



Canada's PFAS Problem

Barriers and Opportunities for Action

February 2024



environmental
defence

TABLE OF CONTENTS

1.	What are PFAS?	p. 3
2.	The PFAS a Problem	p. 4
3.	PFAS in Products	p. 5
4.	PFAS in our Bodies and Associated Health Harms	p. 7
5.	We Are All Affected by PFAS, but We Are Not All Affected Equally	p. 8
a.	Northern Indigenous Communities and Food Sovereignty	p. 8
6.	Corporate Bad Behaviour & Lack of Accountability for PFAS Contamination	p. 9
7.	PFAS Lobbyists Undermine PFAS Action in Canada	p. 10
8.	Demanding Better: Holding Companies to Account and Recognizing Industry Leaders	p. 12
a.	PFAS-free Champions in Canada	p. 12
10.	A Path Forward	p. 13





WHAT ARE PFAS?

Per- and poly-fluoroalkyl substances (PFAS), also known as “forever chemicals,” are chemicals with strong fluorine-carbon bonds (the strongest bond in organic chemistry). Because of this strong bond, once PFAS are formed they don't break down. Instead, they persist “forever” and accumulate in the environment and our bodies.

These chemicals are common in a range of materials and applications, including: waterproof textiles, grease resistant paper, lubricants, coatings on electronics, non-stick cookware, diapers and even period products. There are thousands of PFAS (estimates range from 4700 to 14,000) in over 200 applications.¹



THE PFAS PROBLEM

Forever is a long time, but the truth is that PFAS will survive for hundreds of years beyond their initial and intended uses. That should be as concerning to companies and policy makers as it is to the rest of us.

PFAS live their longest life in the environment, where we are continually re-exposed to them in water, soils, air and food. The evidence of contamination can be found all around us, including Great Lakes fish, Quebec groundwater, and wild foods that people living in the Far North depend on.

For example, consuming just one serving of freshwater fish—an essential food for many communities, but particularly Indigenous people²—can expose people to a high amount of PFAS, comparable to an entire month of average drinking water.³ And while there are many ways PFAS can end up in the environment and fish, microplastics (now ubiquitous in the environment) may play a role. Particularly in aquatic environments, microplastics can act like sponges, accumulating PFAS and transporting concentrated PFAS to aquatic organisms and fish.⁴

Canada's federal contaminated sites inventory lists PFAS-polluted airports and military sites—places where PFAS-laden firefighting foams are used for training, testing, or emergency response—but this is a vast undercounting of the true number of contaminated sites in the country.⁵ The US Environmental Protection Agency has compiled lists of the thousands of facilities that potentially handle PFAS based on their industrial profile, and now requires reporting for some PFAS.⁶ In Canada, potential PFAS-handling facilities are not required to report their PFAS releases to the National Pollution Release Inventory (NPRI), meaning we have little information about industrial releases. PFAS releases have gone unreported for decades in numerous sectors, including:

- ➔ Oil and gas fracking⁷
- ➔ Metal coating
- ➔ Chemical manufacturing, including fertilizers and pesticides^{8,9,10}
- ➔ Plastics and resins
- ➔ Mining and refining sites
- ➔ Waste

While firefighting foam has been singled out for regulation, it is certainly not our only problem.¹¹ We are still creating and using PFAS, and as a result, polluting our planet and ourselves. This is happening through a broad array of activities, including: fluorination processes (used in plastics manufacturing), pulp and paper manufacturing, oil and gas fracturing, biosolid spreading, firefighting foam use, and product manufacturing and use.

PFAS IN PRODUCTS

The government acknowledges in its draft “State of PFAS” report that releases are expected to occur during the manufacture, processing, use, and disposal of PFAS-containing products.¹² These PFAS-containing products are ubiquitous in our daily life and include electronics (wires, coatings), textiles, rubber, coated silicone, stickers, moulded plastics, personal care products and more.¹³

From creation and processing, through manufacturing to disposal, a PFAS-containing product can contaminate groundwater, soil, and household dust. When these products enter the recycling stream, they can go on to contaminate products made from recycled materials. Our previous research reports and educational materials have highlighted the problem with PFAS in products and food contact materials, as well as the health and environmental consequences.¹⁴

In Canada, product importers and retailers are not required to disclose PFAS content to regulators or consumers. As a result, there is very little information on the volumes and types of these substances entering the country, our homes and our bodies.



A comprehensive list of potential PFAS sources in Canada is not known, but these are a few of the known sources:

