



**Basic Information on
PFAS**

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**Department of the Environment
Water Supply Program**

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Reference for Acronyms Used in this Report

PFBS: perfluorobutanesulfonic acid

PFHpA: perfluoroheptanoic acid

PFHxS: perfluorohexanesulfonic acid

PFNA: perfluorononanoic acid

PFOA: perfluorooctanoic acid

PFOS: perfluorooctanesulfonic acid

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Basic Information on PFOA, PFOS, and other PFAS

What are PFAS?

Per- and polyfluoroalkyl substances (PFAS) are a group of man-made chemicals that include PFOA, PFOS, GenX, and many other chemicals. PFAS have been manufactured and used in a variety of industries around the globe, including in the United States since the 1940s. These chemicals are persistent in the environment and the human body, meaning they do not break down easily and can accumulate over time. There is evidence that exposure to PFAS can lead to adverse human health effects, such as: increased cholesterol levels, decreased fertility, increased risk of cancer, and others outlined later in this document.

Historical Background

In 1949, the Minnesota Mining and Manufacturing Company (3M Company), helped pioneer the science of fluorochemistry by producing fluorinated organic chemicals, part of a larger family of compounds referred to as Perfluoroalkyl Substances (PFASs). Perfluoroalkylated substances are a large group of compounds consisting of a fully fluorinated hydrophobic alkyl chain of varying length (typically 4 to 16 carbon atoms) and a hydrophilic end group. PFOA and PFOS are made up of “chains” of eight carbon atoms that are attached to fluorine and other atoms (See Fig. 1). Replacement chemicals, like GenX, tend to have fewer carbon atoms in the chain, but have many similar physical and chemical properties as their predecessors, such as oil and water repulsion.

Usage of PFAS

Fluorochemicals have proven to be useful for a variety of manufacturing processes and industrial applications. Starting in the 1950s, these compounds were used in the manufacturing of a wide range of consumer goods, including: non-stick cookware (e.g. Teflon), textiles, leather, stain-resistant carpets, polishes, paints, fire-retarding foams, photographic processing paper, food packaging, cleaning products, pesticides, surfactants, and other items designed to be waterproof and stain-resistant. Other uses included aviation hydraulic fluid, metal plating, electronic, and circuit board manufacture.

PFAS can now be found in living organisms, including fish, animals and humans, where PFAS have been able to accumulate and persist over time. PFOA and PFOS, two of the most widely studied PFAS, have been detected in the blood serum of up to 99% of samples collected between 1999 and 2012 in a population that is representative for the U.S.

Health Concerns Related to PFAS Exposure

Most people have been exposed to PFAS because of their use in common consumer goods (i.e. cookware, pizza boxes and stain repellants). Certain PFAS can accumulate and stay in the human body for long periods of time. There is evidence that exposure to PFAS can lead to adverse health effects in humans. The most-studied PFAS chemicals are PFOA and PFOS. Studies

indicate that PFOA and PFOS can cause reproductive, developmental, liver, kidney, and immunological effects in laboratory animals. Both chemicals have caused tumors in animals. The most consistent findings are increased cholesterol levels among exposed populations. Other findings include: low infant birth weights, hormonal changes, decreased fertility, risk of cancer in populations exposed to PFOA, and thyroid disruption for populations exposed to PFOS. Newborn babies are also at an increased risk to PFAS contamination.

Industries in the United States have phased out production of PFOA and PFOS because of their associated health risks to humans, replacing them with GenX. There is a substantial body of knowledge on the risk management of PFOS and PFOA, but much less is known about GenX and other replacement PFAS.

Certain PFAS, including PFOS and PFOA, have been identified as contaminants of emerging concern internationally. In recent years, PFAS have been found in a number of drinking water sources raising concerns about the safety of drinking water and potential impacts on the public health.

Structural Similarities in PFOS and other PFAS

On a molecular scale, PFAS seem identical. They contain rigid electronegative rods with a negatively charged end. The electropositive carbons are completely shielded from interacting with other molecules by the electronegative fluorines. For instance, PFOS and PFOA homologs appear the same. The only difference is that the length varies.

Many shared properties of PFOS, PFOA, and their homologs include: surfactants at less than a monolayer concentration, resistance to thermal degradation, and resistance to chemical degradation.

