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PFAS

Forever chemicals… forever pollution?

Astrid Pierard
ESG Analyst

Jessica Carlier
ESG Analyst

Bastien Dublanc
Senior Portfolio Manager

PFAS have been widely used for decades due to their unique properties in various domestic and industrial applications. They are resistant to water and virtually indestructible, earning their nickname "forever chemicals". They are also seen as the poison of the century.

The increasing awareness of their impact on health and on our environment has put PFAS in the spotlight for regulators, particularly in Europe and to a lesser extent in the US. Restricting their use poses regulatory and market risk for companies but also opens up investment opportunities, notably in pollution cleanup solutions or in PFAS replacement.

Explore Close up

1. Used everywhere and last forever!

PFAS, Per- and Polyfluoroalkyl Substances, are a group of manufactured chemicals, used since the 1940s and originally designed and developed to be extremely resistant, and therefore called 'forever chemicals'. They contain carbon-fluorine atom bonds, which make the chain of molecules in PFAS almost “unbreakable”. As thousands of years may be needed to eliminate them, they have accumulated in ecosystems, water sources and in living organisms, including humans.

PFAS have been mostly used in products and processes where water and oil-repellent properties are needed, especially in high temperature, high pressure, or acidic environments - in domestic uses for cooking ware, food packaging, textile, cosmetics, fire extinguishers, and in industrial uses for coatings, paintings, insulation foams, and even pesticides.

Figure 1:
PFAS are used everywhere in our daily lives

Source: Candriam

2. Measuring impacts: it's just the beginning.

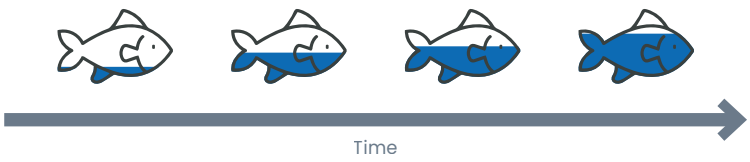
The release of PFAS into the environment raises concerns, as they can lead to soil, groundwater, and surface water contamination, posing risks to public health, safety and ecosystems. **We have probably underestimated both the quantity that has been released and accumulated, as well as the health and pollution impact of its bioaccumulation.**

Infiltration of PFAS in the environment and most notably water supply has long been a key concern, estimated to have caused about 6 million deaths in the US between 1999 and 2018[1]. Widespread contamination is observed across 50 states in the US[2]. PFAS are potentially **present in the blood of 95-100% of the US population**[3].

Figure 2:
Bioaccumulation and biomagnification, the two main vectors or PFAS contamination

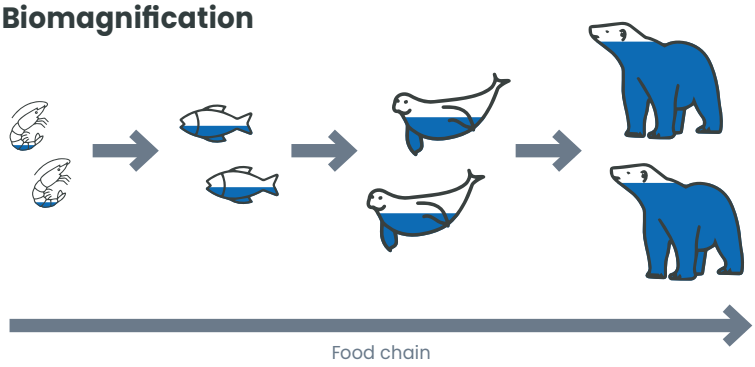
Contaminant levels

Bioaccumulation



Bioaccumulation: accumulation over time of a substance and especially a contaminant in a living organism

Biomagnification



Biomagnification: the process by which a compound (such as a pollutant or pesticide) increases its concentration in the tissues of organisms as it travels up the food chain

Sources: MIT, www.merriam-webster.com

1 - Source: BofA, Wen et al., 2022
2 - Source: BofA
3 - Source: US Centers for Disease Control (CDC)

Most PFAs are considered to be **moderately to highly toxic for humans**, and linked to various hormonal, reproductive and carcinogenic illnesses. Medical studies associate PFAS exposure with conditions such as thyroid disease, low fertility, and various cancers.

