CL:AIRE

PFAS SP 11
(July 2026)

PFAS Site Profile

PFAS Site Profiles were developed as part of the Environment Agency PFAS Risk Screening Project and represent an understanding of PFAS uses and occurrences from specific industry sectors at the time of writing in March 2024. This profile focuses on Waste Water Treatment Works.

Waste Water Treatment Works

1. INTRODUCTION

1.1 Overview

Per- and poly-fluoroalkyl substances (PFAS) are a broad group of more than 12,000 synthetic fluorinated organic chemicals. PFAS have been used in a wide variety of consumer products and industrial applications since the 1940s because of their unique chemical and physical properties, including oil, water and stain repellence, temperature and chemical resistance, and surfactant properties. These properties mean they are also extremely persistent in the environment. Some PFAS are bio-accumulative and toxic, and/or highly mobile.

Increasing awareness of the widespread presence of PFAS has heightened regulatory concerns about their potential risks to human health and the environment. To ensure effective actions are implemented the Environment Agency needs to better understand the potential sources of PFAS, the mechanisms of transport (pathways) and the relative significance of these substances in the environment.

As part of the Environment Agency PFAS risk screening project (Phases 1 to 4 carried out between 2020 to 2025) Jacobs developed individual site profiles for several potential high risk site types. They focus on specific industry sectors, representing potentially important sources of PFAS, whether from use or manufacture, with the potential for release into the environment.

The primary aim of these profiles is to help those parties involved in the regulation, investigation and remediation of sites where these problem chemicals present a risk to health and the wider environment. These are not definitive studies, but they introduce some of the technical considerations that need to be borne in mind when assessing a particular type of facility. Representing an understanding of PFAS at the time of writing (March 2024) and with published literature notably increasing continuously as practitioners and regulators seek to improve their understanding of PFAS, users must make their own appropriate assessments with current knowledge and specific to their site.

The reader is referred to Ross and Hurst (2019) and ITRC (2023) for more detailed information on PFAS chemistry, properties, fate and transport, risk assessment and remediation, to Glüge et al. (2020) for a review of the diversity of uses of PFAS, and to Ross (2023) for an overview of the uses of PFAS to assist with identification of sites of concern.

1.2 Site Profile Selection and Preparation

The site types for which site profiles have been developed in this project have been selected to represent potentially important users and sources of PFAS release to the environment in terms of quantity, frequency and historical records available.

Technical and scientific publications, fact-sheets, regulations, product websites, articles and online newspaper reporting interviews on the PFAS discussions were researched and reviewed to obtain information on the use of PFAS, with particular reference to the United Kingdom.

Each site profile includes site background information focused on PFAS use and identification of specific zones (where applicable), description of the processes involving PFAS, types of PFAS likely to be present, and an indication of the impact to water and soil. Brief examples and case studies from the literature are also provided.

For each site type a number of zones or activities have been identified where PFAS may be used. It should be recognised that not every site of this type will have all the activities identified. For example, a fire station site may be anything from a building where fire tenders containing Aqueous Film-Forming Foam (AFFF) are based (but filling, maintenance and training happen elsewhere) to a hub with a wide range of activities such as fire practice training, concentrate storage etc. in addition to vehicle storage.

Site profiles have been created for the following site types identified as potentially important potential sources of PFAS release to the environment:

- Civil and Military Airfields and Airports;
- Control of Major Accident Hazards (COMAH) Regulated Sites;
- Fire-fighting Grounds and Fire Stations;
- Landfills;
- Metal Manufacturing and Finishing;
- Military Bases (other than Air Transport Sites);
- Oil and Gas Industry (onshore exploration and extraction operations);
- Paper and Cardboard Manufacturing;
- Refineries and Fuel Sites;
- Textiles, Upholstery, Leather, Apparel and Carpets (TULAC) Manufacturing; and
- Waste Water Treatment Works.

Additional site profiles which do not relate directly to a particular site type have been developed for the following subject areas, which have potential applications within many different site types:

- Aqueous Film-Forming Foam (AFFF); and
- Fire Suppression Systems.

