REDS Environmental Risk Management

Briefing Note
PFAS (Per and Polyfluoroalkyl Substances)

What are PFAS?

Per and Polyfluoroalkyl Substances (PFAS) are man-made organic fluorides.

Hydrocarbons in which some (poly) or all (per) of the hydrogens have been replaced by fluorine atoms.

Estimated to be ~6 million different compounds. The best known group are the PFAA (perfluoroalkyl acids), which includes the compounds PFOS and PFOA.

POLYFLUOROALKYL SUBSTANCES
Poly-FAS, sometimes used to replace PFOS and PFOA, can act as precursors, transforming to long-chain Per-FAS in the environment and acting as an ongoing source.

Short and long chain PFAAs have different properties.
Short chain: mobile, soluble, low adsorption, found in groundwater.
Long chain: found in soil, PFSA sorb more strongly than PFCA.

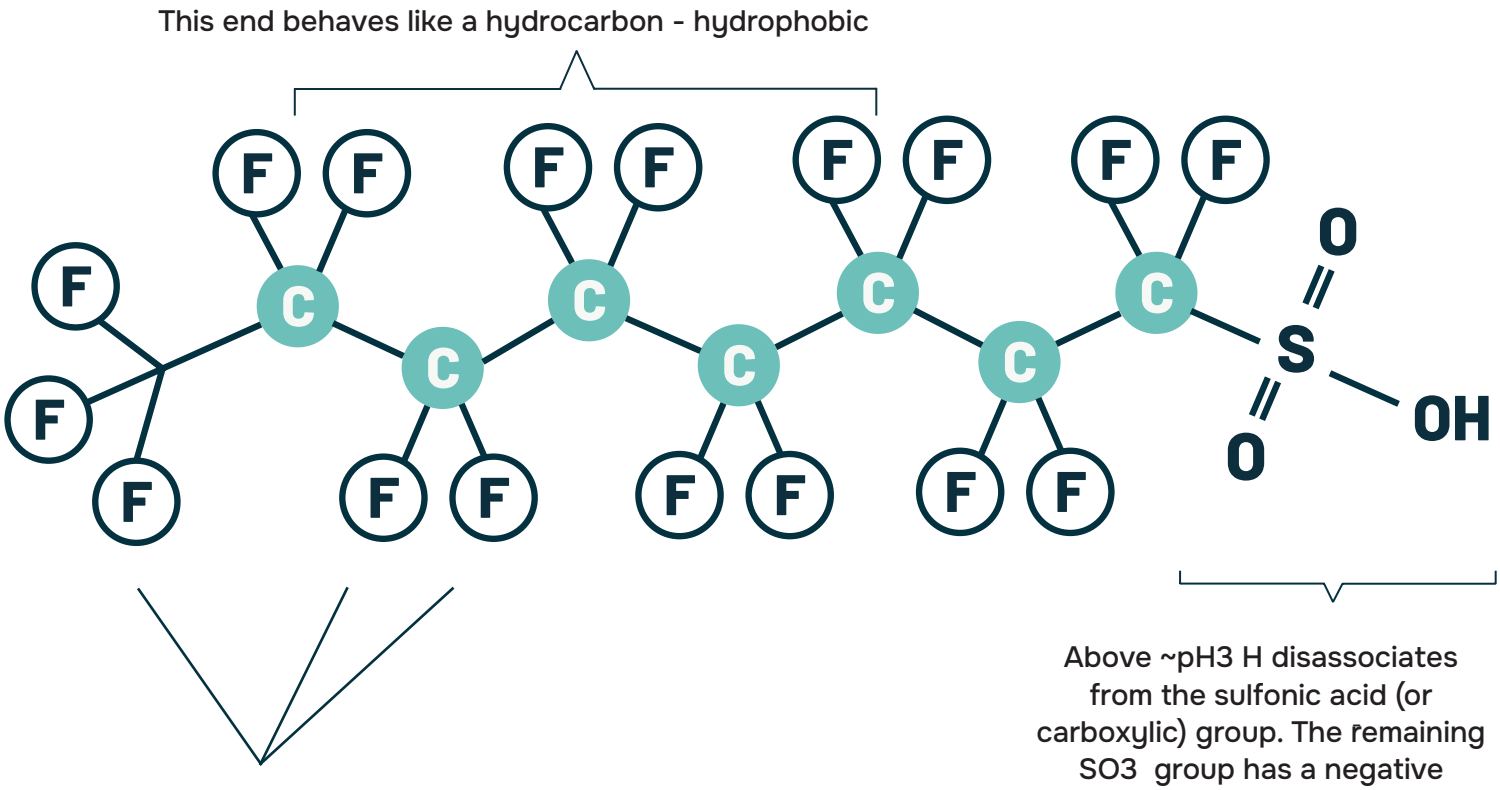
PFAA - Perfluoroalkyl Acids
Similar to chlorinated solvents but have a functional group (carboxylic /sulfonic acid) which creates some of the unusual behaviour.
They can be linear or branched (l-PFOS and b-PFOS).