In addition, PFAS contamination in both water and land poses a biodiversity risk, through bioaccumulation and biomagnification in animals. PFAS may induce health and reproductive issues, endangering wildlife populations. The EWG (Environmental Working Group) identifies over **600 species at risk due to PFAS exposure.**

PFAS contaminated water is not a new concern. Companies such as 3M[4] and Du Pont have been involved in class actions lawsuits due to contamination in water systems. In June 2023, 3M agreed to pay $10.3 billion to settle hundreds of claims the company polluted public drinking water with the chemicals[5].

The U.S. Environmental Protection Agency recognises PFAS an "**urgent public health and environmental issue**" and is in the process of taking steps to regulate them.

PFAS are becoming a focus for public authorities in a growing number of countries, pushing regulators to act.

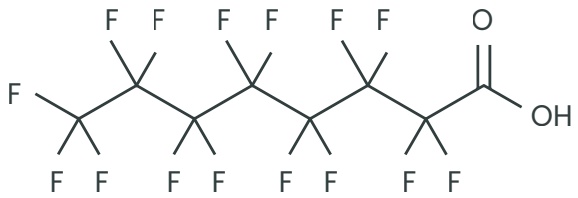
3. Europe at the forefront on regulatory aspects.

The regulatory landscape for PFAS is complex and varied, with fragmentation across regions and even, in the US, across States.

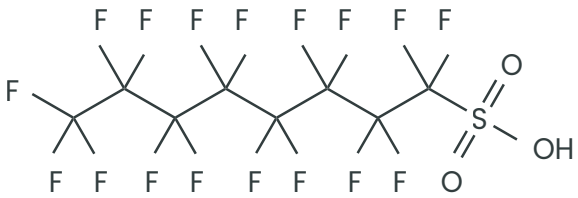
In Europe, recent studies indicate broader contamination than previously believed. **The Stockholm Convention serves as a key regulation.** Adopted in 2009, it designates **three subgroups of PFAS** - PFHxS, PFOA and PFOS - a**s industrial Persistent Organic Pollutants (POPs) and prohibits their use in the EU.** This regulation targets what are considered as the most well-known and studied forms of PFAS but does not cover thousands of other forms of PFAS that are structurally similar in their composition. Some others are designated as Substances of Very High Concern (SVHC) under the **REACH regulation**[6], which restricts their use and includes transparency requirements. The 2021 update of the Drinking Water Directive and food product regulations established in 2022 in the EU have imposed stricter limits.

4 - At the time of writing, Candriam holds minor exposure to 3M and Du Pont stocks
5 - https://www.reuters.com/legal/government/chemours-dupont-corteva-reach-110-mln-forever-chemicals-ohio-settlement-2023-11-29/
6 - REACH stands for Registration, Evaluation, Authorization and Restriction of Chemicals. This regulation of the European Union was adopted to improve the protection of human health and the environment from the risks that can be posed by chemicals, while enhancing the competitiveness of the EU chemicals industry. It also promotes alternative methods for the hazard assessment of substances in order to reduce the number of tests on animals. It entered into force on 1 June 2007.

Figure 3:
Chemical structure of PFOA and PFOS



PFOA: Perfluorooctanoic acid



PFOS: Perfluorooctanesulfonic acid

Source: ResearchGate

In the US, there is currently no overarching regulation but various states have implemented restrictions, with broader regulations under consideration notably in Maine and Minnesota.

Two overarching regulations are currently being discussed in the EU and in the US, that could significantly restrict or at least control the manufacture and use of PFAS.