- ➔ **Textiles:** PFAS coatings are used to make fabrics water repellent, stain-resistant, and oil- and sweat-repellent, but their effectiveness is questionable and these coatings rub off.¹⁵
- ➔ **Plastics:** Plastic packaging is “fluorinated” to prevent products from damaging their containers, and moulded plastics will have PFAS residues from the lubricant sprays applied to the moulds.
- ➔ **Paper:** Food contact paper products such as takeout containers and microwave popcorn bags can be intentionally coated in PFAS to be grease-repellant,¹⁶ and PFAS can also be embedded in paper products such as toilet paper due to its chemical pulping process.¹⁷
- ➔ **Fertilizers and biosolids:** Sludge from wastewater, paper mills and food byproducts are sent to farms, contaminating soils with PFAS,¹⁸ and destroying farmer livelihoods.
- ➔ **Menstrual products and diapers:** The liners and absorbent filling in disposable diapers, menstrual pads,¹⁹ and tampons²⁰ expose people who menstruate, babies, young children, and people with incontinence to PFAS.
- ➔ **Cookware and food contact materials:** Non-stick cookware coatings, such as Teflon, are well-known sources of exposure to PFAS. But single-use paper and plastic items with PFAS coatings, along with fluorinated plastic food packaging, are also an exposure source.
- ➔ **Cosmetics:** From waterproof mascara to long-lasting foundation, we have been applying PFAS-laden products to our skin, inhaling it in powders, and washing it into our drinking water sources for decades.²¹
- ➔ **Artificial turf:** In addition to the highly toxic old tires used as the base for artificial turf, researchers have found PFAS in the blades, backing and filling of these turf products.²²
- ➔ **Paints, coatings and varnishes:** These products use PFAS for its durability, water and oil resistance properties.²³

Recognizing the pervasive presence of PFAS in such a range of products and uses, governments must work quickly to impose comprehensive restrictions on these “forever chemicals”. Otherwise, we will see increasing levels of PFAS contaminating our environment and bodies.

PFAS IN OUR BODIES AND ASSOCIATED HEALTH HARMS

We ingest PFAS through drinking water and food, absorb it through products that come into contact with our skin,²⁴ and inhale it through household dust.²⁵ These exposures are of particular concern for infants and small children whose sensitive respiratory systems and tendency to put everything in their mouths put them at higher risk.

Although the federal government recently established a drinking water guideline of 30 nanograms per litre for PFAS in municipal water systems,²⁶ there is little that a municipality can do on its own to address this contamination or the increasing sources of PFAS that are contributing to the contamination issue in the first place. The vast majority of drinking water and wastewater treatment facilities are not equipped to remove PFAS from water before it reaches our homes, schools, and other facilities, or when releasing the water back into the environment.

Food contact materials are also of particular concern. Fluorinated substances can leach out of plastic packaging and contaminate the food.

PFAS have been linked to a range of adverse health outcomes, including: asthma, low/high infant birth weight, early menopause, immune suppression, thyroid disease, cancers (including testicular and kidney), high cholesterol, prediabetes and fatty liver.

Once in our bodies, PFAS mimic fatty acids (an essential nutrient), and are stored in our liver. PFAS have been linked to a range of adverse health outcomes,²⁷ including: asthma, low/high infant birth weight, early menopause, immune suppression, thyroid disease,²⁸ cancers (including testicular and kidney), high cholesterol, prediabetes and fatty liver.²⁹

In acknowledgement of the health risks posed by PFAS exposures, the US National Academies of Sciences, Engineering, and Medicine have issued guidance for screening individuals with suspected elevated PFAS exposure. This includes assessing for ulcerative colitis, and breast, kidney, and testicular cancer; testing their PFAS blood levels and thyroid function; monitoring blood pressure; and assessing for pregnancy-induced hypertension.³⁰

The Nordic Council of Ministers estimates the cost of human health harms resulting from PFAS exposure in Canada at upwards of \$9 billion annually.³¹

WE ARE ALL AFFECTED BY PFAS, BUT WE ARE NOT ALL AFFECTED EQUALLY

PFAS build up and persist in the environment and our bodies. 98.5 per cent of people in Canada have it in their blood.³² But while we are all impacted, we are not all impacted equally.

Exposures to environmental toxins and their effects impact some communities more than others.³³ In particular, low income and racialized people tend to experience a wider range of PFAS exposures from a variety of sources, putting them at higher risk.³⁴

What's more, PFAS-laden products inevitably make their way to landfills, incinerators, composting facilities, and hazardous waste dumps. The resulting PFAS-laden runoff and atmospheric releases from these sites disproportionately impact racialized and low-income people, because these facilities are often cited in close proximity to their communities. This is environmental racism. The harm is made worse by a lack of public information, weak enforcement of environmental laws, and limited resources for testing, including biomonitoring. Together, these factors can increase exposures for these communities.

Northern Indigenous Communities and Food Sovereignty

Long-range movement of PFAS contaminants are disproportionately impacting the health of Northern Indigenous communities.

Lucy Grey is the Public Health Inuit Research Advisor for the Nunavik Regional Board of Health and Social Services, and as an Inuk mother, she has been pushing for action on PFAS at a national and international level. "Accessing safe and uncontaminated country food is a matter of Inuit rights. Wildlife health is directly connected to Inuit health and well-being, and it is essential to preserve resources for the next generations."

Grey's research partners, Dr. Amira Aker and Dr. Melanie Lemire at the Université Laval and Centre Hospitalier Universitaire de Québec, agree that we must go further. Due to the long-range movement³⁵ of these chemicals through the ecosystem, we are seeing these substances build up in species and people at alarming levels in Northern Indigenous communities. PFAS are contaminating Arctic ice,³⁶ and marine species from plankton to seals and polar bears³⁷ at a disproportionately higher rate than other areas.