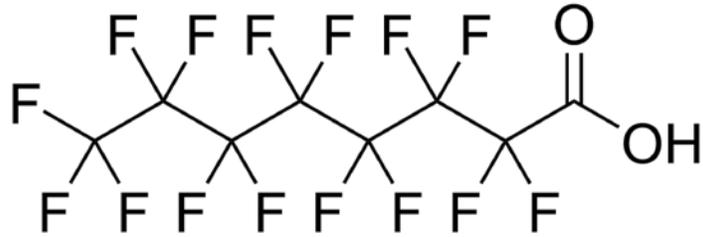
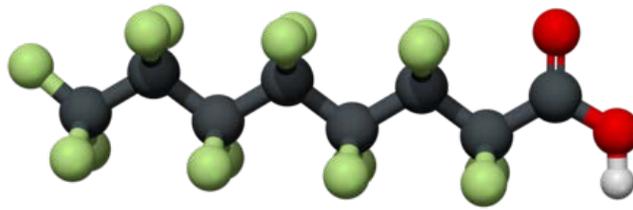
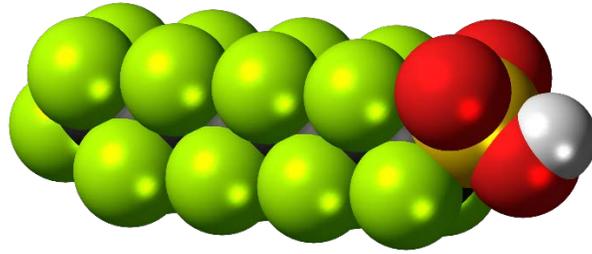
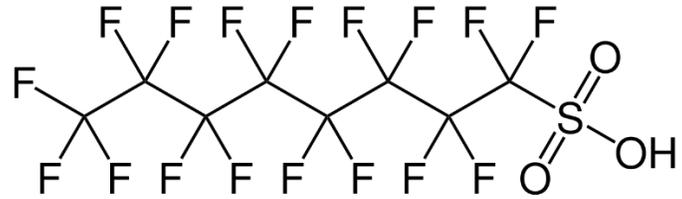


Fig.1 Structurally similarity of PFOS and other PFAs

Environmental Risks and Fate of Fluorochemicals

Releases of PFAS to the environment include their stable forms (perfluoroalkyl sulphonic [PFASs] and carboxylic acids [PFCAs]), and their less stable precursor compounds that may undergo abiotic or biotic transformation to PFASs and PFCAs. Their fate and transport properties include: high solubility, moderate sorption, non-volatility, high stability, and surfactant qualities.

While many studies have been published on environmental concentrations of PFASs and PFCAs, precursors are likely to have different physical and chemical properties to their breakdown products, leading to differences in their transport behavior. For example, cationic or zwitterionic precursors may bind to clay minerals through ion exchange.

Biomagnification and trophic transfer of PFAS in fish have been shown in some food webs (Franklin 2016; Fang et al. 2014). Because PFAS partition into proteins rather than lipids, however, the degree of observed biomagnification and trophic transfer in the field may be related to the quantity and composition of protein in the tissue measured, as well as the capability of the fish for metabolic biotransformation of PFAA precursors (Butt et al. 2010; Asher et al. 2012; Gebbink, Bignert, and Berger 2016).

One of the primary concerns about PFOS and PFOA is that their persistence. As complex synthetic substances, they are not easily broken-down or degraded by natural processes. The compounds used in commercial perfluorinated formulations are sometimes identified by the number of carbon atoms they contain. In general, the longer the carbon chain length, the more the PFAA persists in the body. For instance, perfluorobutane sulfonate (PFBS), which has 4 carbons, is removed in approximately 1 month in humans, on average, while PFOA and PFOS (so-called C8 compounds with 8 carbons each) are removed in 3.8 and 5.4 years, respectively. Perfluorohexane sulfonate (PFHxS), with 6 carbons, is an exclusion to the degree; it is eliminated in 8.5 years.

The environmental fate of a substance characterizes its transport, partitioning, and transformation processes after being released into the environment (Figure 2). During or after the production and usage of PFAS-containing products, PFASs can, as detailed in the Sources section, be released into the aquatic environment. Because PFOS and PFOA are persistent, bio-accumulative, toxic, and of moderate solubility, they can be transported long distances in water and air, and can transfer between different media (i.e. soil, sediment, surface water, and groundwater).