1.3 Methodology for Calculating Source Potential

For the purposes of the risk prioritisation project for which these site profiles were originally developed, an overall source potential has been developed for each site profile, based on professional judgment informed by the literature review. The source potential is constructed considering the magnitude and likelihood of PFAS presence and use in site profile zones.

The magnitude has been developed with a score of 1–5 (1 – low; 5 – high) based on the expected quantum of PFAS in the activity in the zone. For example, fire training practice using AFFF is recorded as high magnitude, because of the high volume and concentration of PFAS in this activity. Aircraft maintenance using hydraulic fluids containing PFAS is low magnitude because of the relatively low volume and concentration.

The likelihood for each activity is scored 1–5 (1 – low; 5 – high) based on the likelihood of a release to the environment occurring, taking into account frequency of activities where release may occur, and likelihood of loss of containment. For example, fire training practice using AFFF is likely to take place regularly at the same location over a period of years, with potential loss to ground or surface water, so is scored high. Although aircraft maintenance is likely to be undertaken all the time, significant accidental loss of containment is likely to be infrequent, so this is scored low.

The magnitude and likelihood are then multiplied to give the source potential (scored 1–25). It should be noted that these scores are generic and subjective and are based on professional judgment and should continue to be refined as more information becomes available. Further refinement could include expansion to consider changes in practice over the years as pollution prevention practices have improved.

2. BACKGROUND TO WASTE WATER TREATMENT WORKS

Waste Water Treatment Works (WWTW) are potential receivers of PFAS-containing materials within waste waters received from domestic and industrial users.

Domestic sewerage will likely contain PFAS from a very wide range of diffuse sources, including (but not limited to): toilet paper, cosmetics, soaps, detergents, sun cream, stain protection products, waterproof clothing, treated textiles, packaging, food contact materials, cookware and coatings, and human waste. The washing of certain protective clothing, such as those used by firefighters and the military, could also represent a significant PFAS source, either resulting from leaching of PFAS embedded into the fabric or washing of clothes contaminated during AFFF deployments (refer to the site profile for AFFF (CL:AIRE, 2026l)).

Another potential pathway for PFAS contamination of waste waters, is through surface runoff in roads, car parks, airports, and other urban/residential areas during rainfall events. Pluvial sewer waters may be treated separately or mixed with other influents, once received at the WWTW, depending on site design.

Industrial WWTW may receive PFAS impacted waters from a diverse range of uses, including both specific processes which use PFAS, and from use of PFAS containing materials (refer to the site profiles for Metal Manufacturing and Finishing (CL:AIRE, 2026e), Paper and Cardboard Manufacturing (CL:AIRE, 2026h) and Textiles, Upholstery, Leather, Apparel and Carpets (TULAC) (CL:AIRE, 2026j)). WWTW may also receive waste water from the use of AFFF in fire-fighting activities, training, testing and maintenance of fire suppression systems, and accidental losses (refer to the site profiles for AFFF (CL:AIRE, 2026l), Fire Suppression Systems (CL:AIRE, 2026m), Fire-Fighting Grounds and Fire Stations (CL:AIRE, 2026k), COMAH Regulated Sites (CL:AIRE, 2026b), Refineries and Fuel Sites (CL:AIRE, 2026i)). Residual PFAS may continue to be present in waste water effluent long after their use on a site has been discontinued, as a result of past sorption and continued release from permeable media including concrete.

WWTW may also be receivers of landfill leachate, either directly through sewage discharges, or indirectly in tankered waste. PFAS have been found to be ubiquitous in raw and treated landfill leachate.

In summary, where waste water is collected through control processes to prevent discharge of untreated water to the environment, it is likely to end up at a Waste Water Treatment Works (WWTP) and therefore WWTW become a ‘collector point’ for many sources of PFAS. As PFAS are emerging contaminants, in the UK there is currently very little management or control of PFAS concentrations in trade effluents.

