Technical Supporting Documentation for Regulatory Determinations Report to the Legislature

Safer Products for Washington Cycle 1.5 Implementation Phase 3

Hazardous Waste and Toxics Reduction

Washington State Department of Ecology

Olympia, Washington

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State of Washington

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Related Information

- Per- and Polyfluoroalkyl Substances Chemical Action Plan (CAP)[2]
- Safer Products for Washington Cycle 1 Implementation Phase 2: Report to the Legislature on Priority Consumer Products[3]
- Safer Products for Washington Cycle 1 Implementation Phase 3: Final Report to the Legislature on Regulatory Determinations[4]
- Safer Products for Washington Cycle 1 Implementation Phase 4:
    - Chapter 173-337-Washington Administrative Code (WAC)—Safer Products Restrictions and Reporting[5]
    - Concise Explanatory Statement[6]
- Safer Products for Washington Cycle 1.5 Implementation Phase 3: Regulatory Determinations Report to the Legislature[7]

[1] ecology.wa.gov/accessibility
[2] apps.ecology.wa.gov/publications/summarypages/2104048.html
[3] apps.ecology.wa.gov/publications/summarypages/2004019.html
[4] apps.ecology.wa.gov/publications/summarypages/2204018.html
[5] app.leg.wa.gov/WAC/default.aspx?cite=173-337
[6] apps.ecology.wa.gov/publications/summarypages/2304033.html
[7] apps.ecology.wa.gov/publications/summarypages/2404023.html

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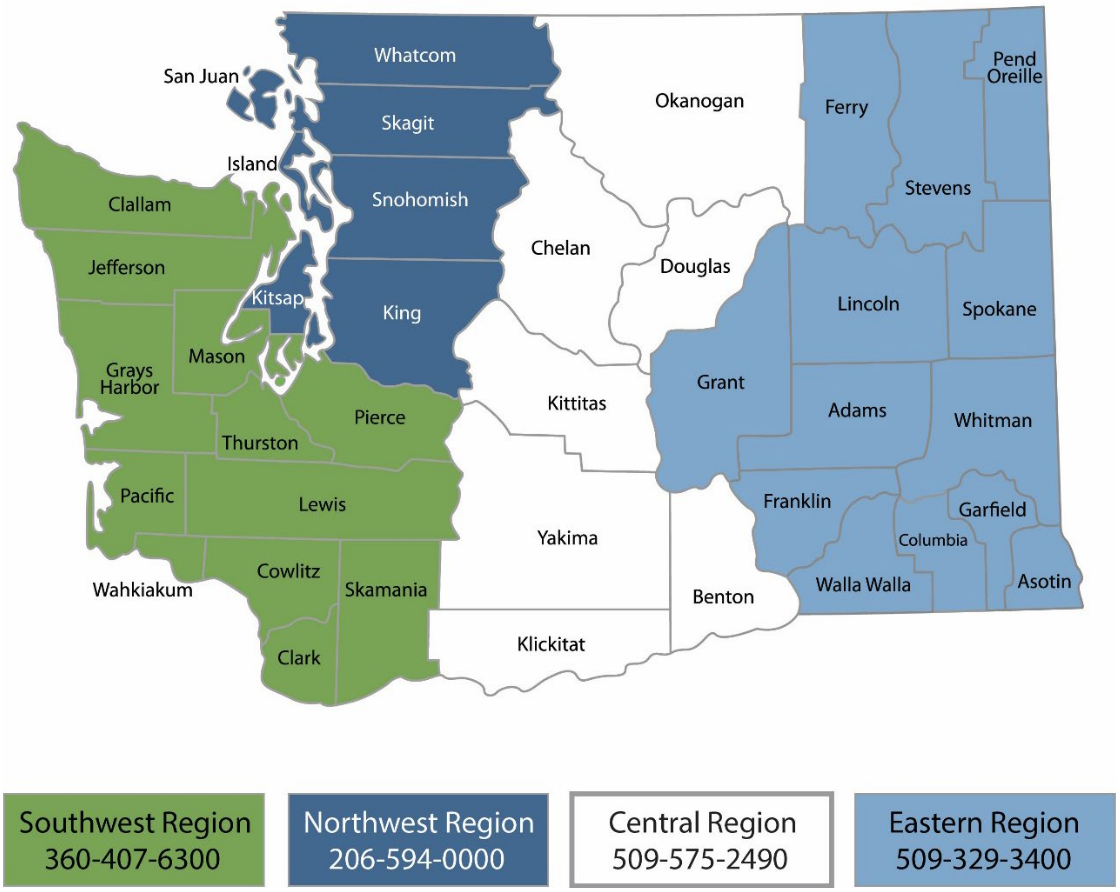

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Safer Products for Washington Cycle 1.5

Technical Supporting Documentation for Regulatory Determinations

Hazardous Waste and Toxics Reduction Program
Washington State Department of Ecology
Olympia, WA

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DEPARTMENT OF
ECOLOGY
State of Washington

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Chapter 1: Apparel and Gear

Priority product scope

This priority product includes apparel and gear marketed for general consumer use, as well as extended-use products. Apparel is defined as clothing, including outerwear meant to cover the body. Examples of apparel include athleticwear, rain wear, reusable diapers, menstrual underwear, school uniforms, dresses, hats, scarves, gloves, and shoes. Apparel designed for infants, children and adults are included. Gear includes non-clothing items that are used for a particular purpose, such as backpacks, sleeping bags, umbrellas, camping furniture, and climbing rope.

Extended-use products are defined as outdoor apparel designed for experts or professionals who are exposed to extreme weather for extended periods of time. Extended-use products provide protection against extended exposure to extreme wet weather conditions, such as hurricanes, or against extended immersion in water or wet conditions, including snow, to protect the health and safety of the user. Examples of extreme and extended-use products include outerwear for offshore sailing, whitewater kayaking, and mountaineering. This definition aligns with the definition of "outdoor apparel for severe wet conditions" in California Health and Safety Code Section 108970.[9]

Due to varying performance standards, non-firefighting personal protective equipment (PPE) with specific performance standards (e.g., surgery gowns) and used in occupational settings are excluded from this priority product category. Firefighting PPE is addressed as a separate priority product.

Function of the priority chemical in the priority product

To identify alternatives, we first determine whether the priority chemical is necessary to meet the performance requirements of the priority product at the chemical, material, or product level. If the priority chemical is not serving a function, the chemical can be removed, and there is no need to identify alternatives. For this priority product category, we determined that the function of PFAS varies and, as a result, the performance needs depend on the function and garment type. We identified four categories of functions: no functional use, surface water penetration resistance, oil repellency/stain resistance, and barrier.

Function – no functional use identified

We did not find marketing information regarding the use or known function of PFAS in existing activewear and sportswear. We did not find any currently known studies for activewear and sportswear that report levels of PFAS or total fluorine correlated to intentional use. In most

[9] California Health and Safety Code, Division 104, Division 104, Part 3, Chapter 13.5. Textile Articles. leginfo.legislature.ca.gov/faces/codes_displayText.xhtml?lawCode=HSC&division=104.&title=&part=3.&chapter=13.5.&article=

cases activewear marketing promotes functions that are counter to the function of PFAS, such as wicking (Hsieh, 1995).

Function – surface water penetration resistance

We determined that PFAS can be added to apparel and gear for water penetration resistance, to keep both the apparel textile and the user of the product dry. Water penetration resistance occurs by reducing the adhesion of water molecules to a surface. When surface adhesion is reduced, the textile absorbs less moisture from rain (or wicked sweat from the body); moisture evaporates from the apparel more quickly because the textile repels the moisture.

The need for varying degrees of water penetration resistance can be influenced by the scenario in which garments are used, such as extreme rain or other extended-use applications. Therefore, apparel and gear that contain this function are marketed in terms of water penetration resistance.

- Water resistant (low penetration resistance)
- Water repellent (moderate penetration resistance)
- Waterproof (impenetrable to water)

The surface water penetration resistance imparted by PFAS might come from a durable water repellent (DWR) coating.

Priority products that have this function include rain gear or outdoor gear marketed as water resistant, water repellent, or waterproof, for general consumer and extended-use applications.

Function – oil repellency or stain and soil resistance

In some apparel, PFAS is added to provide oil repellency or stain resistance. Oil repellency provides a protective function in some workwear (e.g., preventing skin exposure to motor oil). Stain and soil resistance is used primarily to maintain the appearance of the apparel and make the apparel surface easier to clean. School uniforms and dress shirts marketed as stain resistant are examples of products that could potentially include PFAS to provide that function.

Function – barrier

PFAS can also provide a barrier function in apparel. PFAS help prevent seepage of liquids, such as water or bodily fluids, through the apparel textile. Descriptions such as “leakproof” or “waterproof” indicate the presence of the barrier function. Menstrual underwear is one example of apparel that can contain a PFAS durable water repellant to provide a barrier function against bodily fluids. The inner liner of rain jackets can also contain PFAS, such as PTFE to provide a waterproof barrier in general consumer and extended-use products.

Safer, feasible, and available alternatives

Alternatives are safer, feasible and available

Our analysis of PFAS indicated that they do not meet our minimum criteria for safer. Therefore, the minimum criteria will be used to evaluate potential safer alternatives to PFAS in apparel and gear. Under this lens, we identified alternatives to PFAS in apparel and gear that meet our criteria for safer.

Chemical alternatives that meet the minimum criteria for safer will be considered safer alternatives for replacing PFAS. Alternative materials, products, and processes can also be safer alternatives to chemical treatments, assuming that there are no known associated chemical hazards leading to regrettable substitutions.

Additional resources from our 2022 Safer Products for Washington Regulatory Determinations Reports to the Legislature, describing our methods for identifying safer, feasible, and available alternatives, are below.

- **Hazards of PFAS:** Chapter 3 of the 2022 report describes the hazards of PFAS and why alternatives that meet our minimum criteria for safer are safer than PFAS as a class (Ecology, 2022b).
- **Criteria for safer:** Appendix C of the 2022 report describes our hazard-based approach for determining whether alternatives are safer than PFAS. It describes how we evaluate alternative chemicals to determine whether they are safer than PFAS. It also describes how we determine whether an alternative product or process is a safer alternative. Terms such as "very high," "high," "moderate," "low," and "very low" are defined for each relevant hazard endpoint (Ecology, 2022b).
- **Criteria for feasible and available:** Appendix D of the 2022 report describes our approach for determining whether safer alternatives are feasible and available. Our methods are based on the Level 1 Performance Module and Level 1 Cost and Availability Module described in the IC2 Guide (Ecology, 2022b).
- **Existing certifications and hazard assessments:** Appendix E of the 2022 report describes how and why existing certifications and hazard assessments, such as Safer Choice, GreenScreen®, and SciveraLENS® GHS+, can align with our minimum criteria for safer. It also describes transparency, antibias, and third-party review requirements for each type of assessment (Ecology, 2022b). The sections below reference assessments that meet our minimum criteria for safer, such as a Yellow SciveraLENS GHS+ Verified assessment.

Chemical alternatives

We identified and engaged with more than a dozen manufacturers of non-PFAS durable water repellent alternatives, alternative product manufacturers, and apparel brands who manufacture non-PFAS product lines. We also used our authority under RCW 70A.350.040[10] to order product ingredient information from apparel and gear manufacturers. There are numerous non-PFAS chemical durable water repellants manufactured and used in apparel and gear. Manufacturers in the apparel and gear sectors are switching to non-PFAS repellants (Milliken & Company, 2023; Ram, 2023). While alternative durable water repellants are available, there is a fundamental lack of transparency regarding these formulations. This is a barrier to identifying and assessing these alternatives against our criteria for safer. Despite this barrier, one manufacturer disclosed information regarding their product formulation, which allowed us to evaluate the ingredients.

Nikwax Durable Water Repellent – Direct.Dry

NikWax shared Scivera GHS+ assessments of all intentionally added ingredients, impurities, and residual monomers for the Nikwax Direct.Dry durable water repellant through a confidential business information agreement (Scivera, 2024). We found that all the ingredients that are intentionally added to serve the function of PFAS, as well as the residual monomers of those ingredients as well as all impurities that are present above 1,000 parts per million, met our minimum criteria for safer. In addition, impurities and residual monomers of ingredients added to serve the function of PFAS that are present between 100 and 1,000 parts per million did not score high (based on our criteria for safer) for group one human health hazards (carcinogenicity, mutagenicity, reproductive and developmental toxicity, or endocrine disruption). As a result, we conclude that Nikwax Direct.Dry meets our minimum criteria for safer. Appendix E, in our Cycle 1 Regulatory Determinations Report to the Legislature,[11] describes how chemicals evaluated using Scivera GHS+ meet our minimum criteria for safer.

Garments treated with durable water repellants are imparted with a chemical-based surface water repellency. Technical feasibility and performance of the durable water repellant will depend primarily on the type of fabric the treatment is applied on. It is technically feasible for Nikwax Direct.Dry to provide the function of surface water repellency to synthetic outdoor apparel fabrics (Nikwax LLC, 2023b).

Outdoor Research, a manufacturer of outdoor apparel and gear, is Nikwax's global launch partner of the Direct.Dry factory-applied durable water repellant. Direct.Dry will be used in the Outdoor Research fall 2024 redesigned Foray and Aspire waterproof shell collections (Outdoor Research LLC, "Statement on the Nikwax Direct.Dry X OR Collection", Email, February 9, 2024).

Alternative materials

Alternative weave

Fibers can be engineered to specific yarn counts and fiber densities. These specifically engineered fibers, when constructed from inherently water repellent materials and woven to

[10] app.leg.wa.gov/RCW/default.aspx?cite=70A.350.040
[11] apps.ecology.wa.gov/publications/SummaryPages/2204018.html

have a smaller, altered weave, can provide water penetration resistance to some apparel (Helly Hansen, 2020; Vessi, 2018).

Because the altered weave is what provides the surface water repellency function, a durable water repellant is not needed. We have identified two types of altered weaves as safer for this application: polypropylene-based knit and polyurethane based knit. Both polypropylene and polyurethane were evaluated against the criteria for safer in Safer Products for Washington cycle 1 and was determined to be safer alternatives to PFAS (Ecology, 2022b).

Polypropylene-based knit

Polypropylene is an inherently stain- and water-resistant material that does not require additional topical treatments. Polypropylene knits can be engineered to specifications, as described above, to provide surface water repellency to apparel without the need of a durable water repellant. In the 2022 Safer Products for Washington Regulatory Determinations Reports to the Legislature, no known carcinogens, mutagens, reproductive or developmental toxicants or endocrine disruptors were identified in polypropylene. Polypropylene was listed as a green circle on the U.S. Environmental Protection Agency (EPA) Safer Chemicals Ingredients List, scored an A- on Clean Production Action's plastics scorecard, and was determined to have the lowest environmental risk of six plastics assessed by the Minnesota Department of Environmental Assistance. Therefore, polypropylene meets our minimum criteria for safer (Ecology, 2022b).

Polyurethane-based knit

Polyurethane-knits can be engineered to specifications as described above to provide water repellency to apparel without the need of a durable water repellant. Polyurethane has been evaluated as yellow in a verified SciveraLENS® GHS+ assessment, indicating it does not contain known carcinogens, mutagens, or reproductive or developmental toxicants. While different monomers are used throughout polyurethane manufacturing and can be chemicals of concern (e.g., diisocyanates), we determined polyurethane, as a durable water repellant material alternative, is not a regrettable substitution for two reasons.

1) EPA and others predict low residual concentrations and exposure potential for diisocyanates in cured polyurethane products.
2) Untreated thermoplastic polyurethane is a safer alternative to PFAS-treated thermoplastic polyurethane (Ecology, 2022b).

Materials constructed with an altered weave contain smaller pores that inhibit the passage of water through the fabric, which gives surface water repellency. In some apparel, an altered weave as described is feasible and available to provide the function of surface water repellency.

Vessi designs and manufacturers waterproof shoes, jackets, and accessories with their Dyma-tex® technology, which is an altered weave of untreated polyurethane (Vessi, 2018). Helly Hansen has released the LIFA INFINITY PRO™ series of jackets and shell pants, which are made with a multilayered laminate fabric containing an altered weave of polypropylene as the water-repellent face fabric (Helly Hansen, 2020). While the use of Dyma-tex and LIFA® fibers is feasible and available for water repellent shoes, jackets, and ski pants, it is unknown if these technologies can be used in gear or extended-use apparel products.

Laminated textiles

Non-PFAS-based, inherently water repellent materials can be used to construct laminated textiles. Laminated textiles usually consist of a pre-prepared polymeric film sandwiched between two pieces of fabric and then joined together using adhesives, heat, or pressure (Scott, 1995). Laminated textiles prevent liquids or other soils from seeping through the textile providing a barrier function.

Polypropylene laminates

Alternatives to PFAS need to meet our minimum criteria to be considered safer alternatives. We have identified polypropylene laminate fabric as safer for this application. The Alternative weave section above includes the chemical hazard evaluation of polypropylene. Polypropylene was listed as a green circle on the U.S. EPA Safer Chemicals Ingredients List and assessed against their criteria, which indicates it meets our additional criteria for safer.

Polypropylene laminated textiles are feasible and available alternatives to PFAS for providing a barrier function in apparel. Helly Hansen's LIFA INFINITY PRO™ series of jackets and shell pants also contain a polypropylene membrane, in addition to its altered weave, to add a barrier function to each product.

Polyurethane laminates

Polyurethane laminates can be used as an alternative to fabric treated with a durable water repellant, to support a barrier function without the need of a repellant treatment. Menstrual underwear is an example where this might be relevant. We have identified polyurethane laminate fabric as safer for this application. The Alternative weave section above includes the chemical hazard evaluation of polyurethane.

The Period Company makes menstrual underwear utilizing a five-layer leakproof gusset that contains a laminate of polyurethane sandwiched between polyester fabric (The Period Company, 2020). For apparel that needs a liquid or soil barrier, laminated textiles are feasible and available alternatives to PFAS.

Alternative processes

Untreated apparel and safer cleaning methods

Untreated textile products can be manufactured without using any topical chemical treatments or stain-resistant fabric. A fabric without PFAS is safer than a fabric treated with PFAS. Because the base material is not expected to change, untreated products are considered safer alternatives.

Instead of applying topical chemical treatments for stain resistance, cleaning methods can be used to remove soils and stains after they occur on apparel. Examples of cleaning methods include professional wet cleaning (e.g., for formal wear and delicate apparel) and laundering apparel using a Safer Choice laundry detergent (e.g., for dress shirts and coveralls).

Professional wet cleaning is a means of cleaning apparel like dry cleaning that uses water and specialized detergents in place of perchloroethylene or other solvents. When we evaluate an alternative process, we aren't comparing two chemicals, but we are comparing different processes. Instead of using our criteria for safer, we assess whether known carcinogens, mutagens, reproductive and developmental toxicants, or endocrine disruptors were intentionally used.

Laundering apparel is another safer cleaning method when using a detergent with no known carcinogens, mutagens, reproductive and developmental toxicants, or endocrine disruptors. A Safer Choice–certified laundry detergent only contains ingredients that meet the criteria outlined in the EPA Safer Choice standard and contains no known regrettable substitutions.

While professional wet cleaning and laundering do not make apparel stain resistant, they do prevent permanent stains. By preventing stains, the appearance of the apparel and gear is maintained, providing the same effect accomplished by PFAS. These alternatives processes meet the performance needs of the product and do not contain regrettable substitutions. They are considered safer alternatives.

Professional wet cleaning uses detergents with no known carcinogens, mutagens, reproductive and developmental toxicants, or endocrine disruptors.

