



13 Stakeholder Perspectives

This section identifies the concerns of stakeholders who have been or may be affected by PFAS contamination. In this section, we summarize many of the concerns that have been expressed by local communities, tribes, and environmental groups. Evaluation of exposure levels and potential human health consequences are of paramount concern to stakeholders.

Section Number	Topic
13.1	Stakeholder Concerns
13.2	Specific Tribal Stakeholder Concerns
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The term “stakeholder” is defined broadly by ITRC as members of environmental organizations, community advocacy groups, tribal entities or other citizens’ groups that deal with environmental issues, or a concerned citizen who is not a member of any organization or group. Public stakeholders, such as advocacy groups, often speak for the communities that are affected by environmental issues. In this document, a differentiation is made between public stakeholders and interested parties (responsible parties, state regulators, and owners and operators of contaminated sites).

Stakeholders share greater ownership of outcomes when they have the opportunity to influence site characterization, remedy selection, and long-term site management. Because PFAS are so abundant in consumer products, stakeholders are also concerned with the production and eventual use of these products and are seeking safer alternatives and sometimes outright bans (see [Section 2.5](#) for information about PFAS Uses and information about certifications related to reduction or elimination of PFAS in products). Environmental regulators and responsible parties also benefit from informed, constructive stakeholder involvement because it can help them make better decisions, reduce the likelihood of costly, time-consuming repeated work, and allow those in affected communities to have a voice in governing the long-term use of land, water, and other resources. Often, stakeholders such as long-time residents have unique site knowledge as well as a major stake in the remedial outcome. In the case of PFAS, many national environmental organizations have made community outreach a major focus. Local grassroots organizations and one, the National PFAS Contamination Coalition (<https://pfasproject.net>), have led a major effort to inform the public and influence policy. In addition, ATSDR studies (for example, [ATSDR 2022](#)) and National Academy of Science ([NAS 2022](#)) studies have included community outreach efforts.

Developing site-specific characterization and remediation strategies for communities and tribal organizations can be challenging, because there are many misconceptions about PFAS. The lack of scientific knowledge about many of these PFAS further enhances the need to educate the public. Therefore, early and effective community engagement emphasizing timely access to test data, transparency, and responsiveness is imperative. Community engagement may be able to address many stakeholder concerns and help to communicate risks. The [ITRC Risk Communication Toolkit for Environmental Issues and Concerns](#) includes information about stakeholder engagement and is published as a separate document. [Section 14](#) addresses tools for PFAS-specific risk communication challenges, and provides some examples of PFAS risk communication issues.

This section identifies the concerns of stakeholders who have been or may be affected by PFAS contamination. Because PFAS are emerging contaminants and have been detected in ecological receptors (animals and plants, see sections [5.5](#) and [5.6](#)) and blood serum in many humans ([Section 7.1](#)), there are many individuals who are potentially affected worldwide.

In this section, we summarize many of the concerns that have been expressed by local communities, tribes, and environmental groups. Evaluation of exposure levels and potential human health consequences are of paramount concern to stakeholders. The list of concerns below is not all inclusive, as developments in science and identification of contaminants in the environment are likely to lead to additional concerns. This list was developed from general research on PFAS, direct communication and involvement with environmental and community groups, a consultant for one of the tribes, and

extensive review of news reports. **This section is intended to highlight the concerns that have been expressed by various groups. It is not intended to be a definitive statement of the technical merits of those concerns.**

USEPA conducted five community engagement events and one event with tribal representatives during the summer of 2018. Meeting materials, information, and summaries of each event are provided on USEPA's website: <https://www.epa.gov/pfas/pfas-community-engagement>. Series-specific lists of concern and associated social factors identified from presentations by public and community stakeholders during the USEPA PFAS community meetings held in 2018 are provided in the [ITRC Risk Communication Toolkit for Environmental Issues and Concerns](#) which is published as a separate document, and are discussed in [Section 14.3.4](#). See also <https://pfascommunityengagement.org> for information about EPA virtual listening sessions in Spring 2023.

The following concerns were identified during preparation of this document, with details of these concerns in the following sections.

<ul style="list-style-type: none"> • Lack of comprehensive regulatory standards or advisories for thousands of PFAS for the following (13.1.1): <ul style="list-style-type: none"> Drinking water (13.1.1.1) Environmental media other than drinking water (13.1.1.2) Human consumption of food (13.1.1.3) Ecological risk (13.1.1.4) 	<ul style="list-style-type: none"> • Limited availability of information on the health effects of PFAS (13.1.15)
<ul style="list-style-type: none"> • Desire for one standard or screening level for PFAS (13.1.2) 	<ul style="list-style-type: none"> • Responsibility for sampling and treatment on private property (13.1.16)
<ul style="list-style-type: none"> • Lack of Occupational standards (13.1.3) 	<ul style="list-style-type: none"> • The potential for PFAS emissions from cleanup methods (13.1.17)
<ul style="list-style-type: none"> • Lack of comprehensive monitoring information (13.1.4) 	<ul style="list-style-type: none"> • Lack of scientific evidence that current PFAS treatment and disposal methods and remedies are fully protective of human and ecological health and prevent toxic emissions (13.1.18)
<ul style="list-style-type: none"> • Need to apply a precautionary approach in decision making (13.1.5) 	<ul style="list-style-type: none"> • Stormwater and PFAS manufacturing discharges that may contain PFAS (13.1.19)
<ul style="list-style-type: none"> • Safety of short-chain substitutes (13.1.6) 	<ul style="list-style-type: none"> • Psychological effects (13.1.20)
<ul style="list-style-type: none"> • Contamination from AFFF release sites (13.1.7) and unused AFFF disposal (13.1.8) 	<ul style="list-style-type: none"> • Economic consequences of local PFAS contamination (13.1.21)
<ul style="list-style-type: none"> • Duty to warn AFFF responders (13.1.9) 	<ul style="list-style-type: none"> • Remediation of PFAS with other contaminants, especially chlorinated solvents (13.1.22)
<ul style="list-style-type: none"> • Limitations in sampling and analysis methods (13.1.10) 	<ul style="list-style-type: none"> • Pesticides containing PFAS (13.1.23)
<ul style="list-style-type: none"> • Limited programs for health monitoring and blood testing (13.1.11) 	<ul style="list-style-type: none"> • Artificial turf (13.1.24)
<ul style="list-style-type: none"> • PFAS in food packaging (13.1.12) 	<ul style="list-style-type: none"> • Semiconductor manufacturing (13.1.25)
<ul style="list-style-type: none"> • Potential PFAS contamination in recycling, compost, and fertilizer (13.1.13) 	<ul style="list-style-type: none"> • Remediation using monitored natural attenuation (MNA) (13.1.26)
<ul style="list-style-type: none"> • Lack of disclosure by product manufacturers (13.1.14) 	

Stakeholders who use this document should consider that much of the information is very technical. Nevertheless, it aims to lay a framework by which to understand this set of compounds, the foundational nature of the science, and many of the uncertainties.

