MJPHD

"AVOID FOAM" AND OTHER CONSEQUENCES OF LIVING IN A WORLD WITH PFAS

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CREATIVE DIRECTOR
MJPHD, LLC

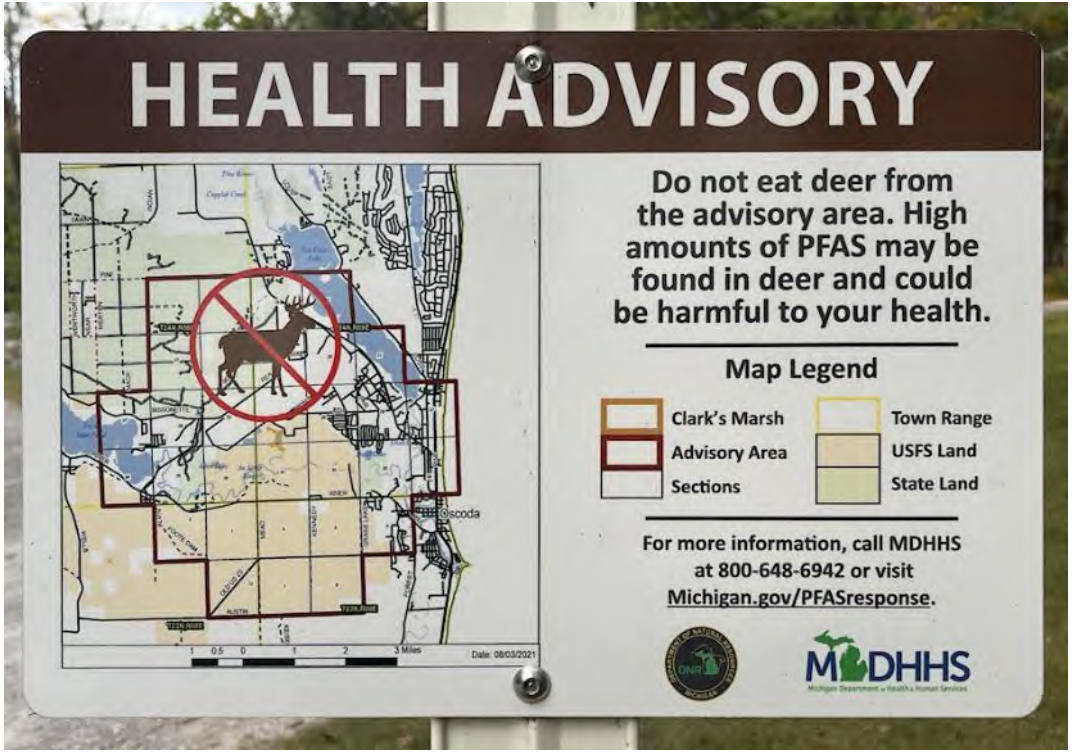
presented to

tag.

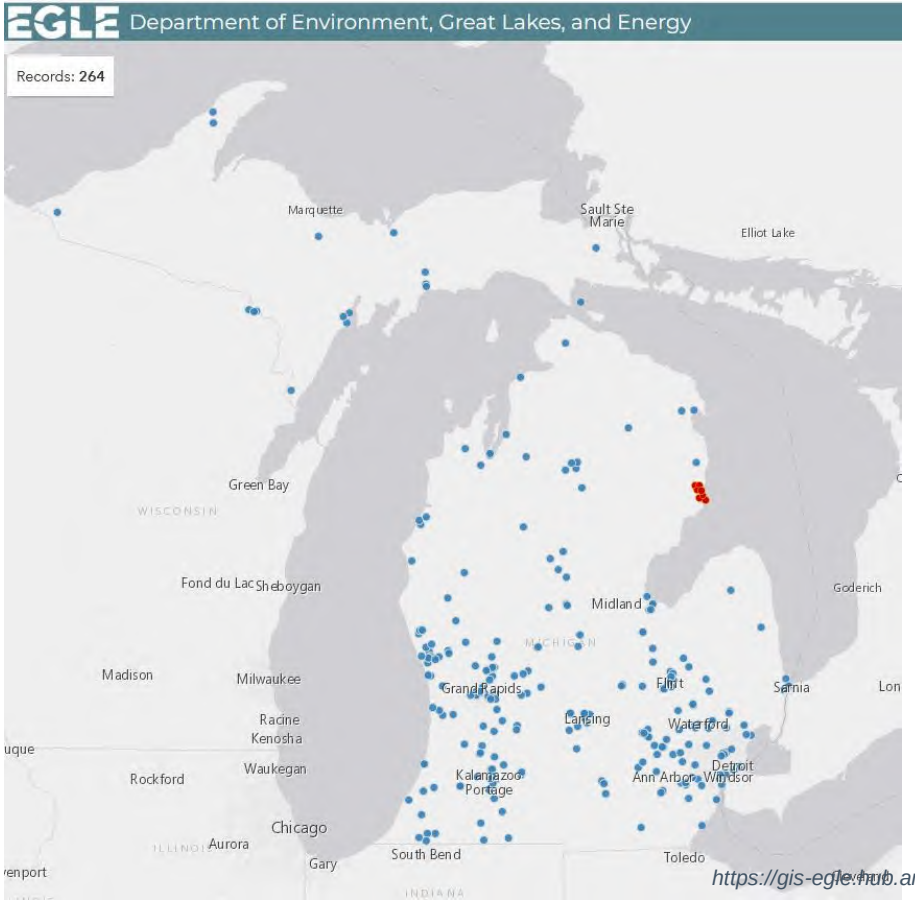
6 September 2023


Van Etten Lake State Forest Campground
Google Earth

Signs from Oscoda



MICHIGAN PFAS SITES



https://gis-egle.hub.arcgis.com/datasets/egle::michigan-pfas-sites/

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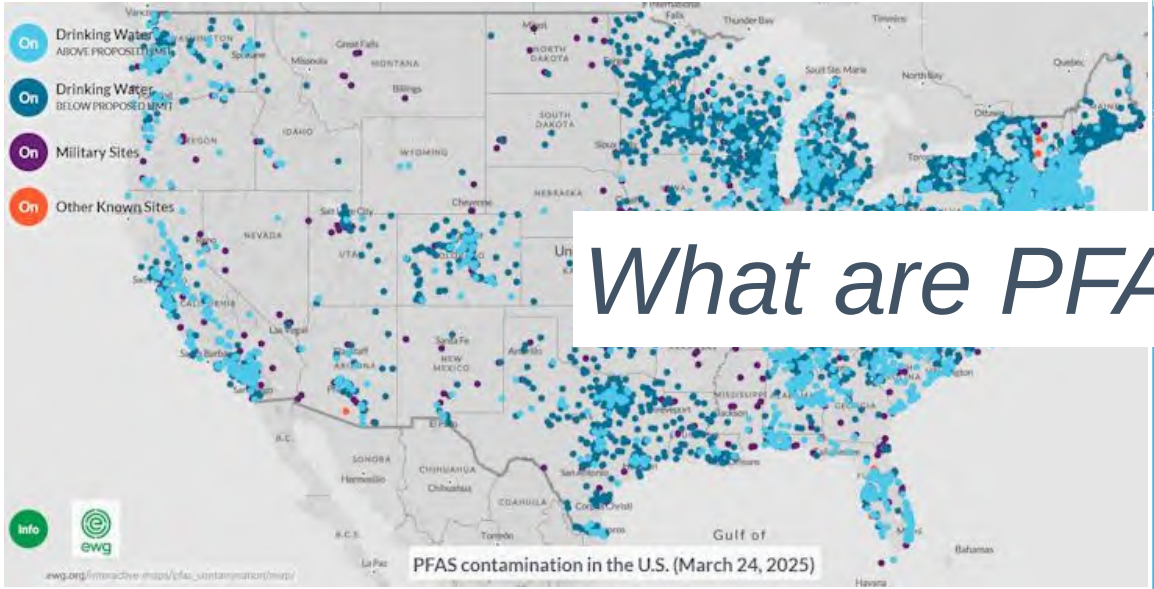
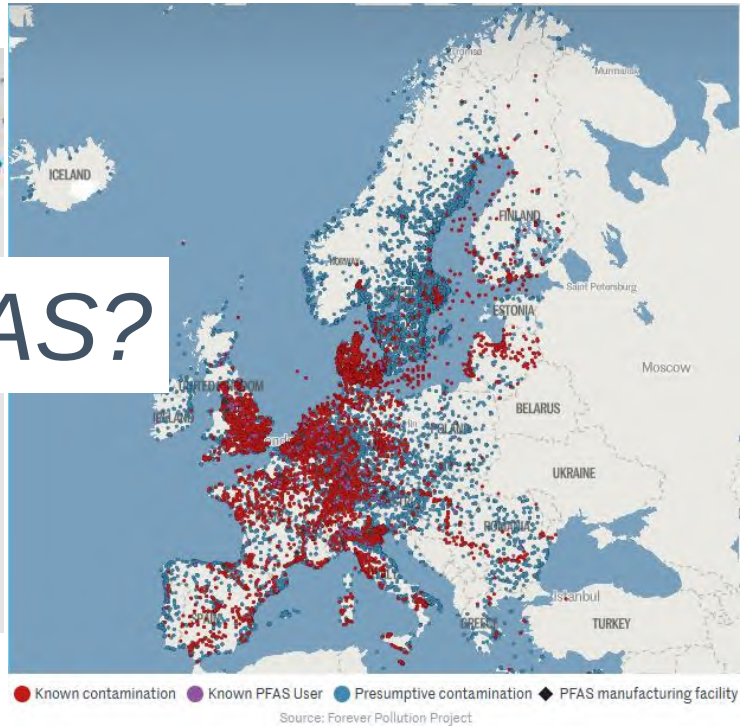
PFAS Around The Globe



What are PFAS?



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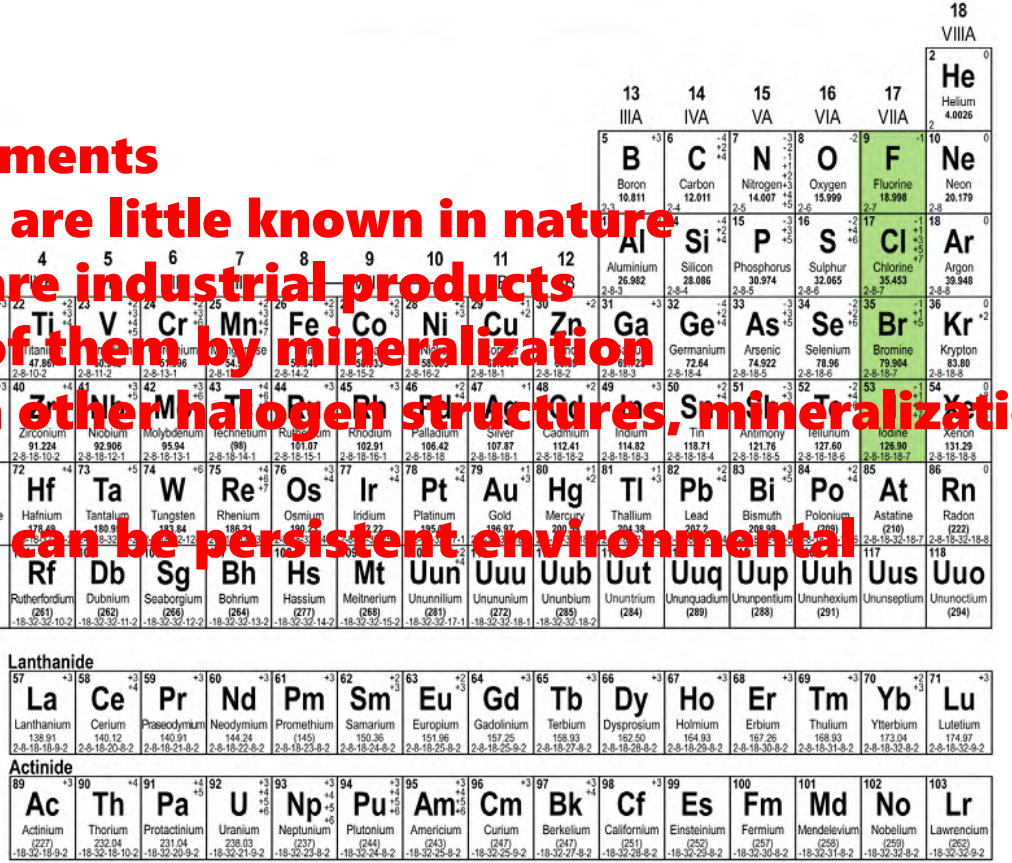
HALOGENS

- halogens are elements
- organohalogens are little known in nature
- organhalogens are industrial products
- nature gets rid of them by mineralization
- for F and certain other halogen structures, mineralization is very slow
- organohalogens can be persistent environmental contaminants.




PFAS
OR
Not

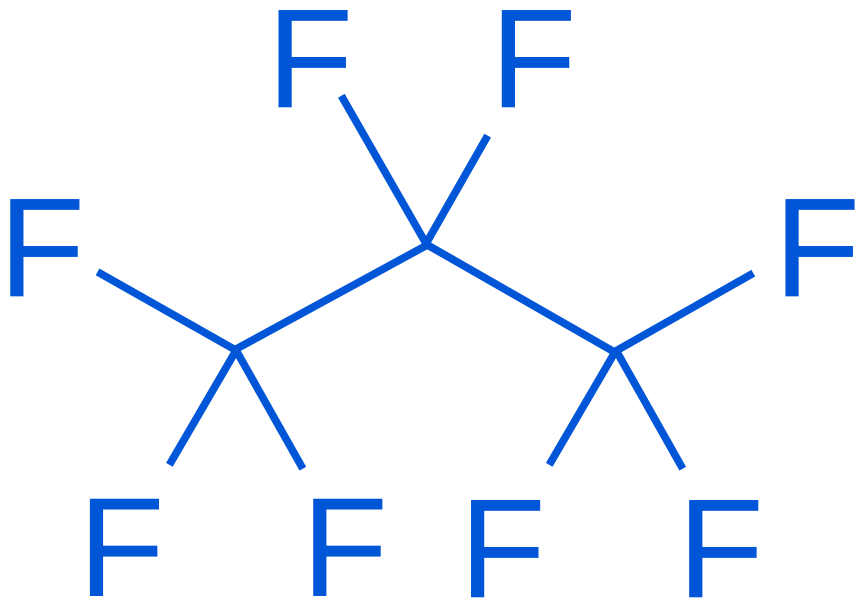
PFAS Acronym

- Historic: Perfluorinatedalkyl Substances
- Recent: Perfluorinated and Polyfluorinatedalkyl Substances
- Shorthanded: Per- and Polyfluorinated Substances

EPA used a limited definition of PFAS: "Chemicals with at least two adjacent carbon atoms, where one carbon is fully fluorinated and the other is at least partially fluorinated."