WWTW may also be a source of PFAS to the environment, through direct spills and loss to ground, through liquid effluent discharge, through sludge disposal and through reuse of biosolids. Standard water treatment methods currently used in the UK are not effective at removing or destroying PFAS, although some PFAS precursors are transformed within WWTW and there is some partitioning between the liquid (effluent) and soil (sludge) phases, meaning that the effluent is compositionally different to the influent. The concentrations of some terminal products can thus be found to be higher in the effluent than they are in the influent.

PFAS are found in untreated waste water treatment sludge, and in biosolids (treated sludge which can be recycled to agricultural land as organic manure). In the past, sludge may have been deposited to land at WWTW. Currently around 87% of UK waste water sludge is recycled to agricultural land as biosolids. While there are quality standards that must be adhered to for the production of biosolids for agricultural use, these do not currently include reference to PFAS. As this site profile focusses on potential impacts to the environment from PFAS sources associated with the location of the WWTW themselves, the environmental impacts of biosolids recycled to agriculture are not considered further here.

PFAS Site Profile

3. CASE STUDIES

PFAS associated with WWTW have been studied extensively in various countries around the world with numerous scientific publications as well as other industry studies and reviews. ITRC (2023) provides a summary of some recent relevant publications and studies, with a focus on US practice and experience. Table 1 summarises some examples of studies from around the world and the UK.

4. PROCESS

PFAS enter the WWTW via influent flow or tankering (for example landfill leachate) and exit the WWTW via effluent. The influent passes through stages of treatment train, which varies between sites. Treated liquid effluent is discharged to surface water or via soakaway to groundwater. PFAS composition and concentration change through the treatment process as PFAS are transformed and partition between solid and liquid phases. Precursor transformation can result in substantial increases in intermediate PFAS (such as 6:2

Table 1. Case studies.