13.1 Stakeholder Concerns

13.1.1 Lack of Comprehensive Regulatory Standards or Advisories for Thousands of PFAS

This section discusses the lack of advisory standards or screening values for various environmental media and exposure pathways.

13.1.1.1 PFAS in Drinking Water

The USEPA published National Primary Drinking Water Regulations (NPDWR) for six PFAS ([USEPA 2024](#)).

Several states have regulatory values for some specific PFAS, but the majority of PFAS are not included in any of the states' regulations. Information about available current regulatory standards and guidance values for PFAS in drinking water are provided in [Section 8](#), with a summary table linked on the [PFAS fact sheet page](#).

Stakeholders are concerned because the health consequences of these other compounds remain uncertain. Firm conclusions relating individual PFAS to specific health outcomes remain elusive ([Guelfo et al. 2018](#)). Information about health impacts for other PFAS is provided in [Section 7.1](#).

13.1.1.2 PFAS in Environmental Media Other than Drinking Water

With the exception of regional soil screening levels for a limited number of PFAS ([USEPA 2023](#)), there are no federal standards or screening levels for evaluating environmental media (air, soil, and surface water and groundwater not used for drinking) and limited federal requirements that compel such monitoring at the time of publication.

USEPA has developed interim recommendations for screening and remediation of groundwater for PFOS and PFOA at CERCLA and RCRA regulated sites ([USEPA 2019](#)). [Section 8](#) includes information about regulations, guidance, and advisories for PFAS. In addition, the [Environmental Media Values Table](#) Excel file is available.

There are few limits by the federal and most state governments on PFAS in biosolids being applied to land for food and/or nonfood crops. PFAS, such as PFOA and PFOS, have been detected in biosolids produced at wastewater treatment plants (WWTPs), and in soil, surface waters, and leachate from landfills. WWTP biosolids are commonly applied to land as a soil amendment, and can remobilize PFAS to other migration and exposure pathways. Stakeholders are concerned about uptake by crops eaten by humans and animals. [Section 2.6](#) introduces PFAS sources at landfills and WWTPs, and [Section 5.6](#) and [Section 6.5.1](#) discuss plant uptake of PFAS. USEPA will be performing a risk assessment of biosolids as part of the PFAS Strategic Roadmap ([USEPA 2021](#)).

There are few regulatory or guidance limits for PFAS in surface water that may affect fish and consumers of fish. In addition, PFAS in surface water also creates an exposure pathway that potentially affects ecological and human health. For more information on PFAS in surface water, see [Section 16](#).

While recognizing that drinking water is the dominant exposure pathway, [Vestergren and Cousins \(2009\)](#) identified that PFAS impacts to other media need to be considered because "there is a clear need of investigations of how to remediate the hotspot areas with focus on the unsaturated zone," because "PFAS that are pooled in the unsaturated zone will continue to infiltrate and spread from contaminated areas as long as the source is not removed, or infiltration of precipitation is inhibited."

13.1.1.3 Human Consumption of Food

Many stakeholders want clear advisories or standards on PFAS in food due to the occurrence of PFAS in a variety of food. In Europe important sources of human exposure to PFOA and PFOS have been found to include the consumption of fish, meat, and eggs ([EFSA 2018](#)). The US Food and Drug Administration (FDA) has published information on their PFAS studies on their website ([USFDA 2019\[1768\]](#)). Few screening levels or advisories have been posted; for example, Maine has developed screening levels for fish for PFBS, PFOS, and PFOA, and for milk and beef for PFOS ([ME DEP 2021](#)). Further information about development of standards for food consumption is found in [Section 8.2.2.11](#). PFAS are found in a variety of foods, including homegrown produce and wildlife. Some areas of concern regarding foods include the following:

- PFAS have been found in food purchased at stores. Some occurrence information for foods collected as part of the FDA's Total Diet Study is published in [Genualdi et al. \(2021\)](#).
- Some states have issued fish consumption advisories for specific lakes and rivers after tests confirmed the presence of PFAS in surface water. [Section 15.3](#) includes a case study example about a recently enacted fish consumption advisory by the New Jersey Department of Environmental Protection.
- In February 2018, the Environmental Protection Authority of Victoria, Australia, "assessed waterfowl from three wetlands to better understand the extent and distribution of PFAS contamination ahead of the duck hunting season. PFAS was detected in waterfowl from all three wetlands." As a result, health risk assessments were undertaken and human health advisories were issued ([Environmental Protection Authority Victoria 2019](#)), p.1).
- In Wisconsin, the Department of Natural Resources (DNR) recommended not consuming the liver of deer killed within a 5-mile radius of an industrial site where elevated levels of PFOS were found. "DNR And DHS Issue Do Not Eat Advisory for Deer Liver In Five-Mile Area Surrounding JCI/Tyco Site In Marinette", September 15, 2020, <https://dnr.wisconsin.gov/newsroom/release/37921>.
- Alaska Community Action on Toxics (ACAT) ([Byrne 2009](#)) reported that "A study by [Martin et al. \(2004\)](#) on the presence of PFOS in the livers of arctic animals revealed elevated PFOS levels in almost all species studied." Furthermore, it reported that "In a recent study (Ostertag et al. 2009[2119]) of foods consumed by a Canadian Inuit population, traditional foods were more widely contaminated and contained higher concentrations of PFCs [PFAS] than nontraditional foods. Caribou had the highest concentrations of perfluorinated compounds (PFCs), including PFOS." At the request of the Yupik people of St. Lawrence Island, the ACAT is conducting a study to determine the safety of the traditional foods they eat for subsistence ([Byrne 2009](#)).

13.1.1.4 Ecological Risk

There is wide stakeholder concern that ecological receptors have been or will be harmed by releases of PFAS to the environment ([Section 7.2](#)). Currently, there are no federal risk-based ecological guidelines or thresholds for environmental media. Ecotoxicity studies are generally limited to a relatively small number of PFAS (typically PFOA and PFOS). Stakeholders are asking for expanded studies in this field to evaluate additional PFAS, including short-chain precursor compounds as well as "next-generation" substitute compounds. Several states have established some criteria that are intended to protect aquatic organisms in their respective surface waters (see [Section 16.3](#)).