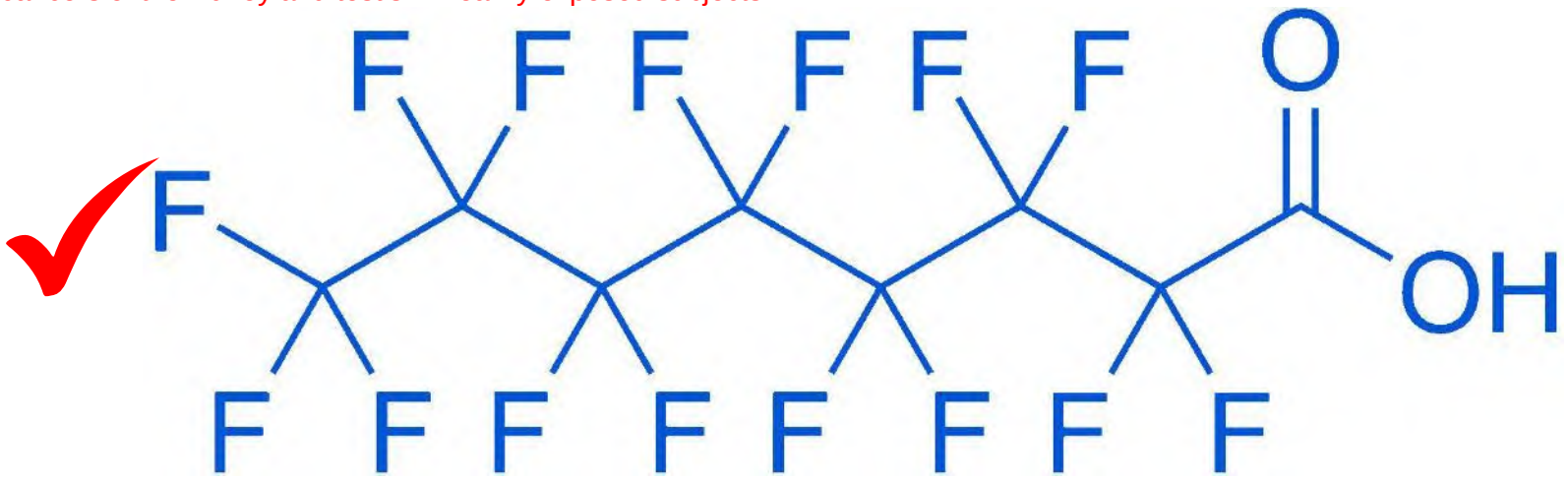
For the purposes of Nov 2022 CCL 5, the structural definition of per- and polyfluoroalkyl substances (PFAS) includes chemicals that contain at least one of these three structures:
(1) R-(CF2)-CF(R')R", where both the CF2 and CF moieties are saturated carbons, and none of the R groups can be hydrogen.
(2) R-CF2OCF2-R', where both the CF2 moieties are saturated carbons, and none of the R groups can be hydrogen.
(3) CF3C(CF3)RR', where all the carbons are saturated, and none of the R groups can be hydrogen.

PFAS or Not



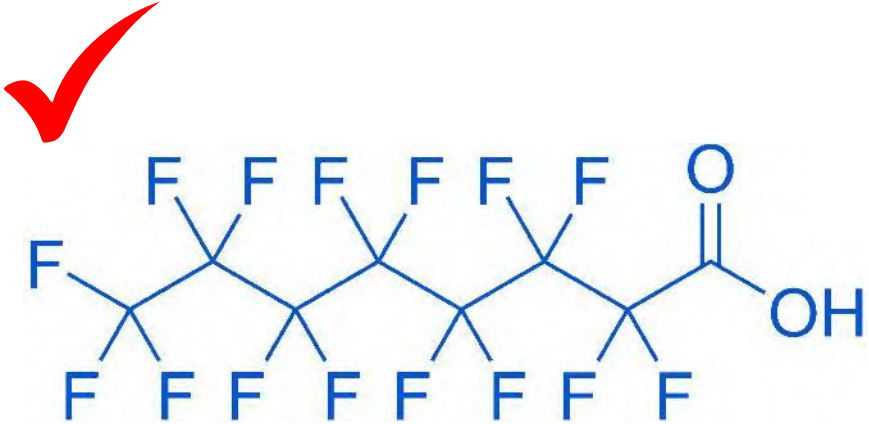
PFAS or Not

In 2017, the International Agency for Research on Cancer (IARC) classified perfluorooctanoic acid (PFOA), the most well-studied per- and polyfluoroalkyl substance (PFAS), as a possible human carcinogen based in part on limited epidemiologic evidence of associations with cancers of the kidney and testis in heavily exposed subjects.

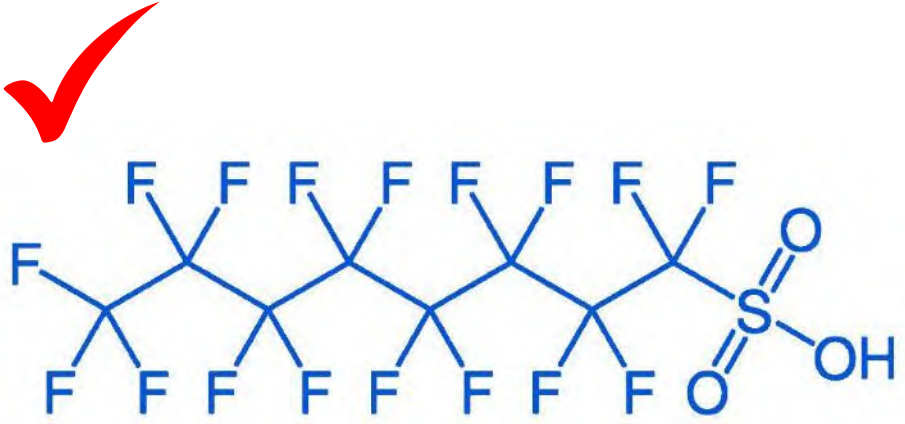


Perfluorooctanoic Acid = PFOA

MOST WELL-STUDIED PFAS



PFOA



PFOS

Perfluorooctanesulfonic acid

On August 26, 2022, EPA proposed designating these as hazardous substances under CERCLA, or Superfund. This rulemaking would increase transparency around releases of these harmful chemicals and help to hold polluters accountable for cleaning up their contamination.
March 3, 2021, EPA made final determinations to regulate perfluorooctanesulfonic acid (PFOS) and perfluorooctanoic acid (PFOA) in drinking water under the Safe Drinking Water Act (SDWA).

PFOA and PFOS are:

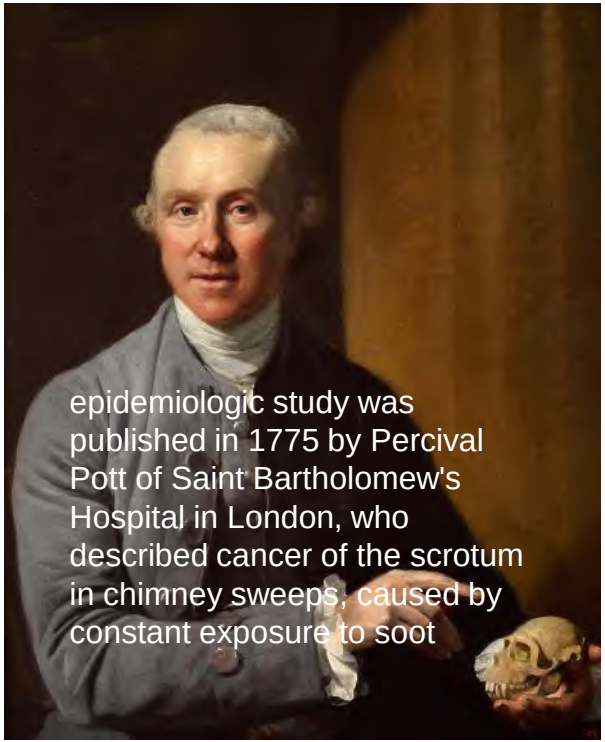
- man-made chemicals
- have been widely used in industry and consumer products since the 1940s
- remain in the environment for a long time.

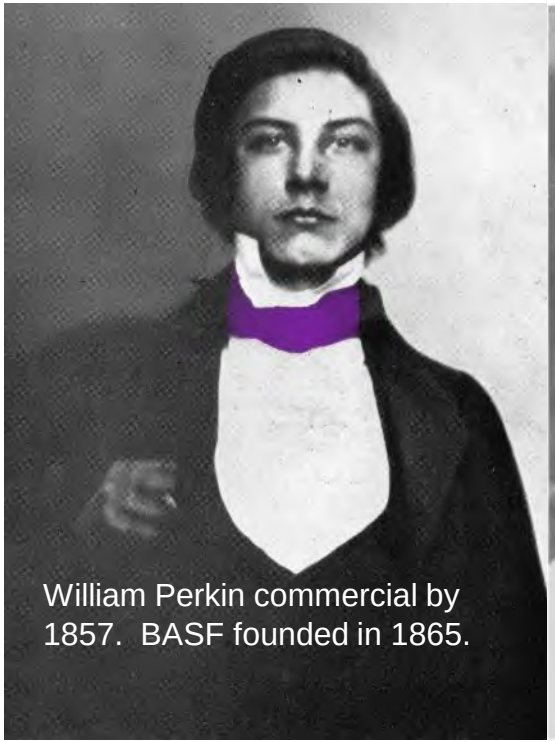
Fluorinated organic substances:

- *overwhelmingly* man-made chemicals
- have been widely used in industry and consumer products since the 1940s
- ~~remain in the environment for a long time.~~

The most famous naturally existing organic fluorine containing compound is probably monofluoroacetic acid (FCH_2CO_2H). This compound is found in a South African plant called "Gifblaar," which is known to be so poisonous that ingesting only a half of its leaf is enough to kill a cow.

EPIDEMIOLOGY





Possible Health Impacts of PFAS

- reduction in immunity
- metabolic diseases like obesity & diabetes
- thyroid disfunction
- reduced vaccination response
- ulcerative colitis
- low sperm count
- smaller penis size
- affect the growth, learning, and behavior of infants and older children
- lower a woman's chance of getting pregnant
- interfere with the body's natural hormones
- increased cholesterol levels
- increased risk of testicular cancer
- increased risk of prostate cancer
- increased risk of breast cancer
- increased risk of heart disease
- increased risk of kidney disease
- increased risk of liver disease
- increased risk of osteoarthritis
- increased risk of Parkinson's disease
- increased risk of autoimmune disease

Epidemiological Studies of PFOA and PFOS

Research involving humans suggests that high levels of certain PFAS **may** lead to the following:


Increased cholesterol levels


Decreased vaccine response in children


Changes in liver enzymes

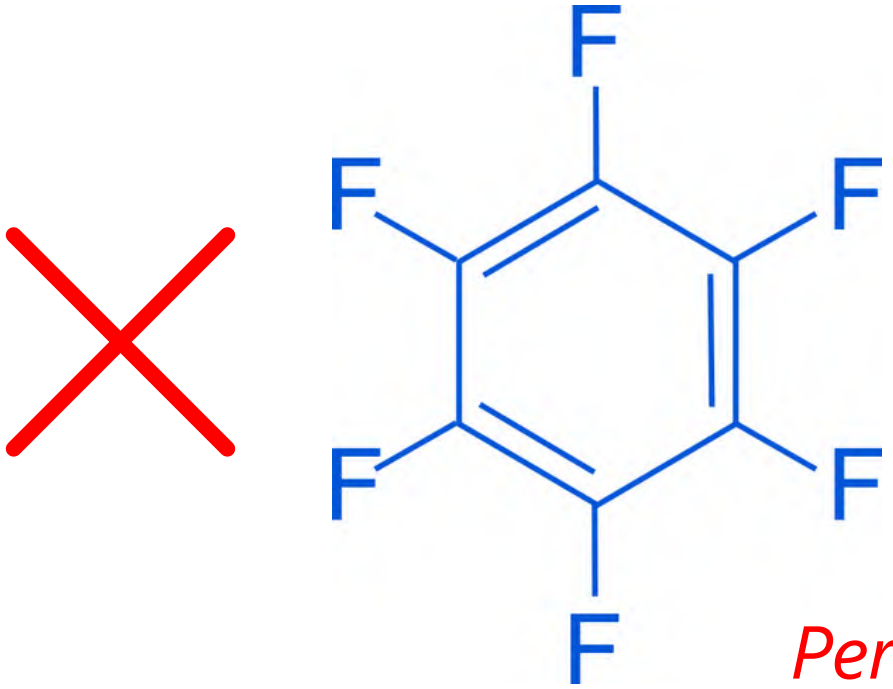

Increased risk of high blood pressure or pre-eclampsia in pregnant women


Small decreases in infant birth weights


Increased risk of kidney or testicular cancer

https://www.atsdr.cdc.gov/pfas/health-effects/index.html

PFAS or Not



Perfluoro but not alkyl

New OECD Definition

PFASs are defined as fluorinated substances that contain at least one fully fluorinated methyl or methylene carbon atom (without any H/Cl/Br/I atom attached to it)

With a few exceptions, any chemical with at least a perfluorinated methyl group (–CF3) or a perfluorinated methylene group (–CF2–) is a PFAS.

from Reconciling Terminology of the Universe of Per- and Polyfluoroalkyl Substances: Recommendations and Practical Guidance, July 2021

Evolving EPA Definition

EPA used a limited definition of PFAS: “Chemicals with at least two adjacent carbon atoms, where one carbon is fully fluorinated and the other is at least partially fluorinated.”