1. Municipal waste water treatment plants in the USA
Thompson et al. (2022) provide an overview of PFAS in municipal waste water treatment plants in the USA. They note that PFAS are ubiquitous in municipal waste water and biosolids, and while there are major point sources from industrial activities, PFAS have been detected in waste water even without direct industrial sources, such as in septic tanks and office buildings. They note that some PFAS in waste water effluent can be ascribed to PFAS in the community drinking water supply. Their meta-analysis of long term trends based on multiple published studies concluded that concentrations of long-chain PFAS, particularly PFOA, declined over time in waste water effluent, while concentrations of short chain PFAS such as PFBA may be increasing. They concluded there was a long term trend away from industrial contributions of PFAS to WWTW, to a higher proportion of the PFAS in WWTW influent coming from domestic waste water.
2. WWTW effluent and sludge in seven Nordic countries
Aro et al. (2021) studied effluent and sludge samples from WWTW in seven Nordic countries. They used Extractable Organic Fluorine (EOF) and a list of 73 target PFAS to evaluate which compounds are released back into the environment. Based on the fluorine mass balance analysis of the effluent they estimated that on average 90% of the EOF could not be explained by the target analysis. Ultra short chain PFAS (C2 – C3) were identified as accounting for 4% of the EOF, while the remaining target analysis explained only a further 6% of EOF on average. The largest contributors were short chain PFCAs (C4 – C7), followed by long chain PFCAs and PFSAs. The predominant precursor and intermediate compounds identified were 5:3 FTCA, 6:2 FTSA and 6:2 diPAP. Trace levels of PFECHS were detected in some effluent samples. Unknown intermediate and precursor PFAS with the potential to transform into PFAAs were considered likely to be significant contributors to the unknown organofluorine. Fluorinated pharmaceuticals are proposed as a further source of up to 18% of the EOF. Aro et al. (2021) found less unidentified organofluorine mass in sludges compared to effluent, with around half the organofluorine accounted for by target compounds. The PFAS class accounting for the majority of the identified EOF in sludge were diPAP, with 5:3 FTCA, EtFOSAA and MeFOSAA also substantially present. PFCAs and PFSAs made up around 10% of the EOF and were predominantly long chain. Potential sources of organofluorine were postulated to be fluorinated polymers and perfluoropolyethers (or side-chain-fluorinated polymers).
3. PFAS in Canadian municipal waste water
Gewurtz et al. (2024) studied PFAS in Canadian municipal waste water and biosolids and assessed time trends of PFAS in waste water from 2009 to 2021. The concentrations of PFAS were determined in raw influent, final effluent, and treated biosolids at Canadian WWTPs to evaluate the fate of PFAS through treatment trains and to assess time trends of PFAS in waste water between 2009 and 2021. Data for 42 PFAS in samples collected from 27 WWTPs across Canada were used to assess current concentrations and 48 WWTPs were included in the time trends analysis. They found that PFOS, PFOA and other long-chain PFAS continue to be widely detected in Canadian waste water and biosolids despite having been phased out from new uses, although (with the exception of PFOS) concentrations of long chain PFAS were found to have declined over time. Short-chain PFAS were also widely detected, and concentrations of short-chain PFCAs in waste water influent and effluent consistently increased between 2009 and 2021, reflecting the use of short-chain PFAS as replacements for phased-out and regulated longer-chained PFAS. Emerging PFAS including Gen-X (HFPO-DA), ADONA and F-53B (9Cl-PF3ONS and 11Cl-PF3OUdS) were not detected in the influent, effluent or biosolids. Interestingly the cyclic PFAS PFECHS was reported to be present in all influent and effluent samples in the Canadian study, although it has not been widely reported in other countries, suggesting a possible widespread alternative use of this substance in Canada.
4. Michigan waste water treatment plants
Helmer et al. (2022) included a detailed study of 10 Michigan WWTPs with industrial pretreatment programs. Their work indicated numerous chemical transformations across the plants that yield effluent PFAS concentrations as much as 19 times greater than influent, attributed to transformations of unmeasured precursors in the influent to measured, stable PFAS in the effluent. PFOA, PFHxA, PFPeA, PFBA, and PFBS show the greatest increases across the plant ranging from 20% to nearly 2,000%. PFOS concentrations decreased across six WWTPs, consistent with a strong tendency to adsorb onto biosolids.
5. PFAS in a waste water network in Uppsala, Sweden
Gobelius et al. (2023) assessed mass flows of 26 PFAS in a waste water network and WWTP in Uppsala, Sweden, to provide insights into their sources, transport, and fate in different treatment steps. PFAS composition profiles and mass flows were used to identify sources within the sewage network. Waste water from one pumping station showed elevated concentrations of C3 – C8 PFCA, likely caused by an industrial source, and two stations had elevated concentrations of 6:2 FTSA, probably originating from a nearby firefighter training facility. Within the WWTP, short-chain PFAS dominated in waste water, whereas long- chain PFAS dominated in sludge.

PFAS Site Profile

Table 1. Case studies (continued).