13.1.2 Desire for One Standard or Screening Level for PFAS

Among stakeholders there is a difference of opinion regarding how standards for PFAS should be established. Many stakeholders believe that PFAS should be treated as a class of chemicals ([Kwiatkowski et al. 2020](#)), similar to how PCBs or dioxin are currently regulated. In 2021, Vermont concluded that further information is needed to evaluate the feasibility of regulating PFAS in drinking water as a class ([VT ANR 2021,2021](#)). [Section 7.1](#) includes information about approaches for assessing toxicity of PFAS mixtures.

Given the lack of toxicological information for the vast majority of PFAS, when even less is known about the potential additive and synergistic effects associated with PFAS mixtures (see [Section 7.1.5](#)), many stakeholders support evaluating the mass of total PFAS as a preferred screening method, rather than limited compound-specific testing using target analyte lists ([CSWAB 2018](#)). However, it is noted that given the lack of a method to test for total PFAS (see [Section 13.1.10](#)), screening might need to be completed using a method such as the TOP assay, total organic fluorine, or non-target analysis as described in [Section 11](#). For example, the Conservation Law Foundation in New England put forth a petition requesting that PFAS in drinking water be regulated as a group with a treatment technique drinking water standard.

See <https://www.nhpr.org/post/activists-ask-new-england-states-regulate-pfas-chemicals-class#stream/0> and <https://www.mass.gov/lists/pfas-information-a-petition-for-rulemaking-to-establish-a-treatment-technique-drinking-water>. However, some interested parties do not support treating PFAS as a class of chemicals, because some PFAS, such as certain fluoropolymers, like PTFE, might need less toxicological information because they are unable to enter cells, they are not mobile in the environment, they do not bioaccumulate, and they are therefore not available to cause adverse health effects ([Henry et al. 2018](#)), although this issue needs further study ([Lohmann et al. 2020\[1821\]](#)). See also [Section 2.2.2.1](#).

13.1.3 Lack of Occupational Standards

There are few standards or guidance values for occupational exposure for PFAS. NIOSH identified occupations that might have a higher potential exposure to PFAS, and identified occupational exposure studies and other research ([NIOSH 2021](#)). Stakeholders are concerned that paper mills and wastewater treatment plants where PFAS have been documented in

indoor air, and manufacturers and industrial users of PFAS, do not have specific occupational standards for all of the PFAS that the workers might be exposed to during workplace activities.

13.1.4 Lack of Comprehensive Monitoring Information

Many stakeholders are concerned that most individuals and communities do not have any testing for PFAS. Moreover, there is no comprehensive federal requirement for PFAS testing of all drinking water systems and private wells. Based on publicly available data, there is an estimate that up to 80 million people in the United States might have drinking water with PFOA and/or PFOS concentrations greater than 1 nanogram per liter ([Andrews and Naidenko 2020](#)).

Limited testing has occurred in some public water systems, and USEPA's Unregulated Contaminant Monitoring Rule (UCMR) and other regulatory programs have provided more (see [Section 8](#)). Some significant points regarding the status of a comprehensive monitoring effort follows:

- As described in [Section 8.2.2.4](#), the third round of USEPA's required monitoring program (UCMR3), which occurred between 2013 and 2015, sampled for only six of the thousands of PFAS. UCMR3 was limited to public water systems (PWS) serving more than 10,000 people and a nationally representative subset of smaller PWSs, but private wells and many smaller PWSs were not included. More information about the UCMR3 data is included in [Section 8.2.2.4](#). From this data set, it was estimated that approximately 6 million residents of the United States have drinking water that exceeds the 2016 health advisory for PFOA or PFOS, or both ([APHA 2016](#)).
- Sampling for UCMR4 ([USEPA 2016](#)), which occurred between 2018 and 2020, did not include any PFAS in its analyte list ([USEPA 2020](#)). Many stakeholders are concerned that an opportunity to better understand the magnitude of PFAS contamination on PWSs was not taken.
- Summarizing information about the UCMR, [Siros \(2018\)](#) stated, "America's Water Infrastructure Act of 2018 ... requires drinking water systems serving more than 3,300 people to test for unregulated contaminants pursuant to USEPA's [UCMR]. Prior to this new law, only drinking water systems that served more than 10,000 people were required to monitor for unregulated contaminants. ...Th[e] new testing requirement, which goes into effect in 2021, is expected to add more than 5,000 drinking water systems to the list of systems that are required to test for these unregulated contaminants." UCMR5 testing, scheduled for 2023–2025, will analyze for 29 PFAS chemicals (for which there is a validated USEPA testing method) in systems serving more than 3,300 people using lower detection limits than previous UCMRs. UCMR5 will also include monitoring at a nationally representative subset of PWSs (approximately 800) serving fewer than 3,300 people, contingent on appropriations, ([USEPA 2023](#)). UCMR5 does not mandate sampling of private water wells ([USEPA 2023](#)).
- Some states (for example, New Hampshire, Massachusetts and Vermont) have initiated testing of private wells in certain locations where there is a high potential for PFAS contamination, and require testing of public water systems subject to maximum contaminant level (MCL) regulations. The Washington State Department of Health announced that it will be conducting additional testing for PFAS at several hundred untested water systems. The state of Michigan is also testing all public community water systems for PFAS (see <https://www.michigan.gov/pfasresponse/drinking-water/statewide-survey>). New Jersey requires that sellers of private homes must test the wells prior to the sale of a home, and requires that landlords test private wells every 5 years (<https://dep.nj.gov/pfas/drinking-water/#is-testing-for-pfas-required-under-new-jerseys-pwta>).

13.1.5 Need to Apply a Precautionary Approach in Decision Making

Given the lack of toxicological data for the great majority of PFAS and PFAS mixtures, many stakeholders want a precautionary approach to the use, treatment, and analysis of PFAS-containing chemicals. This precautionary approach presumes compounds of similar structure may be expected to have similar modes of action and pose a similar risk to human health and the environment, lacking evidence to the contrary. This is particularly true because there are many nonessential uses of PFAS in consumer products (see [Section 2.5](#)) that receive no regulatory scrutiny.