• **In the US**, in April 2024, the Environmental Protection Agency announced the first national drinking water limit on PFAS, entering into a new era of drinking water standards for Americans. The **National Primary Drinking Water Regulation** set limits on 6 types of PFAS including PFOA and PFOS. Public water systems must complete initial monitoring of PFAS levels by 2027 and by 2029 implement PFAS reduction solutions.[7]

• **In the EU**, the European Chemicals Agency (ECHA) put forward a **Blanket Ban Proposal** in February 2023 to restrict the manufacture, use, and sale/import of PFAS, or substances/articles containing PFAS, above a certain concentration. The proposal restricts 10,000 PFAS in the EU, and would represent one of the largest bans on chemicals in Europe. The EU ban is expected to enter into force in 2025.

The proposal includes two options, the first being a **blanket ban only** and the other a **blanket ban with longer transition periods for some specific**

> **Filthy water cannot be washed.**
>
> **– African proverb**

7 - https://www.epa.gov/sdwa/and-polyfluoroalkyl-substances-pfas
https://apnews.com/article/forever-chemicals-pfas-pollution-epa-drinking-water-1c8804288413a73bb7b99fc866c8fa51
https://natlawreview.com/article/us-environmental-protection-agency-finalizes-national-primary-drinking-water

uses – the option recommended by ECHA, which would consider the existence, or not, of alternatives. This latter option would incorporate a 1.5 year transition period following entry into force, after which all manufacture, use and placement on the market is banned. After the transition period ends, some uses will have an additional 5 or 12 years before the ban is applicable.

Derogations are proposed based on the "**non-existence of technically and economically feasible alternatives**" before entry into force. Most of them relate to health (medical devices), safety (textiles for personal protective equipment), existing regulation (housing codes for air-conditioning), and extreme temperatures/conditions (refrigerants for -50°C or lower).

In April, the French Assemblée Nationale adopted a bill to ban the use of PFAS in France[8]. Its flagship measure will ban the manufacture, import and sale of products containing PFAS in France. The ban, effective January 1, 2026, will prohibit PFAS in three categories of consumer goods: cosmetics, clothing textiles (excluding protective clothing for security and civil protection workers) and ski waxes. All textiles will be covered by the ban from January 1, 2030. An exemption was made for non-stick frying pans, following industry pressure.

In the rest of the world, countries like Japan, the UK, and Canada are also contemplating PFAS regulations. Despite varying restrictions worldwide, a common trend towards tightening regulations exists. The influential roles of the EU and the US, two of the largest consumer markets, are expected to shape global PFAS use.

8 - Le Monde, French lawmakers vote to ban 'forever chemicals' except in cooking utensils, https://www.lemonde.fr/en/environment/article/2024/04/05/french-lawmakers-vote-to-ban-forever-chemicals-except-in-cooking-utensils_6667451_114.html

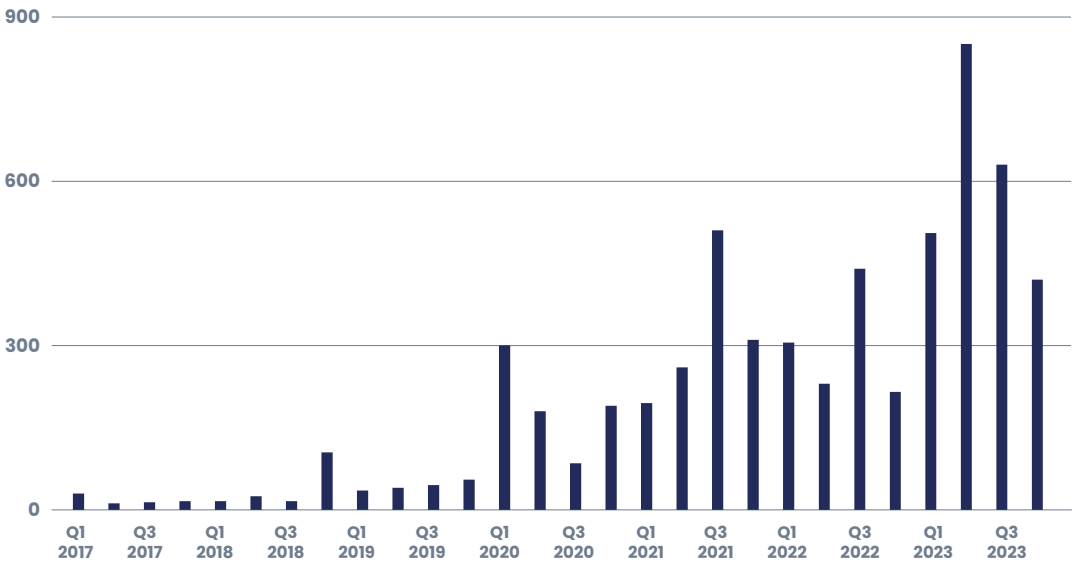
4. Regulatory risks are on the rise, market risk will follow.