6. PFAS in an industrial waste water treatment plant, France
Dauchy et al. (2017) studied PFAS in an industrial WWTP receiving raw effluents from a fluorochemical manufacturing facility. PFHxA and nine target fluorotelomers (FTs) were detected in raw effluent from the facility. The overall PFCA mass flow in the raw effluent was negligible compared to the FTs but increased drastically after secondary treatment (through degradation of fluorotelomer precursors) and decreased after the floatation tank (through adsorption onto floatation sludge) but remained at high levels in the final effluent. Similar patterns in mass flow were observed in the FTs, indicating the presence of other unidentified precursors in the raw effluent. Two fluorotelomer PFAS were predominant (6:2 Fluorotelomer sulfonamide alkylbetaine (6:2 FTAB) and 6:2 Fluorotelomer sulfonamide propyl N,N dimethylamine (M4)), accounting for more than 75% of the total PFAS mass flow in the final effluent. While this may be an extreme example of industrial effluent, it demonstrates the persistence of some 'precursor' PFAS through waste water treatment processes.
7. UKWIR Chemicals Investigation Programme, UK
The Chemical Investigations Programme (CIP) is a joint initiative by the UK water industry and regulators in response to current and emerging legislation on trace chemical substances in the water environment. It is managed by United Kingdom Water Industry Research (UKWIR). It involves the investigation of a range of chemical substances, often contained in many domestic products, that find their way into sewage and biosolids and reach rivers and streams. CIP1 (2010 – 2015) investigated the sources/pathways of chemicals getting into rivers via WWTW and characterised treated waste water in terms of these chemicals. CIP2 (2015 – 2020) included further investigation of around 600 WWTW including monitoring chemicals present in effluents and in rivers upstream and downstream of the WWTW discharge points. This monitoring included PFOS and PFOA (but no other PFAS). The study focused on sites with low dilution in the receiving waters. PFOS and PFOA were detected in at least 98% of more than 9,000 effluent samples with a mean of around 0.005 µg/l. Preliminary examinations of fluorocarbon data indicated the presence of significant PFAS concentrations upstream of the WWTW discharge such that, in the overall national context, the inputs from WWTWs have a smaller than expected effect on downstream concentrations. This evidence is contrary to the usual assumption, that holds true for many other substances, that local sewage discharges make at least a significant contribution of trace chemicals to nearby in-river concentrations. Concentrations of PFOS and PFOA upstream of WWTW discharges already exceed the PFOS Environmental Quality Standard (EQS) by a large margin. On average, the concentration of PFOS is reported to be 19% higher downstream of WWTW compared with upstream samples and for PFOA, downstream concentrations are 35% higher (UKWIR, 2021). CIP2 data indicate there are some sites that are subject to important local inputs, either via sewage works or possibly directly to rivers. In particular, there is reasonable circumstantial evidence of the association between aviation activities and markedly higher fluorocarbon concentrations in surface water. However, out of the 609 CIP2 sites, only a handful of locations could be associated with plausible fluorocarbon sources such as airfields, airports or facilities where PFOS might be used in the context of fire prevention. This is a consequence of the CIP site selection process, which did not factor in the investigation of specific types of sites, other than those primarily where WWTW effluent was subject to relatively low dilution in the respective receiving water. It is noted that CIP2 was limited to PFOS and PFOA and does not analyse other PFAS, therefore, it is unclear if concentrations for other PFAS may change the trend shown at CIP2. CIP3 (2020 – 2022) included more detailed investigation to fill some gaps identified in earlier phases, with 16 separate elements planned, reported in 13 volumes. Studies most relevant to this site profile included: *Volume 3 – Groundwater Investigations* 39 different WWTWs were investigated to understand the potential risk to groundwater from effluent discharge. Each site was sampled at four monitoring locations: at effluent as well as one upgradient groundwater and two downgradient groundwater points to capture the effects of the effluent. Samples were analysed for Environment Agency Specific Chemical List – groundwater substances and concentrations upgradient and downgradient of WWTWs were compared to Drinking Water Standards (DWS) as a benchmark for potential non-compliance. *Volume 5 – Substances of Emerging Concern* This study assesses the spatial and seasonal variation of emerging substances in waste water treatment work influent, effluent, and sites in the receiving watercourses both upstream, and downstream of the effluent discharge locations. The report aims to highlight substances with the highest probability of exceeding Predicted No-Effect Concentrations (PNEC), where no EQS values have been set for some substances. The contribution of each of the works to their receiving watercourses was assessed by comparing both upstream and downstream sites to final effluent concentration. Removal efficiencies were calculated by comparing influent and effluent concentrations across monitoring sites. The study included monitoring at 30 WWTW for the following PFAS: PFBS, PFHxS, PFPeA, PFHpA, PFHxA, 6:2 FTAB (referred to as CMDFPAH), 6:2 FTS (referred to as TDFOSA), HFPO-DA (referred to as GENX), with PNECs sourced from the NORMAN Ecotox Database. None of the PFAS were found to exceed their respective PNEC values, however the detailed monitoring data shows the widespread presence of all the PFAS tested in influent, effluent and receiving watercourses. The PFAS with the highest individual concentrations were 6:2 FTAB (up to 1960 ng/l) and 6:2 FTS (up to 780 ng/l). The CIP monitoring shows PFAS were found to be present in the effluent at most WWTW sites, in groundwater samples collected upgradient and downgradient of WWTW sites, and in surface water samples collected upstream and downstream of the WWTW sites. WWTW sites with a larger population equivalent generally have greater influent and effluent concentrations of PFAS than those with a small population equivalent. This is likely due to the potential for a greater number of possible PFAS source sites contributing to waste water in the catchment. PFAS concentrations vary greatly across the WWTW sites such that it is inherently difficult to pinpoint a common contaminant PFAS source site for each WWTW. The factors controlling PFAS in WWTW influent and effluent are likely to be dependent on the type of treatment involved, treatment efficiency and partitioning to sludge.

