

# MJPHD

## “AVOID FOAM” AND OTHER CONSEQUENCES OF LIVING IN A WORLD WITH PFAS

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*29 November 2022*



## ABSTRACT

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“Avoid Foam” signs now warn of PFAS, per- and polyfluorinated alkyl substances, contamination in parts of Michigan. Christened “forever chemicals”, PFAS are of great concern across the globe, with Michigan being particularly impacted. This talk will review the definition of PFAS, why they are a concern, the history and decisions leading to the issues faced today, and what is being done. PFAS are an example of unintended consequences of a chemical technology. They are used because they provide benefits, but those benefits come with risks that are only now being understood. Getting rid of something that lasts forever is a daunting task. It is made more daunting by introduction of new PFAS materials, including pharmaceuticals and agricultural chemicals.



Van Etten Lake State Forest Campground

Google Earth

# SIGNS FROM OSCODA

## Avoid Foam



Foam may have high amounts of PFAS.

Rinse off foam after contact. Rinsing in the lake or river is okay.

Bathe or shower after the day's outdoor activities.

PFAS contaminated foam can:

- Be bright white
- Be lightweight
- Pile up like shaving cream
- Be sticky
- Blow inland

Touching the water is not a health concern. Enjoy swimming, boating, and fishing.




Do not allow pets to drink foamy water. Rinse pets with water after contact with foam to avoid swallowing PFAS that may be on their fur.



For more information, call MDHHS at 800-648-6942 or visit [www.michigan.gov/PFASresponse](http://www.michigan.gov/PFASresponse).









## HEALTH ADVISORY




Do not eat deer from the advisory area. High amounts of PFAS may be found in deer and could be harmful to your health.

### Map Legend

	Clark's Marsh		Town Range
	Advisory Area		USFS Land
	Sections		State Land

For more information, call MDHHS at 800-648-6942 or visit [Michigan.gov/PFASresponse](http://Michigan.gov/PFASresponse).









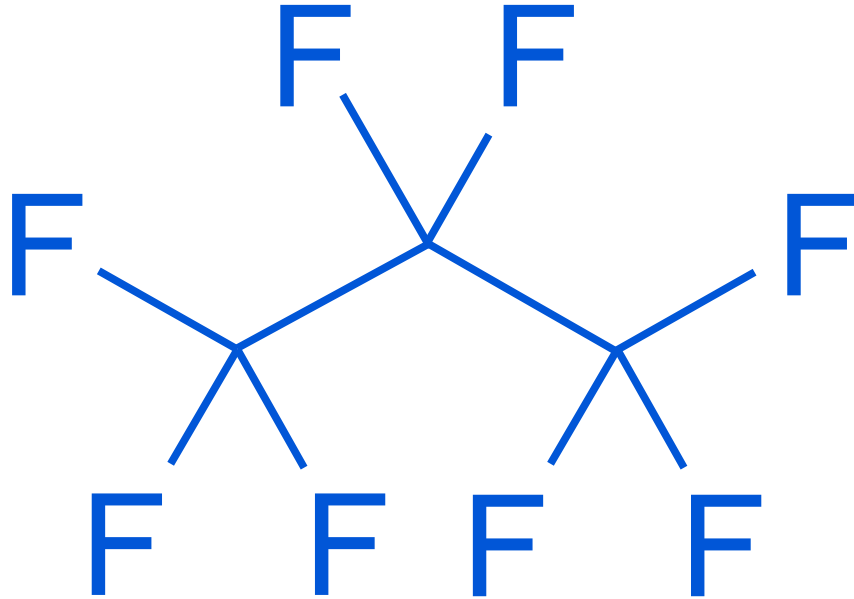


- Historic: Perfluorinatedalkyl Substances
- Recent: Perfluorinated and Polyfluorinatedalkyl Substances
- Shorthanded: Per- and Polyfluorinated Substances



# PFAS OR NOT

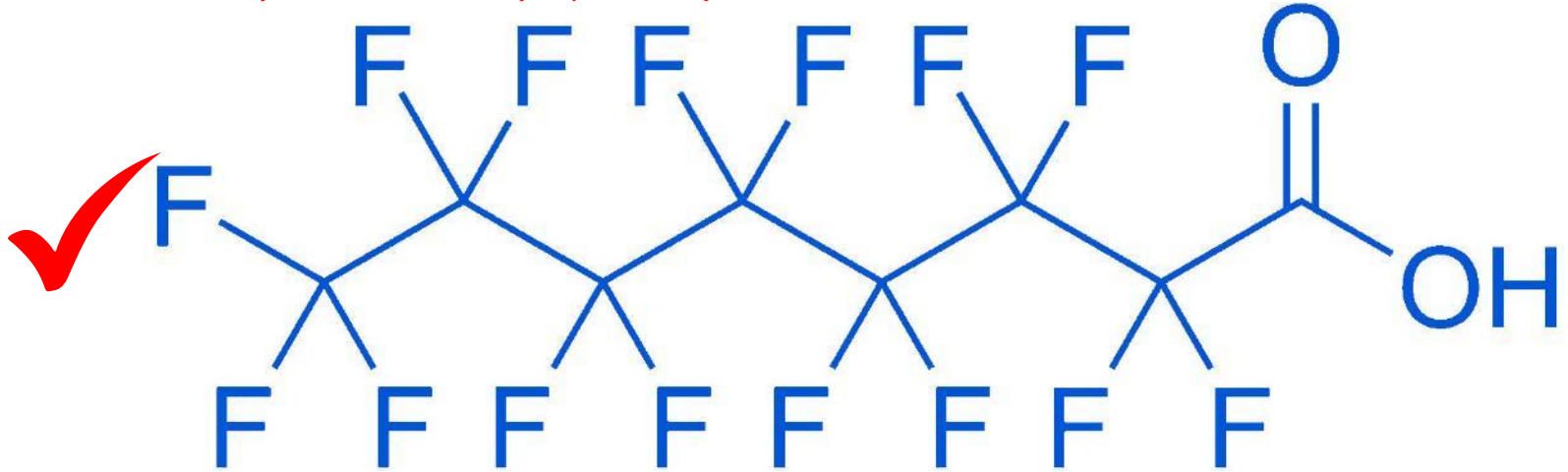
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## PFAS OR NOT

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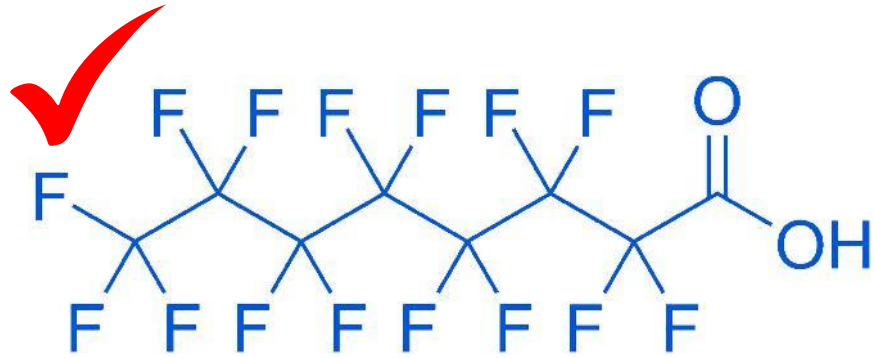
In 2017, the International Agency for Research on Cancer (IARC) classified perfluorooctanoic acid (PFOA), the most well-studied per- and polyfluoroalkyl substance (PFAS), as a possible human carcinogen based in part on limited epidemiologic evidence of associations with cancers of the kidney and testis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



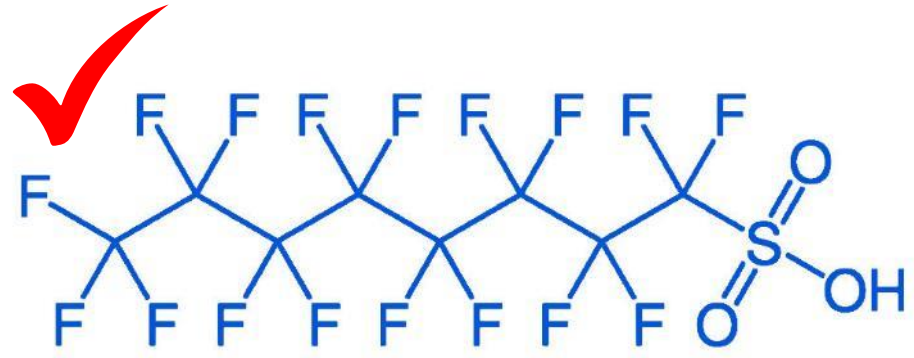
Perfluorooctanoic Acid = PFOA

## MOST WELL-STUDIED PFAS

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PFOA



PFOS

Perfluorooctanesulfonic acid

## PFOA AND PFOS

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### 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.