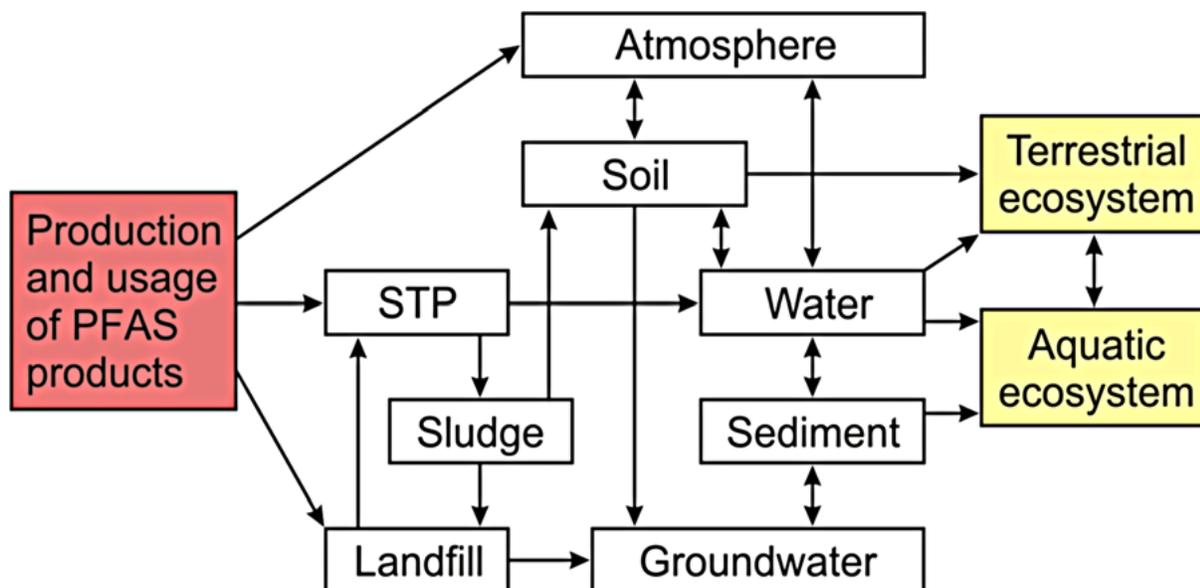


Figure 2: Pathways of Polyfluoroalkyl and Perfluoroalkyl Substances

Plants and PFAS

Studies show evidence of uptake and accumulation of PFAAs by plants in several settings and applications, including both controlled experiments and field investigations. Concerns about introducing PFAAs into livestock or crops have led to investigations of uptake and accumulation in plants. Uptake mechanisms, and the extent to which native plant species remove and accumulate PFAS, have not been as extensively studied. PFAS may be introduced to plants from soil, water, or air by: irrigation of water, application of bio-solids, nearby release of PFAS into soil and groundwater, atmospheric deposition and rainwater.

Aquatic Environments and PFAS

Because polyfluoroalkyl and perfluoroalkyl compounds are incessantly introduced into aquatic ecosystems and are universally present in complex mixtures, exposure to PFASs is continuous. Further information about their ecotoxicological potential in multiple generations, species interactions, and energy transfer within and across ecosystem boundaries may help in judging the risks for PFASs to affect ecosystem structure (e.g. biodiversity) and function in the aquatic environment.

Polyfluoroalkyl and perfluoroalkyl substances are subject to geochemical cycling processes in the aquatic environment, including indirect and direct emissions, transport, partitioning, and transformation processes. A better understanding of the influence of environmental conditions and the physicochemical properties of PFASs on these complex processes is needed (Ahrens et al., 2011).

PFAS are moderately soluble and highly mobile in water. Once in surface water or groundwater, PFAS can travel long distances. Where high levels of PFAS are present in soil, such as at some

firefighting training grounds, PFAS may leach to surface water and groundwater for decades. Contamination of food and water supplies is a significant risk.

Landfills and Wastewater Treatment

Landfills have a high potential to be a long-term point source of PFASs entering the environment (Allred et al., 2015; Fuertes et al., 2017). The materials disposed of in a landfill, such as municipal solid waste from both domestic and industrial sources, municipal sewage sludge, ash etc., are prone to contain PFASs. After their disposal, they are exposed to chemical reactions, degradation processes and precipitation, possibly throughout a period of a few decades. The percolation process allows the water to take up PFASs and dislocate them into the leachate (Busch et al., 2010; Fuertes et al., 2017; Yan et al., 2015). The translocation process; however, is influenced by several factors such as pH, electrical conductivity and precipitation (Benskin et al., 2012). Nowadays, landfills are usually equipped with or connected to wastewater treatment plants (WWTPs), where the leachate is handled. However, the question about the efficiency of these treatment processes remains open, since the most effective treatment methods, such as adsorption on activated black carbon, are not part of the treatment process in most of the cases. (Allred et al., 2015; Yan et al., 2015). Some studies have shown that WWTPs even increase the concentration of PFCAs and PFSAAs in the effluent compared to the influent due to the biodegradation of precursor compounds (Ahrens et al., 2011; Busch et al., 2010).

Groundwater and PFAS

Groundwater is a potential carrier of PFAS, through the direct ingestion of contaminated drinking water or indirect ingestion of PFAS on crops irrigated with the contaminated water. Groundwater may also discharge to surface water, which can also expose humans and the environment to PFAS. Due to the movement and persistence of aqueous film-forming foams (AFFFs) in soil and groundwater, PFAAs are expected to form larger plumes than other contaminants in the same hydrogeological setting. Sorption and partitioning, however, may restrict leaching rates from the vadose zone and reduce the advection-driven transport velocity of PFAS in groundwater, depending on specific properties of the compounds. These processes may help limit plume development and discharge to surface water and may also provide time for transformation of PFAA precursors.

