THEMATICS asset management *Insights*

INSIGHTS
PFAS

October 2021

RECENT DEVELOPMENTS

On October 18th, 2021, the US Environmental Protection Agency issued its 2021-2024 'strategic roadmap' to regulating PFAS (Per- and Polyfluoroalkyl Substances) chemicals. The three-year roadmap is centered on three guiding strategies: (1) increase investments in research, (2) leverage authorities to take action now to restrict PFAS chemicals from being released into the environment, and (3) accelerate the cleanup of PFAS contamination. Alongside the release of the roadmap, the agency announced a new national testing strategy that requires PFAS manufacturers to provide the agency with toxicity data and information on categories of PFAS chemicals.

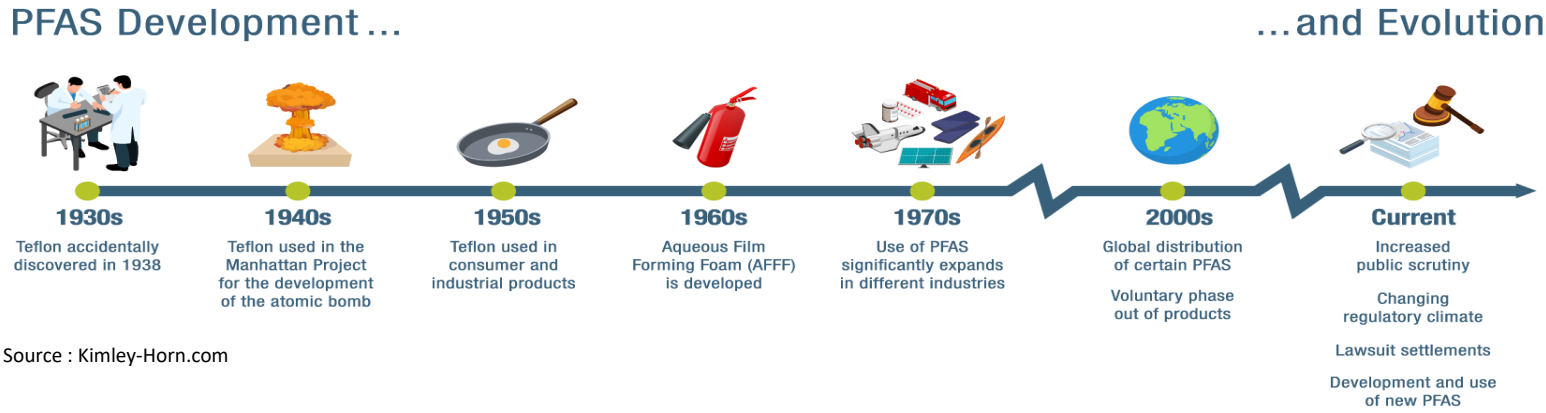
In our view, the two important developments in the EPA's plan are (1) the proposed drinking water limits for PFOA (perfluorooctanoic acid)and PFOS (perfluorooctane sulfonate) expected by fall 2023, and (2) the proposed designation of PFOA/PFOS as hazardous substances expected by spring 2022. On the first item, the importance of the EPA setting National Primary Drinking Water Regulations (NPDWRs) for drinking water contaminants and required monitoring of public water is that utilities in the US will now have defined national levels of PFAS to monitor for vs. the current state-by-state approach we see today. Clarity in national regulations helps to give water utilities confidence in deploying treatment/testing technologies on a larger scale. Secondly, the agency will propose designating PFOA and PFOS as hazardous Superfund substances by spring 2022. Such designations would require facilities across the country to report on PFOA and PFOS releases that meet or exceed the reportable quantity assigned to these substances. But importantly, PFAS being designated as a hazardous substance under the federal Superfund law would jumpstart the process of identifying and cleaning up PFAS. Once designated a hazardous substance, the EPA can finance cleanups by suing the polluters responsible for the pollution to recover its costs and then negotiate settlements for remaining costs.