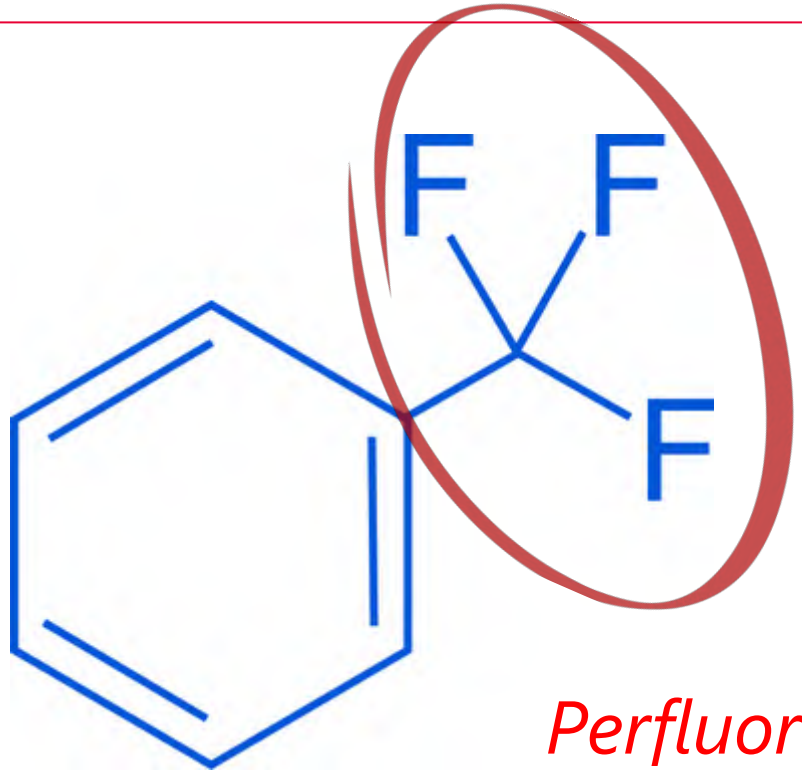
Per- and polyfluorinated substances that structurally contain the unit R-(CF_2)-C(F)(R’)R’’ where both the CF_2 and CF moieties are saturated carbons and none of the R groups (R, R’, or R’’) can be hydrogen. *2021 Multi-industry Report*

As of November 2, 2022 Contaminant Candidate List (CCL) 5, the structural definition of PFAS includes chemicals that contain at least one of these three structures:

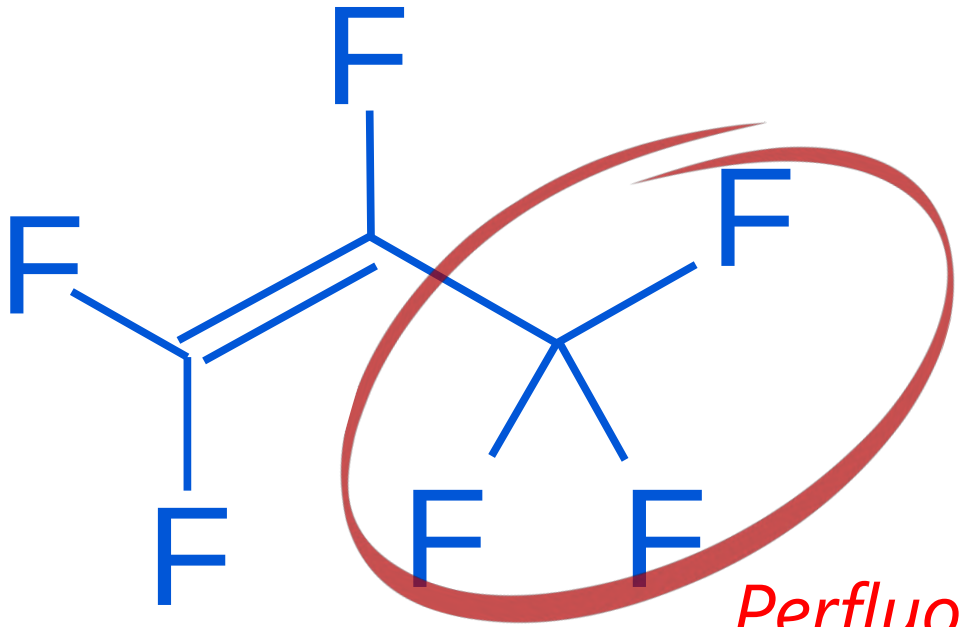
1. R-(CF2)-CF(R′)R″, where both the CF2 and CF moieties are saturated carbons, and none of the R groups can be hydrogen.
2. R-CF2OCF2-R′, where both the CF2 moieties are saturated carbons, and none of the R groups can be hydrogen.
3. CF3C(CF3)RR′, where all the carbons are saturated, and none of the R groups can be hydrogen.

The Contaminant Candidate List lists contaminants currently not subject to any proposed or promulgated national primary drinking water regulations but are known or anticipated to occur in public water systems. Contaminants listed may require future regulation under the Safe Drinking Water Act.

PFAS or Not

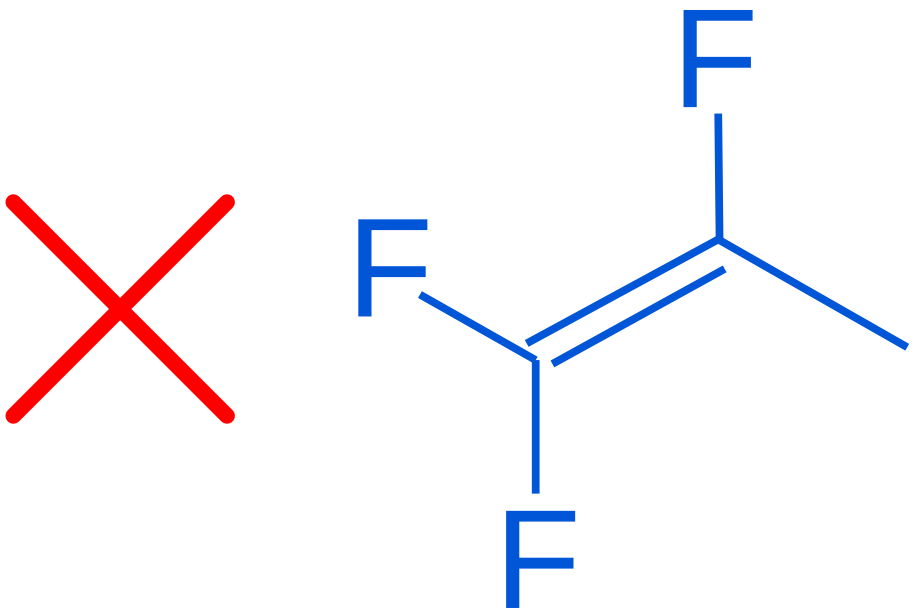


Perfluoro alkyl group

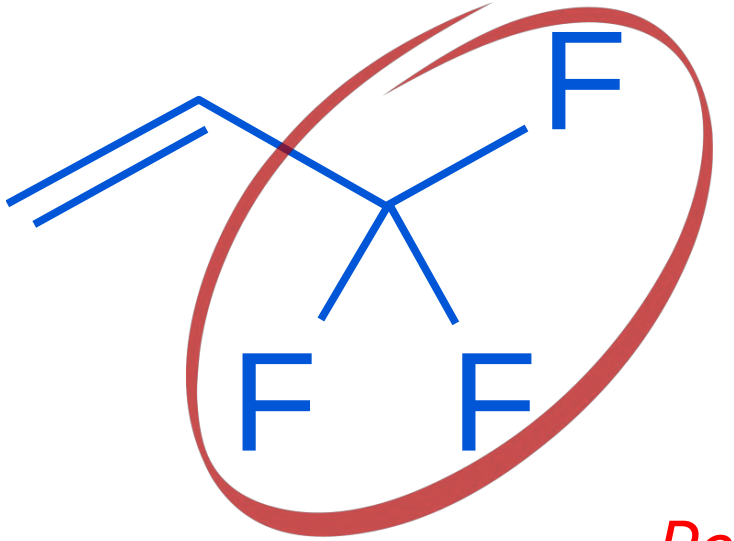


Perfluoro alkyl group

PFAS or Not

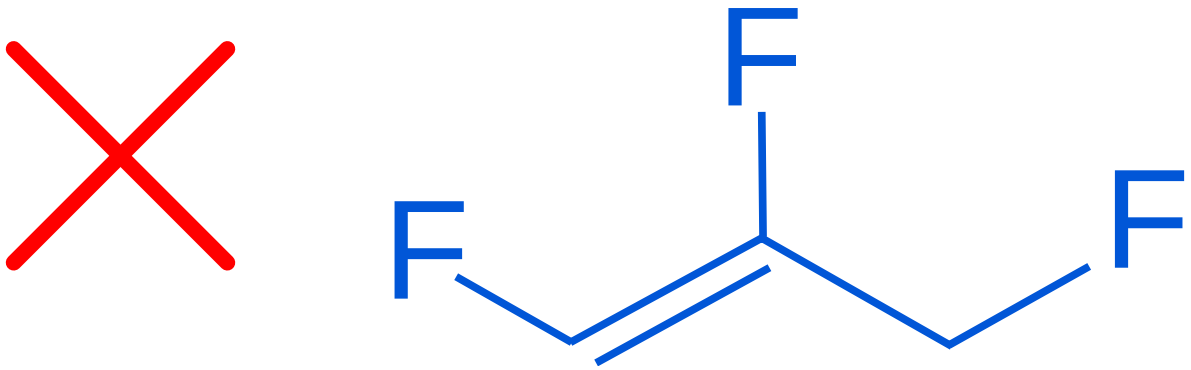


PFAS or Not

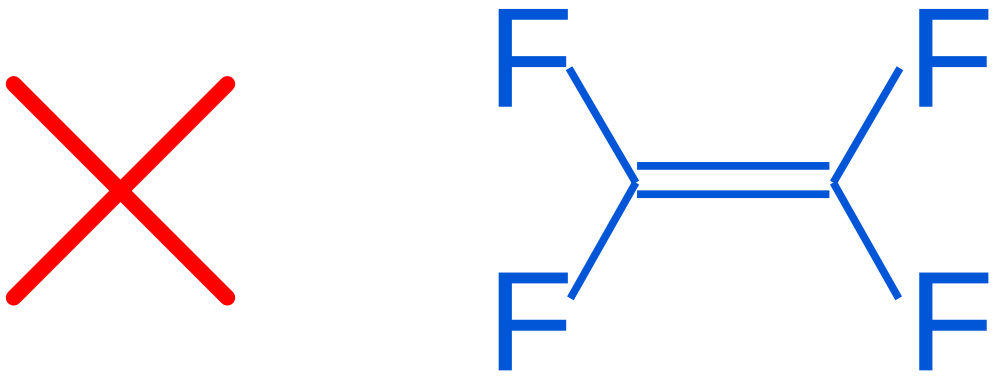


Perfluoro alkyl group

PFAS or Not

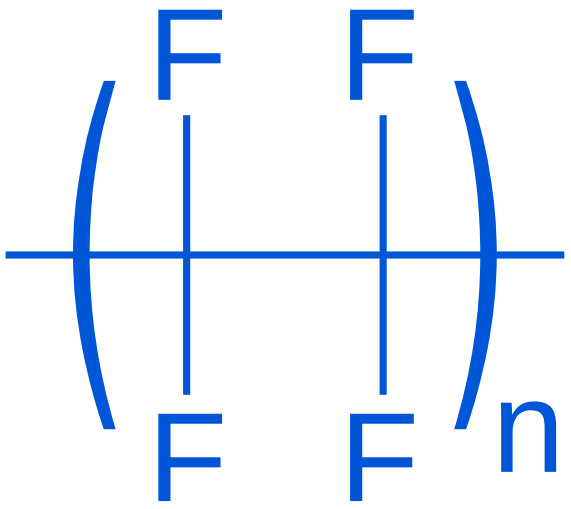


PFAS or Not



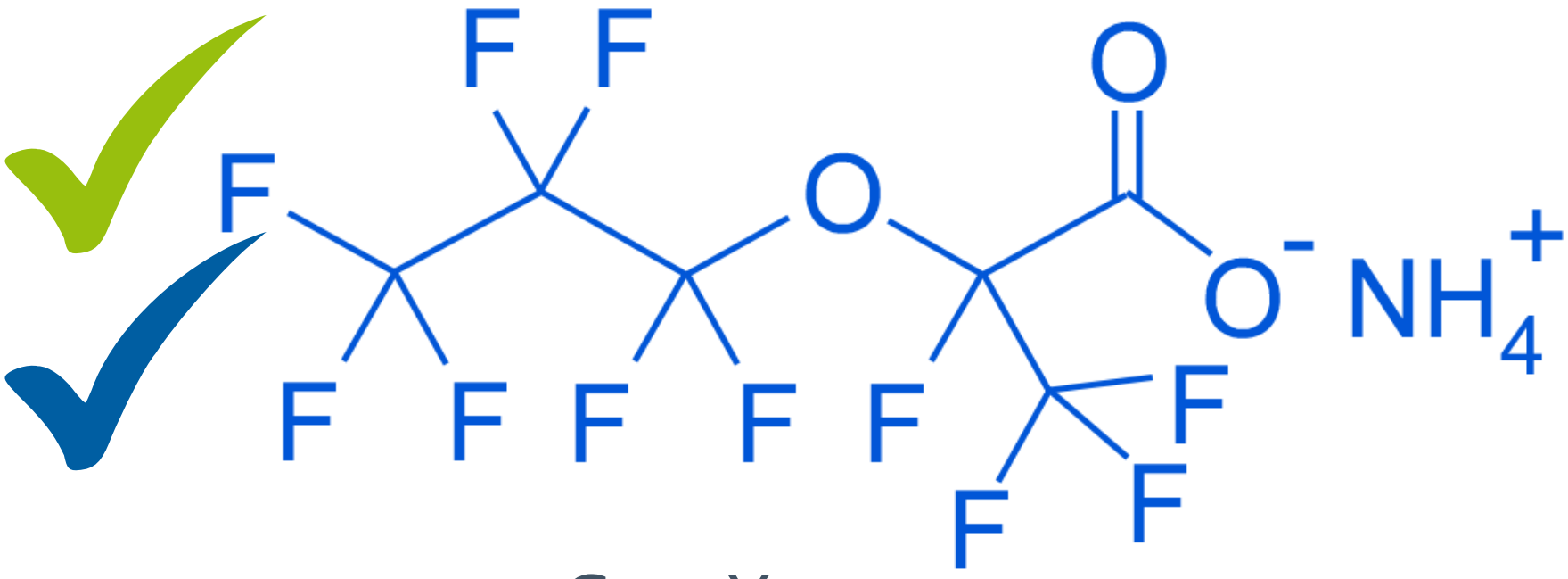
Tetrafluoroethylene

PFAS or Not



PTFE = Teflon

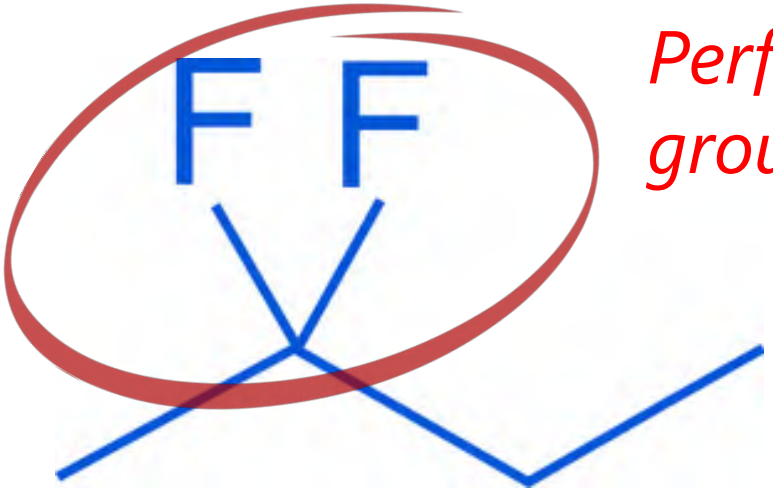
PFAS or Not



Gen X

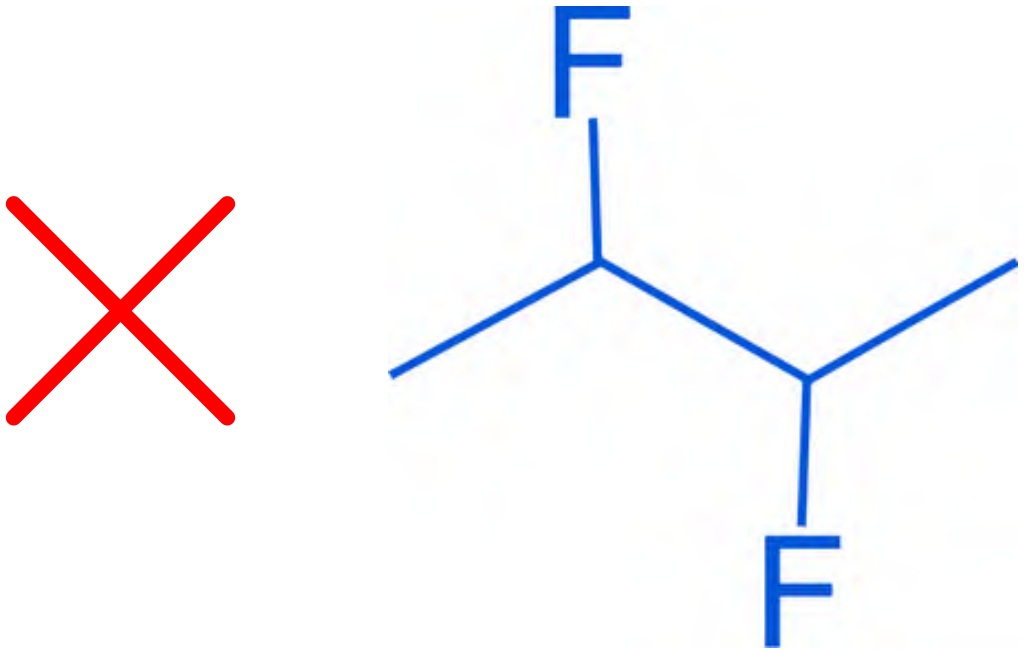
Hexafluoropropylene oxide (HFPO) dimer acid and its ammonium salt, FRD-902 (ammonium (2,3,3,3-tetrafluoro-2-(heptafluoropropoxy)propanoate)), are known as "GenX chemicals" because they are used in the GenX process. GenX is the Chemours trade name for technology used to make fluoropolymers without PFOA.

