PFAS: Forever Chemicals – Investor Briefing

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First Sentier MUFG
Sustainable Investment Institute

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The First Sentier MUFG Sustainable Investment Institute (the Institute) aims to provide research on topics that can advance sustainable investing. The Institute is jointly supported by First Sentier Investors and Mitsubishi UFJ Trust and Banking Corporation, a consolidated subsidiary of MUFG.

As investors, both First Sentier Investors and MUFG recognise our collective responsibility to society and that investment decisions should be made with consideration to our communities both now and in the future.

The Institute commissions research on Environmental, Societal and Governance (ESG) issues, looking in detail at a specific topic from different viewpoints. The Institute recognises that investors are now looking in far greater depth, and with far greater focus, at issues relating to sustainability and sustainable investing. These issues are often complex and require deep analysis to break down the contributing factors. If as investors we can better understand these factors, we will be better placed to consider our investment decisions and use our influence to drive positive change for the benefit of the environment and society.

The Institute is jointly supported by First Sentier Investors (FSI) and Mitsubishi UFJ Trust and Banking Corporation, a consolidated subsidiary of MUFG. Representatives of both organisations will provide input to the activities of the Institute.

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About Chronos Sustainability

The Institute commissioned Chronos Sustainability to develop this document. Chronos Sustainability was established in 2017 with the objective of delivering transformative, systemic change in the social and environmental performance of key industry sectors through expert analysis of complex systems and effective multi-stakeholder partnerships. Chronos works extensively with global investors and global investor networks to build their understanding of the investment implications of sustainability related issues, developing tools and strategies to enable them to build sustainability into their investment research and engagement. For more information visit www.chronossustainability.com and @ChronosSustain

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Executive Summary

Perfluoroalkyl and Polyfluoroalkyl Substances (PFAS) are a group of chemicals whose typical properties – including chemical inertness, temperature resistance, and oil, water and stain-repellence – makes them useful in a broad range of consumer and industrial applications. Some of the major industry sectors using PFAS include aerospace and defence, automotive, aviation, textiles, construction, household products, electronics, food processing, food packaging and medical devices.

However, the properties that make PFAS so useful have also led to global concern about their adverse health and environmental impacts. PFAS are resistant to environmental degradation and may persist in the environment longer than any other human-made chemical. Exposure to PFAS from contaminated drinking water and food has been linked with human health impacts including endocrine disruption, increased cholesterol, higher risk of certain cancers, thyroid issues, reduced birth weights, lower response to vaccines and cardiovascular disease. PFAS exposure has also been shown to cause adverse effects in species including invertebrates, fish, amphibians, birds, reptiles, mammals, and plants.

Regulatory focus on PFAS is growing, with a trend toward phasing out and banning these substances. The European Union (EU) is considering a proposal that would ban PFAS from all applications for which there are available substitutes. For applications currently without alternatives, derogations of up to 12 years are proposed with the expectation that substitutes would be developed during this time. Bans on PFAS-containing firefighting foam are being introduced in the EU, New Zealand, and several US states, while regulators are restricting the use of PFAS in consumer applications such as food packaging, cosmetics and textiles.

This tightening regulation, along with litigation – particularly in the US – and increased public awareness presents potentially material risks to PFAS chemical producers and a host of product manufacturing sectors. Meanwhile, there are new opportunities for waste management, water treatment and environmental testing service providers. These risks and opportunities are summarised in Box 1.

Given these trends in regulation and litigation, investors need to ensure that PFAS-related risks and opportunities are integrated. The investment community can support wider action on PFAS by:

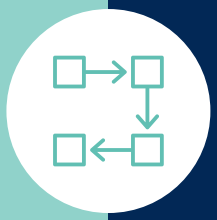
- Advocating for corporate disclosure on the production, use and management of PFAS.
- Encouraging proactive corporate action to phase out PFAS and reduce releases of PFAS to the environment.
- Building investor support for policy engagement.
- Building partnerships and collaborating with other investors and other key stakeholders.

Executive summary

Box 1: Risks and Opportunities

Investors wishing to incorporate PFAS-related risks and opportunities into their investment research and decision making should pay particular consideration to PFAS producers, product manufacturers using PFAS, and waste management, water treatment and environmental testing service providers.

PFAS producers face risks including potential lost revenues and reduced profitability due to reductions in demand, especially in the EU due to the EU PFAS restriction proposal. Front runners could develop new revenue streams through the development and commercialisation of PFAS-alternatives. Producers face increased costs due to new reporting requirements (for example in the US under the Toxic Substances Control Act (TSCA)) and tightening wastewater standards. In addition, they face the risk of litigation and enforcement action costs.



Product manufacturers may incur additional expenses as regulations drive action to phase out PFAS and reformulate products using alternatives to PFAS. The EU's PFAS restriction proposal may also drive increased Research and Development (R&D) spending to develop alternatives for applications without available substitutes. There will be increased costs due to new reporting requirements (e.g. TSCA in the US) and tightening wastewater standards, and a risk of litigation costs. There are also opportunities for product manufacturers to differentiate by bringing PFAS-free products to market.

For **waste management, water treatment and environmental testing service providers**, opportunities are emerging in the form of increased demand for water and wastewater treatment upgrades, the development of new PFAS destruction technologies, heightened need for remediation services and a need for expanded analytical testing capabilities and capacity. Yet, waste management companies may have to manage costs related to remediation, such as addressing leachate from landfills, and adapting to stricter waste standards.

Investors can encourage companies to:

- Acknowledge PFAS-related risks as an important issue for their businesses.
- Map their supply chains to identify where and why PFAS are used and to understand whether PFAS substitutes are available.
- Make commitments to phase out the production and use of PFAS, formalising this in a policy statement.
- Develop time-bound plans with objectives and targets for the phase-out of PFAS, and improved emissions management and remediation.
- Establish a governance framework to oversee progress against their targets.
- Provide timely reporting on their management of PFAS and the impacts arising from the use of PFAS.
- Invest in R&D into PFAS-substitutes and, where appropriate, in infrastructure, such as upgrades to wastewater management and waste management systems to reduce emissions.

Introduction

This report has been commissioned by the First Sentier MUFG Sustainable Investment Institute (the Institute) to brief investors on the topic of PFAS – or Forever Chemicals. The report forms part of the Institute's wider objective to provide research on topics that can advance sustainable investing, including examining market trends and practices that the investment industry must address if it is to make an active and positive contribution.

This report has five key objectives:

1. **To raise awareness among investors about the risks posed by PFAS pollution to human health and the environment.**
2. **To present an overview of the regulatory and litigation responses which are likely to impact PFAS producers and a host of product manufacturing sectors.**
3. **To assist investors in the assessment of their exposure across geographies and sectors and the assessment of PFAS-related risks and opportunities.**
4. **To provide guidance on how investors can engage on PFAS-related risks and opportunities.**
5. **To identify key points in the value chain where specific contributions made by investors could reduce exposure to PFAS-related risks.**

The Institute has commissioned this research with a view to assisting investors to incorporate PFAS-related risks and opportunities in their investment methodologies and decision-making processes and form a basis for collaborative investor engagements on the topic.

What are PFAS?

Perfluoroalkyl and Polyfluoroalkyl Substances (PFAS) or 'forever chemicals' are a large family of synthetic chemicals numbering more than 10,000 chemical entities.[1]

PFAS have useful characteristics including chemical inertness, temperature resistance and oil-, water- and stain- repellence. As a result, PFAS are used in a wide range of sectors and industrial and consumer applications, many of which underpin much of the modern industrial economy. These sectors using PFAS include the textiles, packaging, lubricants, refrigerants, electronics, and construction sectors.[1]

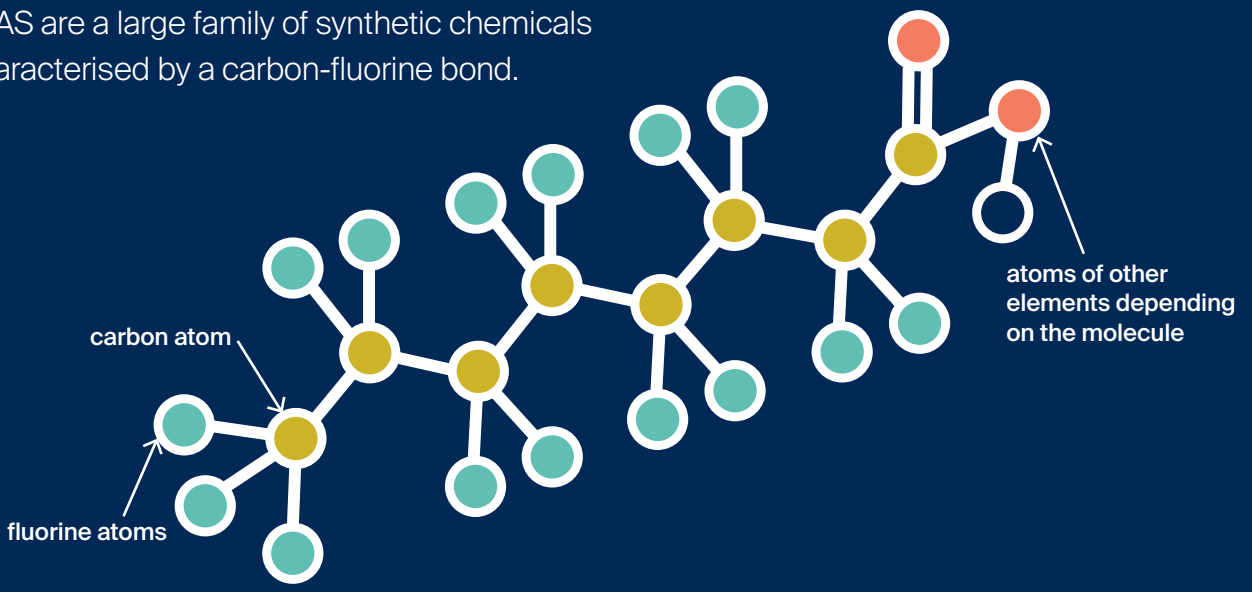
PFAS are characterised by a strong carbon-fluorine bond, one of the strongest in nature, which results in a common characteristic of strong resistance to natural degradation or 'very high persistence'. As a result, they have come to be known as "forever chemicals".

The first chemicals in the PFAS family were developed and commercialised in the 1940s. Since then, the number of PFAS chemicals which are marketed and used has increased substantially, with industry sources suggesting that there are now a few hundred commercially relevant PFAS currently being marketed.[2]

Introduction

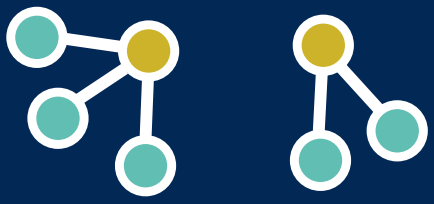
Figure 1

PFAS are a large family of synthetic chemicals characterised by a carbon-fluorine bond.



According to the OECD 2021 definition, with a few noted exceptions, any chemical with at least a perfluorinated methyl group (–CF3) or a perfluorinated methylene group (–CF2–) is a PFAS.

Contains at least one of the following:



Studies on the early developed and commercialised PFAS (specifically, Perfluorooctanoic Acid (PFOA), Perfluorooctane Sulfonate (PFOS) and Perfluorohexanesulphonic acid (PFHxS)) demonstrated that exposure to these chemicals is linked to significant adverse human health impacts. These findings resulted in litigation in the US in the 1990s, and a nationwide phase-out of the production of these chemicals. In 2009, PFOS was added to the Stockholm Convention on Persistent Organic Pollutants (POPs) and consequently is being banned or phased out in most countries. Meanwhile, PFOA and PFHxS were added to the Stockholm Convention in 2019 and 2022 respectively.

Subsequent studies have shown that substitutes to these 'legacy' PFAS, in the form of other chemicals in the PFAS family, have entered the environment and also have negative health impacts. The replacement of PFOA with a substitute known as 'GenX' (hexafluoropropylene oxide dimer acid) is an example of such 'regrettable substitution'. Research on animals exposed to Gen X chemicals has shown impacts on the immune system, liver, kidneys, and development of offspring, and has even linked these chemicals to cancer.[3]

Initial litigation in the US centred around two chemicals from the PFAS family: PFOA (associated with DuPont and its non-stick cookware coating Teflon brand, with 3M being the PFAS supplier) and PFOS (associated with 3M, used in Scotchgard fabric protector and firefighting foam products).