As regulatory and market risks increase, companies neglecting the materiality of PFAS risks on their business could face costly business disruption, such as environmental liabilities, lawsuits, reputational harm, leading to reduced shareholder value. **Over 9,900 PFAS-related lawsuits were filed in US federal courts between July 2005 and December 2023**[9], primarily directed at PFAS manufacturers. Only twelve main companies account for a majority of the PFAS production in the world[10]. Last year, lawsuits against major chemical manufacturers resulted over $11 billion in settlements[11].

Tightening regulations and evolving disclosure requirements will likely lead to an increase in legal action, including class actions, against manufacturers and expanding to intermediaries using PFAS in their value chain. Sectors such as Semiconductors, Electronic Components, Industrials, waste management, transportation of PFAS-containing products, and Retailers selling clothing containing PFAS, may face increased litigations.

Widespread PFAS pollution cases and growing regulatory transparency may also alter consumer behavior and notably purchasing habits, **posing market risks for companies selling products containing PFAS.**

Figure 4:
Number of US federal lawsuits containing the keywords 'PFAS' by quarter, Q1 2017-Q4 2023



Source: BofA US ESG Research, Bloomberg Law

9 - Source: Bloomberg Law's litigation database
10 - Source: ChemSec, 2023
11 - https://www.reuters.com/legal/litigation/forever-chemicals-were-everywhere-2023-expect-more-litigation-2024-2023-12-28/

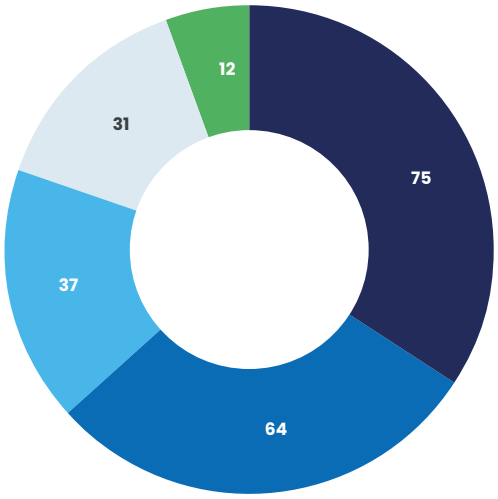
5. Where are the opportunities?

PFAS are used in so many ways, and their chemical properties are so unique, that a plethora of alternatives will be needed to replace them. There have been few initiatives from industrials to address the issue of replacing PFAS with less harmful substances. Shorter-term opportunities therefore lie in water treatment, supply and protection.

Addressing PFAS contamination in soil, air or water sources requires innovative advanced technologies and tailored solutions capable of effectively removing these persistent pollutants. Investing in these technologies is key to mitigate PFAS' negative externalities. The environmental consulting agency Aecom estimates that **the global spend to tackle PFAS contamination is over $250 billion**[12]. In the US alone, the estimated addressable PFAS market represents about $219 billion[13] (see figure 5). Wastewater reflects the largest addressable sub-sector, followed by industrial remediation.

Several water-linked technologies have been developed for PFAS filtration and remediation, offering promising solutions to this pressing environmental challenge.