For example, we identified a safety data sheet for a wet cleaning detergent that does not list any globally harmonized system of classification and labeling of chemicals hazard phrases. The two chemicals listed, Chemical Abstracts Service numbers 73296-89-6 and 1300-72-7 (Kleerwhite Chemical, 2015), are listed as green full circles on EPA's Safer Chemical Ingredients List and have been evaluated against the surfactant criteria. While the surfactant criteria do not necessarily meet our minimum criteria for safer, they can be used to assess alternative processes.

Untreated apparel, such as cotton dress shirts (Ralph Lauren Corporation, 2022), rayon blouses (Fast Retailing Co. Ltd., 2023), and blended fabric dress pants (H&M Group, 2022), can be cleaned to remove soils and stains. Cleaning methods, such as professional wet cleaning and home laundering with an EPA Safer Choice detergent, are feasible and available alternatives to using PFAS for stain resistance in apparel and gear. As of 2022, at least 50 dry cleaning businesses across Washington state have started replacing their dry cleaning services with professional wet cleaning (Ecology, 2022a).

The EPA's Safer Choice program recognizes laundry detergents that meet the Safer Choice criteria. As of the release of this report, there are currently over 200 brands of Safer Choice certified laundry detergents available for purchase (EPA, 2023). One example of an available professional wet cleaning detergent is Kleerwite SMARTCare™ (Kleerwhite Chemical, 2015).

Protective garments

Wearing a protective garment is an alternative process that can be used to protect clothing from soils and stains. Examples of protective garments include aprons, coveralls, and bibs. Protective garments block contact between a soil and apparel surface by absorbing the soil or stain, thus protecting the apparel from getting stained. Washable, untreated materials, such as cotton, can be used to construct protective garments. These protective garments can be cleaned using professional wet cleaning or cleaned with EPA Safer Choice detergent as described in the "Alternative processes – Untreated apparel and safer cleaning methods" section above. Alternatively, synthetic fabrics with inherent stain-resistant properties, such as nylon or polyester, can be used to construct protective garments. While there are concerns regarding potential exposure to antimony from polyester use, both nylon and polyester were evaluated against our criteria for safer in cycle 1 of Safer Products for Washington, and we determined that using these fabrics are safer alternative processes (Ecology, 2022b).

Wearing protective garments to prevent stains on apparel is a feasible and available alternative to using PFAS for oil repellency or stain resistance. While they do not make apparel oil-repellent or stain- and soil-resistant, protective garments prevent oil or stains on apparel. This prevention maintains the appearance of the apparel, achieving the same goal as a PFAS-based treatment. Several options for protective garments are available at a variety of retail stores. Examples of available untreated, washable protective garments include the MATVRÅ baby bibs (IKEA, 2023b), the Trimaco 100 percent polypropylene coveralls (Trimaco, 2023), and the KÅLFJÄRIL apron (IKEA, 2023a).

Conclusion on alternatives

We identified one chemical alternative, three alternative materials, and two alternative processes that are safer, feasible, and available. These alternatives either provide the function of PFAS or eliminate the need for the function of PFAS. While we found alternatives for most apparel, we did not identify examples of these alternatives in use for apparel designed for outdoor experts and professionals to protect their health and safety.

The use of these alternatives in footwear is limited. We only identified one company using alternatives in footwear, so we were unable to assess the breadth of applicability of footwear alternatives. In many cases, we determined PFAS did not serve a function and no alternatives were needed. Table 1 focuses on safer, feasible and available alternatives when PFAS is serving a function. The conclusions were based on which PFAS function the alternative material or processes can replace.

Table 1. Summary of safer, feasible, and available alternatives to PFAS for apparel.

Functions	Chemical Alternative durable water repellant	Altered material alternatives	Cleaning methods alternatives	Protective clothing alternatives
Water repellency	Will be used in apparel in fall 2024. Examples include jackets and pants.	Used for apparel and shoes.* Examples include jackets, ski pants, shell pants, shoes, and gloves.	NA	NA
Oil repellency and stain or soil resistance	NA	NA	Used in apparel. Examples include washing products with Safer Choice detergents and professional wet cleaning.	Used in apparel. Examples include coveralls or aprons for painting and working with oil.
Barrier	NA	Used in apparel. Menstrual underwear is an example.	NA	NA

Table 1 notes:

* We only found one example of shoes using alternative weaves, and we are unable to assess the breadth of applicability of the alternative for shoes.

Reducing PFAS exposure

Apparel and gear are a significant source and use of PFAS

In our PFAS CAP, we identified and evaluated how PFAS is used in Washington State, and we recommended actions to reduce exposure to PFAS. The CAP identified several consumer products that use PFAS and can be sources of PFAS exposure for people and the environment.

In 2022, the Washington State Legislature amended Chapter 70A.350 RCW[12] allowing us to consider products listed in the CAP as priority products. The CAP recommended Safer Products for Washington evaluate water- and stain-resistant clothing and gear. Based on the products included in the sources and uses appendix of the CAP, we clarified and renamed this category water- and stain-resistant apparel and gear.

The CAP estimates the volume of PFAS used in apparel and gear and discusses human and environmental exposure pathways. The information included in the CAP aligns with the criteria for identifying consumer products that are significant sources or uses of PFAS listed in RCW 70A.350.030.[13] In determining whether a restriction would reduce a significant source or use of PFAS, we summarized relevant information from the CAP to address the estimated volume of PFAS in the product and the potential for exposure to sensitive populations and species. Information describing the estimated volume in Washington and presence of PFAS in the environment can be found in the CAP. Existing regulations from other states or nations and the availability and feasibility of safer alternatives are discussed elsewhere in this report.

In the CAP, we summarized available information on PFAS in apparel. This information can be found in the sources and uses appendix. Highlighting two studies discussed in the CAP, we report that PFAS has been found in apparel membranes at 1,590 ug/kg fluorotelomer alcohol and fluorotelomer sulfonate (Liu et al., 2015) and 124 ug/kg perfluoroalkyl carboxylic acid (Guo et al., 2009). Concentrations of PFAS in treated membranes were found at 464 ug/kg fluorotelomer alcohol and fluorotelomer sulfonate (Liu et al., 2015) and 198 ug/kg perfluoroalkyl carboxylic acid (Guo et al., 2009).

People, including sensitive populations, can be exposed to PFAS used to treat apparel and gear for stain and water resistance. Exposure can occur during product manufacturing, which can lead to disproportionately high exposure in certain occupations. Exposure can also happen during use and disposal. In tested stain- and water-resistant coats and raincoats, 72 percent were found to contain PFAS (Schreder & Goldberg, 2022), and PFAS-containing coats from Germany were shown to emit fluorotelomer alcohols (Knepper et al., 2014). A recent analysis of children’s uniforms found school uniforms can have similar levels of PFAS as outdoor apparel (Xia et al., 2022). Adults and children are exposed to PFAS from gear and apparel through skin contact and inhalation. Children mouthing clothing can have an additional oral exposure route (DEPA, 2015; Knepper et al., 2014), especially when raining, which can mobilize some types of PFAS (Schellenberger et al., 2022).

As apparel ages, increases in PFAS emissions from fabric degradation leads to PFAS inhalation and increased exposure in the home (Schellenberger et al., 2022). Fabric degradation can also lead to airborne PFAS exposure for people working with apparel and gear in retail settings. High levels of fluorotelomer alcohols have been found in the air of outdoor clothing shops (Schlummer et al., 2013). Low levels of fluorotelomer alcohols have also been identified in dryer

[12] app.leg.wa.gov/RCW/default.aspx?cite=70A.350
[13] app.leg.wa.gov/RCW/default.aspx?cite=70A.350.030

lint after washing and drying PFAS-containing clothing, although levels in dryer lint were found to be lower than in household dust and air (Shoeib et al., 2011b).

Apparel and gear release PFAS into the environment through several routes. When people wash apparel and gear, PFAS can be released into wastewater and reach the environment (Cui et al., 2020). For example, migration of PFAS from children's apparel into water from washing products has been documented (DEPA, 2015). Wastewater treatment plants do not currently have effective technology to fully remove PFAS from influent, leading to relatively consistent PFAS detection in effluent from these facilities (Lenka et al., 2021). PFAS from wastewater treatment plants are not limited to water contamination. Airborne PFAS have been detected as emissions from treatment plant aeration tanks (Hamid & Li, 2016).

Water-soluble PFAS can wash off apparel and gear outdoors and enter the environment directly after it has been raining (Schellenberger et al., 2022). After products are discarded, PFAS can contaminate landfills and can leach into the environment. Prior research identified PFAS in over 50 percent of tested samples and estimated approximately 600 kg/year of PFAS landfill leachate (Lang et al., 2017).

Factories creating PFAS-treated apparel and gear also generate contaminated discharge that can reach surface and groundwater systems. These discharges can also contaminate the soil and expose terrestrial and aquatic biota over time. Factory emissions contaminated with PFAS are also taken up by long-range atmospheric transport, exposing non-local habitats (Faust, 2023). This finding is supported by PFAS detection in remote areas (Faust, 2023a; Kurwadkar et al., 2022b).

Once PFAS are in the environment, sensitive species such as salmon can be exposed. Many PFAS bioaccumulate, so apex predators, such as orca whales, tend to have higher concentrations of PFAS in their bodies (Joyce Dinglasan-Panlilio et al., 2014; Kwiatkowski et al., 2020; Lee et al., 2023).

Restriction would reduce a significant source or use

Apparel and gear are significant sources and uses of PFAS; therefore, a restriction on PFAS in apparel and gear will reduce a significant source or use. As described in the preceding section, when fabric degrades, PFAS can wear off over time. This exposes people to PFAS when they sell, use, and discard products. Reducing sources or uses of persistent chemicals is important for protecting people and the environment, particularly sensitive species and populations.

Chapter 2: Firefighting Personal Protective Equipment

Priority product scope

RCW 70A.400.005(4)[14] defines "firefighting personal protective equipment" (also referred to as Firefighting PPE) as, "any clothing designed, intended, or marketed to be worn by firefighting personnel in the performance of their duties, designed with the intent for use in fire and rescue activities, including jackets, pants, shoes, gloves, helmets, and respiratory equipment."

WAC 296-305-01005,[15] Safety Standards for Firefighters, divides protective clothing for firefighters into five types:

(a) Structural firefighting protective clothing;

(b) Liquid splash-protective clothing;

(c) Vapor-protective clothing;

(d) High temperature-protective proximity clothing; and

(e) Wildland firefighting clothing.

Protective equipment that has the primary purpose of covering the body for protection (e.g., jackets, gloves, boots, and suits) will be grouped as apparel firefighting PPE. All other protective equipment that is not meant to cover the body (e.g., self-contained breathing apparatuses [SCBAs]) will be grouped as non-apparel firefighting PPE.

Function of the priority chemical in the priority product

To identify alternatives, we first determined whether the priority chemical is necessary to meet the performance requirements of the priority product at the chemical, material, or product level. If the priority chemical is not serving a function, the chemical can be removed without substitution.

Performance requirements for firefighting PPE are specified in National Fire Protection Association Standard standards. Chapter 296-305 WAC[16] states the standards that PPE gear in Washington is required to meet. The standards vary depending on the type of firefighting protective clothing. Descriptions of each type of firefighting protective clothing, based on the WAC and National Fire Protection Association Standards definitions and applicable standards, are outlined in Table 2 below.

[14] app.leg.wa.gov/RCW/default.aspx?cite=70A.400.005
[15] app.leg.wa.gov/WAC/default.aspx?cite=296-305-01005
[16] app.leg.wa.gov/WAC/default.aspx?cite=296-305

Table 2. Types of protective clothing and National Fire Protection Association requirements.

Protective Clothing Type	Description	Required NFPA Standard(s) Per WAC 296-305
Structural firefighting	Includes a helmet, coat, pants, boots, gloves, and a hood. Structural firefighters' protective clothing provides limited protection from heat but might not provide adequate protection during hazardous materials incidents. This type of protective clothing is typically referred to as turnout gear and is used when firefighters enter direct flames.	Clothing: NFPA 1971, Protective Ensembles for Structural Firefighting, 1991 or 1997 edition Gloves: NFPA 1971, Protective Ensembles for Structural Firefighting, 2000 edition Footwear: NFPA 1971, Protective Ensembles for Structural Firefighting, 2007 (or later) editions
Proximity firefighting	Radiant reflective protective garments configured as a coat and trousers, or as a coverall, and interface components that provide protection from conductive, convective, and radiant heat. This type of protective clothing is used in aircraft rescue scenarios or scenarios involving high radiant heat (e.g., fuel fire) but is not used for entering flames.	NFPA 1976, Protective Ensembles for Proximity Firefighting, 2000 edition

Protective Clothing Type	Description	Required NFPA Standard(s) Per WAC 296-305
Vapor-protective	Clothing that significantly inhibits or completely prevents sweat produced by the body from evaporating into the outside air. This includes encapsulating suits, various forms of chemical-resistant suits used for PPE, and other forms of nonbreathing clothing. This type of protective clothing is used in scenarios where the maximum available protection against dermal, inhalation, and ocular exposure is needed (e.g. unknown chemical hazards).	NFPA 1991, Standard on Vapor-Protective Ensembles for Hazardous Materials Emergencies, 2000 edition
Liquid-splash	Clothing that offers protection against some risks of hazardous materials during emergency incident operations involving liquid chemicals. This clothing does not offer gas-tight performance. This type of protective clothing is used in scenarios involving chemical releases where vapor protection is not needed and the hazards of the released chemicals are known.	NFPA 1992, Standard on Liquid Splash Protective Ensembles and Clothing for Hazardous Materials Emergencies, 2000 edition

Protective Clothing Type	Description	Required NFPA Standard(s) Per WAC 296-305
Wildland	Clothing worn by firefighters during fire suppression and property conservation efforts in woodlands, forests, grasslands, brush, and other such vegetation or any combination of vegetation, involving a fire situation but not within buildings or structures.	NFPA 1977, Standard Protective Clothing and Equipment for Wildland Firefighting, 2005 edition

To understand the functions of PFAS in a product, we looked at the different components commonly used in the listed types of protective clothing and identified the functions in the components.

- For structural and proximity firefighting PPE, protective clothing usually consists of an outer shell, moisture barrier, and thermal layer (NFPA, 1997).
- Structural and proximity firefighting gloves and boots are constructed with the same moisture barrier but contain no thermal layer (NFPA 2000a, 2000b). Usually, glove bodies are made with an outer shell that is the same as the turnout gear (NFPA, 2000a), while boots are made with an "upper" connected to the sole (NFPA 2007, 2018).
- Vapor-protective clothing consists of a chemically resistant fabric, like aramids, laminated to a barrier film and is considered a single material.
- Liquid-splash clothing consists of a chemically resistant layer and a thermal layer.
- Wildland gear consists of a puncture-resistant base fabric with a thermal layer.

The different layers have varying performance requirements, therefore the intended function of PFAS in apparel firefighting PPE will differ between layers and PPE types. Additionally, PFAS are also used to treat mechanical components of non-apparel PPE. We identified six functions that PFAS can serve in firefighting PPE. Each function listed below is discussed in terms of the performance requirements set by the applicable NFPA standards for the component described. At the end of the Functions of PFAS in apparel firefighting PPE section below, Table 3 summarizes the functions of PFAS, the relevant components, and protective clothing type for apparel firefighting PPE.

Functions of PFAS in apparel firefighting PPE

No function in wildland firefighting clothing and thermal layers

We did not find a specification in the 2005 edition of NFPA 1977 standards requiring a known function of PFAS for wildland firefighting protective clothing. Therefore, we determined that

PFAS are not necessary in wildland firefighting clothing. While it is not a necessary function, we have identified that a durable water repellant has been used on this type of clothing. (Tencate Protective Fabrics, 2020; *True North Gear LLC, "Sale of Firefighting PPE Containing PFAS Chemicals", Letter, May 10,* 2019).

The thermal layer is the component of structural and proximity firefighting protective clothing closest to the wearer. The function of the thermal layer is to provide an insulating barrier from heat. The thermal layer also provides a wicking substrate for sweat, to keep firefighters dry and comfortable. Through our research, we did not find a performance standard associated with the thermal layer in the 1991 and 1997 versions of NFPA 1971 standards that requires a function PFAS can provide. For these reasons, PFAS are not necessary in the thermal layers of structural and proximity firefighting protective clothing.

Structural and proximity firefighting

Function in outer shells

The outer shell is the most external layer of both structural and proximity firefighting coats, trousers, and gloves. Per the requirements of the 1997 edition of NFPA 1971, the outer shell must meet standards for water absorption and thermal resistance. To adhere to the standard, water absorption in structural and proximity firefighting coats, trousers, and glove outer shells cannot exceed an average of 30 percent.

To meet this requirement, PFAS can be used to give water repellency to outer shells. Water repellent coatings provided by PFAS are also resistant to thermal degradation, which is an additional requirement.

Functions in moisture barriers

The moisture barrier is the middle layer of structural and proximity firefighting coats, trousers, firefighting gloves, and boots. Moisture barriers are not included in the construction of wildland firefighting PPE. Typically, the moisture barrier is made of a fabric laminated with a PFAS film and prevents seepage of liquids through the turnout gear, protecting the wearer from directly contacting the liquid. The 1997 edition of NFPA 1971 requires moisture barriers for use in structural and proximity firefighting PPE to meet performance standards for:

- Liquid penetration resistance
- Viral penetration resistance
- Thermal resistance
- Anti-melting (NFPA, 1997)

While it is likely a variety of materials can meet some of these performance standards, since PFAS is the current sole component of moisture barriers, we identified all the performance requirements associated with PFAS. They are described below.

- To satisfy requirements for liquid penetration resistance, the moisture barrier must be able to resist liquids other than water. In this test, the moisture barrier must resist penetration to solutions of aqueous film-forming firefighting foam, sulfuric acid, phosphate ester-based fire-resistant hydraulic fluid, hydrocarbons, chlorine, and ethylene glycol. To meet the performance standard, moisture barriers cannot have seepage of any of these liquids through their materials after one hour of exposure.

- The moisture barrier materials are also evaluated for viral penetration resistance. For this test, the moisture barrier is exposed to a viral challenge on one side of the moisture barrier for one hour. If the virus does not appear on the side opposite of the challenge, the moisture barrier meets the performance standard.
- The materials for moisture barriers cannot show signs of melting or degradation after thermal resistance testing.

While not relevant in the 1991 or 1997 editions of NFPA 1971 (the standards that are required in Washington State), a light degradation resistance test was included in NFPA 1971 starting in 2007. This performance requirement was added as an effort to assess moisture barriers for premature failure. The light degradation resistance test measures how much the moisture barrier degrades after exposure to light. To meet the standard, the moisture barrier must not shrink, crack, or show any signs of degradation after 40 hours of continuous UV light exposure (NFPA, 2018). It is often argued that the light degradation resistance test is unnecessary since the moisture barriers are rarely exposed to light (Kelly, 2021), but it is required in the current edition of the NFPA 1971 standard. PFAS is added to PPE to meet this standard.

Functions in vapor protective clothing

Firefighters are often first responders in other emergency situations where vapor protective clothing is used. The 2000 edition of NFPA 1991 requires vapor protective clothing to have chemical permeation resistance to a broad range of chemicals, including acids, bases, and gases. Under this edition of NFPA 1991, vapor protective clothing is also required to have chemical permeation resistance to different families of solvents, including hydrocarbons, nitrogen-containing solvents, and both halogenated and non-halogenated solvents (NFPA, 2000c). To meet the performance requirements for vapor protective clothing, none of the test chemicals can degrade or permeate the vapor protective clothing materials in one hour or less.