Introduction

Why should investors be concerned about PFAS?

The adverse health and environmental impact of PFAS contamination in the environment (in water, soil, and air) and the use of PFAS in industrial and consumer products has become a global concern.

Government agencies and regulators are beginning to address the issue, and increased regulation controlling the use of PFAS is strongly anticipated. In particular, the emerging regulatory response in the EU is expected to impact PFAS producers and a host of manufacturing sectors. In addition, litigation, particularly in the US, and an increasingly aware public pose potentially material risks to companies across multiple sectors.

For investors, PFAS contamination, and the regulatory and litigation interventions, present both risks and opportunities for companies in which they are invested. PFAS-related risks – these potentially include lost revenues, increased research and development (R&D) costs, direct costs associated with product reformulation, and litigation costs – could be financially significant to PFAS producers and to a range of product manufacturing companies. Meanwhile, opportunities exist, particularly for companies in the waste and water remediation and environmental testing services sectors, as well as producers and manufacturers involved in the research and development or application of PFAS substitutes.

To effectively manage risks and to capitalise on emerging opportunities, companies must be aware of the drivers and trends that are likely to alter how PFAS are used, and how this is likely to vary across geographies. For instance, PFAS producers must consider the likely continued demand for applications where no substitutes to PFAS are available, alongside trends to phase out and substitute PFAS for those applications where alternatives exist.

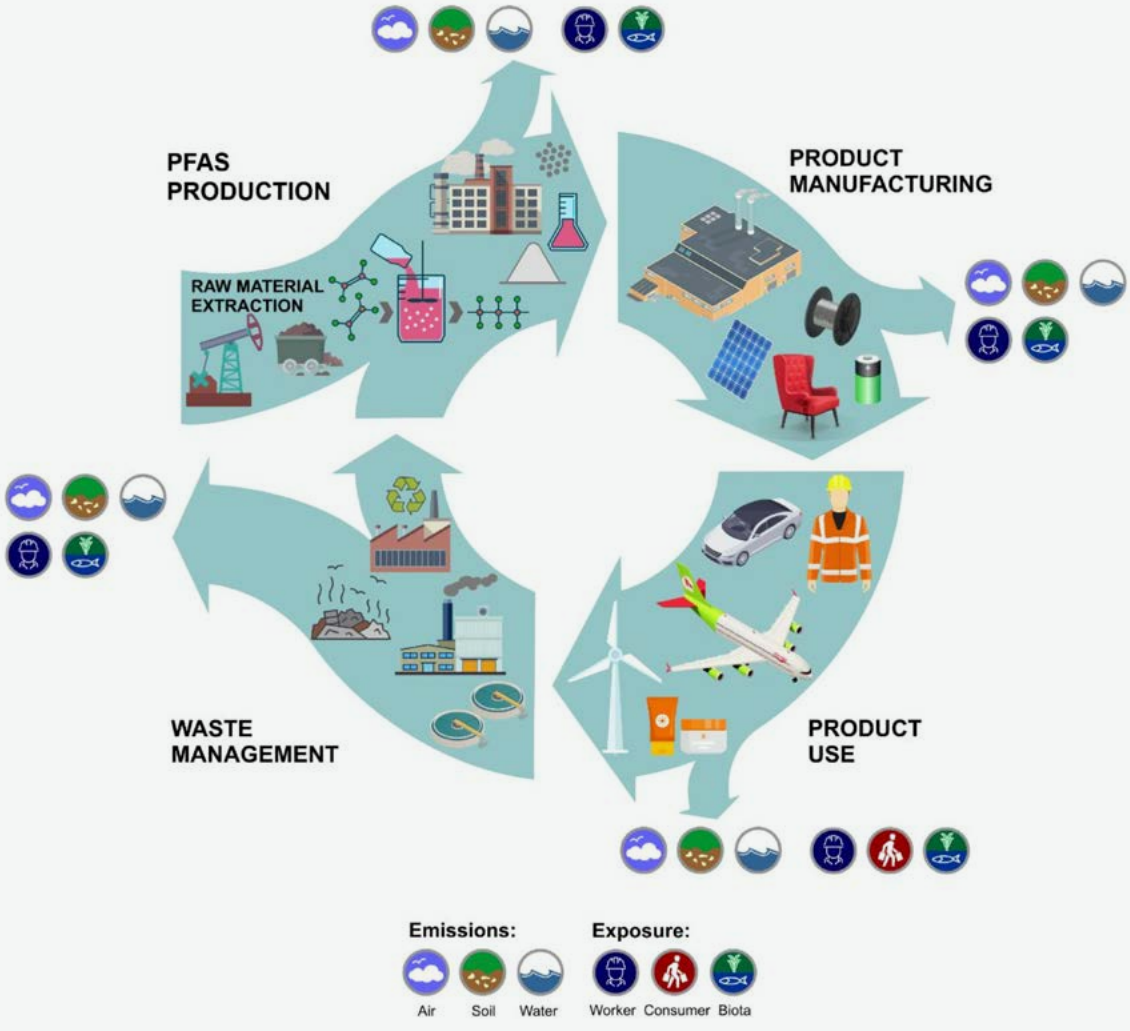
PFAS Contamination in the Environment

PFAS have entered the environment (water, soil, and air) from every stage of the PFAS life cycle.

The PFAS life cycle, as depicted in Figure 2, includes the production stage, the product manufacturing stage (where PFAS are processed and where PFAS-containing articles are applied), the product use stage and the waste management stage.

The quantity of emissions and the stage of the life cycle at which the emissions occur varies for different PFAS chemicals. This is due to their diverse characteristics and the wide range of applications in which they are used. For example, for fluorinated gases or 'F-gases' (comprising of a number of PFAS sub-groups), emissions occur at the product use stage with almost all of the gas used emitted into the environment. Meanwhile, for fluoropolymers (a PFAS sub-class), emissions occur at the production, product manufacturing and waste management stages. While there appear to be relatively limited emissions during the product use stage, waste management and disposal is another significant source of emissions.

Figure 2: The lifecycle of PFAS.[4]



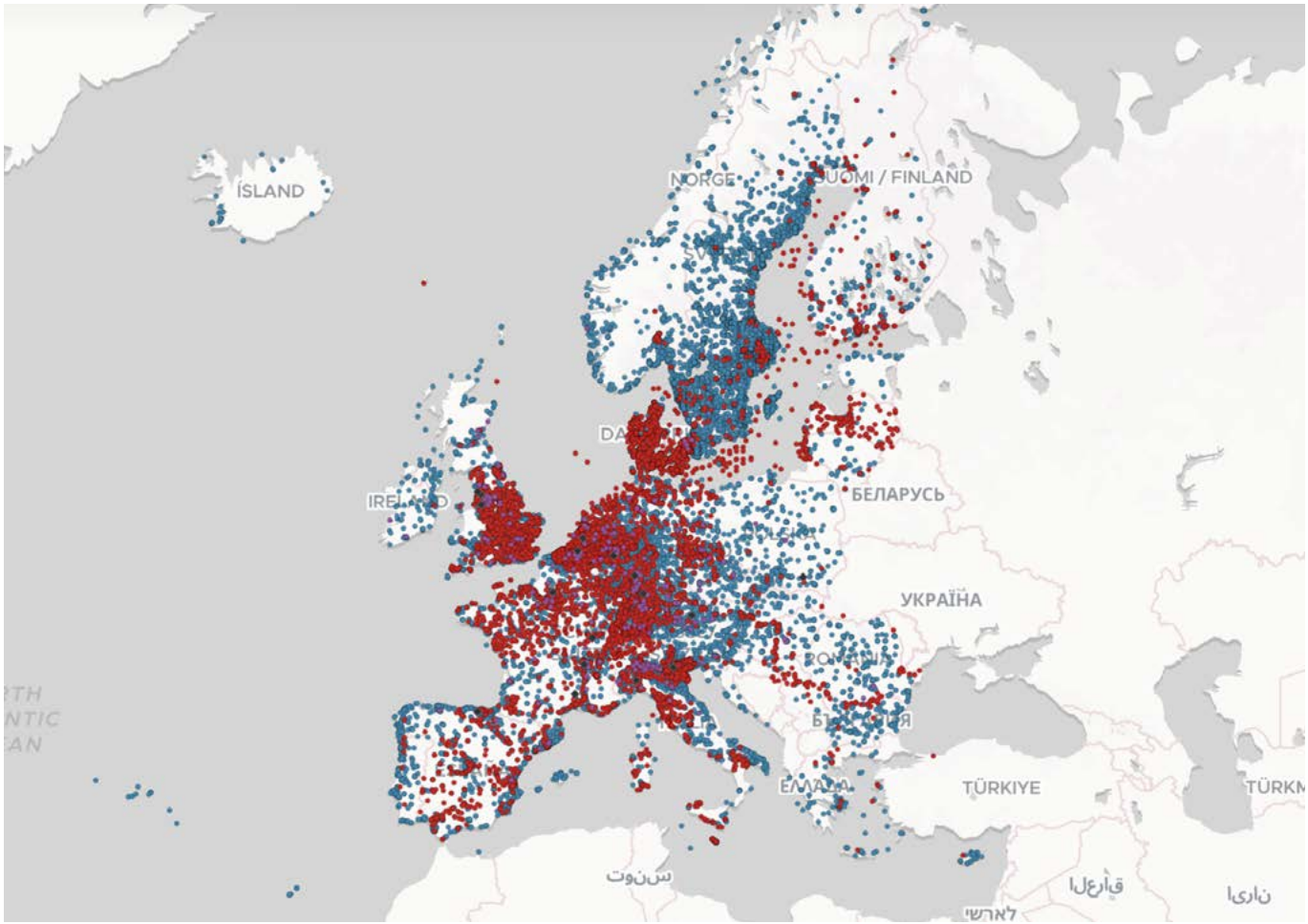
PFAS Contamination in the Environment

The **high persistence** of PFAS makes them a particularly problematic pollutant. Many PFAS are also **highly mobile in water** which leads to widely dispersed pollution.[5] Over recent decades, it has been established that PFAS contamination in the environment is ubiquitous and presents hazards to the environment and to human health. Recent studies have found that more than 98% of humans worldwide have PFAS in their blood (US population study).[6]

Mapping PFAS Contamination in Water, Soil and Air

The **high mobility** of many PFAS in water and the common characteristic of **persistence** have resulted in contamination spreading and accumulating across the globe. Mapping projects of sampling and testing activities confirm widespread contamination in water and highlight hotspots next to production and manufacturing facilities. A notable historical source of PFAS contamination is aqueous film forming firefighting foam (AFFF) which was used in training and firefighting scenarios resulting in large quantities of PFAS emissions to the environment particularly at military sites and airports. See Figure 3.[7]

Figure 3: EU: Forever Pollution Project. Le Monde, Watershed Investigations, 2024. 23,000 sites with known contamination and >21,500 sites with presumptive contamination (e.g. airports) depicted in red and blue respectively.[7]



The Impact of PFAS on Human Health

There is a substantial body of evidence available that demonstrates the risks of PFAS exposure to human health. Experimental data is, however, limited, in part due to the sheer number of PFAS chemicals. The nature of the available data is leading to varying regulatory responses reflecting different principles and methodologies. Notwithstanding this, a heightened research interest in PFAS is strengthening the evidence linking PFAS exposure, for an expanding number of PFAS types, and at lower levels of exposure, to a host of adverse health effects. Such evidence is being used to trigger litigation, particularly in the US.

Human biomonitoring studies **unambiguously demonstrate world-wide exposure** to a wide range of PFAS, with especially high exposure levels in populations living close to PFAS point sources such as PFAS production, and product manufacturing facilities, as well as in occupationally exposed individuals.[8,9,10]

The key exposure routes for PFAS are through contaminated food (including vegetables and animal products), dust, air and drinking water, as well as through the use of products containing PFAS and occupational exposure (chemical and textile manufacturing workers, firefighters, and ski wax technicians among others). Some PFAS have been shown to bioaccumulate in both animal and human tissue.[11,12]

PFAS exposure has been linked with multiple long-term human health impacts. This relates particularly to PFAS arrowheads which are ultimately persistent in the environment. Some precursors may be of less concern with regard to human health effects but will ultimately add to human exposure of PFAS arrowheads due to degradation.