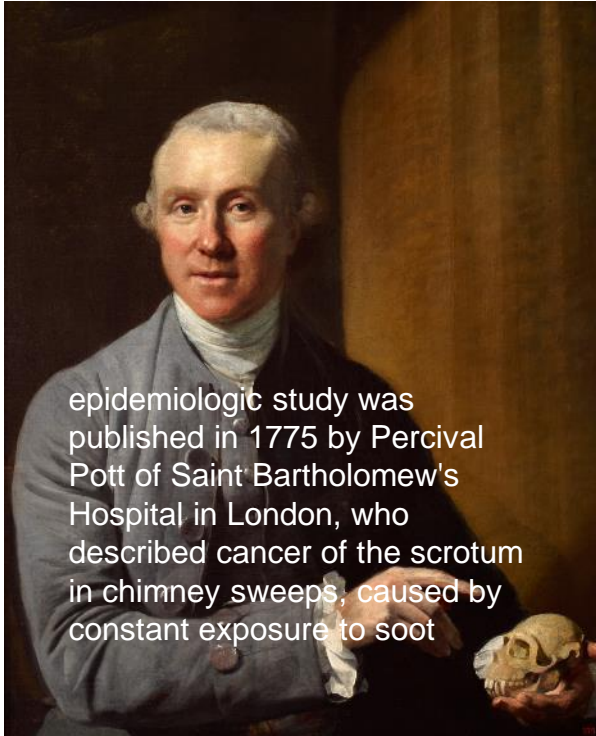
### Fluorinated organic substances:

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

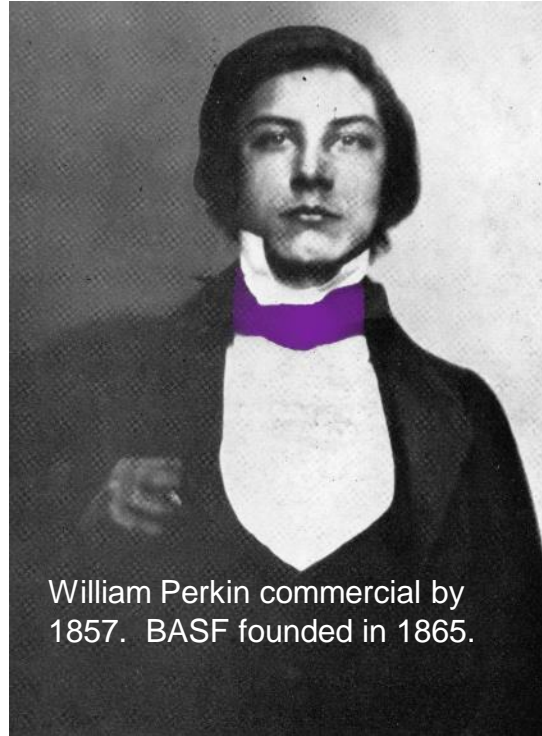
The most famous naturally existing organic fluorine containing compound is probably monofluoroacetic acid ( $\text{FCH}_2\text{CO}_2\text{H}$ ). This compound is found in a South African plant called "Gifblaar," which is known to be so poisonous that ingesting only a half of its leaf is enough to kill a cow.

# EPIDEMIOLOGY

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epidemiologic study was published in 1775 by Percival Pott of Saint Bartholomew's Hospital in London, who described cancer of the scrotum in chimney sweeps, caused by constant exposure to soot



William Perkin commercial by 1857. BASF founded in 1865.



1890s that a German surgeon reported the first cases of bladder cancer in dye workers. Ludwig Wilhelm Carl Rehn (1849–1930), Presented results 1895.

## EPIDEMIOLOGICAL STUDIES OF PFAO AND PFOS

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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

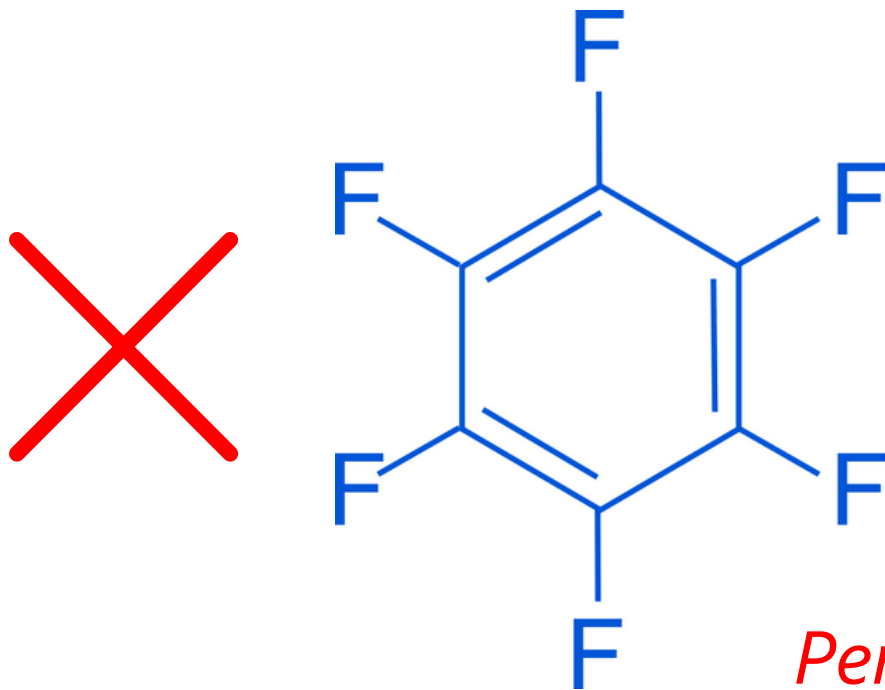


Increased risk of kidney or testicular cancer



# PFAS OR NOT

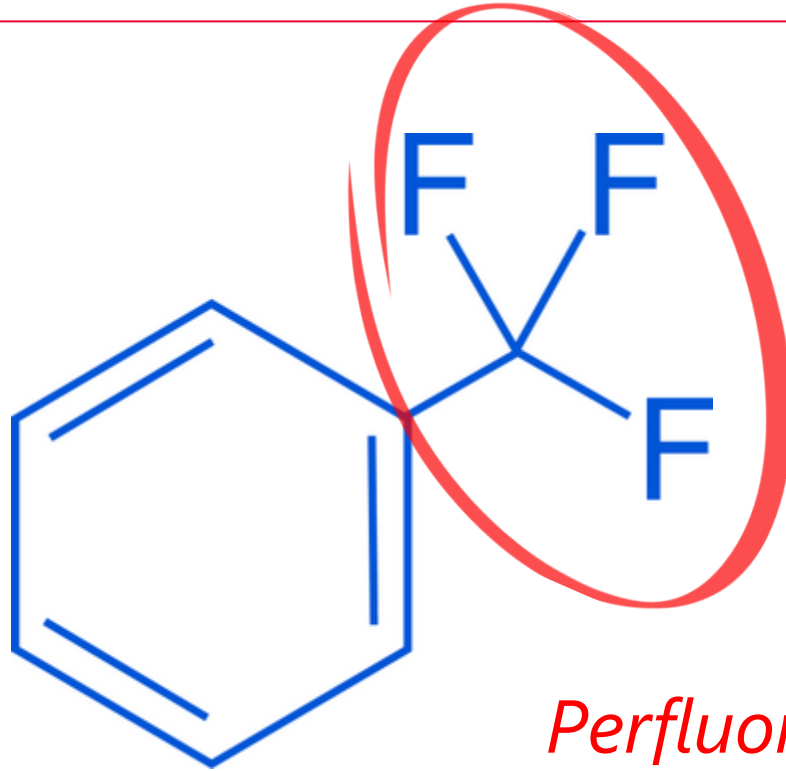
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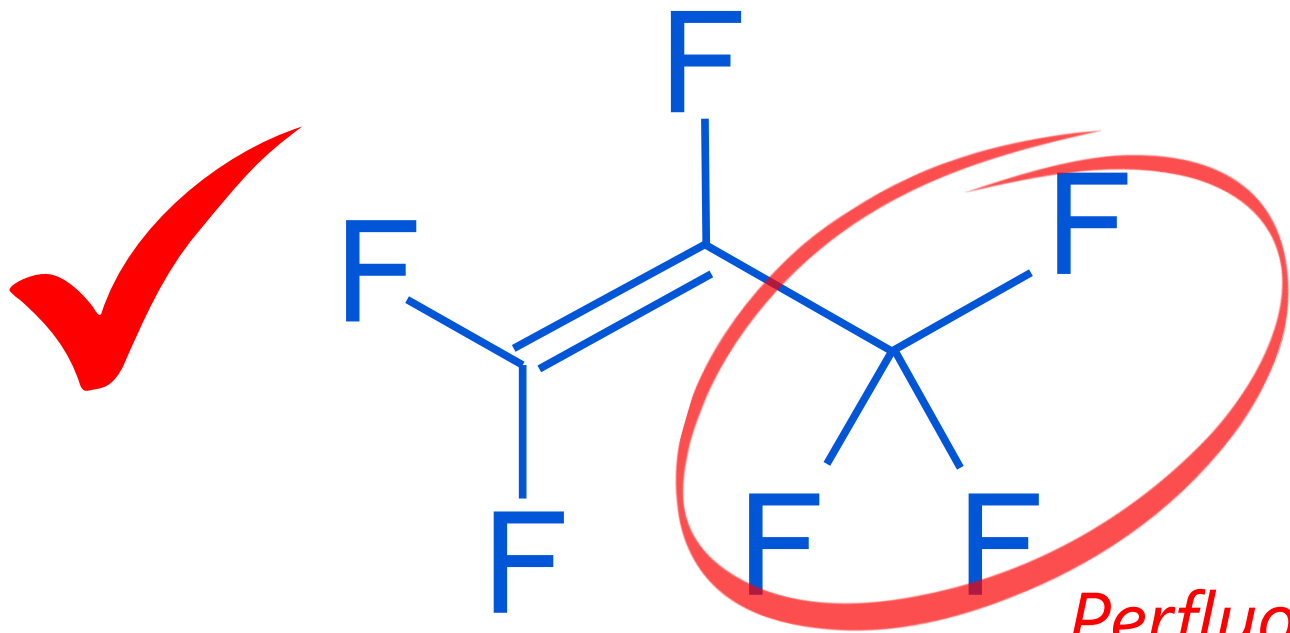
*Perfluoro but  
not alkyl*