PFCA - Perfluoroalkyl Carboxylic Acids
Short chain up to C6 e.g. PFBA
Long chain C7+ e.g. PFOA
PerFluoroOctanoic Acid

PFSA - Perfluoroalkyl Sulfonic Acids
Short chain up to C5 e.g. PFPS
Long chain C6+ e.g. PFOS
PerFluoroOctane Sulfonic Acid

This gives the number of Carbons
E.g. O = Octanoic/Octane = 8C
B = Butanoic/Butane = 4C

Chemical Properties of PFAA



Very strong C-F bonds	• PFAAs are highly resistant to degradation. • Can resist chemical attack and high temperatures.
Hydrophobic fluoro end / hydrophilic functional group end	• Oil and water repellent. • Act as surfactant (can foam). • Activity tends to occur at the air / water interface.
Different functional groups	• Different functional groups create different behaviour in the environment. Well characterised PFOS and PFAS may not be suitable as proxies for other PFAA groups.

Why do they matter?

They are persistent – don't readily degrade.

They are ubiquitous – found in soil, rainwater, animals and humans.

The Committee on Toxicology found that current background concentrations are likely to exceed any existing health criteria values.

Bioaccumulation – concentrations may be higher in produce than in soil and can accumulate in humans and animals.

There is limited toxicological data, but several PFAS compounds have already been classified as carcinogenic.

Major Sources of PFAS

*AFFF - Aqueous Film Forming Foam

Airports	Fire training facilities & Major fire locations	Manufacturing industry	Waste water	Landfill
PFAA foams (AFFF*, hydraulic fluid, coolants)	AFFF	Paper & cardboard, carpets, textiles, cosmetics, food packaging & chromium plating	Water discharge, biosolids, sludge to land	Short chain PFAS in leachates

Potential Exposure Pathways

- Ingestion of homegrown produce
- Ingestion of soil & indoor dust
- Inhalation / dermal contact
- Drinking water ingestion
- Background / ambient

Problems Assessing PFAS

Large number of compounds with different functional groups and therefore different behaviours.

Better studied compounds, PFOS/PFOA, cannot necessarily be used as proxies for other compounds.

Lack of, or conflicting, information on toxicological, physical, and chemical properties. Literature values can vary by several orders of magnitude.

Few published standards. Published standards vary.

Risk assessment models can be used to derive Generic Assessment Criteria (GAC), but model algorithms and results should be treated with caution.

Regulators likely to receive a wide range of bespoke assessments and GACs for consideration, increasing their work load.

Some GACs will be very low, potentially below laboratory Limit of Detection (LoD).

Assessment of PFAS Liabilties

1. Preliminary Risk Assessment

- Rigorous desk study required to identify current and historical PFAS use and any potential precursors.

2. Analysis Costs

- Standards and targets may be below typical laboratory limits of detection. Additional costs to obtain suitably low limit of detection.
- TOP Assay required to get proper characterisation of site.
- Analysis suites likely to expand as additional PFAS are considered contaminants of concern.

3. Consultancy Time

- Assessment and research more complex and time consuming where there is a lack of data or standards.
- Negotiation with regulators more complicated for new or unfamiliar contaminants.

4. Uncertainty

- Lack of regulation and standards.
- Open ended list of chemicals to be considered.
- Attitude of regulators not predictable – PFAS new to everyone.
- State of knowledge, policies, attitudes and awareness continually developing which may affect past and future assessments.
- Consultants can only work with the information currently available.

5. Future Issues

- Environmental permits may soon include PFAS limits.
- PFAS risk assessments to be considered in due diligence programmes.
- Insurance policies with PFAS related risks and liabilities.
- Currently there is little information on short chain PFAS, often associated with landfills. Likely to become a future focus of attention.
- Remediation of PFAS impacted soil and groundwater is challenging. Treatment of abstracted groundwater possible and in-situ treatment options emerging.