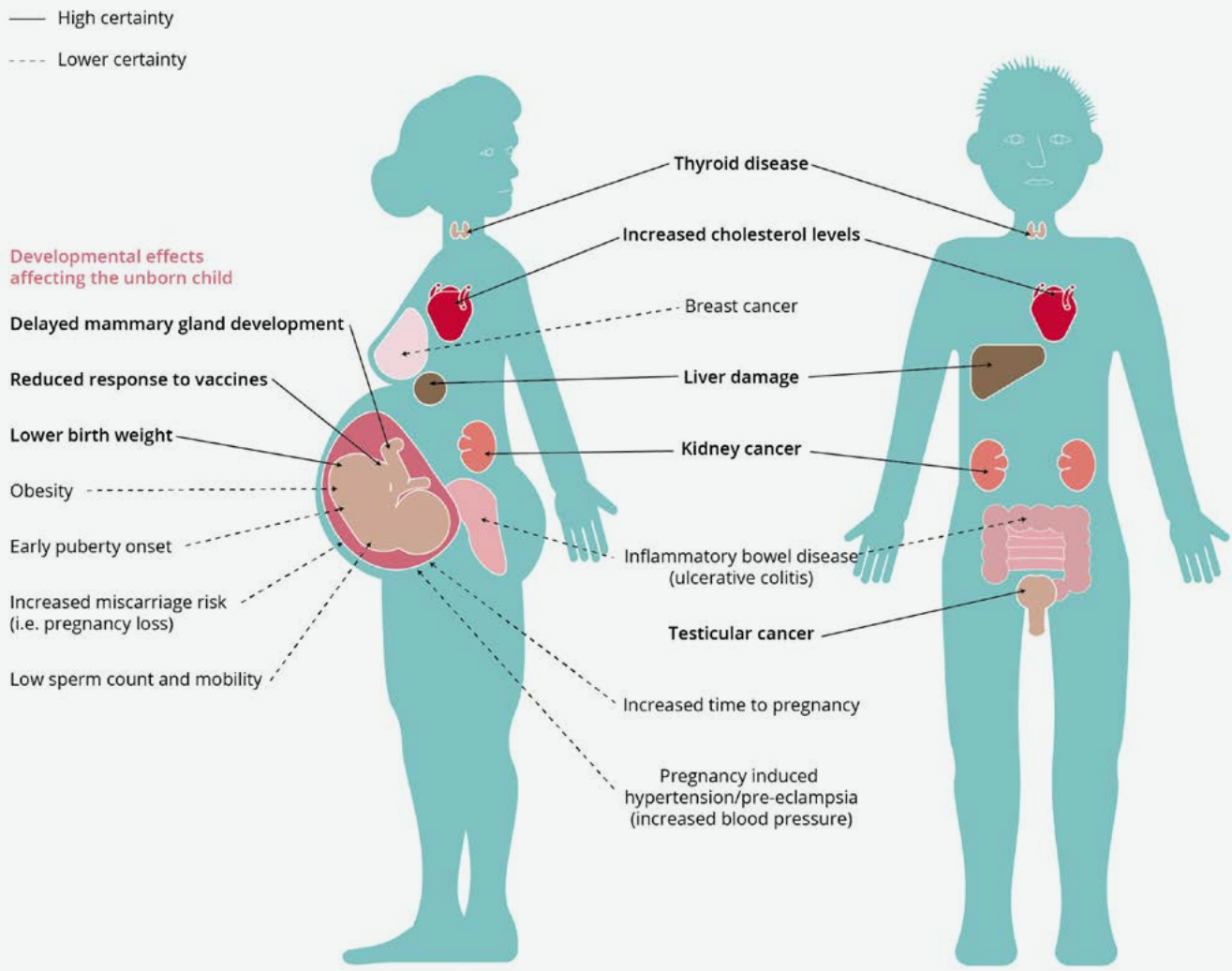
The human health impacts include endocrine disruption, increased cholesterol, higher risk of certain cancers, reduced birth weights, lower response to vaccines as well as cardiovascular disease. Epidemiological studies have reported a strong association between certain PFAS and particular health impacts, while conclusive results for these PFAS and other health impacts require further studies with larger cohorts.[13,14] A summary of such health impacts of PFAS is depicted in Figure 4.

PFAS Persistence

PFAS can be divided into **"precursors"** and **"arrowheads"**. PFAS precursors degrade on a timescale from hours to years to **PFAS arrowheads** which ultimately persist in the environment.[1]

The Impact of PFAS on Human Health

Figure 4: Effects of PFAS on human health.[15] Original sources for this figure: National Toxicology Program (2016), C8 Science Panel (2012), IARC Working Group on the Evaluation of Carcinogenic Risks to Humans (2017), Barry et al. (2013), Fenton et al. (2009), and White et al. (2011b).



The Impact of PFAS on Human Health

It is likely that evidence establishing health impacts of PFAS for more types of PFAS and exposure routes will strengthen over time.

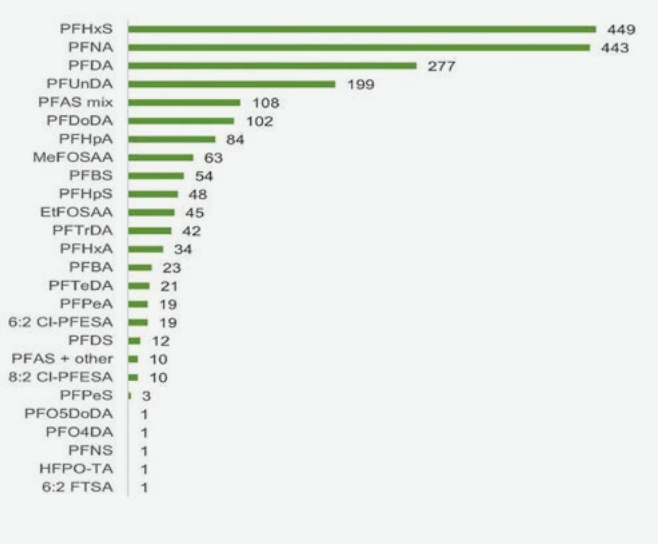
Research on the health impacts of PFAS exposure has been consistently rising over the past decade, with a significant surge in recent years.[16]

Increasing research efforts beyond the most well studied PFOS and PFOA report similar adverse effects for other PFAS, including the 'Gen X' PFAS subgroup, although there remains insufficient data for adequate assessment.[1] See Figure 5.

Whilst different PFAS have different potencies, meaning impacts are observed at different levels of exposure, the overall effect patterns are similar for a variety of PFAS.[1]

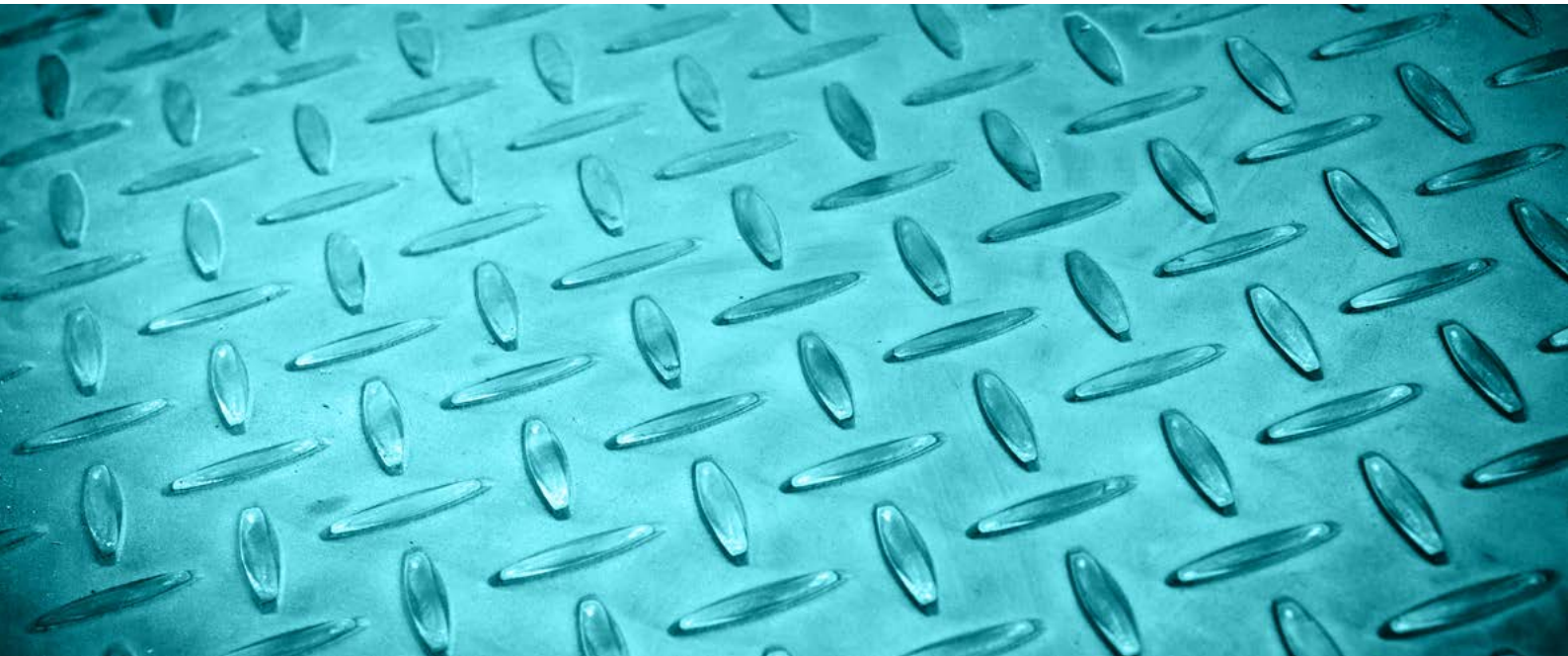
Moreover, there is increasing evidence demonstrating adverse health impacts at increasingly low exposure levels; levels that in some cases are below the limit of detection of available analytical techniques.

Figure 5: Number of human studies identified for each PFAS (beyond the well-studied PFOA and PFOS)[16]



The Impact of PFAS on Nature

Numerous PFAS have been detected in ecosystems and wildlife worldwide. While most studies to date investigate PFAS impacts in aquatic organisms, PFAS-induced illnesses have been discovered in both terrestrial and aquatic species including invertebrates, fish, amphibians, birds, reptiles, mammals, plants or other wildlife.[17,12] PFAS have been shown to build up in the blood, liver, and kidneys of animals leading to impaired immunity, liver damage, and growth and reproductive issues. Moreover, PFAS are particularly harmful to young animals. This exacerbates challenges for species already facing decline due to various stressors.[18,19,20]



Key Interventions

The tightening of PFAS regulation globally is likely to significantly affect PFAS producers and a range of product manufacturing sectors. However, regulators across geographies are at different stages. The EU proposal to restrict PFAS as a family of chemicals is the most far reaching, while others, including the US Environmental Protection Agency (EPA), are focused on information-gathering and clean up. There is also significant litigation risk, particularly in the US, with recent lawsuits in other countries like Sweden and the Netherlands suggesting other countries might also see increased legal activity in the coming years.

The regulatory and litigation responses to PFAS contamination and emissions have increased rapidly over recent years and are considered the principal interventions for addressing the issue. Other interventions include Non-Governmental Organisation (NGO) and consumer advocacy campaigns, public perception and consumer sentiment, and investor engagement. See Figure 6.

Figure 6: Key interventions in phasing out PFAS.

Regulatory Response

- EU Restriction Proposal
- US EPA, and US state level regulations
- Others including Australia, Canada, New Zealand

Litigation

- Huge number of cases and increasing in number and variety (particularly relevant in the US)

Investors

- Expecting industry to prepare for regulation, map lifecycle and phase out PFAS where possible.

NGO and Public Scrutiny

- NGOs (e.g. Chemsec) pushing for the phase-out of PFAS and a strengthening of the regulatory response.

Key Interventions

1. Tightening Regulation

Many countries – see Table 1 – have banned or are phasing out the three PFAS chemicals, PFOA, PFOS and PFHxS, which are included in the Stockholm Convention on Persistent Organic Pollutants (POPs). Currently, the POP Review Committee is evaluating a proposal from Canada nominating long-chain perfluorocarboxylic acids (PFCAs) for addition to the Stockholm Convention. See Table 1 for an overview of the regulatory landscape.