CONTEXT

We are continually reminded to drink more water by members of the medical profession and other health practitioners, for largely very obvious reasons. But, at the same time, there seems to be an increasing undercurrent of more sinister news relating to potentially harmful and even potentially toxic chemicals in tainted water supplies. It can feel increasingly difficult to know where to turn, even in developed nations at times, either for safe drinking water, or the correct information to understand the risks of a polluted supply.

Over the last few years, it is possible that you have heard about 'PFAS' and its dangers both to humans and biodiversity more broadly. If not, you are perhaps more likely to have heard of the documentary film "Dark Waters", which sheds some light on the topic and has raised the collective awareness of these chemicals, which remain poorly understood by the public at large. In this paper, we will bring some perspective on this issue, starting with a description of what PFAS is, its use, its impact on our health, existing treatment solutions, and the potential investment opportunities that are arising from an increasingly urgent need to find and treat this family of 'forever' substances.

WHAT IS PFAS?



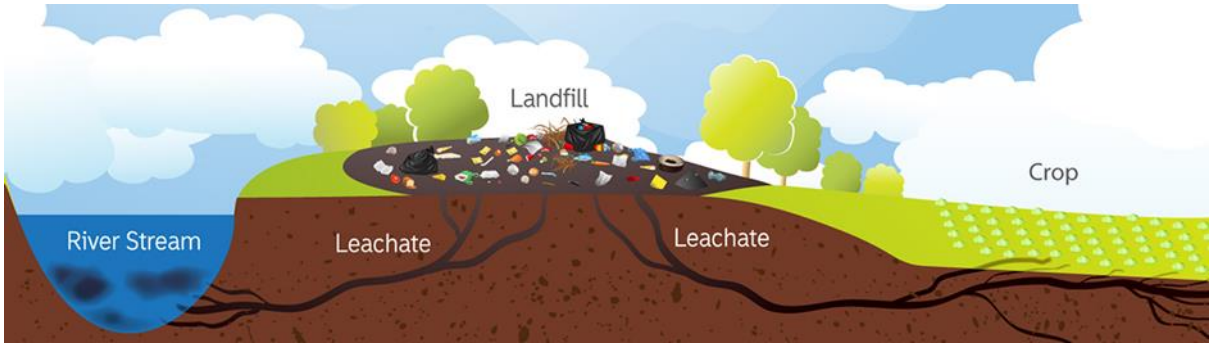
Source : Kimley-Horn.com

PFAS stands for per- and poly-fluoroalkyl substances which comprise a group of more than 4,700 man-made chemicals (OECD, 2018). The two most extensively produced and studied of these chemicals are perfluorooctanoic acid (PFOA) and perfluorooctane sulfonate (PFOS). PFAS has been manufactured and used in a variety of industries around the world, perhaps most notably in the United States since the 1940s - essentially to make products that resist oil, grease, stains, and water. For all of many and varied benefits of these characteristics, we know that PFOA and PFOS are also both very persistent in the environment and in the human body – meaning they don't break down and are prone to accumulate over time. Not for nothing are these substances often referred to as "forever chemicals"; they can take up to 1000 years to break down in nature - longer even than the decomposition of a plastic bottle.

Despite the fact that these two forms of PFAS have been phased out in most of the world by companies and governments, they remain persistent in the world's oceans. Furthermore, there are new generations being created to substitute PFOA and PFOS – though sadly, 'new' does not necessarily mean less hazardous for humans – it often simply means they are less well-understood.

WHERE IS PFAS PRESENT (PRODUCTS, LANDFILL AND GEOGRAPHY)

As mentioned, PFAS is present in many products that the consumers use in their day-to-day lives. They may be exposed to PFASs in non-stick cookware, grease-resistant paper, fast food wrappers, microwave popcorn bags, stain-resistant carpets and fabrics, water-resistant clothing, cleaning products, personal care products and cosmetics. Based on these applications, it's not a surprise to find PFAS very much in evidence in landfill sites – and in increasing concentrations, due to the fact that many products using these chemicals are single use items. As we can see in the picture below, the leachate (containing PFAS) that comes from a typical landfill site has the potential to contaminated rivers, stream and the agricultural land following a potential incursion into the water table or aquifer.



