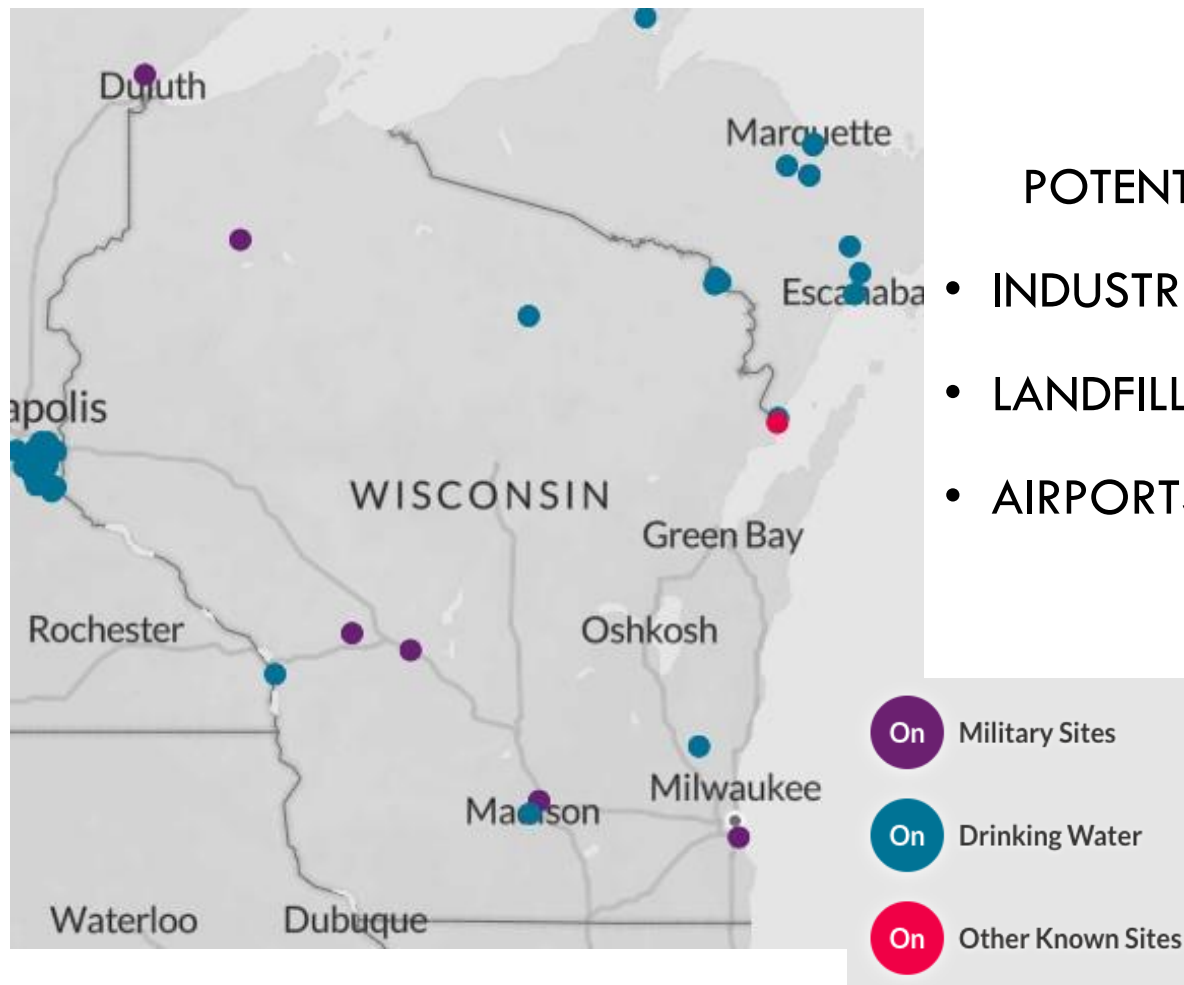
# POTENTIAL HUMAN HEALTH IMPACTS

- REPRODUCTIVE :
  - PREGNANCY-INDUCED HYPERTENSION
  - INCREASED TSH– HYPERTHYROIDISM DURING PREGNANCY
  - DECREASED FERTILITY
  - LOWER BIRTH WEIGHT
- DEVELOPMENTAL
  - DECREASED EFFICACY OF VACCINES, IMMUNE SUPPRESSION
- HEPATIC EFFECTS: INDICATIONS OF LIVER DAMAGE, INCREASED LIPIDS IN LIVER
- CARDIOVASCULAR EFFECTS: HIGHER CHOLESTEROL IN ADULTS AND CHILDREN
- ENDOCRINE EFFECTS: THYROID DISEASE
- CANCERS