13.1.6 Safety of Short-chain Substitutes

Many stakeholders are concerned with the use of substitute short-chain PFAS. After concerns arose that PFOA and PFOS (both long-chain PFAS) have health risks at very low concentrations, industry began to substitute them with shorter chain PFAS (see [Section 2.4](#)). Although some short-chain PFAS appear to be less bioaccumulative, the publicly available data are limited. Some short-chain PFAS can be persistent, and tend to be more water-soluble and more mobile than long-chain PFAS. Because of their greater water solubility, studies indicate short-chain substitutes are more readily taken up by plants than longer chain PFAS, including food crops ([Higgins 2017](#)). In their Interim Chemical Action Plan for PFAS, the [Washington State](#)

[Department of Ecology and Washington State Department of Health \(2019 p. 1\)](#) states that short-chain PFAS are difficult to remove from water, noting further, “Without additional health and safety data, it is impossible for us to evaluate whether short-chain replacements are safe substitutes. If environmental exposures to short-chain PFAS are found to pose health risks to people or the environment, mitigation will be difficult and expensive.” Precursor compounds for some short-chain PFAS are also of interest in future monitoring studies; for example, perfluoro-1-butane-sulfonamide (FBSA, a precursor to PFBS), has been documented with high detection frequency (32 out of 33 samples) in fish from North America ([Chu et al. 2016](#); [Ericson, Jogsten, and Yeung 2017](#)). Finally, in the Helsingør Statement ([Scheringer et al. 2014](#)) and the Madrid Statement on Poly- and Perfluoroalkyl Substances ([Blum et al. 2015](#)), scientists and other professionals expressed concerns about the embrace of short-chain PFAS as preferable replacements for long-chain PFAS.

13.1.7 Contamination from AFFF Release Sites

Many stakeholders believe that all potential AFFF release sites should be investigated, and where necessary, potential exposure should be mitigated. Investigations to date have identified the use of AFFF as one of the main sources of PFAS releases to the environment, and AFFF releases have been responsible for PFAS contamination of multiple drinking water sources. Although AFFF foams typically contain less than 2% total PFAS, thousands of gallons of foam mixture may be applied during a given event, and the concentrations of concern for PFAS are very low (below 100 parts per trillion (ppt)). Typical locations where AFFF is stored and used include civilian airports, military bases, chemical plants, municipal fire departments, oil refineries, bulk fuel storage facilities and terminals, and crash sites. AFFF was used abundantly for training purposes at military bases with flight operations and at civilian airports. Additional information is presented in the ITRC [AFFF fact sheet](#) and in [Section 3](#).

13.1.8 Contamination from Unused AFFF Disposal

Stakeholders are concerned that incineration of unused AFFF is not always specifically regulated with PFAS-specific emission conditions and limits, and that incineration may generate dangerous byproducts (see [Section 3.10](#) on AFFF Disposal; [USEPA 2020](#); [Earthjustice 2020](#)). The U.S. military indicated plans to collect and destroy unused firefighting foam that contains PFOS and PFOA ([USDOD 2018](#)). In a 2017 request for AFFF disposal research project proposals ([U.S. Air Force 2017](#)), the Air Force acknowledged that the foam, which was designed to resist extremely high temperatures, is difficult to burn and that “the high-temperature chemistry of PFOS and PFOA has not been characterized, so there is no precedent to predict products of pyrolysis or combustion, temperatures at which these will occur, or the extent of destruction that will be realized.” Stakeholders are concerned that there are no federally mandated protocols that require incineration to reach certain temperatures to specifically target PFAS. (See <https://theintercept.com/2019/01/27/toxic-firefighting-foam-pfas-pfoa/>)

The National PFAS Contamination Coalition (an assembly of stakeholder groups from across the U.S.) opposes incineration (and similar thermal treatment technologies) for disposal of PFAS-contaminated wastes and collected PFAS products because stakeholders are concerned that thermal treatment technologies may not be specifically permitted to treat PFAS, and that demonstration is needed that treatment will fully destroy PFAS, that is, reduce the molecules to carbon, fluoride salts, and/or other constituents ([National PFAS Contamination Coalition Statement on Incineration of PFAS - National PFAS Contamination Coalition \(pfasproject.net\)](#)). See [Section 13.1.18](#) below.

The USEPA’s Interim Guidance, Version 2 ([USEPA 2024](#)) indicates that thermal treatment (which includes incineration) is commercially available and potentially has the capability to destroy PFAS or manage the migration of PFAS in PFAS-containing materials, but that further research activities are needed. Some facilities in the United States have been permitted by state regulatory agencies for the thermal treatment of PFAS.

The Foam Exposure Committee (FEC), a subgroup of the Fire Department Safety Officers Association ([FDSOA 2021](#)), whose objective is to reduce firefighter/first responder exposures to PFAS in firefighting foams, reports that the absence of federal and state regulations addressing disposal provides more opportunities for fire departments to expose their firefighters and contaminate their own communities with AFFF products. Current regulatory programs that address use and disposal of AFFF are provided in [Section 8.2](#).

13.1.9 Duty to Warn AFFF First Responders

Aside from standard workplace safety requirements regarding hazardous materials right-to-know, stakeholders are concerned that there has been no legal duty to warn or to require notice of hazards to first responders who handle AFFF. Several studies have concluded that some PFAS were elevated in the blood of first responders.

- The New Hampshire Department of Health and Human Services PFC Blood Testing Program ([NH DHHS 2016](#)) results indicate the geometric mean levels of PFOS and PFHxS in the blood serum of firefighters were elevated versus the geometric mean levels of those who had not worked as firefighters. Numerous other studies indicated that blood serum levels were elevated in firefighters ([LeMasters et al. 2006](#); [Jin et al. 2006](#); [Dobraca et al. 2015](#)). It is difficult to tease out whether these higher levels are related to exposures to AFFF, PFAS in firefighter gear (clothing), consumption of water from PFAS-contaminated drinking-water wells in affected communities, especially those that may be located near training facilities that have used AFFF, or other sources.
- IPEN (International Pollutants Elimination Network) released a report that presents information from recent studies that firefighters using AFFF have elevated blood levels of both PFHxS and PFOS; see also [NIOSH \(2021\)](#) for links to additional research. Earlier IPEN reports describe fluorine-free firefighting foam alternatives that can replace uses of toxic fluorinated firefighting foams ([IPEN 2018, 2019](#)). The FEC recommends replacing older stocks of AFFF with fluorine-free foam solutions ([FDSA 2021](#)).

13.1.10 Limitations in Sampling and Analysis Methods

Stakeholders are concerned that current PFAS site investigations may not adequately define the types and total mass of PFAS present, due to limitations in analytical methods (see [Section 11](#)) that are still evolving. Moreover, the PFAS family of compounds contains thousands of chemicals, but standard analytical methods can identify only a fraction of these chemicals.

