



CALL FOR COMMENTS

Proposal for New Chemical Class Prohibition:

Per- and Polyfluoroalkyl Substances (PFAS)

Prohibited in Cleaning and Personal Care Products

December 8, 2021. Green Seal® is inviting feedback on a proposed update to the criteria for cleaning products and personal care products: a new prohibition on per- and polyfluoroalkyl substances (PFAS) in product formulas. We are seeking comments from all stakeholders including industry experts, public health researchers, product designers, raw material suppliers, product testing laboratories, purchasers, end users, and the public. Instructions for submitting comments are on Page 3 of this document.

Summary of Proposed Prohibition:

Products cannot be intentionally formulated with PFAS and cannot include PFAS as contaminants at more than 100 ppm.

Green Seal Standards with Criteria Proposed for Revision

- GS-8 Standard, General Purpose Cleaning Products for Household Use
- GS-37 Standard, General Purpose Cleaning Products for Industrial and Institutional Use
- GS-41 Standard, Hand Cleaners and Hand Sanitizers for Industrial and Institutional Use
- GS-44 Standard, Soaps, Cleansers, Hand Sanitizers, and Shower Products
- GS-48 Standard, Laundry Care Products for Household Use
- GS-50 Standard, Personal Care and Cosmetic Products
- GS-51 Standard, Laundry Care Products for Industrial and Institutional Use
- GS-52 Standard, Specialty Cleaning Products for Household Use
- GS-53 Standard, Specialty Cleaning Products for Industrial and Institutional Use

Green Seal® is the leading U.S. ecolabel, symbolizing transparency, integrity, and proven environmental leadership. We develop life-cycle-based standards and certify products and services that can prove they meet our strict criteria for human health, reduced environmental impacts, and effective performance. Operating as a nonprofit since its founding in 1989, Green Seal has certified thousands of products and services in over 450 categories, and is specified by countless schools, government agencies, businesses, and institutions.

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Section I. Instructions for Submitting Comments

Green Seal develops standards through an open, transparent process that prioritizes stakeholder input. Public comment periods are a mechanism for soliciting input and promoting Green Seal's intended outcomes for product certification against the proposed new or revised criteria.

Guidelines for Submitting Comment

- Comments should be specific in nature.
- Comments should include a technical or market-focused justification.
- Comments should include references from reputable sources.
- Comments should include actionable solutions.

Public Comment Closing Date

This comment period is open for 45 calendar days. The comment period closes on January 22, 2022.

Submit Comments via Email

Submit all comments to standards@greenseal.org using the subject line: "PFAS Phase I Revision."

Requests for Comment Period Extension

Any request for comment period extensions should be submitted via email to standards@greenseal.org. If granted, extensions will be publicly announced on Green Seal's website.

Comment Review Process

Upon receiving comments, Green Seal will confirm receipt and may reach out to schedule a brief conference call to request clarification.

Within 90 days of the close of the comment period, Green Seal publishes will publish a Response to Comments document which includes the text of all written comments submitted during the Public Comment Period and summarizes actions taken as well as justifications for inaction regarding the changes to the standard.

For Questions About this Process

For other inquiries, contact Brittany Maule, Manager, Science and Standards at bmaule@greenseal.org.

Section II. Proposal Overview

Green Seal is proposing to add a new chemical class prohibition on per- and polyfluoroalkyl substances (PFAS) to our standards that cover cleaning and personal care products. Historically in these standards, Green Seal has restricted several long-chain PFAS chemicals (typically containing seven or more carbon atoms) in certified products due to their hazard classifications. A growing body of evidence indicates that all PFAS chemicals, including short-chain PFAS, have the same harmful health and environmental effects as the legacy PFAS they are replacing. Therefore, using a precautionary approach, Green Seal is proposing to prohibit PFAS as a chemical class (i.e., to prohibit the group of approximately 12,000 chemicals).

Green Seal piloted a PFAS Prohibition via the development and issuance of new criteria for hand sanitizers in 2020.¹ With a stronger understanding of PFAS in product formulations, Green Seal is now initiating a full Phase I for PFAS Prohibitions by expanding the existing criteria prohibiting PFAS to all cleaning and personal care products. This additional requirement is intended to raise the bar of health protections provided by product certification, to provide product transparency for purchasers and consumers, to incentivize the phase-out of PFAS in the supply chain, and to increase the demand for safer alternative chemicals that provide the same functions as PFAS. See the Intended Outcome section herein for more details.