PFAS or Not



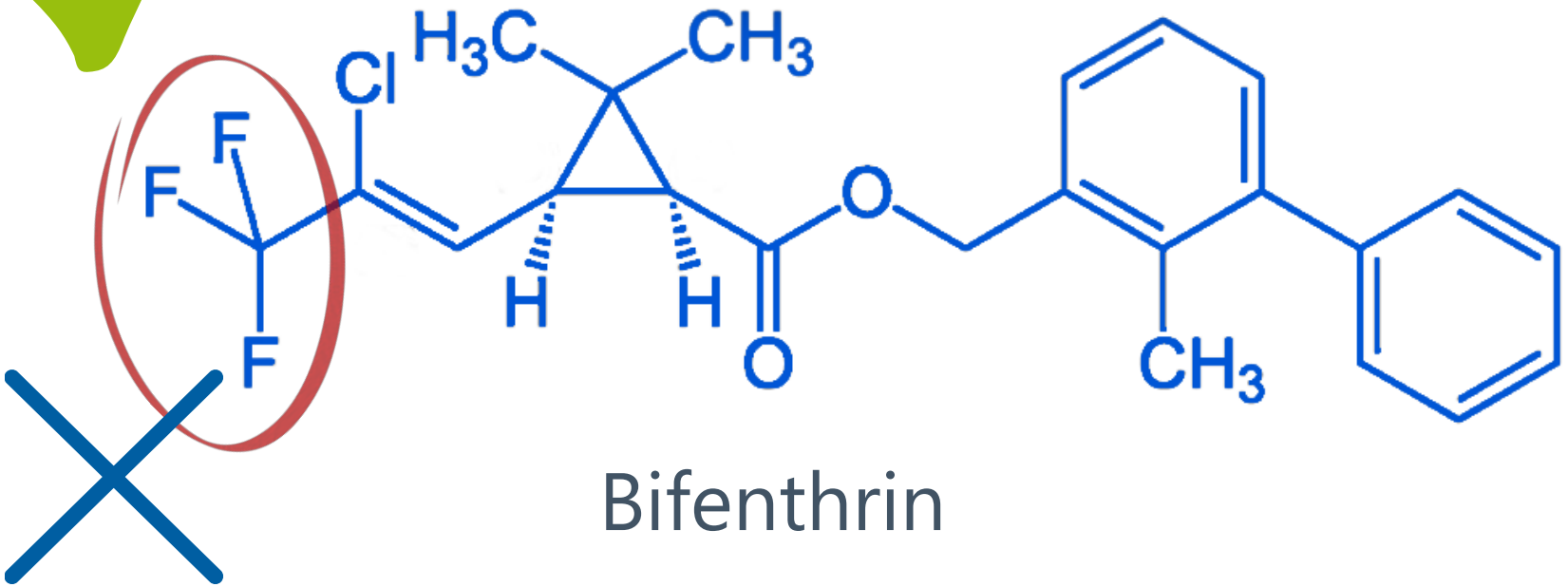
Perfluoro alkyl group

PFAS or Not



PFAS or Not

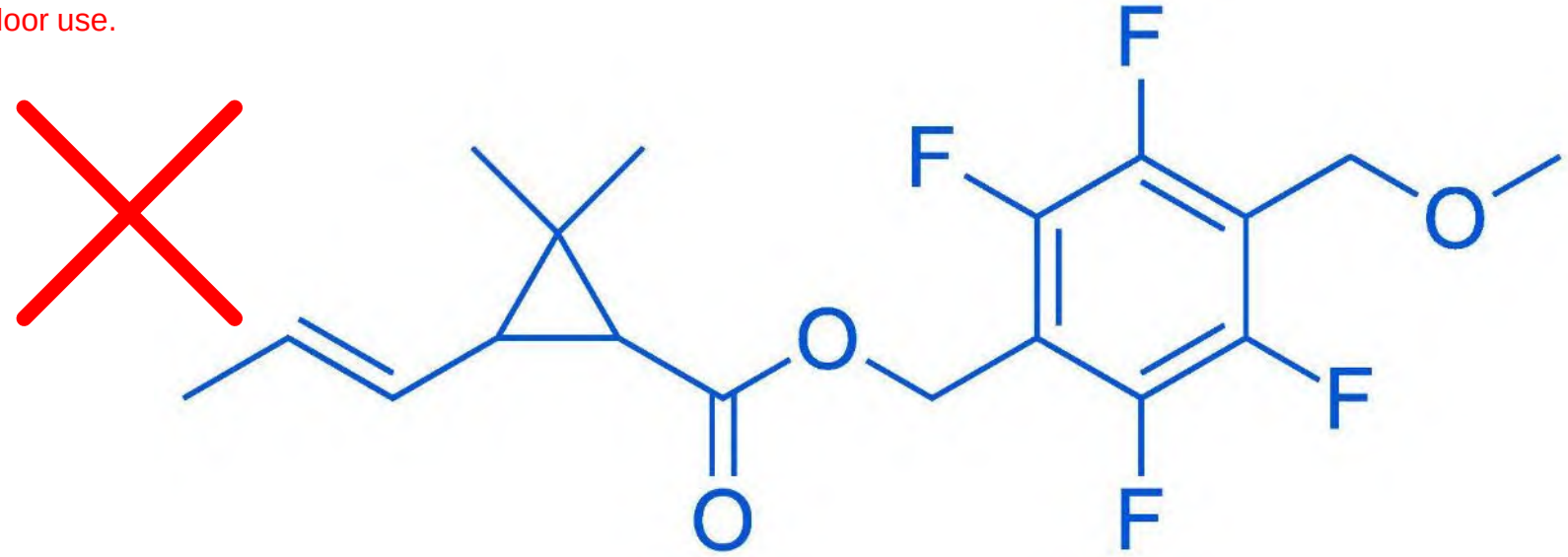
One of the most widely used fluorinated pesticides is bifenthrin. It targets insects' nervous system and is the prime ingredient in more than 600 pesticide formulations used on corn, soy, vegetables, berries and orchard crops. Bifenthrin is also a persistent pollutant with a half-life of 97 to 345 days in soil, depending on soil type. Used in Ortho Home Defense Max.



Bifenthrin

PFAS or Not

Metofluthrin is a pyrethroid used as an insect repellent. The vapors of metofluthrin are highly effective and capable of repelling up to 97% of mosquitoes in field tests. Metofluthrin is used in a variety of consumer products, called emanators, for indoor and outdoor use.



Metofluthrin

PFAS or Not

Eli Lilly introduced Prozac (fluoxeine) in Jan 1988. It is the first marketed selective serotonin reuptake inhibitor. Over 25 million prescriptions per year in US alone - estimated over 100 million world wide. A top 25 drug. Listed by WHO as an essential medication. Best selling antidepresant of all time.

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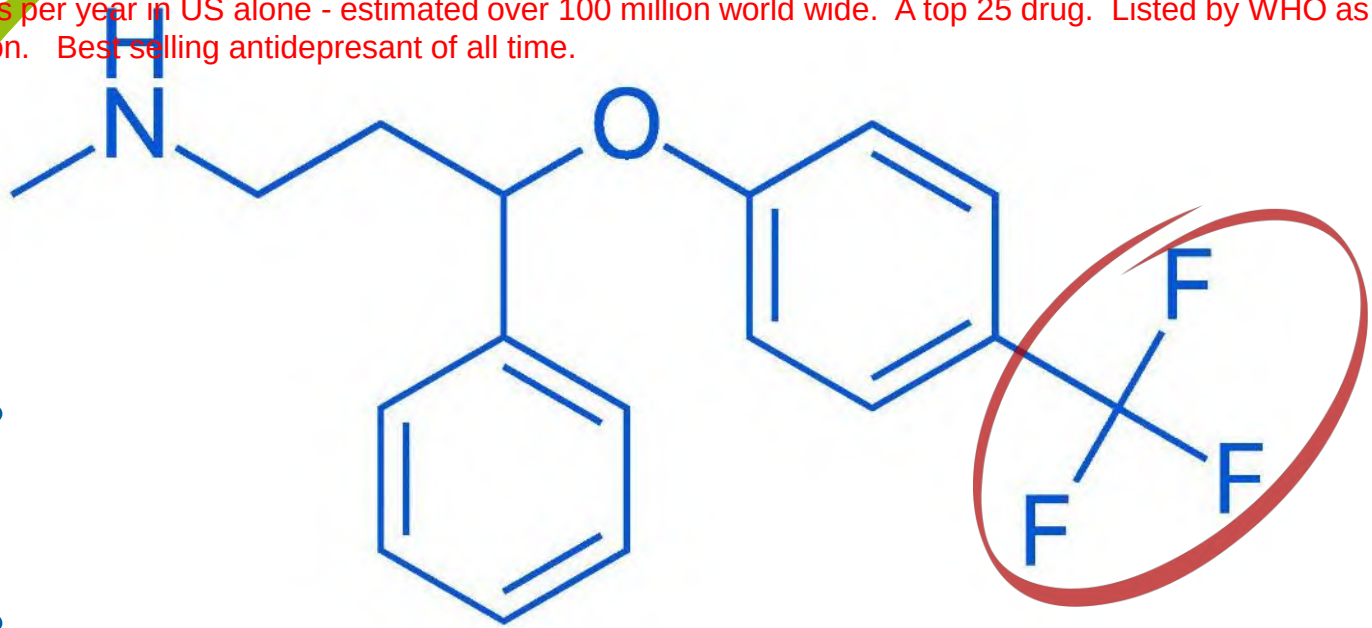

Fluoxetine = Prozac

PFAS or Not

Aprepitant, sold under the brand name Emend among others, is a medication used to prevent chemotherapy-induced nausea and vomiting and to prevent postoperative nausea and vomiting.

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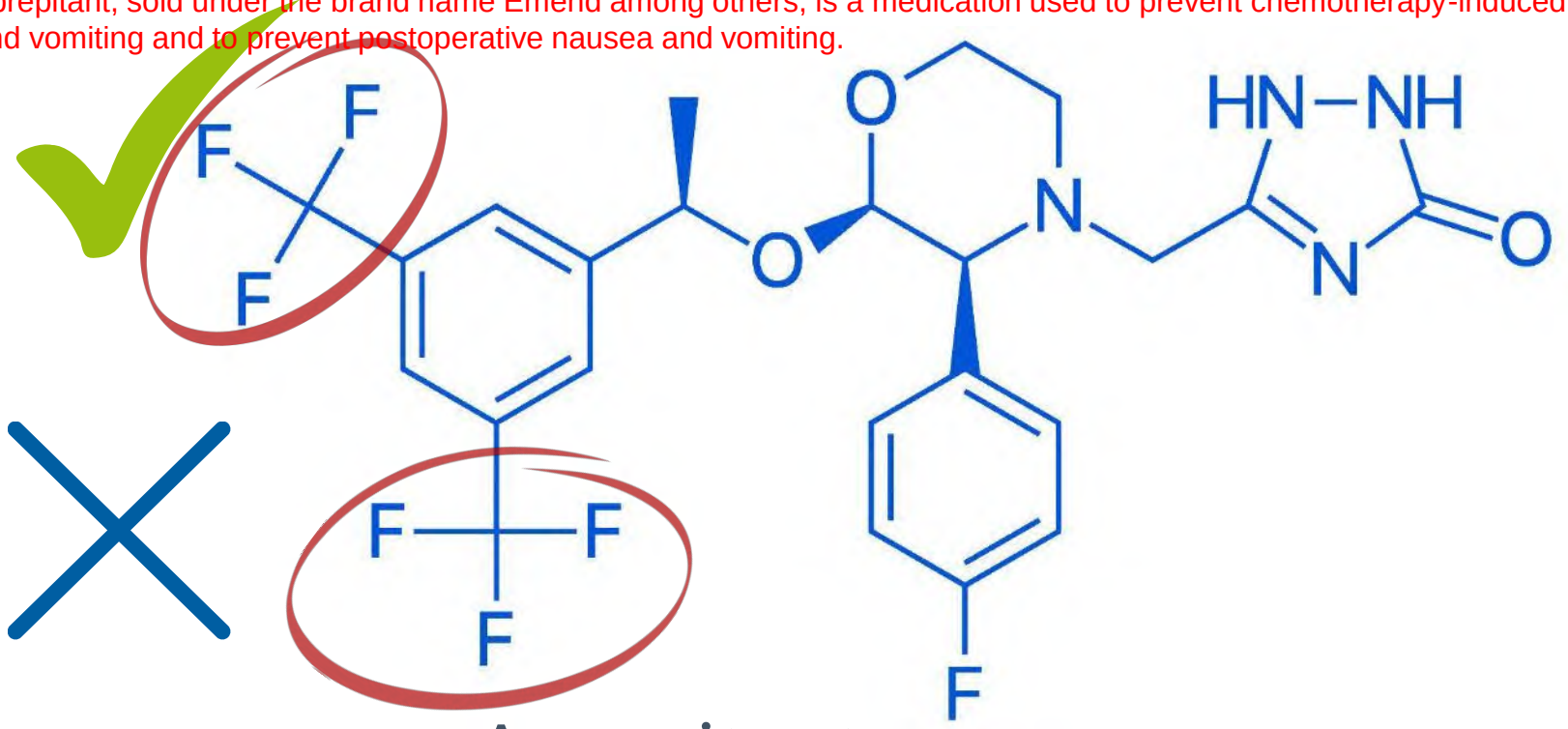

Aprepitant

2005 Green Chemistry Challenge winner

PFAS or Not

Nirmatrelvir is an antiviral medication developed by Pfizer which acts as an orally active 3C-like protease inhibitor. It is part of a nirmatrelvir/ritonavir combination used to treat COVID-19 and sold under the brand name Paxlovid.