A related concern is that the specification for shorter chain AFFF published by the Department of Defense ([USDOD 2018](#); [NAVSEA 2017](#)) still allows concentrations of PFOA and PFOS up to 800 ppb in AFFF concentrate, because that is the lowest concentration of either PFOA or PFOS that can be measured in the concentrate with current analytical methods. This is because the overall high concentrations of the many chemicals in the AFFF concentrate “swamp” the lab instrument, interfering with its ability to detect any individual compound except when it is present at high concentrations. The DOD has recently published a draft analytical method, DOD AFFF01, to quantify PFOA and PFOS with a limit of quantitation of less than 25 ppb ([Willey 2021](#)). The modern short-chain AFFF formulations are fluorotelomer-based, so PFOS (and other PFASs) should not be present and PFOA may be present only as contamination from the production process (as discussed in [Section 3.1](#)), but without analytical methods to prove this, users cannot know for certain if the new AFFF products are PFOS- and PFOA-free. The ITRC [AFFF fact sheet](#) and [Section 3](#) include more information about AFFF specifications.

13.1.11 Limited Programs for Health Monitoring and Blood Testing

Some PFAS (for example, PFOA, PFOS) bind to proteins in the blood, making blood testing a means of investigating human exposure to PFAS (see [Section 7](#)). Many communities where PFAS have been detected have asked that the government establish a program for blood serum testing and long-term health monitoring so that they can better understand any health risks associated with PFAS exposure. ATSDR established a multi-site study with seven partners across the country to better understand the connection between PFAS exposures and health effects ([ATSDR 2020](#)).

Some states have provided limited testing on people in high-impact areas. For example, New Hampshire provided blood serum testing for people who worked on, lived on, or attended childcare on an AFFF-impacted site and were exposed to contaminated drinking water ([NH DHHS 2016](#)). New Hampshire also performed blood tests in selected towns where people used private wells that tested above the 2016 health advisories for PFOA and PFOS. However, many state and local governments are wary of blood testing programs because there is no correlation between the PFAS level in blood serum and any definitive health effects. People who participate in such tests are usually informed of their results and provided context about how they compare with national and location-specific averages. Only limited long-term programs have been established to monitor the health outcomes of exposed populations (for example, C8 Science Panel ([C8 Science Panel 2020](#))). If there is no assistance from the government, many community members cannot afford to have their blood tested.

13.1.12 PFAS in Food Packaging

Many stakeholders are concerned that food packaging containing PFAS leaches into food. Food packaging, such as bowls, plates, clamshells, trays, and pizza boxes, often includes PFAS for anti-grease resistance, and PFAS is sometimes used in the molding process to manufacture paper plates and containers. A 2008 FDA study found that “fluorochemical paper additives do migrate to food during actual package use,” and oil and grease “can significantly enhance migration of a fluorochemical from paper” ([Begley et al. 2008](#)).

There is only limited peer-reviewed information regarding PFAS transfer to food. One study documented that 6:2 FTOH moves from dishware or containers into food (Yuan et al. 2016). A Canadian analytical lab found that PFBA moves from cupcake liners into cupcakes (CEH 2018).

The FDA has approved 20 next-generation, short-chain PFAS for coating paper and paperboard used to serve food. The FDA Effective Food Contact Substance Notifications database is available online (FDA 2018). Concerns have been raised that these compounds have not been adequately tested for human impact. Because of trade secrecy laws with regard to patents, the government does not publicly disclose the identity of the specific chemicals in food packaging. However, according to The Intercept (Lerner 2016), in documents filed with the USEPA, under TSCA section 8(e) requirements, DuPont (2010) reported that substitute PFAS used to produce food contact paper could pose a “substantial risk of injury,” including cancerous tumors in the pancreas and testicles, liver damage, kidney disease, and reproductive harm. For more information about FDA’s PFAS activities and food contact materials (FCM) PFAS phaseouts, please see Section 8.2.

Although there are no enforceable PFAS limits in food or water at the federal level as presented above in Section 13.1.1.3, some states and cities are moving forward with bans. Several states, including Washington, Minnesota, Maine, New York, and Vermont, have enacted laws to ban PFAS use in some food packaging. See Section 8.2 and the Regulatory Programs Summary Excel file for information about regulatory programs. Stakeholders are concerned because not only does PFAS in food packaging pose potential risks to consumers of the food, but the used packaging may end up in compost or landfills. Compost is eventually applied to soil and PFAS are potentially transferred to certain food crops, and may leach to groundwater. If compost goes to a landfill, PFAS potentially ends up in the landfill’s leachate.

13.1.13 Potential PFAS Contamination in Recycling, Compost, and Fertilizer

Carpeting, furniture, and numerous other items containing PFAS are often recycled. There is concern that the recycled materials are often used in products where the consumer has no way of knowing whether it has PFAS contamination. Biosolids from wastewater treatment plants are used in some composts and fertilizers and PFAS sampling may not be part of the screening process for these products. However, this is changing; New Hampshire and Maine both require testing. Additionally, stakeholders are calling for more testing and regulation for land-applied or disposed paper mill waste due to potential PFAS impacts. Stakeholders are concerned that composting of paper mill waste to make fertilizer, which, for example, is still done in Michigan, should get more attention. It is difficult to know which mills make “waterproof” or food contact papers that contain PFAS.

13.1.14 Lack of Disclosure by Product Manufacturers

Some stakeholders are concerned that chemical and product manufacturers are not required to disclose when they sell, make, or use PFAS in their products because some formulations are proprietary and may not be listed on a Safety Data Sheet. For example, many sturdy, waterproof, and heat-resistant products containing PFAS are produced for the construction industry, including polished granite countertops. Additionally, there is lack of disclosure and transparency concerning the composition of AFFF, because AFFF suppliers claim that formulations are proprietary.

13.1.15 Limited Availability on Information on the Health Effects of PFAS

Some stakeholders are concerned that politics may delay or even prevent the full disclosure of PFAS toxicity information. For example, the 2018 release of ATSDR’s Draft Toxicological Profile for PFAS was reportedly delayed because of concerns about the public response. This example, if replicated, may lead to distrust and reduce the efficacy of risk communication. Additionally, collected health data may not be clearly and fully shared or explained to stakeholders.

13.1.16 Responsibility for Sampling and Treatment on Private Property

When off-site contamination is suspected or discovered, stakeholders believe that the responsible parties should be accountable for establishing an entire program to deal with the problem. This includes sampling and analysis, disclosure of PFAS content, health monitoring, and if appropriate, remediation and mitigation. Upon detection of PFAS above state or USEPA limits, stakeholders maintain that responsible parties should be required to provide affected residents with alternative water supplies. Additionally, stakeholders believe that the cost of the program, including long-term treatment and monitoring, should be borne by responsible parties.