Overview of PFAS

Per- and polyfluoroalkyl substances (PFAS) are a group more than 12,000 man-made chemicals which share a structural similarity: strong carbon-fluorine bonds. This structure makes these chemicals highly stable and thus resistant to breaking down in the environment and in human bodies. PFAS have been used in a variety of industries dating back to the 1940s from cookware, textiles, and food packaging to paints and coatings, cosmetics, and some cleaning products. These chemicals do not naturally degrade and therefore are now ubiquitous in the environment. According to the US Centers for Disease Control and Prevention (CDC), biomonitoring studies show that most humans have been exposed to PFAS² and that both PFOS and PFOA are found in most human blood samples. Exposure to PFAS is linked to several adverse health effects for people and wildlife.

PFAS are Non-Essential for Cleaning and Personal Care Products

In 2021, Green Seal completed a feasibility assessment for a PFAS prohibition that included a review of the North American cleaning and personal care product markets, a review of product formulations, and outreach to relevant stakeholders. For personal care products, PFAS are non-essential chemical ingredients, i.e., their presence in these products is not critical for effective functional performance. Additionally, safer functional alternatives are commercially available.³ Similarly, PFAS are not common functional ingredients in cleaning products, and in fact, the chemical compositions of most cleaning products would not require or benefit from their inclusion.⁴

Phased Approach to PFAS Revision Project

¹ Final Criteria for Hand Sanitizers. https://greenseal.org/storage/standards/September%202020/Green-Seal-Hand-Sanitizers-Final-Criteria_09.2020.pdf

² PFAS in the U.S. Population. <https://www.atsdr.cdc.gov/pfas/health-effects/us-population.html>

³ The concept of essential use for determining when uses of PFASs can be phased out. <https://doi.org/10.1039/C9EM00163H>

⁴ Industry feedback received in outreach process.

Eliminating PFAS from product supply chains is a critical pathway to protecting human health and preventing long-term environmental contamination from this chemical class. Green Seal’s efforts to prohibit PFAS is a multi-year, phased approach working toward the following objective: All certified product formulas and product packaging will be verified as free of PFAS. The scope of the project is separated into three phases, based on evidence that PFAS are widely used in many industries, including as functional ingredients in the paints and coatings industry⁵ and as an unintentional byproduct of a strengthening process in the plastic product packaging industry.^{6,7} However, evidence also suggests challenges in addressing PFAS in these use cases. For example, it may be difficult for manufacturers in the paints and coatings industry to reformulate due to the variety of functions fluorosurfactants perform in a product formula and their ability to be used at very low levels – particularly in floor care products.⁸ Thus, more research is needed to understand how Green Seal can set feasible leadership criteria for these product categories and use scenarios. The scope of each of the three phases is described below.

Phase I (Current Phase): This phase includes cleaning and personal care products via this proposed update to nine Green Seal standards covering more than 200 product types. This phase is anticipated to be completed in early 2022.

Phase II: This phase will explore and potentially set criteria for additional product categories such as floor care, paints and coatings, and sanitary paper products. Research and development are anticipated to begin in 2022.

Phase III: This phase will explore and potentially set criteria for product packaging. Research and development are anticipated to begin in 2023.

Green Seal develops standards in a transparent, stakeholder-based process and welcomes ongoing feedback on every phase of this initiative.

⁵ An overview of the uses of per- and polyfluoroalkyl substances (PFAS). <https://engrxiv.org/2eqac/>

⁶ Beyond paper; PFAS linked to common plastic packaging used for food, cosmetics, and much more. <http://blogs.edf.org/health/2021/07/07/beyond-paper-pfas/>

⁷ Perfluorinated Carboxylic Acids in Directly Fluorinated High-Density Polyethylene Material. <https://doi.org/10.1021/es1043968>

⁸ Alternatives to Fluorosurfactants in Paints and Coatings. <https://www.pcimag.com/events/2680-alternatives-to-fluorosurfactants-in-paints-and-coatings>

Intended Outcomes

Stronger Protections for Human Health

Exposure to PFAS has been associated with serious health effects, including thyroid dysfunction,⁹ increased risk of certain cancers,¹⁰ and even decreased immune response to vaccinations.¹¹ Negative health outcomes have been especially well documented among vulnerable populations such as children and women who are pregnant. Nearly all Americans have measurable levels of PFAS in their blood.² Health risks associated with long-term exposure in communities with PFAS contamination in drinking water sources has been well documented.¹² There is also evidence that individuals are exposed to PFAS through food packaging, ingesting and inhaling household dust, and via dermal exposure through personal care products. Eliminating PFAS as a chemical class from products will reduce individuals' exposure and therefore reduce the likelihood of negative health outcomes. Additionally, prohibiting PFAS in consumer products used routinely in schools, daycares, etc. will reduce exposure in these vulnerable populations.