# PFAS OR NOT

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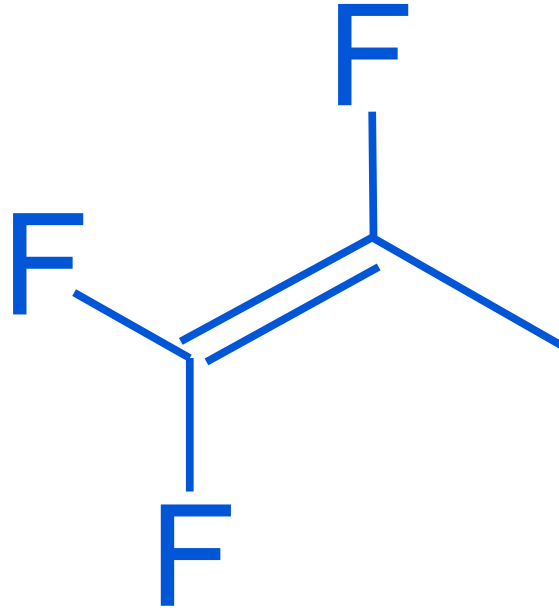
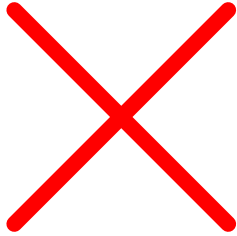
*Perfluoro alkyl group*

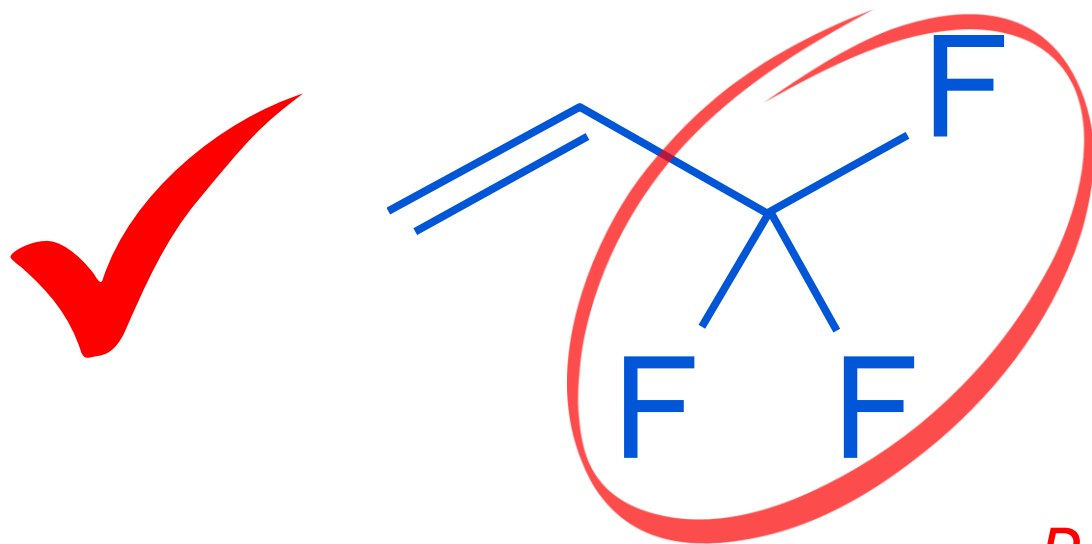


*Perfluoro alkyl  
group*

# PFAS OR NOT

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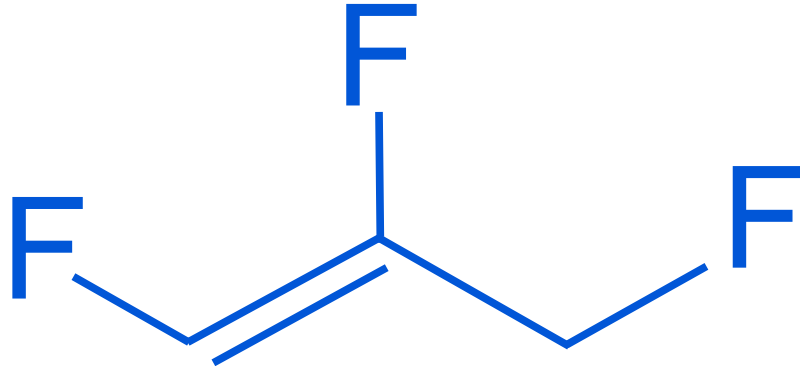
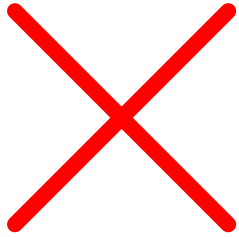


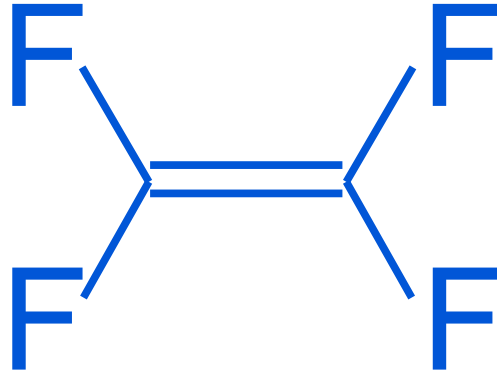
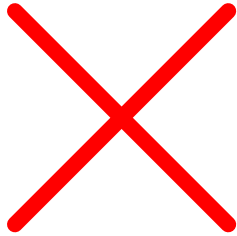


*Perfluoro alkyl  
group*

# PFAS OR NOT

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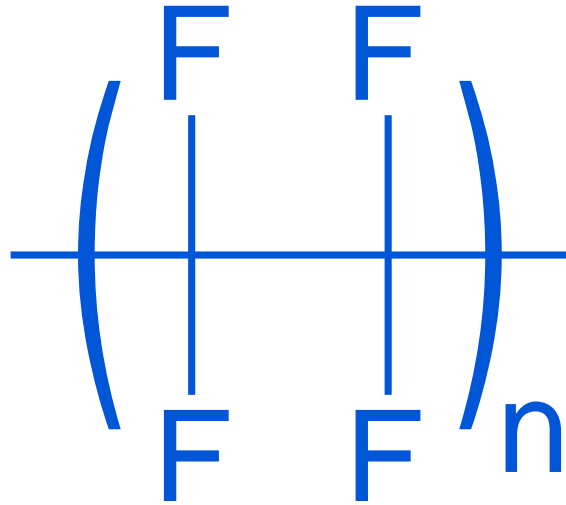


Tetrafluoroethylene

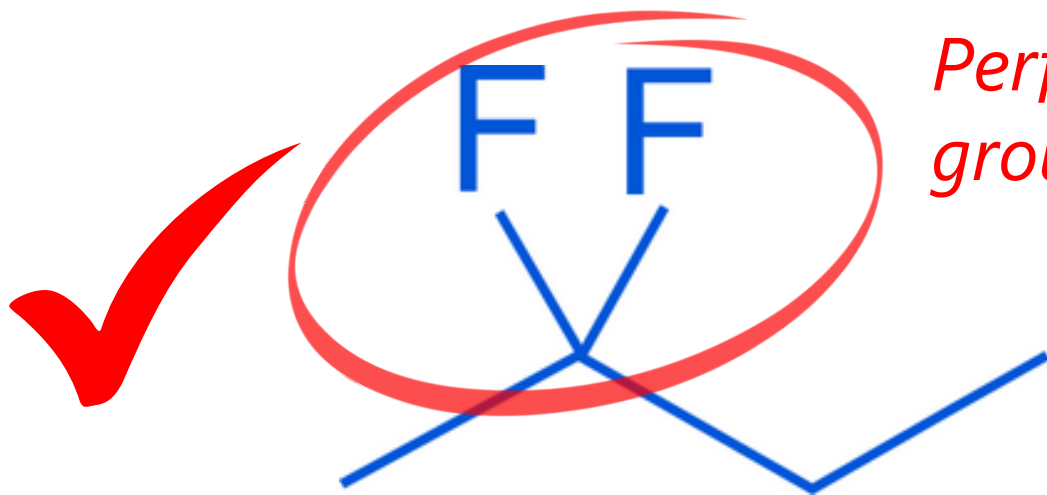


# PFAS OR NOT

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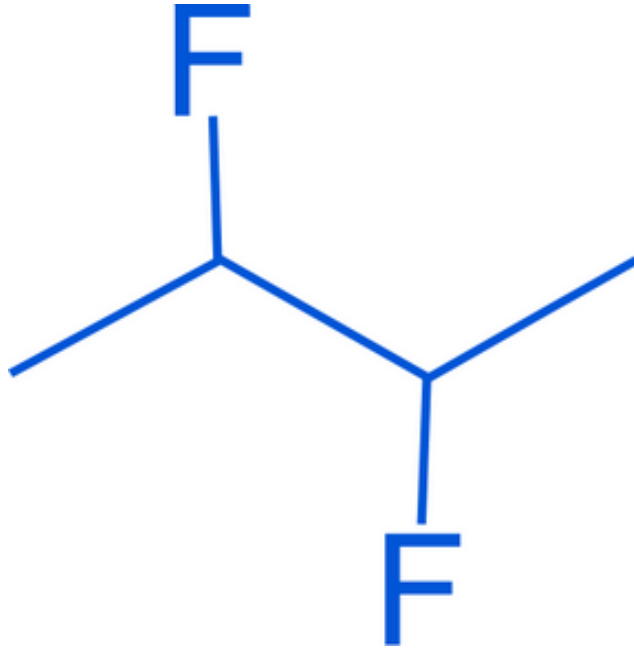
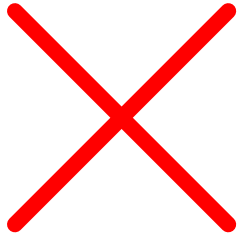
PTFE = Teflon