FTS) and terminal PFAS (PFCAs and PFSAs) through the process. Adsorption to organic matter can show a small degree of removal of PFAS from the aqueous phase with long chain PFAS having higher sorption potentials than shorter chain compounds.

In WWTW with a long history of activity, processes by which PFAS may have become a source of PFAS to the environment include sludge disposal within the site, direct spills and loss to ground, and adsorption to semi-permeable surfaces including infrastructure, pavements and drainage.

5. KEY PFAS CONTAMINANTS OF CONCERN

The composition of PFAS in waste water treatment influent, effluent, sludge and biosolids will depend on the different sources to the WWTW (including industrial and domestic) and the processes within the WWTW. Biological and chemical transformation of precursor PFAS may take place within the WWTW. Physical and chemical partitioning may also take place affecting the composition of PFAS in different media.

The study by Aro et al. (2021) demonstrates the challenge in understanding PFAS in WWTW samples, with evidence for the presence of many more PFAS than can be identified in standard target analysis.

PFCAs and PFSAs are commonly reported in WWTW samples. PFOS and PFOA are the most commonly detected PFAS in WWTW effluent, but they are also the most studied. Studies from the UK and around the world show that even though the use of PFOS and PFOA is now restricted, they continue to be present in WWTW influent and effluent. Sources may include older products still in use (such as treated textiles and carpets), landfill leachates, continued release of PFAS previously adsorbed to semi-permeable surfaces within drainage infrastructure, and recycling of PFAS within the water use cycle. While the overall load of long chain PFAS including PFOS and PFOA may be decreasing, literature studies suggest the load of short chain PFAS is increasing.

Other types of PFAS commonly reported include sulfonamides, fluorotelomer sulfonates, and other fluorotelomer precursors such as alkyl betaines. While these substances are often referred to as precursor compounds, they have also been reported in effluent from municipal WWTPs indicating they are not wholly transformed within the WWTW. The UK CIP3 monitoring demonstrates the occurrence of these substances in effluents from municipal WWTW around England.

6. SOURCE POTENTIAL FOR WASTE WATER TREATMENT WORKS

Following the methodology set out in section 1.3, source potential has been developed for each site profile zone and detailed in Table 2.

ACKNOWLEDGEMENTS AND SUGGESTED CITATION

The PFAS Site Profiles were originally prepared by Jacobs for the Environment Agency PFAS Risk Screening Project (Phase 4) and have been edited for publication by CL:AIRE. The authors were Jane Thrasher, Francesca Giacomello, Hugh Masters-Williams, Yolande Macklin, Laura Richmond, Simon Tempest and Hannah Foster.

This bulletin should be cited as follows: CL:AIRE, 2026. Waste Water Treatment Works. PFAS Site Profile 11. CL:AIRE, UK.

Table 2. Site Profile Zone Source Potential.

Site Profile – Zones	Magnitude	Likelihood	Source Potential	PFAS presence and use
Effluent from WWTW	2	5	10	PFAS not treated in the process and released directly to surface water or groundwater. Concentrations of PFAS may increase post treatment. The non-biodegradable PFAAs are not transformed during waste water treatment, instead they remain in the effluent or partition to the sludge. Magnitude of source from individual WWTW sites is assessed as low relative to point source activities.
Influent domestic waste water	2	5	10	Diverse PFAS from multiple consumer users. Includes wash water that could include small amount of PFAS that are now restricted.
Influent trade waste	2	5	10	Currently potential of wide variety of PFAS types and concentrations. PFAS content in trade effluent not regulated by service provider.
Sludge	4	2	8	PFAS are present in WWTW sludge, with long chain PFAS preferentially partitioning into the solid phase. PFAS are likely to be present in sludge disposed to land in past activities within WWTW. This profile does not consider off-site disposal of WWTW solids.
Treatment process	4	2	8	During heavy rainfall events, lagoon overflow may occur with PFAS being transported via overland flow to surface water.
Raw water handling	2	2	4	Tanks containing leachate can leak which can reach surface watercourse via direct runoff.