# WHERE IS IT FOUND IN WISCONSIN?

- MILITARY SITES (GROUNDWATER ON BASE)
  - FORT MCCOY- 120,000PPT PFOA/PFOS
  - DANE COUNTY AIRPORT- SEE NEXT SLIDE
  - VOLK FIELD- 2,800PPT PFBS, 5,800 PPT PFOA, 20,000PPT PFOS
  - GENERAL MITCHELL AIRPORT- SEE NEXT SLIDE
- TESTED DRINKING WATER (MAX)
  - MADISON- 56PPT TOTAL PFAS
  - WEST BEND- 43PPT PFOA
  - LA CROSSE- 32PPT PFHXS, 140PPT PFOS
  - RHINELANDER- 117PPT PFHXS



# TYCO-ANSUL FIRE PRODUCTS

- INVESTIGATION STARTED LATE 2017
  - 98 GROUNDWATER SAMPLES TAKEN, CONCENTRATIONS RANGING FROM ND TO 1,653 PPT
  - ON-SITE PONDS HAD CONCENTRATIONS RANGING FROM 417-4,620 PPT
  - PRIVATE WELL TESTING SHOWED 11 WITH LEVELS ABOVE 70 PPT, INSTALLATION OF TREATMENT SYSTEMS OFFERED
- WORK PLAN APPROVED BY DNR IN SPRING 2018
  - INCLUDES CONTINUED MONITORING
  - INSTALLATION OF CARBON FILTERS TO MITIGATE RELEASE



# AIRPORT CONTAMINATION

## Test Results:

PFA	Location detected	Maximum Level (ppt) Years tested
PFBS	Groundwater On-base	404 2019
PFHpA	Groundwater On-base	214 2019
PFHxS	Groundwater On-base	135,000 2019
PFNA	Groundwater On-base	53 2019
PFOA	Groundwater On-base	844 2019
PFOS	Groundwater On-base	32,600 2019
PFOS+PFOA	Groundwater On-base	33,046 2019

← Left: General Mitchell

Right: Dane County Regional  
Airport →

Source: WIDNR via  
Environmental Working  
Group

## Test Results:

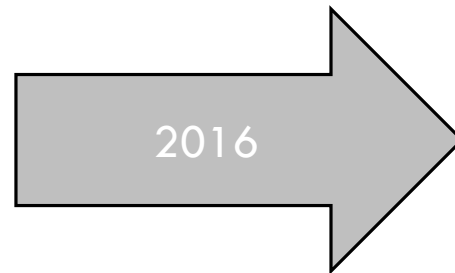
PFA	Location detected	Maximum Level (ppt) Years tested
PFBS	Groundwater On-base	357 2019
PFHpA	Groundwater On-base	294 2019
PFHxS	Groundwater On-base	8,820 2019
PFNA	Groundwater On-base	125 2019
PFOA	Groundwater On-base	528 2019
PFOS	Groundwater On-base	28,400 2019
PFOS+PFOA	Groundwater On-base	28,749 2019