Regulators, particularly across Europe and North America, are engaged in understanding the environmental and health risks posed by PFAS contamination and developing pathways for managing PFAS emissions and contamination. Specifically, there are emerging regulatory responses in the EU, in the US (particularly across several US states), Australia, New Zealand and Canada.

The EU proposal to restrict PFAS as a family of chemicals is the most far-reaching. In the US, the Environmental Protection Agency (EPA) is approaching regulation on a category-by-category basis, with a current focus on information gathering and "pursuing responsible parties for...exposures as a top enforcement priority", although a range of regulations to restrict the use of PFAS are being pursued at state level.[21]

Drinking water limits for PFAS are also entering into force and tightening in some countries, with specifications on PFOS, PFOA, PFHxS as well as several PFAS which are not currently banned from use. Notably, in April 2024, the US EPA announced the final National Primary Drinking Water Regulations (NPDWR) for PFAS.

PFAS Regulation

EU Proposal to Restrict PFAS as a Family

In order to guarantee the safe use of chemicals throughout Europe, the European Chemicals Agency (ECHA) is the principal organisation responsible for implementing EU chemicals legislation. Several PFAS-related regulations have been proposed within the EU. The most consequential is the EU PFAS restriction proposal by ECHA which proposes restrictions on PFAS as a family of chemicals. At the time of writing (June 2024), this proposal is in the legislative phase, undergoing assessment by ECHA's scientific committees – the Risk Assessment Committee (RAC) and the Socio-Economic Analysis Committee (SEAC). The RAC and SEAC will jointly evaluate the proposed restriction along with feedback from consultations in stages. The European Commission is expected to decide on this proposal following the receipt of final opinions from RAC and SEAC. A decision is expected in 2025 and, if passed, the restriction would apply for use cases or sectors where substitutes are currently available such as textiles, food packaging, and cosmetics, with derogations of either 5 years or 12 years applied to sectors and applications where there is sufficient evidence that substitutes are not currently available. Examples of sectors likely to receive derogations are the transport, energy, petroleum, and mining sectors. The length of the proposed derogation reflects time required for R&D, certification or regulatory approval, commercialisation and for sufficient quantities of alternatives or reformulated products to become available on the market. See Figure 7 for a summary of major use sectors and proposed derogations. The EU is also considering some more general derogations, e.g. for PFAS used as active substances in Plant Protection Products, Biocidal Products and human and veterinary Medicinal Products as these are addressed under their respective regulations.[1]

> In the EU restriction proposal, PFAS exposure is set out as a hazard that is non-threshold in nature meaning any level of exposure may cause harm.[5] Contamination in the environment then serves a proxy for risk.

During the 2023 public consultation on the proposed regulations, more than 5,600 comments (with more than 100,000 pages) were submitted. Over two thirds of the comments were from companies and trade associations, many of whom opposed to the restriction of PFAS as a family. Many of the comments submitted argue that PFAS are used in essential applications where there is a lack of available substitutes and that a restriction would result in a host of negative socio-economic impacts.[22]

Due to the volume of submissions to be considered, opinions due to be issued by ECHA's RAC and SEAC may be delayed. The updated proposals may include changes to the proposed derogations and transition periods as a result of the information received.[23]

Some EU countries, including France and Sweden, are progressing with regulation on the use of PFAS independently and in parallel to the EU restriction proposal.

EU Water-related Regulations

Separately, the updated EU Drinking Water Directive (2020) includes group limits for total PFAS of 0.5 µg/L and the sum of 20 PFAS of most concern of 0.1 µg/L.

On wastewater, in April 2024, the European Parliament updated regulations to introduce stricter monitoring of pollutants, including increased focus on PFAS, requiring Wastewater Treatment Plant (WWTP) operators to implement advanced treatment methods to remove PFAS before discharge.[24]

Key Interventions

Figure 7: Major use sectors and the proposed derogation type per sector in the EU restriction proposal.[1] Sectors and applications where there is evidence of a lack of available substitutes have derogations of 5 or 12 years.

			Length of proposed / considered derogation	
	No derogation (for certain identified sub-use(s))	Derogation proposed or for consideration (for certain identified sub-use(s))	5-year	12-year
TULAC (textile, upholstery, leather, apparel and carpets)	✓	✓	✓	✓
Food contact materials and packaging	✓	✓	✓	
Metal plating and manufacture of metal products	✓	✓	✓	
Consumer mixtures	✓			
Cosmetics	✓			
Ski wax	✓			
Applications of fluorinated gases	✓	✓	✓	✓
Medical devices	✓	✓		✓
Transport		✓	✓	✓
Electronics and semiconductors	✓	✓		✓
Energy sector		✓	✓	
Construction products	✓			
Lubricants		✓		✓
Petroleum and mining	✓	✓		✓

US State Level Regulation & Tightening Drinking Water Standards

The US EPA is moving much less aggressively than the EU in intervening on the use of PFAS. The EPA is focused on understanding the extent to which PFAS exposure poses a threat to human health and to the environment and is reviewing PFAS on a category-by-category approach. There is greater focus on the management and reduction of emissions through the life cycle, specifically during the PFAS production, product manufacturing and waste management stages, rather than pursuing a phase-out.

In April 2024, the EPA released a final rule to designate PFOA and PFOS as "hazardous substances" under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), also known as Superfund. A direct consequence of this rule is that companies are required to report releases of PFOA and PFOS that meet or exceed the reportable quantity within a 24-hour period. The indirect impacts are likely to be much farther reaching, affecting a broad range of companies who may own sites with PFOA and PFOS contamination. Under the CERCLA "polluter pays" principle, EPA can seek to recover cleanup costs from 'potentially responsible parties' (PRPs) or can require such parties to conduct the cleanup. In addition, affected parties are allowed to seek contributions from each other for cleanup costs. This raises litigation risks for companies as companies may be held legally liable for contamination and may be compelled to pay for conducting investigations and clean up.[25]

In April 2024, the US EPA finalised the first nationwide legally enforceable drinking water standard for PFAS (drinking water limits) which imposes new requirements on water systems nationwide. Water treatment facilities will have three years to test for the chemicals and two years to purchase, install and operate the technologies that can filter out forever chemicals if they exceed the standard.[26] Several states, however, already enforce their own standards for specific PFAS in drinking water.

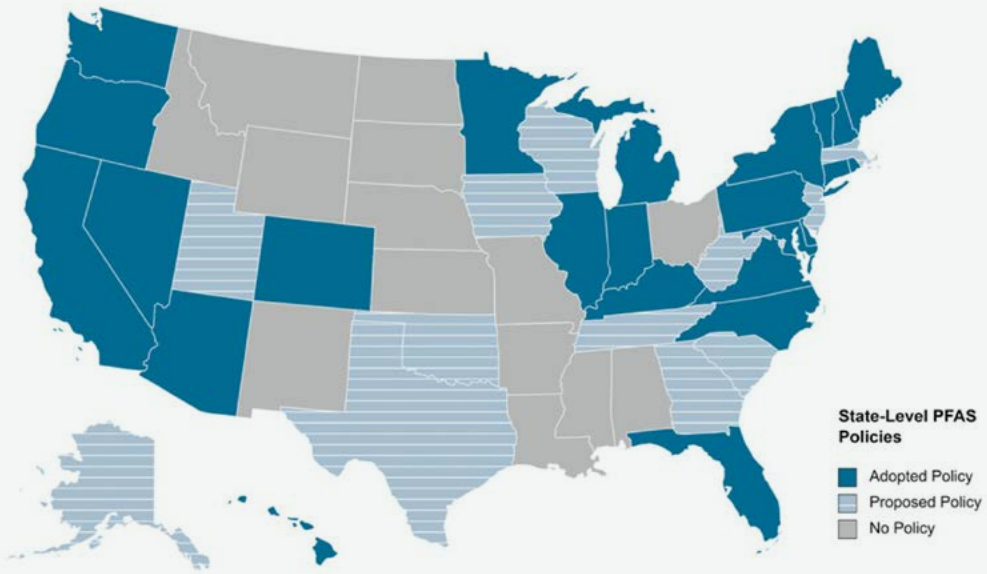
Key Interventions

The US has also expanded disclosure requirements under the Toxic Substances Control Act (TSCA). Retroactive reporting for PFAS manufactured or imported since 2011 is now required under TSCA. In addition, as a result of the removal of the "de minimis" exemption, from 2024, more facilities are expected to report PFAS use to the Toxics Release Inventory. Companies will be required to fund and conduct a reasonable assessment for the full scope of their organisation, which may include inquiries to upstream suppliers and downstream users, with a deadline of May 2025 for submissions.

At state level, comprehensive bans are being considered in Maine and Minnesota. In addition, many states have adopted or are working on policies that limit the use of PFAS in particular products, with food packaging being among the most common prohibitions.

As of May 2023, out of the 24 states with adopted PFAS policies, 13 states had adopted policies on PFAS-containing products specifically. In addition, 13 states had proposed policies on PFAS-containing products. See Figure 8.[27]

Figure 8: State Level Policy adoption and introduction (as of Jun 2023)[27]



What can investors expect to see on regulation?

The global response to PFAS contamination faces a significant challenge: inconsistent regulation across countries. Due to varying levels of engagement with the issue, regulations and their timelines are likely to remain fragmented. Regulators grapple with balancing the need to curb PFAS through phase-out and stricter emissions management, against potential economic disruptions and regional goals. While the proposed EU restriction might spur similar actions elsewhere, the current geographical inconsistency weakens the overall effectiveness in tackling PFAS emissions and contamination. This creates unnecessary complexity for companies operating internationally.

Therefore, while there is evidence of tightening regulation across multiple geographies, there is also uncertainty as to the likely extent and pace of regulation. See Table 1 for a summary of the regulatory landscape.

It is possible that other PFAS chemicals may be added to the Stockholm Convention on POPs resulting in a phase-out and ban across multiple countries. However, for this to happen, a sufficient body of evidence on the adverse health impacts of exposure to the particular PFAS chemical(s) would be required.

It is also likely that drinking water standards will be tightened to lower the acceptable levels of PFAS. Greater regulation of wastewater emissions is also likely.

Key Interventions

Table 1: The regulatory landscape. The EU proposal to restrict PFAS as a family of chemicals is the most far reaching. Others, including the US, are taking a more measured approach by assessing risks and regulating different categories of PFAS individually.

Country	Regulatory Landscape
EU	• Stockholm Convention POPs implemented: PFOS – since 2009; PFOA – since 2019; PFHxS – since 2022. • Several PFAS-related regulations underway including additions to the Substances of Very High Concern list (leading to potentially increasingly stringent authorisation processes for their use), and a proposal to outlaw all PFAS in firefighting foams. • EU restriction proposal, restricting PFAS as a family of chemicals, currently under discussion. • EU Drinking Water Directive (2020) updated to include limits for total PFAS (transposed into national law of member states by 2023) • In April 2024, France passed the first reading of a ban, starting 2026, on the manufacture, import and sale of cosmetics, ski waxes and clothing textiles containing PFAS and extending to all textiles by 2030.
US	• At a federal level, there is a focus on understanding exposure risks and managing and reducing emissions throughout lifecycle (particularly during the production, product manufacturing and waste management stages). • Increased disclosure obligations under the Toxic Substances Control Act (TSCA) apply for the 2024 reporting period and retroactively for PFAS manufactured or imported since 2011. • Nationwide legally enforceable drinking water standard for PFAS introduced in 2024. Several states, including New York and Washington, enforce their own drinking water standards. • Several states are implementing phase-outs for PFAS in specific products, e.g. food packaging.
UK	• Stockholm Convention POPs implemented: PFOS – since 2009; PFOA – since 2019; PFHxS – since 2023. • Aligns with EU regulations – 36 PFAS registered under UK REACH (2022) (necessitating evidence of safe usage by manufacturers and importers). • Designated PFAS as a substance of focus from 2023 to 2025, implying a concentrated effort to evaluate and regulate PFAS during this period.
Canada	• Manufacture, use, sale, offer for sale, and import of PFOS, PFOA, long chain -PFCAs, and products that contain them prohibited since 2016 under the Prohibition of Certain Toxic Substances Regulations (PCTSR), 2012 with a limited number of exemptions. • Enhancing regulations under the Canadian Environmental Protection Act (CEPA): proposed classification of PFAS as toxic, mandating data reporting by manufacturers (2024) and implementing controls on specific PFAS uses. • A final version of the PFAS drinking water objective is expected in 2024. • Provincial level regulations less advanced – British Columbia is currently the only province to adopt federal non-binding drinking water guidelines for certain PFAS.
Australia	• Stockholm Convention POPs (PFOA, PFOS, and PFHxS) to be implemented starting 2025. • Fluorinated firefighting foams banned in South Australia (2018). • States, territories, and the national government to develop the PFAS National Environmental Management Plan (NEMP), encompassing aspects including communication, monitoring, site evaluation, sampling techniques, waste management, and future research. • Focus on prevention (early stages of lifecycle) in PFAS Strategic Roadmap.
New Zealand	• PFOS and PFOA banned (with exemptions since 2006; without any exemptions since 2020); manufacture and use of PFHxS prohibited since 2023. • Gradual ban on all PFAS in firefighting foams (2025) and cosmetics (starting 2026).
Japan	• Stockholm Convention POPs implemented: PFOS – since 2010; PFOA – since 2021; PFHxS – 2024. • PFAS included to designated substances lists, requiring prompt action in case of accidental discharge; provisional target values for PFAS in water. • Evolving regulations on PFAS – plans to strengthen management and risk communication.