Lucy Grey

*Public Health Inuit Research Advisor for
the Nunavik Regional Board of Health
and Social Services*

CORPORATE BAD BEHAVIOUR AND LACK OF ACCOUNTABILITY FOR PFAS CONTAMINATION

The chemical industry has been aware of the toxicity of PFAS since the 1970s, but kept this information from the public for decades.³⁸ Following the regulation and phase-out of a handful of legacy PFAS chemicals, such as PFOS, thousands of replacement PFAS substances were introduced into the market with little to no regulatory or policy response. These replacement chemicals are comparable in terms of toxicity and persistence,³⁹ and also pose new challenges as some have an increased potential⁴⁰ to travel long distances in the environment and to degrade into more dangerous substances.

Chemical companies get away with introducing this multitude of PFAS “similar” because they are allowed to operate behind a wall of confidentiality and “trade secrets”. Researchers have stated that the “lack of transparency in industry-driven research on industrial chemicals has significant legal, political and public health consequences.”⁴¹ The public isn’t allowed to know what hazards lurk in our products, bodies, and ecosystems. This needs to end.

ChemSec, a European advocacy organization, found that just 12 chemical companies⁴² are responsible for the majority of the global PFAS production.⁴³ They also found that the companies’ combined \$26 billion in annual profits pales in comparison to the global societal costs of PFAS (attempted remediation, health care, etc.) of over \$23 trillion per year. ChemSec estimates that if these societal costs were included in the average market price of PFAS, the accurate price would be nearly 1000 times higher: \$27,388 per kilogram, instead of just \$28 per kilogram.

The European Union estimates that, if left unaddressed, PFAS emissions will increase 50 times, meaning there will be 4.4 million tonnes in the environment by 2050.

**The European Union estimates that by 2050, if left unaddressed,
total PFAS in the environment will increase 50 times to**

4.4 million tonnes

PFAS LOBBYISTS UNDERMINE PFAS ACTION IN CANADA



Chemical industry lobbyists have come out in record numbers to resist federal government ambition to address PFAS. Their efforts began in April 2021, when the federal government signalled its intent to examine PFAS as a class of chemicals, instead of one at a time. When the PFAS assessment was released in spring 2023, that resistance intensified. Hundreds of submissions were made in response, including comments from industry associations representing many companies across Canada.⁴⁴ Their lobbyists have been active in Ottawa to undermine and slow this overdue and necessary federal action on PFAS.⁴⁵



A similar response was mounted by the chemical industry when the EU initiated its process to restrict PFAS. Companies and industry associations made thousands of submissions attempting to delay or block government action. Lobbyists tried to argue that going PFAS-free is too difficult, or impossible. However, going PFAS-free is possible, as many companies are already transitioning away from its production and use.



The world's leading scientists on PFAS recommend a class-based approach to regulating PFAS, and other jurisdictions such as the EU have already done so. And yet, the Chemistry Industry Association of Canada states that taking a class-based approach to PFAS is somehow "a departure from Canada's reputable Chemicals Management

Plan (CMP) process and its foundational science- and risk-based approach."⁴⁶ Instead, CIAC recommends a narrow definition of PFAS.

They seem to want to return to the substance-by-substance approach that led to the current situation where a handful of PFAS were restricted only to be replaced with thousands of lookalike chemicals. Questioning the scientific basis of a program in an effort to undermine it is a common tactic used by industry⁴⁷ to preserve its ability to continue to contaminate people and the planet with toxic substances.⁴⁸

Fertilizer Canada, the industry association representing fertilizer manufacturers, defends the use of PFAS as “essential” in their production process in Canada.⁴⁹ But there are already many sources of agricultural PFAS contamination, including contaminated compost and biosolids.^{50,51} These products are spread on farmers’ fields and used in residential gardens, representing an important exposure and contamination pathway.

Fertilizer Canada attempts to undermine the validity and process of the PFAS class assessment by stating it “contains significant gaps” and that, despite the lack of hazard data on many novel PFAS, that “[i]nformation should be gathered on PFAS subgroups in order to prevent unnecessary PFAS restrictions.”⁵² This would create years of delay that would require years of data collection and research, when the existing and emerging science points to similar toxicity profiles for the entire class of chemicals.

Cosmetics manufacturers are also denying their role in PFAS exposures, while simultaneously justifying their continued use. When presented with testing results showing PFAS in cosmetic products, the president of the Cosmetics Alliance of Canada stated that the PFAS found in products were not “intentionally added” and therefore not of concern.⁵³ This, despite research suggesting possible use of fluorinated ingredients in cosmetics.⁵⁴ Additionally, he argued that the government should set a standard for PFAS that allows for this level of harmful chemicals in these products.



This is part of the industry lobbyist playbook:⁵⁵ to deny wrongdoing, delay progress, and defend its poor behaviour and damaging practices as essential to the economy and our way of life.⁵⁶ It echoes the tactics of the tobacco lobbyists, which is fitting given that the liabilities around PFAS are projected to eclipse those of Big Tobacco.⁵⁷

DEMANDING BETTER: HOLDING COMPANIES TO ACCOUNT AND RECOGNIZING INDUSTRY LEADERS

Governments such as the Netherlands are holding companies liable for the harm they have inflicted.⁵⁸ Litigation on PFAS in the US on property damage, health, false advertising and other claims of harm have reached thousands of lawsuits, including a recent decision against 3M that awarded \$10.2 billion USD to municipal drinking water systems. Canada has not begun to hold these corporations to account.

