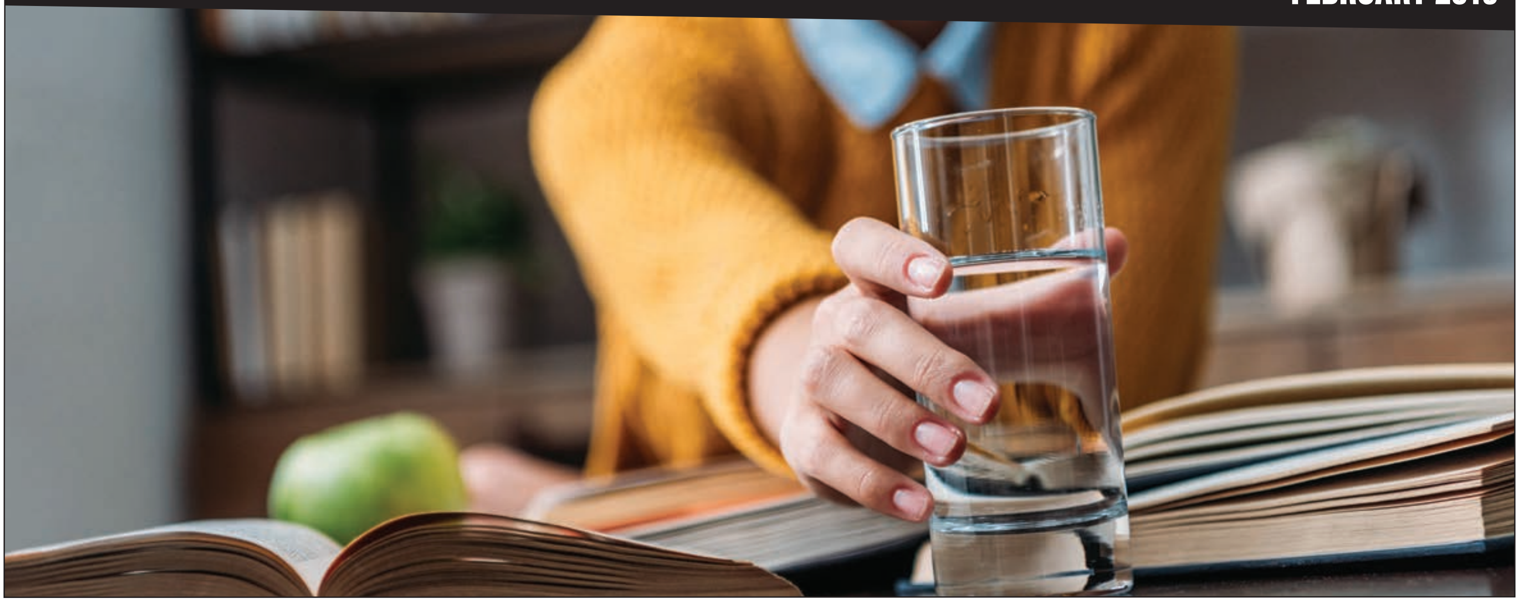


These Chemicals Are Forever:

Water Contamination from PFOA, PFOS and other PFASs

The introduction of per- and polyfluorinated substances (PFASs) in the mid-twentieth century unleased a wave of persistent and toxic chemicals into the environment, contaminating everything from food and drinking water to the dust around us. Also known as "forever chemicals," these substances continue to persist in the environment and in our bodies even after a partial phase-out of their production in the United States, often resistant to even the most advanced water treatment technologies.

Now, mounting evidence shows that the emergence of seemingly safer and less persistent "alternatives" to legacy PFASs may pose the same problems as their predecessors. An ineffective and broken regulatory system and weak environmental laws in the United States have done little to stymie the ever-revolving chemical treadmill that has contaminated entire communities and put public health at risk. The federal government must take immediate action to strengthen regulations to stop PFASs from contaminating our environment, and to remove them from our drinking water.

Per- and polyfluoroalkyl substances are a large group of related synthetic compounds that were introduced in the 1940s and 1950s, when chemical regulations were even weaker than today.[1] Due to their stable chemical structure, PFASs are long-lived substances with the ability to repel both water and oil, making them extremely useful in a wide variety of applications and products.[2] However, the characteristics that have made them attractive for use in an array of products are the very ones that have led to their widespread contamination of the environment and people.