Increased Transparency and Safer Supply Chains

PFAS use is widespread. Public health advocacy groups are uncovering how commonly these chemicals are intentionally included in product formulas, used as additives in the manufacturing process, or found to be a component in product packaging. While manufacturers have voluntarily phased out certain well-studied long-chain PFAS (seven or more carbon atoms), short-chain replacement chemicals have been shown to act similarly to their long-chain predecessors and, in some cases, may be just as harmful.¹³ It can be challenging for consumers and even manufacturers to ensure products do not include PFAS. For example, PFAS are often used in raw materials for which the formula is not often fully disclosed to a final manufacturer. By verifying that Green Seal-certified products do not contain PFAS, Green Seal will provide greater transparency for final manufacturers and buyers and encourage the elimination of PFAS from supply chains.

Preventing Environmental Pollution

PFAS do not naturally biodegrade in the environment, and as a result, they are a problem throughout their product life cycle, from production to use and disposal.¹⁴ Researchers anticipate that certain PFAS are likely to take centuries to fully degrade.¹⁵ PFAS are released into the environment from industrial sites, airports, military bases, landfills, and water treatment plants, as well as from the use of consumer products. Thus, PFAS are found in ecosystems around the globe and are known to bioaccumulate in plants and animals.^{16,17} Removing PFAS from supply chains and ensuring that they are not in consumer products will slow and prevent additional environmental contamination.

⁹ Thyroid Disrupting Effects of Old and New Generation PFAS.

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7851056/>

¹⁰ What are the health effects of PFAS? <https://www.atsdr.cdc.gov/pfas/health-effects/index.html>

¹¹ Serum vaccine antibody concentrations in children exposed to perfluorinated compounds.

<https://doi.org/10.1001/jama.2011.2034>

¹² C8 Probable Link Reports. http://www.c8sciencepanel.org/prob_link.html

¹³ EPA: GenX Nearly as Toxic as Notorious Non-Stick Chemicals It Replaced. <https://www.ewg.org/news-insights/news-release/epa-genx-nearly-toxic-notorious-non-stick-chemicals-it-replaced>

¹⁴ Disposal of products and materials containing per- and polyfluoroalkyl substances (PFAS): A cyclical problem. <https://doi.org/10.1016/j.chemosphere.2020.127659>

¹⁵ Investigation of the Biodegradation Potential of a Fluoroacrylate Polymer Product in Aerobic Soils

<https://doi.org/10.1021/es0710499>

¹⁶ Perfluorinated compound (PFC) concentrations in northern gannet eggs 1977-2014: a Predatory Bird Monitoring Scheme (PBMS) report. https://pbms.ceh.ac.uk/sites/default/files/PBMS_Gannet_PFCs_report_2013.pdf

¹⁷ Plant uptake and translocation of perfluoroalkyl acids in a wheat-soil system.

<https://pubmed.ncbi.nlm.nih.gov/30178412/>

Section III. Red-Lined Tracked Changes

Text in the boxes below show the details of the proposed revisions.

The **red text** shows proposed additions. Any text ~~with strikethrough lines~~ are proposed deletions.

Green Seal proposes the revisions below to our cleaning product and personal care standards. The language will be added as a criterion in the Product-Specific Health and Environmental Requirements section and in the definitions Annex of each standard. Relevant defined terms in each standard will be italicized. See the red-line standard documents on Green Seal’s website for a complete review of all changes.

This proposed revision affects these standards:

- GS-8, Cleaning Products for Household Use
- GS-37, Cleaning Products for Industrial and Institutional Use
- GS-41, Hand Cleaners and Hand Sanitizers for Industrial and Institutional Use
- GS-44, Soaps, Cleansers, Hand Sanitizers, and Shower Products
- GS-48, Laundry Care Products for Household Use
- GS-50, Personal Care and Cosmetic Products
- GS-51, Laundry Care Products for Industrial and Institutional Use
- GS-52, Specialty Cleaning Products for Household Use
- GS-53, Specialty Cleaning Products for Industrial and Institutional Use

Per- and Polyfluorinated Alkyl Substances (PFAS). The undiluted product shall not contain any ingredients or components that are Per- and Polyfluorinated Alkyl Substances (PFAS).