# EPA HEALTH ADVISORY

## LIFETIME HEALTH ADVISORY

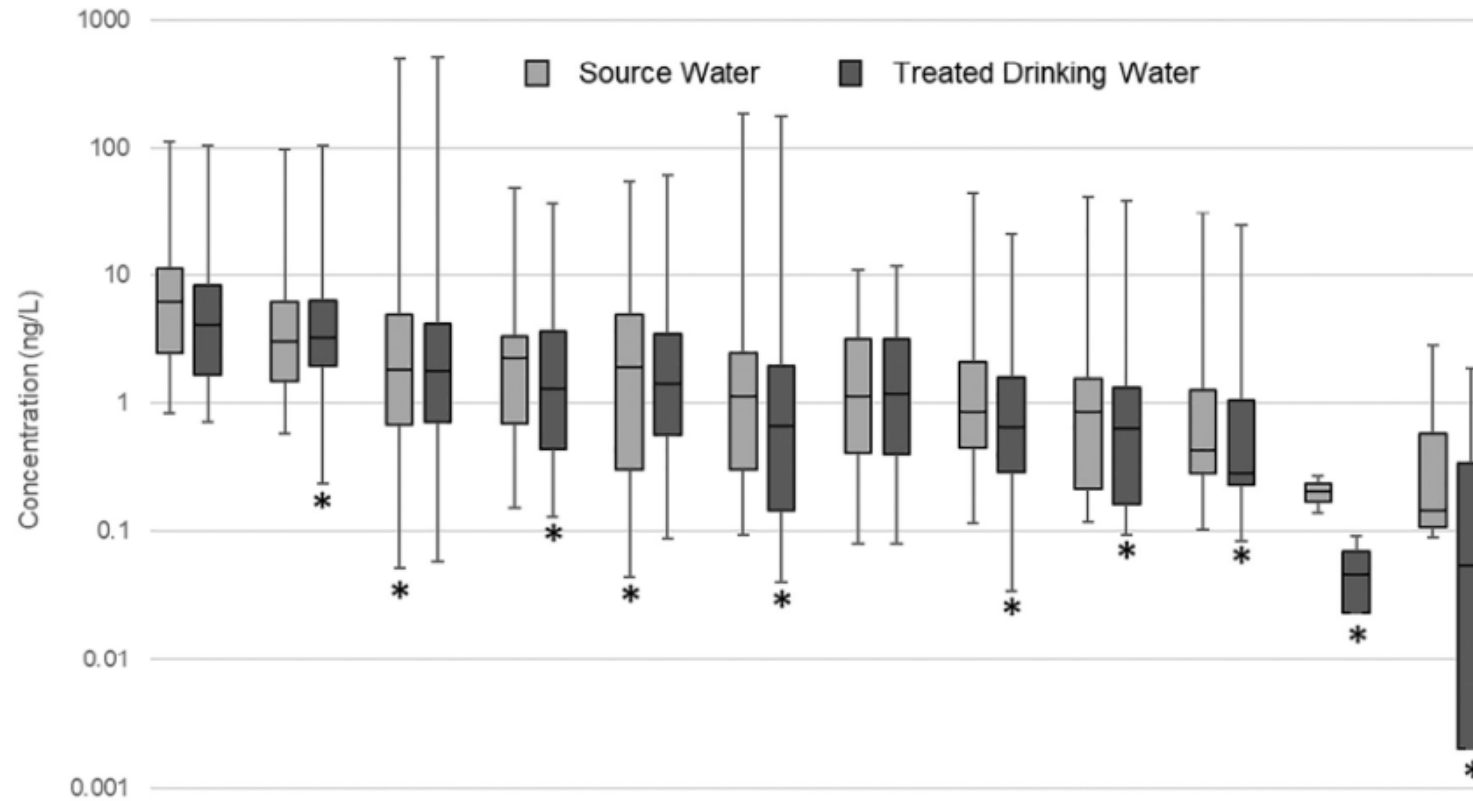
**200** parts per trillion for PFOA

**400** parts per trillion for PFOS



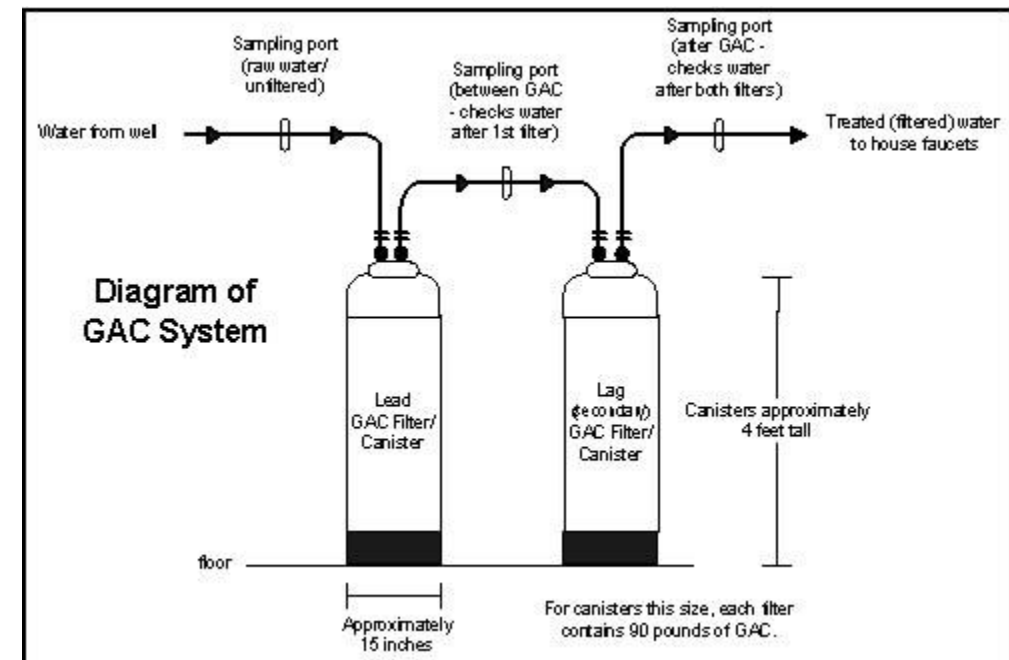
**70** parts per trillion for PFOA and PFOS, separately or in combination