Groundwater geochemistry may dictate the extent of transformation since nearly all processes identified to date are aerobic (Liu and Mejia-Avendaño 2013). Groundwater extraction and treatment for containment or remediation of other contaminants can also influence plume development and distribution of PFAS in groundwater. At sites with remediation systems for other contaminants, PFAS-impacted water can be unknowingly reinjected into groundwater, as well as discharged to surface water or wastewater treatment plants and create secondary releases. As part of the third Unregulated Contaminant Monitoring Rule (UCMR3) USEPA generated the most extensive PFAS groundwater occurrence dataset when it required approximately 4,900 public water systems (all large systems serving more than 10,000 people, plus a subset of smaller systems) to monitor six PFAAs in drinking water at points of entry to the drinking water distribution system.

Data collected between 2013 and 2015 under the UCMR3 included the results from treated water from public water systems with largely groundwater sources, but also included surface water and mixed sources. Groundwater sources had approximately double the detection rate of surface water sources (Hu et al. 2016). Detections of longer-chain PFAAs were highly associated with groundwater, while shorter-chain PFAAs such as PFBS and perfluoroheptanoic acid (PFHpA) were more associated with surface water.

Surface Water and PFAS

Human exposure to PFAS from surface water can occur through direct ingestion or by consuming aquatic biota from contaminated waterbodies. Most PFAAs that reach surface water tend to remain in solution, although there can be partitioning to sediment and uptake to biota. Once in surface water, PFAAs can contaminate groundwater through groundwater recharge (Liu et al. 2016; ATSDR 2008) or be transported to the oceans where they are then transported globally by ocean currents (Benskin et al. 2012). Upon reaching saline waters, however, the solubility of anionic PFAAs decreases and sorption increases, which likely results in a salting-out effect that scavenges some PFAAs, especially long-chain PFAAs, to the sediments of estuarine environments (Hong et al. 2013). Consequently, oceans are likely the main sink for PFAS, and have been estimated to contain the majority of PFCAs historically released into the environment (Armitage et al. 2006). In contrast to PFAAs, other PFAS (for example, FTOHs and some perfluoroalkyl sulfonamides) remain neutral at environmentally relevant pHs, have higher volatilities, and tend to partition into air. PFAS composition may also change within surface water because of biotic and abiotic degradation of PFAA precursors. Freshwater, marine water, and stormwater PFAS concentrations usually depend on proximity to releases. In addition to releases associated with identified sources, stormwater runoff water from nonpoint sources may contribute significant loads of PFAS to surface water (Wilkinson et al. 2017; Zushi and Masunaga 2009).

In surface water algae is typically considered to be the basis of autotrophic food webs. However, PFASs seem to have the potential to affect the functioning of these organisms' cell membranes, which is more pronounced with increasing PFAS chain length and lower proportion of indigestible structural components, such as cellulose, in the algal cell wall. These processes may have implications in the food quality for algae consuming animals, such as filtering and grazing invertebrates (Figure 4). Hence, it might be assumed that implications for reproduction of the standard test species (among others) or the development of zooplankton communities may be driven by not only direct exposure but also indirect exposure via an altered nutritious quality of algae.