Insurance companies also recognize the risk when it comes to their own exposure to PFAS litigation, and are seeking to limit their liability to PFAS costs. PFAS clauses are now a common feature of corporate insurance policies.

As a result of these pressures on markets to transform their business practices, over 100 brands have joined the PFAS movement to commit to PFAS-free products across cookware, textiles, food contact packaging and other products contributing to PFAS exposure and contamination.⁵⁹

While this is a welcome development, we can't rely on all businesses to voluntarily eliminate PFAS from their products, and this piecemeal approach misses other significant sources of PFAS pollution. We need government action.

PFAS-free Champions in Canada

Aisle

Aisle is a Canadian reusable menstrual products company that uses PFAS-free textiles in their menstrual pads. Given the PFAS found in period products and period underwear, this company's commitment to not only formulating their products without PFAS, but also educating their supply chain on eliminating this contaminant and testing for compliance, are important for consumer health and safety and reducing gendered PFAS exposures.

FireRein

Firefighters are exposed to PFAS through firefighting foams and their personal protective equipment 'turnout gear'.⁶⁰ More firefighters are dying of exposure-related cancers than from the risks of firefighting itself; they identify that up to 80 per cent of these cancers are linked to PFAS exposure.

FireRein is a Canadian plant-based firefighting gel that was developed by firefighters seeking to address PFAS contamination resulting from more traditional firefighting foams, and to reduce their exposures at work. These firefighters have pushed to have their innovative product certified for use and become a safer substitution for municipal fire fighting units, in commercial and industrial fire safety, for wildfires and in military applications and training.



A PATH FORWARD

We need comprehensive federal action on PFAS “forever chemicals” now. There are many non-essential uses of PFAS that are being phased out and replaced with existing safer substitutions. Therefore, many of PFAS’ past uses should no longer be allowed.

Other jurisdictions are leading the way on policies regulating and prohibiting PFAS. The EU has a roadmap for phasing out all PFAS,⁶¹ and this approach is the gold standard for driving reformulation and safer substitution in products. EU nations have also started taking action to get this class of chemicals out of their paper products.⁶²

The U.S. is in the midst of implementing their 2021-2024 PFAS Strategy and has recently established a binding drinking water standard, while individual states such as California, Washington, New York, Maine and others have put forward PFAS legislation that requires reporting and product-based prohibitions.

While Canada recently recognized that PFAS are toxic,⁶³ its proposed regulatory action⁶⁴ focuses only on PFAS-laden firefighting foams, ignoring more insidious sources of PFAS lurking in everyday consumer products.⁶⁵

Consumer products are a main source of PFAS exposure for the majority of people. The federal government needs to take urgent action and tackle this issue in a more comprehensive way, as PFAS researchers have been promoting for years.⁶⁶

To help address the growing threat posed by PFAS, the Canadian government must:

- ➔ **Define Essential Use and Priorities for Phaseouts:** Canada must establish a timeline for phasing out PFAS in products, as is being done in other jurisdictions, and challenge industry claims that PFAS phaseouts are too difficult. For example, the Montreal Protocol has been one of the most successful international efforts on eliminating toxic substances to date, and its successful approach shaped the 2015 Madrid Statement on PFAS 'essential uses' and priorities for phaseouts.⁶⁷
- ➔ **Promote PFAS-free Solutions:** There is a big opportunity to demonstrate that PFAS-free options already exist in the marketplace and Canada can help develop the safer substitutes still needed for some uses of PFAS. Canada can support PFAS-free products in its federal innovation funding and procurement, and target sectors such as personal care products and textiles as its first priorities.
- ➔ **Protect Drinking Water:** Canada is discussing the need for action on PFAS at an international level. However, until the government tests, discloses, and regulates the thousands of PFAS on the Canadian market, these international commitments will do little to improve the toxic reality of PFAS contamination in Canada. The federal government also recently proposed municipal drinking water "objectives",⁶⁸ but until it prohibits PFAS contamination of our waters from pulp and paper production, fracking, manufacturing and other releases, the objectives will do little to reduce PFAS contamination in drinking water.
- ➔ **End Plastics with PFAS:** In terms of Canada's plastics policies, Canada must do more to address PFAS plastic additives and fluorination processes. These plastics contaminate the waste stream and undermine recycling and circularity. Reusable and refillable containers must be PFAS-free.
- ➔ **Scope risk management to include product-based sources of PFAS:** The government's 2023 draft State of PFAS Report concluded that 4700 PFAS substances are toxic, therefore they must be treated as a class under the *Canadian Environmental Protection Act* (CEPA). This is a significant acknowledgement of the risks posed by PFAS, and a call for federal action. However, the draft risk management is narrowly scoping regulation to just one source—firefighting foams—which means the proposed regulation will fall short of what's needed. CEPA was recently amended to require consideration of vulnerable populations and cumulative effects, and these considerations must strengthen the regulatory action that emerges from this assessment. Canada must move quickly to impose a product-based phaseout.
- ➔ **PFAS regulations must ensure that Canada takes a comprehensive approach:** In order to reduce the impacts on the environment and human health and avoid regrettable substitutions within the PFAS class, Canada must ensure all PFAS are included in the class and regulated under CEPA; The Minister should fast-track the process to list the PFAS class on part 1 of Schedule 1 of CEPA based on the findings of the Draft Report, because it meets the criteria in subsection 77(3) of CEPA and poses the "highest risk" to prioritize its prohibition; The PFAS Risk Management Strategy (RMS) environment and health objectives should be revised to reduce releases of these substances to the environment, address impacts on biological

diversity, reduce exposure of vulnerable populations to these substances to levels that are protective of human health, and completely ban PFAS with exceptions only for uses recognized as essential and a goal to phase these out over time.