*Perfluoro alkyl  
group*

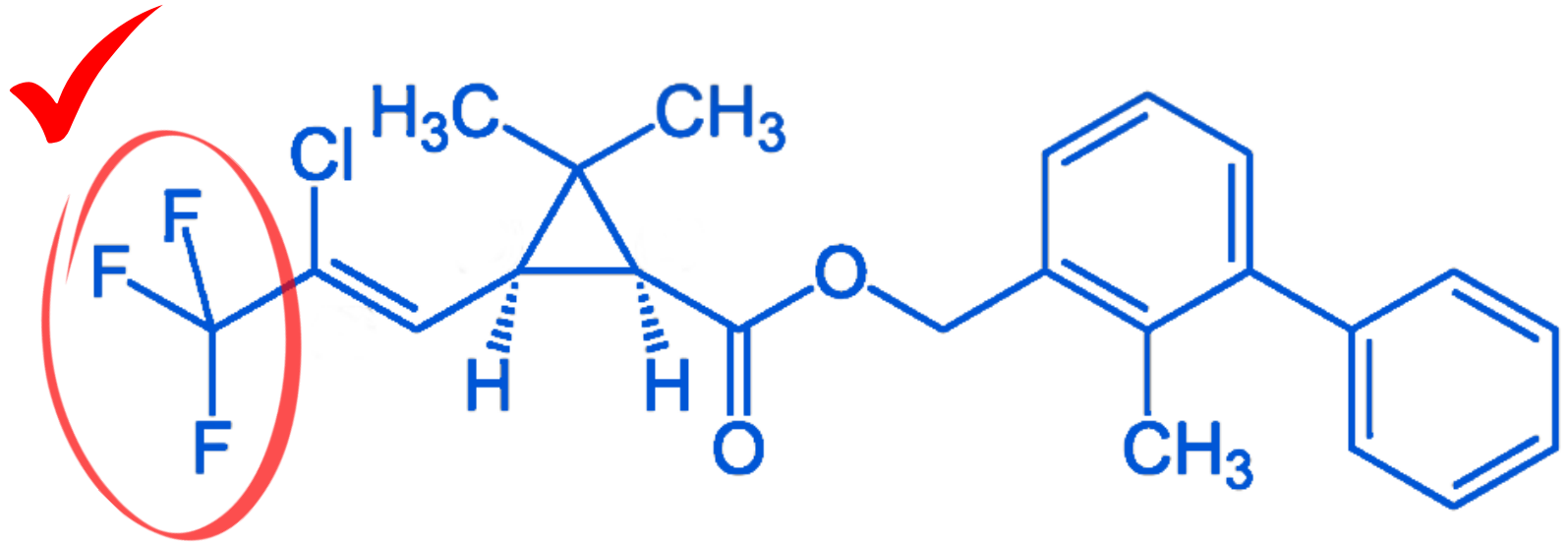
# PFAS OR NOT

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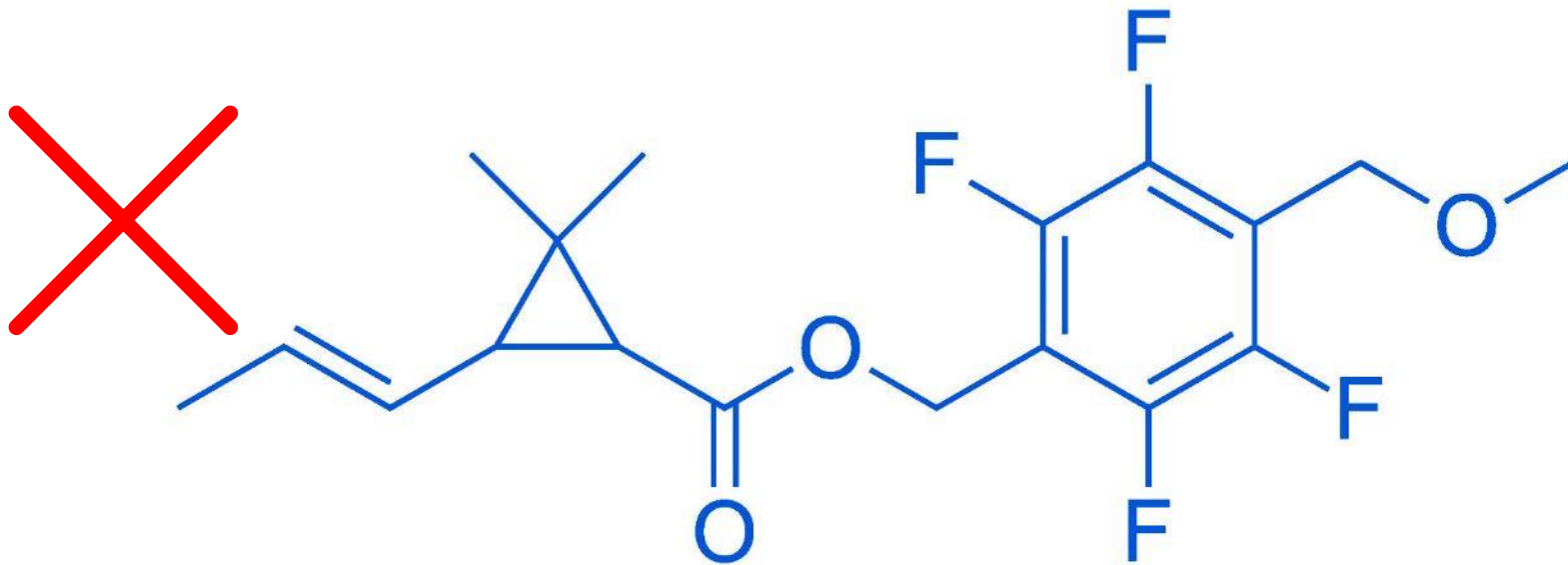


# PFAS OR NOT

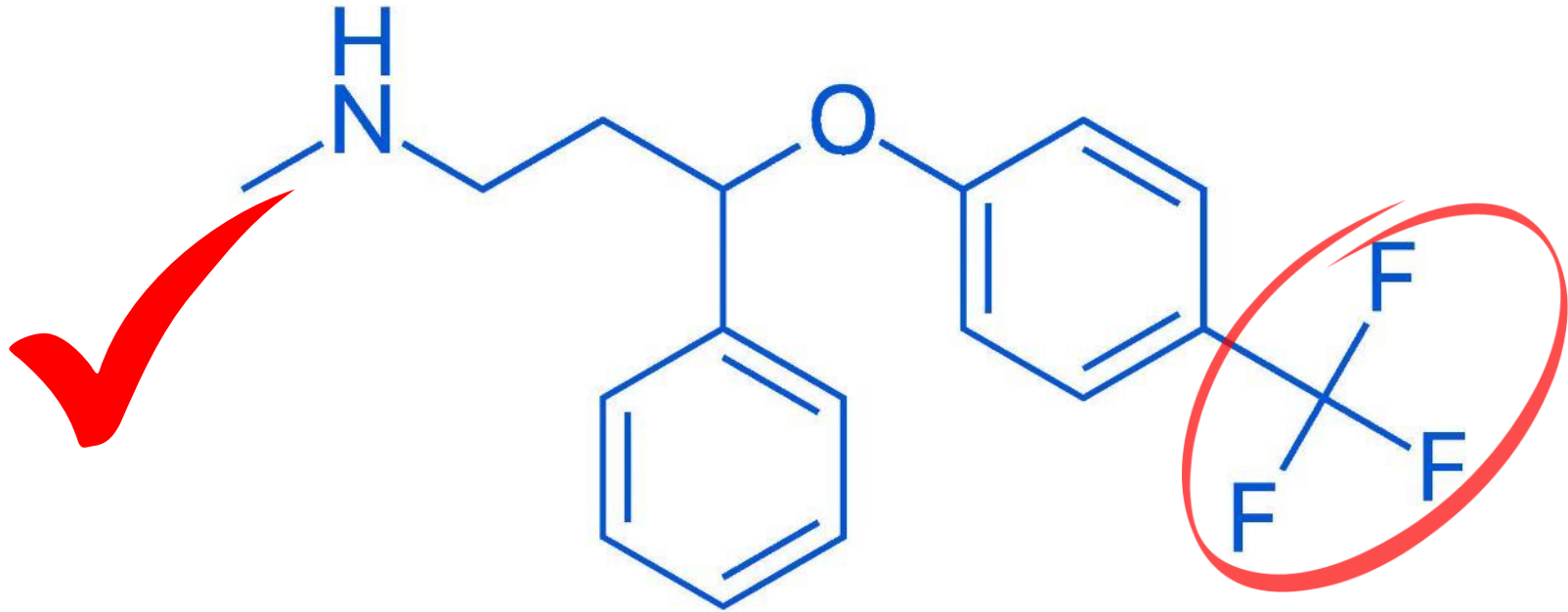
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Bifenthrin