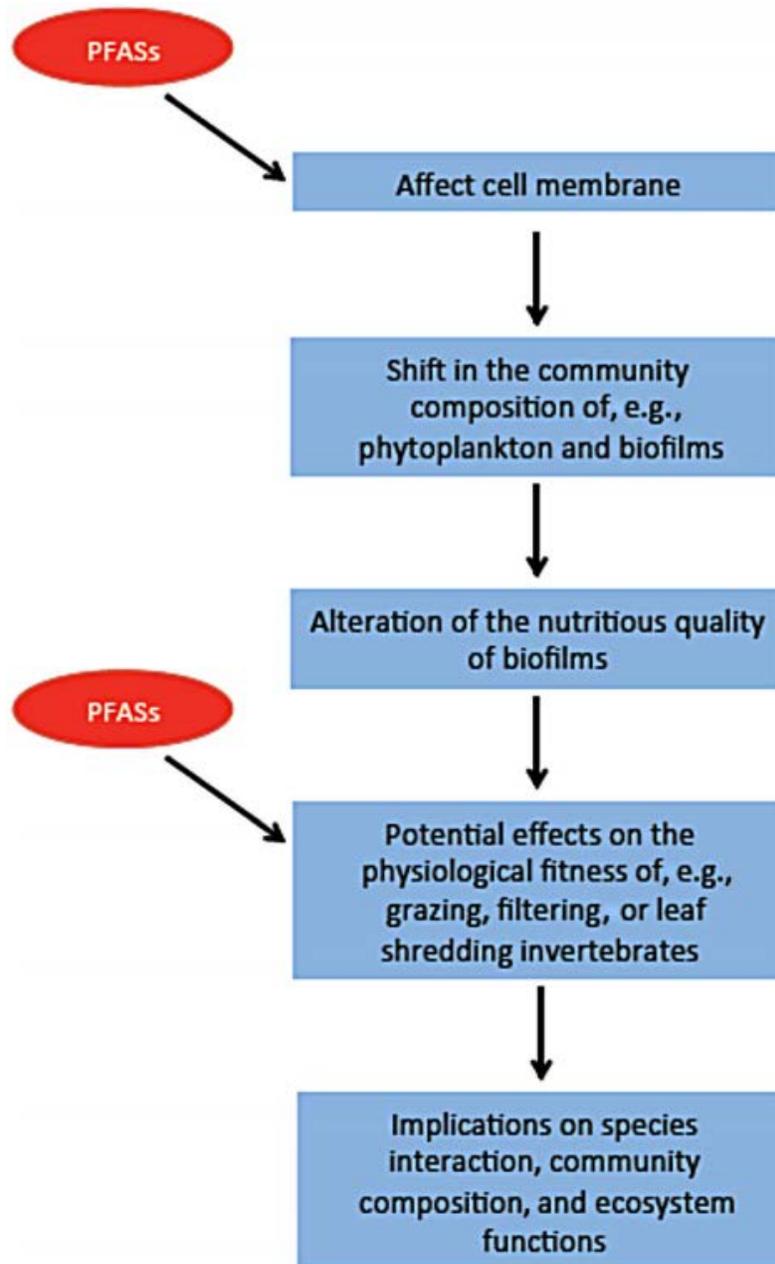


Figure 3: Potential (in)direct effect pathways of polyfluoroalkyl and perfluoroalkyl substances (PFASs) on grazing, filtering, and leaf shredding invertebrates as well as higher levels of ecological complexity as a result of alterations on the basis of autotrophic or heterotrophic food webs. After Lutz Ahrens and Micro Bundschuh (2014).

Drinking Water Systems Background

In the US, more than 150,000 public water systems are regulated under the Safe Drinking Water Act. These public water systems monitor for more than 90 regulated contaminants.

However, unregulated or unknown contaminants such as Perfluorochemicals (PFCs) may sometime be present in the drinking water sources. PFCs may get into tap water in a variety of ways. Industries dispose their PFC laden wastewater into rivers or it seeps into surrounding groundwater. Many public water systems use surface and groundwater as drinking water sources. While these facilities treat the river or reservoir water to make it drinkable, current systems are not designed to remove perfluorochemicals. There are a number of pathways by which PFCs reach water supply systems, including: point source discharges, nonpoint source discharges (especially areas where biosolids are applied to the land), and via contaminated groundwater. The SDWA applies to all public water systems in the United States but does not apply to private domestic drinking water wells nor to water not being used for drinking, e.g., cooling and irrigation water.

Much of the currently available data regarding PFAS in public drinking water was generated by USEPA under the Unregulated Contaminant Monitoring Rule (UCMR3). USEPA uses the UCMR to collect data for chemicals that are suspected to be present in drinking water but do not have health-based standards set under the SDWA. The monitoring effort, under UCMR3, included:

- perfluorooctanesulfonic acid (PFOS)
- perfluorooctanoic acid (PFOA)
- perfluorononanoic acid (PFNA)
- perfluorohexanesulfonic acid (PFHxS)
- perfluoroheptanoic acid (PFHpA)
- perfluorobutanesulfonic acid (PFBS)

PFAS in U.S. Drinking Water

PFASs were detected at or above the Maximum Residual Levels (MRLs) in 194 of 4,864 public water supplies serving, 16.5 million residents in 33 different states, three American territories (American Samoa, Northern Mariana Islands, and Guam), and the Salt River Pima-Maricopa Indian Community. Drinking water from 13 states accounted for 75% of detections, including, by order of frequency of detection, California, New Jersey, North Carolina, Alabama, Florida, Pennsylvania, Ohio, New York, Georgia, Minnesota, Arizona, Massachusetts, and Illinois (Figure 5). Detection frequencies for PFASs across the 4,864 public water supplies were 2.2% for PFOA, 2.0% for FOS, 1.7% for PFHpA, 1.1% for PFHxS, and <0.003% for others.

The USEPA, and select states, use occurrence data produced by the UCMR program to help determine substances to consider for regulation. .

DuPont introduced GenX in 2009 to replace PFOA, also known as C8, a chemical it had used for decades in North Carolina, West Virginia, and other locations to make Teflon and other products.