- ➔ **Regulations must clearly demonstrate our right to a healthy environment:** The duty to protect the right of every individual in Canada to a healthy environment compels action without delay where that right is being violated.
- ➔ **Legal action for damages and redress:** The Canadian government should explore legal action to secure resources and compensation for cleanup and health care costs, especially when vulnerable populations are affected.

Now, more than ever, we need governments to prioritize human and environmental health, which includes taking a precautionary and holistic approach to regulating toxics. If we want to stop this contamination and the health harms and injustices that accompany it, we need to cut off all the sources of PFAS. “Forever chemicals” shouldn’t take forever to regulate.



ENDNOTES

1. Juliane Glüge et al., "An Overview of the Uses of Per- and Polyfluoroalkyl Substances (PFAS)," *Environmental Science: Process & Impacts* 22, no. 12 (December 2020): 2345–2373, <https://doi.org/10.1039/D0EM00291G>.
2. Élyse Caron-Beaudoin et al., "Perfluoroalkyl acids in pregnant women from Nunavik (Quebec, Canada): Trends in exposure and associations with country foods consumption," *Environment International* 145 (October 2020), <https://doi.org/10.1016/j.envint.2020.106169>.
3. Nadia Barbo et al., "Locally caught freshwater fish across the United States are likely a significant source of exposure to PFOS and other perfluorinated compounds," *Environmental Research* 220 (March 2023), <https://doi.org/10.1016/j.envres.2022.115165>
4. Yanhui Dai, Jian Zhao, Chunxiao Sun, Diying Li, Xia Liu, Zhenyu Wang, Tongtao Yue & Baoshan Xing, "Interaction and combined toxicity of microplastics and per- and polyfluoroalkyl substances in aquatic environment," *Frontiers of Environmental Science & Engineering* 16 no. 136 (April 2022), <https://doi.org/10.1007/s11783-022-1571-2>.
5. "Federal contaminated sites inventory: PFAS," Treasure Board of Canada Secretariat, accessed on February 2, 2024, <https://map-carte.tbs-sct.gc.ca/map-carte/fcsi-rscf/map-carte.aspx?Language=EN&qid=2416949&backto=www.tbs-sct.gc.ca/fcsi-rscf/numbers-numeros-eng.aspx?qid=2416949>.
6. "Addition of certain PFAS to the Toxics Release Inventory by the National Defense Authorization Act," Environmental Protection Agency, last updated on January 18, 2024, <https://www.epa.gov/toxics-release-inventory-tri-program/addition-certain-pfas-tri-national-defense-authorization-act>.
7. Dusty Horwitt, Fracking with 'Forever Chemicals' (Physicians for Social Responsibility, 2021), <https://www.psr.org/wp-content/uploads/2021/07/fracking-with-forever-chemicals.pdf>.
8. Lada Lukić Bilela et al., "Impact of per- and polyfluorinated alkyl substances (PFAS) on the marine environment: raising awareness, challenges, legislation, and mitigation approaches under the One Health concept," *Marine Pollution Bulletin* 194, Part A (September 2023), <https://doi.org/10.1016/j.marpolbul.2023.115309>.
9. Diogo A.M. Alexandrino, C. Marisa R. Almeida, Ana P. Mucha, and Maria F. Carvalho, "Revisiting pesticide pollution: the case of fluorinated pesticides," *Environmental Pollution* 292, Part A (January 2022), <https://doi.org/10.1016/j.envpol.2021.118315>.
10. "EPA releases data on leaching of PFAS in fluorinated packaging," Environmental Protection Agency, released September 8, 2022, <https://www.epa.gov/pesticides/epa-releases-data-leaching-pfas-fluorinated-packaging>.
11. "Draft state of per- and polyfluoroalkyl substances (PFAS) report," Government of Canada, accessed February 2, 2024, <https://www.canada.ca/en/environment-climate-change/services/evaluating-existing-substances/draft-state-per-polyfluoroalkyl-substances-report.html>.
12. "Draft state of per- and polyfluoroalkyl substances (PFAS) report," Government of Canada, accessed February 2, 2024, <https://www.canada.ca/en/environment-climate-change/services/evaluating-existing-substances/draft-state-per-polyfluoroalkyl-substances-report.html>
13. Juliane Glüge et al., "An Overview of the Uses of Per- and Polyfluoroalkyl Substances (PFAS)," *Environmental Science: Process & Impacts* 22, no. 12 (December 2020): 2345–2373, <https://doi.org/10.1039/D0EM00291G>
14. Cassie Barker and Melanie Langille, Passing the buck: the toxic cost of dollar store products in Canada (Environmental Defence, 2023), <https://environmentaldefence.ca/report/passing-the-buck/>