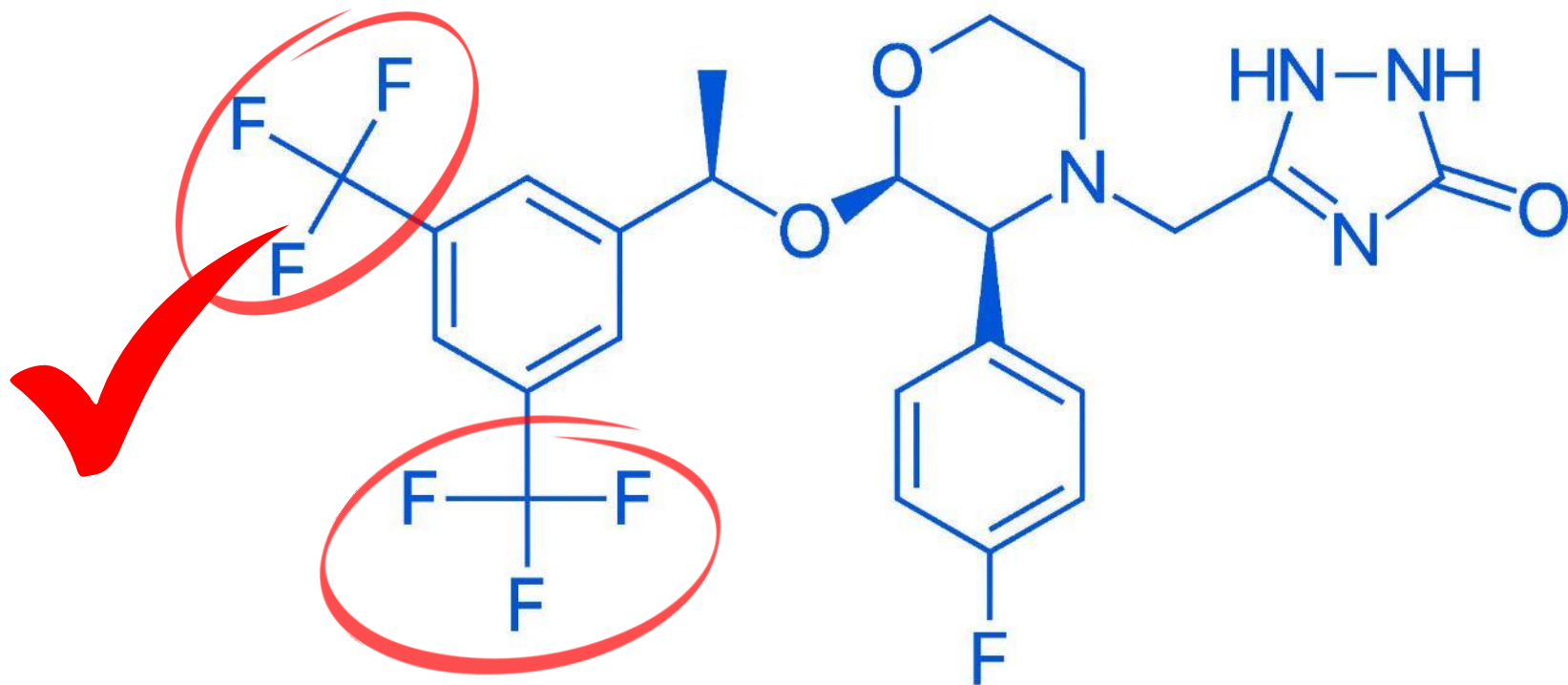
Metofluthrin



Fluoxetine = Prozac

# PFAS OR NOT

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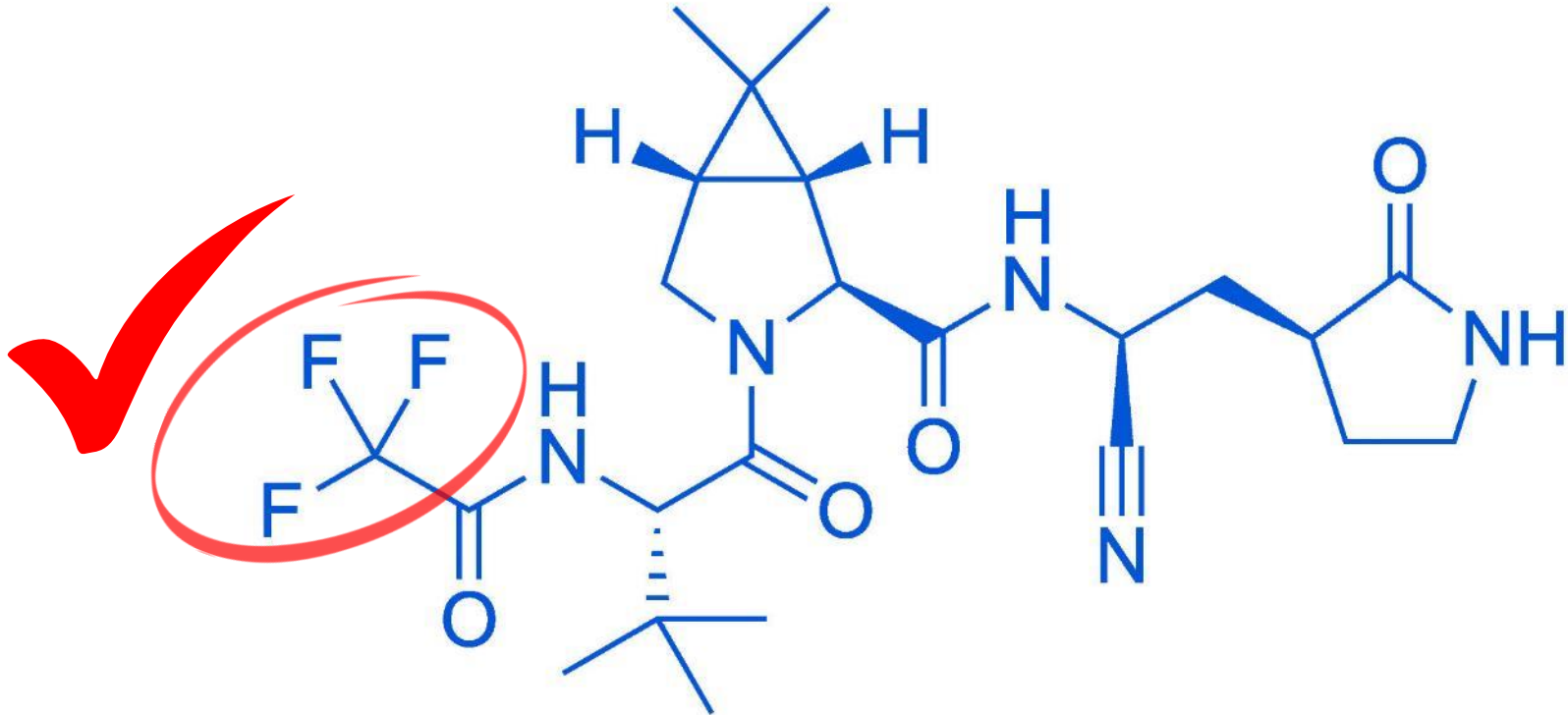
Aprepitant

2005 Green Chemistry Challenge winner



# PFAS OR NOT

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Nirmatrelvir = Paxlovid

## NEW OECD DEFINITION

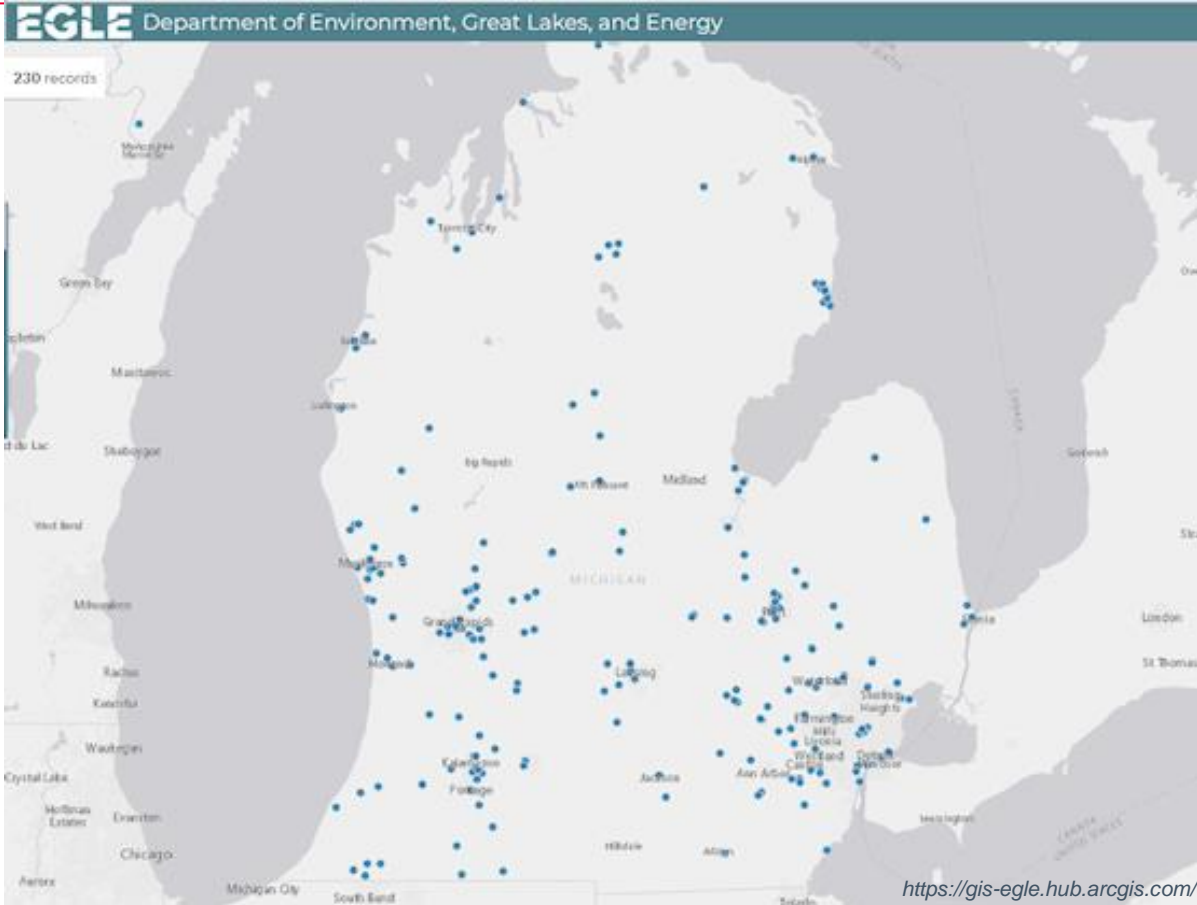
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PFASs are defined as fluorinated substances that contain at least one fully fluorinated methyl or methylene carbon atom (without any H/Cl/Br/I atom attached to it)

With a few exceptions, any chemical with at least a perfluorinated methyl group ( $-\text{CF}_3$ ) or a perfluorinated methylene group ( $-\text{CF}_2-$ ) is a PFAS.