While the 2000 edition of NFPA 1991 is focused on vapor protective clothing that is not designed to be used in fires, to comply with the standard, vapor protective clothing must also be tested for flame resistance.

Because they are flame resistant and can repel the families of chemicals listed above, PFAS can be used to satisfy these functions.

Function in liquid-splash protective clothing

The 2000 edition of NFPA 1992 requires liquid-splash protective clothing to be resistant to liquid penetration and provide flame resistance. To meet the performance requirements for liquid-splash protective clothing, none of the liquid test chemicals may penetrate the garment after one hour of contact (NFPA, 2000d). Families of liquid test chemicals include acids, bases, hydrocarbon solvents, nitrogen-containing solvents, and both halogenated and non-halogenated solvents. To meet this performance requirement, PFAS are used to serve these functions because they repel the full suite of liquid test chemicals listed and are resistant to flame.

Table 3. Summary of the functions of PFAS, the relevant components, and protective clothing type for apparel firefighting PPE.

Component	Performance Requirements Met by PFAS	Relevant Protective Clothing Type
Thermal layer	No function	Structural, proximity, liquid-splash, and wildland
Outer shell	Water absorption and thermal resistance	Structural and proximity
Moisture barrier	Liquid and viral penetration resistance, thermal resistance, anti-melting, and UV degradation resistance*	Structural and proximity
Chemically resistant face fabric	Chemical penetration and/or permeation resistance and thermal resistance	Vapor-protective and liquid-splash

Table 3 notes:
* Relevant only in NFPA 1971, 2007 edition and later.

Functions of PFAS in non-apparel firefighting PPE

Non-apparel firefighting PPE, such as self-contained breathing apparatuses (SCBAs) are critical elements to firefighting response. Performance requirements for SCBAs are outlined in NFPA 1981, Open-Circuit Self-Contained Breathing Apparatus for Emergency Services, 2019 edition. Performance standards in NFPA 1981 associated with PFAS use include the heat and flame tests. Additionally, complete SCBAs must pass the accelerated corrosion test, where the SCBA is exposed to a 5 percent salt solution fog for 48 hours. After a storage period of 48 hours, the airflow performance of the SCBA is assessed to determine pass or fail (NFPA, 2019).

While these tests are for the entire product, it is usually individual components that fail. In non-apparel firefighting PPE, PFAS could be used in some mechanical components to meet these standards. Some examples include seals (washers, O-rings, and gaskets), anti-seize thread seal tape, electrical components (insulation, vents, connectors, capacitors, and batteries), and some lubricants.

Safer, feasible, and available alternatives

We were unable to identify safer, feasible, and available alternatives for PFAS in firefighting personal protective equipment. This applies to both apparel and non-apparel firefighting PPE. We considered both alternative chemicals and alternative processes. Alternative chemicals must meet the minimum criteria for safer. Alternative processes that avoid the use of PFAS or replacement chemicals are safer alternatives if they do not contain known carcinogens, mutagens, reproductive and developmental toxicants, or endocrine disruptors at concentrations above 100 parts per million parts per million. More information on our methods can be found in our 2022 Safer Products for Washington Phase 1 Cycle 3 Regulatory Determinations Reports to the Legislature (Ecology, 2022b).

We've included a summary of our findings below.

- We were able to identify alternative durable water repellants for structural and proximity firefighting outer shells, but were unable to identify the ingredients in these formulations and could not confirm whether they are safer than PFAS.
- We were also able to identify a PFAS-free moisture barrier marketed for use in structural and proximity firefighting protective clothing and compliant with the 1991, 1997, and 2018 editions of the NFPA 1971 standard. We were unable to identify the materials and could not confirm whether they are safer than PFAS.
- While we were able to identify PFAS-free alternatives in vapor and liquid-splash protective clothing, we were unable to confirm the materials that were used. Therefore, we were unable to assess if the materials were safer.
- We found that PFAS was not necessary for any required function for wildland firefighting clothing and thermal layers, per the required NFPA standards. While not necessary, we have one report that confirms the use of PFAS durable water repellant in wildland clothing. We could not confirm that untreated wildland clothing or thermal layers were available for sale, so we could not confirm a safer alternative was available.

Conclusion on alternatives

Though there are alternatives to PFAS in firefighting PPE that appear to be feasible and available, we were not able to confirm that they are safer than PFAS.

Reducing PFAS exposure

Firefighting PPE is a significant source and use of PFAS

In our PFAS CAP, we identified and evaluated how PFAS is used in Washington State, and we summarized available information on PFAS in firefighting PPE. PFAS has been identified within all layers and types of firefighting PPE. We identified 26 different types of PFAS from 20 tested textiles, including clothing and heat-resistant masks. The concentration of these PFAS ranged from 2 ug/kg up to approximately 1,520 ug/kg depending on the type of PFAS used (Maizel et al., 2023), although fluoropolymers are most common.

Firefighters are exposed to PFAS from PPE. Their continuous use of fire suppressants and PPE containing PFAS has led to a disproportionally higher PFAS exposure among firefighters when compared to the general population after examining blood levels (Rosenfeld et al., 2023). Through repeated use, heating, and decontamination cleaning post use, PPE degrades. PFAS can be ingested or inhaled by firefighters wearing older clothing. Firefighters also receive direct dermal exposure to PFAS in PPE simply by wearing PFAS-containing clothing. It is difficult to avoid PFAS exposure from turnout gear by wearing non-contaminated clothing underneath. PFAS can migrate across clothing layers, traveling from areas of higher concentration to clothing layers close to the skin (Peaslee et al., 2020). Firefighters are also exposed to PFAS through contaminated dust found in their fire stations. Degraded fabric frays are likely part of the PFAS-contaminated dust (Mazumder et al., 2023).

Families of firefighters can also be exposed to PFAS from contaminated clothing used underneath turnout gear or worn at the station. If firefighters bring their clothes home to launder, it could bring PFAS into the home. The occupational take-home pathway is well documented for farmworkers (López-Gálvez et al., 2019). Similarly, PFAS from PPE could accumulate in house dust and expose children.

As firefighting PPE is manufactured, used, and discarded, PFAS can be released into the environment. Firefighting PPE manufacturing can generate industrial waste, which can enter the environment through airborne emissions and water discharge. Factory emissions contaminated with PFAS can be taken up by long-range atmospheric transport, exposing non-local habitats as well (Faust, 2023). This is supported by PFAS detection in remote areas (Faust, 2023; Kurwadkar et al., 2022). Once PFAS are in the environment, sensitive species such as salmon can be exposed. Many PFAS bioaccumulate, so apex predators, such as orca whales, can have higher concentrations of PFAS in their bodies (Joyce Dinglasan-Panlilio et al., 2014; Kwiatkowski et al., 2020; Lee et al., 2023).

PPE degrades over time, shedding PFAS-containing particles into the environment and air as chips, frays, and dust, which can then spread into large areas of the environment. Water contamination also occurs after washing PPE, with water going to wastewater treatment plants. These facilities do not currently have effective technology to fully remove PFAS from influent, leading to relatively consistent PFAS detection in wastewater effluent (Lenka et al., 2021). PFAS from treatment plants is not limited to water contamination. Airborne PFAS has been detected as emissions from wastewater aeration tanks (Hamid & Li, 2016).

Disposal of firefighting PPE also leads to landfill contamination, which can leach into the environment. Prior research identified PFAS in over 50 percent of tested samples and estimated approximately 600 kg/year of PFAS landfill leachate (Lang et al., 2017). Eventually that leached PFAS can make its way into waterways and soil, introducing PFAS particles into the water cycle and exposing terrestrial and aquatic biota over time.

Restriction would reduce a significant source or use

Firefighting PPE is identified in RCW 70A.350.090 as a priority product, which is a significant source or use of priority chemicals. A restriction on PFAS in firefighting PPE would reduce a significant source and use of PFAS. Further, restricting the use of PFAS in firefighting PPE would reduce disproportionately high exposures to PFAS in firefighters.

Chapter 3: Cleaning Products

Priority product scope

This priority product category includes cleaning products and cleaning agents intended for household and institutional uses. Examples include all-purpose cleaners and disinfectants, as well as cleaners for glass, bathrooms, dishes, tiles, boats, trucks, and cars. For this review, we did not assess the propellant function of PFAS in cleaning products that contain propellants. We included PFAS added for other uses in this report. We excluded propellants from this analysis because they are used across a variety of product categories, not just cleaning products, and therefore evaluating alternatives could be done more completely in a future cycle when we can address the breadth of product use.

Function of the priority chemical in the priority product

To identify potential safer alternatives, we first determine whether the function(s) provided by the priority chemical is necessary to meet the performance requirements of the priority product at the chemical, material, product, or process level. If the priority chemical does not provide a necessary function, the chemical can be removed, and there is no need to identify alternatives.

PFAS serve as a surface-active agent, which is also known as a surfactant. Surfactants provide a necessary function in cleaning products. Surfactants lower interfacial surface tension of cleaning compositions and aid the removal of soils and stains. For cleaning products, mixtures of various ionic, cationic, nonionic, and amphoteric surfactants are used to optimize a formulation (Olson et al., 1994). Surfactants provide “anti-fog” properties by lowering the inherent surface tension of a cleaning composition, which allows for easier spreading of other components in the composition. Surfactants in floor and general-purpose cleaning compositions act as wetting or penetrating agents. For soil and stain removal, surfactants help mitigate settling of ejected material, such as dirt, from a surface during cleaning. Ejected material is encapsulated by micelles, which prevent unwanted material from resettling on the clean surface. Glass cleaning products are example applications for this usage.

Multiple surfactants can be combined as a mixture to tune properties of a formulation. For example, surfactant use can control the ability and extent to which a cleaning composition will foam during application.

Safer, feasible, and available alternatives

Safer alternatives

Safer chemical alternatives

The hazard assessment scores for alternative surfactants that meet our minimum criteria for safer are described below. We identified several alternative surfactants that met our minimum criteria for safer. It is important to note that surfactants are often toxic, particularly in aquatic environments, with a high propensity for bioaccumulation (Jardak et al., 2016). Many of the alternatives still have hazards but are safer than PFAS. We also note that one alternative chemical—acetic acid—can be both a cleaning agent and an ingredient in cleaning product formulations used with other surfactants to improve cleaning efficacy.

Table 4. Identified safer alternatives to PFAS in cleaning products.

Associated CAS(s)	Common Name	Third-Party Hazard Assessment Score	Meets Minimum Criteria?
151-21-3; 68585-47-7	Sodium lauryl sulfate	GreenScreen® BM-2	Yes
9004-82-4	Sodium laureth sulfate	SciveraLENS® GHS+ Yellow Verified	Yes
68585-34-2	Sodium lauryl ether sulfate	SciveraLENS GHS+ Yellow Verified	Yes
61789-40-0	Cocamidopropyl betaine	GreenScreen BM-2	Yes
1643-20-5	Lauramine oxide	SciveraLENS GHS+ Yellow Verified	Yes
68155-09-9	Cocamidopropyl amine oxide	GreenScreen BM-2	Yes
3332-27-2	Myristamine oxide	SciveraLENS GHS+ Yellow Verified	Yes
68515-73-1	Capryl/decyl glucoside	GreenScreen BM-2	Yes
110615-47-9	Lauryl glucoside	SciveraLENS GHS+ Yellow Verified	Yes
68439-57-6	Sodium C14-16 olefin sulfonate	SciveraLENS GHS+ Green/Yellow Verified	Yes
68081-81-2	Sodium C10-16 alkylbenzenesulfonate	SciveraLENS® GHS+ Yellow Verified	Yes

Associated CAS(s)	Common Name	Third-Party Hazard Assessment Score	Meets Minimum Criteria?
1300-72-7	Sodium xylene sulfonate	SciveraLENS GHS+ Green/Yellow Verified	Yes
1847-58-1	Sodium lauryl sulfoacetate	GreenScreen BM-2	Yes
64-19-7	Acetic acid	SciveraLENS GHS+ Yellow Verified	Yes

Sodium lauryl sulfate (Chemical Abstracts Service [CAS]: 151-21-3/CAS: 68585-47-7) is listed on the EPA's Safer Chemical Ingredients List as a Green Full Circle (surfactant function), scores BM-2 in a GreenScreen® assessment, and meets our minimum criteria for safer. In the GreenScreen assessment, carcinogenicity, mutagenicity, and developmental toxicity score low. There is a data gap for reproductive toxicity. Acute and chronic aquatic toxicity score very high and high, but persistence and bioaccumulation both score very low.

Sodium laureth sulfate (CAS: 9004-82-4) is listed on the EPA's Safer Chemical Ingredients List as a Green Full Circle (surfactant function), scores Yellow in a SciveraLENS GHS+ verified assessment and meets our minimum criteria for safer. Sodium laureth sulfate scores moderate or lower for carcinogenicity, reproductive, and developmental toxicity and mutagenicity. Acute and chronic aquatic toxicity score high, but persistence and bioaccumulation score moderate or lower.

Sodium lauryl ether sulfate (CAS: 68585-34-2) is listed on the EPA's Safer Chemical Ingredients List as a Green Full Circle (surfactant function) and scores Yellow in a SciveraLENS GHS+ verified assessment. Sodium lauryl ether sulfate meets our minimum criteria for safer. Sodium lauryl ether sulfate scores low for carcinogenicity, mutagenicity, and reproductive and developmental toxicity. Aquatic toxicity scores high, but persistence and bioaccumulation are low.

Sodium C14-17 alcohol sulfonate (CAS: 68037-49-0) is on EPA's Safer Chemical Ingredients List as a Green Full Circle (surfactant function) and scores Yellow in a SciveraLENS GHS+ verified assessment. Sodium C14-17 alcohol sulfonate meets our minimum criteria for safer. Sodium C14-17 alcohol sulfonate scores moderate or lower for carcinogenicity, mutagenicity, and reproductive and developmental toxicity. Aquatic toxicity scores high, but persistence and bioaccumulation are low.

Cocamidopropyl betaine (CAS: 61789-40-0) is on EPA's Safer Chemical Ingredients List as a Green Full Circle (surfactant function), scores BM-2 in a GreenScreen assessment, and meets our minimum criteria for safer. Cocamidopropyl betaine scores moderate or lower for carcinogenicity, mutagenicity, and developmental toxicity. There is a data gap for reproductive toxicity. Acute and chronic aquatic toxicity are very high and high, but persistence and bioaccumulation are very low.

Lauramine oxide (CAS: 1643-20-5) is on EPA's Safer Chemical Ingredient List as a Green Full Circle (surfactant function) and scores Yellow in a SciveraLENS® GHS+ verified assessment. This meets our minimum criteria for safer. Lauramine oxide scores moderate or lower for carcinogenicity, mutagenicity, and reproductive and developmental toxicity. Lauramine oxide scores very high for acute aquatic toxicity but low for persistence and bioaccumulation.

Myristamine oxide (CAS: 3332-27-2) is on EPA's Safer Chemical Ingredients List as a Green Full Circle (surfactant function) and scores Yellow in a SciveraLENS GHS+ verified assessment. This meets our minimum criteria for safer. Myristamine oxide scores moderate or lower for carcinogenicity, mutagenicity, and reproductive and developmental toxicity. Acute aquatic toxicity scores very high, but persistence and bioaccumulation are moderate or lower.

Cocamidopropyl amine oxide (CAS: 68155-09-9) is on EPA's Safer Chemical Ingredients List as a Green Full Circle (surfactant function) and scores BM-2 in a GreenScreen® assessment. This meets our minimum criteria for safer. Cocamidopropyl amine oxide scores low for carcinogenicity, mutagenicity, and reproductive and developmental toxicity. Acute and chronic aquatic toxicity score very high and high, but persistence and bioaccumulation are low and very low.

Capryl/decyl glucoside (CAS: 68515-73-1) is on EPA's Safer Chemical Ingredients List as a Green Full Circle (surfactant function), scores BM-2 in a GreenScreen assessment, and meets our minimum criteria for safer. Capryl/decyl glucoside scores low for carcinogenicity, mutagenicity, and reproductive and developmental toxicity. Acute aquatic toxicity scores high, but persistence and bioaccumulation are very low.

Lauryl glucoside (CAS: 110615-47-9) is on EPA's Safer Chemical Ingredients List as a Green Full Circle (surfactant function), scores Yellow by SciveraLENS GHS+ verified assessments, and meets our minimum criteria for safer. Lauryl glucoside scores low for carcinogenicity, mutagenicity, and reproductive and developmental toxicity. Acute aquatic toxicity is high, but both persistence and bioaccumulation are low.

Sodium C14-16 Olefin sulfonate (CAS 68439-57-6) is on EPA's Safer Chemical Ingredients List as a Green Full Circle (surfactant function), scores Green/Yellow in a SciveraLENS GHS+ verified assessments and meets our minimum criteria for safer. Sodium C14-16 Olefin sulfonate scores low for carcinogenicity, mutagenicity, and reproductive and developmental toxicity. Acute aquatic toxicity is high, but both persistence and bioaccumulation are low.

Sodium C10-16 alkylbenzenesulfonate (CAS 68081-81-2) is on EPA's Safer Chemical Ingredients List as a Green Full Circle (surfactant function), scores Yellow in a SciveraLENS GHS+ verified assessment and meets our minimum criteria for safer. Sodium (C10-16) alkylbenzenesulfonate scores low for carcinogenicity, mutagenicity, and reproductive and developmental toxicity. Aquatic toxicity is high, but both persistence and bioaccumulation are low.

Sodium xylene sulfonate (CAS 1300-72-7) is on EPA's Safer Chemical Ingredients List as a Green Full Circle (surfactant function), scores Green/Yellow by a SciveraLENS GHS+ verified assessment and meets our minimum criteria for safer. Sodium xylene sulfonate scores low for carcinogenicity, mutagenicity, and reproductive and developmental toxicity. Aquatic toxicity and persistence are moderate, and bioaccumulation is low.

Sodium lauryl sulfoacetate (CAS 1847-58-1) scores BM-2 in a GreenScreen® assessment. This meets our minimum criteria for safer. Sodium lauryl sulfoacetate scores low for carcinogenicity, mutagenicity, and reproductive and developmental toxicity. Acute and chronic aquatic ecotoxicity both score high with very low persistence and very low bioaccumulation.

Acetic acid (CAS: 64-19-7) is on EPA's Safer Chemical Ingredients List as a Green Full Circle (processing aids and additives function), scores Yellow in a SciveraLENS® GHS+ verified assessment and meets our minimum criteria for safer. Acetic acid scores low for carcinogenicity, mutagenicity, and reproductive and developmental toxicity. Aquatic toxicity, persistence, and bioaccumulation are all moderate or lower.

Referenced hazard assessments:

- GreenScreen Assessments were accessed from www.theic2.org/hazard-assessment-database.
- SciveraLENS GHS+ assessments were accessed from www.enhesa.com/sustainablechemistry/ghsplus.
- EPA Safer Chemical Ingredients List was accessed from www.epa.gov/saferchoice/safer-ingredients.

Feasible and available alternatives

PFAS are used as surfactants in cleaning products. We identified several alternative surfactants that meet our minimum criteria for safer and are used in cleaning products. Because surfactants are often used in mixtures, we also identified several cleaning products that only use surfactants that meet our minimum criteria for safer.

We list performance objectives and requirements for chemicals acting as surfactants in cleaning products below.

- Surfactants are needed for efficient surface cleaning.
- Cleaning formulations as a product must be able to effectively clean surfaces.
- Surfactants must mix easily with other cleaning solution components.