ENDNOTES

15. "Study finds harmful PFAS don't actually actually prevent furniture stains," Green Science Policy Institute, released April 4, 2023, <https://greensciencepolicy.org/news-events/press-releases/study-finds-harmful-pfas-dont-actually-prevent-furniture-stains>.
16. Håkon A. Langberg et al., "Paper product production identified as the main source of per- and polyfluoroalkyl substances (PFAS) in a Norwegian lake: source and historic emission tracking," *Environmental Pollution* 273, (March 2021), <https://doi.org/10.1016/j.envpol.2020.116259>.
17. Jake T. Thompson, Boting Chen, John A. Bowden, and Timothy G. Townsend, "Per- and polyfluoroalkyl substances in toilet paper and the impact on wastewater systems," *Environmental Science & Technology Letters* 10, no. 3 (March 2023): 234–239, <https://doi.org/10.1021/acs.estlett.3c00094>.
18. Klaus Röhler, Alexander Arthur Haluska, Bernd Susset, Binlong Liu, Peter Grathwohl, "Long-term behavior of PFAS in contaminated agricultural soils in Germany," *Journal of Contaminant Hydrology* 241, (August 2021). <https://doi.org/10.1016/j.iconhyd.2021.103812>
19. Leah Segedie, "PFAS "Forever Chemicals" Inside Sanitary Pads & Incontinence Pads — Report 2022," Mamavation, accessed February 5, 2024, <https://www.mamavation.com/beauty/pfas-forever-chemicals-sanitary-pads-incontinence-pads.html>.
20. Leah Segedie, "Do Your Tampons Contain PFAS "Forever Chemicals?" They Might — Report," Mamavation, accessed February 5, 2024, <https://www.mamavation.com/beauty/pfas-tampons.html>
21. Heather D. Whitehead et al., "Fluorinated Compounds in North American Cosmetics," *Environmental Science and Technology Letters* 8 no. 7 (June 2022), <https://pubs.acs.org/doi/10.1021/acs.estlett.1c00240>.
22. Mélanie Z. Lauria, Ayman Naim, Merle Plassmann, Jenny Fäldt, Roxana Sühling, and Jonathan P. Benskin, "Widespread Occurrence of Non-Extractable Fluorine in Artificial Turfs from Stockholm, Sweden," *Environmental Science & Technology Letters* 9, no. 8 (August 2022): 666–672, <https://doi.org/10.1021/acs.estlett.2c00260>.
23. "Report on Per- and Polyfluoroalkyl Substances and Alternatives in Coatings, Paints and Varnishes (CPVs): Hazard Profile", Organisation for Economic Co-operation and Development, accessed February 5, 2024, [https://one.oecd.org/document/ENV/CBC/MONO\(2023\)22/en/pdf](https://one.oecd.org/document/ENV/CBC/MONO(2023)22/en/pdf).
24. Oddný Ragnarsdóttir, Mohamed Abou-Elwafa Abdallah, Stuart Harrad, "Dermal uptake: An important pathway of human exposure to perfluoroalkyl substances?" *Environmental Pollution* 307 (August 2022), <https://doi.org/10.1016/j.envpol.2022.119478>.
25. Somrutai Poothong, Eleni Papadopoulou, Juan Antonio Padilla-Sánchez, Cathrine Thomsen, Line Småstuen Haug, "Multiple pathways of human exposure to poly- and perfluoroalkyl substances (PFASs): From external exposure to human blood," *Environment International* 134 (January 2020), <https://doi.org/10.1016/j.envint.2019.105244>.
26. "Objective for Canadian Drinking Water Quality Per- and Polyfluoroalkyl Substances," Health Canada, accessed February 6, 2024, <https://www.canada.ca/content/dam/hc-sc/documents/programs/consultation-draft-objective-per-polyfluoroalkyl-substances-canadian-drinking-water/overview/overview.pdf>
27. "Health Outcomes," PFAS-Tox Database, accessed February 5, 2024, <https://pfastoxdatabase.org/>
28. Jung Eun Lee and Kyungho Choi, "Perfluoroalkyl substances exposure and thyroid hormones in humans: epidemiological observations and implications," *Annals of Pediatric Endocrinology & Metabolism* 22, no. 1 (March 2017): 6–14, <https://doi.org/10.6065%2Fapem.2017.22.1.6>.