Figure 5:
Estimated PFAS opportunity in the US: $219 B (2023)



Wastewater/ Biosolids	75
Industrial Remediation	64
Federal Remediation	37
Drinking Water	31
Aviation	12

Source: Environmental Business Journal, Volume 35, 7/8, 2023

12 - Source: AECOM, What is the addressable PFAS market, 2023
13 - Source: Environmental Business Journal, Volume 35, 7/8, 2023

Figure 6:
Overview of available PFAS Treatment Technologies

Separation	High-Pressure Membranes	Membrane technologies are used to concentrate PFAS contaminants in a reject stream.
	Flotation	Microbubble technology (ozone or air) works to concentrate PFAS in a froth. This technology is best suited for very high initial PFAS concentrations.
Capture	Granular Activated Carbon (GAC)	A proven technology and the most widely used to date among capture technologies, with application in 80-90% of installations. After use, GAC media can be reactivated and reused.
	Anion Exchange	Also a proven technology. Uses ion exchange and absorption mechanisms. Anion exchange media includes both single use and regenerable options.
	Novel Adsorbents/ Precipitants	May include clay-, cellulose- or starch-based options. Some may have an affinity for small chain PFAS. Further testing is required.
Destruction	Thermal	Currently the most widely used method. Further application will depend on the ongoing evaluation of the fate of PFAS in solids and gas phases.
	Plasma, Catalytic Electrochemical Oxidation and Sonolysis	Early stage of development, with potential for on-site destruction

Source: Suez, Candriam

In our analysis, investment opportunities linked to PFAS can be broken down in **three segments: water treatment, water supply and water protection.**

Water treatment technologies:

As outlined in the table above, the main technologies to capture PFAS are Granular Activated Carbon and Anion Exchange. Companies like Veolia[14] or Xylem - notably following its acquisition of Evoqua - have these technologies off their shelf. Besides, their mobile solutions (treatment trucks) can be deployed on any given industrial site. Ecolab, through the acquisition of Purolite, has developed ion exchange resins to remove PFAS from drinking and industrial water.

UV-based solutions to treat PFAS are academically (and lab-) proven but the economics are not there yet. Companies such as Xylem and Halma are notably looking into UV applications for treatment solutions.

Before utilities are able to distribute water whose PFAS level complies with regulations, users can implement water treatment solutions at "point of entry" – where water is treated at the entrance of the building (house, shopping center, restaurant…) or at "point of use" – upstream of the distribution point (tap, water fountain…). Companies such as Zurn Elkay or A.O. Smith have developed such solutions

Water supply opportunities:

With more stringent rules about PFAS concentration, US Water Utilities will need to make large investments to address new requirements. The capital spending that companies will need to deploy could be around 6%/6.5% of their budget, according to preliminary estimates[15]. Those investments will garner a regulated return on equity (around 10%) which will turn into a growth driver for earnings.

Water protection opportunities:

The market opportunity to tackle sites contaminated by PFAS is estimated at $250+B. As a rule of thumb, 3 to 5% of any project ends in consulting/engineering, leading to a $10B+ opportunity[16]. Firms like TetraTech has a strong track record in PFAS remediation work (notably for US military bases) but we believe that direct PFAS revenue exposure is below 3%. Given the market outlook, this number could grow.

14 - At the time of writing, Candriam holds some exposure to Veolia, Xylem, Ecolab, Halma, Zurn Elkay and Tetratech stocks.
15 - Sources: companies' investor presentations.
16 - Source: Candriam estimate, March 2024

Conclusion : forever pollution?

PFAS are not called forever chemicals by accident. While they are broadly recognised as toxic, they are so deeply impregnated into soils, water and organisms that it is highly complex to remediate the pollution they have caused. Besides, they have such powerful properties and are so widely used that alternatives will take time to develop. Regulators worldwide, led by the EU and the US, are finally addressing the issue, but it will take time before the implementation of new rules makes a real difference. In the meanwhile, market risks increase, potentially causing business disruption for companies.

Before suitable alternatives are found, technological solutions are being developed to remedy pollution and protect water, creating an estimated addressable PFAS market of $250 billion[17] or more – the size of the opportunity pool could have us look at our takeaway food packages differently! This is yet another area where private capital flows can make a difference and contribute to a more sustainable world.

17 - Source: Aecom