As of 2018, at least 478 PFASs had been reported to the U.S. Environmental Protection Agency (EPA) as being used in U.S. commerce.[3] Other sources report that thousands of PFASs have been produced and used by various industries, in both the United States and around the world.[4]

The most studied and pervasive chemical forms are perfluorooctanoic acid (PFOA) and perfluorooctane sulfonate (PFOS).[5] PFOA has been used in the production of the chemical polytetrafluoroethylene (PTFE), best known by the commercial name Teflon™, which was first synthesized in 1938 by a DuPont scientist and came into widespread use in the 1960s.[6] The compound also has been used in waterproof textiles, electrical wire casing and more.[7]

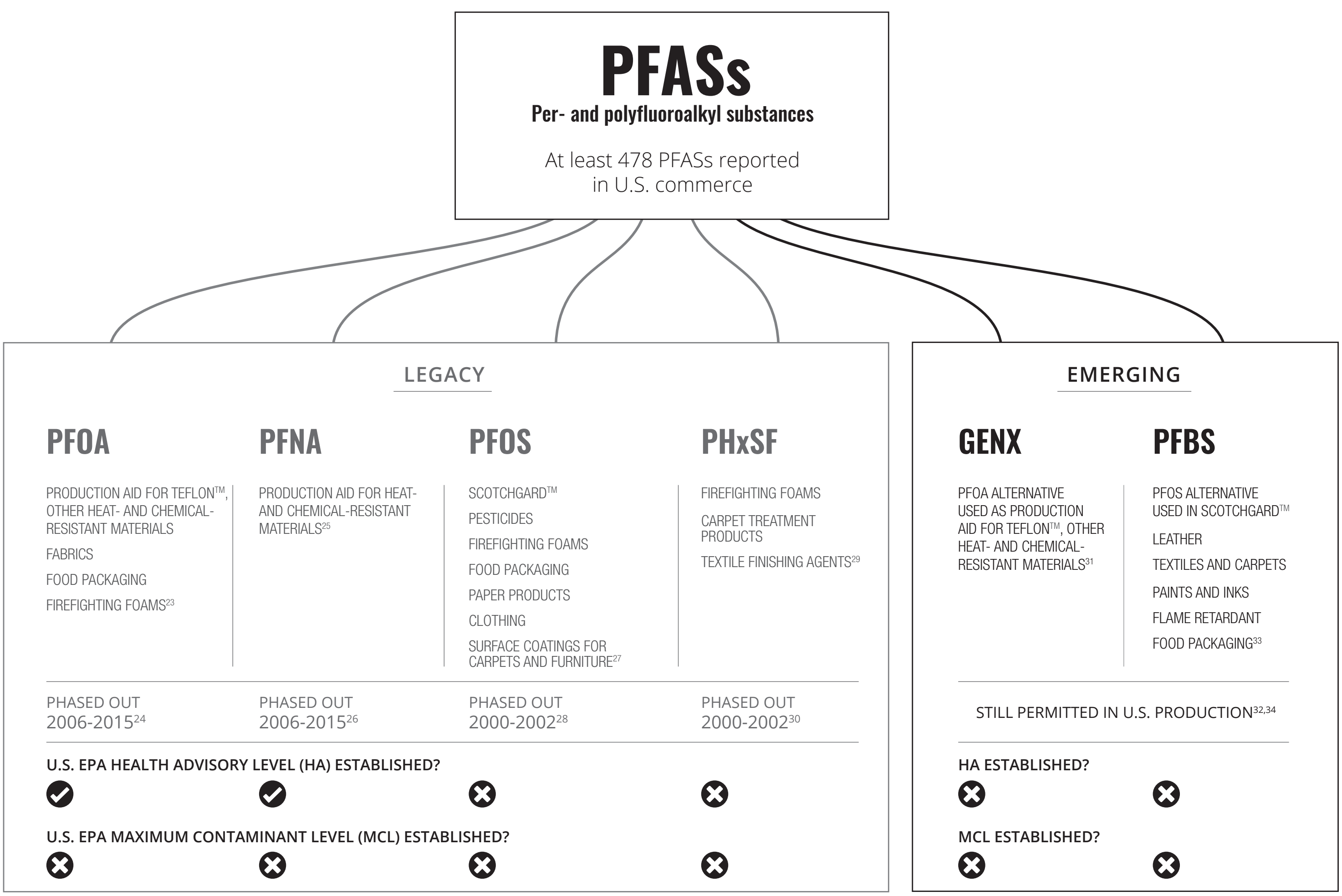
Similar to PFOA, PFOS has been used in the production of everyday household items as well. One of the most well-known products that contained PFOS was 3M's line of Scotchgard™ stain repellants.[8] PFOS also has been used in pesticides, surface coatings for carpets, furniture, waterproof apparel and paper goods.[9]