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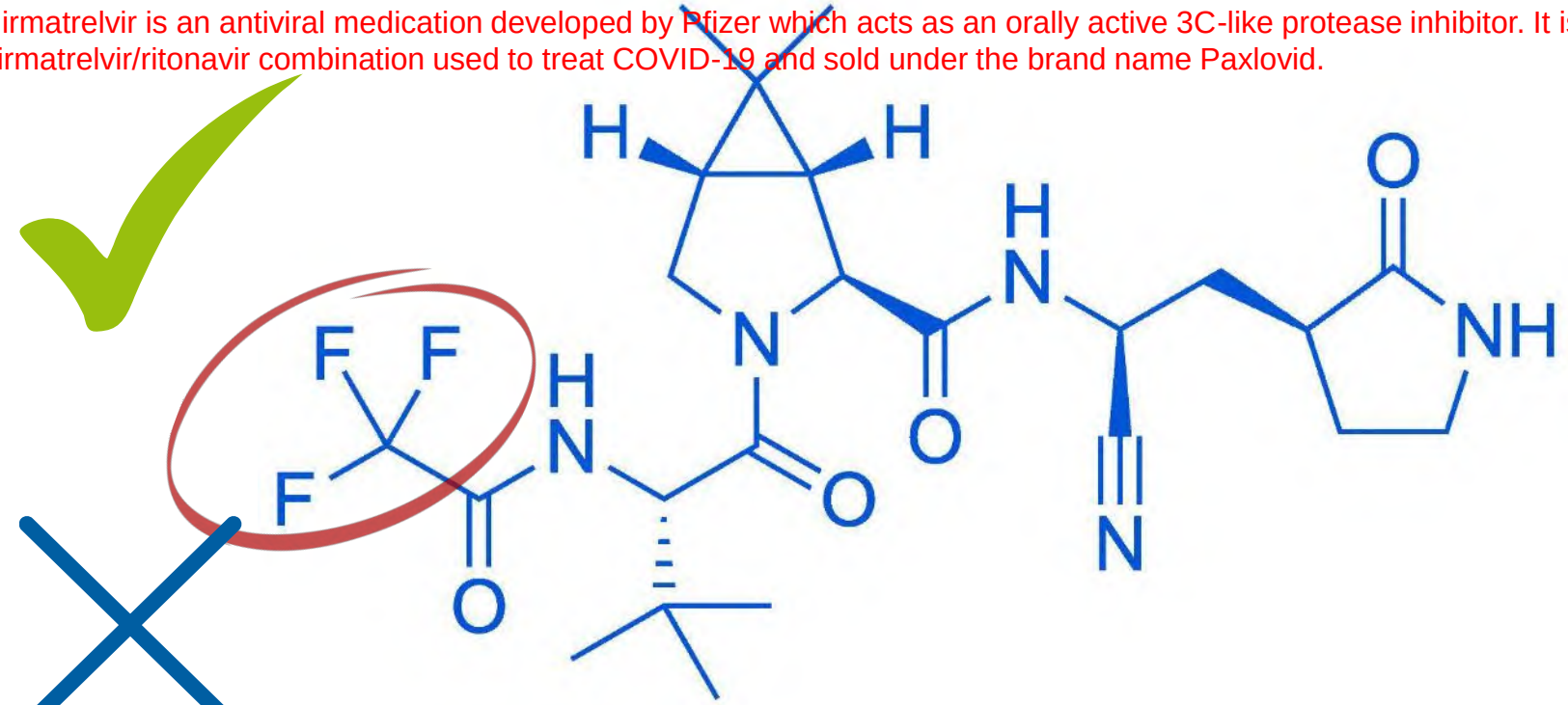
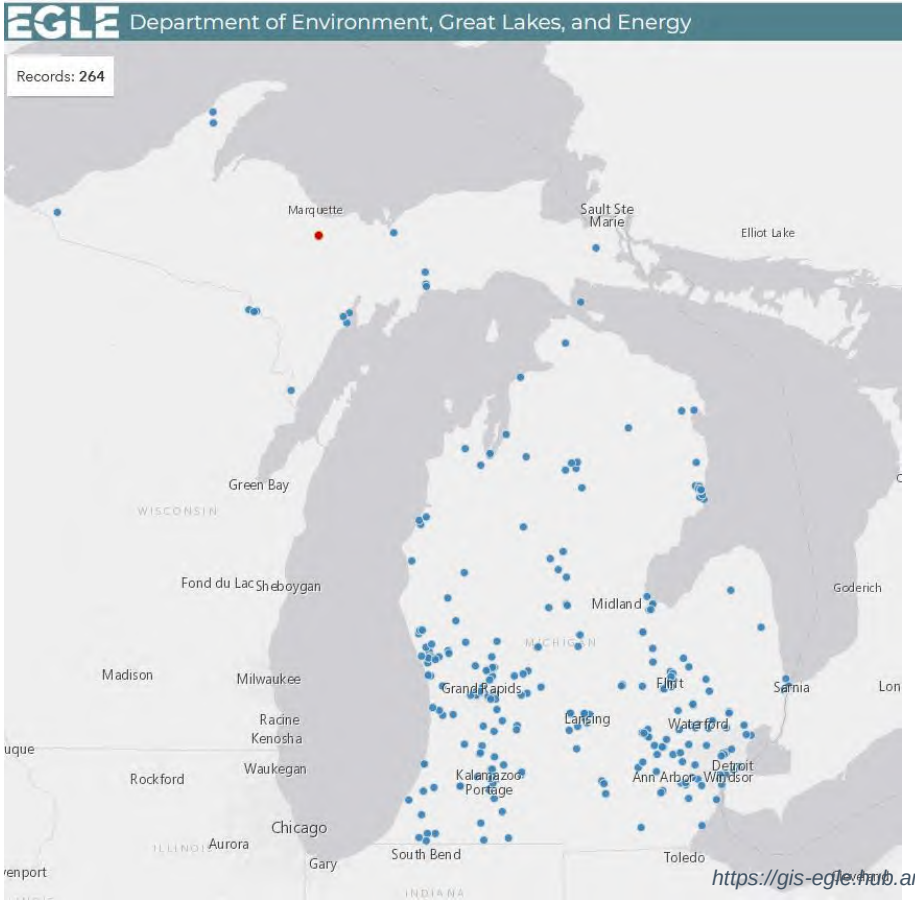


Nirmatrelvir = Paxlovid


PFAS
The End
Not

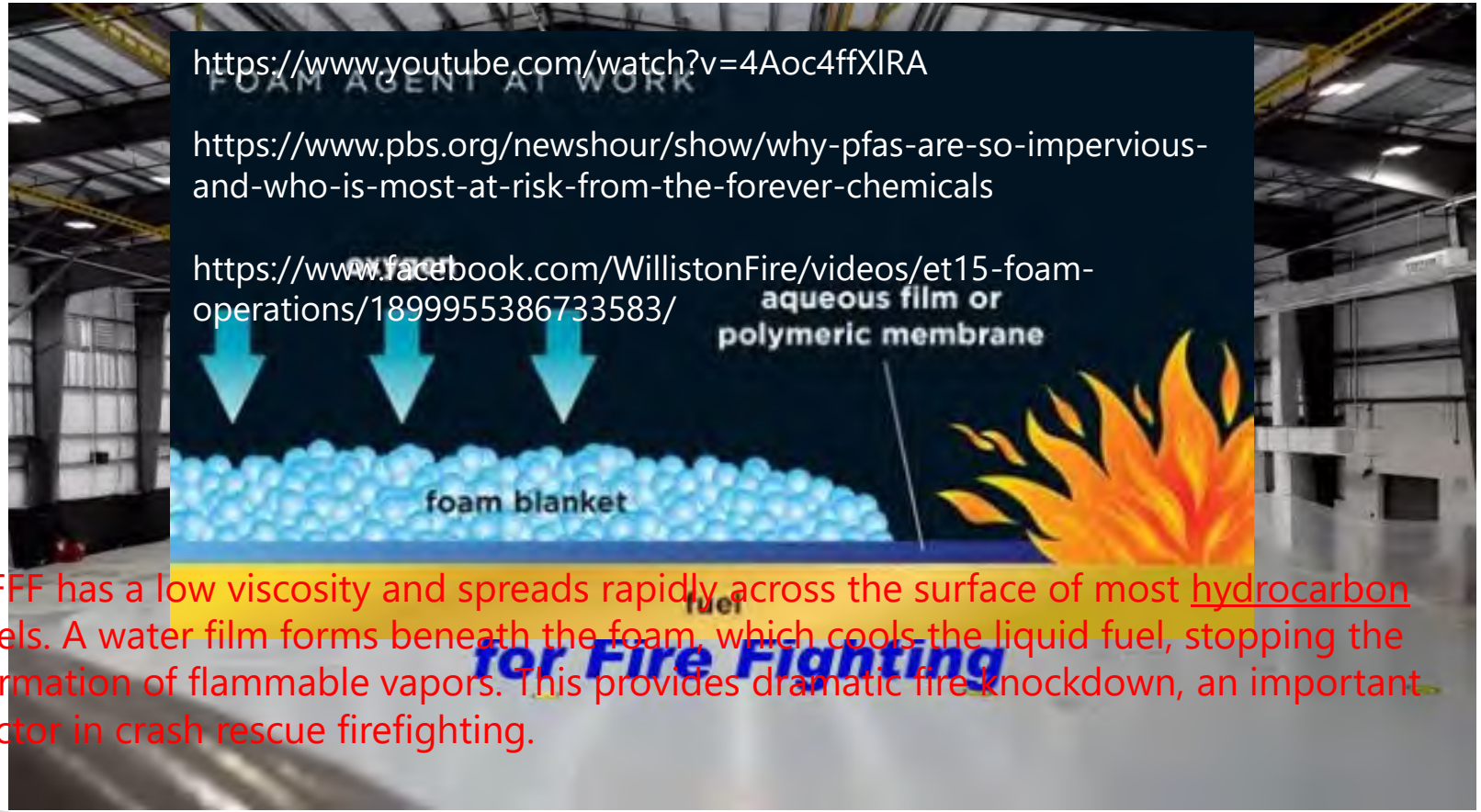
USES OF PFAS



https://gis-egle.hub.arcgis.com/datasets/egle::michigan-pfas-sites/

https://www.youtube.com/watch?v=vl_a4YhuQ88

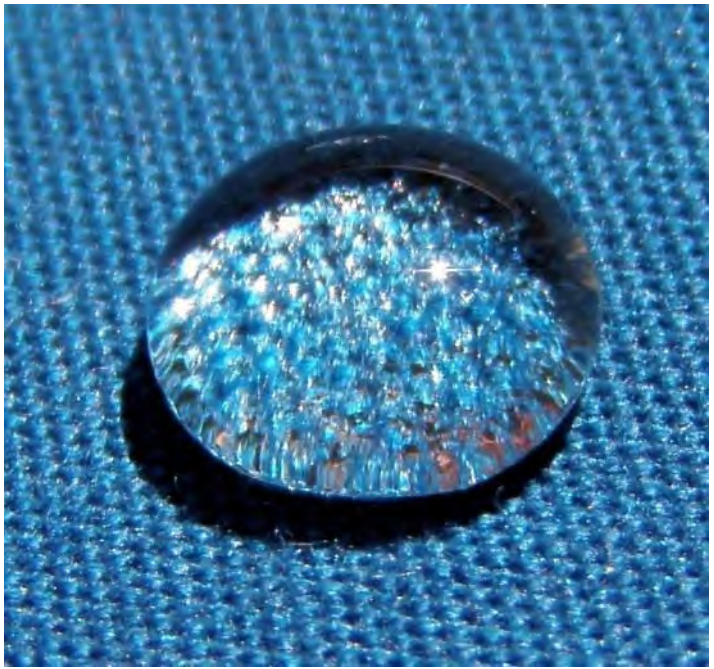
AFFF (Aqueous Film-Forming Foam)

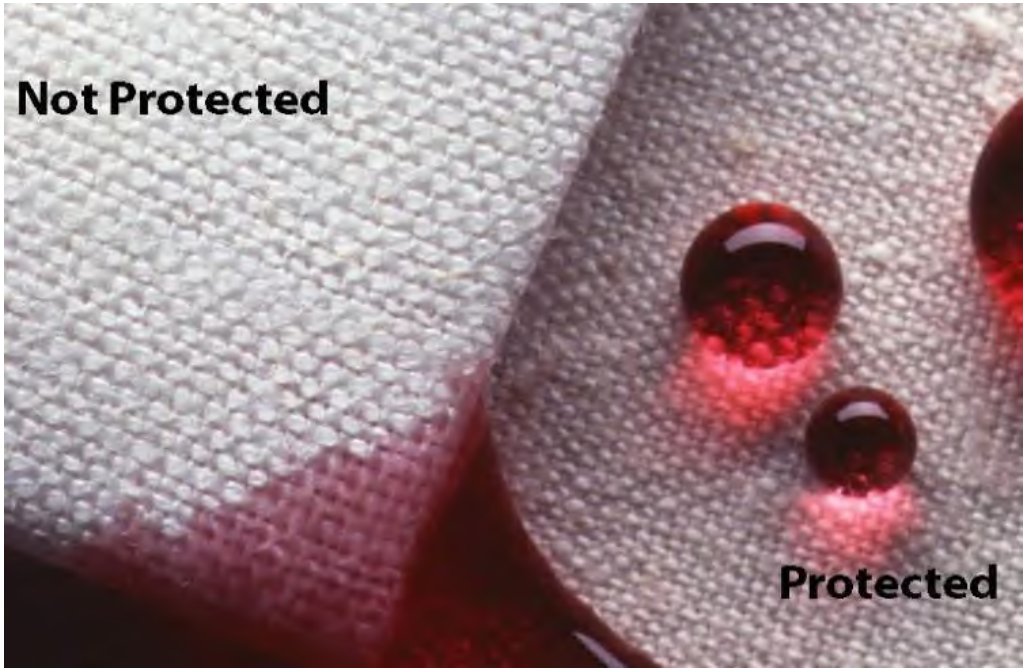


AFFF has a low viscosity and spreads rapidly across the surface of most hydrocarbon fuels. A water film forms beneath the foam, which cools the liquid fuel, stopping the formation of flammable vapors. This provides dramatic fire knockdown, an important factor in crash rescue firefighting.