13.1.17 Potential PFAS Emissions from Cleanup Methods

Stakeholders believe that treatment systems (from large public water treatment systems to small private point-of-use systems) should be monitored for effectiveness, as the type and frequency of monitoring may vary for all systems. There is also concern that disposal or regeneration of GAC canisters, resins, and byproducts will add contaminant loads of PFAS to the air, land, and water. Stakeholders are concerned that companies that thermally treat spent carbon filters that contain PFAS do not provide publicly accessible information that documents full destruction of all PFAS; some companies claim all PFAS are destroyed, yet the research appears to be focused on targeted PFAS (for example, PFOS and PFOA) destruction. More concerns about thermal treatment are discussed in [Section 13.1.8](#), with further information provided in [Section 12.4](#).

13.1.18 Lack of Scientific Evidence that Some PFAS Treatment and Disposal Methods and Remedies Are Fully Protective of Human and Ecological Health and Prevent Toxic Emissions

Historically, the three standard practices for PFAS waste management are landfilling, wastewater treatment, and incineration. Stakeholders' concerns with these disposal practices are highlighted in a study sponsored by the Environmental Working Group (EWG) (<https://www.ewg.org/news-insights/news-release/study-disposal-pfas-waste-increases-contamination>). One of the conclusions of that study is that all three methods have been found to not effectively contain or destroy PFAS. Tasha Stoiber, EWG senior scientist and primary author of the study, found that "The three common 'disposal' options for getting rid of PFAS do not eliminate these contaminants but rather end up just returning either the same chemicals or their byproducts back into the environment." Additionally, USEPA has confirmed that while "Thermal treatment technologies are common remediation approaches for contaminated media and waste, limited information exists on the efficacy, potential atmospheric emissions, operational conditions, costs, etc. for thermal treatment technologies specifically targeted for PFAS" ([Mills et al. 2020](#)).

Additionally, USEPA stated that "Research on thermal stability of PFAS compounds, the ability to fully capture and identify PFAS compounds and their thermal decomposition byproducts, and the efficacy of emission control technologies are areas of targeted research. These efforts, in cooperation with states and industries, [are] aimed at proper disposal of PFAS-laden wastes without media-to-media transfer or environmental release" ([USEPA 2019](#)). In USEPA's Interim Guidance, Version 2 ([USEPA 2024](#)), they identified areas for further study to assess the efficacy of destruction and disposal of PFAS-containing materials (that are not consumer products) to help protect public exposure to PFAS. Recent testing and reporting of PFAS destruction by incineration has been documented (see [Section 12.4](#)).

Additionally, it should be noted that other technologies besides the three methods can be used in remediation. These include ion exchange, granulated activated carbon (GAC), and reverse osmosis (see [Section 12](#)).

An example that demonstrates the stakeholders' concerns about adequate protection provided by disposal options is the Holston Army Ammunition Plant (Holston) in Tennessee. In a July 16, 2019, letter to USEPA Region 4 Administrator (<https://cswab.org/wp-content/uploads/2019/07/Holston-Citizen-Petition-Region-4-PFAS-July-2019.pdf>), several environmental groups stated that Holston will present a risk to human health and the environment by burning polymer-bonded explosives (PBXs) containing PFAS. The groups cited a recent decision by the neighboring State of Kentucky to prohibit the Blue Grass Army Depot from open-air burning or detonation (OB/OD) of "munitions wastes that are a potential source of Per- and polyfluoroalkyl substances (PFAS), including Teflon, Viton, and Viton-A. This includes both short and long chain PFAS." Both bases are located in USEPA Region 4. The groups stated: "Open air burning and detonation do not provide either sufficient or sustained temperatures times to achieve destruction. OB/OD activities at Holston are very likely resulting in the ongoing release and dispersion of PFAS to the environment, posing a potentially substantial health risk to workers and residents."

13.1.19 Stormwater and PFAS Manufacturing Discharges that May Contain PFAS

PFAS, including PFOA, have been detected at the storm drain outfalls at active facilities. Stakeholders are concerned that most NPDES effluent permits do not require PFAS sampling and the magnitude of PFAS concentrations in such discharges remains unknown. Older and inactive facilities' discharge areas, many of which have not been sampled for PFAS, may also act as long-term sources of stormwater and/or groundwater contamination due to residual PFAS in soil at stormwater discharge areas.

13.1.20 Psychological Effects

It was reported at one Superfund community (Tucson AZ) that children in some communities are scared to drink water (Strauss 2024) where contaminated drinking water supplies have the effect of deterring children from drinking clean water. Additionally, blood level values have become an identity, and there are pictures of people holding up signs identifying their blood levels.

In addition, the Agency for Toxic Substances Disease Registry (ATSDR) has identified that studies “suggest that the experience of exposure to hazardous substances and the resulting psychosocial changes can result in adverse physical and psychological health effects” (ATSDR 1995).

13.1.21 Economic Consequences of Local PFAS Contamination

Individuals have voiced concerns about significant economic consequences on property values and businesses. See the USEPA community meetings information provided on USEPA’s website: <https://www.epa.gov/pfas/pfas-community-engagement>. In one case in Massachusetts, the Board of Health added PFAS to the list of substances homeowners with private wells in certain areas of town must test for before selling their homes (Town of Harvard, MA 2020). In New Jersey, PFOA, PFOS, and PFNA were added to a list of chemicals that private well owners must test for prior to selling their homes under the NJ Private Well Testing Act. This also applies to landlords who rent homes with private wells (see https://www.nj.gov/dep/rules/adoptions/adopt_20200601a.pdf). In another instance, because PFAS was detected in water used by dairy cattle, the farmer had difficulty selling the milk products. Stakeholders are particularly concerned about facilities located in economically disadvantaged communities. These communities need the economic benefits of a facility but have few resources to demand enough testing of air emissions and of potential health impacts on the community.

13.1.22 Remediation of PFAS With Other Contaminants Especially Chlorinated Solvents

At many sites where PFAS has been found, especially military sites that are contaminated with AFFF, there is concern that past cleanup efforts have spread PFAS. Many military sites have been listed as Superfund sites because they are contaminated with chlorinated solvents (<https://www.epa.gov/fedfac>). The early remedy for removal of solvents from groundwater was pump and treat with air strippers. Since air stripping doesn’t remove PFAS, groundwater contaminated with PFAS was, and in some cases continues to be, discharged into streams and rivers, through reinjection, discharge to wastewater treatment plants, or reuse such as irrigation or make-up water for recycling.