PFOA and other PFASs have been used to produce Teflon™ and other fluoropolymers, which coat a wide range of products to protect against heat, chemicals and corrosion.[10] PFASs also have been used in aqueous film forming foam, which was developed in the late 1960s to extinguish petroleum fires.[11]

PFASs, and PFOA and PFOS in particular, have been in the spotlight due to numerous incidents of widespread contamination and mounting toxicological evidence, much of which came from the producers and users of the chemicals themselves.[12] As a result, PFOA and PFOS have been targeted for control and removal by various cities, states and the federal government. While awareness of these substances seems to have gained momentum over the past 20 years, evidence of PFASs' stubborn persistence and toxicity has been around since the late 1960s and 70s, only to be overlooked until relatively recently. This resulted in delayed intervention, even as the substances continue to be released into the environment.[13]

The manufacture and use of PFOA, PFOS and other similar PFASs have decreased significantly in the United States due to a series of EPA-facilitated voluntary phase-outs by major manufacturers that occurred starting in 2000.[14] Remaining sources of these chemicals may come from existing stocks that might still be in use, from com-

BACKGROUND: What Are They and Where Did They Come From?



* *These chemicals are the most studied or prominent of the PFAS family and represent a sample of the many hundreds that are known to exist in U.S. commerce.*

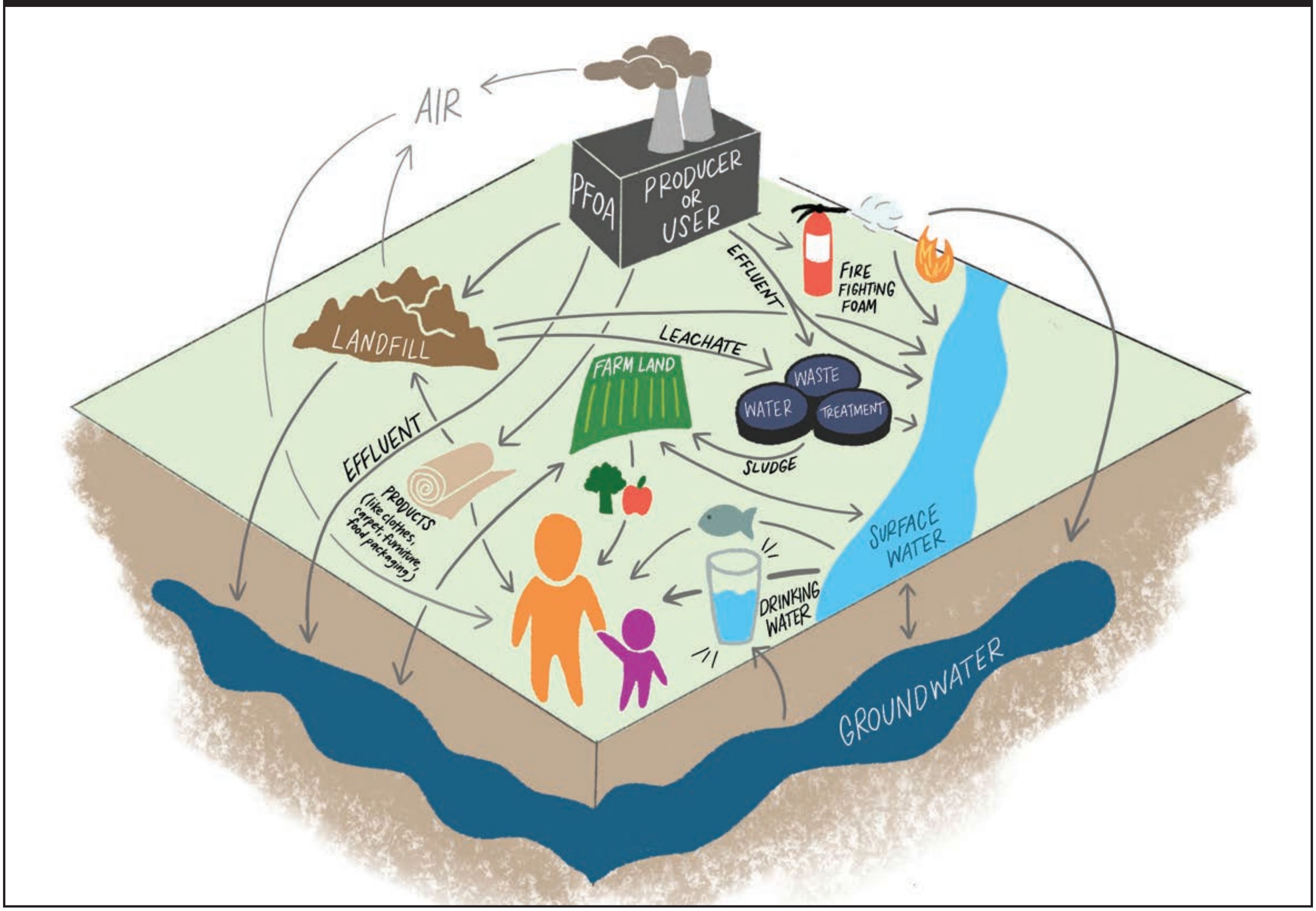
panies not participating in the voluntary phase-out of these chemicals, and the presence of these substances in imported products.[15] While industrial releases of PFOA and related compounds have declined in the United States, along with production in other industrialized nations, China's production has been increasing, and the country is now the largest emitter of PFOA in the world.[16]