2. Increasing Litigation

Litigation has increased steadily over the years and is expected to continue to grow. This is more prevalent in the US.

In 2023, there were two landmark class action settlements, with settlement values significantly higher than previous PFAS settlements. Both settlements were part of multidistrict litigation (MDL) in South Carolina. MDLs are legal instruments employed in mass tort cases to help streamline litigation and facilitate settlements and consistent rulings on critical issues.

- The chemical company 3M settled with multiple public water systems for $10.3 billion over 13 years to address PFAS contamination. The agreement has been finalised and will support water systems detecting PFAS, or likely to detect it in the future, benefiting U.S.-based systems providing drinking water nationwide.[28]
- Separately, Chemours, DuPont, and Corteva agreed to a $1.2 billion fund to resolve PFAS-related drinking water claims for various US water systems.[29,30]

Having initially targeted PFAS producers, lawsuits have now expanded to include and target a diverse range of defendants including companies that own or operate sites contaminated with PFAS, and companies engaged in the disposal or distribution of products containing PFAS across sectors including food, cosmetics, and public utilities.

Further examples of lawsuits include the following:

- In September 2023, a class action lawsuit was filed against Chemours, a US chemicals company, and its parent company in The Hague, Netherlands, regarding PFAS pollution dating back to 1962. This follows on from a ruling in September 2023 where the company was found liable for PFAS-related environmental damage from 1984 to 1998 and was found to have failed to properly inform nearby towns.
- The Swedish Supreme Court ruled in December 2023 that the municipal water company, Ronneby Miljöteknik, was liable for the personal injury suffered by over 150 residents of the municipality of Ronneby who had high levels of PFAS in their blood due to drinking water contaminated with PFAS.
- In 2022, L'Oréal USA, Inc. faced a lawsuit in a U.S. District Court for falsely claiming its waterproof mascaras were safe, effective, and high quality, despite containing harmful PFAS. The case was dismissed in 2023, citing lack of evidence from the plaintiffs. Nonetheless, similar cases may continue despite evidentiary hurdles.[31]

Litigation is being driven by:

- The designation of PFOS and PFOA as "hazardous substances" under the CERCLA regulations by the US EPA which significantly raises the risk of litigation for companies that may be held legally liable in site-remediation situations.
- Growing knowledge of the adverse impacts of PFAS exposure and an increased awareness of their widespread use in products without adequate disclosure.
- Public and financial pressures on local governments and water utilities.
- Perceived successes in legal action including value of settlements.

What can investors expect to see on litigation?

As cases continue to grow, there is an expanding variety of defendants (producers and product manufacturers across sectors), plaintiffs (individuals, water utilities, state attorney generals) and types of claims (class action, personal and property damage, environmental pollution, consumer product liability).

Further developments are expected from the MDL in South Carolina. There are currently over 6,000 cases in the MDL and more cases are added almost daily. The cases in the MDL fall into three categories:

1) Personal injury plaintiffs claiming injury from exposure to PFAS;
2) Actions filed by individual states by Attorney Generals for natural resource and other damages; and
3) Public water supplier plaintiffs seeking drinking water testing and remediation costs.

The 3M and DuPont settlements pertain only to the last category of cases.

There is still a considerable amount of litigation to unfold, and potential liabilities are open-ended. This may prompt companies to settle and avoid substantial verdicts. Beyond the financial repercussions, businesses face the risk of reputational damage stemming from lawsuits and environmental concerns.

Implications of PFAS Interventions on Companies

The changing regulatory and litigation landscape presents material financial risks and opportunities for PFAS producers and product manufacturers across multiple sectors.

Potential risks include lost revenues resulting from future reductions in demand, litigation and enforcement action costs, remediation costs, higher direct manufacturing expenses associated with substitutes and product reformulations, and reduced access to finance.

Conversely, the growing demand for PFAS testing and remediation from governments, municipalities, and industry will create opportunities for waste and wastewater service providers and for companies providing environmental testing services. In addition, there are opportunities for chemical companies to respond to the growing demand for PFAS substitutes, and for product manufacturers to capitalise on the growing market for PFAS-free products.

PFAS Producers

PFAS producers include chemical companies which produce[8]:

1. **Perfluoroalkyl acids (PFAA) and PFAA precursors** (precursors include perfluoroalkyl iodides, perfluoroalkane sulfonyl fluorides and perfluoroalkenes)
2. **Fluorinated gases or 'F-gases'** (used as starting materials in the production of polymeric PFAS including fluoropolymers).
3. **Polymeric PFAS**
    - Fluoropolymers (with PTFE, PVDF, and FEP accounting for most of the world market for fluoropolymers).
    - Perfluoropolyether.
    - Side-chain fluorinated polymers (volumes are low compared to fluorinated gases and fluoropolymers).

Box 2: Fluoropolymer Producers - A powerful link in the value chain

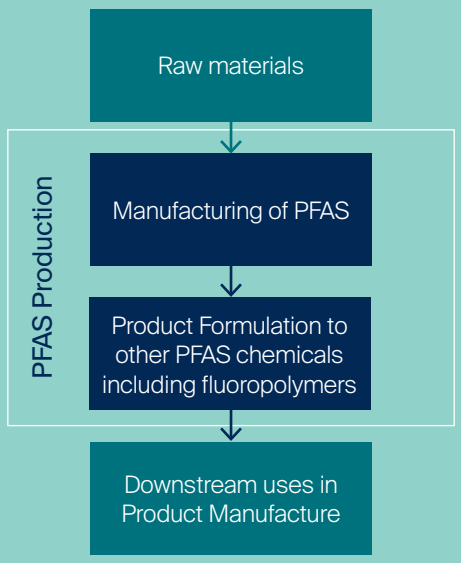
Fluoropolymer producers are a critical link in the value chain between PFAS producers more broadly and product manufacturers that use or apply fluoropolymer products in product manufacturing.

Fluoropolymers make up 60% of the worldwide PFAS market.[1] However, **fluoropolymer producers are a key consumer of PFAA and PFAA precursors* and fluorinated gases****, using them as starting materials and production aids in the manufacture of fluoropolymers.[1]

The fluoropolymer production market is consolidated with a relatively small number of companies supplying most of the market. **The eight main global manufacturers of fluoropolymers include Shandong Dongyue Group (China), Chemours (US), Daikin (Japan), Solvay (Belgium), Arkema (France), 3M (US), AGC Inc. (Japan), Archroma (Switzerland).**[8]

* PFAA and PFAA precursors are used as starting materials and production aids.

**45% of fluorinated gases produced are used in the production of polymeric PFAS including fluoropolymers (EU data)[8]



Implications of PFAS Interventions on Companies

Business Risks and Opportunities for PFAS Producers

The EU PFAS restriction proposal and increased litigation as a result of the designation of PFOS and PFOA as "hazardous substances" under CERCLA represent key risks for PFAS producers. A description of these risks and potential impacts, together with relevant mitigation measures, is summarised in Table 2.

Table 2: Risks and possible mitigation measures for PFAS Producers for two key risk drivers – regulation and litigation.

Risk Drivers	Risks	Impacts	Mitigation Measures
Regulation, particularly the ECHA PFAS Restriction Proposal.	Producers (located within the EU and outside the EU) face reduced demand from EU-based product manufacturers.	• Reduced revenues. • Reduced economic efficiencies in production and reduced profitability.	• Lobbying to protect market access through additional or extended derogations or through row back on proposed restrictions. • Investment in existing and new production facilities in other geographies. • Closure of production facilities in the EU due to possible significant declines in demand within the EU and restrictions on export from the EU. • Exiting of particular product market. • Sale of patents. • Development of alternatives – through organic or inorganic investments, although it is unclear how viable or effective this would be in offsetting other costs and losses. • Business closure in the EU, also affecting the wider supply chain.
Litigation, particularly in the US as a result of CERCLA.	Producers face large expenses due to litigation.	• Higher expenses. • Reduced profitability.	• Ensure compliance with regulatory requirements. • Invest in emissions management and remediation (to mitigate risks related to personal and property damage, cases among others). • Disclose the presence of and emission factors on product packaging (to manage risks related to consumer product liability claims).

Producer companies are starting to take action in response to regulatory and litigation risks. For example, 3M has committed to exiting from PFAS production by 2025 and to working to discontinue the use of PFAS across its product portfolio by the end of 2025. 3M reported that its PFAS production volumes were down 20% in 2023.[32]

Implications of PFAS Interventions on Companies

The PFAS-related regulatory and litigation risks faced by producers in geographies such as Europe may be offset by an expected growth in demand for PFAS in applications for which there are currently no available substitutes and in applications in markets with low regulation. For example, demand is expected to grow in applications such as immersion cooling (used in data centres among other uses), electrification in transport, and semiconductors; these all rely on PFAS, but substitutes are not currently available.

PFAS producers with a customer base or a manufacturing footprint concentrated in Europe may be more exposed to tightening legislation and increased demand for PFAS substitutes than those whose business operations are diversified across markets including those with low regulatory intervention.

Opportunities exist for PFAS producers and other chemical companies to provide safer alternatives to PFAS, although the incentives needed to push such substitutes downstream to product manufacturers may only emerge once regulation is introduced. Notwithstanding this, some companies can be expected to capitalise on the opportunity to create new markets for PFAS substitutes.

Product Manufacturers

Demand for PFAS is driven by the 'product manufacturing' sectors, of which there are 14 major use sectors (Figure 9). These include the textiles, upholstery, leather, apparel, and carpets (TULAC) sectors, as well as medical devices, and applications of fluorinated gases, food contact materials, transport, construction, and electronics.[1] The TULAC, medical devices and applications of fluorinated gases sectors are the sectors with the highest demand (tonnes/year). These sectors also rank highest in terms of emissions.[1]

PFAS are used in many applications where there are no suitable substitutes. These include medical devices (such as catheters), applications in the aerospace and defence industries, and applications critical to the net-zero transition (such as semiconductors and electric vehicles).