ANNEX A - DEFINITIONS (Normative)

Per- and Polyfluorinated Alkyl Substances (PFAS). A class of fluorinated organic chemicals containing at least one fully fluorinated carbon atom. This includes but is not limited to PFAS identified via the US EPA’s CompTox database PFAS Master List¹

¹ <https://comptox.epa.gov/dashboard/chemical-lists/PFASMASTER>

Related Standard Updates

If the PFAS Prohibition is enacted, additional minor updates will be made to individual standards to account for differences in defined terms and ensure a consistent implementation across multiple standards. A summary of these revisions is below and can also be viewed on the Red-lined Tracked Changes documents of each standard, available for review on the [Standards Revision web page](#).

GS-8 Standard: (1) The term “component” and its definition will be added to this standard. The definition will be consistent with the definition in the GS-37 Standard.

GS-41 Standard: (1) The term “component” and its definition will be added to this standard. The definition will be consistent with the definition in the GS-37 Standard. (2) The current definition of PFAS in Annex A will be updated to match the definition proposed above. (3) The ingredient prohibition on PFAS that exists in Annex B for hand sanitizers will be deleted, as the new criterion added for PFAS will apply to all product categories, including hand sanitizers.

GS-44 Standard: (1) The current definition of PFAS in Annex A will be updated to match the definition proposed above. (2) The ingredient prohibition on PFAS that exists in Annex C for hand sanitizers will be deleted, as the new criterion added for PFAS will apply to all product categories, including hand sanitizers.

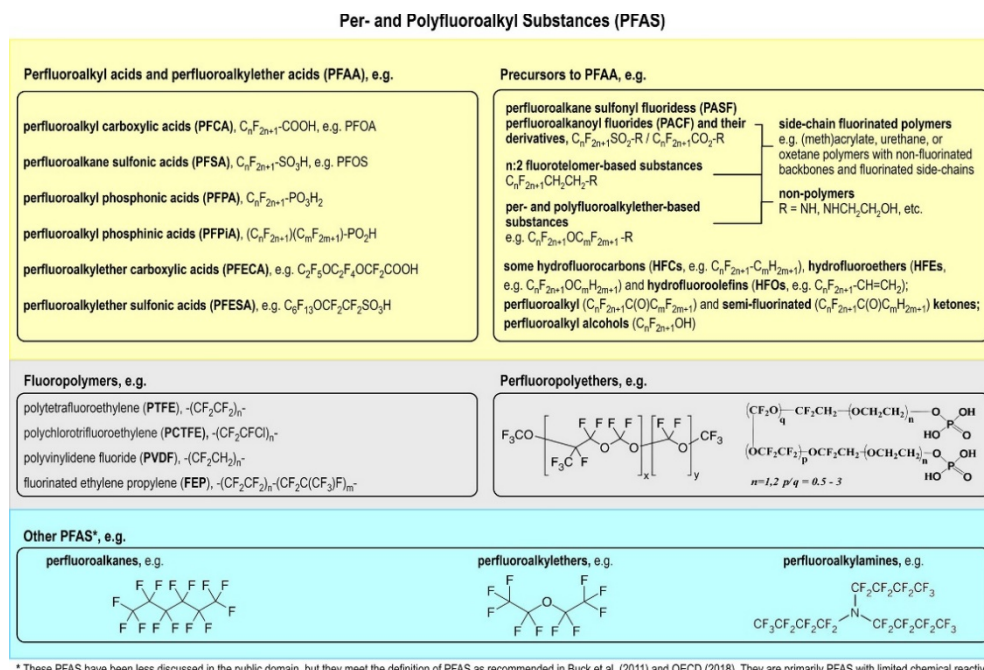
Multiple Standards: GS-48, GS-50, GS-51, GS-52, GS-53: (1) The criterion language for PFAS above will not contain the reference to “ingredients” because that is not a defined term in those standards.

Section IV. Research Record

The following section summarizes research focused on the composition, function, and prevalence of PFAS. This section also summarizes adverse health risks and environmental impacts associated with PFAS, chemical exposure pathways, and current regulatory policy.

Overview of PFAS as a Chemical Class

PFAS are a large group of man-made chemicals that have been used in industrial processes since the 1940s. Thousands of PFAS have been identified and sub-grouped, with the most well-studied being perfluoroalkyl acids and perfluoroalkylether acids (PFAA). One organization of those sub-groups with common names is presented below.¹⁸



* These PFAS have been less discussed in the public domain, but they meet the definition of PFAS as recommended in Buck et al. (2011) and OECD (2018). They are primarily PFAS with limited chemical reactivity.