To demonstrate the feasibility and availability of alternatives, we gathered information on where the safer alternatives are found using the Mintel Global New Products Database for the U.S. Using a network of shoppers, the Mintel Global New Products Database collects data on product claims, packaging attributes, and ingredients (Mintel, 2023). The shoppers purchase products used for dishwashing, toilet care, fabric care, and hard surface care. The number of products and example categories where the alternatives have been found are listed below. Table 5 also lists which of these chemicals is on the EPA High Production volume list (EPA et al., 2017).

Table 5. Safer alternatives that can be used as surfactants in cleaning products.

Associated CAS(S)	Common Name	On EPA High Production Volume List (Y/N)	Number Of Cleaning Products Found In*	Example Cleaning Product Types
151-21-3; 68585-47-7	Sodium lauryl sulfate	Yes	455	Dishwashing products, spot and stain remover, all-purpose and multi-purpose surface cleaner, glass cleaner, toilet cleaner, and floor care
9004-82-4; 68585-34-2	Sodium laureth sulfate; sodium lauryl ether sulfate	Yes	347	Dishwashing products, spot and stain remover, all-purpose and multi-purpose surface cleaner, and glass cleaner
68037-49-0	Sodium C14-C17 alcohol sulfonate	Yes	1	Toilet cleaner
61789-40-0	Cocamidopropyl betaine	Yes	215	Dishwashing products; spot and stain remover; all-purpose and multi-purpose surface cleaner; bath, shower, and tile care; and glass cleaner
1643-20-5	Lauramine oxide	Yes	419	Dishwashing products; spot and stain remover; all-purpose and multi-purpose surface cleaner; floor care; bath, shower, and tile care; glass cleaner; kitchen care; and drain care
68155-09-9	Cocamidopropyl amine oxide	Yes	78	All-purpose and multi-purpose surface cleaner; bath, shower, and tile care; and glass cleaner

Associated CAS(S)	Common Name	On EPA High Production Volume List (Y/N)	Number Of Cleaning Products Found In*	Example Cleaning Product Types
3332-27-2	Myristamine oxide	Yes	16	Dishwashing products, all-purpose cleaner, glass cleaner, wood surface cleaner, bathroom cleaner
68515-73-1	Capryl/decyl glucoside	No	389	Dishwashing products, spot and stain remover, all-purpose and multi-purpose surface cleaner, glass cleaner, furniture care, and toilet cleaner
110615-47-9	Lauryl glucoside	No	309	Dishwashing products; spot and stain remover; bath, shower, and tile care; toilet cleaner; floor care, all-purpose and multi-purpose surface cleaner; and glass cleaner
68439-57-6	Sodium C14-16 olefin sulfonate	Yes	24	Dishwashing products, laundry detergent, toilet cleaner, and hard surface cleaner
68081-81-2	Sodium C10-16 alkylbenzenesulfonate	No	84	Laundry detergent, dishwashing product, and glass cleaner
1300-72-7	Sodium xylene sulfonate	Yes	111	Dishwashing products; all-purpose cleaner; mold and mildew stain remover; glass cleaner; toilet cleaner; hard surface cleaner; and bath, shower, and tile care

Associated CAS(S)	Common Name	On EPA High Production Volume List (Y/N)	Number Of Cleaning Products Found In*	Example Cleaning Product Types
1847-58-1	Sodium lauryl sulfoacetate	Yes	6	Toilet cleaner, dishwashing products, laundry detergent
64-19-7	Acetic acid	Yes	58	All-purpose and multi-purpose surface cleaner; bath, shower, and tile care; and glass cleaner

Table 5 notes:

* Data on dishwashing, toilet cleaner, fabric care, and hard surface care products was retrieved from The Mintel Global New Products Database focused on the U.S.

Surfactants can frequently be used as mixtures in a formulation. Table 6 below shows examples of products that only list the surfactants we identified as safer on their product disclosure documentation. These surfactants can be single ingredients or a mixture. We show a range of product types that can be used in both household and institutional settings.

Table 6.Examples of currently available cleaning products with all surfactant ingredients that meet the minimum safer criteria.

Ingredients (product types contain one or more of these ingredients)	Example Product Types	Example Products*
Lauryl glucoside: (110615-47-9) Capryl/decyl glucoside: (68515-73-1) Acetic acid: (64-19-7)	Glass cleaner General-purpose cleaner Window cleaner Floor cleaner Granite and stainless cleaner Outdoor furniture cleaner Whiteboard cleaner	Green Solutions® Glass Cleaner (Spartan Chemical Company, 2019) Clorox® Free & Clear Multi-Surface Spray Cleaner (The Clorox Company, 2022) CLR EVERYDAY CLEAN (Jelmar LLC, 2020) ECOS All-Purpose Cleaner – Parsley(Earth Friendly Products, 2023) ECOS Window Cleaner(Earth Friendly Products, 2020c) Bona Pet System Multi-Surface Floor Cleaner, Dog Formulation (BonaKemi USA Inc., 2021) Boulder Clean Granite + Stainless Cleaner (1908 Brands Inc., 2019) CLR Outdoor Furniture Cleaner (Jelmar LLC, 2021) Sustainable Earth by Staples Whiteboard Cleaner (Staples Inc., 2019)
Sodium lauryl sulfate (CAS: 151-21-3 or 68585-47-7) Sodium lauryl ether sulfate (CAS: 68585-34-2)	Bathroom cleaner Toilet cleaner Glass cleaner	Seventh Generation Disinfecting Bathroom Cleaner – Lemongrass Citrus (Seventh Generation, 2023) Blueland Toilet Bowl Cleaner (Blueland, 2020) Simple Green Clean Building® Glass Cleaner (Sunshine Makers Inc., 2021)
Cocamidopropyl betaine (CAS: 61789-40-0)	Dish cleaner Kitchen, bath, utility room cleaner	ECOS® Pro Dishmate™ Manual Dishwashing Liquid (Earth Friendly Products, 2020b) ECOS Surface Scrub – Lemon (Earth Friendly Products, 2020a)

Ingredients (product types contain one or more of these ingredients)	Example Product Types	Example Products*
Lauramine oxide (CAS: 1643-20-5), Myristamine oxide (CAS: 3332-27-2)	Rust stain remover Multi-purpose cleaner	CLR Calcium, Lime & Rust Remover (Jelmar LLC, 2023) Waxie-Green EDC 43 HP Multi-Purpose Cleaner (WAXIE Sanitary Supply, 2019a)
Sodium lauryl sulfate (CAS: 68585-47-7) Sodium lauryl ether sulfate (CAS: 68585-34-2) Cocamidopropyl betaine (CAS: 61789-40-0) Lauramine oxide (CAS: 1643-20-5) Myristamine oxide (CAS: 3332-27-2) Sodium C14-16 olefin sulfonate (CAS 68439-57-6) Sodium C10-16 alkylbenzenesulfonate (CAS 68081-81-2) Sodium xylene sulfonate (CAS 1300-72-7)	Car cleaner Boat cleaner	Meguiar's® Shampoo Plus (Meguiar's Inc., 2018) Meguiar's Citrus Power Cleaner Plus (Meguiar's Inc., 2022) Meguiar's Marine/RV Gel Wash (Meguiar's Inc., 2021) Meguiar's Extreme Marine Multi-Surface Cleaner (Meguiar's Inc., 2019)

Ingredients (product types contain one or more of these ingredients)	Example Product Types	Example Products*
Sodium lauryl ether sulfate (CAS: 68585-34-2) Cocamidopropyl Betaine (CAS: 61789-40-0)	Dish cleaner	Waxie-Green™ SOLSTA 943 Dish Kleenz Liquid Dish Soap (WAXIE Sanitary Supply, 2019b)
Sodium xylene sulfonate (CAS: 1300-72-7) Sodium lauryl sulfate (CAS: 151-21-3) Sodium lauryl sulfoacetate (CAS: 1847-58-1)	Windshield cleaner/washer tablet	Dissolving Windshield Washer Fluid Tablet (Wurth USA, 2021)

Table 6 notes:

* Any reference in this publication to persons, organizations, services, products, or activities does not constitute or imply endorsement, recommendation, or preference by the Washington Department of Ecology.

Conclusion on alternatives

We identified safer, feasible, and available alternatives to PFAS used as surfactants in cleaning products. Safer surfactants are widely used in cleaning products intended for household and institutional use. Alternative surfactants are used for indoor and outdoor cleaning products, including vehicle washes. Because surfactants can be used in mixtures, we also identified available products that use mixtures of only safer surfactants. Taken together, this supports the feasibility and availability of safer alternatives.

Reducing PFAS exposure

Cleaning products are a significant source and use of PFAS

In the PFAS CAP, we summarized available information on PFAS in cleaning products. This information can be found in the sources and uses appendix. Cleaning agents were estimated to be one of the largest contributors of fluorotelomer alcohols and fluorotelomer sulfonates in a typical home (667,700 ug/kg) and are a significant source or use of PFAS (Kotthoff et al., 2015).

Cleaning products are widely used, so exposure to PFAS-containing products can be broad. People can be exposed to PFAS during product manufacturing, use, and disposal. When using cleaning products, people can be exposed to PFAS through inhalation, ingestion, or dermal contact (Poothong et al., 2019). People touching recently cleaned surfaces can be exposed to residual PFAS, and some cleaning products leave residues that have been found in house dust. These residues can be inhaled (Poothong et al., 2019).

Sensitive populations, such as children, can have increased exposure to PFAS from some cleaning products. This can be due to increased hand-to-mouth behavior and the frequency of cleaning necessary in childcare facilities. PFAS can also be ingested if residues remain on food contact surfaces.

People who use cleaning products more often can have higher exposure. Some occupations, such as janitorial staff and housekeepers, can have disproportionately higher exposure to PFAS in cleaning products. Occupational data on PFAS exposure is limited. However, workers can be exposed to other ingredients in cleaning products (Bello et al., 2009).

The intersections of race and occupation can further contribute to disproportionate exposures to PFAS. People who already experience social stress from factors like poverty and racism are even more vulnerable when exposed to harmful chemicals. Studies have shown that Black and Brown people disproportionately suffer from health effects due to harmful exposures where they live and work. Black and Brown workers with high potential for exposure to PFAS are more vulnerable than their White counterparts for this reason. According to data from the U.S. Bureau of Statistics, 17.4 percent of janitors and building cleaners identified as Black or African American and 24.6 percent identified as Hispanic or Latino. Similarly, among maids and housekeepers, 15.7 percent identified as Black or African American, and 51 percent identified as Hispanic or Latino. This is compared to the general working population where 12.6 percent identified as Black or African American and 18.5 percent identified as Hispanic or Latino (BLS, 2022). The intersectionality of occupation and race can further contribute to disproportionate exposures to PFAS.

PFAS are widely detected in Washington's environment (Ecology, 2022b). PFAS as a class contain chemicals that do not readily degrade or transform into nondegradable, stable PFAS species (Kwiatkowski et al., 2020). Therefore, PFAS that enter the environment are persistent in the environment and will have an increasing presence until PFAS development is fully stopped. Cleanup of existing PFAS is needed to remove it from contaminated areas. Cleaning products are typically discharged down the drain, leading to direct entry into waterways through wastewater treatment plants and the sewage system. These facilities do not currently have effective technology to fully remove PFAS from influent, leading to relatively consistent PFAS detection in wastewater effluent (Lenka et al., 2021). PFAS from treatment plants is not limited to water contamination. Airborne PFAS have been detected as emissions from wastewater aeration tanks (Hamid & Li, 2016). Alternatively, PFAS from sprayed products can enter the environment directly as aerosols. Once in the environment, PFAS can expose sensitive species and bioaccumulate to the point where apex predators, such as orca whales, have high concentrations of PFAS within their bodies (Joyce Dinglasan-Panlilio et al., 2014; Kwiatkowski et al., 2020; Lee et al., 2023) PFAS can also leach into the environment from partially used cleaning products disposed in landfills and from manufacturing discharge. Prior research identified PFAS in over 50 percent of tested samples and estimated approximately 600 kg/year of PFAS landfill leachate (Lang et al., 2017). Factory emissions contaminated with PFAS are also taken up by long-range atmospheric transport, exposing non-local habitats (Faust, 2023). This is supported by PFAS detection in remote areas (Faust, 2023; Kurwadkar et al., 2022). Creating PFAS-contaminated cleaning products also generates contaminated discharge that can reach surface and groundwater systems, as well as contaminate the soil and expose terrestrial and aquatic biota over time (Faust, 2023; Kurwadkar et al., 2022).

Restriction would reduce a significant source or use

A restriction on PFAS in cleaning products will reduce a significant source or use because cleaning products are a significant source and use of PFAS. Cleaning products contribute to PFAS in our homes, bodies, and environment. People are exposed to PFAS during cleaning product manufacturing, use, and disposal. Sensitive populations, such as people who work with cleaning products and children, can have disproportionately higher exposure to PFAS from cleaning products. When released into the environment, through use or disposal, cleaning products can expose sensitive species to PFAS. Reducing sources or uses of persistent chemicals is important for protecting people and the environment, particularly sensitive species and populations.

Chapter 4: Waxes and Polishes

Priority product scope

This priority product category includes the product types below.

- Automotive polishes and waxed-based products are formulated products marketed for use on an automotive exterior as either a wax, polish, or finish. Examples include polish, wash and wax, all-in-one wax, spray wax, and wet wax for motor vehicles, which includes cars, recreational vehicles, and boats. When waxes and polishes are applied during automotive manufacturing, they are excluded from this product scope.
- Floor polishes and waxed-based products are formulated products designed to polish, protect, or enhance a floor's surface. Examples include multi-surface floor finishes, low-gloss, semigloss, and high-gloss polishes.
- Ski wax products are formulated products intended for use on snow equipment, like skis and snowboards, with the intent of modifying friction properties. Example products include hot wax, spray wax, and rub-on wax for Nordic skis, alpine skis, and snowboards.

Function of the priority chemical in the priority product

A summary of relevant functions of PFAS chemicals that are used in relevant waxes or polishes are described in Table 7.

Table 7. Function provided by PFAS in relevant wax and polish-based products.

Product Categories	Function of PFAS
Automotive wax and polish	Provides aqueous repellency for a surface; provides protection from environmental elements
Floor wax and polish	Provides aqueous and oil repellency of a surface; increases the spreading abilities of other components in a wax formulation
Ski wax and polish	Decreases friction properties (wet friction coefficient) for skis and other similar snow sporting equipment

Safer, feasible, and available alternatives

Alternatives can be chemical replacements or alternative materials and processes. Chemicals must meet our minimum criteria for safer to be considered safer alternatives. Chemicals that serve the same function as PFAS in relevant wax or polish-based products must meet the minimum criteria for safer. Alternative materials, products, or processes that avoid the use of PFAS or replacement chemicals can be safer alternatives, provided they are not regrettable substitutions.

Safer alternatives

Safer chemical alternatives

Chemical alternatives used to replace PFAS must meet the minimum criteria for safer to be considered safer alternatives. We only received the necessary ingredient disclosure to evaluate one full product formulation. Potential alternative chemicals with similar or related functions to PFAS in this product category were identified using partial ingredient disclosures and pertinent product database search queries. However, several ingredients that can serve part of the same function as PFAS in products in this category are listed below. In practice, these ingredients are used in mixtures, and we did not have enough information on alternative products to confirm whether safer chemicals were used to provide the same function as PFAS.

Carnauba wax (Chemical Abstracts Service [CAS]: 8015-86-9) is on EPA's Safer Chemical Ingredient List as a green full circle and scores a yellow in a verified SciveraLENS GHS+ assessment. It does not have a specific functional class associated and has therefore been evaluated against the master criteria. Chemicals with green full circles evaluated against the master criteria meet our minimum criteria for safer.

Beeswax (CAS: 8012-89-3) is on EPA's Safer Chemical Ingredients List as a green full circle. It does not have a specific functional class associated and has therefore been evaluated against the master criteria. Chemicals with green full circles evaluated against the master criteria meet our minimum criteria for safer.

Paraffin waxes (CAS: 8002-74-2) score green/yellow in a verified SciveraLENS GHS+ assessment and scored BM-3 in a GreenScreen assessment. Paraffin waxes meet our minimum criteria for safer. Carcinogenicity, mutagenicity, and reproductive and developmental toxicity all score low. Persistence, bioaccumulation, and aquatic toxicity all score moderate or lower.

Sodium lauryl sulfate (CAS: 151-21-3), also known as sodium dodecyl sulfate, is listed on the EPA's Safer Chemical Ingredients List as a green circle (surfactant function), scored BM-2 in a GreenScreen® assessment, and meets our minimum criteria for safer. Carcinogenicity, mutagenicity, and developmental toxicity score low. There is a data gap for reproductive toxicity. Acute and chronic aquatic toxicity score very high and high, however persistence and bioaccumulation both score very low.

Dimethicone (CAS: 63148-62-9/9006-65-9/9016-00-6) was assigned a BM-2 score in a GreenScreen assessment. Dimethicone meets our minimum criteria for safer, provided oligomer concentrations of cyclic volatile methylsiloxanes are below 1000 parts per million in the final product. Carcinogenicity, mutagenicity, reproductive toxicity, and developmental toxicity all scored low. Persistence scored very high, however acute and chronic aquatic toxicity and bioaccumulation scored low.

Referenced hazard assessments

- GreenScreen Assessments were accessed from www.theic2.org/hazard-assessment-database.
- SciveraLENS® GHS+ assessments were accessed from www.enhesa.com/sustainablechemistry/ghsplus.
- EPA Safer Chemical Ingredients List was accessed from www.epa.gov/saferchoice/safer-ingredients.

Safer products

Due to lack of ingredient disclosure, it is unclear if feasible and available alternative products, containing only safer chemistries serving the wax and surfactant function, exist for most product categories. We found a limited number of PFAS-free alternatives available for floor waxes and polishes. We were able to identify a few automotive polishes that were PFAS-free. However, we were unable to identify alternative ingredients and could not confirm whether the alternative ingredients met our minimum criteria for safer. We identified one safer alternative ski wax product without PFAS.

Nikwax Ski Skin Proof: We received formulation disclosure from Nikwax through a confidential business information agreement. A SciveraLENS GHS+ verified assessment of all intentionally added ingredients, impurities, and residual monomers was conducted. We found that all the intentionally added ingredients, residual monomers, and impurities present above 1,000 parts per million parts per million met our minimum criteria for safer. Impurities and residual monomers present between 100 and 1,000 parts per million did not score high (based on our criteria for safer) for group one human health hazards (carcinogenicity, mutagenicity, reproductive and developmental toxicity, or endocrine disruption). Nikwax Ski Skin Proof is marketed as enhancing the performance of your ski skins, improving glide, and reducing kick. It is sold at several recreational sports stores as well as online (Nikwax LLC, 2023a). We conclude that Nikwax Ski Skin Proof meets our minimum criteria for safer, as well as our criteria for feasible and available.

Although other PFAS-free ski wax products have been identified, the lack of detailed ingredient disclosures inhibit our ability to determine if these alternatives are safer alternatives.

Alternative process

Using existing flooring or installing new flooring that does not have a finish and does not require waxes or polishes are both viable process-based alternatives. This is provided no known carcinogens, mutagens, reproductive and developmental toxicants, or endocrine disruptors were intentionally used in the alternative. If a finish added during manufacturing is free of PFAS and has been assessed for no known carcinogens, mutagens, reproductive and developmental toxicants, or endocrine disruptors, this is also safer. Flooring and finishes that are certified as Cradle to Cradle® gold or platinum for material health (version 3.1 or newer) meet this criterion.