Several studies found polytetrafluoroethylene (PTFE) cookware to contain residual PFOA in the low µg/kg range, concluding that fluoropolymer food contact materials were not likely to be a major source of PFASs. PFCAs, particularly PFOA, and fluorotelomer alcohols (FTOHs) have been shown to be released from coated cookware at normal cooking temperatures. Studies of migration into food during the cooking process are inconclusive. Only relatively small amounts are released into foods, when compared to concentrations that are found in the raw food.

Water-repellant Treatments / Stain-resistant Treatments





Initial POSF-based product lines for surface treatment applications were developed in 1957 and marketed under the trade name of Scotchgard, and paper and packaging applications in the 1960s marketed under the trade name of Scotchban.

Grease-resistant Food Packaging

CR's Food Packaging Test Results

These results show levels of total organic fluorine, a measure of PFAS, in 118 food packaging products gathered from major fast-food and fast-casual restaurants, as well as supermarkets. PFAS in food packaging have been linked to potential harms to human health and the environment. Products with two red squares have 100 parts per million organic fluorine or more. Starting next year, California will ban food packaging that exceeds that level. Products with one red square have 20 ppm organic fluorine or more, a stricter standard for food packaging set by Denmark. CR supports that lower cutoff.

20 ppm or more	100 ppm or more	ND Not Detected

Burger King

Bag for cookies, French toast sticks	■■	345.7
Wrapper for Whopper	■■	249.7
Bag for chicken nuggets	■■	165.0
Container for french fries		13.0
Container for chicken, french fries		12.0
Container for tater tots		8.5

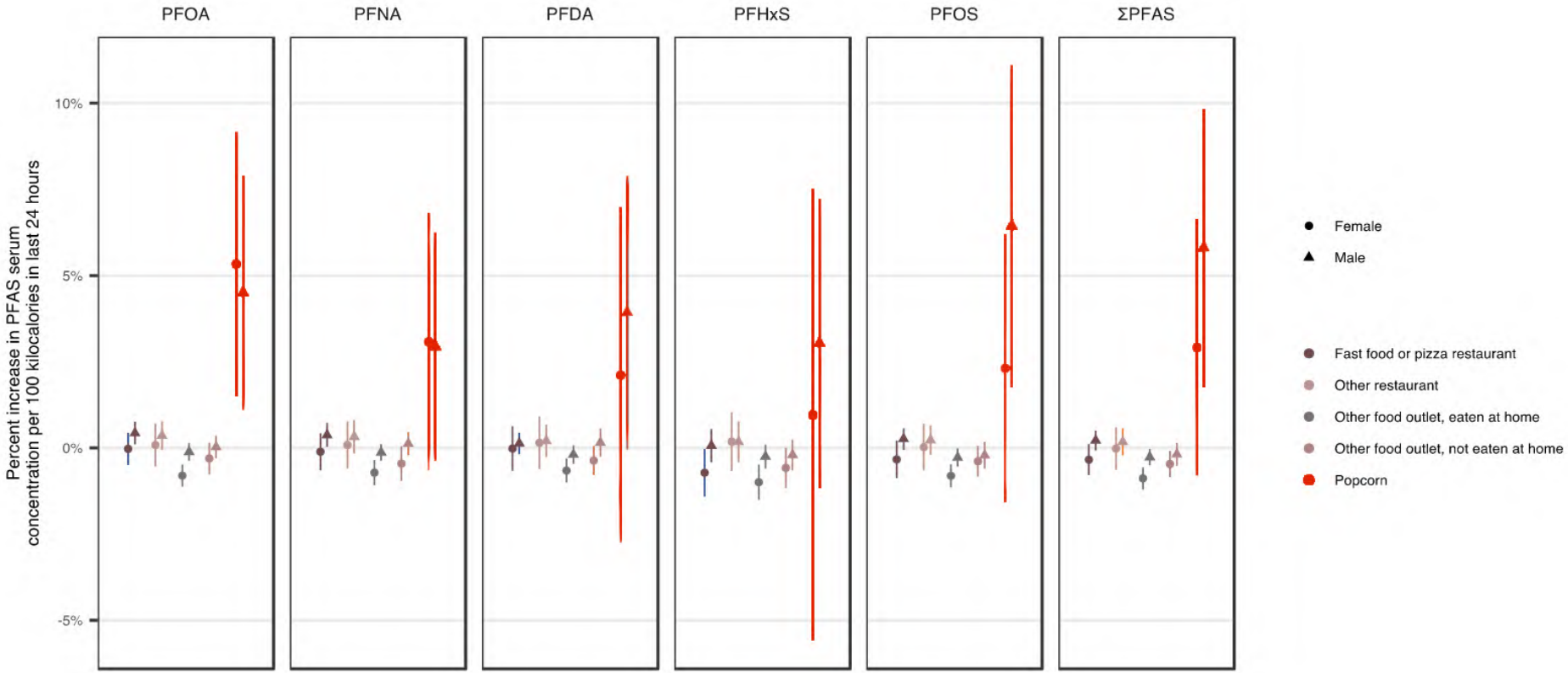
Five Guys

Wrapper for hamburger, aluminum foil	8.0
Container for french fries	ND
Wrapper for vegetable sandwich, aluminum foil	ND
Wrapper for hot dog, aluminum foil	ND

Sweetgreen

Paper bag for focaccia	■■	288.0
Fiber bowl for salad		9.3
Fiber bowl for sides, meals		8.8

https://www.consumerreports.org/pfas-food-packaging/dangerous-pfas-chemicals-are-in-your-food-packaging-a3786252074/

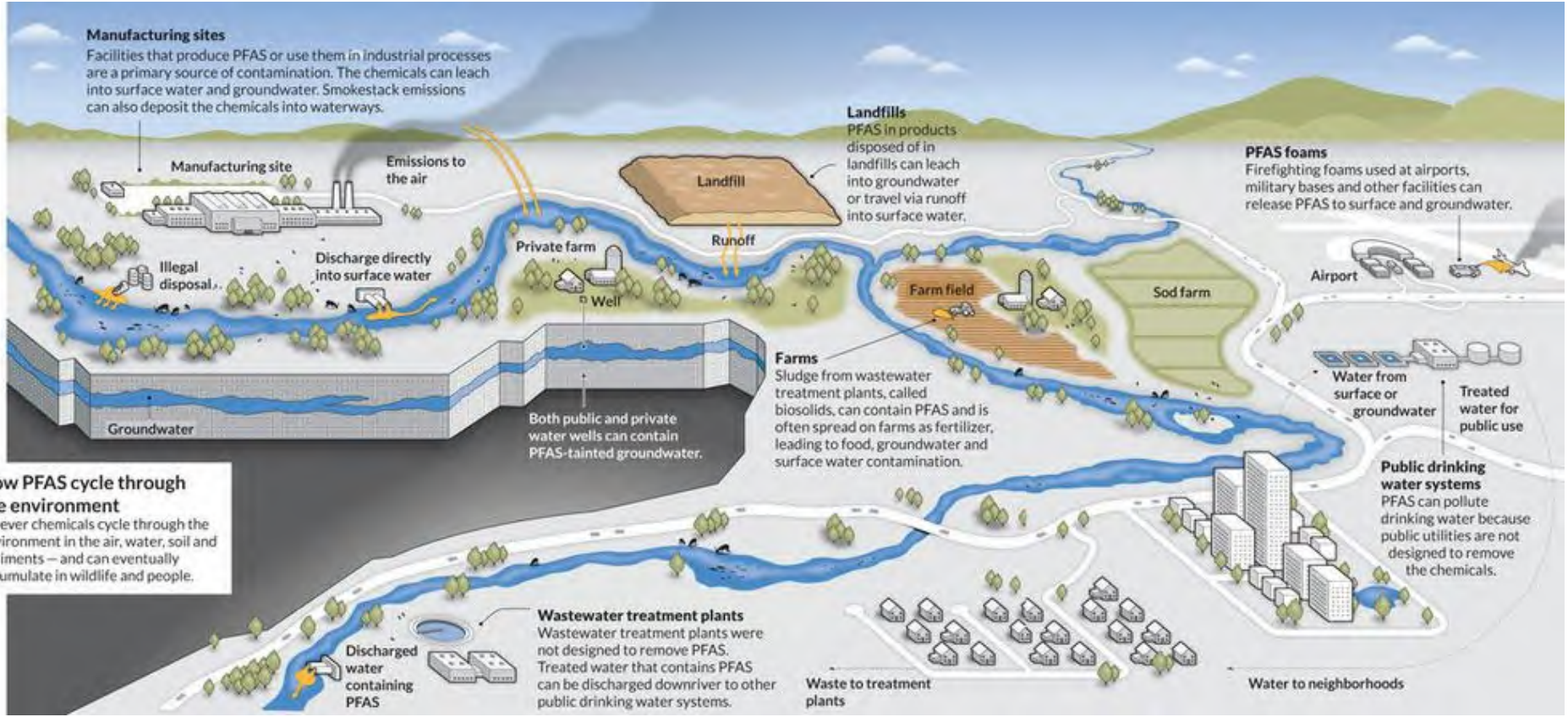


Susmann, Herbert P., Laurel A. Schaider, Kathryn M. Rodgers, and Ruthann A. Rudel. "Dietary habits related to food packaging and population exposure to PFASs." Environmental health perspectives 127, no. 10 (2019): 107003. https://doi.org/10.1289/EHP4092


Ag
Chem


GORE
GUARANTEED
TO KEEP YOU DRY
GORE-TEX
PRODUCTS
GORE

https://atslab.com/prop-65/pfas-regulations/

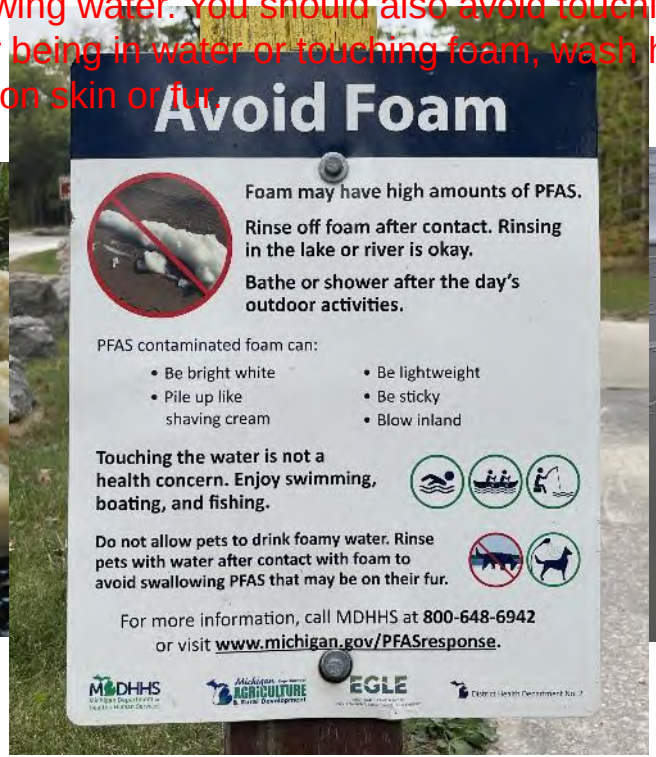


https://www.sciencenewsdigital.org/sciencenews/library/item/november_19__2022/4055387/

Touching lake, river, or stream water that has PFAS is not an immediate health concern. You should avoid drinking or accidentally swallowing water. You should also avoid touching foam on the water that might be contaminated with PFAS. After being in water or touching foam, wash hands and rinse pets to prevent swallowing PFAS that may be on skin or fur.

Naturally occurring foam…

Is off-white and/or brown
Often accumulates in bays, where there is circular movement of water, or river blockages
May smell earthy or fishy



PFAS foam….

Can have bright white coloring
Tends to pile up like shaving cream
Can be sticky
May blow inland and collect on lake shores and river banks
Is usually lightweight

Wastewater Treatment

WWT Doesn't Remove PFAS

Figure 25. PFOS Influent and Effluent Concentrations for the 42 WWTPs Assessment

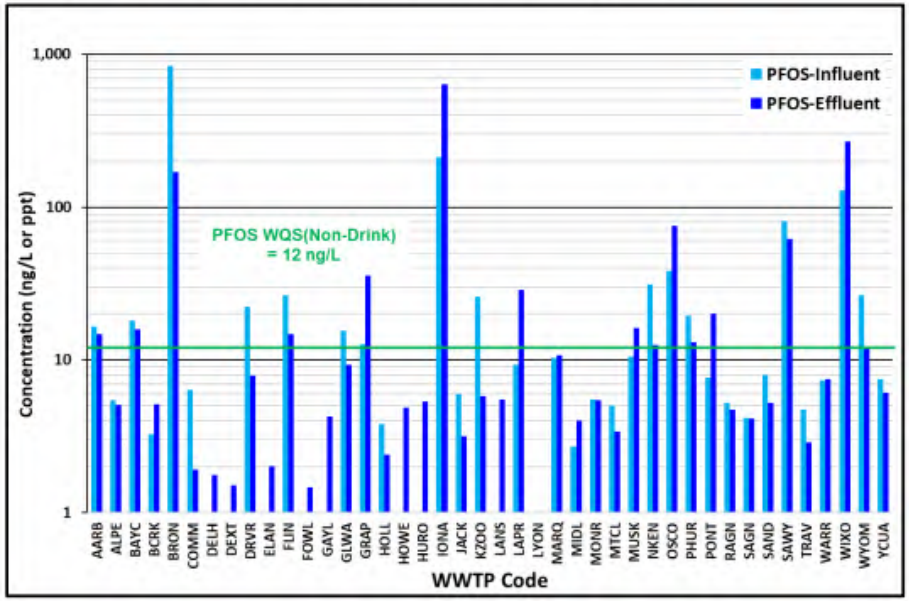
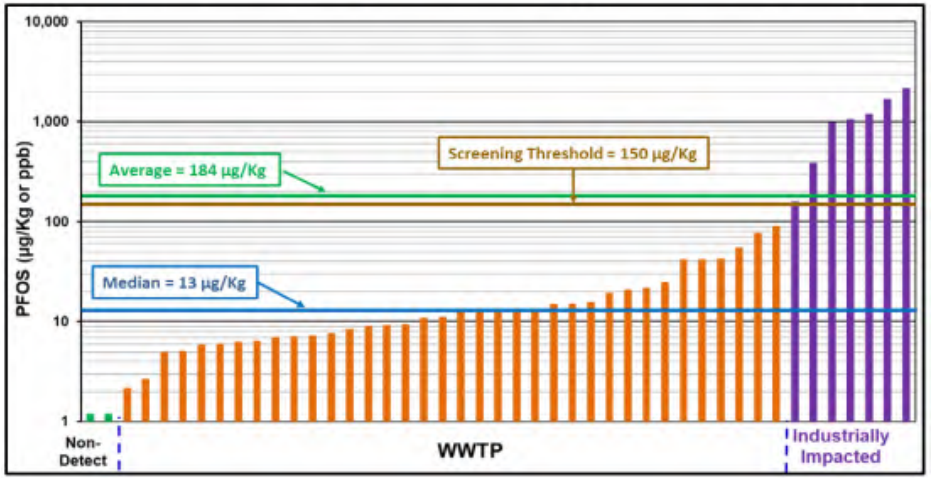
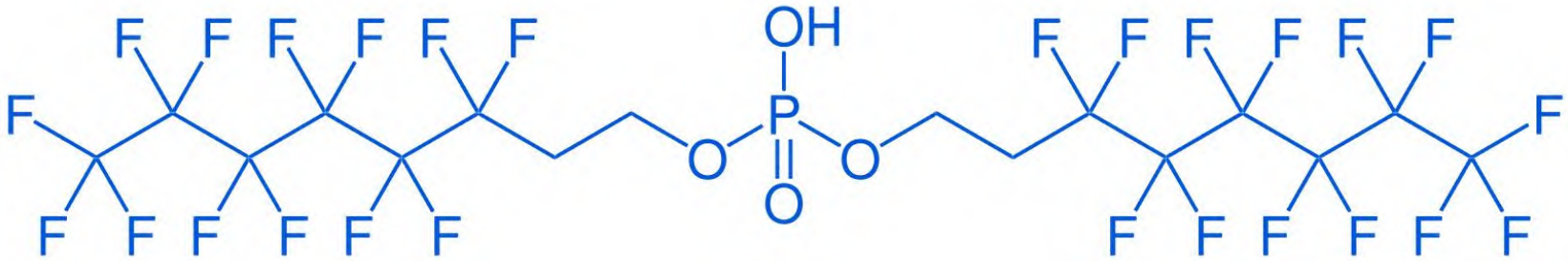