PFAS is also used in industrial processes and, notably, in firefighting foams used by the military, airport authorities, as well as by local fire and rescue agencies. In a process similar to that shown in the landfill site above, fire-fighting foams can contaminate ground water supplies, and in turn, agricultural sights become tainted, followed by the vegetables and grains produce on the site, which are often used to feed local livestock. As such, the meat can become contaminated in turn. Perhaps more worrying still is that any fish living in contaminated rivers are often found to have higher PFAS loads because their "oxygen" is contaminated.

PFAS has been found in the blood of 97% of Americans[1] - clearly related to the fact that 2,300 locations in 49 states have recorded some level of PFAS contamination[2]. And as you can no doubt imagine, this problem is not limited to the USA. Areas around industrial production and manufacturing sites have been found to be particularly contaminated by PFAS. As such, the total number of sites potentially emitting PFAS is estimated to be in the order of 100 000 in

[1] The guardian : "forever chemicals"

[2] discovermagazine.com/health/theres-pfas-in-our-water-how-do-we-get-them-out

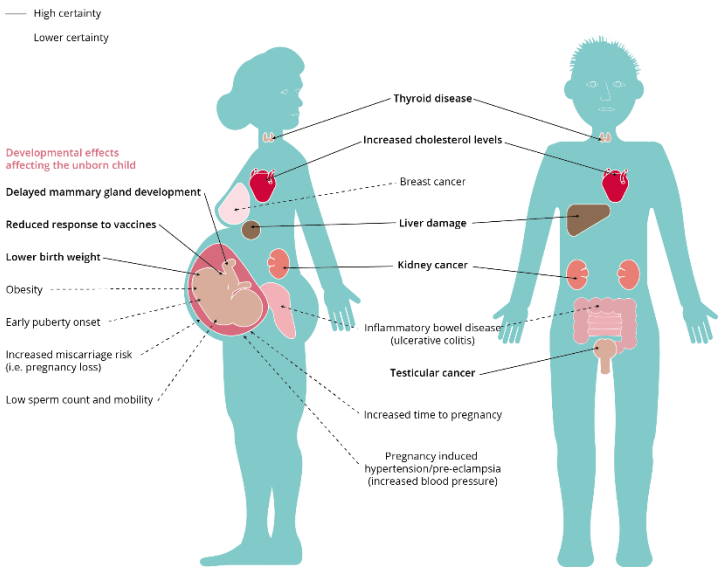
Europe[3]. However, concentrations of PFAS are not only concentrated in densely populated or urban areas. PFAS has been found on Mount Everest and in the Artic sea ice. Indeed, the PFAS levels in rainfall exceed that of other legacy contaminants, such as mercury and pesticides. The main cause of this is from sea-spray aerosols from the ocean - the biggest source of atmospheric PFAS.

Experts previously considered that food and water were the two main routes by which humans were exposed to PFAS - but a new study suggests that PFAS is also present in indoor air, where we spend around 90% of our time[4]. So – the mere act of breathing probably represents a third significant exposure route.

WHY IS PFAS A PROBLEM FOR HUMAN HEALTH?

We have explained PFAS' existence in water and food around the world, but why is it problematic for human health?

Firstly, we know that the chemicals collect in our bodies in the same way they do in nature and the environment. PFAS doesn't clear out of our system with time. Following PFAS accumulation in the human body, both very clear as well as more mysterious problems have been known to arise.



Sources: US National Toxicology Program, (2016); C8 Health Project Reports, (2012); WHO IARC (2017); Barry et al., (2013); Fenton et al., (2019); and White et al., (2011).