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

# USES OF PFAS

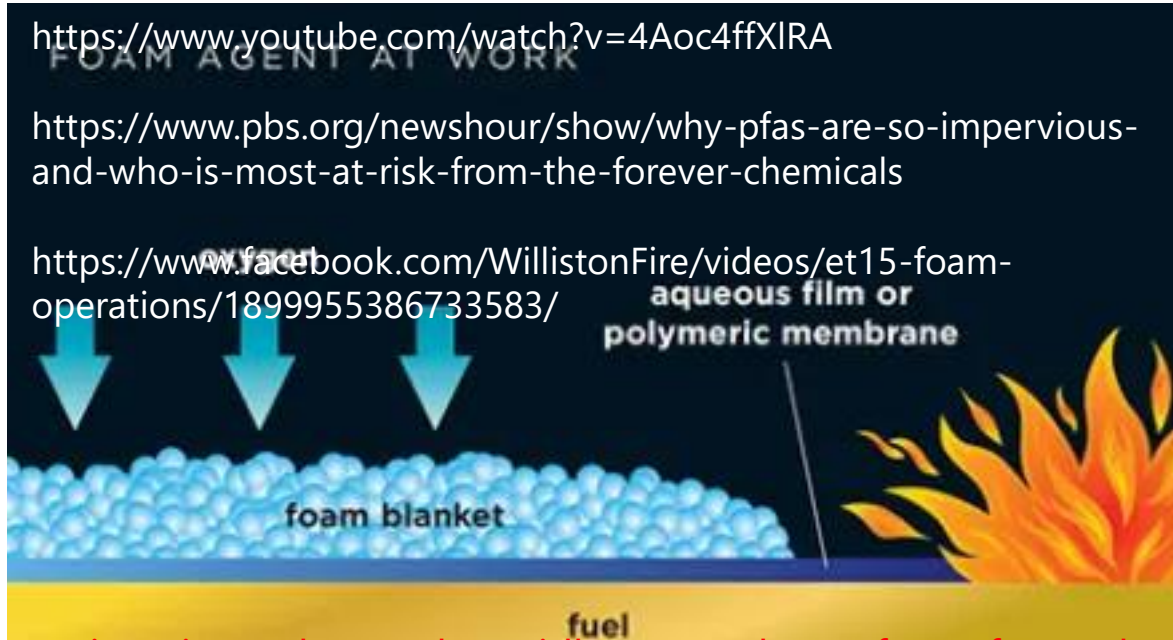


<https://gis-egle.hub.arcgis.com/datasets/egle::michigan-pfas-sites/>



[https://www.youtube.com/watch?v=vl\\_a4YhuQ88](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.

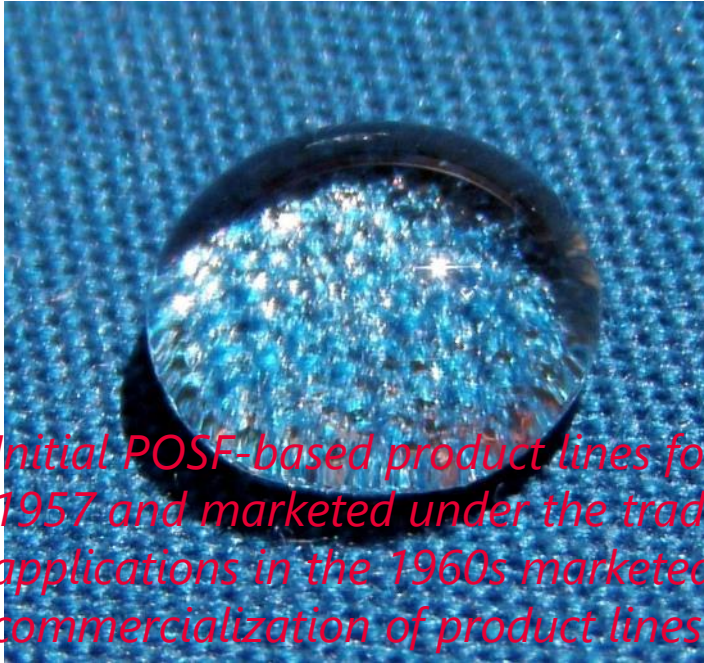
*Several studies found polytetrafluoroethylene (PTFE) cookware to contain residual PFOA in the low  $\mu\text{g}/\text{kg}$  range, concluding that fluoropolymer food contact materials were not likely to be a major source of PFASs. PFCAs, particularly PFOA, and fluorotelomer alcohols (FTOHs) have been 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

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*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. Another commercialization of product lines as performance chemicals before 2002 were marketed under Fluorad and were made of low molecular weight compounds including PFOS, for the use as fire-fighting foams, surfactants, etc.*



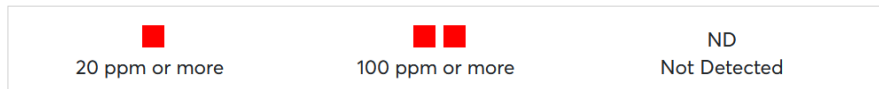
# GREASE-RESISTANT FOOD PACKAGING

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# 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.



## 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



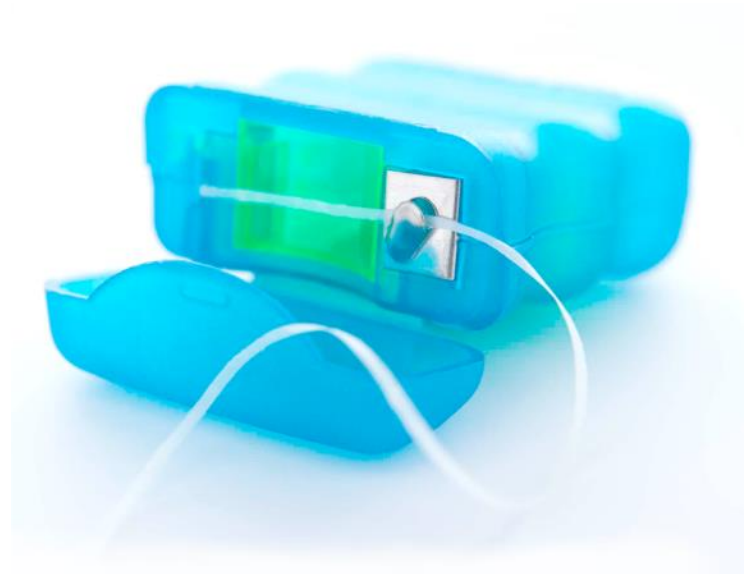
Paper bag for focaccia		288.0
Fiber bowl for salad		9.3
Fiber bowl for sides, meals		8.8



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**PERSONAL  
CARE PRODUCTS**