We identified two process-based alternatives that are currently available to consumers and safer than PFAS:

- Use existing flooring or install new flooring that does not have a finish and does not require waxes or polishes is a safer alternative. An example is a Cradle to Cradle® certified tile-based flooring (C2C Products Innovation Institute, 2021).
- Use flooring with a finish that does not require waxes or polishes. An example is Cradle to Cradle certified linoleum-based flooring, which does not require a wax or polish (C2C Products Innovation Institute, 2022). However, it is inappropriate to consider this alternative process as readily available because these flooring materials might not be suitable for varying specific consumer needs.

Conclusion on alternatives

PFAS bestows various properties in waxes and polishes, including liquid and oil repellency, protection against the elements, increasing spreadability, and decreasing friction. We evaluated alternative chemicals and alternative processes. We identified several safer chemicals that might be able to serve these functions. Because alternative chemicals are often used in mixtures, we need specific formulations to determine whether mixtures containing only safer chemicals can meet product performance needs.

One manufacturer was willing to disclose product formulation, and we were able to confirm that the ingredients in that product are safer. We identified Nikwax Ski Skin Proof as a safer alternative to PFAS for ski skins. However, for other types of ski wax, floor wax, and automotive wax, we were unable to identify products with sufficient ingredient transparency to determine whether the safer alternatives identified are feasible and available for those applications. Lack of sufficient ingredient transparency also hindered our ability to assess if feasible and available alternatives free of PFAS were safer. We determined the alternative process to waxing and polishing floors, using flooring that does not require waxes or polishes, is only available to those purchasing new flooring and isn't feasible in situations where flooring already exists.

Reducing PFAS exposure

Waxes and polishes are a significant source and use of PFAS

In the PFAS CAP, we summarized available information on PFAS in waxes. This information can be found in the sources and uses appendix. The concentration of residential PFAS from ski wax is 11,365.5 ug/kg perfluoroalkyl carboxylic acid on average (Kotthoff et al., 2015). In the home, the concentration of PFAS from floor waxes includes total treated floor waxes as well as hard surface sealants. These concentrations are at 2,430 ug/kg of perfluoroalkyl carboxylic acid (Guo et al., 2009) and 423,000 ug/kg of fluorotelomer alcohol or fluorotelomer sulfonate (Liu et al., 2015). Finally, the concentration of PFAS from car waxes used residentially are estimated at 1.4 to 2.8 ug/m^2 PFOA (Borg & Ivarsson, 2017).

People are exposed to PFAS from waxes and polishes during manufacturing and application, as well as home use. Workers and applicators can inhale PFAS from waxes while they are applying the waxes. For professional ski wax applicators, exposure can be particularly high. Ski wax is heated before application, which can increase concentrations of PFAS in the breathing space. A study of professional ski wax applicators found that 37 percent of tested waxers had PFAS levels that exceeded occupational exposure limits (Nilsson et al., 2013). People applying floor waxes, such as janitorial staff and custodians, can inhale PFAS. Other occupations with the potential for exposure include people operating car washes that offer waxes. Employees applying wax through a spray nozzle or drying recently waxed cars can have both dermal and inhalation exposure. Occupational exposures are particularly concerning because workers can be exposed daily.

People can also be exposed to PFAS from waxes and polishes used in their homes. People applying floor waxes or car waxes can be exposed through inhalation and dermal exposures. A pilot study investigating PFAS exposure found some PFAS levels increased significantly during professional floor polishing (Zhou et al., 2022).

The intersections of race and occupation can further contribute to disproportionate exposures to PFAS. People who already experience social stress from factors like poverty and racism are even more vulnerable when exposed to harmful chemicals. Studies have shown that Black and Brown people disproportionately suffer from health effects from harmful exposures where they live and work. For this reason, Black and Brown workers with high potential for exposure to PFAS are more vulnerable than their White counterparts. According to the U.S. Department of Labor, the percentage of janitors and building cleaners who identify as Black or African American or Hispanic is higher than the general worker population (BLS, 2022).

Children, who spend more time on or near the floor and have increased hand-to-mouth activity, can be exposed to PFAS orally, dermally, and through inhalation if they come into contact with a waxed surface or play in recently waxes areas. Overtime, waxes also wear off and PFAS can accumulate in house dust, providing an additional exposure route that is particularly important for children (DeLuca et al., 2022; Trudel et al., 2008).

PFAS is ubiquitous throughout Washington (Ecology, 2022b). PFAS as a class contain chemicals that either transform into nondegradable, stable PFAS products or do not readily degrade at all (Kwiatkowski et al., 2020). Therefore, PFAS that enter the environment are persistent and will have an increasing presence in the environment until PFAS development is fully stopped. Even then, cleanup of existing PFAS is needed to fully remove it from contaminated areas.

Waxes introduce several routes of PFAS environmental contamination into Washington’s habitats. Car wax is often sprayed on the vehicle. Wax that misses the vehicle or does not adhere can be released into wastewater or directly into the environment. Sprays release PFAS particulates in the air, which can travel long distances through long-range atmospheric transport and lead to remote environmental exposures (Faust, 2023; Kurwadkar et al., 2022).

Shoes and clothes can be contaminated with floor wax during application; then, the contaminated shoes and clothes can be tracked outside. Floor waxes can also chip off with time and be tracked outside on shoes.

After wax application, leftover product and spills can be released into wastewater or directly into the environment, depending on where the wax was applied. Car waxes applied outside of professional car wash facilities generate runoff that is often released directly into the environment. Disposal of partially used containers and wax products can lead to PFAS landfill contamination and potential PFAS-containing leachate, with an estimated 600kg/year of PFAS leachate occurring in the United States (Lang et al., 2017).

When wax wears off cars over time, it can be released directly into the environment. Similarly, wax wearing off skis during use can release PFAS into the environment (Carlson & Tupper, 2020). Once PFAS has entered the environment, it can continue cycling with the water cycle, exposing a variety of terrestrial and aquatic biota, including sensitive species (Conard et al., 2022), and bioaccumulating into apex predators such as the orca whale (Joyce Dinglasan-Panlilio et al., 2014; Kwiatkowski et al., 2020; Lee et al., 2023)

Due to the need for newer technology in wastewater treatment plants, PFAS from waxes that enter wastewater are not always effectively removed, leading to PFAS detection in wastewater effluent (Lenka et al., 2021). PFAS from treatment plants are not limited to water contamination. Airborne PFAS have been detected as emissions from wastewater aeration tanks (Hamid & Li, 2016).

Restriction would reduce a significant source or use

Waxes and polishes are a significant source and use of PFAS. They contribute to concentrations of PFAS in our homes, bodies, and environment. People and wildlife can be exposed to PFAS from waxes and polishes during manufacturing, application, over time as the product wears off, and disposal. Sensitive populations such as children and some workers can have higher exposure to PFAS from waxes and polishes. The intersection of occupation and race demonstrates the importance of disproportionate exposures in this product category. When used in outdoor products, such as cars and skis, PFAS from waxes can be released directly into the environment as they wear off. Disposal of partially used waxes can release PFAS into the environment as well.

Once introduced into the environment, PFAS are persistent. Reducing sources or uses of persistent chemicals is important for protecting people and the environment, particularly sensitive species and populations. Wax-based products (e.g., ski wax, floor wax, and automotive wax) are a significant source and use of PFAS. A restriction would reduce a significant source and use of PFAS. However, because the statutory requirements for a restriction have not been met, we are currently proposing a reporting requirement. This will give us information needed for a possible future restriction once safer alternatives have been found to be feasible and available.

Chapter 5: Hard Surface Sealants

Priority product scope

Hard surface sealants are used to seal hard, porous surfaces such as stone, unglazed tile, concrete, and wood. They are designed to protect a variety of surfaces from liquids and soil. They can be used for interior and exterior applications.

Function of the priority chemical in the priority product

PFAS function as water and soil repellants. They are added to sealant formulations to increase the water and oil repellency of the sealant.

Safer, feasible, and available alternatives

We did not evaluate alternatives to PFAS in hard surface sealants at this time.

Reducing PFAS exposure

Hard surface sealants are a significant source and use of PFAS

The CAP estimates the volume of PFAS used in sealants and discusses human and environmental exposure pathways. Based on the products included in the sources and uses appendix of the CAP, we revised this category to focus on hard surface sealants. The information included in the CAP aligns with the criteria for identifying consumer products that are significant sources or uses of PFAS listed in RCW 70A.350.030.[17] In determining whether a restriction would reduce a significant source or use of PFAS, we summarized relevant information from the CAP to address the estimated volume of PFAS in the product and the potential for exposure to sensitive populations and species. Information describing the estimated volume in Washington and presence of PFAS in the environment can be found in the CAP. Appendix C of this report contains existing regulations from other states or nations.

In the CAP, we summarized available information on PFAS in sealants. We reported concentrations found in two studies that combined PFAS from total treated floor waxes as well as hard surface sealants in the home. These concentrations are 2,430 ug/kg of perfluoroalkyl carboxylic acid (Guo et al., 2009) and 423,000 ug/kg of fluorotelomer alcohol or fluorotelomer sulfonate (Liu et al., 2015).

Hard surface sealants can be used on stone, tile, grout, concrete, wood, and asphalt. People can be exposed to PFAS during the manufacture, use, and disposal of hard surface sealants. Workers from certain occupational groups that apply hard surface sealants can have higher exposure to PFAS. As sealants degrade over time, the surface starts to chip. Chipped surfaces release PFAS into dust, which can be inhaled by children and adults. Young children are also at risk of ingesting PFAS from house dust because they commonly explore their environment with

[17] app.leg.wa.gov/RCW/default.aspx?cite=70A.350.030

their hands and are more likely to be exploring on the floor (DeLuca et al., 2022; Trudel et al., 2008). Sealants used on food contact surfaces, such as countertops, can contaminate food.

PFAS from hard surface sealants can enter the environment through several routes, adding to the ubiquitous nature of PFAS in Washington's environment (Ecology, 2022b). Factory discharge from industries manufacturing hard surface sealants can get into the groundwater and surface water, as well as emit PFAS into air. Factory emissions contaminated with PFAS can be taken up by long-range atmospheric transport, exposing non-local habitats (Faust, 2023). This is supported by PFAS detection in remote areas (Faust, 2023; Kurwadkar et al., 2022). Sealants used outdoors can degrade over time and release PFAS into the environment. As hard surface sealants are often applied using a spray, PFAS-contaminated particles can easily spread around the application area, contaminate soil, and spread through the air using long-range atmospheric transport. Landfills can leach PFAS from discarded sealant products into the soil and groundwater. Research has estimated that approximately 600kg/year of PFAS leaches from landfills in the United States (Lang et al., 2017).

Once PFAS have entered the environment, they can spread into the water table, travel further into the soil, and expose terrestrial and aquatic biota. As many PFAS are capable of bioaccumulation, this can lead to high concentrations in predators like orca whales (Joyce Dinglasan-Panlilio et al., 2014; Kwiatkowski et al., 2020; Lee et al., 2023). PFAS bioaccumulation can also lead to maternal offloading to offspring (Conard et al., 2022), which is of particular concern for sensitive species.

PFAS as a class contain chemicals that do not readily degrade or transform into nondegradable, stable PFAS products (Kwiatkowski et al., 2020). Therefore, PFAS that enter the environment are persistent in the environment and will have an increasing presence in the environment until PFAS development is fully stopped. Even then, cleanup of existing PFAS is needed to fully remove it from contaminated areas.

Restriction would reduce a significant source or use

Hard surface sealants are a significant source and use of PFAS. Sensitive populations, such as children and workers, can be exposed to PFAS from sealants. PFAS can be released into the environment during the manufacturing, use, and disposal of sealants. Once in the environment, sensitive species can be exposed to PFAS and bioaccumulation can occur.

Once introduced into the environment, PFAS are persistent. Reducing sources or uses of persistent chemicals is important for protecting people and the environment, particularly sensitive species and populations. Hard surface sealants are a significant source and use of PFAS. Therefore, a restriction on PFAS in hard surface sealants would reduce a significant source or use. However, we are currently proposing a reporting requirement that will give us more information and help us prioritize products for further evaluation. We might assess whether safer alternatives are feasible and available in the future.

Chapter 6: Cookware (Food Contact Materials)

Chapter overview

PFAS are used as a nonstick coating in cookware. People can be exposed to PFAS during the manufacture, use, and disposal of cookware with PFAS. Workers, like cooks, in certain occupations can have higher exposure from inhaling PFAS released during cookware use. People who eat food prepared using nonstick cookware can be exposed to PFAS. PFAS from cookware can be released into the environment and expose sensitive species. A restriction on PFAS in cookware would reduce a significant source and use of PFAS.

To restrict PFAS in cookware, we need to identify safer alternatives. We did not evaluate safer alternatives to PFAS in cookware in this cycle of Safer Products for Washington. We might evaluate safer alternatives to PFAS in cookware and kitchen supplies in the future. This chapter describes how a restriction on PFAS in cookware could reduce a significant source and use of PFAS exposure to people and the environment.

Priority product scope

Cookware includes durable houseware items that are used in homes and restaurants to prepare, dispense, or store food, foodstuffs, or beverages. Examples include frying pans, cooking pots, rice cookers, waffle makers, griddles, bakeware, reusable baking liners, and cooking utensils.

Function of the priority chemical in the priority product

PFAS are used in food contact materials as a nonstick coating in cookware. They can also be used as nonstick baking mats.

Safer, feasible, and available alternatives

We did not evaluate alternatives to PFAS in cookware at this time.

Reducing PFAS exposure

Cookware is a significant source and use of PFAS

In the CAP, we summarized available information on PFAS in cookware. This information can be found in the sources and uses appendix. PFAS are used widely in cookware. The CAP reported PFAS concentrations in nonstick cookware to average 1,234.74 ug/kg perfluoroalkyl carboxylic acid, and 10.55 ug/kg fluorotelomer alcohol and fluorotelomer sulfonate (Herzke et al., 2012).

People can be exposed to PFAS from cookware during manufacturing, use, and disposal. Sensitive populations, such as workers, can be exposed during cookware manufacturing, particularly from inhaling PFAS dust and emissions. Cooks using nonstick cookware to prepare food can inhale PFAS as cookware heats. Prior research has shown that certain PFAS are expelled from some nonstick cookware when the cookware is heated (Sajid & Ilyas, 2017;

Sinclair et al., 2007). This expelled PFAS can be inhaled, leading to potentially higher exposure for people in cooking-based occupations. People eating food prepared using nonstick cookware can also be exposed to PFAS. Sensitive populations, such as children and the elderly, can be exposed to PFAS from food prepared in cafeterias and nursing homes due to the migratory ability of some PFAS into food when heated (Lerch et al., 2022; Ramírez Carnero et al., 2021). PFAS can migrate from cookware, like nonstick pans, cooking utensils, and dishes, into food. This migration typically happens after heat exposure, which can occur when heating up food (Ramírez Carnero et al., 2021). Even heat-stable PFAS can chip off and be introduced into cooking food or liquids. Chipped off surfaces can eventually turn into dust, which can be inhaled and ingested.

People using nonstick cookware at home can be exposed to PFAS if anyone is cooking with PFAS-containing cookware or if they ingest food from PFAS-containing cookware. PFAS dust from chipped cookware can be inhaled and or taken up by children exploring the environment with their hands and ingested.

Disposal of old cookware can release PFAS into landfills, which can leach into soil and groundwater systems. Analysis of landfills in the United States shows approximately 600kg/year of PFAS in landfill leachate (Lang et al., 2017). Factories that manufacture PFAS-containing cookware also create PFAS-contaminated discharge that goes directly into the sewage system. These factories can also release PFAS-contaminated emissions that spread throughout the environment. Factory emissions contaminated with PFAS can be taken up by long-range atmospheric transport, exposing non-local habitats (Faust, 2023). This is supported by PFAS detection in remote areas (Faust, 2023; Kurwadkar et al., 2022). Washing older cookware that might have chipping surfaces can lead to PFAS contamination directly into the water. PFAS has been found in wastewater treatment plant effluent because treatment plants are unable to remove all of the PFAS (Lenka et al., 2021).

PFAS contamination from wastewater treatment plants is not limited to water contamination. Airborne PFAS has been detected as emissions from wastewater aeration tanks (Hamid & Li, 2016). Once PFAS has entered the environment through these sources, it can leach into the soil, spread throughout ground and surface water, and expose aquatic and terrestrial biota, including sensitive species. Bioaccumulative properties of some PFAS also allow for maternal offloading to offspring (Conard et al., 2022) or bioaccumulation within apex predators like orca whales (Joyce Dinglasan-Panlilio et al., 2014; Kwiatkowski et al., 2020; Lee et al., 2023).

Restriction would reduce a significant source or use

Cookware is a significant source and use of PFAS. People, including sensitive populations, can be exposed to PFAS during the manufacturing, use, and disposal of PFAS-containing cookware. Exposure to PFAS from using nonstick cookware can occur from PFAS movement into food from the product and emissions released after heating cookware. PFAS can be released into the environment when cookware is washed, manufactured, and discarded. Sensitive species are also exposed to bioaccumulative PFAS in the environment, which can negatively affect offspring and predators.

Once introduced into the environment, PFAS are persistent. Reducing sources or uses of persistence chemicals is important for protecting people and the environment, particularly sensitive species and populations. Cookware is a significant source and use of PFAS. Therefore, a restriction on PFAS in cookware would reduce a significant source or use. However, we are currently proposing a reporting requirement, which will give us information needed for a restriction in the future, once alternatives have been found.

Chapter 7: Market Analysis

Chapter overview

We conducted a market analysis on the priority products identified within this report. Particular focus was placed on the product categories for which there will be proposed restrictions on intentionally added PFAS – apparel and cleaning products. Dun & Bradstreet economic data was used to look at the sales volume of companies that manufacture these products and ultimately estimate the size of the industry. Using third-party lists and certifications, we found that PFAS-free alternatives for both apparel and cleaning products are prevalent in the market. While there is insufficient data to determine the market share of specific products, many apparel brands and retailers have transitioned away from PFAS or have committed to a timeline for doing so.

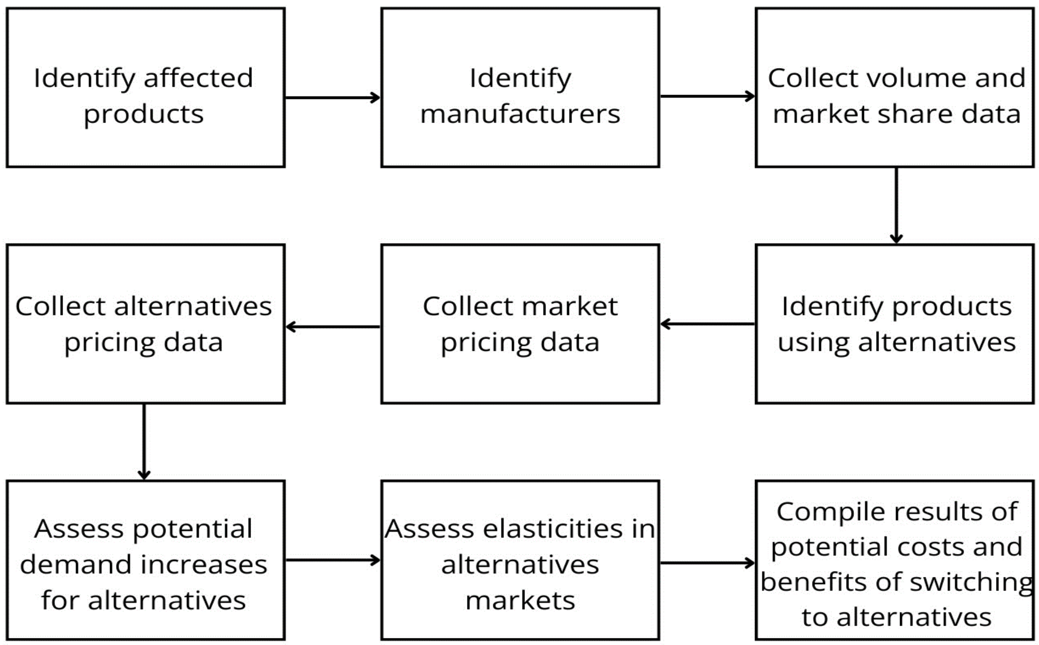
Data concerning the costs of manufacturing the priority products is limited due to the proprietary nature of the various production processes. As a result, we used publicly available data from online retailers to estimate the price differences between products that contain PFAS and PFAS-free products. The expected response of consumer demand to PFAS restrictions is approximated using existing literature. This literature includes published estimates of consumer responses to eco-labeling and estimates of demand response to price changes.