ENDNOTES

29. Pi-I D. Lin a, Andres Cardenas b, Russ Hauser c, Diane R. Gold c d, Ken P. Kleinman e, Marie-France Hivert a f, Abby F. Fleisch g h, Antonia M. Calafat i, Thomas F. Webster j, Edward S. Horton k, Emily Oken, "Per- and polyfluoroalkyl substances and blood lipid levels in pre-diabetic adults—longitudinal analysis of the diabetes prevention program outcomes study," *Environment International* 129 (August 2019): 343-353, <https://doi.org/10.1016/j.envint.2019.05.027>
30. National Academies of Sciences, Engineering, and Medicine, "Guidance on PFAS Exposure, Testing, and Clinical Follow-Up" Washington, DC: The National Academies Press, 2022, <https://doi.org/10.17226/26156>.
31. Gretta Goldenman et al., The cost of inaction: A socioeconomic analysis of environmental and health impacts linked to exposure to PFAS (Copenhagen: Nordisk Ministerråd, 2019), 191, <http://norden.diva-portal.org/smash/record.isf?pid=diva2%3A1295959&dswid=4099>.
32. "Canadian Health Measures Survey: Environmental laboratory data, 2016 and 2017," Government of Canada, released November 13, 2019, <https://www150.statcan.gc.ca/n1/daily-quotidien/191113/dq191113a-eng.htm>.
33. "Draft state of per- and polyfluoroalkyl substances (PFAS) report," Government of Canada, accessed February 2, 2024, <https://www.canada.ca/en/environment-climate-change/services/evaluating-existing-substances/draft-state-per-polyfluoroalkyl-substances-report.html>.
34. Shelley H. Liu, Leah Feuerstahler, Yitong Chen, Joseph M. Braun, and Jessie P. Buckley, "Toward Advancing Precision Environmental Health: Developing a Customized Exposure Burden Score to PFAS Mixtures to Enable Equitable Comparisons Across Population Subgroups, Using Mixture Item Response Theory," *Environmental Science and Technology* 57, no. 46 (August 2023): 18104-18115, <https://pubs.acs.org/doi/abs/10.1021/acs.est.3c00343>.
35. "Persistent Organic Pollutants (POPs)," Inuit Circumpolar Council, accessed February 6, 2024, <https://www.inuitcircumpolar.com/icc-activities/environment-sustainable-development/persistent-organic-pollutants-pops/>
36. William F. Hartz, Maria K. Björnsdotter, Leo W.Y. Yeung, Andrew Hodson, Elizabeth R. Thomas, Jack D. Humby, Chris Day, Ingrid Ericson Jogsten, Anna Kärrman, Roland Kallenborn, "Levels and distribution profiles of Per- and Polyfluoroalkyl Substances (PFAS) in a high Arctic Svalbard ice core," *Science of The Total Environment* 871 (May 2023), <https://doi.org/10.1016/j.scitotenv.2023.161830>
37. Sabrina Tartu et al., "Choose Your Poison—Space-Use Strategy Influences Pollutant Exposure in Barents Sea Polar Bears," *Environmental Science and Technology* 52, no. 5 (January 2018): 3211-3221, <https://pubs.acs.org/doi/10.1021/acs.est.7b06137>.
38. Nadia Gaber, Lisa Bero, and Tracey J. Woodruff, "The devil they knew: chemical documents analysis of industry influence on PFAS science," *Annals of Global Health* 89, no. 1 (June 2023): 37, <https://doi.org/10.5334/aogh.4013>.
39. Carol F. Kwiatkowski et al., "Scientific basis for managing PFAS as a chemical class," *Environmental Science & Technology Letters* 7, no. 8 (June 2020): 532-543, <https://doi.org/10.1021/acs.estlett.0c00255>.
40. Stephen Brendel et al., "Short-chain perfluoroalkyl acids: environmental concerns and a regulatory strategy under REACH," *Environmental Sciences Europe* 30, no. 1 (February 2018): 9, <https://doi.org/10.1186%2Fs12302-018-0134-4>.
41. Nadia Gaber, Lisa Bero, and Tracey J. Woodruff, "The devil they knew: chemical documents analysis of industry influence on PFAS science," *Annals of Global Health* 89, no. 1 (June 2023): 37, <https://doi.org/10.5334/aogh.4013>.

ENDNOTES

42. The top 12 PFAS producers in the world and the staggering societal costs of PFAS pollution (ChemSec: the International Chemical Secretariat, 2023), <https://chemsec.org/reports/the-top-12-pfas-producers-in-the-world-and-the-staggering-societal-costs-of-pfas-pollution/>.
43. *Ibid.*
44. Maya Berci, Virginie Bergeron and Don Gutzman, "Federal activities on per- and polyfluoroalkyl substances (PFAS) in Canada" (presentation, Ontario Environment Industry Association, Virtual on Zoom, September 19, 2023).
45. Registry of Lobbyists: Chemistry Industry Association of Canada / Association canadienne de l'industrie de la chimie / Bob Masterson, PRESIDENT AND CEO, Lobby Canada, accessed February 22, 2024, <https://lobbycanada.gc.ca/app/secure/ocl/lrs/do/vwRg?cno=568®Id=945425>
46. "RE: draft state of per- and poly-fluoroalkyl substances (PFAS) report and risk management scope published in the Canada Gazette, Part 1, Volume 157 on May 20, 2023," Chemistry Industry Association of Canada, submitted July 19, 2023, <https://www.semi.org/sites/semi.org/files/2023-08/CIAC%20Submission%20-%20State%20of%20PFAS%20Report%20%282023-07-19%29.pdf>.
47. Genna Reed et al., "The disinformation playbook: how industry manipulates the policy process—and how to restore scientific integrity," *Journal of Public Health Policy* 42, no. 4 (November 2021): 622-634, <https://doi.org/10.1057%2Fs41271-021-00318-6>.
48. *Ibid.*
49. "RE: draft state of per- and polyfluoroalkyl substances (PFAS) report and risk management scope. Published in Canada Gazette, part 1, volume 157 on May 20, 2023," Fertilizer Canada, submitted July 19, 2023, <https://fertilizercanada.ca/wp-content/uploads/2023/08/PFAS-Consultation-July-2023-Final.pdf>.
50. Klaus Röhler et al., "Long-term behaviour of PFAS in contaminated agricultural soils in Germany," *Journal of Contaminant Hydrology* 241, (2021), <https://doi.org/10.1016/j.iconhyd.2021.103812>.
51. Sludge in the garden: toxic PFAS in home fertilizers made from sewage sludge (Ecology Center and Sierra Club, 2021), <https://www.sierraclub.org/sludge-garden-toxic-pfas-home-fertilizers-made-sewage-sludge>.
52. "RE: draft state of per- and polyfluoroalkyl substances (PFAS) report and risk management scope. Published in Canada Gazette, part 1, volume 157 on May 20, 2023," Fertilizer Canada, submitted July 19, 2023, <https://fertilizercanada.ca/wp-content/uploads/2023/08/PFAS-Consultation-July-2023-Final.pdf>.
53. Michelle McCann, David Common, and Anu Singh, "Does your makeup contain 'forever chemicals'?" CBC Marketplace, Nov 4, 2023, <https://www.cbc.ca/news/business/marketplace-makeup-pfas-forever-chemicals-1.7016203>
54. Heather D. Whitehead et al., "Fluorinated compounds in North American cosmetics," *Environmental Science & Technology Letters* 8, no. 7 (June 2021): <https://doi.org/10.1021/acs.estlett.1c00240>.
55. David Michaels, *The Triumph of Doubt: Dark Money and the Science of Deception*, (New York: Oxford University Press, 2020), <https://global.oup.com/academic/product/the-triumph-of-doubt-9780190922665?cc=us&lang=en&>
56. David Michaels, *Doubt is Their Product: How Industry's Assault on Science Threatens Your Health*, (New York: Oxford University Press, 2008), <https://global.oup.com/academic/product/doubt-is-their-product-9780195300673?lang=en&cc=us>
57. Jeffrey Kluger, "'Forever chemical' lawsuits could ultimately eclipse the big tobacco settlement," *Time*, July 12, 2023, <https://time.com/6292482/legal-liability-pfas-chemicals-lawsuit/>