**FIREFIGHTING  
FOAMS**



**WATER RESISTANT  
CLOTHING**



**PAINT**



**COSMETICS**



**NON-STICK  
COOKWARE**

# PFAS



**PHOTOGRAPHY**



**FAST FOOD  
PACKAGING**



**STAIN RESISTANT  
FURNITURE**



**STAIN RESISTANT  
PRODUCT**

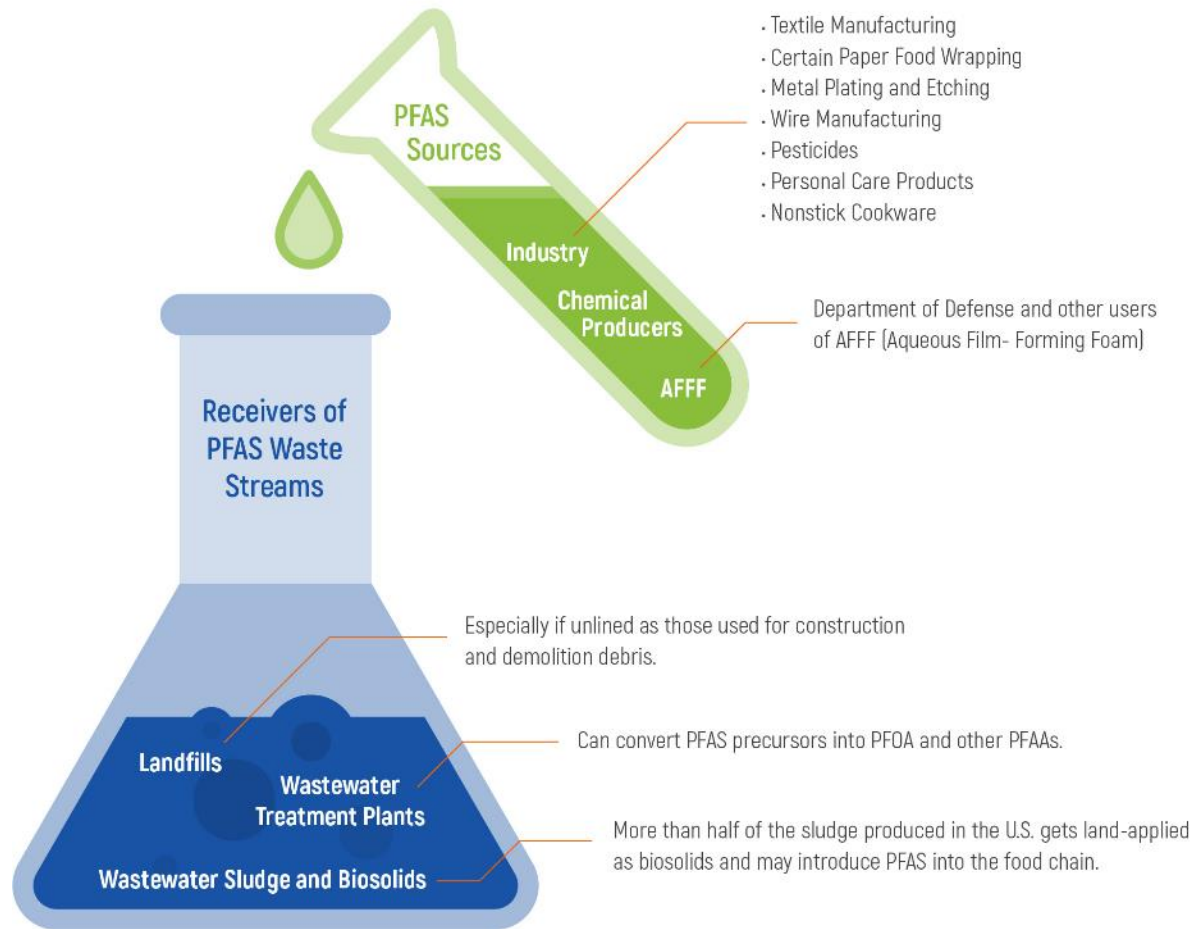


**MICROWAVE  
POPCORN BAGS**

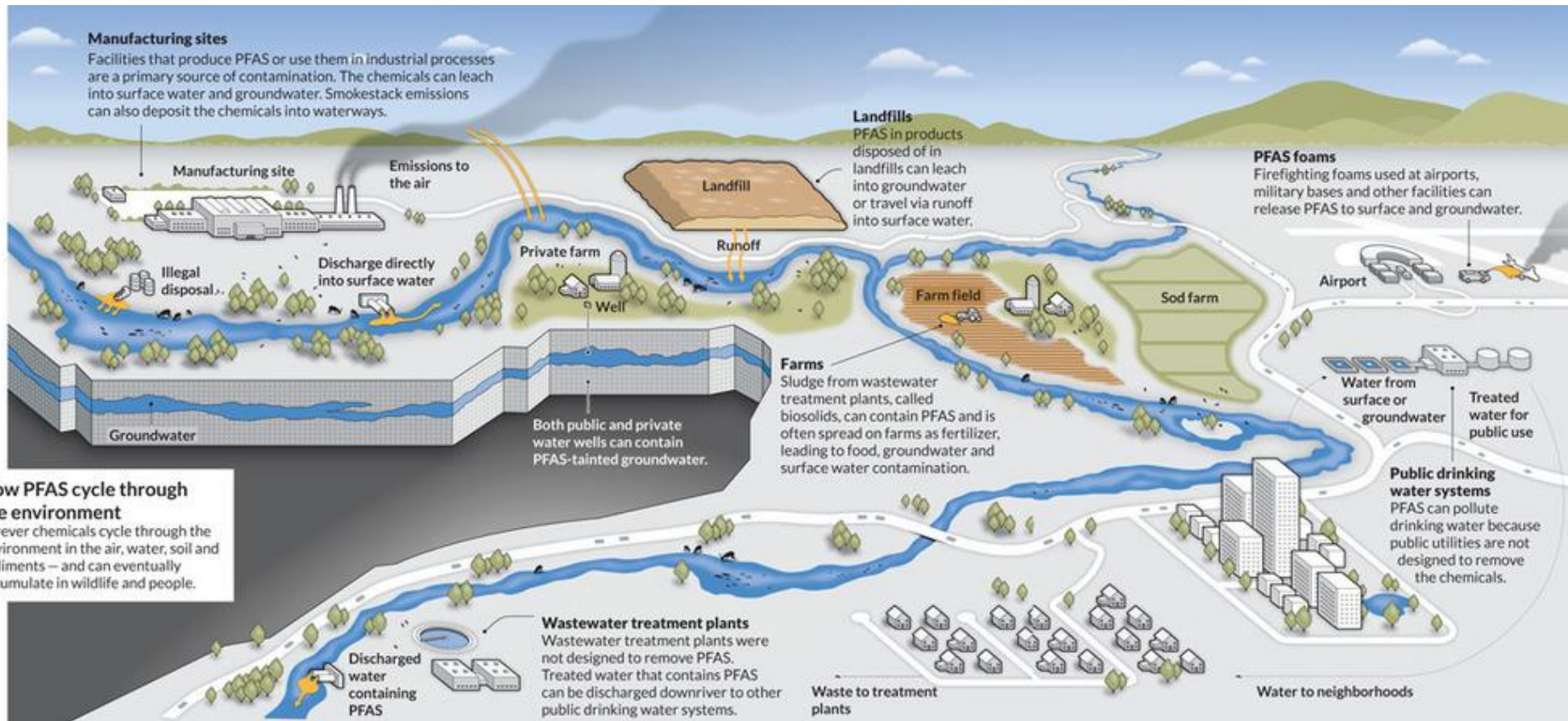


**PESTICIDES**

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

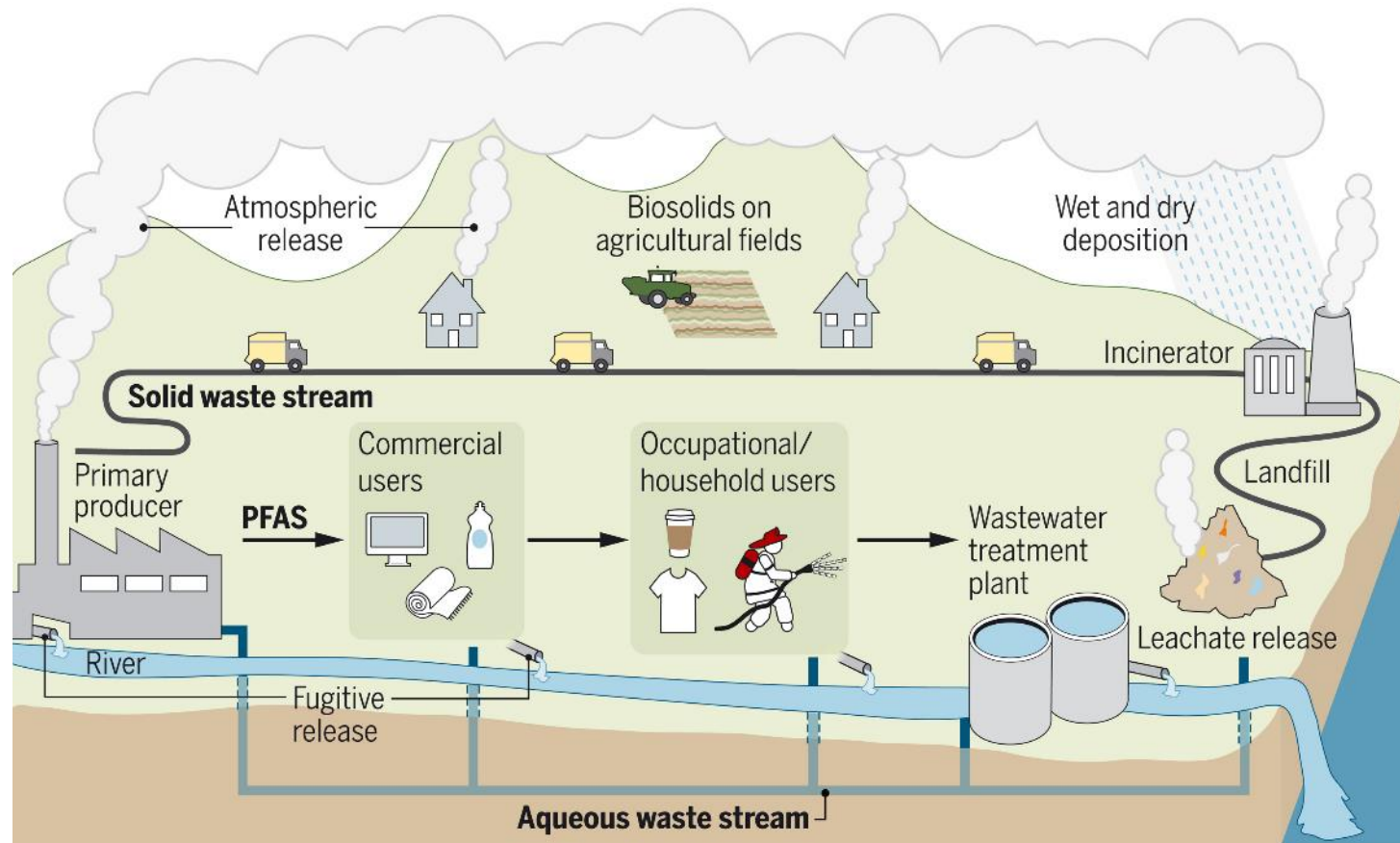






[https://www.sciencenewsdigital.org/sciencenews/library/item/november\\_19\\_\\_2022/4055387/](https://www.sciencenewsdigital.org/sciencenews/library/item/november_19__2022/4055387/)





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





## POSSIBLE HEALTH IMPACTS

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- reduction in immunity
- metabolic diseases like obesity & diabetes
- thyroid dysfunction
- 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



## HEALTH IMPACTS OF PFAO AND PFOS

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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

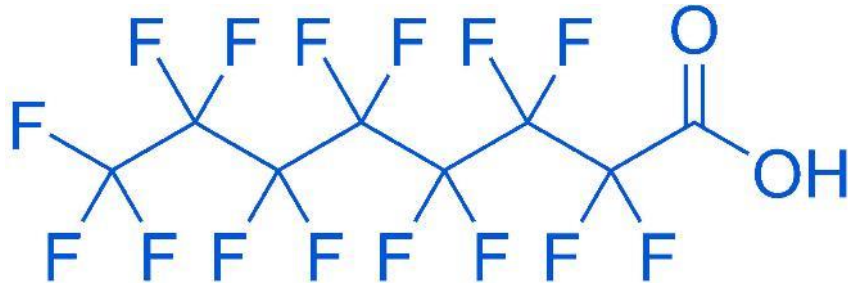
## WHAT'S BEING DONE

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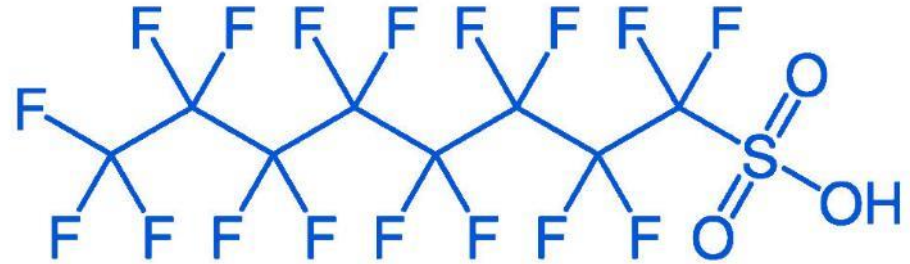
- Alternatives are being used
- Bans on added PFAS
- Regulators are reducing levels of concern
- Increased monitoring
- Implementation of removal technologies