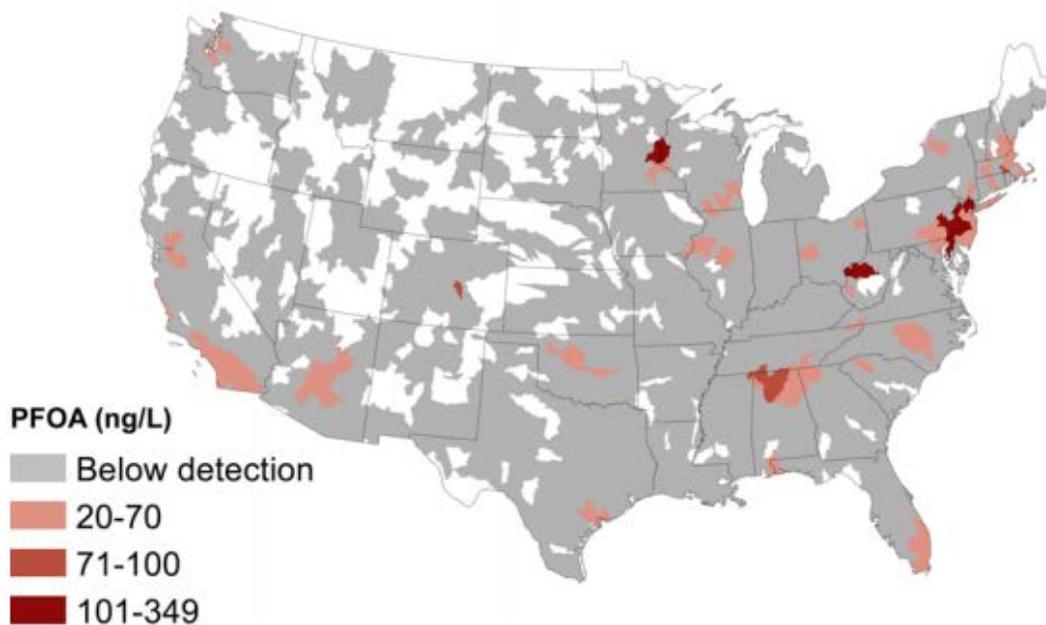
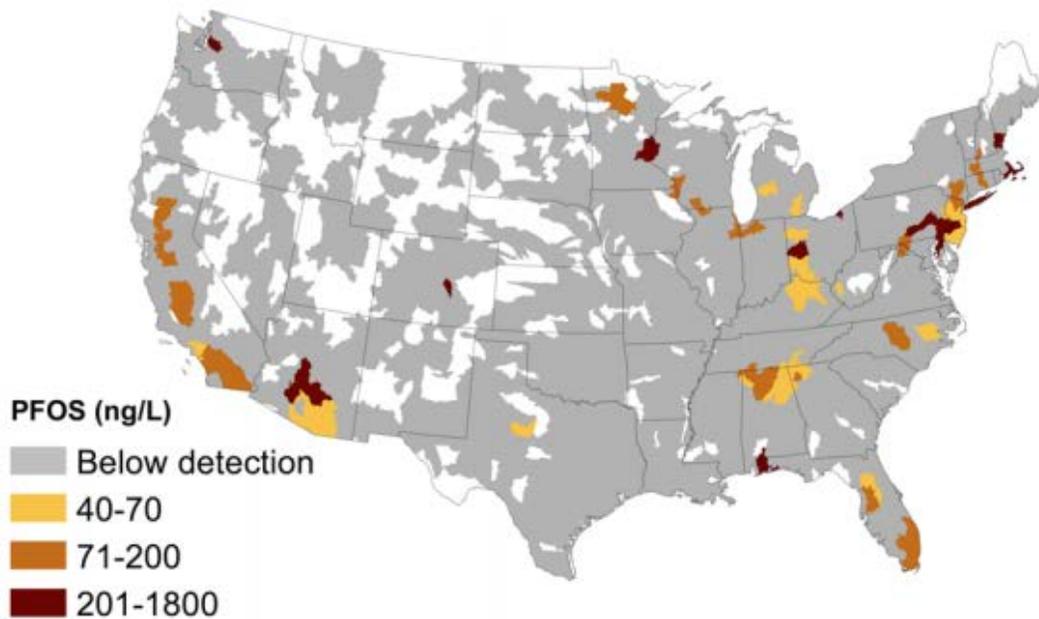


Figure 4: Hydrologic unit codes (eight-digit HUCs) used as a proxy for watersheds with detectable PFOA and PFOS in drinking water measured in the US EPA’s UCMR3 program (2013–2015). Blank areas represent regions where no data are available

Safe Levels of PFAS in Drinking Water

The principal law governing the safety of drinking water in the United State is the Safe Drinking Water Act (SDWA), which sets the standards for drinking water quality. The SDWA only applies to public water systems and does not apply to individual domestic drinking water wells.

There are currently no maximum contaminant levels (MCLs) established for PFAS chemicals. EPA initiated the steps to evaluate the need for an MCL for PFOA and PFOS under the regulatory determination process. However, EPA has issued a non-enforceable health advisory for PFOA and PFOS levels in drinking water at a combined 70 parts per trillion in 2016.

Maryland's Progress

The state hasn't initiated any action to set drinking water standards for PFOA or PFOS, but it is awaiting the results of EPA's evaluation of the need for an MCL.

Maryland's Department of the Environment (MDE) has developed a multi-administration work plan addressing these contaminants. Recently, MDE has formed an internal workgroup to assess existing information and identify information needs. Additionally, MDE is partnering with EPA Region III to execute a GIS-based project to identify potential sources of PFAS in Maryland and prioritize water sources for PFAS sampling. As the department continues their efforts, MDE will proceed to report key findings.