Figure 1. Examples of PFAS chemistries

Chemical Structure. The defining characteristic of PFAS is that they contain bonds between carbon and fluorine atoms – one of the strongest bonds in organic chemistry.¹⁹ The perfluoroalkyl portion (C_nF_{2n+1}) of PFAS is also hydrophobic and lipophobic meaning it repels water and fats.²⁰ This chemical structure makes PFAS useful in industry applications because as “extremely stable chemicals, they resist high temperature and degradation and most notably, they repel both grease and water.”²¹ As a result they often function as repellents of water, dirt, and oil including as surfactants and friction reducers. A distinction has been made between “long-chain” and “short-chain” PFAS with the “chain” referring to the number of carbon atoms in some sub-groups of PFAS, with long-chain PFAS generally regarded to have seven or more carbon atoms.²² The two

¹⁸ Scientific Basis for Managing PFAS as a Chemical Class. <https://doi.org/10.1021/acs.estlett.0c00255>

¹⁹ Smart BE, Dixon DA. Bond-energies and stabilities of poly(perfluoroethers). In: Abstracts of papers of the American chemical society, vol. 207. 1994. p 31–FLUO

²⁰ Kissa E. Fluorinated surfactants and repellents, vol. 97. 2nd ed. New York: Marcel Dekker, Inc.; 2001

²¹ PFAS the ‘Forever Chemicals’ Invisible threats from persistent chemicals. https://chemtrust.org/wp-content/uploads/PFAS_Brief_CHEMTrust_2019.pdf

²² Perfluoroalkyl and polyfluoroalkyl substances in the environment: Terminology, classification, and origins. <https://doi.org/10.1002/ieam.258>

most well-studied and regulated PFAS are long-chain: Perfluorooctanoic acid (PFOA) and Perfluorooctane sulfonic acid (PFOS).

PFAS Definition. Because PFAS are a broad group of thousands of chemicals, there have been many attempts to define them.^{22,23,24} Green Seal has aligned with other entities such GreenScreen Certified,²⁵ Cradle to Cradle,²⁶ and the State of California²⁷ by proposing to prohibit PFAS as a chemical class: “A class of fluorinated organic chemicals containing at least one fully fluorinated carbon atom.” One of the tools Green Seal will use to implement a PFAS Prohibition is the EPA CompTox PFAS Master List. The EPA CompTox database serves as a “consolidated list of substances...defining a practical boundary of PFAS chemical space...of current interest to researchers and regulators worldwide.”²⁴

PFAS Consumer Presence. PFAS’s unique chemical structure allows them to confer waterproof, stainproof, greaseproof, and low-friction properties to a variety of products and processes. PFAS are used in many industries including as stain repellants in textiles, coatings for cookware and food packaging, fluoropolymers in surgical meshes, and protective coatings in several manufacturing applications. The use of PFAS in this revision’s two categories of interest are described below in more detail.

Personal Care Products and Cosmetics: In cosmetics, PFAS make products that are applied to skin absorb more easily; introduce waterproof properties to items like mascara; and generally increase the long-term wearability of these products.²⁸ The presence of PFAS in cosmetics and personal care products has now been well documented,^{29,30} however, it has also been determined that PFAS in personal care products are not an essential use,³ and that alternatives for these chemicals exist based on the rising number of manufacturers who demonstrate they formulate without using PFAS.³¹

Cleaning Products: The most documented use of PFAS in cleaning products is as surfactants, which lower the surface tension of water so the molecules in the product are more likely to react with oil and grease. However, cleaning product formulas do not require fluorinated surfactants because their product chemistry does not need them to perform their intended function. Hundreds of product formulas perform well without the use of these chemicals, indicating sufficient alternatives are available.⁴

²³ Reconciling Terminology of the Universe of Per- and Polyfluoroalkyl Substances: Recommendations and Practical Guidance. [www.oecd.org/officialdocuments/publicdisplaydocumentpdf/?cote=ENV/CBC/MONO\(2021\)25&docLanguage=en](http://www.oecd.org/officialdocuments/publicdisplaydocumentpdf/?cote=ENV/CBC/MONO(2021)25&docLanguage=en)

²⁴ EPA CompTox Chemicals Dashboard PFAS Master List of PFAS Substances. <https://comptox.epa.gov/dashboard/chemical-lists/pfasmaster>

²⁵ GreenScreen Certified™ Standard for Food Service Ware. <https://www.greenscreenchemicals.org/certified/food-service-ware>

²⁶ Cradle to Cradle Certified® Product Standard. https://www.c2ccertified.org/resources/detail/cradle_to_cradle_certified_product_standard

²⁷ AB-1200 Plant-based food packaging: cookware: hazardous chemicals. https://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=20210220AB1200