## ALTERNATIVES

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PFOA



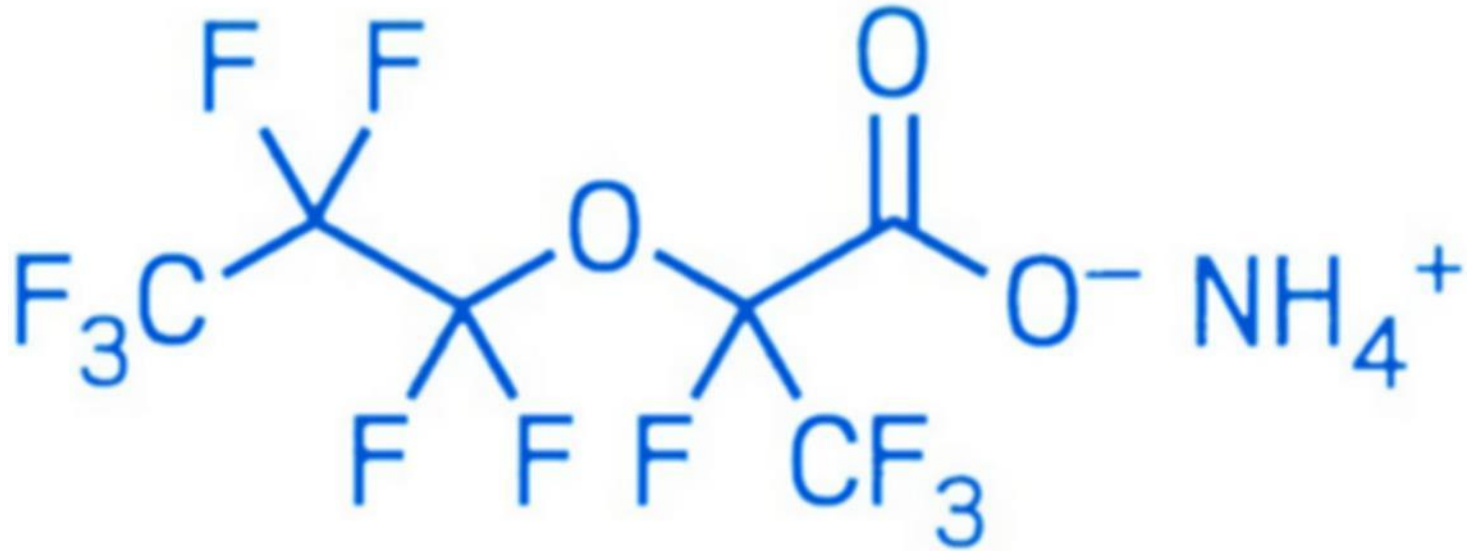
PFOS

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



## SAFER ALTERNATIVE?

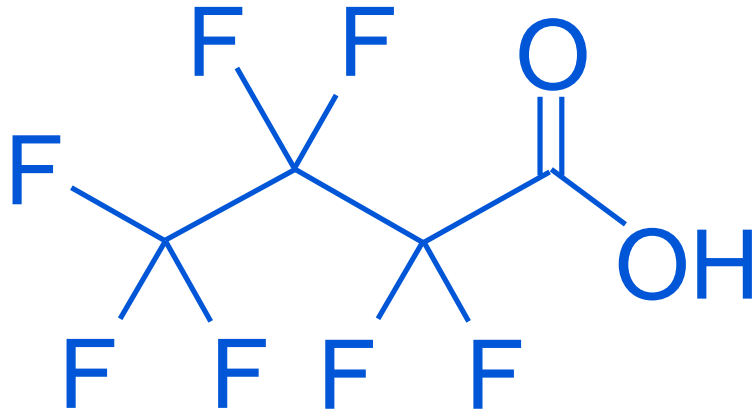
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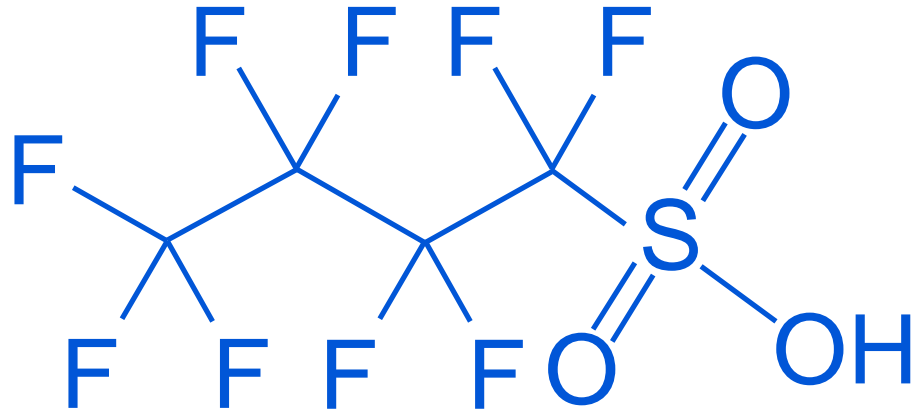
GenX

## 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*

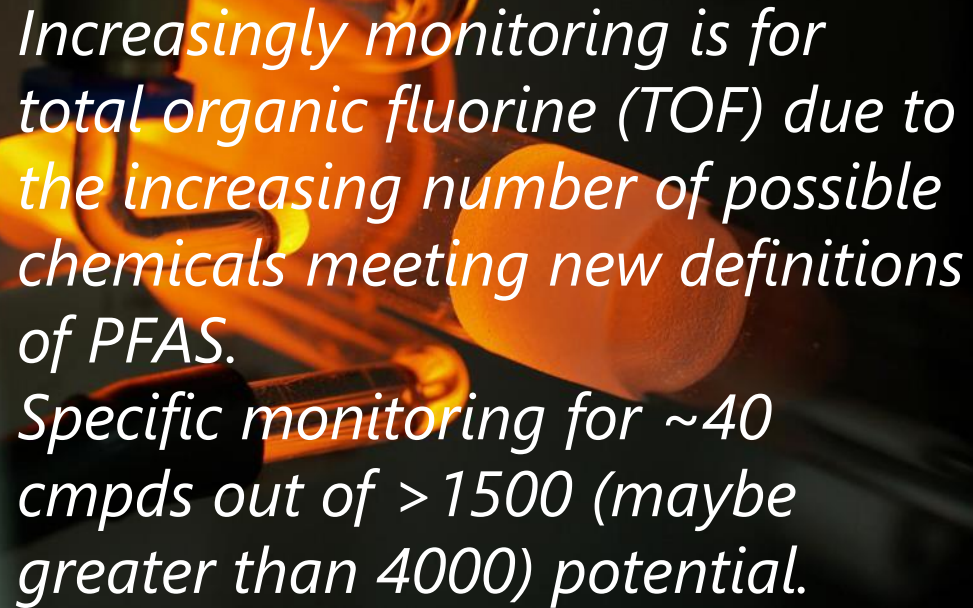
## WHAT IS BEING DONE

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- 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)

## INCREASED MONITORING

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A photograph of laboratory glassware, including a round-bottom flask and a test tube, illuminated with a warm, orange light. The background is dark, making the glassware stand out.

*Increasingly monitoring is for total organic fluorine (TOF) due to the increasing number of possible chemicals meeting new definitions of PFAS.  
Specific monitoring for ~40 cmpds out of > 1500 (maybe greater than 4000) potential.*

# IMPLEMENT REMOVAL TECHNOLOGIES

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## HOW TO REDUCE PERSONAL EXPOSURE

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

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

*Forever chemicals will not be going away.*





Slides will be posted on [mjphd.net/presentations](http://mjphd.net/presentations) soon

## **Partial Bibliography**

<https://www.mass.gov/doc/fluorinated-compounds-presentation-december-14-2021-h-wijnja/download>

<https://news.bloomberglaw.com/environment-and-energy/fear-of-pfas-disposal-costs-looms-over-firefighting-foam-switch>

<https://www.oecd.org/chemicalsafety/portal-perfluorinated-chemicals/PFASs-and-alternatives-in-food-packaging-paper-and-paperboard.pdf>

<https://atslab.com/pfas/new-pfas-regulations-by-state/>

[https://www.michigan.gov/-/media/Project/Websites/pfasresponse/Folder1/Folder1/Perfluorobutane\\_Sulfonic\\_Acid\\_PFBS\\_Chemistry\\_Production\\_Uses\\_and\\_Environmental\\_Fate.pdf?rev=71658a93b56640f2adad5c116e625fed](https://www.michigan.gov/-/media/Project/Websites/pfasresponse/Folder1/Folder1/Perfluorobutane_Sulfonic_Acid_PFBS_Chemistry_Production_Uses_and_Environmental_Fate.pdf?rev=71658a93b56640f2adad5c116e625fed)

[https://www.3m.com/3M/en\\_US/pfas-stewardship-us/pfas-history/](https://www.3m.com/3M/en_US/pfas-stewardship-us/pfas-history/)

<https://www.nationalacademies.org/news/2022/07/new-report-calls-for-expanded-pfas-testing-for-people-with-history-of-elevated-exposure-offers-advice-for-clinical-treatment>

Fluorinated Pharma & Ag Chems:

<https://www.sciencedirect.com/science/article/pii/S2589004220306593>

PFAS in the environment: <https://www.science.org/doi/full/10.1126/science.abg9065>

Firefighters: <https://pubs.acs.org/doi/abs/10.1021/acs.est.9b05490>

Nonstick Cookware: <https://pubs.acs.org/doi/abs/10.1021/es062377w>

Popcorn: <https://www.sciencedirect.com/science/article/pii/S0308814617304545>