# DRINKING WATER: TREATMENT NOT GREAT AT REMOVING PFAS IN GENERAL



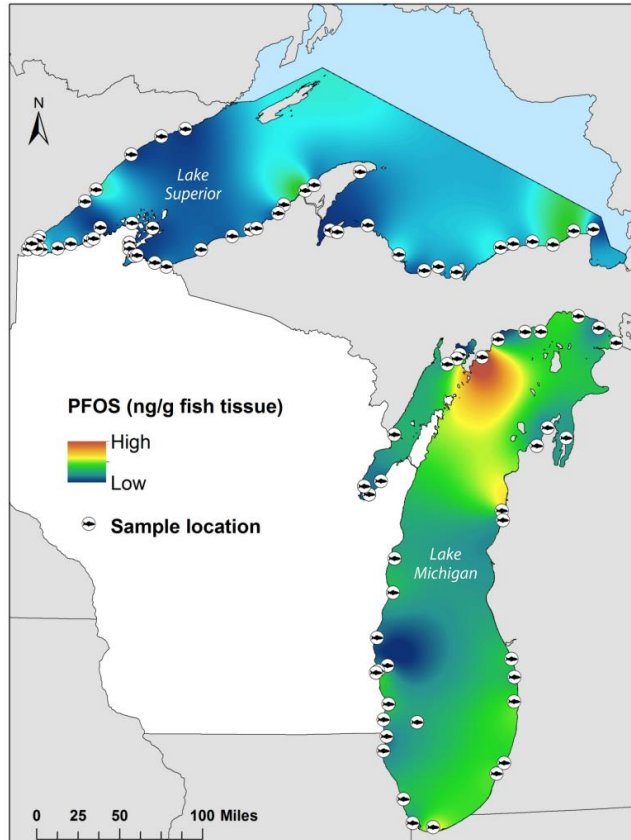
# REMOVAL OPTIONS FROM DRINKING WATER

- ACTIVATED CARBON:
  - WORKS WELL WITH LONGER CHAIN COMPOUNDS, ESPECIALLY WHEN CARBON IS CHANGED OFTEN
  - 70-80% FOR C6-C13 PFAS
  - 60-70% FOR PFOA
  - 14-32% REMOVAL OF SHORT-CHAIN PFAS
- ION EXCHANGE RESINS
  - REMOVAL EFFICIENCIES OF 70-90% FOR C6-C13 PFAS
  - REMOVAL EFFICIENCIES OF 10% FOR PFBA (C3), AND 23% FOR PFPEA (C4)