After the phase-out of PFOA and PFOS, manufacturers began replacing them with different, but similar, chemicals, with claims of reduced toxicity and bioaccumulation.[17] However, there are concerns that these alternatives to legacy PFASs may in fact have the same problems as their older relatives.[18] While these chemicals may not be as likely to accumulate in the tissues of people and animals as their predecessors, they are still resistant to breaking down.[19] The emerging PFASs also are less effective, creating concern that they may be used in larger volumes and thus negate any benefits of lower bioaccumulation.[20] Moreover, there is evidence that they can transform into legacy PFASs.[21] Many of these newer chemicals lack important, publicly available data on characteristics such as their chemical properties and toxicity.[22]

PFASs Are "Forever Chemicals" That Contaminate the Environment and Animals

PFASs are incredibly prevalent and persistent in the environment, meaning that they stay in the soil and water for long periods of time. Often referred to as "forever chemicals," PFASs are immune to degradation, regardless of environmental conditions.[35] Natural breakdown over time is assumed to be virtually nonexistent.[36]

How Are People Exposed to PFASs?



SOURCE: Image based on Oliaei, Fardin et al. "PFOS and PFC releases and associated pollution from a PFC production plant in Minnesota (USA)." *Environmental Science and Pollution Research*. Vol. 20, Iss. 4. April 2013 at figure 1 at 1979.

PFAS contamination is pervasive and comes from a wide range of sources. These chemicals can enter the environment directly from landfills where products such as carpets and textiles break down and leach into the air, soil and water.[37] They also can indirectly enter the environment when precursor chemicals break down to form compounds like PFOA and PFOS.[38] PFASs have been shown to linger long after their production and use.[39] PFOS, PFOA and other PFASs have been shown to be present in groundwater for anywhere from 5 to 15 years following the end of firefighting activities at a military base in Michigan.[40] PFASs also have been found in a number of plants and animals. Residues have been found in strawberries and lettuce, as well as fish, seals, polar bears and dolphins.[41]

Due to characteristics such as their high water solubility and persistence, PFASs are mobile in soil, are prone to leaching into groundwater and can travel large distances.[42] PFASs have been found to contaminate environments of all sorts, including landfills and wastewater treatment plants, as well as remote and seemingly pristine regions, such as the deep sea and the Arctic.[43]