Even if remediation systems use GAC or other techniques to clean up chlorinated solvents (for example, PCE and TCE), these systems are not typically optimized for PFAS capture. If they are optimized for PFAS capture, it is unclear if they will be as effective for solvent capture. Additionally, it is not clear whether in the past PFAS was released during the regeneration process for solvent-laden GAC, thus spreading some PFAS through air during the heating process. More information about treatment systems and co-contaminants is included in [Section 12.8](#).

13.1.23 Pesticides containing PFAS

Some pesticides contain PFAS. PFAS have been used as an active and inert (or inactive) pesticide ingredient. PFAS can be used as herbicidal dispersants and wetting agents and to aid wetting and penetration in insecticides. A patent has been issued for insecticides and fungicides having branches composed of perfluoroalkyl chain molecules. Other pest control patents refer to compounds with some of the side chains composed of perfluoroalkyl (Gaines 2022). This creates a number of problems, including low levels residing in soil, uptake in food, and “masking” other sources of the PFAS in areas that have been historically sprayed with insecticides. Some pesticides have received new USEPA guidance, including <https://www.epa.gov/pesticides/epa-stops-use-12-pfas-pesticide-products> and <https://www.epa.gov/pesticides/pfas-packaging>. More information about PFAS uses is included in [Section 2.5](#).

13.1.24 Artificial Turf

Many stakeholders are concerned that plastic grass blade and/or “rubber crumb” backing in artificial turf contains PFAS. Artificial grass blades are plastic and were found by one nonprofit organization to contain PFAS. This issue was investigated by the Connecticut Department of Energy & Environmental Protection (CH DPH 2022), which analyzed “grass” blades from a previous study and suggested that the PFAS had a different origin (see [Table 2-6](#)). While this may be true for the product

analyzed, artificial turf in parks and schools is from many different manufacturers. Additionally, “[a]rtificial turf infill is often made from recycled tires, which may be another source of PFAS. Polymeric pellets manufactured specifically as infill are also available, and patents indicate that these materials may contain PFAS as well” ([Fernandez, Kwiatkowski, and Bruton 2021](#)). The City of Boston has recently banned all new artificial turf in city parks. (<https://www.theguardian.com/environment/2022/sep/30/boston-bans-artificial-turf-toxic-forever-chemicals-pfas>)

13.1.25 Semiconductor Manufacturing

There is concern that the semiconductor industry has long been a source of PFAS that has been overlooked. A recent survey of the technical literature by researchers from Cornell University “revealed that there are several specific examples of fluorocompounds that are currently in use by the semiconductor industry in the lithography process” ([Ober, Florian, and Deng 2022](#)). More information about PFAS use is available in reports from the Semiconductor Industry Association ([SIA 2023](#); [SIA 2023](#)). As with the concern about remediation of PFAS with other contaminants, the manufacture of semiconductors has also seen releases of chlorinated solvents. In the remediation process, the industry used pump and treat with air stripping, which does not remove PFAS from contaminated water; thus, PFAS remained in the discharge waters. In one case (Moffett Field), the site was contaminated by a plume of chlorinated solvents that spread from a center for semiconductor development that is now commingled with the VOCs and other PFAS used at Moffett Field. Recently, NASA, which is the steward of the site, found PFAS from past use of AFFF and from the semiconductor industry adjacent to Moffett ([Tetra Tech 2022](#)).

13.1.26 Monitored Natural Attenuation (MNA) for PFAS

Although early in the research stages, using remediation techniques that employ MNA for PFAS presents a range of problems and concerns for community and tribal stakeholders. As this document points out in its discussion of these still unproven processes to remediate PFAS (see [Section 12.6.7](#)), there are no currently recognized destructive attenuation pathways for PFAAs (a class of PFAS) in natural settings. Communities generally do not favor prolonged cleanup approaches with uncertain funding, with a commensurate degree of risk, and a shift of the burden for environmental cleanup to another generation. A related stakeholder concern is that the strictest cleanup standards be applied. Cleanup standards may differ from site to site based on risk assessments, site conditions, or state regulations. Additionally, many community members perceive MNA as a “do-nothing” approach.

MNA for PFAS is similar to nondestructive retention processes for metals and radionuclides, thus leaving diluted PFAS in the environment ([ITRC 2010](#), section 5 Stakeholder and Tribal Issues). This referenced document details major concerns that are specific to leaving contamination in place, including requirements for enhanced community participation; need for long-term monitoring and maintenance; future use considerations; and long-term health and safety, as well as many tribal concerns. The framework from ITRC ([2010](#), section 5), is used here to address stakeholder perspectives and concerns about using MNA for PFAS.

- Enhanced Community Participation

Attenuation-based restoration projects require the community to coexist with some residual level of contamination for an extended period. Attenuation-based projects should always include communicating this temporal component. Prior to beginning attenuation projects, the public must be fully informed of planned activities and potential consequences. Afterwards, stakeholders must be informed about the progress in retaining chemicals “safely” in place and the risks of long-term environmental changes that may affect the retention capability of the subsurface, such as geochemical changes in the subsurface, earth movement, and a host of natural phenomena.

- Need for Long-Term Monitoring and Maintenance

Stakeholders may be concerned that attenuation-based restoration of PFAS will require extensive long-term monitoring and maintenance to ensure that public health and ecological parameters are met. Significant uncertainties in attenuation cleanup efficacy and timelines may conflict with stakeholder expectations. Consequently, stakeholders should receive additional communication of technical information, results of monitoring, and prognoses. Stakeholders will also be concerned about what will happen if attenuation does not proceed at the projected rate. Stakeholders may expect that target contamination levels be set for future dates and for reassessment of the cleanup strategy if monitoring shows that targets are not being met by natural attenuation. As an important precept, the responsible party must commit that the remedy will be revisited (for Superfund sites, this occurs every 5 years) and selection of attenuation will not hinder future investigations

and consideration of other means to remove the contaminants.

- Future Use Considerations

Generally, the public favors site cleanup that leads to unrestricted use. If unrestricted use is not possible, the smallest area possible should be set aside, and institutional and engineering controls should be incorporated into the activity (see also [Section 14](#)). If the future use does lead to unrestricted use, a long-term stewardship program must be developed to ensure that the contaminants are reduced to acceptable levels or eliminated. While MNA may be less costly than other remediation techniques, the public generally is not concerned with simply reducing the overall restoration costs; they may be more concerned with removing the contamination quickly and gaining access to the land—or lifestyle—as before the contamination occurred. As such, the public should be full partners in future land-use decisions. If MNA is selected, the site should be visibly marked and documented for long-term identification.