U.S. Drinking Water Regulation Timeline

- 2009: EPA issued provisional health advisory levels for PFOA (400 ppt) and PFOS (200 ppt) to protect against short-term exposures
- May 2012: Unregulated Contaminant Monitoring Rule (UCMR) identifies six PFAS for further evaluation and monitoring under the Safe Drinking Water Act (SDWA) including PFOA, PFAS, PFNA, PFHxS, PFHpA, and PFBS
- May 2016: EPA issued new Lifetime Health Advisory levels for PFOA and PFOS in drinking water (70 ppt).
- February 2019: EPA released a PFAS Action Plan : https://www.epa.gov/sites/production/files/2019-02/documents/pfas_action_plan_021319_508compliant_1.pdf

Actions to Take

PFOS and PFOA poses a risk to human and environmental health. EPA has recognized health advisories for PFOA and PFOS based on the agency's assessment of the latest peer-reviewed science to provide drinking water system operators, and state, tribal and local officials who have the primary responsibility for overseeing these systems, with information on the health risks of these chemicals, so they can take the appropriate actions to protect their residents.

Here are three ways to avoid PFAS:

- Avoid purchasing household wares that could be problematic.
 - a. Although use of Fluorochemicals, has been severely restricted in the United States, other countries have continued to employ them for industrial purposes. Strive to purchase organic textiles and carpets made from natural materials. Steer clear of non-stick cookware and coated food packaging. Opt for green cleaning products and avoid household pesticides.
- Filter household water
 - a. Activated carbon and reverse osmosis filters have been found to effectively remove PFAS contaminants.
- Check to see if your area has been contaminated
 - a. The Environmental Working Group has taken a county to county approach in creating an interactive map to show areas where drinking water may be unsafe. The map can be accessed [here](#).

Steps to Assess Contamination

- Drinking water systems and public health officials should provide consumers with information about: The levels of PFOA and PFOS in their drinking water.
- Specific information on the risks to fetuses during pregnancy and breastfed and formula-fed infants from exposure to drinking water.
- Actions they are taking
- Identify options that consumers may consider to reduce risk such as:
 - a. seeking an alternative drinking water source
 - b. in the case of parents of formula-fed infants, use formula that does not require the addition of water.

How to Detect PFAS

EPA scientists develop sensitive analytical methods to:

- detect Per- and Polyfluoroalkyl Substances (PFAS)
- determine breakdown of precursor fluoropolymers into PFAS
- determine PFAS levels in consumer products
- evaluate the relationship between PFAS levels in freshwater and the health of fish populations.

Drinking water system operators can reduce concentration of perfluoroalkyl substances, including PFOA and PFOS, by closing contaminated wells and changing the rates of blending water sources.

Many home drinking water treatment units are certified by independent accredited third party organizations against American National Standards Institute (ANSI) standards to verify their contaminant removal claims. NSF International (NSF®) has developed a protocol for NSF/ANSI Standards 53 and 58 that establishes minimum requirements for:

- Materials
- Design and construction
- Performance of point-of-use (POU)
- Activated carbon drinking water treatment systems
- Reverse osmosis systems that are designed to reduce PFOA and PFOS in public water supplies.

This protocol has been established to:

- Certify systems (e.g., home treatment systems) that meet the minimum requirements. The systems are evaluated for contaminant reduction by challenging them with an influent of $1.5 \pm 30\%$ $\mu\text{g/L}$ (total of both PFOA and PFOS).
- Reduce this concentration by more than 95% to $0.07 \mu\text{g/L}$ or less (total of both PFOA and PFOS) throughout the manufacturer's stated life of the treatment system.
- Product certification to this protocol for testing home treatment systems verifies that devices effectively reduces PFOA and PFOS to acceptable levels

Recommendations

- List of some specific actions including banning PFAS: Setting enforceable drinking water standards for total PFAS
- Mandating reporting of PFAS releases
- Investigating drinking water contamination
- Adding the entire class of PFAS to the EPA's toxic pollutant list and hazardous substance list
- Providing support to states to clean and filter contaminated water sources
- Including standardized test methods for a broad range of legacy and replacement PFAS.