For decades, PFASs have contaminated drinking water in the United States and around the world, presenting a huge risk to public health.[44] PFASs have been found to frequently exceed the U.S. EPA's lifetime health advisory level, sometimes many times over.[45] As of 2016, PFASs had been detected in 194 of 4,864 surveyed public water supplies in the United States, potentially exposing 16.5 million people in 33 states.[46]

State- and local-level testing has found evidence of even more widespread contamination. In 2018, the Michigan Department of Environmental Quality found that 50 percent of drinking water and groundwater samples were found to have detectable limits of PFASs.[47] A 2018 report from the Vermont Department of Environmental Conservation found PFOA in over 400 out of the approximately 600 drinking water wells tested, with about 75 percent of these wells containing levels greater than the state's 20 parts-per-trillion (ppt) PFOA/PFOS drinking water standard.[48]

Recent reports show that emerging PFASs, such as GenX, have been on the rise, with concentrations vastly exceeding those of legacy PFASs.[49] Despite claims of low bioaccumulation, emerging PFASs are as environmentally persistent as their predecessors.[50] Additionally, there is evidence that these newer chemicals can break down to form their legacy counterparts.[51]

PFASs Are Toxic

PFASs have been found in nearly the entire U.S. population, and a growing body of science has been documenting their toxicity and public health impacts. PFOA and PFOS have been most studied of the PFAS chemicals in terms of their health impacts on humans, but there is a dearth of literature for many other PFASs, particularly the emerging chemicals that are now used as substitutes.

Reports of PFAS contamination in humans and the environment began appearing in the 1970s and 1980s.[52] Humans are exposed to PFASs via a large number of sources, including food (both homegrown and store-bought), food packaging, drinking water, the dust inside homes and more.[53] A 2003 to 2004 survey by the U.S. government estimated that over 98 percent of the U.S. population had detectable levels of PFASs in their blood.[54]

PFASs can concentrate in the bodies of humans and animals over time through a process known as bioaccumulation.[55] For example, as a result of PFOA's tendency to bioaccumulate and its long half-life in humans, PFOA's presence in the body can persist even after exposure stops.[56] PFOA's half-life (the length of time it takes for a substance to decrease to half of its original value) in humans is anywhere from over two to nearly four years, while other PFASs have been shown to have a half-life of over eight years.[57] There is also evidence that some PFASs can biomagnify, or increase in concentration, up the food chain.[58]

Some evidence indicates that even very low levels of PFAS exposure may not be completely safe for human health.[59] Ongoing exposure to low levels of PFOA found in drinking water can substantially increase total exposure in humans and can lead to concentrations in the body high enough to potentially increase health risks.[60] Infants may be especially vulnerable to PFOA, due to PFOA contamination of breast milk and their higher intake of water relative to their body weight.[61] PFOA and related substances have been found in human maternal and cord blood in North America and abroad.[62]

PFASs pose serious risks to human health. There are a number of well-documented health effects associated with exposure to PFOA and other PFASs. This includes high cholesterol, thyroid disease and weight gain.[63] PFOA also has been shown to be associated with reproductive effects, such as decreased fertility and pregnancy-induced hypertension.[64] Increased exposure to PFOA was found to correlate with decreases in birth weight.[65] PFOA exposure also has been shown to cause adverse impacts on the liver and on the immune system — with a link to decreased vaccine response and ulcerative colitis — as well as result in neurobehavioral effects such as attention deficit hyperactivity disorder (ADHD).[66] There also has been increased concern about the link between PFASs and endocrine disruption.[67]

PFASs may cause cancer. The World Health Organization's cancer research arm, the International Agency for Research on Cancer, classifies PFOA as a Group 2B carcinogen, or "possibly carcinogenic to humans."[68] The U.S. EPA concludes that there is "suggestive evidence" of carcinogenicity of PFOA in humans.[69] Highly exposed humans were observed to have correlating increases in testicular and kidney cancer.[70]

Water Treatment Can Remove Some Forms of PFASs

According to the EPA's Drinking Water Treatability database, PFOA and PFOS can be removed by up to 99 percent by processes such as granular activated carbon, membrane separation, ion exchange and powdered activated carbon.[71] Aside from these technologies, PFAS removal is resistant to many, if not most, water treatment processes, while other technologies may in fact increase their concentrations.[72] Other processes, such as powdered activated carbon, are effective at removing older PFASs, but become less effective with newer PFASs, many of which are replacing the legacy PFASs.[73]