The diagram on the left summarizes conditions identified as a result of PFAS in both men and women. Kidney cancer, thyroid disease, liver damage, and increased cholesterol levels are among the illnesses linked to these chemicals. In addition, there are more gender specific ailments, such as testicular cancer for men, and illnesses unique to women which can be even more problematic during pregnancy. During pregnancy, observed problems can include lower birth

[3]eea.europa.eu/publications/emerging-chemical-risks-in-europe

[4] https://www.theguardian.com/society/2021/aug/31/pfas-toxic-forever-chemicals-air-breathing

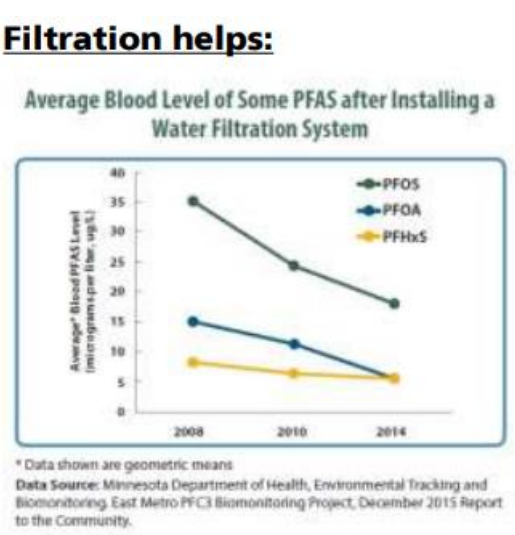
weights for unborn children and reduced vaccine responses from newborns born to mothers with high PFAS concentrations, which may lead to further childhood illnesses. Additionally, there are other, more deferred concerns linked to the unborn child such as obesity, early puberty and low sperm count and mobility.

WHAT ARE THE SOLUTIONS?

This chemical family is known to be accumulative in the environment and requires longer time than plastic to disappear from nature. Several solutions exist to remove it from water, though, none are perfect.

How to remove it from water?

The good news is that there is a range of methods for the removal of PFAS from and additional treatment technologies are under development. For the individual consumer, home treatment systems are widely available that use filtration technology, as well as those based on Granular Activated Carbon (GAC) and reverse osmosis systems. Such systems are able to filter some but not all PFAS. A 2020 study found that GAC – installed generally in a water jug or refrigerator – varied widely in how well they can filter PFAS, while reverse osmosis systems, which put water through specialized membranes, performed better. Unfortunately, osmosis systems are not quite so widely available due to cost – but the technology continues to develop with costs coming down.



Such small-scale solutions for PFAS removal can be simply echoed at a far more significant size for municipal and utility scale water treatment. For example, the Cape Fear River (North Carolina) was found contaminated by PFAS in 2016 and a new facility was built at the Sweeney Water Treatment Plant 2 years later. This investment comprised four 12-meter-long beds of GAC, about 7 meters wide and 3.7 meters deep, to remove PFAS from water[5]. However, it should be noted that this kind of facility is very restrictive in terms of space, with the carbon needing to be replaced and incinerated approximately every 400 days. To try to overcome this inefficiency, researchers are developing other technologies that water treatment plants can add-on to existing infrastructure to address

[5] https://cen.acs.org/environment/persistent-pollutants/Forever-chemicals-technologies-aim-destroy/97/i12

the PFAS pollution challenge. Ionic fluorogel resin is one technology being examined and is designed to attract and trap PFAS. The result of an initial study, published in 2020, found that the resin filtered more types of PFAS much more effectively than GAC or other resins.[6]

More new solutions need to be developed as well as new regulation on these chemicals to raise awareness of individuals on this topic and its dangers.

Regulation:

As mentioned above, the proposed designation of PFOA/PFOS as hazardous substances is expected by spring 2022. Our view is that the US will lead on this designation and will be followed elsewhere in the world – and will empower states or countries to enforce a cleanup of contaminated areas. It is envisaged that a part of the cleanup costs would be subsidized by those states and countries, with the balance being met by the company responsible for the chemical's production. These companies could also be asked to support the medical monitoring and treatment costs of any effected individuals under US Tort law, where people are enabled to seek compensation for wrongs committed to them. If PFAS is indeed designated a hazardous substance, it will likely give rise to a wave of lawsuits against the manufacturers in the same way that asbestos has in the past several decades.

We would also anticipate lawsuits from governments or municipalities for the increasing costs related to the treatment of waste in the landfills, specifically in the area of leachate treatment. One could also foresee large landfill operators installing new technologies (such as reverse osmosis) to manage and treat leachate, while the rising costs of treatment will burden smaller, local landfill players.