ENDNOTES

58. "Dutch government to hold 3M liable for 'forever chemicals' damage," Reuters, May 23, 2023, <https://www.reuters.com/business/environment/dutch-government-hold-3m-liable-forever-chemicals-damage-2023-05-23/>
59. "PFAS Movement", ChemSec, accessed February 6, 2024, <https://chemsec.org/pfas/>
60. "Statement from IAFF General President Edward A. Kelly on PFAS lawsuits," International Association of Fire Fighters (IAFF), accessed February 6, 2024 <https://www.iaff.org/news/statement-from-iaff-general-president-edward-a-kelly-on-pfas-lawsuits/>
61. Arthur Nelsen, "EU unveils plan for 'largest ever ban' on dangerous chemicals," The Guardian, April 25, 2022, <https://amp.theguardian.com/environment/2022/apr/25/eu-unveils-plan-largest-ever-ban-on-dangerous-chemicals>
62. "Portal on Per and Poly Fluorinated Chemicals," OECD Denmark, accessed February 6, 2024, <https://www.oecd.org/chemicalsafety/portal-perfluorinated-chemicals/countryinformation/denmark.htm>
63. "Per- and polyfluoroalkyl substances (PFAS)," Government of Canada, accessed on February 6, 2024, <https://www.canada.ca/en/health-canada/services/chemical-substances/other-chemical-substances-interest/per-polyfluoroalkyl-substances.htm>
64. "Draft state of per- and polyfluoroalkyl substances (PFAS) report," Government of Canada, accessed on February 6, 2024, <https://www.canada.ca/en/environment-climate-change/services/evaluating-existing-substances/draft-state-per-polyfluoroalkyl-substances-report.html#toc0>
65. "Risk management scope for per- and polyfluoroalkyl substances (PFAS)," Government of Canada, accessed on February 6, 2024, <https://www.canada.ca/en/environment-climate-change/services/evaluating-existing-substances/risk-management-scope-per-polyfluoroalkyl-substances.html>
66. Carol F. Kwiatkowski et al., "Scientific Basis for Managing PFAS as a Chemical Class," *Environmental Science & Technology Letters* 7, no. 8 (June 2020): 532-543, <https://doi.org/10.1021/acs.estlett.0c00255>
67. "The Madrid Statement on Poly- and Perfluoroalkyl Substances (PFASs)", Green Science Policy Institute, accessed on February 6, 2024 <https://greensciencepolicy.org/our-work/science-policy/madrid-statement/#:~:text=The%20Madrid%20Statement%20documents%20the,information%20and%20prevent%20further%20harm>
68. "Draft objective for per- and polyfluoroalkyl substances in Canadian drinking water: Overview," Government of Canada, accessed on February 6, 2024, <https://www.canada.ca/en/health-canada/programs/consultation-draft-objective-per-polyfluoroalkyl-substances-canadian-drinking-water/overview.html>



environmental
defence

Copyright © February 2024 by ENVIRONMENTAL DEFENCE CANADA.

Permission is granted to the public to reproduce or disseminate this backgrounder, in part, or in whole, free of charge, in any format or medium without requiring specific permission. Any errors or omissions are the responsibility of ENVIRONMENTAL DEFENCE CANADA.

ACKNOWLEDGEMENTS

Research and writing: Cassie Barker

With contributions by: Dr. Elaine MacDonald, Ali Naraghi, Lauren Thomas, Ashley Wallis

Graphic design: Amanda Colvin | Melontree Studios, with Lauren Thomas