PFAS Testing and Cleanup for Concerned Consumers

At the moment, testing for PFASs in drinking water may be difficult and expensive. Food & Water Watch suggests reaching out to your state environmental agency for more information on getting your drinking water tested. The U.S. EPA also recommends a list of approved laboratories participating in the drinking water monitoring program for unregulated contaminants, which meet EPA standards for testing.[74]

NSF International, a global organization that develops standards and provides certifications to improve public health and the environment, recommends water treatment products that are certified to P473 to reduce PFOA and PFOS contamination to below the EPA's health advisory level.[75] The Environmental Working Group has additional recommendations of filters capable of removing PFOA, PFOS and other PFASs on their website at **bit.ly/2q0EgHJ**.

Consumers who wish to avoid potential PFAS exposure from drinking water or who live in communities affected by PFAS contamination should keep in mind that PFAS testing is currently not required for bottled water. Testing bottled water is not mandated under federal law, although some companies may voluntarily do it.[76]

PFASs Are Weakly Regulated

Drinking water quality: There is no current enforceable federal standard for PFASs in drinking water. The EPA has established a lifetime drinking water health advisory level of 0.07 micrograms per liter (mg/L), or 70 ppt, for PFOA and PFOS, but it has not yet issued an enforceable Maximum Contaminant Level for drinking water.[77] The health advisory level falls short not only in lack of effectiveness, but in stringency. Sure enough, emails disclosed in early 2018 found that the EPA suppressed a scientific assessment of PFASs from a federal health research agency that recommended a much more stringent level of protection that was nearly 7 to 10 times lower than the EPA's health advisory.[78]

The EPA collects data for unregulated contaminants in drinking water that the agency has not set a health-based standard for under the Safe Drinking Water Act. This means the agency is only monitoring the prevalence of these chemicals, but does not require drinking water providers to reach any specific contamination level through treatment. Six PFASs were included in the previous 2013 to 2015 monitoring cycle, including PFOA and PFOS.[79]

A handful of states have worked to develop enforceable and more stringent standards. New Jersey is in the process of implementing a limit for PFOA at 14 ppt and has proposed limits for PFOS and PFNA at 13 ppt, constituting some of the lowest standards in the country.[80] Vermont's combined health advisory level for five PFASs (PFOA, PFOS, PFHxS, PFHpA and PFNA) is 20 ppt.[81]

Partial phase-out: In 2006, the EPA invited eight major chemical manufactures to participate in a global stewardship program on PFOA and other related chemicals. The companies — Arkema, Asahi, Ciba, Clariant, Daikin, DuPont, 3M/Dyneon and Solvay Solexis — all agreed to commit to reducing these chemicals from their emissions and products by 95 percent by 2010 and by 100 percent by 2015.[82]

The phase-out has not completely eliminated these legacy PFASs from U.S. production and use. Some companies are not participating in the PFOA Stewardship Program, some companies may be using existing stocks, and there are still limited acceptable uses of these chemicals. Additionally, PFOA and PFOS are allowed in goods imported from other countries.[83]

Limited data are available on ongoing production and use of PFOA, PFOS and other PFASs within the United States, and any relevant data reported are done so as confidential business information.[84] Information on industrial PFAS releases is also sparse. Facilities are not required to test for or report PFAS wastewater discharges since the EPA has not classified any of these chemicals as toxic pollutants or hazardous substances under the Clean Water Act, and are not required to report on environmental releases of these chemicals to the EPA's Toxics Release Inventory.[85]

International attempts to curb PFAS use: In 2009, PFOS was added to Annex B of the Stockholm Convention, in which participating countries must restrict the production and use of the substance due to its persistence in the environment, long-range environmental transport and ability to bioaccumulate and biomagnify in mammals and birds.[86] PFOA and PFHxS are currently proposed for listing.[87] The United States signed the Stockholm Convention in 2001 but has not ratified it.[88]

PFASs Continue to Be Used on Military Installations

PFASs contained in firefighting foam products that are used to put out petroleum fires have contaminated military bases and surrounding communities for decades and continue to do so despite restrictions.[89]

Watersheds that contain military fire training areas have higher concentrations of PFAS chemicals than areas with-out.[90] In 2017, 401 military installations were found to have a known or suspected PFAS release, and 23 percent of public and private drinking water systems tested off-base were found to have PFAS levels above the EPA's health advisory level.[91]