²⁸ Risk assessment of fluorinated substances in cosmetic products. <https://mst.dk/service/publikationer/publikationsarkiv/2018/nov/risk-assessment-of-fluorinated-substances-in-cosmetic-products/>

²⁹ Fluorinated Compounds in North American Cosmetics. <https://pubs.acs.org/doi/10.1021/acs.estlett.1c00240>

³⁰ Per- and polyfluoroalkyl substances and fluorine mass balance in cosmetic products from the Swedish market: implications for environmental emissions and human exposure. <https://doi.org/10.1039/C8EM00368H>

³¹ PFAS-Free Products. <https://pfascentral.org/pfas-free-products/>

Exposure Pathways. Common PFAS exposures include dermal and inhalation exposure via the use of consumer products and ingestion of contaminated food and water. PFAS have been found in drinking water sources across the globe (discussed further below) and ingesting drinking water contaminated with PFAS is considered the primary chronic exposure pathway.³² Additionally, because of their use in paper-based food packaging as grease-proofing agents,³³ people are also exposed to PFAS when eating food contaminated by PFAS-treated food packaging: “Studies on food contact materials have reported the migration of PFAS, including PFOA, PFBA, perfluorohexanoic acid (PFHxA), PFNA, and fluorotelomer alcohols (FTOHs), from materials such as microwave popcorn bags and paper bowls into foods and food simulants...leading to PFAS contamination of food.”³⁴ There is also some evidence that short-chain PFAS can accumulate in vegetables grown in contaminated soil, further highlighting food as a PFAS exposure pathway.^{35,17} Using consumer products like personal care or paints can result in dermal exposure to PFAS as products are applied to the skin. Some products, such as lipsticks, can also be inhaled or ingested.²⁹ Additionally, when PFAS are present in other consumer products that are used regularly in indoor spaces, they can be found in dust, which can then also be ingested or inhaled.³⁶

Impacts on Human Health

As noted above, humans are exposed to PFAS through several avenues, including drinking water, food, and the use of consumer products. This potential chronic exposure, coupled with the fact that many PFAS do not leave the human body for years,³⁷ has led to PFAS being found in the blood of nearly all humans, even newborns, in the US and other countries around the globe.^{38,39}

Of the overall PFAS chemical class, PFOA and PFOS have received the most study and are both associated with several adverse health outcomes. PFOA has been designated as a probable carcinogen⁴⁰ and has been associated with increased risk of testicular and kidney cancer, as well as several other conditions such as ulcerative colitis, thyroid disease, and impacts on pregnancy.¹² PFOS has been shown to cause “hepatotoxicity, neurotoxicity, reproductive toxicity, immunotoxicity, thyroid disruption, cardiovascular toxicity, pulmonary toxicity, and renal toxicity in laboratory animals and many in vitro human systems.”⁴¹ Both chemicals have been found to cause “reproductive and developmental, liver and kidney, and immunological effects in

³² PFAS Contamination of Drinking Water Far More Prevalent Than Previously Reported. <https://www.ewg.org/research/national-pfas-testing/>

³³ The Regulation (and Deregulation) of Additives for Use in Food Contact Paper in the U.S. https://www.martindale.com/legal-news/article_keller-and-heckman-llp_2505182.htm

³⁴ Emerging Issues in Food Waste Management Persistent Chemical Contaminants. <https://www.epa.gov/system/files/documents/2021-08/emerging-issues-in-food-waste-management-persistent-chemical-contaminants.pdf>

³⁵ Uptake of Perfluorinated Alkyl Acids by Hydroponically Grown Lettuce (*Lactuca sativa*). <https://doi.org/10.1021/es302398u>

³⁶ A review of the pathways of human exposure to poly- and perfluoroalkyl substances (PFASs) and present understanding of health effects. <https://www.nature.com/articles/s41370-018-0094-1>

³⁷ Breaking It Down: Estimating Short-Chain PFAS Half-Lives in a Human Population. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7657368/#c4>

³⁸ Maternal serum concentrations of perfluoroalkyl acids in five international birth cohorts. <https://pubmed.ncbi.nlm.nih.gov/28063899/>

³⁹ Fourth National Report on Human Exposure to Environmental Chemicals Updated Tables, March 2018, Volume One. https://www.cdc.gov/exposurereport/pdf/fourthreport_updatedtables_volume1_mar2018.pdf

⁴⁰ Perfluorooctanoic Acid (PFOA), Teflon, and Related Chemicals. <https://www.cancer.org/cancer/cancer-causes/teflon-and-perfluorooctanoic-acid-pfoa.html>