Market analysis

Figure 3 outlines the market analysis process. We applied this process, using available data, to the PFAS-containing priority products listed in the [2021 PFAS Chemical Action Plan (CAP)](apps.ecology.wa.gov/publications/SummaryPages/2104048.html).[18]

[18] apps.ecology.wa.gov/publications/SummaryPages/2104048.html

Figure 1. Market analysis outline.



The market analysis process outlined in Figure 3 includes the following steps:

1. Identify affected products.
2. Identify manufacturers.
3. Collect volume and market share data.
4. Identify products using alternatives.
5. Collect market pricing data.
6. Collect alternatives pricing data.
7. Assess potential demand increases for alternatives.
8. Assess elasticities in alternatives markets.
9. Compile results of potential costs and benefits of switching to alternatives.

Priority products

The full list of priority products includes:

- Apparel and gear
- Firefighting PPE
- Cleaning products
- Automotive washes
- Automotive waxes

- Floor waxes
- Ski waxes

We identified the Washington businesses involved in manufacturing any of the priority products and estimated the sales revenue for all industries manufacturing the priority products. However, in many of the subsequent sections, we prioritized the product categories for which restrictions have been proposed. Should these recommendations be adopted, phasing out PFAS from the production process would require a larger effort than efforts to comply with a reporting requirement. These product categories include cleaning products, automotive washes, and many apparel products. Reporting requirements were proposed for the remaining priority products.

Identify manufacturers

We identified the industries likely to manufacture and produce the priority products listed in this report. This was done by searching the North American Industry Classification System (NAICS) list on the United States Census Bureau's website and identifying the codes most closely associated with the products we had listed. To ensure that we are only calculating how a regulation can be applied one time, we determined that using the manufacturing industries (versus wholesale or retail) would provide the most comprehensive count of businesses. The following industries, with associated NAICS codes, are likely to contain businesses that would be impacted.[19]

Table 8. Likely affected industries.

NAICS Code	Description	Product Category
313310	Textile and fabric finishing mills	Firefighting PPE
315250	Cut and sew apparel manufacturing (except contractors)	Apparel and gear
315990	Apparel accessories and other apparel manufacturing	Apparel and gear
325510	Paint and coating manufacturing	Hard surface sealants
325611	Soap and other detergent manufacturing	Cleaning products
325612	Polish and other sanitation good manufacturing	Cleaning products

[19] NAICS definitions and industry hierarchies are discussed at census.gov/naics/?58967?yearbck= 2022.

NAICS Code	Description	Product Category
332215	Metal kitchen cookware, utensil, cutlery, and flatware manufacturing	Cookware
339113	Surgical appliance and supplies manufacturing	Firefighting PPE
339920	Sporting and athletic goods manufacturing	Ski waxes

Collect volume and market share data

We used the NAICS codes above to identify manufacturers that would potentially be affected by reporting requirements or restrictions. We looked at the U.S. sales volumes for these manufacturers. The Dun & Bradstreet Market Insight database[20] provided global data on businesses and their high-level characteristics but did not include data specific to Washington product sales or detailed product breakdowns. As a result of these data limitations, we made the following assumptions to scale business counts and sales data to Washington.

- We downloaded information for the global businesses under each identified NAICS code, including their location and sales volume, from the Dun & Bradstreet database.
- We filtered for businesses with a low financial stress marketing score, indicating their low likelihood of business failure.
- To avoid counting businesses that operate under the appropriate NAICS code but do not manufacture priority products, we created a ratio within each NAICS code to estimate the percentage of priority product businesses per 6-digit NAICS code. For example, "firefighting suits and accessories manufacturing" and "suits, firefighting, manufacturing" are two entries under the "surgical appliance and supplies manufacturing" NAICS code that would apply to firefighting personal protective equipment. The ratio was calculated to be two applicable product industries divided by 84 total entries under the NAICS code for that priority product category.
- This ratio was multiplied by the number of global businesses within the NAICS code to estimate the high number of businesses that might be in a target industry.
- The businesses that are listed as being physically located in Washington were multiplied by the NAICS industry ratio to determine the low estimate of businesses in the target

[20] Dun & Bradstreet, July 2023. Market Insight database

industries. We assumed businesses that manufactured in Washington were likely to sell products in Washington.

- The total U.S. sales volume of businesses under each industry was added and then multiplied by the NAICS industry ratio to determine the estimated U.S. market size for the target industry. To find the estimated Washington market size of the target industries, the U.S. market size was then multiplied by the Washington percent of the U.S. gross domestic product (GDP).

Low and high assumptions helped us develop value ranges, which allowed us to capture likely variability of businesses selling the identified priority products in Washington. Additional sources of uncertainty include:

- Data gaps within Dun & Bradstreet, from businesses that might not have been included in the database.
- Businesses being identifiable by only one NAICS code.
- The number of businesses that might sell products in Washington but do not have a low financial stress marketing score.
- The sales volume of businesses selling products that are not a target of the analysis.

Table 9. Number of impacted businesses and sales volume of each priority product in Washington.

Product Categories	Low Number of Businesses	High Number of Businesses	Estimated Washington Market Size
Firefighting PPE	1	63	$8.0 million
Apparel and gear	7	395	$140.4 million
Cleaning products	6	201	$250.7 million
Automotive waxes and washes	1	48	$12.5 million
Floor waxes and polishes	1	48	$12.5 million
Hard surface sealants	3	90	$3.7 million
Ski waxes	2	75	$77.3 million
Cookware	1	48	$2.0 million

Products using alternatives

Apparel and gear

Several sources have generated lists of companies that claim their products do not contain intentionally added PFAS or perfluorinated chemicals. These sources include the Environmental Working Group (EWG), Green Science Policy (GSP), and the National Resource Defense Council (NRDC). The lists lack some of the monitoring associated with more formal certifications, such as the EPA's Safer Choice program, which we discuss in the following section.

The Environmental Working Group list is current as of December 2021 and claims to have "independently reviewed company product claims and public statements regarding PFAS,"[21] though their list does not explicitly define the eligibility criteria for which chemicals are considered PFAS. The product list includes food processing, carpet manufacturers, durable water repellent, rain gear and apparel, bakeware and cookware, dental floss, and cosmetic products.

[21] Products without intentionally added PFAS or PFCs | Environmental Working Group (ewg.org). Accessed September 29, 2023.

Green Science Policy lists products that meet their eligibility criteria for PFAS-free products,[22] including outdoor gear (raingear and others), apparel, shoes, nonstick cookware, durable water repellent, sealers, and fire extinguishers and suppressants. Any company is eligible to be included in this list, if they make a public statement that their products are PFAS free. Their statement must be supported by documentation on a company website or other source. Using the term “PFC-Free” alone does not meet the eligibility requirements set by Green Science Policy. However, Green Science Policy notes that it does not validate any PFAS-free statements and provides this list based on information from a variety of other sources.

The Natural Resource Defense Council[23] employed surveys to access the PFAS-related policies and commitments of 30 top U.S.-based apparel brands and retailers, including companies in the footwear, indoor apparel, and outdoor apparel sectors. They graded the apparel brands and retailers based on:

- Their PFAS phaseout timelines.
- The company’s policies for covering a wide range of products.
- Information available to the public regarding the company’s PFAS commitments.
- Their PFAS labeling and testing protocols.

In cases where companies maintained restricted substances lists, they evaluated whether these lists excluded some PFAS chemicals.

Using the three sources mentioned above, in Table 10 we compiled the apparel and gear manufacturers and retailers listed as producing or selling PFAS-free products. While not incorporated into the table, the Environmental Working Group list also includes PFAS-free durable water repellents that can be used as alternatives to PFAS-containing durable water repellants when treating fabric for water resistance.

Table 10. PFAS-free apparel and gear manufacturers and retailers.

Description	Company Name	Sources	Products (if not all)
Apparel retailer	H&M	GSP	NA
Indoor apparel	Benetton	GSP	NA
Indoor apparel	Esprit	GSP	NA
Indoor apparel	Helmut Lang	GSP	NA

[22] pfascentral.org/perch/resources/products/pfas-free-products-list-eligibility-one-pager.pdf. Accessed September 29, 2023.
[23] nrdc.org/resources/going-out-fashion-us-apparel-manufacturers-must-eliminate-pfas-from-their-supply-chains. Natural Resource Defense Council (2022). Going Out of Fashion: U.S. Apparel Manufacturers Must Eliminate PFAS “Forever Chemicals” From Their Supply Chains (PDF).

Description	Company Name	Sources	Products (if not all)
Indoor apparel	J Brand	GSP	NA
Indoor apparel	Levi Strauss & Co.	GSP, NRDC	NA
Indoor apparel	Nine Alarm	GSP	NA
Indoor apparel	prAna	GSP	Select products
Indoor apparel	Ralph Lauren	NRDC	NA
Indoor apparel	Theory	GSP	NA
Indoor apparel	UNIQLO	GSP	NA
Indoor apparel	Victoria's Secret	NRDC	NA
Indoor apparel	Zara	GSP	NA
Outdoor apparel and gear	Black Diamond	GSP	GTT durable water repellant products
Outdoor apparel and gear	Burberry	GSP	NA
Outdoor apparel and gear	deuter	EWG, GSP	NA
Outdoor apparel and gear	Didriksons	GSP	NA
Outdoor apparel and gear	ELVINE	EWG	NA
Outdoor apparel and gear	Endura	EWG, GSP	NA
Outdoor apparel and gear	Hawk Tools	GSP	NA
Outdoor apparel and gear	Houdini	EWG, GSP	NA
Outdoor apparel and gear	Jack Wolfskin	EWG, GSP	NA
Outdoor apparel and gear	Mammut	GSP	Select products
Outdoor apparel and gear	Marmot	EWG, GSP	EVODry rainwear
Outdoor apparel and gear	Nau	EWG, GSP	PFC-Free durable water repellant collection

Description	Company Name	Sources	Products (if not all)
Outdoor apparel and gear	On	GSP	Select products
Outdoor apparel and gear	Ornot	GSP	Select products
Outdoor apparel and gear	ORTOVOX	GSP	Select products
Outdoor apparel and gear	Páramo	EWG, GSP	NA
Outdoor apparel and gear	Royal Robbins	EWG	NA
Outdoor apparel and gear	Stierna Equestrian Sportswear	EWG	NA
Outdoor apparel and gear	TheTentLab	EWG	NA
Outdoor apparel and gear	VAUDE	EWG, GSP	NA
Shoes	Allbirds	GSP	Mizzles products
Shoes	Deckers Brands	NRDC	NA
Shoes	Icebug	GSP	Select products
Shoes	KEEN	GSP, NRDC	NA

In addition to the companies that have eliminated PFAS from their products or from select product lines, the survey also summarized commitments among apparel manufacturers and retailers to transitioning toward being PFAS-free in the future. Where applicable, these commitments and target dates are summarized in Table 11.

Table 11. Commitments to PFAS removal in apparel based on NRDC survey.

Description	Company Name	Commitment
Apparel retailer	Costco	Encourages removal from supply chain
Apparel retailer	Target	Removal from owned brands by 2025
Indoor apparel	Abercrombie & Fitch	Total removal by 2025
Indoor apparel	American Eagle Outfitters	Total removal by 2024

Description	Company Name	Commitment
Indoor apparel	Gap Inc.	Total removal by 2023
Indoor apparel	PVH Corp.	Partial removal by 2020, complete removal by 2024
Outdoor apparel and gear	Columbia Sportswear	Company-wide phase-out of some PFAS chemicals
Outdoor apparel and gear	L.L.Bean	Total removal by 2026
Outdoor apparel and gear	Patagonia	Total removal by 2024
Outdoor apparel and gear	REI	Total removal by 2026
Outdoor apparel and gear	VF Corporation	Total removal by 2025
Shoes	New Balance	Eliminated all PFAS other than PTFE
Shoes	Nike	Eliminated most PFAS from most items

Among the 30 companies represented in the survey, we were able to find sales data in Dun & Bradstreet for 26 of them, including eight indoor apparel brands, five outdoor apparel and gear brands, seven apparel retailers, and six shoe brands. Phase out of PFAS was greatest among indoor apparel brands, with 48 percent of the market (weighted by sales volume) reporting that they had removed all PFAS. An additional 35 percent reported that they had plans to remove all PFAS in the future.

While only five percent of the shoe market has already removed PFAS, an additional 75 percent of the market has partially removed PFAS, meaning they have removed certain types of PFAS or removed PFAS from certain products. None of the outdoor apparel brands or apparel retailers have already removed PFAS from their products, though some have engaged in partial removal. We report the full results in Table 12.

Table 12. Percentage of U.S. market share (by company type) in the NRDC survey that has committed to some level of PFAS removal.

Industry Categories	Already Removed	Timeline for Future Removal	Partial Removal	Any PFAS commitment
Indoor apparel	48	35	0	83
Outdoor apparel and gear	0	7	26	32
Apparel retailer	0	0	33	33
Shoes	5	0	75	80

Unlike indoor apparel brands, which can simply exclude PFAS in many cases without compromising an essential function, outdoor apparel and gear brands often produce heavy-weather gear where PFAS is beneficial for waterproofing.

Some outdoor apparel brands that have partially removed PFAS have done so based on developing PFAS-free alternatives to use within their own production processes. That technology would not necessarily be available to other manufacturers. Helly Hansen produces a PFAS-free line using a technology called LIFA INFINITY PRO™.[24] The North Face uses their own trademarked PFAS-free solution, a nanofiber called FUTURELIGHT™.[25] Patagonia developed a series of PFAS-free durable water repellants for use in their products.[26] While these companies have PFAS-free products, they are still using PFAS in some products.

Many apparel manufacturers have a production process that relies on textile manufacturers providing intermediate products. The process would require these textile suppliers to develop PFAS-free alternatives. As of October 2023, we are aware of two severe-weather textile suppliers who have announced the full or partial removal of PFAS from their fabrics. Polartec®, a textile brand acquired by Milliken in 2019, announced the complete removal of PFAS from their durable water repellant treatments as of July 2021.[27] This includes fleece and waterproof fabrics. W.L. Gore & Associates, the manufacturer of GORE-TEX® and supplier of waterproof textiles, has developed a PFAS-free membrane option, though there is still PFAS in the durable water repellant treatment.[28] If the market for PFAS-free intermediate products like this were to mature, it would provide outdoor apparel manufacturers with a greater opportunity to purchase, rather than develop their own, PFAS-free waterproof fabric.

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[24] hellyhansen.com/lifa-infinity-pro/

[25] thenorthface.com/en-ca/about-us/technology-innovation/technology/futurelight. Accessed September 28, 2023.

[26] patagonia.com/stories/say-goodbye-to-forever-chemicals/story-133800.html. Accessed September 28, 2023.

[27] polartec.com/news/polartec-announces-full-use-of-non-pfas-dwr-treatments. Accessed October 19, 2023.

[28] toxicfreefuture.org/press-room/gore-tex-manufacturer-announces-availability-of-new-pfas-free-membrane-but-still-uses-forever-chemicals-to-make-its-outdoor-apparel-and-gear/. Accessed September 28, 2023.

Cleaning products

The EPA administers a voluntary certification program called "Safer Choice,"[29] which covers a variety of cleaning products, such as all-purpose cleaners, car cleaners, hand soaps, laundry products, and pet care, among others. Certification requires a disclosure of all chemical ingredients that is reviewed against the EPA Safer Choice standards. As of March 2022, any product that is certified under the Safer Choice program must not contain any intentionally added PFAS.[30]

As of September 25, 2023, the program lists 2,162 certified products, including 338 all-purpose cleaners, 131 dish soaps, 159 carpet cleaners or spot removers, 146 glass cleaners, and 16 car cleaning products. (For more information, see the full list of Safer Choice products.)[31]

One market report published in 2021 estimated that "environmentally friendly" cleaning products comprised 43 percent of the global market as of 2016. This is expected to increase to 53 percent by 2026, though the criteria for what constitutes "environmentally friendly" was not explicit in the analysis.[32] While there is currently no data concerning the proportion of the market that Safer Choice certified products represent, major brands such as Clorox®, ECOS, Seventh Generation, and Amazon brand have cleaning products that are Safer Choice certified.

We do not have access to direct data about the market for non-PFAS surfactants and other chemical substitutes that are used by manufacturers of PFAS-free cleaning products. However, published market research reports for two such ingredients, bio-acetic acid[33] and sodium lauryl sulfate,[34] indicate that the markets are highly competitive and decentralized. This means that chemical suppliers would likely be able to meet increasing demand for such chemicals among manufacturers of PFAS-free cleaning supplies.

Market pricing

The production process and associated costs for PFAS-free products are proprietary, and there is little publicly available data on the relative cost of manufacturing PFAS-free alternatives. We rely on public price information collected from online retailers to estimate prices for products and PFAS-free alternatives to existing products.

Apparel and gear

To gather information on apparel and gear, we used price data listed on the Recreational Equipment Inc. (REI) online store. REI has committed to phasing out the use of PFAS over the next several years, but apparel and gear containing PFAS are still available for sale in their online store as of September 22, 2023. We recognize that REI online retail is a small segment of

[29] www.epa.gov/saferchoice
[30] epa.gov/newsreleases/epa-continues-take-actions-address-pfas-commerce
[31] epa.gov/saferchoice/products
[32] smithers.com/resources/2021/feb/sustainable-cleaning-market-surge-110-billion. Accessed September 29, 2023.
[33] grandviewresearch.com/industry-analysis/bio-acetic-acid-market-report. Accessed September 29, 2023.
[34] mordorintelligence.com/industry-reports/sodium-lauryl-sulfate-market. Accessed September 29, 2023.

the apparel market However, there is little centralized data that clearly delineates between market alternatives with and without PFAS. We assume that the relative price differences with respect to PFAS-free alternatives in the wider apparel market is similar to what we observe in the REI online store.

Within the REI online store, we researched prices for products that are listed as bluesign® certified and compared them to non-certified products. bluesign is a third-party certification company that verifies commitments to certain environmental standards, including restrictions on the use of certain chemicals.[35] As of October 2023, not all PFAS chemicals are currently restricted. This makes it possible for some bluesign-approved products, on the REI online store and elsewhere, to contain some PFAS chemicals.[36] In general, third-party environmental certification standards are beginning to include PFAS among their lists of restricted substances, and bluesign expects that all approved fabrics will be PFAS-free by July 2024.[37] We assume a completely PFAS-free alternative would be priced similarly to a bluesign-certified product because:

- On the REI online store, most of the bluesign-certified products are marketed as PFAS-free.
- There are few widely used alternatives to bluesign certification to denote apparel produced without particular chemicals. It is the only certification we found that is actively used in marketing apparel.
- Among outerwear brands that have developed proprietary PFAS-free technology, a small-sample comparison between PFAS-free and PFAS-containing products suggests a price premium for PFAS-free products that is similar to the price premium we find for bluesign certified products.