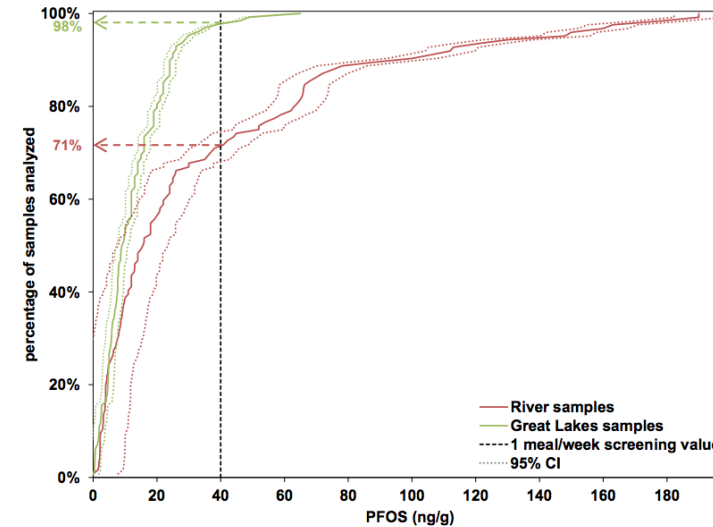


Many options being explored for environmental removal but no conclusions yet.  
Best options: stop using compounds and proper handling of waste

# FISH CONSUMPTION



**Figure 4.** Spatial distribution of PFOS measured in fillets of fish sampled from Lake Michigan and the U.S. waters of Lake Superior. Gradient was interpolated from point measurements in ArcMap 10.1 (ESRI) using the Spline with Barriers tool (Spatial Analyst).



**Figure 5.** Cumulative distribution functions of PFOS in fish fillet samples ( $\pm$  95% confidence interval) from rivers (red) and the Great Lakes (green). Dotted line indicates the Minnesota Department of Health 1 meal/week screening value of 40 ng/g. Two percent of the Great Lakes fillet samples and 29% of river fillet samples contained PFOS in excess of the screening value. All river samples exceeding 40 ng/g came from Mississippi River fish fillets.

Wisconsin DNR evaluated concentrations of PFCs found in 28 fishspecies from 7 river systems and Lakes Michigan and Superior. Great Lakes were generally lower than those sampled from riverine locations, particularly the Mississippi River. PFOS levels in most fish from most locations did not supersede Wisconsin's general statewide advisories or advice already in place due to polychlorinated biphenyl (PCB) concentrations.

# EPA ACTION PLAN: FEBRUARY 2019

- FILL IN MISSING DATA
  - HUMAN HEALTH AND TOXICITY
  - SOURCES AND ENVIRONMENTAL CONCENTRATIONS
  - AIR TRANSPORT
- PROVIDE GUIDANCE
  - CLEANUP
  - HEALTH GUIDELINES
- REGULATORY STEPS
  - LISTING OF PFOS AND PFOA AS HAZARDOUS SUBSTANCES



# STATE POLICIES

State	Limit (ppt)	Compound(s)
California	14;13;70	PFOA; PFOS; Sum PFOA, PFOS (notification level)
Connecticut	70	Sum PFOA, PFOS, PFNA, PFHxS, PFHpA
Massachusetts	70	Sum PFOA, PFOS, PFNA, PFHxS, PFHpA
Minnesota	35;15;47	PFOA; PFOS; PFHxS
New Hampshire	12; 15; 18; 11	PFOA; PFOS; PFHxS; PFNA
New Jersey	14;13;13	PFOA; PFOS; PFNA
North Carolina	140	GenX
Vermont	20	Sum PFOA, PFOS, PFNA, PFHxS, PFHpA

# EFFORTS IN WISCONSIN

- PFAS TECHNICAL ADVISORY BOARD (ANYONE CAN JOIN)
- EXECUTIVE ORDER
  - CREATE WEBSITE ON PFAS: CURRENTLY [HTTPS://DNR.WI.GOV/TOPIC/CONTAMINANTS/PFAS.HTML](https://dnr.wi.gov/topic/contaminants/pfas.html)
  - DNR COUNCIL TO FORM ACTION PLAN AND ANALYZE HEALTH RISKS, SET ENFORCEABLE STANDARDS
    - 1/22/2020: WISCONSIN NATURAL RESOURCES BOARD APPROVES DNR EFFORT TO CREATE NEW PFAS STANDARDS: PFAS PERMANENT RULEMAKING PROCESS MOVES FORWARD
  - MODIFY VOLUNTARY CLEANUP LAWS TO INCLUDE ACCOUNTABILITY FOR HISTORIC CONTAMINATION– DOES NOT AFFECT PROPERTIES THAT ALREADY HAVE A CERTIFICATE OF COMPLETION
- LAST SUMMER INTERIM LEVEL OF 20 PPT PROPOSED, RECENTLY CLOSED PUBLIC COMMENT PERIOD