PFAS Site Profile

IMPORTANT NOTES FOR READERS OF THE PFAS SITE PROFILES

The PFAS Site Profiles are based on available online literature and review of readily available technical publications at the time of writing (2020-2024). The authors recognise that additional information may be available that has not been used in this study.

The published literature on PFAS occurrence and distribution is vast and continually expanding. For example, the Interstate Technology and Regulatory Council web resource cited in the PFAS Site Profiles as "ITRC (2023)" was substantially updated in January 2026.

The purpose of the PFAS Site Profiles is to provide regulators and other interested parties with researched advice on how to assess problem sites that may be impacted by legacy use or release of PFAS. The profiles do not seek to address the specific circumstances of each site as these will be unique. As such, the PFAS Site Profiles should be read with the following reservations in mind:

- Practices can vary between different sites and therefore individual sites may not have been exposed to the typical PFAS contaminants of concern as detailed in each site profile;
- Site exposure to PFAS contaminants of concern may vary based on practices and equipment used on site; and
- Given the longevity of PFAS in the environment, site profiles may refer to practices which are no longer followed, and subsequently may omit current practices which avoid contamination.

DISCLAIMER

The information, views and conclusions drawn concerning the PFAS Site Profiles are based, in part, on information supplied to Jacobs by third parties; and from publicly available information. Jacobs has proceeded in good faith on the assumption that this information is accurate and complete. Jacobs accepts no liability for any inaccurate conclusions, assumptions or actions taken resulting from any inaccurate information supplied to Jacobs by third parties or available from public sources.

All users must make their own appropriate assessments specific to their site (or group of sites).

For the avoidance of doubt none of CL:AIRE, Jacobs or the Environment Agency accept liabilities resulting from the use or interpretation of the contents of the PFAS Site Profiles.