⁴¹ Assessing the human health risks of perfluorooctane sulfonate by in vivo and in vitro studies. <https://doi.org/10.1016/j.envint.2019.03.002>

laboratory animals.”⁴² While the manufacturing and use of PFOA and PFOS has been mainly phased out in the US, many of the short-chain chemicals meant to replace these two chemicals also display concerning health impacts. For example, Perfluorobutane sulfonic acid (PFBS), meant to replace PFOS, has been shown to have impacts on the thyroid,⁴³ and a chemical by the trade name of GenX, meant to replace PFOA, has been associated with “hepatic and renal effects and suppressed immune function in mice.”¹⁸

Of particular concern is the effects of PFAS on human development and thus vulnerable populations, such as those who are pregnant and children. Many studies have documented associations between PFAS and “adverse immune outcomes” in children.³⁹ For example, exposure to PFAS has been associated with reduced antibody responses to vaccinations: “children exposed to higher levels of PFAS during development had a reduced immune response to routine tetanus vaccination.”¹¹ Additional impacts on children and pregnancy include delayed puberty in children exposed to PFAS while in utero,²¹ lower birthweights,⁴² and pregnancy-induced hypertension.¹²

Environmental Impacts

Because of their resistance to breaking down naturally, and their widespread use, PFAS contamination in the environment has been well documented throughout the chemical life cycle. For example, during manufacturing and product use, PFAS can be released into the air, soil, and water.⁴⁴ PFAS used as raw materials or processing agents can be released as emissions or into wastewater streams, and “current emission filters do not completely capture them, nor is there an effective means of disposing of captured PFAS.”¹⁸ PFAS can also enter the environment through a products’ end-of-life, or disposal phase: “incineration of PFAS wastes can release toxic air pollutants and greenhouse gases” and consumer products can leach PFAS when disposed in landfills.¹⁴ It’s estimated that over 45,00 tons of Perfluorooctane sulfonate (PFOS) — just one PFAS — were released into air and water sources between 1972 and 2002.⁴⁵

Releases of PFAS in the environment have long-term consequences because PFAS can have such large half-lives – the time in which 50 percent of the chemical is expected to degrade. For example, some PFAS polymers have estimated half-lives of over 1,000 years in soil.^{15,46} These long half-lives also mean PFAS can travel far distances from their original release into the environment^{47,48} — a problem not specific to long-chain PFAS, as short-chain PFAS have also been detected in waterbodies and, in some cases were found to be more persistent in aquatic systems.^{49,50} PFAS contamination has been widely documented in waterbodies across the U.S. and globally. It is estimated that some level of PFAS is now found in all U.S. water supplies that use surface water for their drinking water supply, with a recent study finding 1,400 sites in 49 U.S. states containing PFAS contamination in drinking water.³² The widespread contamination of PFAS has also been

⁴² PFAS Explained. <https://www.epa.gov/pfas/basic-information-pfas>

⁴³ Learn about the Human Health Toxicity Assessment for PFBS. <https://www.epa.gov/chemical-research/learn-about-human-health-toxicity-assessment-pfbs>

⁴⁴ What are PFAS? <https://www.atsdr.cdc.gov/pfas/health-effects/overview.html>

⁴⁵ A First Global Production, Emission, and Environmental Inventory For Perfluorooctane Sulfonate. <https://doi.org/10.1021/es802216n>

⁴⁶ Degradability of an acrylate-linked, fluorotelomer polymer in soil. <https://doi.org/10.1021/es9002668>

⁴⁷ A global survey of perfluorinated acids in oceans. <https://pubmed.ncbi.nlm.nih.gov/15913661/>

⁴⁸ Atmospheric perfluorinated acid precursors: chemistry, occurrence, and impacts.

https://link.springer.com/chapter/10.1007%2F978-1-4419-6880-7_1

⁴⁹ Short-chain per- and polyfluoroalkyl substances in aquatic systems: Occurrence, impacts and treatment.

<https://doi.org/10.1016/j.ccej.2019.122506>

⁵⁰ Chapter 14 - Analysis of GenX and Other Per- and Polyfluoroalkyl Substances in Environmental Water Samples.