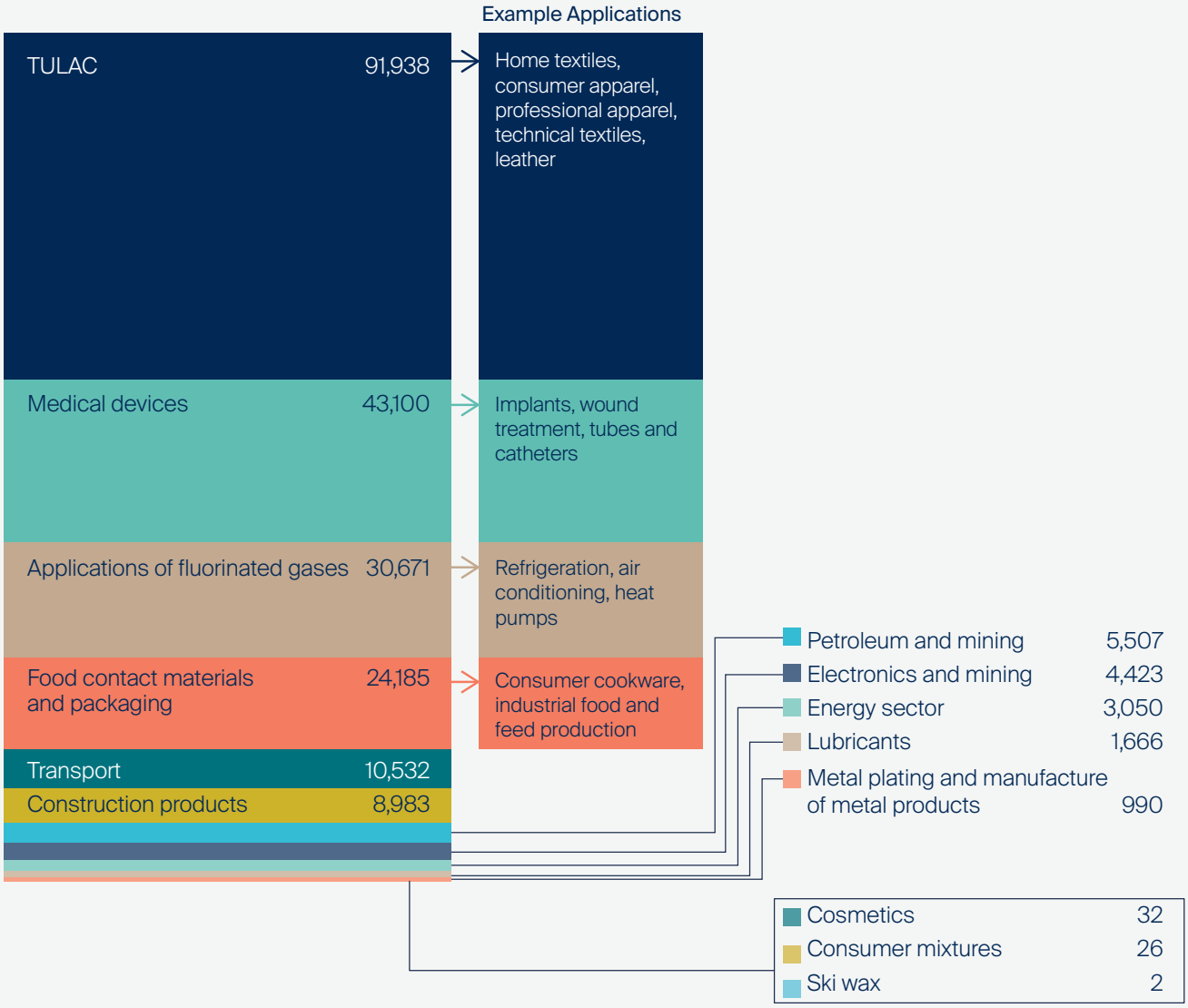
However, a significant proportion of the PFAS produced is used in applications, such as textiles and food packaging, where alternatives do exist.

Figure 9: PFAS are used in a wide range of sectors. The 14 major use sectors identified by ECHA are depicted.

Implications of PFAS Interventions on Companies

The demand for PFAS in the EU by the major use sectors in 2020 (as identified by ECHA) is illustrated in Figure 10.

Figure 10: Major use sector demand by volume (tonne/yr.). Supply is based on PFAS produced and imported in the EU. Example applications for sectors with highest demand are noted.[8] Source of image of the lifecycle of PFAS.[33]



Implications of PFAS Interventions on Companies

Box 3: The Textiles Sector – The Largest Source of PFAS Demand in the EU

The textiles, upholstery, leather, apparel, and carpets (TULAC) sector **is the largest source of demand for PFAS by tonne in the EU**. Of the sub-uses within the TULAC sector, consumer apparel accounts for 30% of PFAS use.[1] Over 75% of the PFAS used in TULAC are fluoropolymers, almost half of which is PTFE. A large proportion of these textiles are imported as mainly finished products from Asia.[8]

Business Risks and Opportunities for Product Manufacturers

Tightening regulation and the likelihood of increased litigation linked to PFAS present significant risks to product manufacturers (see Table 3).

Table 3: Risks and possible mitigation measures for Product Manufacturers for two key risk drivers – regulation and litigation.

Risk Drivers	Risks	Impacts	Mitigation Measures
Regulation	Product manufacturers may incur costs to modify products and production lines. R&D expenses are likely to be required to develop and commercialise PFAS-free products.	Varies across sector. Sectors with substitutes available which meet costs and functionality requirements may be at lower risk. Sectors with no substitutes available must develop alternatives and are at higher risk if the sector is producing products which are viewed as 'not essential' or the use of PFAS is viewed as "avoidable".	• Lobbying to protect access to PFAS and PFAS-containing products through obtaining additional or extended derogations, or through reductions in the proposed restrictions. • Investment in the development and commercialisation of new products and manufacturing lines. • Development of PFAS-free products – through organic or inorganic investments.
Litigation	Product manufacturers face large expenses due to litigation.	Varies across sectors. Higher expenses. Reduced profitability.	• Ensure compliance with regulatory requirements. • Invest in emissions management and remediation (to mitigate risks related to personal and property damage, cases among others). • Disclose the presence of and emission factors on product packaging (to manage risks related to consumer product liability claims).

The PFAS-related regulatory and litigation risks and impacts faced by product manufacturers vary based on factors such as the location of a company's markets and manufacturing capacity, the availability of substitutes for the PFAS it uses, and the extent to which the sector or products are regarded as 'essential' by regulators.

Location of markets and manufacturing capacity: Some companies may decide to adapt their product offering according to the regulatory environment across different geographies. It is possible that companies may pursue a staged phase-out approach, prioritising phase-out in certain applications and geographies, while continuing to use PFAS and offer PFAS-containing products in other markets. Others may decide to adopt more widely applicable or global positions on phasing out PFAS or banning PFAS ahead of regulation.

Availability of substitutes: Product manufacturers with access to substitutes that meet both cost and performance criteria will be at reduced risk from a PFAS-ban or phase out. Manufacturers of textiles, cosmetics, and food packaging products, for example, may be able to develop products using PFAS substitutes and benefit from increased consumer demand for PFAS-free products.

Implications of PFAS Interventions on Companies

Box 4: The Textiles Sector – A sector with substitutes available

In the textiles sector, there are substitutes which meet the industry's performance and economic criteria. Alternatives to PFAS for textiles application include hydrocarbons, silicones, polyurethane, and nanomaterials among others.[34]

As such, there appears to be an acceptance of and a movement towards a phase out of PFAS within the sector. Companies such as Home Depot and Lowe's have chosen to eliminate PFAS in their carpets and rugs, and a wave of clothing brands, including Ralph Lauren, Patagonia and Under Armour, are making public commitments to remove PFAS. Meanwhile, others, including Levi Strauss & Co., Victoria's Secret, GAP, and Deckers Brands, have already removed PFAS from their products.

Product manufacturers who lack access to viable substitutes may be able to protect market access by providing sufficient evidence to the regulators on the lack of available alternatives and by justifying the critical nature of their products.

However, product manufacturers who are not able to provide strong evidence on the lack of available substitutes and who are unable to justify why continued market access is critical, may be at a heightened risk of regulations to ban or phase out PFAS, or to litigation or public pressure.

Essential use: The concept of essential use has not yet been formally defined either by the ECHA or other regulators. Applications which are critical to the net-zero transition, such as semiconductors and electric vehicles, as well as to health, such as medical devices, are expected to be considered as 'essential'.

Applications with no substitutes and which are viewed as 'essential' are likely to be shielded from bans until alternatives are developed (e.g. the electronics sector). Manufacturers of essential applications will need to ensure the continued availability of the PFAS chemicals and products they procure from PFAS producers at a time when producers may be adapting to shifts in demand which might alter or constrain their ability to supply PFAS.

Opportunities exist for some companies to take the lead on committing to a phase out of PFAS from their products through the development and application of substitutes.

Against a backdrop of uncertainty around what regulation will apply, product manufacturers may struggle to secure investments in R&D or make decisions about the location of their manufacturing facilities. Companies will need to identify and assess the potential impacts of regulation and litigation on their business and may need to pursue multiple pathways to adequately manage risk and maximise opportunity.

Waste Management, Water Treatment and Environmental Testing Providers

For waste management, water treatment and environmental testing providers, emerging regulation and litigation potentially pose material opportunities for their businesses.

Waste management providers including AECOM and Montrose Environmental Group suggest that the total addressable market for such solutions could be around $250bn.[35,36]

For instance:

- The **wastewater management market** is expected to increase substantially with tens of billions of dollars expected to be spent as producers and manufacturers seek to reduce PFAS emissions from their facilities. For example, AECOM has suggested that the market opportunity could be $75 bn,[35] with Montrose Environmental Group suggesting that it could $160 bn.[36] Improved wastewater infrastructure will require services including engineering (project design and execution), and operation. **There are opportunities for companies with new solutions** including PFAS destruction technology. Acquisitions are likely as companies attempt to capture market share as part of their growth strategies within what is currently a highly fragmented environmental industry, particularly in the US.

- **Waste management providers stand to benefit from opportunities in the management of waste solids**. There are opportunities for companies to develop effective solutions for dealing with PFAS-contaminated sewage sludge, the by-product of water treatment.

Implications of PFAS Interventions on Companies

- There is opportunity to provide **services for the remediation of PFAS from contaminated soil** using existing technologies and through the development of more effective solutions. For instance, one company currently offering soil remediation services can inject a colloidal active carbon filtration product into the subsurface to reduce PFAS contamination. While estimates vary, the market for water and soil remediation in the Nordic countries is expected to surpass $17 billion.[35]

- **There is opportunity in the drinking water treatment market** where upgrades to existing facilities will be required to meet the lowering of drinking water limits for PFAS. There are also opportunities linked to the demand for additional testing service requirements, as new requirements on monitoring and control are introduced. Significant capital spend is expected alongside increased operational expenditure.

The US government has dedicated $9 billion in funding to address PFAS and other emerging contaminants in drinking water. An additional $12 billion in funding from the Bipartisan Infrastructure Law supports general drinking water investments, including PFAS treatment.[37]

- **Environmental testing R&D and service providers:** Whilst there are many testing service providers who can test PFAS, current analytical capabilities are limited. There are opportunities for companies who can offer improved analytical techniques for detecting PFAS (single and mixture) and for companies who can provide testing at a much larger scale (e.g., PFAS-specific high throughput assays).

In the waste and water treatment sector, companies like AECOM, Jacobs, Montrose Environmental Group, Xylem and Veolia see increased market opportunities. Other companies at the forefront of new technologies include Revive Environmental, Aquagga, and Allonnia.

Players in the growing PFAS testing market include Merck KGaA (Germany), Agilent Technologies (US), LGC Limited (UK), Waters Corporation (US), SGS (Switzerland), Eurofins (Luxembourg) and ALS (Australia).

What can investors expect from companies?

The landscape of increased regulation and litigation presents potentially material risks and opportunities for companies, including PFAS producers (chemical companies), product manufacturers that use PFAS, waste management providers, and companies offering environmental testing services.

These companies face uncertainties with respect to market access and revenue streams for PFAS-containing products, as well as impending regulation and increased litigation costs.

Companies will be expected to pursue a range of mitigation measures to manage these risks and to capitalise on new market opportunities. Typical actions by companies may include:

- Mapping their supply chains to identify where and why PFAS are used (and the extent to which their use is considered essential or not) and to understand whether PFAS substitutes are available.
- Formalising their commitment to the responsible use of PFAS in a policy statement.
- Setting time-bound targets to phase out or ban PFAS where substitutes are available.
- Measuring progress against their targets to phase out or ban PFAS.
- Investing in R&D into PFAS-substitutes.
- Reporting on their management of PFAS and on the impacts arising from their use of PFAS.
- Investing in infrastructure, such as upgrades to wastewater management and waste management systems to reduce emissions.

Actions for Investors

The investment community can support action on PFAS by:

1. Advocating for corporate disclosure on PFAS
2. Encouraging corporate action on PFAS
3. Building investor support for policy engagement
4. Building partnerships and collaborating with other investors and other key stakeholders

Investors can encourage companies to disclose relevant information on the production, use and management of PFAS. They can also advocate for proactive measures to phase out PFAS and enhance emissions management. As a set of investor objectives, these would apply to producers, product manufacturers and waste management providers alike. Further objectives specific to the particular sectors are set out in Boxes 5, 6 and 7.