Figure 33. Final Treated Solids (Sludge and Biosolids) PFOS Concentrations for 42 WWTPs



https://www.michigan.gov/-/media/Project/Websites/egle/Documents/Programs/WRD/IPP/pfas-initiatives-statewide-full-report.pdf?rev=946d5956f41b45a2a00d752149f57dc0

PFAS in Toilet Paper



6:2 diPAP

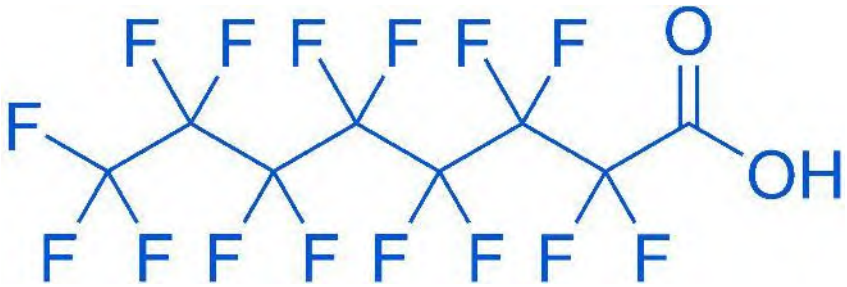
bis[2-(perfluorohexyl)ethyl] phosphate

bis(3,3,4,4,5,5,6,6,7,7,8,8,8-tridecafluoro-1-octanol) hydrogen phosphate

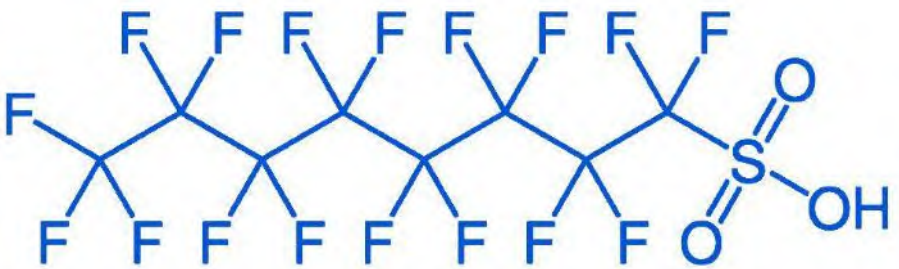
What's Being Done

- Alternatives are being used
- Bans on added PFAS
- Regulators are reducing levels of concern
- Increased monitoring
- Implementation of removal technologies

ALTERNATIVES



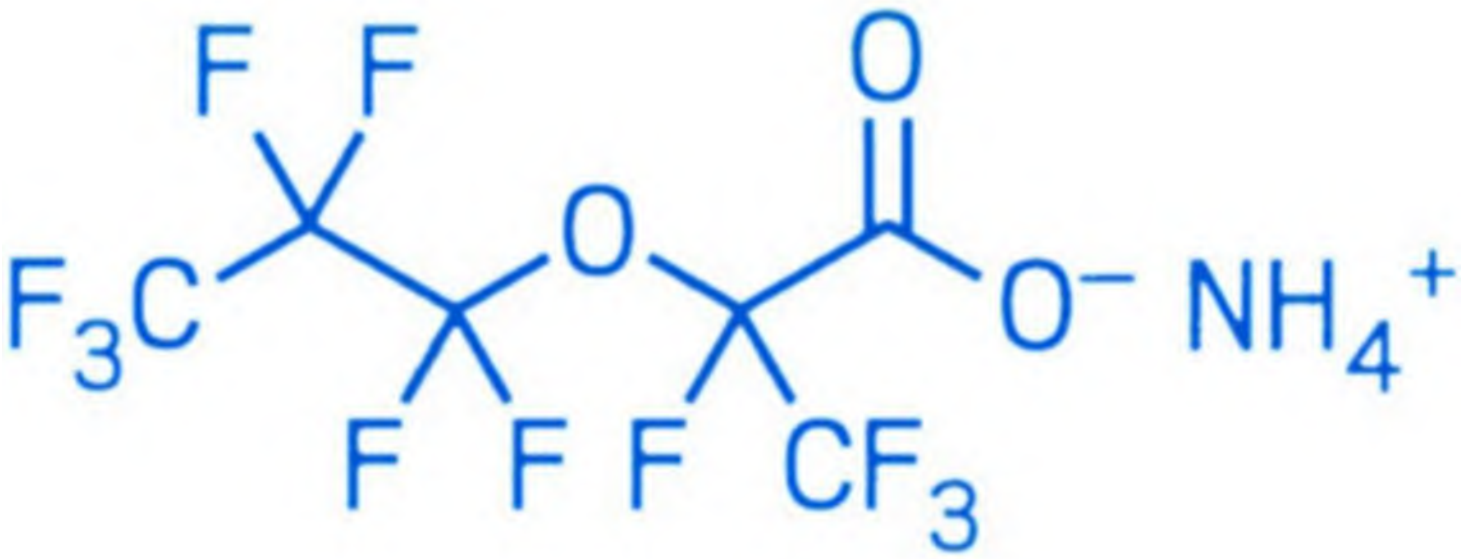
PFOA



PFOS

Human blood levels of PFOA and PFOS in the US are more than 70–85% less than they were in 1999.

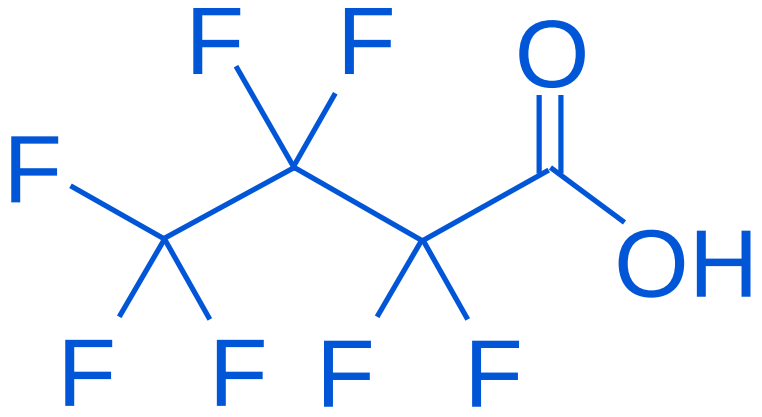
Safer Alternative?



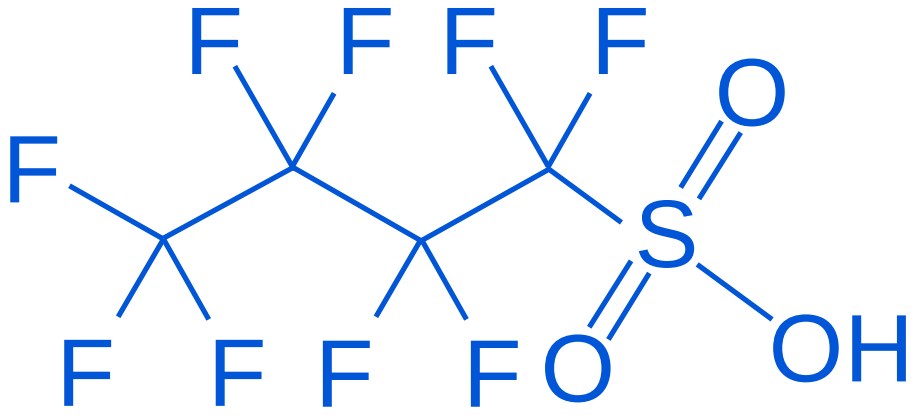
GenX

Shorter Chain Alkyl

the estimated half-lives for short-chain PFASs (such as PFBA, PFBS and PFHxA) were found to range from a few days to approximately one month, whereas for compounds having a long perfluoroalkyl chain length (such as PFOA, PFNA, PFDA, PFHxS or PFOS), it can be several years.



PFBA

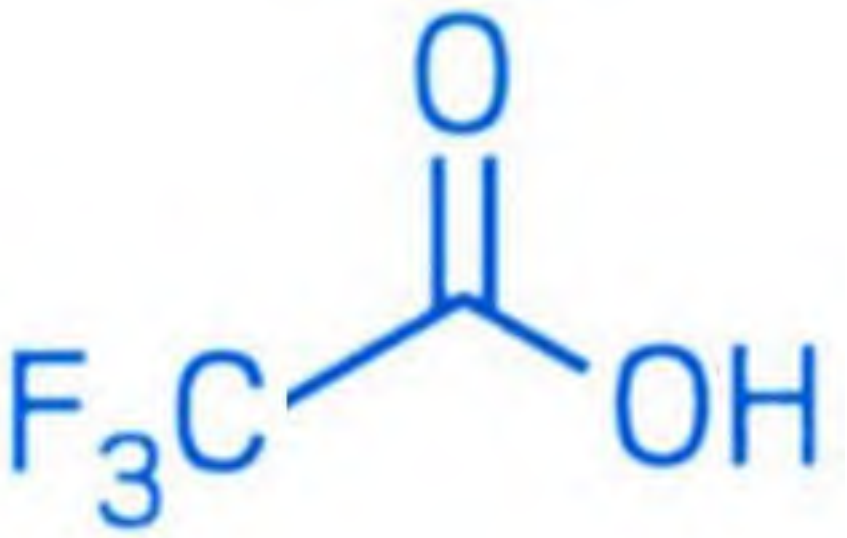


PFBS

In 2002, 3M announced a new fluorosurfactant as an alternative to perfluorooctane sulfonic acid (PFOS). The new chemical, perfluorobutane sulfonic acid (PFBS), was a shorter chain PFAS and was believed to be less biologically accumulative than its longer chain counterpart PFOS.

Regrettable Substitution

Perfluoroacetic Acid



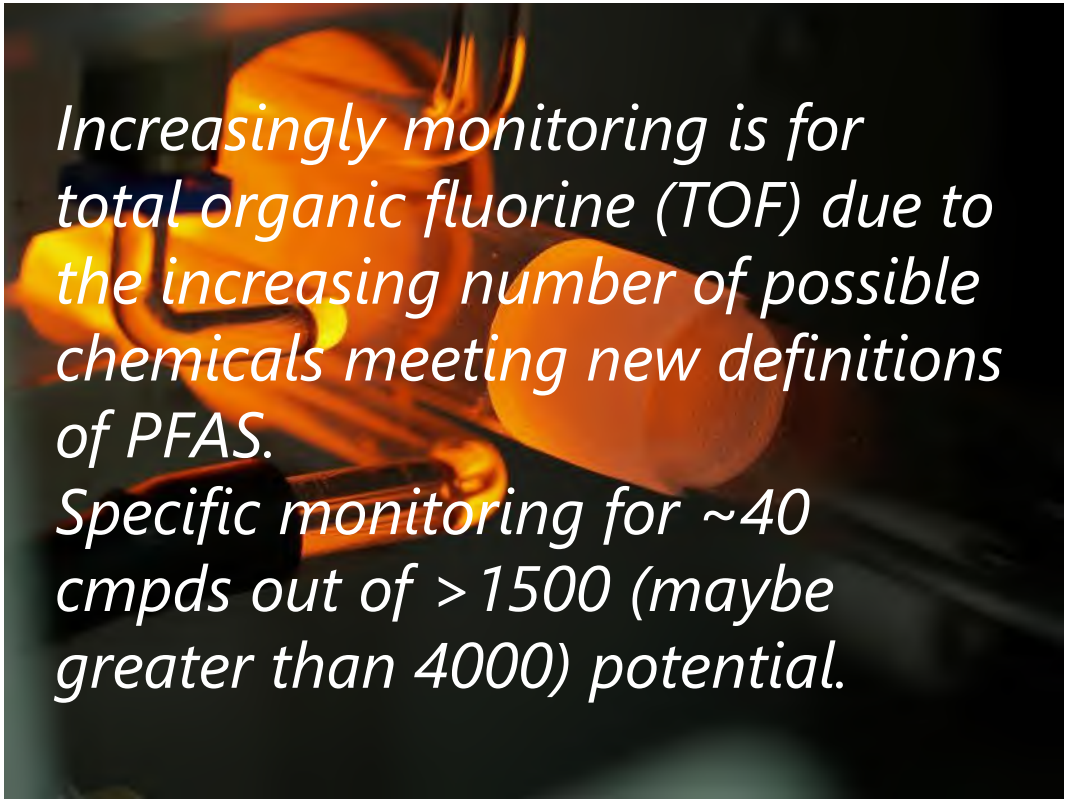
What is Being Done

- Bans on added PFAS
  - California, Colorado, Hawaii, Maine, Maryland, Minnesota, New York, Oregon, Rhode Island, Vermont, and Washington have passed laws on the manufacture and selling of articles containing PFAS.
- Regulators are reducing levels of concern
  - EPA (June 2022):
    - PFOA from 70 ppt to 0.004 ppt
    - PFOS from 70 ppt to 0.02 ppt
    - GenX chemicals to 10 ppt
    - PFBS to 2 ppb (2000 ppt)
  - WHO (29 Sept 2022):
    - PFOA 100 ppt
    - PFOS 100 ppt
    - total PFAS of 500 ppt (6 compounds)

BANS

- Jan 1, 2023 banned food packaging with intentionally added PFAS
  - covers packages or packaging components intended for direct food contact and are comprised mainly of paper, paperboard, or materials from plant fibers
  - included consumer goods like paper plates, cups and bowls
- Effective Jan 1, 2025 banned intentionally added PFAS in apparel
  - OECD definition – just one fully fluorinated carbon
  - Gore Tex exemption until Jan 1, 2028 for outdoor apparel for severe wet conditions

