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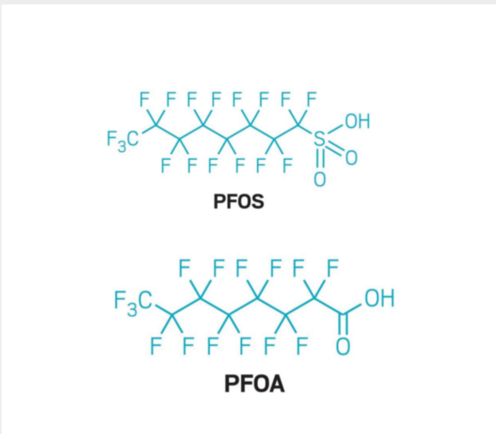
<table>
<tr><th colspan="2">CONTAMINANT INFO-SHEET</th></tr>
<tr><td>CONTAMINANT</td><td>Poly- and Per-fluoroalkyl Substances (PFAS)</td></tr>
<tr><td>WHEN TO CONSIDER PFAS AS A SOURCE?</td><td>PFAS were widely used between the 1940s and late 2010s for a variety of applications. PFOS was introduced into firefighting foams in 1964 and was restricted in 2009. The Environment Agency considers the historical land-uses with the highest potential risk as a PFAS source to be:

• Airfields;
• Fire stations and training centres;
• Wastewater treatment works; and
• Landfills.

The exhaustive list to consider PFAS includes:
• Aviation and aerospace (military and civil airfields)
• Carpet manufacturing
• Chemical works (cosmetic/personal care products)
• Chrome plating sites
• Electronics manufacturing
• Fire (particularly large scale where firefighters would have been called)
• Landfills
• Military bases
• Paper and cardboard manufacturing
• Petrochemical industry
• Textiles and leather manufacturing
• Wastewater treatment works – biosolids disposal

PFAS have a wide range of uses and can readily enter the environment during manufacture, during use or following disposal. With a resistance to degradation, their presence within the environment is inevitable and will provide long-term exposure for human health as well as ecology.</td></tr>
<tr><td>CHEMISTRY</td><td>The carbon-fluorine bond is the strongest in organic chemistry and provides thermal, biological and chemical stability, leading to extreme persistence. As a result of their persistence, PFAS have recently been nicknamed the ‘forever chemicals’. The substances are very difficult to remove / destroy using conventional methods, so they recirculate throughout the environment.



PFOS and PFOA are ‘dead end’ daughter products of the majority of PFAS. As they are extremely persistent, they are good to use as markers. PFAS are typically very soluble (520 – 3,400 mg/l) and have low to moderate sorption to soils making them highly mobile which means they can travel large distances and ultimately accumulate within groundwater.
PFAS are able to bioaccumulate in mammals and plants fixing to proteins rather than the usual fats, leading to remaining within the organism and not being expelled. A variety of health impacts have</td></tr>
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	been recorded, including: altered immune and thyroid function; liver disease; reproductive issues; and embryonic development issues.
SCHEDULING SAMPLES	When scheduling for PFAS there are a number of options available. Most common testing comprises PFOS and PFOA, whereas a PFAS suite containing a number of additional PFAS is also available. Concrete can now also be tested for PFAS. A common additional test that can be utilised is a Total Oxidisable Precursor (TOP) Assay test. Top Assay is a standardises pre-treatment of sample extracts in order to expose underlying PFAS not identified within the testing outlined above. These substances weather to PFAS over time. Costs: • PFAS on concrete core - £299. Excl. VAT • PFAS Total Suite (soils) - £315. Excl. VAT • PFOS and PFOA (soils or water) - £170. Excl. VAT • PFAS Total Suite (water) - £415.50. Excl. VAT • Top Assay Suite (water) - £650.25. Excl. VAT Costs correct as of December 2022. 
REMEDIATION	Even with sources of PFAS decreasing, concentrations within impacted soils / groundwater will not decrease quickly given the slow degradation rates. Given the nature of these compounds and their persistence, PFAS remediation often requires multiple treatment technologies as some PFAS can quickly transit Activated Carbon and so are not removed effectively. *Soils* Conventional soil treatment methods include excavation and disposal to landfill, however, in addition to cost, the potential long-term liability of this option should be carefully considered given PFAS' persistence. At present only PFOS and PFOA have criteria that must be met for deposition to landfill. Excavated soils may be incinerated at high temperatures (>1,100°C) to destroy PFAS, although this may be prohibitively expensive for many sites. In the UK, waste containing PFOS (as a Persistent Organic Pollutant (POP)) above 50 mg/kg may require destruction even if classified as Non-Hazardous. Soil washing may be suitable to minimise volumes of PFAS-impacted soil waste for larger projects and for soils with relatively low fines content, however, water treatment and fines treatment/disposal may be complex and expensive, with a lack of data demonstrating effectiveness. Approaches involving stabilisation and solidification using binding reagents to prevent leaching to groundwater are becoming of increasing focus for source zone impacts. *Groundwater* Reverse Osmosis and Nanofiltration have been shown to be extremely effective in removing PFAS, however, these systems are expensive and typically employed with large-scale drinking water systems. For groundwater applications, the suspended solids and water geochemistry must be assessed and managed to prevent the deterioration of the membrane used within these methods. The use of activated carbon, ground to 1-2um in size, allows additional adsorption sites for PFAS and retards the migration from a source. This can be applied as either a vertical or a horizontal barrier. This approach also generates a low volume, high concentration solution which requires treatment or disposal.