All of these costs could negatively affect the companies cited in term of results and reputation, while it is even possible that the large number of potentially impacted constituencies could even be a barrier to hazardous substance designation (from an agricultural perspective). Indeed, prohibiting farm products above the minimum concentration level of PFAS (set if hazardous substance designation is granted) will cut farmers' revenues at a time where it is already under pressure. It therefore remains a possibility that legislators could act based on vested interests and public concern instead of science-based evidence.

While we recognize that any regulation of PFAS would doubtless negatively affect some firms, we believe that new regulations would also means new markets and opportunities for those companies supplying solutions and technologies to deal with these chemicals.

[6] https://www.discovermagazine.com/health/theres-pfas-in-our-water-how-do-we-get-them-out?

IMPACT ON INVESTMENT OPPORTUNITIES

As mentioned, there are a range of companies that are exposed to different risks regarding their prior links to the production of PFAS. These could clearly be negatively affected by litigation costs relating to claims arising from problems created by PFAS in terms of human health and the environment.

Though from a wide range of sources, environmental clean -up costs seem to average around $1561/person effected, while medical monitoring costs have averaged 3k/person and compensation 190k/person[7]. Please note that these average costs are from a prior Dupont lawsuit settlement.

Opportunities:

When we think of investments that we can make in businesses that look set to capitalize on the future designation of PFAS as a hazardous substance, in addition to the benefits already accruing to businesses that are dealing with these chemicals, we tend to think of the opportunity set as splitting into 4 main categories.

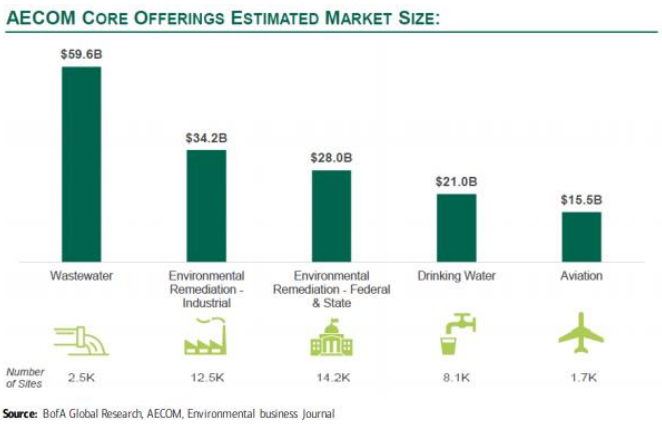
Firstly, we would point to the Water Utilities.
To capitalize on the future need to test for PFAS, we believe that the regulated utilities are well placed to benefit from increased investments in chemical testing – investments that can be recouped from customers in water bills. One beneficiary is Essential Utilities in the US. Essential has already announced an innovative and proactive step in standardizing its activities to address the presence of PFOA, PFOS and Perfluorononanoic acid (PFNA) in drinking water across its eight-state footprint. Beginning in 2020, Essential initiated capital investments (in the range of tens of millions of dollars over several years) to install mitigation technology at water treatment facilities where source water exceeds 13 parts per trillion (ppt) for any of the three PFAS. Adding capital investments for a regulated water utility is a positive, as it is integrated into its Regulated Asset Base, on which it is allowed to earn a return.

American Waterwork is also a key potential beneficiary. In addition to making targeted investments in areas where pollution levels are high (such as in Sacramento, California) to deal with PFAS contamination, American looks well-placed to benefit in other ways. With many municipalities across the US that own and operate their own water systems already

[7] UBS Electrical Equipment & Multi-Industry Global Research, June 2021

finding it challenging to keep up with costly required maintenance and regulations, most are ill-equipped to remove PFAS from the water they treat. This means that they will need to invest significantly to upgrade their systems when their state and/or the EPA regulates these chemicals. This should provide an impetus for more of them to put their systems up for sale, which municipalities have increasingly been doing in recent years. American Water in addition to Essential, is in a strong position to picking-up municipally owned water utilities that go on the market in its home state of NJ and other states -- and tough PFOA and PFOS regulations have the potential to magnify the company's competitive advantage by increasing the pool of possible acquisition targets.