1. Advocating for corporate disclosure on PFAS

Investors should advocate for corporate disclosure on:

- The use or presence of PFAS and the types and quantities of PFAS used.
- Emissions of PFAS throughout product portfolios and product lifecycles.
- The availability of alternatives to PFAS within product portfolios.

2. Encouraging corporate action on PFAS

Investors should encourage companies to:

- **Acknowledge PFAS-related risks as an important issue for the business**.
- **Make commitments** to phase out the production and use of PFAS, formalising this in a policy statement or equivalent.
- **Develop time-bound plans with objectives and targets for:**
  - **The phase-out of PFAS**, and reformulation incorporating the time required for R&D, commercialisation, regulatory approval (if applicable) and production line changes.
  - **Improved emissions management and remediation** within their facilities and surrounding areas.
- **Establish a governance framework** to oversee delivery against the plans.
- **Measure progress against their commitments and targets** for the phase-out of PFAS, improved emissions management and remediation.
- **Report** on the management of PFAS and on the impacts arising from the use of PFAS.

Box 5: Investor Engagement with PFAS Producers

Fluoropolymer producers are a critical link in the PFAS value chain, buying PFAS precursors and fluorinated gases, and selling PFAS in the form of fluoropolymers to downstream product manufacturers. Given the relatively consolidated nature of the fluoropolymer market, investors could significantly impact PFAS production by influencing a relatively small number of companies producing fluoropolymers. Investors could:

1. Engage with PFAS producers to **push for improved transparency** on the types and volumes of PFAS they procure, use, produce and/or market.
2. Encourage PFAS producers to make c**ommitments, and issue time-bound plans for the phase-out of PFAS, to identify, develop and commercialise safer and more sustainable alternatives** and for **emissions reduction**. As part of this, investors could share examples of producers who have made commitments to phase out the production of PFAS. For example, 3M has committed to exiting production of PFAS by 2025.[32]
3. Engage with PFAS producers to **encourage emission reductions** across their manufacturing footprint including in geographies with weaker emissions standards.

Refer to Appendix 3 for key questions investors may ask of PFAS producers.

Investors could also consider engagements beyond producers; for example, they could engage with their key customers or with the downstream product manufacturers.

Actions for Investors

Box 6: Investor Engagement with Product Manufacturers

Investors could:

1. Engage with product manufacturers to push for improved transparency on the types and volumes of PFAS they use.
2. Encourage product manufacturers to make commitments and to issue a PFAS phase-out plan outlining the approach and timeline for reformulation across all applications including those with and without available substitutes.
3. Engage with product manufacturers which use PFAS in applications without available substitutes (e.g. semiconductor manufacturing, medical devices) to understand their strategy for ensuring continuity of PFAS supply during the period while alternatives are being developed.
4. Encourage investment in the development and commercialisation of alternatives, the use of circular design principles, and emissions reduction.
5. Support industry collaboration for the establishment of relevant standards or encourage engagement and adherence to existing ones.

Refer to Appendix 3 for key questions investors may ask of product manufacturers, brands, and retailers.

Product Manufacturers in the Textiles Sector – A sector where investor engagement could drive change.

The textile industry is one of the most extensive users of PFAS and is among the sectors with the largest emissions contribution. In the absence of regulation, PFAS-demand and emissions from the textiles sector are expected to increase. Emissions occur during manufacture, use and waste stages. Within this sector, where brands are the key players, some brands have already eliminated PFAS while others have made commitments for phase out.

An investor collaboration with a specific focus on the textiles sector over a set period could be impactful. This sector, a significant source of demand for PFAS in the EU, shows a readiness for change due to the availability of substitutes, the low capital needed for transitioning to alternatives, and the precedent set by early adopters in the industry.

Product Manufacturers in Food Packaging and other Plastics

Many investors are engaged on plastic pollution, for example, through the 2024 private sector statement to Global Plastics Treaty negotiators prepared by UNEP FI, the Principles of Responsible Investment (PRI), the Finance for Biodiversity Foundation, the Business Coalition, VBDO, and CDP.

While not directly referenced in this 2024 statement, investors are becoming increasingly aware of the presence of hazardous chemicals in plastics. Of the thousands of chemicals used in the production of plastics, many PFAS chemicals are used, for example, in the linings for food containers and wrappers. The use of such chemicals is a barrier to the development of a safe and sustainable circular plastics economy.

Box 7: Investor Engagement with Waste Management Service Providers

Investors could:

1. Encourage waste management service providers to set out time-bound plans with objectives and targets for improved emissions management and remediation, even in geographies where the tightening of standards and limits is likely to lag.
2. Engage with wastewater and waste management providers to implement best practices in managing PFAS-containing waste. This could include encouraging them to:
    - Invest in new technologies.
    - Comply with tightening waste regulations and limits.

Refer to Appendix 3 for key questions investors may ask of waste management service providers.

3. Building investor support for policy engagement

Investors can play a role in policy engagement, encouraging international collaboration as well as supporting regional and country-level regulatory efforts on PFAS.

To this end, investors should support:

- Increased reporting requirements (e.g. reporting requirements similar to the Toxic Substances Control Act (TSCA) in the US which applies from 2024 and retroactively for PFAS manufactured or imported since 2011).
- Bans on PFAS for specific applications where suitable alternatives exist (e.g. proposed bans on PFAS-containing firefighting foam under consideration in several countries, including multiple US states, the EU, and New Zealand, and proposed bans on PFAS-containing food packaging in several US states and the EU, as well as on cosmetics in New Zealand).
- The EU PFAS restriction proposal, with proposed bans on PFAS use in applications with available alternatives (including food packaging, consumer mixtures, cosmetics, and textiles) and temporary derogations for applications without available alternatives.
- Tighter drinking water standards (e.g. the US EPA nationwide legally enforceable drinking water limits).
- Stricter emissions standards (e.g. as driven by designation of PFOS and PFOA as hazardous substances under US CERCLA).
- Calls on regulators to review and ban the application of sludge from wastewater treatment plants to agricultural soils.

For further detail on the regulatory landscape, see Table 1 (page 18).

4. Building partnerships and collaborating with other investors and other key stakeholders

Investors can increase their influence by building partnerships and collaborating with other investors and key stakeholders such as NGOs, with a shared focus on the phase out of PFAS. Such partnerships could focus on coordinating investor engagement to speed up company action to phase out PFAS in favour of safer, sustainable alternatives especially where regulatory efforts lag. For example, the Investor Initiative on Hazardous Chemicals (IIHC) supported by Swedish NGO ChemSec has active engagements in companies from the pool of main global manufacturers. See Box 8.

Box 8: The Investors Initiative on Hazardous Chemicals, supported by ChemSec.

- The Investor Initiative on Hazardous Chemicals is supported by the Swedish NGO, ChemSec, a non-profit organisation that advocates for the substitution of hazardous chemicals with safer alternatives.
- In 2023, the IIHC issued its third joint investor letter to chemical producers from 54 investors with $10 trillion in assets under management.
- The key asks of the IIHC are to:
    1) increase transparency;
    2) publish a time-bound phase-out plan; and
    3) develop safer alternatives.[38]
- The IIHC has active engagements with companies in the pool of main global manufacturers including 3M, AGC Inc., Arkema, Chemours, Solvay, AkzoNobel. Engagements are also ongoing with BASF, Bayer, Dow, DuPont, Nan Ya Plastics, PPG Industries, Sherwin-Williams, Shin-Etsu, Sika, Umicore, Yara.[38]
- Investors can use ChemScore, a comparative assessment of the world's top 50 chemical producers based on their efforts to reduce their production of hazardous chemicals and boost investments in safer and sustainable alternatives.

Appendices

Appendix 1: Family of Chemicals

PFAS compounds number in the thousands and are present in a wide range of industrial, commercial, and consumer goods.

There is **no universal definition for PFAS**. The latest OECD definition (2021) encompasses about 4,700 chemical entities.[39] The **European Chemicals Agency (ECHA)** notes that its definition[1] aligns with the OECD definition, and is **a wide definition** including Perfluoroalkyl acids (PFAAs), polyfluoroalkyl acids, PFAA precursors and other PFAS including fluoropolymers as well as fluorinated gases.[1] The inclusion of pre-cursers within the scope of PFAS drives **expansion of the number of entities to over 10,000**. Within this definition there is an exception concerning fully degradable PFAS subgroups. In the US, **the Environmental Protection Agency (EPA) has used a narrower working definition**, applying to some 5,000 chemical entitles, although this may be evolving.[40]

Figure 11: Number of PFAS entities encompassed by PFAS definitions, including ECHA[1], OECD[37] and US EPA.[38]

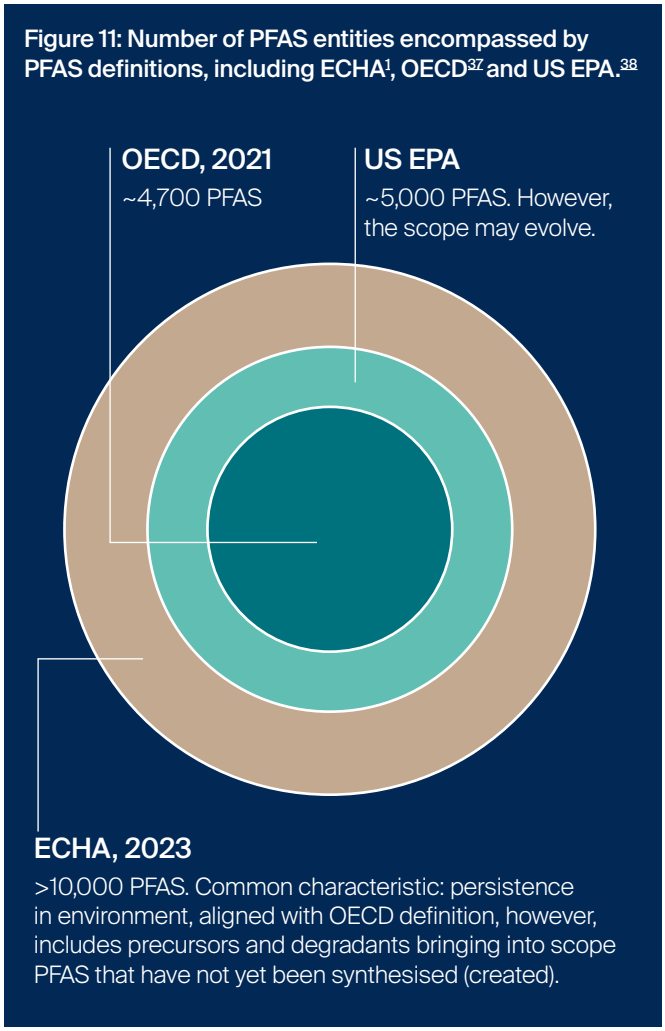
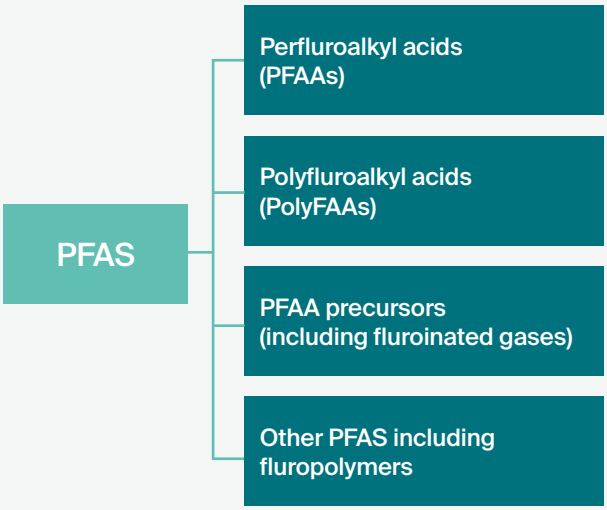


Figure 12: Classes and subgroups in the PFAS family (based on ECHA, 2023).[1]



Appendix 2: Business Risks and Opportunities

An overview of PFAS-related risks and opportunities faced by PFAS producers, product manufacturers and waste management and environmental testing service providers, is provided in Table 4.

Table 4: Potential Risks and Opportunities for PFAS Producers, Manufacturers, and Waste Management and Environmental Testing service providers.

Green denotes positive impacts whereas red denotes negative impacts. Orange represents neutral impacts or general points.