For simplicity, we refer to bluesign-approved products as PFAS-free in the remainder of the section, even though it might not be a wholly accurate description of the listed product.

We gathered price data on all REI online store products listed under the categories “Shorts,” “Casual Pants,” “Active Shirts” (e.g., running or workout shirts), and “Rain Jackets.” We report the average price difference between items with and without PFAS, and the price differences after adjusting for product characteristics and whether the item was REI brand. We list the results in Table 13, Table 14, Table 15, and Table 16, respectively.

[35] bluesign.com
[36] toxicfreefuture.org/blog/buyer-beware-rei-uses-certifications-that-allow-toxic-forever-chemicals
[37] bluesign.com/en/future-of-pfas. Accessed October 19, 2023.

Table 13. Prices (in U.S. Dollars) in REI online retail store among shorts.

Data Measures	Non PFAS-free	PFAS-free	PFAS-free premium	PFAS-free premium (adjusted)
Mean	$49.44	$55.78	12.8%	14.2%
Num. products	367	91	NA	NA

The PFAS-free premium is in terms of percent change compared to non-PFAS-free products. The adjusted premium adjusts expected prices based on product characteristics.

Table 14. Prices (in U.S. Dollars) in REI online retail store among casual pants.

Data Measures	Non PFAS-free	PFAS-free	PFAS-free premium	PFAS-free premium (adjusted)
Mean	$84.68	$72.81	−14.0%	−6.0%
Num. products	170	16	NA	NA

The PFAS-free premium is in terms of percent change compared to non-PFAS-free products. The adjusted premium adjusts expected prices based on product characteristics.

Table 15. Prices (in U.S. Dollars) in REI online retail store among active shirts.

Data Measures	Non PFAS-free	PFAS-free	PFAS-free premium	PFAS-free premium (adjusted)
Mean	$56.92	$52.20	−9.0%	−2.2%
Num. products	363	98	NA	NA

The PFAS-free premium is in terms of percent change compared to non-PFAS-free products. The adjusted premium adjusts expected prices based on product characteristics.

Table 16. Prices (in U.S. Dollars) in REI online retail store among rain jackets.

Data Measures	Non PFAS-free	PFAS-free	PFAS-free premium	PFAS-free premium (adjusted)
Mean	$196.64	$246.66	25.4%	49.9%
Num. products	116	44	NA	NA

The PFAS-free premium is in terms of percent change compared to non-PFAS-free products. The adjusted premium adjusts expected prices based on product characteristics.

In general, the price differences for PFAS-free alternatives were small for most products, and some PFAS-free products even sold at a relative discount. This could be due to limitations in the data. With a small sample, it is difficult to distinguish between brands or styles that might be less desirable or more desirable for consumers and command a higher price despite containing PFAS. However, the price differences could also represent differences in production costs for PFAS-free products.

Excluding intentionally added PFAS from the production process for clothing that does not require water or oil repellency can result in lower costs for manufacturers. A statement from KEEN Footwear said that their first step in removing PFAS from their products was to simply remove it from any products that did not require waterproofing.[38] Removing PFAS can also result in changes to the product that alter consumer demand, which is discussed in the following section.

PFAS-free rain jackets were the one product category with a clear price premium for PFAS-free alternatives. Among apparel brands that produce both PFAS-free and non-PFAS-free alternatives, we also see a price increase for PFAS-free alternatives to heavy-weather outdoor jackets. For example, as of September 2023 the PFAS-free rain jackets using LIFA INFINITY PRO™ produced by Helly Hansen are priced 13 to 85 percent higher than other similar Helly Hansen jackets on the company website.

Cleaning products

To gather price information on cleaning products, we used price data listed on Target.com as well as other company websites. While the Target website represents a small proportion of the overall retail market for cleaning products, it is a convenient way to compare multiple products and provides a similar product selection to what many consumers would face regardless of the retailer. For the purposes of this analysis, we assume the price differences between cleaning products that contain and do not contain PFAS is similar to what we observe in the Target online store.

We accessed Target.com on October 3, 2023, and filtered for the product categories below, sorted by "best seller."

- Liquid laundry detergents
- All-purpose liquid cleaners
- Liquid carpet cleaners

We recorded the price and product details for the 25 best-selling products in each of the three product categories. We compared these products to the list of Safer Choice certified products

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[38] keenfootwear.com/blogs/keen-blog/pfas-free-getting-forever-chemicals-out-of-footwear. Accessed September 29. 2023.

to identify which of the products were Safer Choice certified and therefore free of intentionally added PFAS. For the rest of the chapter, we assume products that are not Safer Choice certified are not PFAS-free. For simplicity, we refer to Safer Choice certified cleaning products as PFAS-free and all others as non-PFAS-free for the rest of the chapter, except where denoted.

Among the top 25 best-selling liquid laundry detergents, we found six were PFAS-free. The average price for a PFAS-free detergent was $4.90 for 32 ounces, while the average price for all other products was $3.61 for 32 ounces. This is a price premium of 36 percent for the PFAS-free alternative. However, Tide®, which had three PFAS-free products and four other products in this data, did not list their PFAS-free products for a higher price than their other products. The apparent premium for PFAS-free products might be due to more expensive brands being more likely to manufacture PFAS-free alternatives.

Among the top 25 best-selling all-purpose liquid cleaners, none of the products were PFAS free. Instead, we compared the price for PFAS-free alternatives in several alternative ways. First, we expanded the list until we found a PFAS-free cleaner. This PFAS-free cleaner costs $4.99 for a 26-ounce bottle, compared to an average price of $4.53 for 26 ounces among all other items. This is a premium of 10 percent for the PFAS-free alternative.

We also identified PFAS-free alternatives produced by Clorox®, which was the brand in the Target.com data that produced PFAS-free alternatives to products that appeared in our original data. We found the PFAS-free version of the Clorox multi-surface cleaner was listed for $5.00 for a 32-ounce bottle, compared to $4.00 for a similar non-certified product. This is a premium of 25 percent for the PFAS-free alternative.

Finally, we relaxed the definition of PFAS-free to include products that were listed as "plant-based" in the Target.com data, particularly Mrs. Meyer's and Method brands. According to the Environmental Working Group, neither of these brands contains PFAS among their known ingredients, despite not bring Safer Choice certified. The average price for plant-based all-purpose cleaners was $9.08 for a 32-ounce bottle, compared to $4.13 for a 32-ounce bottle of non-plant-based cleaners. This is an implied 120 percent premium for the plant-based cleaners.

There are only 24 liquid carpet cleaners listed at the Target.com online store. Twelve items were PFAS-free and 12 were not. The average price for a PFAS-free product was $11.20 for a 32-ounce bottle, compared to $13.60 for a 32-ounce bottle among other products. This accounts for a discount of 18 percent for the PFAS-free alternatives.

Market elasticities

Price elasticities measure the responsiveness of demand and supply in a market to changes in market prices. Excluding PFAS from the production process for a larger segment of the market might cause a shift in production costs, causing a change in the final market price for the product as it becomes more or less expensive to produce. A change in the price consumers face changes the quantity that consumers are willing to purchase. Likewise, as discussed in the previous chapter, consumers might be willing to pay more for PFAS-free alternatives, which would shift the market demand and cause a change in market price that producers could respond to by changing how much they supply to the market.

The price elasticity of demand and supply represents the percentage change in quantity demanded or supplied, respectively, in the market relative to the percentage change in price. If a price increase of ten percent results in a five percent reduction in demand by consumers, this implies a price elasticity of demand of −0.5. With a few notable exceptions, the elasticity of demand is negative, implying that consumers prefer to consume less of a good if the price of that good increases. Conversely, elasticity of supply is usually positive. Producers are incentivized to increase the quantity of a good if the price increases.

The most recent demand elasticity estimate for apparel in the U.S. is −0.48,[39] suggesting consumers would decrease the quantity of apparel purchased by 4.8 percent in response to a ten percent increase in price. However, other studies have estimated a greater consumer response of −0.74 for women's apparel and −0.80 for men's apparel in the U.S.,[40] −0.87 for apparel in North America as a whole,[41] and −0.78 for apparel in Norway.[42] The elasticity demand for shoes, specifically, is estimated at −0.39.[43]

The elasticity of demand for cleaning products has not been the focus of any studies that we are aware of. The closest analogy in the existing literature is estimates of demand elasticities among U.S. consumers for staple commodities. A 2017 estimate of demand elasticities for common food items suggests a range of values between −1.1 for pasta and −2.2 for yogurt and milk.[44] In general, commodities have a greater elasticity of demand than many other market sectors because there are many potential substitutes, so a price increase in one good causes many consumers to reduce consumption by substituting another good in its place. Like food staples, cleaning products have many substitutes, including homemade alternatives from common household chemicals,[45] which would suggest a greater magnitude elasticity of demand.

There are no existing estimates of the supply elasticity for either apparel or cleaning products that we are aware of. The inputs for both industries are readily available, making it more likely

[39] Lee, Juyong and Elena E. Karpova. 2011. The US and Japanese apparel demand conditions: implications for industry competitiveness. *Journal of Fashion Marketing and Management,* 15(1) (2011): 76-90.
[40] Kim, K. (2003). US aggregate demand for clothing and shoes: effects of non-durable expenditures, price, and demographic changes. *International Journal of Consumer Studies*, 27(2), 111-125.
[41] Martinez, L. A. (2012). The country-specific nature of apparel elasticities and impacts of the multi-fibre arrangement. Macalester College.
[42] Kim, H. Y., Molina, J. A., & Wong, K. G. (2022). Durable Goods and Consumer Behavior with Liquidity Constraints: Evidence from Norway. Boston College.
[43] Kim, K. (2003). US aggregate demand for clothing and shoes: effects of non-durable expenditures, price, and demographic changes. *International Journal of Consumer Studies*, 27(2), 111-125.
[44] Perrone, H. (2017). Demand for nondurable goods: a shortcut to estimating long-run price elasticities. *The RAND Journal of Economics*, 48(3), 856-873.
[45] toxicfreefuture.org/healthy-choices/household-cleaners-that-work-without-toxic-chemicals. Accessed Oct 3, 2023.

that production can respond quickly to price changes. In the existing literature on supply elasticities, the closest analog to apparel and cleaning products might be industrial sectors. One study estimated an elasticity of supply of machinery at five.[46] A 1995 study estimated the elasticity of supply of polymers and resins to be 1.49.[47] An analysis of the textile and apparel trade in North American Free Trade Agreement set supply elasticities equal to two and five,[48] though these were parameters the authors chose for their analysis rather than estimates. In the absence of other information, a supply elasticity in this range appears reasonable, but a lot of uncertainty as to the true value currently exists.

Demand for alternatives

Change in consumer demand for PFAS-free alternative products requires that (1) consumers are knowledgeable about the risks posed by PFAS exposure and have some preferences for avoiding those, and/or (2) there is some observable quality difference between products made with PFAS and PFAS-free products.

Consumer surveys suggest that if consumers are given knowledge about PFAS risks, the demand for PFAS-free versions of products can increase. A survey of Swedish citizens asked respondents how likely they would be to buy a pair of PFAS-free children's overalls if other qualities such as stain-resistance and water-repellence stayed the same. Surveyors reported that the median respondent was willing to pay 50 percent more for the PFAS-free alternative.[49] However, this was a survey-based study, where consumers did not actually purchase the product. Moreover, information about the risks of PFAS was supplied to survey respondents as part of the survey, making the issue a more salient part of the purchase decision. This suggests the willingness to pay 50 percent more is the high estimate of the likely market response.

There is one other study of PFAS in apparel that has been registered though not yet completed.[50] There are no other published studies that measure consumer demand for PFAS-free alternatives. We were not able to find any studies that estimated demand for PFAS-free cleaning products.

Similar to the demand for PFAS-free apparel or cleaning products, the demand for organic food could partially stem from a desire to protect the purchaser from toxic chemicals, such as non-organic pesticides. A review of studies that estimated consumer willingness to pay for organically labeled food found that the average estimate was about 30 percent. This indicates

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[46] federalreserve.gov/econres/feds/estimating-machinery-supply-elasticities-using-output-price-booms.htm. Edgerton, J. (2010). Estimating machinery supply elasticities using output price booms.

[47] Pechan, E. H. (1995). Economic Impact Analysis for the Polymers and Resins Group. NESHAP Revised Draft Report. EH Pechan & Associates, Inc.

[48] Bannister, G., & Low, P. (1992). Textiles and Apparel in NAFTA. *World Bank PRE Working Paper,* (994).

[49] Holmquist, H., Jagers, S. C., Matti, S., Svanström, M., & Peters, G. M. (2018). How information about hazardous fluorinated substances increases willingness-to-pay for alternative outdoor garments: A Swedish survey experiment. *Journal of cleaner production*, *202*, 130-138.

[50] doi.org/10.17605/OSF.IO/3KH2G

that the average consumer would be indifferent to purchasing a non-organic food item or an organic food item of the same type that cost 30 percent more.[51]

It is unclear to what extent consumers are broadly knowledgeable about the inclusion of PFAS in products or able to identify PFAS-free alternatives. Unlike organic labeling, which consumers see frequently and might be more generally understood, PFAS-free labeling is less straightforward in the market. While there are some certifications that are used to denote PFAS-free, labeling is less prominent in non-food sectors like apparel. The profusion of labels can be confusing for consumers, and labeling might not convey the information the consumer thinks it does. One study found that PFAS is common in apparel, even when some sort of green labeling is present.[52] Without consumer awareness of PFAS and ability to identify PFAS-free alternatives, there cannot be significant consumer demand for PFAS-free alternatives. We do not know how much consumers would demand these alternatives if they were fully informed about PFAS.

Products without PFAS might lack qualities that consumers prefer, which could decrease demand. Statements from manufacturers have suggested that PFAS-free clothes, especially heavy-weather gear, might not have the same water- and oil-proof benefits as clothing that contains PFAS. Some of these manufacturer statements have suggested that PFAS-free clothes might be more stiff and less comfortable, thereby reducing consumer demand. PFAS is used less extensively to treat indoor apparel for stain- and wrinkle-resistance, and these attributes are often advertised for apparel that contains PFAS. However, a study of PFAS-treated upholstery fabrics suggests treating fabrics with PFAS might not appreciably reduce staining.[53] In that case, the removal of PFAS from the production process might have no impact on consumer demand.

Potential costs, limitations, and opportunities of restrictions

Producer costs

Based on observed market prices for goods, we present scenarios that model the supply costs associated with the production of PFAS-free alternatives, with the following assumptions:

- Constant price elasticity of demand equal to −0.8 for apparel and −1.5 for cleaning products.

[51] Aschemann-Witzel, J., & Zielke, S. (2017). Can't buy me green? A review of consumer perceptions of and behavior toward the price of organic food. *Journal of Consumer Affairs*, *51*(1), 211-251.
[52] Rodgers, K. M., Swartz, C. H., Occhialini, J., Bassignani, P., McCurdy, M., & Schaider, L. A. (2022). How well do product labels indicate the presence of PFAS in consumer items used by children and adolescents? *Environmental Science & Technology*, 56(10), 6294-6304.
[53] LaPier J, Blum A, Brown BR, et al. Evaluating the Performance of Per- and Polyfluoroalkyl Substance Finishes on Upholstery Fabrics. *AATCC Journal of Research*. 2023;10(4):205-213.

- Constant price elasticity of supply of between one (low estimate) and five (high estimate) for both apparel and cleaning products.
- Demand response of −20 percent (low estimate) and +20 percent (high estimate) for both apparel and cleaning products.
- Price premiums for PFAS-free options of 50 percent (wet-weather apparel) and five percent (other apparel and cleaning products).

To calculate the change in cost associated with PFAS-free products given the assumed parameters, we define constant elasticity supply and demand curves.

$$P_s = S \times Q^{\frac{1}{e_s}}; \; P_d = D \times Q^{\frac{1}{e_d}}$$

The subscript 's' denotes supply and 'd' denotes demand. On the left-hand side of each equation, price (P) is set equal to some constant (S and D, respectively), multiplied by quantity (Q) to the power of the inverse elasticity of supply and demand (e), respectively. This is a convenient and frequently used functional form as it allows elasticity to remain constant for all pairs of quantity and price. Equilibrium price and quantity can be found by finding the point where quantity supplied equals quantity demanded, with the associated equilibrium price.

$$P^* = \left(\frac{D^{e_d}}{S^{e_s}}\right)^{\frac{1}{e_d - e_s}}$$

We assume that demand responses shift the parameter D, and changes to the supply costs shift the parameter S. D and S are not identified here, but we can calculate how relative changes to equilibrium price and the demand curve reflects implicit changes to the supply curve by recognizing that any change in the supply and demand curve can be put in terms of the current equilibrium price. For some shift in demand where the value of D is multiplied by 'a', and some shift in supply where the value of S is multiplied by 'b', there is some new price P**.

$$P^{**} = P^* \times \left(\frac{a^{e_d}}{b^{e_s}}\right)^{\frac{1}{e_d - e_s}}$$

We allow the parameter D to shift down by 20 percent or up by 20 percent, corresponding to a value of 'a' of 0.8 and 1.2, respectively, to represent changes in consumer demand for PFAS-free alternatives. Based on our observed prices, we assume the equilibrium price (P**) for PFAS-free indoor apparel and cleaning products is 1.05 times the P*, shifting the price positively by five percent for PFAS-free alternatives. For waterproof apparel, P** is 1.5 times the P*, representing a 50 percent increase in price for PFAS-free alternatives in the waterproof apparel market. Given these parameter values, the equation above can be rearranged to find 'b' which represents the shift in the supply curve and reflects the change in cost associated with PFAS-free manufacturing.

The estimated change in the marginal costs for producers (given our assumed parameters) associated with manufacturing PFAS-free cleaning products, indoor apparel, and waterproof apparel are shown in Table 17, Table 18, and Table 19, respectively. The relative prices faced by consumers would not be impacted by this change in production costs, which we assumed would remain at the level we observed in our price data. It is also an estimate of the current costs, which might be reduced in the future.

Table 17. Estimated producer cost increase associated with PFAS-free cleaning products.

Demand	Low Supply Elasticity	High Supply Elasticity
Low	57.88%	13.93%
High	−14.06%	0.01%

Table 18. Estimated producer cost increase associated with PFAS-free indoor apparel.

Demand	Low Supply Elasticity	High Supply Elasticity
Low	30.52%	9.67%
High	−5.64%	2.78%

Table 19.Estimated producer cost increase associated with PFAS-free waterproof apparel.

Demand	Low Supply Elasticity	High Supply Elasticity
Low	148.02%	65.87%
High	79.32%	55.45%

Market research has suggested that PFAS-free cleaning products will continue to increase their market share, and there are public statements by apparel manufacturers recognizing that the industry must invest in PFAS-free alternatives. These investments would be expected to lower costs of PFAS-free production over time.

Limitations

Our analysis is necessarily limited due to lack of data about the production process, which would be proprietary for the producers involved in the affected markets. Further, there is no reliable information about the proportion of the market that PFAS-free alternatives represent, so we cannot fully parameterize the market supply and demand. We can infer market penetration of PFAS-free alternatives based on the proportion of products in the data that we have gathered that are PFAS-free, but that does not necessarily reflect the market share of those products.

The market level data that was used is not granular enough to precisely identify the number of manufacturers and market share of producers in Washington that would potentially be affected by PFAS restrictions. To estimate the size of this group, we made assumptions about the portion of priority products within NAICS industry codes and the accuracy of businesses being labeled with the applicable NAICS codes that we were analyzing.