The second category we look at are the **Engineering & Construction Consultants**: with a total addressable market of $160 bn in terms of PFAS "clean-up" opportunities at present, these 'environmental consultants' evaluate PFAS where it exists, identify and analyze the relevant compounds, prepare quantified risk assessments and navigate their clients through complex regulations – with each state in the US having differing permitted contamination levels.



An example of a beneficiary among the consultants US group Tetra Tech. The US-based business uses real-time control work and a network of water quality experts to analyze occurrence and risks of different constituents of emerging concern, including PFAS and microplastics. Elsewhere, another US consultant which has been active in the PFAS treatment space since 2001 is AECOM. The Company has developed a sustainable treatment technology that destroys PFAS from contaminated liquids without generating hazardous waste. Unlike certain other existing treatment technologies, the AECOM technology offers a complete PFAS destruction solution through electrochemical oxidation. It can be coupled with non-destructive technologies to deliver a 'whole of life cycle' solution, or as a stand-alone onsite destruction technology. To date, AECOM has invested heavily in an economical solution to PFAS contamination which crucially can be used onsite. Having worked on more than 400 PFAS projects globally, and successfully managed two of Australia's precedent setting PFAS investigations, AECOM is at the forefront of efforts to find solutions to destroying these chemicals.

The third category of companies that we have identified are **Technology Companies** with technologies that are able to treat PFAS. It is widely understood that Granular Activated Carbon (GAC), resins, ion-exchange membranes and filtration component providers are among the technologies most commonly deployed to treat PFAS. A prime example of a technology solution provider is Evoqua. The group is broadly technology-agnostic and therefore can design

the most effective system to meet the client's treatment needs based on a wide variety of media and vessel options. Evoqua partners with municipalities directly or with engineering firms to integrate its solutions into existing systems and can base its designs on site-specific requirements. Despite a range of technologies including GAC and high-pressure membranes, Evoqua's ion exchange technology is often one of the most commonly deployed for industrial wastewater clean-up. Ion exchange resins are like tiny powerful magnets that attract and hold the contaminated materials from passing through the water system.

The final category of businesses that we look at are the range of different Waste Management companies that we have access to in our investment ecosystem. This group incorporates generalist Municipal Solid Waste (MSW) companies, as well as more specialist hazardous waste management companies. Some landfill operators predict that once the EPA sets more specific PFAS limits and regulations, they will need to monitor and track PFAS in more formal ways, such as through landfill leachate and gas sampling. At this point, one needs to consider that landfill operators are 'receivers' of other people's PFAS waste – and are therefore stewards of best practice in terms of managing the risks that come with treating this waste – most often in the form of the leachate – the harmful and highly toxic liquid which seeps from a landfill site. Some waste companies are trying to plan ahead by preemptively collecting data on how and where PFAS appear in their facilities, especially in this leachate. Operators such as Waste Connections and Waste Management say that they are confident that their landfills, which are required to have specific liners and leachate systems to prevent groundwater contamination, are effective at capturing the majority of PFAS. Landfill operators don't know what types of PFAS-laden materials will come through their facility on a given day, so any landfill regulation policy discussions should also go hand in hand with long-term discussions about how to stop PFAS generation at the source. What we think is increasingly clear at this stage is that the costs of dealing with these substances will be passed through to the polluters, and that the Waste Management businesses will be able to profit from their expertise in managing the risk of treating the leachate. Elsewhere Clean Harbors, a hazardous waste management business, anticipates a potential 10 to 15-year window of opportunity on managing these chemicals once regulations are finalized. Clean Harbors meets all disposal requirements related to PFAS, including the incineration of Aqueous Film Forming Foam, Investigation Derived Waste (IDW) or remediated and treated soils and waters. As with the more conventional landfill owner/operators, the increasing cost associated with environmental compliance will accrue to the clients sending volumes to the waste companies, where we expect higher levels of profitability.

Written in November 2021.

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