Risk / Opportunity Driver	PFAS Producers	Product Manufacturers – Substitutes Available	Product Manufacturers – No Substitutes Available	Waste Management and Environmental Testing Service Providers
Example Sectors	Chemical manufacturing; materials science.	Textiles including apparel, cosmetics, consumer mixtures (e.g. cleaning agents, waxes, polishes); food packaging.	Medical devices (e.g. hernia meshes, tubes and catheters); applications of fluorinated gases (e.g. insulating high-voltage switchgear); semiconductor manufacturing.	Environmental consulting and engineering services.
Expanding Regulation	Lost revenues through potential reductions in demand and reduced profitability due to reduced economies of scale in production, notably in the EU due to the EU PFAS restriction proposal. Potential factory closures. Unknown offsetting potential for alternatives. Front runners could develop new revenue streams through the development and commercialisation of PFAS-alternatives. Higher costs due to increased reporting requirements in the US under TSCA. CAPEX and increased costs in waste management due to tightening wastewater standards.	Higher costs related to the tightening regulation requiring the substitution of PFAS with available alternatives, in sectors such as food packaging, cosmetics, consumer mixtures and textiles. Relevant in the EU due to the EU PFAS restriction proposal, as well as in several US states due to various state level regulations, among other geographies. Increased costs due to increased reporting requirements in the US under TSCA. CAPEX and increased costs in waste management due to tightening wastewater standards.	New costs related to R&D particularly in the EU due to the EU PFAS restriction proposal which includes derogations but for limited periods of up to 12 years. Acquisition of emerging technologies or companies. Future potential CAPEX requirements to invest in new manufacturing technologies and production line changes. Increased costs due to increased reporting requirements under TSCA in the US. CAPEX and increased costs in waste management due to tightening wastewater standards.	Significant opportunity for new revenues and profits from expanding markets in the wastewater treatment upgrades, a need for new technologies, remediation services and expanded analytical testing capabilities and capacity as a result of tightening wastewater and drinking water standards, and remediation obligations. Acquisitions are likely as companies attempt to capture market share as part of their growth strategies within what is currently a highly fragmented environmental industry, particularly in the US.
Litigation	Litigation and enforcement action costs - fines and penalties, and corrective actions including clean-up or remediation actions. Could be driven by class action, property and personal damage.	Litigation and enforcement action costs - fines and penalties, and corrective actions including clean up or remediation actions. Could be driven by class action, property and personal damage, or consumer product liability.	Litigation and enforcement action costs - fines and penalties, and corrective actions including clean up or remediation actions. Could be driven by class action, property and personal damage, or consumer product liability.	Litigation and enforcement action including clean up and remediation action.
Reputational – Changing consumer sentiment	Producers with no direct exposure (e.g. through market presence) to EU regulation may be indirectly impacted through the impact of the regulation on public perception and consumer sentiment.	Consumer facing companies could be at risk of changing consumer preferences. Leaders in the phase-out of PFAS could benefit from enhanced reputation and may be able to differentiate themselves through PFAS-free products.	Less risk in comparison to those with available substitutes.	Could be enhanced as a result of role in remediation and reducing future contamination.

Appendix 3: Key Questions for Engagements

Engaging with PFAS Producers

Key questions investors may ask of PFAS Producers are presented in Table 5.

Table 5: Key Questions for PFAS producers.

Expectation	Initial questions	Follow-on questions (if needed)
Acknowledgement	Does the company acknowledge PFAS-related risks as an important issue for the business?	
Commitment	Has the company made a formal commitment to phase out the use of PFAS in product manufacturing?	Is the company planning to make such a commitment and if so, when? Is the company preparing for the phase-out of PFAS by customers in sectors with available substitutes, particularly in geographies which are likely to be impacted by tightening regulation?
Risk assessment and management	What are the types and volumes of PFAS that the company uses? This may include: 1) Types and volumes of PFAS producer and used or applied in product manufacturing. 2) Types and volumes of PFAS contained across the company's product portfolio. 3) Types and volumes of PFAS waste.	In what geographies are the PFAS used or marketed? Does the definition under which the company reports on PFAS align with the definition used by regulators in the geographies in which the company operates? Companies exposed to the EU PFAS restriction proposal should consider the definition used by ECHA which includes fluoropolymers and fluorinated gases.
Risk assessment and management	Outline the PFAS-related risks faced by the company including those arising from interventions such as: • Existing and future regulation • Litigation • Reputational issues	What proportion of the PFAS produced is used in sectors for which substitutes are available (e.g. food packaging, textiles)? Note: Under the EU PFAS restriction proposal, sectors with available substitutes have no derogation proposed. This is depicted in Figure 8 (page 17). Can the company provide scenarios and risk mitigation plans for possible remediation and litigation liabilities?
Time-bound plans	Has the company set out a time-bound plan with objectives and targets for the phase-out of PFAS? Has the company set out a time-bound plan with objectives and targets for improved emissions management and remediation?	Does the company have a formal objective or target to substitute PFAS processing aids in its production? Does the company have a formal objective or target to develop, commercialise or market safer sustainable alternatives for customer applications? Does the company have a time-bound objective or target to reduce PFAS emissions from the manufacture, product use and waste stage of its PFAS chemicals? Does the company have a time-bound objective or target to address PFAS contamination within their facilities and surrounding areas?
Governance	Can the company provide an overview of the governance framework to oversee delivery against the plans?	
Reporting	Does the company report: • The types and volumes of PFAS used. • The types and volumes of PFAS produced. • The types and volumes of PFAS waste. • PFAS emissions. • The availability of alternatives to PFAS within product portfolios. Does the company report on its progress against its PFAS-related objectives or targets? Is the company involved in trade associations and other lobbying-linked activities on PFAS?	If so, what are the primary aims of these lobbying activities?

Appendices

Engaging with Product Manufacturers

Key questions investors may ask of product manufacturers, brands and retailers are presented in Table 6.

Table 6: Key questions for product manufacturers, brands and retailers.

Expectation	Initial questions	Follow-on questions (if needed)
Acknowledgement	Does the company acknowledge PFAS-related risks as an important issue for the business?	
Commitment	Has the company made a formal commitment to phase out the use of PFAS in product manufacturing?	Is the company planning to make such a commitment and if so, when?
Risk assessment and management	What are the types and volumes of PFAS that the company uses? This may include: 1) Types and volumes of PFAS producer and used or applied in product manufacturing. 2) Types and volumes of PFAS contained across the company's product portfolio. 3) Types and volumes of PFAS waste.	In what geographies are the PFAS used or marketed? Does the definition under which the company reports on PFAS align with the definition used by regulators in the geographies in which the company operates? Companies exposed to the EU PFAS restriction proposal should consider the definition used by ECHA which includes fluoropolymers and fluorinated gases.
Risk assessment and management	Outline the PFAS-related risks faced by the company including those arising from interventions such as: • Existing and future regulation • Litigation • Reputational issues	To what extent are substitutes available? Note: Under the EU PFAS restriction proposal, sectors with available substitutes have no derogation proposed. This is depicted in Figure 8 (page 17). Can the company provide scenarios and risk mitigation plans for possible remediation and litigation liabilities?
Time-bound plans	Has the company set out a time-bound plan with objectives and targets for the phase-out of PFAS? Has the company set out a time-bound plan with objectives and targets for improved emissions management and remediation?	What are the company's targets and plans to identify, develop, commercialise or market safer sustainable alternatives? How is the company including PFAS in design towards improved recycling and circularity? Does the company have a time-bound objective or target to reduce PFAS emissions from the manufacture, product use and waste stage of its PFAS-containing products? Does the company have a time-bound objective or target to address PFAS contamination within their facilities and surrounding areas?
Governance	Can the company provide an overview of the governance framework to oversee delivery against the plans?	
Reporting	Does the company report: • The types and volumes of PFAS used. • The types and volumes of PFAS contained in the company's product portfolio. • The types and volumes of PFAS waste. • PFAS emissions. • The availability of alternatives to PFAS within product portfolios. Does the company report on its progress against its PFAS-related objectives or targets? Is the company involved in trade associations and other lobbying-linked activities on PFAS?	If so, what are the primary aims of these lobbying activities?

Appendices

Engaging with Waste Management Service Providers

Key questions investors may ask of waste management service providers are presented in Table 7.

Table 7: Key questions for waste management service providers.

Expectation	Initial questions	Follow-on questions (if needed)
Acknowledgement	Does the company acknowledge PFAS-related risks and opportunities as an important issue for the business?	
Commitment	Has the company formalised its commitment to the responsible management of PFAS-containing waste?	Is the company planning to make such a commitment and if so, when?
Risk assessment and management	What are the types and volumes of PFAS-containing waste that the company manages?	In what geographies are the PFAS-containing waste managed?
Risk assessment and management	Outline the PFAS-related risks faced by the company including those arising from interventions such as: • Existing and future regulation • Litigation • Reputational issues	Can the company provide scenarios and risk mitigation plans for possible remediation requirements? What is the company doing to prepare for regulatory changes including more stringent emissions limits and additional monitoring and reporting requirements? How is the company preparing for the expected growth in demand for PFAS-waste management services?
Time-bound plans	Has the company set out a time-bound plan with objectives and targets for improved emissions management and remediation?	Does the company have a time-bound objective or target to reduce PFAS emissions? What investment is the company making in PFAS remediation and destruction? Does the company have a time-bound objective or target to address PFAS contamination within their facilities and surrounding areas?
Governance	Can the company provide an overview of the governance framework to oversee delivery against the plans?	
Reporting	Does the company report: • The types and volumes of PFAS managed. • PFAS emissions Does the company report on its progress against its PFAS-related objectives or targets?	

Appendices

Appendix 4: Acronyms

Acronym	Full description
AFFF	aqueous film forming firefighting foam
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act (United States)
ECHA	The European Chemicals Agency
HBM	human biomonitoring
IIHC	Investor Initiative on Hazardous Chemicals
MDL	multidistrict litigation (United States)
NIH	National Institute of Health (United States)
PFCAs	perfluorocarboxylic acids
PFHxS	perfluorohexanesulphonic acid
PFOA	perfluorooctanoic acid
PFOS	perfluorooctanesulfonic acid
POPs	persistent organic pollutants
PRPs	potentially responsible parties
TNFD	The Taskforce on Nature-related Financial Disclosures
TSCA	Toxic Substances Control Act (United States)
TULAC	textiles, upholstery, leather, apparel, and carpets
US EPA	The United States Environmental Protection Agency
WHO	World Health Organisation

Appendices

Appendix 5: Glossary/Key Terms

Term	Meaning
AFFF	Aqueous film forming firefighting foam (AFFF) is used by fire departments to put out liquid-fuelled fires such as those caused by oil, gasoline, or other flammable liquids.[41]
Endocrine Disruption	Chemicals, either natural or artificial, that mimic or interfere with the body's hormones, or the endocrine system, are referred to as endocrine disruptors. The effects encompass developmental malformations, reproductive interference, elevated cancer risk, and disruptions in immune and nervous system function.[42]
Gen X	Hexafluoropropylene Oxide Dimer Acid (HFPO-DA) and its ammonium salt are commonly referred to as "GenX chemicals," linked to the GenX processing aid technology. Chemours uses Gen X chemicals as a patented polymerisation aid for fluoropolymer production.[45]
Human Biomonitoring	The concentration of chemicals, contaminants, or their metabolites in human fluids and tissues is directly measured by human biomonitoring, or HBM.[43]
Leachate	Liquid that has extracted soluble, dissolved, or suspended elements from solid waste in a landfill by seeping through it.
Mass tort	In the legal realm, a mass tort is a civil lawsuit filed in state or federal court by numerous plaintiffs (those bringing the lawsuit) against one or a few defendants (those being sued). These lawsuits arise from a similar instance of harm allegedly caused by the defendants, such as a defective product release or negligent action leading to mass injury.
PFAS	PFAS are defined as fluorinated substances that contain at least one fully fluorinated methyl or methylene carbon atom (without any H/Cl/Br/I atom attached to it), i.e. with a few noted exceptions, any chemical with at least a perfluorinated methyl group (–CF3) or a perfluorinated methylene group (–CF2–) is a PFAS."[39]
Toxicology	Toxicology is the scientific discipline that aids in the understanding of the detrimental effects that chemicals, substances, or situations can have on humans, animals, and the environment.[44]

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