The cleanup cost of PFOA-contaminated groundwater is estimated to be up to $2 billion, in addition to the $200 million that the Defense Department has already spent on treating and testing its water supply and providing bottled water.[92]

The Defense Department is looking for replacements for firefighting foams that do not contain PFASs. In the meantime, the military is allowing ongoing use of PFAS foams with some restrictions.[93]

Major Incidents of Contamination

As of 2018, there were 172 documented PFAS contamination sites across 40 states.[94] Several of these have constituted major public health crises due to their especially large reach, affecting millions of residents, as well as to significantly high spikes of PFAS levels in drinking water for a number of vulnerable communities. Below are just a few of the examples from many communities around the country dealing with this contamination:

Hoosick Falls, New York: In 2014, residents of Hoosick Falls, a small town near Albany, New York, became aware of PFOA when testing revealed high levels of the contaminant in their drinking water.[95] A nearby plastics factory, now operated by Saint-Gobain Performance Plastics, which used PFOA in its manufacturing process, had been contaminating the town's water supplies. The majority of samples revealed PFOA levels over 600 ppt, far higher than the 400 ppt U.S. EPA health advisory at the time.[96] Groundwater under a Saint-Gobain plant was found to have PFOA levels at 18,000 ppt.[97] Many residents were found to have PFOA levels in their blood that were 100 times the national average.[98] The U.S. EPA has since added the Saint-Gobain Performance Plastics site to its Superfund National Priorities List of the most hazardous waste sites in the country, which requires the agency to ensure that the contamination is cleaned up.[99]

Parchment, Michigan: As of September 2018, the Michigan Department of Environmental Quality (MDEQ) has identified PFAS contamination in 44 municipal water systems across the state, impacting over 1.6 million residents.[100] At the top of this list is Parchment — at 1,828 ppt, over 25 times the U.S. EPA's health advisory level, the city has the highest level of total PFASs in Michigan.[101] The elevated PFAS levels in Parchment's water supply prompted Michigan state officials to advise residents to stop drinking the water and to declare a state of emergency in July 2018.[102] The MDEQ believes that the sources of contamination include a nearby shuttered paper mill, which used PFAS additives on laminated paper products, and its associated landfill.[103]

Hoosick Falls, New York /

Cape Fear, North Carolina: Chemours, a company spun off of DuPont, contaminated North Carolina's Cape Fear River with GenX and dozens of other PFASs, affecting over 200,000 residents who depend on the river for drinking water.[104] Since a local newspaper reported on the contamination in June 2017, the controversy over Chemours' operation upstream of Wilmington has continued.[105] The North Carolina Department of Environmental Quality (NC DEQ) has charged the company with multiple violations, including one for failing to report a GenX precursor spill in October 2017 and another in February 2018 for failing to control GenX air emissions, which were causing groundwater contamination.[106] But NC DEQ budget cuts have impeded the regulation of PFAS polluters, and ratepayers are facing a looming increase in water costs due to potential water treatment upgrades needed to deal with PFAS contamination.[107]

Conclusion and Recommendations

The risks of PFASs far outweigh their benefits. We need to address the existing PFAS contamination of our water, our bodies and the environment. The federal government must take urgent action to stop the production and use of PFAS-containing products, set up enforceable standards that limit their environmental presence, provide funding for their testing and require cleanup of contaminated sites.

More specifically, Food & Water Watch recommends:

- The U.S. EPA should treat all PFASs as a class, rather than individually. This must apply not only to older PFASs, like PFOA and PFOS, but to their newer substitutes, like GenX and PFBS. After decades of delay and widespread exposure for a large portion of the population, action is urgently needed, and the fastest way to tackle this issue is to regulate PFAS chemicals as a class.
- The U.S. EPA should set a strong enforceable drinking water standard that addresses both old and new PFAS contamination.
- Congress must allocate funds to states and municipalities for the testing and any needed treatment of drinking water from community water systems and individual household wells. If treatment or groundwater remediation is untenable or unsuccessful, support should be provided to connect water systems and households to alternative water supplies.

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foodandwaterwatch.org

info@fwwatch.org
202.683.2500 (DC) • 510.922.0720 (CA)