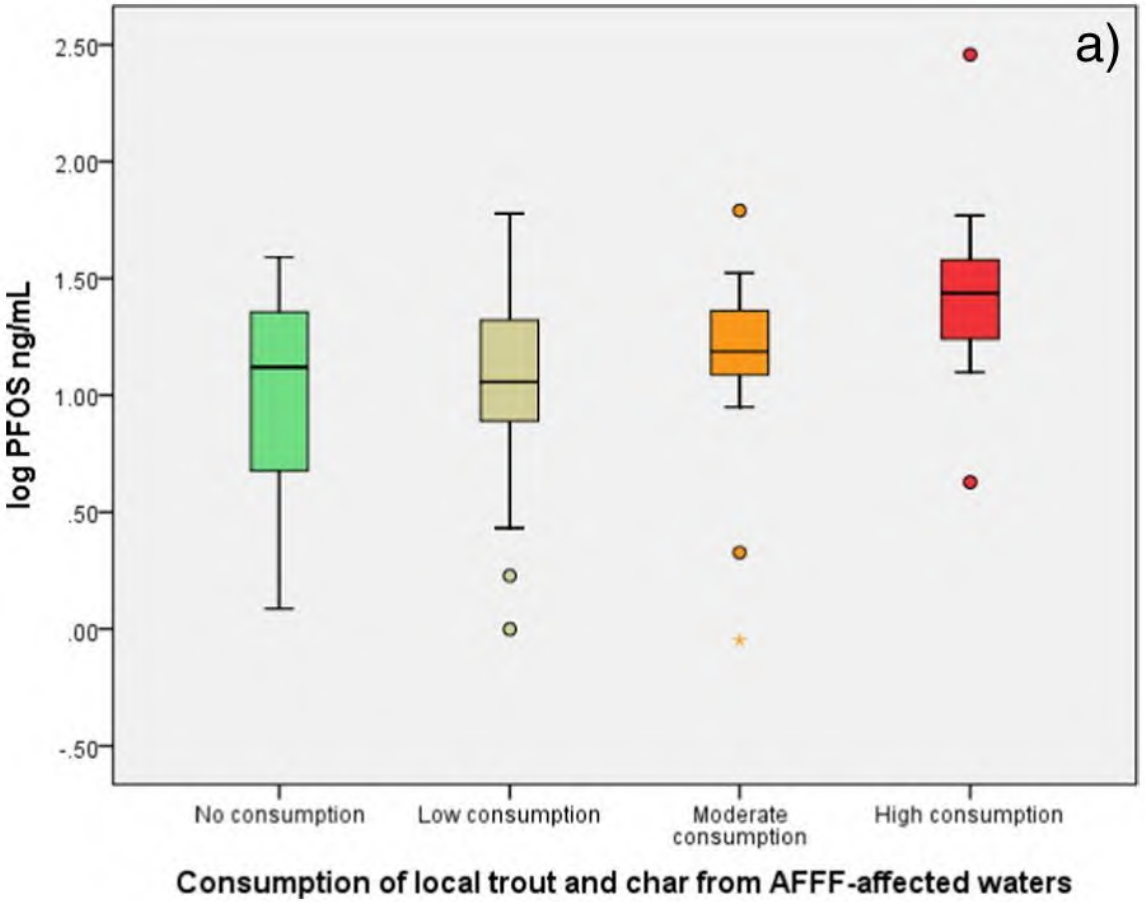
Increased Monitoring



Implement Removal Technologies

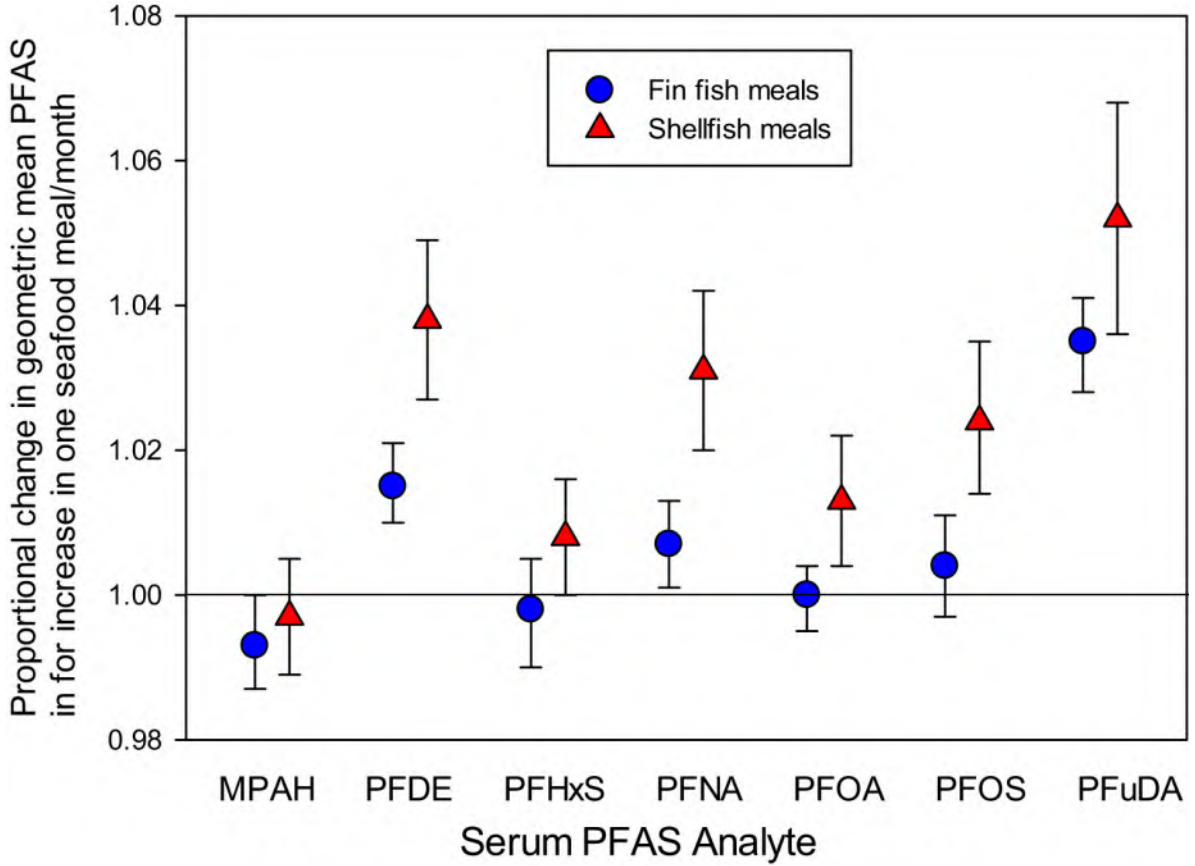
How to Reduce Personal Exposure

- Reduce Use of Products Known to Migrate PFAS
- Reduce PFAS Levels in the Water You Drink and Foods You Eat
  - follow advisories on fish and game from contaminated areas



Box-plot with concentrations (ng/mL) of log transformed PFOS by consumption of trout and char from the aqueous film-forming foam (AFFF)-affected waters of Langvatnet, Lavangsvatnet, and Tårstadelva.

Hansen, Solrunn, Robin Vestergren, Dorte Herzke, Marita Melhus, Anita Evenset, Linda Hanssen, Magritt Brustad, and Torkjel M. Sandanger. "Exposure to per-and polyfluoroalkyl substances through the consumption of fish from lakes affected by aqueous film-forming foam emissions—A combined epidemiological and exposure modeling approach. The SAMINOR 2 Clinical Study." *Environment International* 94 (2016): 272-282.



Associations between any seafood consumption in the last 30 days and PFAS concentrations, after adjusting for age, BMI, sex, race/ethnicity and survey cycle.

Christensen, Krista Y., Michelle Raymond, Michael Blackowicz, Yangyang Liu, Brooke A. Thompson, Henry A. Anderson, and Mary Turyk. "Perfluoroalkyl substances and fish consumption." *Environmental research* 154 (2017): 145-151.

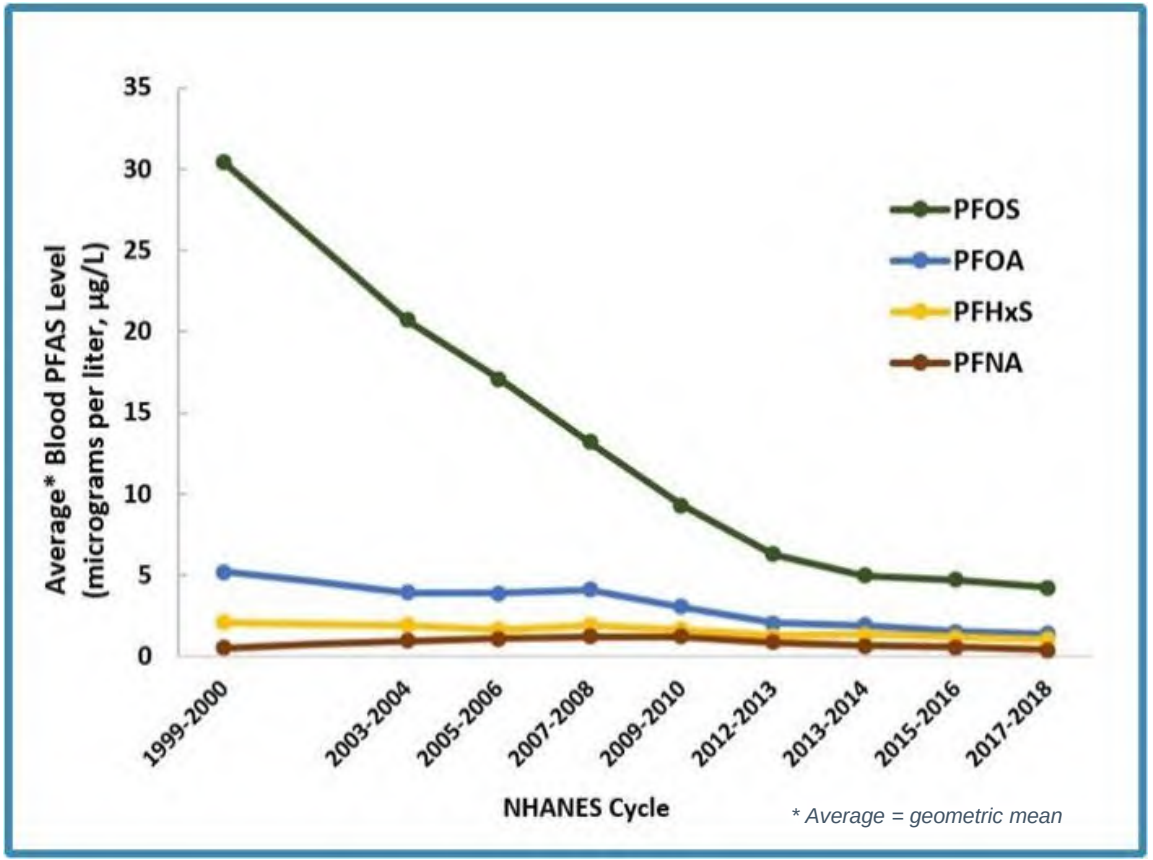
Eat Safe Guidelines – Lake Superior

Type of Fish	Chemicals of Concern	Size of Fish (length in inches)	MI Servings per Month*
Brown Trout	PCBs	Any	1[2x]
Burbot	Mercury	Under 18”	4
		Over 18”	2
Chinook Salmon	PCBs	Any	6 Per Year[2x]
Coho Salmon	PCBs & Toxaphene	Any	4[2x]
Lake Herring	Mercury	Any	8
Lake Trout	PCBs & Toxaphene	Under 24”	2[2x]
	PCBs	24” to 28”	1[2x]
		Over 28”	6 Per Year[2x]

Type of Fish	Chemicals of Concern	Size of Fish (length in inches)	MI Servings per Month*
Lake Whitefish	Dioxins	Any	1[2x]
Northern Pike	Mercury	Any	2
Rainbow Trout	PCBs	Any	2[2x]
Siscowet	PCBs & Toxaphene	Any	Limited▲
Smelt	PFOS	Any	1
Steelhead	PCBs	Any	2[2x]
Suckers	Toxaphene	Any	2[2x]
Walleye	Mercury	Any	2
Yellow Perch	Mercury	Any	2

- **Eat Safe Fish new interim fish consumption guidelines for rainbow smelt and carp as of August 2023.**
  - The following waterbodies have new consumption guidelines for rainbow smelt due to PFOS:
    - Lake Huron: No more than **6 MI Servings per year**.
    - Lake Michigan: No more than **1 MI Serving per month**.
    - Portage Lake in Houghton County: No more than **1 MI Serving per month**.
    - Gull Lake in Kalamazoo County: No more than **2 MI Servings per month.**
    - Higgins Lake in Roscommon County: No more than **4 MI Servings per month.**
    - Lake Superior: **1 MI Serving per month.**

Reason for Some Optimism



Blood Levels of the Most Common PFAS in People in the United States Over Time from National Health and Nutrition Examination Survey (NHANES) cycle 1999-2000 to 2017-2018.

Data Source
Centers for Disease Control and Prevention. National Report on Human Exposure to Environmental Chemicals, Biomonitoring Data Tables for Environmental Chemicals. Atlanta, GA: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention.

https://www.atsdr.cdc.gov/pfas/health-effects/us-population.html

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New Report Calls for Expanded PFAS Testing for People With History of Elevated Exposure, Offers Advice for Clinical Treatment

News Release | July 28, 2022

WASHINGTON — Testing for exposure to perfluoroalkyl and polyfluoroalkyl substances, also known as PFAS, should be offered to patients who are likely to have a history of elevated exposure — such as those exposed to PFAS through their work or who live in areas with known PFAS contamination, says a new report from the National Academies of Sciences, Engineering, and Medicine. The report finds evidence of association between PFAS exposure and increased

MJPhD

- Using serum or plasma concentrations of the sum of the seven PFAS considered by the committee, patients whose tests show a PFAS blood concentration below 2 nanograms per milliliter (ng/mL) are not expected to have adverse health effects.

- Patients with test results between 2 and 20 ng/mL may face the potential for adverse effects, especially in sensitive populations (such as pregnant individuals). Clinicians should encourage reduction of PFAS exposure for these patients. Following the usual standard of care, clinicians should also prioritize screening for dyslipidemia, hypertensive disorders of pregnancy, and breast cancer based on age and other risk factors.

- Patients with test results above 20 ng/mL may face a higher risk of adverse effects. Clinicians should encourage exposure reduction and prioritize screening for dyslipidemia in accordance with guidance for patients with increased risk. In addition to the care recommended for patients who test between 2 and 20 ng/ml, clinicians should also conduct thyroid function testing, and assess for signs of kidney and testicular cancer and of ulcerative colitis at all wellness visits.

- The report recommends clinicians begin with a conversation on how a patient might be exposed to PFAS, and which exposures they are interested in reducing — including questions about occupational exposures. Clinicians should also advise patients with elevated PFAS in their drinking water to filter their water. The report points to a database created by NSF International to help patients locate water filters that can reduce PFAS.

Living With PFAS

- Rapidly changing understanding
- Reasons for caution
  - with some reasons for optimism
- Reduce exposure

Forever chemicals will not be going away.