<https://www.sciencedirect.com/science/article/abs/pii/B9780128157305000144>

shown to result in bioaccumulation in plants and animals. For example, PFOS can build up in fish, birds, and other marine mammals,⁵¹ and it's expected that some PFAS would be found in samples from any wild animal.⁵² Plants can also accumulate PFAS when grown in contaminated soil or irrigated with contaminated water.^{35,17} While less is known about effects on wildlife than in humans, exposure to PFAS has been associated with adverse effects such as toxicity, effects on immune function,^{53,54} and even impacts on subsequent generations of organisms.⁵⁵

In addition to the ecological consequences, the presence of PFAS as an environmental pollutant ultimately becomes another exposure pathway for human health through ingestion of drinking water and contaminated food sources like fish and game. Green Seal has determined that eliminating PFAS from the supply chain is critical to preventing pollution that will persist for decades and for which there is no available remediation technologies.

Current Regulatory Efforts

The majority of regulatory efforts in the US and the European Union have focused on limiting PFAS exposure in drinking water, with recent efforts including restrictions on PFAS in materials designed for food contact. Nearly 20 states in the US have imposed regulatory limits on drinking water. Most states that have PFAS regulations follow the EPA lifetime advisory level of 70 parts per trillion (ppt) for either PFOA or PFOS or 70 ppt total for PFOA and PFOS combined.⁵⁶ Some US states have stricter regulations for other individual PFAS of concern.^{57,58} Certain states have taken steps to prohibit PFAS in consumer product categories. For example, California recently passed a law prohibiting PFAS in paper-based food packaging and will require disclosure of any harmful chemicals in cookware.²⁷

At a federal level in the US, there has been action to limit PFAS exposure such as efforts to ban three PFAS for use in food packaging by the Food and Drug Administration (FDA) in 2016.⁵⁹ The FDA is also monitoring the use of PFAS in cosmetics through efforts such as its Voluntary Cosmetic Registration Program in which manufacturers can self-report uses of PFAS in cosmetics.⁶⁰ Additionally, the US federal government has recently taken steps including efforts to regulate PFAS as hazardous substances; address PFAS contamination

⁵¹ U.S. EPA Long-Chain Perfluorinated Chemicals (PFCs) Action Plan. https://www.epa.gov/sites/default/files/2016-01/documents/pfcs_action_plan1230_09.pdf

⁵² Environmental and Health Impacts of PFAS. <https://dnr.wisconsin.gov/topic/PFAS/Impacts.html>

⁵³ Immunotoxicity in green mussels under perfluoroalkyl substance (PFAS) exposure: Reversible response and response model development. <https://setac.onlinelibrary.wiley.com/doi/10.1002/etc.4060>

⁵⁴ Elevated levels of per- and polyfluoroalkyl substances in Cape Fear River Striped Bass (*Morone saxatilis*) are associated with biomarkers of altered immune and liver function. <https://www.sciencedirect.com/science/article/pii/S0160412019334762>

⁵⁵ Fate and effects of poly- and perfluoroalkyl substances in the aquatic environment: A review. <https://setac.onlinelibrary.wiley.com/doi/10.1002/etc.2663>

⁵⁶ Drinking Water Health Advisories for PFOA and PFOS. <https://www.epa.gov/ground-water-and-drinking-water/drinking-water-health-advisories-pfoa-and-pfos>

⁵⁷ Per- and Polyfluoroalkyl Substances (PFAS) in drinking water. <https://www.mass.gov/service-details/per-and-polyfluoroalkyl-substances-pfas-in-drinking-water>

⁵⁸ Drinking Water Facts: Per- and Polyfluoroalkyl Substances (PFAS) in drinking water. https://www.nj.gov/health/ceohs/documents/pfas_drinking%20water.pdf

⁵⁹ “Forever Chemicals” Called PFAS Show Up in Your Food, Clothes, and Home. <https://www.nrdc.org/stories/forever-chemicals-called-pfas-show-your-food-clothes-and-home>

⁶⁰ Per and Polyfluoroalkyl Substances (PFAS) in Cosmetics. <https://www.fda.gov/cosmetics/cosmetic-ingredients/and-polyfluoroalkyl-substances-pfas-cosmetics>

at military sites; and commit to continued testing to assess the existing contamination of the US food supply.⁶¹ The extent of these efforts highlight the importance of addressing PFAS across supply chains to eliminate the source of environmental pollution so that costly remediation efforts are not needed after chemicals have accumulated and caused adverse health and environmental effects.

At the time of publication, Green Seal is not aware of any active regulatory laws for PFAS surrounding cleaning products or personal care products.

⁶¹ Fact Sheet: Biden-Harris Administration Launches Plan to Combat PFAS Pollution.
<https://www.whitehouse.gov/briefing-room/statements-releases/2021/10/18/fact-sheet-biden-harris-administration-launches-plan-to-combat-pfas-pollution/>