On the demand side, there is not yet clear information about how much consumers would be willing to pay for PFAS-free alternatives. While we can make an analogy to demand for organically labeled food, PFAS-free options are comparatively poorly labeled, and it is not clear how much consumer awareness there is of PFAS.

Opportunities

As a consequence of poor PFAS information and low consumer awareness, a potential benefit associated with restricting the use of PFAS is that many consumers might have been willing to pay substantially more to avoid PFAS if they were fully knowledgeable about the risks associated with PFAS exposure and if PFAS were properly labeled on consumer products. Regulations that restrict PFAS could be beneficial for consumers in a way that is not yet reflected by the market. Restricting PFAS in certain consumer products would be expected to produce direct benefits, including improved health outcomes by reducing pathways for PFAS exposure. Estimating these benefits is complex and is beyond the scope of this market analysis. This estimation could be considered as part of the benefit cost analysis that would be conducted during the rulemaking process.

Another potential opportunity associated with PFAS restriction is that it can trigger innovation that ultimately reduces production costs.[54] There is already a recognition that PFAS-free alternatives will represent a greater share of the apparel and cleaning products markets in the future. The expected demand for PFAS-free alternatives increases as governments restrict the use of PFAS in products.

California[55] and New York[56] have passed bills restricting PFAS in apparel beginning in 2025, and California is set to restrict PFAS in cleaning products beginning in 2026.[57] Restrictions like those recommended here and those passed in other states change the expected market demand for products with and without added PFAS, thereby incentivizing research into alternative products and the adoption of existing alternatives. Despite our current estimates of higher costs associated with producing PFAS-free alternatives, environmental regulation can reduce those costs over time as businesses innovate. These innovations can spread through a market as new

[54] Porter, M. (1991), America's Green Strategy, *Scientific American,* 264(4), 168.
[55] Assembly Bill No. 1817. leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=202120220AB1817
[56] Senate Bill S6291A has been passed by not yet signed into law as of 2023 Oct 4. nysenate.gov/legislation/bills/2021/S6291
[57] Assembly Bill No. 727. leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=202320240AB727

production technologies become adopted. As the cost of producing PFAS-free alternatives is reduced, they could become a larger part of the market even outside of areas where the use of PFAS is restricted.

Appendix A. Acronyms

Table 20. Acronyms with definitions.

Acronym	Definition
ADA	Americans with Disabilities Act
BM	Benchmark
CAP	Chemical Action Plan
CAS	Chemical Abstracts Service
Ecology	Washington State Department of Ecology
EPA	Environmental Protection Agency
EWG	Environmental Working Group
GDP	Gross domestic product
Health	Washington State Department of Health
IC2	Interstate Chemicals Clearinghouse Guide
kg	Kilogram
NAICS	North American Industry Classification System
PFAS	Per- and polyfluoroalkyl substances
PFCs	Perfluorinated chemicals
PPE	Personal protective equipment
ppm	Parts per million
RCW	Revised Code of Washington
ug/kg	Micrograms per kilogram
WAC	Washington Administrative Code

Appendix B. References

Overview

The following citation list was developed to meet the requirements outlined in RCW 70A.350.050[58] and RCW 34.05.272.[59] It identifies the peer-reviewed science, studies, reports, and other sources of information used to support our identification of priority consumer products. The following are the types of sources used to support this report:

1. Peer review is overseen by an independent third party.
2. Review is by staff internal to Ecology.
3. Review by persons that are external to and selected by Ecology.
4. Documented open public review process that is not limited to invited organizations or individuals.
5. Federal and state statutes.
6. Court and hearings board decisions.
7. Federal and state administrative rules and regulations.
8. Policy and regulatory documents adopted by local governments.
9. Data from primary research, monitoring activities, or other sources, but that has not been incorporated as part of documents reviewed under other processes.
10. Records of best professional judgment of Ecology employees or other individuals.
11. Sources of information that do not fit into one of the other categories listed.

Citation list

Table 21. References found in this report, categorized by source type.

Citation	Category
1908 Brands Inc. (2019). *Product Name: Boulder Clean Granite + Stainless Steel Cleaner (Lavender Fields, Lavender Vanilla, and Clear)*. https://bclean.com/product/granite-stainless-cleaner/	**11**
ASTDR, & CDC. (2022). *Per- and Polyfluoroalkyl Substances (PFAS) and Your Health*. https://www.atsdr.cdc.gov/pfas/resources/index.html	**11**

[58] app.leg.wa.gov/RCW/default.aspx?cite=70A.350.050
[59] app.leg.wa.gov/RCW/default.aspx?cite=34.05.272

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BLS. (2022). *Labor Force Statistics from the Current Population Survey*. https://www.bls.gov/cps/cpsaat11.htm	**11**
Blueland. (2020). Product Name: Toilet Bowl Cleaner Tablets. In *2020*. https://www.epa.gov/saferchoice/products#search=a04t0000009vCuGAAU	**11**
BonaKemi USA Inc. (2021). *Product Name: Bona Multi-Surface Floor Cleaner, Dog Formulation*. https://www.bona.com/en-us/products/homeowners/cleaners/pet-multi-surface-dog-32oz/	**11**
Borg, D., & Ivarsson, J. (2017). *Analysis of PFASs and TOF in products*. https://doi.org/10.6027/TN2017-543	**1**
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Cousins, I. T., Johansson, J. H., Salter, M. E., Sha, B., & Scheringer, M. (2022). Outside the Safe Operating Space of a New Planetary Boundary for Per- and Polyfluoroalkyl Substances (PFAS). *Environmental Science & Technology*, *56*(16), 11172–11179. https://doi.org/10.1021/acs.est.2c02765	**1**

Citation	Category
Cui, D., Li, X., & Quinete, N. (2020). Occurrence, fate, sources and toxicity of PFAS: What we know so far in Florida and major gaps. *TrAC Trends in Analytical Chemistry*, *130*, 115976. https://doi.org/10.1016/j.trac.2020.115976	**1**
de la Torre, A., Navarro, I., Sanz, P., & Mártinez, M. de los Á. (2019). Occurrence and human exposure assessment of perfluorinated substances in house dust from three European countries. *Science of The Total Environment*, *685*, 308–314. https://doi.org/10.1016/j.scitotenv.2019.05.463	**1**
DeLuca, N. M., Minucci, J. M., Mullikin, A., Slover, R., & Cohen Hubal, E. A. (2022). Human exposure pathways to poly- and perfluoroalkyl substances (PFAS) from indoor media: A systematic review. *Environment International*, *162*, 107149. https://doi.org/10.1016/j.envint.2022.107149	**1**
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Guo, Z., Liu, X., Krebs, K., & Roache, N. (2009). *Perfluorocarboxylic Acid Content in 116 Articles of Commerce*. U.S. Environmental Protection Agency, Washington, DC, EPA/600/R-09/033	**4**
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Appendix C. Existing Laws, Regulations, and Restrictions

Table 22 and Table 23, respectively, describe existing regulations and voluntary actions to reduce PFAS in relevant consumer products. There are many regulations on PFAS, we focus here on those most relevant to the product categories under consideration for this cycle of Safer Products for Washington. We reviewed actions from other nations, as well as actions at the U.S. federal and state levels. We supplemented the information with voluntary actions taken by retailers. The existing regulations and voluntary efforts listed below could provide insight during potential rulemaking.

The references below from states fall within citation category 5 and from private entities fall within category 11. The citation categories are described in Appendix B.

Table 22. Existing and proposed regulations for PFAS in consumer products.

Entity	Year	Regulation or policy	Requirements and standards
California	2022	CA HSC Sec 108970[60]	Bans the manufacture, distribution, sale, and offer for sale of any new, not previously used, textile articles that contain regulated PFAS. Regulated PFAS includes intentionally added PFAS (effective 2023), 100 ppm PFAS (effective 2025), or 50 ppm PFAS (effective 2027).
California	2022	CA HSC §109010 - 109014[61]	Manufacturer must label cookware sold in CA that contains one or more intentionally added chemicals present in the designated list of chemicals published on DTSC's website (includes PFAS). Effective January 1, 2024.
Colorado	2022	C.R.S. 25-15-604[62]	Label cookware that contains intentionally added PFAS. Effective January 1, 2024.

[60] leginfo.legislature.ca.gov/faces/codes_displayText.xhtml?lawCode=HSC&division=104.&title=&part=3.&chapter=13.5.&article=

[61] leginfo.legislature.ca.gov/faces/codes_displayText.xhtml?lawCode=HSC&division=104.&title=&part=3.&chapter=15.&article=2.

[62] advance.lexis.com/api/document/collection/statutes-legislation/id/6603-CRR3-GXF6-83XN-00008-00?cite=C.R.S.%2025-15-604&context=1000516

Entity	Year	Regulation or policy	Requirements and standards
Illinois	2023	SB0088 (proposed)[63]	Bans the sale, offer for sale, and distribution for sale or use of apparel containing intentionally added PFAS. Effective January 1, 2025. Requires manufacturers to label cookware containing intentionally added PFAS. Effective January 1, 2025.
Indiana	2023	IC 36-8-27[64]	Requires Indiana fire departments to only purchase firefighter gear that is labeled indicating whether the firefighter gear contains PFAS. Effective July 1, 2024.
Maine	2023	L.D. 258[65]	Provides one-time funding to replace firefighting gear that is known to have PFAS.
Maine	2021	MRS Title 38 Chapter 16 Section 1614[66]	Manufacturers must report any product that contains intentionally added PFAS. Effective January 1, 2023. Bans the sale, offer for sale, and distribution of any products containing intentionally added PFAS. Effective January 1, 2030.
Maryland	2022	MD Code § 6-1603[67]	Requires notification for firefighter turnout gear that contains PFAS.

[63] ilga.gov/legislation/fulltext.asp?DocName=&SessionId=112&GA=103&DocTypeId=SB&DocNum=88&GAID=17&LegID=143372&SpecSess=&Session=
[64] iga.in.gov/laws/2023/ic/titles/36#36-8-27-1
[65] mainelegislature.org/legis/bills/getPDF.asp?paper=HP0163&item=14&snum=131
[66] legislature.maine.gov/statutes/38/title38sec1614.html
[67] mgaleg.maryland.gov/mgawebsite/laws/StatuteText?article=gen&section=6-1603&enactments=False&archived=False

Entity	Year	Regulation or policy	Requirements and standards
Massachusetts	2024	H.2317 (proposed)[68]	Would establish a "PFAS Research and Development Public Safety Fund" for the purpose of supporting the development, testing, and purchasing of a PFAS-free firefighter PPE.
Massachusetts	2023	S1556H.2339 (proposed)[69]	Requires notification for firefighter turnout gear that contains PFAS. Proposed effective January 1, 2025. Bans the manufacture, sale, offer for sale, and distribution of firefighting PPE containing intentionally added PFAS. Proposed effective January 1, 2027.
Minnesota	2023	Minn Stat 116.943 (2023)[70]	Bans the manufacture, sale, offer for sale, and distribution of specified products (cleaning products, cookware, ski wax) containing intentionally added PFAS. Effective January 1, 2025. Bans the manufacture, sale, offer for sale, and distribution of any product containing intentionally added PFAS. Effective January 1, 2032.

[68] malegislature.gov/Bills/193/H2317
[69] malegislature.gov/Bills/193/H2339
[70] revisor.mn.gov/statutes/cite/116.943

Entity	Year	Regulation or policy	Requirements and standards
New York	2023	Chapter 43-B § 37-0121[71]	Bans the sale and offer for sale of any new apparel (not previously used) containing intentionally added PFAS. Effective January 1, 2025. Bans the sale and offer for sale of any outdoor apparel for severe wet conditions (not previously used) containing intentionally added PFAS or PFAS above levels that the department will establish, irrespective of whether intentionally added or not. Effective January 1, 2028. Bans the sale and offer for sale of any apparel (not previously used) containing PFAS (irrespective of whether intentionally added or not) at or above levels that the department will establish. Effective January 1, 2027.
North Carolina	2023	HB 660 (proposed)[72]	Bans the manufacture of PFAS for use within the state or for export from the state. Proposed effective 30 days after adoption. Bans the use of PFAS for the production of any product for use within the state or for export from the state. Proposed effective 30 days after adoption. Bans the process and distribution in commerce any PFAS or any product containing PFAS. Proposed effective 30 days after adoption.

[71] nysenate.gov/legislation/laws/ENV/37-0121
[72] webservices.ncleg.gov/ViewBillDocument/2023/3939/0/DRH40355-CCa-7

Entity	Year	Regulation or policy	Requirements and standards
Vermont	2023	H152 (proposed)[73]	Bans the manufacture, sale, offer for sale, distribution for sale, and distribution for use of cookware containing intentionally added PFAS beginning January 1, 2024. Bans the manufacture, sale, offer for sale, distribution for sale, and distribution for use of any product containing intentionally added PFAS beginning July 1, 2030.
Vermont	2023	S25 (proposed)[74]	Bans the manufacture, sale, offer for sale, distribution for sale, and distribution for use of a textile or textile article (not used) containing intentionally added PFAS beginning January 1, 2025.
Vermont	2021	Title 18 Chapter 33C[75]	Bans the manufacture, sale, offer for sale, distribution for sale, and distribution for use of ski wax or related tuning products containing intentionally added PFAS. Effective July 1, 2023.
Vermont	2021	Title 18 Chapter 33[76]	Requires manufacturers to notify the purchaser if firefighting PPE contains PFAS.

[73] legislature.vermont.gov/Documents/2024/Docs/BILLS/H-0152/H-0152%20As%20Introduced.pdf
[74] legislature.vermont.gov/Documents/2024/Docs/BILLS/S-0025/S-0025%20As%20passed%20by%20the%20Senate%20Official.pdf
[75] legislature.vermont.gov/statutes/fullchapter/18/033C
[76] legislature.vermont.gov/statutes/fullchapter/18/033

Entity	Year	Regulation or policy	Requirements and standards
Sweden	2018	KIFS 2017:7 (in Swedish)[77] Explanation document (in English)[78]	Must report PFAS that are deliberately added to chemical products to the Swedish Chemicals Agency's Products Register. This requirement applies to those who manufacture or import notifiable products, irrespective of the percentage of the substance in that product. Examples of products include textiles and leather, firefighting foam, and household goods.
U.S.	2023	40 CFR part 705[79]	Persons who manufactured for commercial purposes PFAS at any period from January 1, 2011, through the end of 2023 must report by May 8, 2025. Effective October 28, 2023.
U.S.	2023	H.R. 5260 (proposed)[80]	Prohibit the U.S. Department of Defense from the procurement and purchase of any "covered item" containing one of the listed PFAS. Covered items include nonstick cookware or food service ware; furniture or floor waxes; cleaning products; and shoes and clothing for which treatment with PFAS was not necessary for an essential function.

Table 23. Voluntary actions for PFAS in consumer products.

Entity	Year	Regulation or policy	Requirements and standards
3M	2022	3M[81]	Work to discontinue use of PFAS across 3Ms product portfolio by the end of 2025. Exit all PFAS manufacturing by the end of 2025.

[77] kemi.se/download/18.f1b904217860f8d6f02669/1702997709162/KIFS-2017-7-konsoliderad.pdf
[78] kemi.se/en/products-register/products-obliged-to-be-reported
[79] epa.gov/system/files/documents/2023-09/prepublicationcopy_7902-02_fr-doc_aa_esignatureverified_2023-09-28.pdf
[80] congress.gov/bill/118th-congress/house-bill/5260/text?s=1&r=1&q=%7B%22search%22%3A%22PFAS+Free+Military+Purchasing+Act%22%7D
[81] news.3m.com/2022-12-20-3M-to-Exit-PFAS-Manufacturing-by-the-End-of-2025

Entity	Year	Regulation or policy	Requirements and standards
Dick's Sporting Goods	2023	Dick's Sporting Goods[82]	Dick's Sporting Goods restricted PFAS from their products.
IKEA	2016	IKEA[83]	Restricted the use of PFAS in textile materials.
Jack Wolfskin	2019	Jack Wolfskin[84]	Makes PFC-free clothing, footwear, and equipment. All their clothing items, packs, and bags are completely 100% PFC-free since 2019.
KEEN	2018	KEEN[85]	Eliminated PFAS from their entire product line and ban all PFAS chemical compounds from their entire supply chain. Keen also maintains a restricted substances policy.
Office Depot	2021	Office Depot[86]	Restricted PFAS in disposable food ware, furniture, and textiles.
Patagonia	2023	Patagonia[87]	By fall 2023, about 96% of Patagonia's weather and waterproof garments that include DWR membranes and finishes will be made without PFCs and PFAS. All DWR finishes, except those for waders, will be PFAS-free. Effective 2024.
REI	2023	REI[88]	Ban PFAS in all textile products and cookware from its suppliers. Effective 2024.
Salomon	2020	Salomon[89]	Salomon's entire collection of shoes for running and hiking (2020-2021 footwear range) are PFC- or PFC EC-free. Salomon's bag collection (2021 spring/summer) are PFC- or PFC EC-free. Salomon expects to have apparel and winter sports PFC- or PFC EC-free in 2023.

[82] s27.q4cdn.com/812551136/files/doc_downloads/csr/Restricted-Substances-List-(RSL)-April-2022.pdf
[83] ikea.com/us/en/files/pdf/2a/0f/2a0f5e67/ikea_restricted_substance_list.pdf
[84] jack-wolfskin.com/information-pfc/
[85] keenfootwear.com/blogs/keen-blog/outdoor-footwear-pfas-challenge
[86] media.officedepot.com/image/upload/v1612302301/content/od/pdf/BRSL_List_2021.pdf
[87] patagonia.com/stories/say-goodbye-to-forever-chemicals/story-133800.html
[88] rei.com/assets/stewardship/sustainability/rei-product-impact-standards/live.pdf
[89] salomon.com/en-us/blog/pfc-ec-free-footwear

Entity	Year	Regulation or policy	Requirements and standards
Staples	2019	Staples[90]	Restricted intentionally added PFAS in disposable food ware, furniture, and textiles.
Target	2021	Target[91]	Seeks to remove intentionally added PFAS from owned brand products including textiles, formulated, cosmetics, beauty, and cookware by 2025.

[90] media.staples.com/pdf/Staples_Priority_Chemicals_of_Concern_List.pdf
[91] corporate.target.com/sustainability-governance/responsible-resource-use/chemicals

Appendix D. Exemptions

Under the Safer Products for Washington program, Ecology will not identify the items below as priority consumer products.

- Plastic shipping pallets manufactured prior to 2012.
- Food or beverages.
- Tobacco products.
- Drug or biological products regulated by the United States food and drug administration.
- Finished products certified or regulated by the federal aviation administration or the department of defense, or both, when used in a manner that was certified or regulated by such agencies, including parts, materials, and processes when used to manufacture or maintain such regulated or certified finished products.
- Motorized vehicles, including on and off-highway vehicles, such as all-terrain vehicles, motorcycles, side-by-side vehicles, farm equipment, and personal assistive mobility devices.
- Chemical products used to produce an agricultural commodity, as defined in the Revised Code of Washington (RCW) 17.21.020.[92]

Ecology might identify the packaging of products listed above as priority consumer products. For an electronic product identified by Ecology as a priority consumer product under this section, the department might not make a regulatory determination under RCW 70A.350.040[93] to restrict or require the disclosure of a priority chemical in an inaccessible electronic component of the electronic product.

[92] app.leg.wa.gov/RCW/default.aspx?cite=17.21.020

[93] app.leg.wa.gov/RCW/default.aspx?cite=70A.350.040