Who to Contact:

- Biosolid Concerns:
 - Liz Resek, Resek.Elizabeth@epa.gov
- Effluent Guidelines
 - Michael Scozzafava, Scozzafava.MichaelE@epa.gov
- Fish Tissue Concentrations
 - Shari Barash, Barash.Shari@epa.gov
- Aquatic Life Criteria
 - Kathryn Gallagher, Gallagher.Kathryn@epa.gov
- Human Health Criteria and PFAS Toxicity Values, Office of Science and Technology
 - Jamie Strong, Strong.Jamie@epa.gov
- EPA Office of Ground Water and Drinking Water
 - Jennifer McLain, McLain.Jennifer@epa.gov
- EPA Office of Research and Development
 - Tom Speth, Speth.Thomas@epa.gov

Additional Information

- There are over 50 classes of PFASs, comprised of several individual homologs. PFAS can be present in various industrial and consumer products such as:
 - unreacted raw materials (referred to as residuals),
 - undesired reaction byproducts (referred to as impurities), or
 - cross contaminants along the production and supply chains.
- PFOS and PFOA are fully fluorinated, organic compounds and are the two perfluorinated chemicals (PFCs) that have been produced in the largest amounts within the United States (ATSDR 2009; EFSA 2008).
- They are human-made compounds, not occurring naturally in the environment (ATSDR 2009; EPA 2009c).
- PFOA is a perfluoroalkyl carboxylate that is produced synthetically as a salt. Ammonium salt is its most widely produced form (EFSA 2008; EPA 2009 c).
- PFOS synonyms include 1-octanesulfonic acid, heptadecafluoro-1-perfluorooctanesulfonic acid, heptadecafluoro-1-octanesulfonic acid, perfluoro- n-octanesulfonic acid, perfluorooctanesulfonic acid and perfluorooctylsulfonic acid (ATSDR 2009; UNEP 2005).
- PFOA synonyms include pentadecafluoro-1-octanoic acid, pentadecafluoro-n-octanoic acid, pentadecafluorooctanoic acid, perfluorocaprylic acid, perfluorooctanoic acid, perfluoroheptanecarboxylic acid and octanoic acid (ATSDR 2009).
- They are stable chemicals that include long carbon chains. Because of their unique lipid- and water-repellent characteristics, PFOS and PFOA are used as surface-active agents in various high-temperature applications and as a coating on surfaces that come in contact with strong acids or bases (Schultz and others 2003; UNEP 2005).
- Through 2001, PFCs were used to manufacture Aqueous Film Forming Foam (AFFF). PFOS-based AFFF is used to extinguish flammable liquid fires (for example, hydrocarbon fueled), such as fires involving gas tankers and oil refineries (EPA 2013a; DoD SERDP 2012).
- PFOS and PFOA can form through environmental microbial degradation or metabolically by larger organisms from a large group of related substances or precursor compounds (ATSDR 2009; UNEP 2006).

Additional Resources

EPA's Drinking Water Health Advisories for PFOA and PFOS can be found at:

<https://www.epa.gov/ground-water-and-drinking-water/drinking-water-health-advisories-pfoa-and-pfos>

PFOA and PFOS data collected under EPA's Unregulated Contaminant Monitoring Rule are available:

<https://www.epa.gov/dwucmr/occurrence-data-unregulated-contaminant-monitoring-rule>

EPA's stewardship program for PFAS related to TSCA:

<https://www.epa.gov/assessing-and-managingchemicals-under-tsca/and-polyfluoroalkyl-substances-pfass-under-tsca>

EPA's research activities on PFASs can be found at:

<http://www.epa.gov/chemical-research/perfluorinated-chemical-pfc-research>

The Agency for Toxic Substances and Disease Registry's Perfluorinated Chemicals and Your Health webpage at:

<http://www.atsdr.cdc.gov/PFC>

[Fact Sheet: PFOA and PFOS Drinking Water Health Advisories \(PDF\)](#)

[EPA's webpage on PFAS](#)

[ITRC's webpages of PFAS](#)

[Association of State and Territorial Solid Waste Management Officials, Inc. \(ASTSWMO\) webpage on PFAS](#)

ASTSWMO's [Perfluorooctanoic Acid \(PFOA\) & Perfluorooctane Sulfonate \(PFOS\) Information Paper](#)

Northeast Waste Management Officials Association (NEWMOA) - [Past and future PFAS presentations](#)

Some manufacturers have replaced their use of long chain PFAS with shorter chained versions. For more information, visit:

- [Fluorinated Alternatives to Long-Chain Perfluoroalkyl Carboxylic Acids \(PFCAs\), Perfluoroalkane Sulfonic Acids \(PFASs\) and Their Potential Precursors](#)
- [Legacy and Emerging Perfluoroalkyl Substances Are Important Drinking Water Contaminants in the Cape Fear River Watershed of North Carolina](#)

Health information for PFAS:

- [NJDOH Fact Sheet for PFCs in Drinking Water](#)
- [Agency for Toxic Substances and Disease Registry \(ATSDR\): Per- and Polyfluoroalkyl Substances and Your Health](#)

Other Resources:

- [Detection of Poly and Perfluoroalkyl Substances in US Drinking Water Linked to Industrial Sites, Military Fire Training areas and Waste Water Treatment Plants](#)

- [Department of the Navy's strategy to manage PFAS \(including the investigation of AFFF and cleanup of PFOA/PFOS releases\)](#)
- <https://news.bloombergenvironment.com/environment-and-energy/glass-half-full-on-state-solutions-to-chemicals-in-water?context=article-related>

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