13.2 Specific Tribal Stakeholder Concerns

Tribes share many concerns with other stakeholders; however, they differ from other stakeholders in several key aspects. The 573 federally recognized tribes are each culturally, governmentally, and socially unique. Some tribes view any level of contamination of their lands and natural and cultural resources as unacceptable. Many tribes have culturally significant or sacred areas, which may include springs, mountains, hunting areas, plant-gathering areas, or burial sites. When culturally significant or sacred areas are affected, traditional methodologies that nontribal environmental professionals rely on (such as the applicable exposure scenarios or factors for a risk assessment) may not be sufficient to portray the effect to a tribe. For example, some plants and animals can have tremendous cultural or religious importance to a tribe, including birds and feathers, game animals, and herbs. Many tribes sustain themselves through hunting, fishing, and gathering of foodstuffs. Additionally, many tribal cultural ceremonies include the use of water. Other areas of difference include diet (for example, some tribes consume more fish per capita) and growing crops or grazing animals on areas fertilized by biosolids from wastewater treatment facilities.

Tribes are sovereign entities that have established government-to-government relationships with federal, state, and local governments—relationships that must be recognized in the decision-making process. When a PFAS-contaminated site affects a tribe, the project timeline must include tribal approvals in addition to other typical agency approvals. Sampling, research, and services on tribal lands generally require institutional review board or tribal council approval. Each sovereign nation operates differently, ranging from tribes that have no research capacity to tribes that have a full review board with a formal application process. The initial steps in the approval process may include drafting a proposal, preparing a poster or podium presentation, and presenting to the tribal government.

Once tribal approval is granted and the project commences, the practitioner must obey tribal protocol with respect to cultural practices. The tribe may reserve the right to retain the findings in the case of exploratory research and restrict publication. Regulatory findings for water and soil concentration, level of treatment, and monitoring are first reported to the tribe's department of environmental quality or natural resources and then forwarded to state environmental organizations and USEPA.

A Tribal PFAS Working Group was formed in 2020 to “help address and reduce PFAS in Indian Country.” The working group is comprised of members of the National Tribal Water Council, Tribal Science Council, National Tribal Toxics Council, Tribal Waste and Response Steering Committee, and Tribal Pesticide Program Council ([National Tribal Water Council 2023](#)).

Most of the concerns that tribes have are listed in [Section 13.1](#). However, as mentioned above, there may be some distinctions that are important to tribes:

- PFAS in surface waters and lakes may have a higher level of concern when they are used for fishing, given that tribal members rely on these water bodies.
- Drinking water and irrigation water in the arid Southwest are limited, and there is heightened concern that tribes will be unduly impacted if drinking or irrigation water is contaminated. Stakeholders are concerned with lack of PFAS sampling of tribal PWSs. USEPA performed limited sampling of tribal PWS during the 2022–2023 timeframe with no PFAS results above the detection limit ([USEPA 2022](#); [Mok et al. 2022](#)).
- Tribal lands are often close to installations that used AFFF (notably DOD) or other industrial sources of PFAS (manufacturers, leather tanneries).
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- Where biosolids have been applied to tribal farmlands or grazing lands, there is a need to sample these tribal lands for PFAS contamination. In some cases, cities may have paid tribal communities to spread biosolids from WWTPs that may have been unknowingly contaminated with PFAS.
- Activities on and near tribal lands may have involved use of PFAS-containing chemicals that could impact tribal members working in these facilities through inhalation and dermal exposure.
- Landfills on tribal lands that accepted outside waste need to be sampled for PFAS contamination, which may be in the landfill leachate. Companies that paid a fee to the tribes to use their land managed many of these landfills. Although most required sampling, often the sampling plans did not include sampling landfill leachate for PFAS.
- A big issue facing tribes is that tribal environmental offices and budgets are typically small, and they do not have the people or money to perform appropriate site investigations to determine if they have PFAS in their community.

13.3 Stakeholder Resources

Below are a number of resources for communities available at the time of publication. These resources are websites of major environmental organizations and projects that specifically deal with PFAS. These groups aim to help environmental and community groups to better understand the issues and science around PFAS. These websites have not been reviewed for accuracy or to determine if they are up to date.

<https://cswab.org/pfas/about-the-pfas-campaign/> and <https://cswab.org/wp-content/uploads/2010/09/List-of-military-fire-and-cash-training-sites-2014.pdf>

<https://pfasproject.com> (A project of Northeastern University)

<https://earthjustice.org/features/breaking-down-toxic-pfas>

<http://www.testingforpease.com>

<https://www.civilianexposure.org/the-military-covers-up-the-extent-of-pfas-contamination-across-the-country-while-it-continues-to-poison-hundreds-of-communities/>

<https://toxicfreefuture.org/science/chemicals-of-concern/pfas-nonstick-nightmare/>

<http://gatehousenews.com/unwellwater/>

<https://www.ewg.org>

[PFASCentral.org](https://www.pfascentral.org)

<https://greensciencepolicy.org/highly-fluorinated-chemicals/>

<https://www.sixclasses.org/videos/highly-fluorinated-chemicals>

<https://www.ucsusa.org/center-science-and-democracy/preserving-science-based-safeguards/toxic-threat-pfas-contamination-military-bases>

<https://www.nrdc.org/experts/anna-reade/epa-finds-replacements-toxic-teflon-chemicals-are-also>

<https://silentspring.org/research-area/about-highly-fluorinated-chemicals-pfass>

[https://clu-in.org/contaminantfocus/default.focus/sec/Per-_and_Polyfluoroalkyl_Substances_\(PFASs\)/cat/Policy_and_Guidance/](https://clu-in.org/contaminantfocus/default.focus/sec/Per-_and_Polyfluoroalkyl_Substances_(PFASs)/cat/Policy_and_Guidance/)

<https://theintercept.com/2019/09/19/epa-new-pfas-chemicals/>

<https://stories.usatodaynetwork.com/unwellwater/foam-1995/>

<https://www.ewg.org/pfaschemicals/what-are-forever-chemicals.html>

<https://pfas-exchange.org>

<https://silentspring.org/project/women-firefighters-biomonitoring-collaborative>

<https://www.epa.gov/pfas/basic-information-pfas>

<https://health.ri.gov/water/about/pfas/>

<https://www.fdsoa.org/resourcepage> (click on resources)

https://chemsec.org/app/uploads/2023/04/Check-your-Tech_230420.pdf

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