REFERENCES

- Aro, R., Eriksson, U., Kärrman, A., Chen, F., Wang, T., Yeung, L.W.Y., 2021. Fluorine Mass Balance Analysis of Effluent and Sludge from Nordic Countries. 1(9), pp. 2087-2096. doi:10.1021/acsestwater.1c00168
- CL:AIRE, 2026a. Civil and Military Airfields and Airports. PFAS Site Profile 01. CL:AIRE, UK.
- CL:AIRE, 2026b. Control of Major Accident Hazards (COMAH) Regulated Sites. PFAS Site Profile 02. CL:AIRE, UK.
- CL:AIRE, 2026c. Fire-fighting Grounds and Fire Stations. PFAS Site Profile 03. CL:AIRE, UK.
- CL:AIRE, 2026d. Landfills. PFAS Site Profile 04. CL:AIRE, UK.
- CL:AIRE, 2026e. Metal Manufacturing and Finishing. PFAS Site Profile 05. CL:AIRE, UK.
- CL:AIRE, 2026f. Military Bases (other than Air Transport Sites). PFAS Site Profile 06. CL:AIRE, UK.
- CL:AIRE, 2026g. Oil and Gas Industry (onshore exploration and extraction operations). PFAS Site Profile 07. CL:AIRE, UK.
- CL:AIRE, 2026h. Paper and Cardboard Manufacturing. PFAS Site Profile 08. CL:AIRE, UK.
- CL:AIRE, 2026i. Refineries and Fuel Sites. PFAS Site Profile 09. CL:AIRE, UK.
- CL:AIRE, 2026j. Textiles, Upholstery, Leather, Apparel and Carpets (TULAC) Manufacturing. PFAS Site Profile 10. CL:AIRE, UK.
- CL:AIRE, 2026k. Waste Water Treatment Works PFAS Site Profile 11. CL:AIRE, UK.
- CL:AIRE, 2026l. Aqueous Film-Forming Foam. PFAS Site Profile 12. CL:AIRE, UK.
- CL:AIRE, 2026m. Fire Suppression Systems. PFAS Site Profile 13. CL:AIRE, UK.
- Dauchy, X., Boiteux, V., Bach, C., Colin, A., Hemard, J., Rosin, C., Munoz, J., 2017. Mass flows and fate of per- and polyfluoroalkyl substances (PFASs) in the wastewater treatment plant of a fluorochemical manufacturing facility. 576, pp. 549-558. doi: 10.1016/j.scitotenv.2016.10.130
- Gewurtz, S.B., Auyeung, A.S., De Silva, A.O., Teslic, S., Smyth, S.A., 2024. Per- and polyfluoroalkyl substances (PFAS) in Canadian municipal wastewater and biosolids: Recent patterns and time trends 2009 to 2021. 912. doi: 10.1016/j.scitotenv.2023.168638
- Glüge, J., Scheringer, M., Cousins, I.T., DeWitt, J.C., Goldenman, G., Herzke, D., Lohmann, R., Ng, C.A., Trier, X., Wang, Z., 2020. An overview of the uses of per- and polyfluoroalkyl substances (PFAS). Environmental Science: Processes & Impacts, Issue 12, 2345-2373.
- Gobelius, L., Glimstedt, L., Olsson, J., Wiberg, K., Ahrens, L., 2023. Mass flow of per- and polyfluoroalkyl substances (PFAS) in a Swedish municipal wastewater network and wastewater treatment plant. 336. doi: 10.1016/j.chemosphere.2023.139182
- Helmer, R.W., Reeves, D.M., Cassidy, D.P., 2022. Per- and Polyfluorinated Alkyl Substances (PFAS) cycling within Michigan: Contaminated sites, landfills and wastewater treatment plants. 210. doi: 10.1016/j.watres.2021.117983
- ITRC, 2023. Per- and Polyfluoroalkyl Substances (PFAS) Technical and Regulatory Guidance Read-Only pdf Document September 2023. Interstate Technology and Regulatory Council.
- Ross, I., 2023. An Overview of the uses of PFAS to Assist with Identification of Sites of Concern. CL:AIRE Technical Bulletin TB22.
- Ross, I., Hurst, J., 2019. Managing Risks and Liabilities associated with Per- and Polyfluoroalkyl Substances (PFASs). CL:AIRE Technical Bulletin TB19.
- Thompson, K.A., Mortazavian, S., Gonzalez, D.J., Bott, C., Hooper, J., Schaefer, C.E., Dickenson, E.R.V., 2022. Poly- and Perfluoroalkyl Substances in Municipal Wastewater Treatment Plants in the United States: Seasonal Patterns and Meta-Analysis of Long-Term Trends and Average Concentrations. 2(5), pp. 690-700. doi: 10.1021/acsestwater.1c00377
- UKWIR, 2021. Water industry chemical investigations - current findings & planned work. Presentation by Mark Craig (Severn Trent) & Howard Brett (Thames Water) at Defra UK PFAS Workshop Day 1, April 27th 2021. Slides available at: https://www.claire.co.uk/home/news/1524-defra-hosted-a-uk-pfas-workshop-april-2021-presentations-now-available. CL:AIRE.

PFAS Site Profile

ACRONYMS AND ABBREVIATIONS

Note: this list of acronyms and abbreviations includes those used across all the site profiles and therefore may include some acronyms and abbreviations not used within this profile.

General Acronym / Abbreviation	Definition	General Acronym / Abbreviation	Definition
AFFF	Aqueous Film-Forming Foam	HSE	Health and Safety Executive
ALARP	As Low As Reasonably Practicable	ITRC	Interstate Technology and Regulatory Council
AR-FFFP	Alcohol resistant film-forming fluoroprotein foam	LCMS	Liquid Chromatography Mass Spectrometry
BOW	Bilge and oily waste water	LPG	Liquified Petroleum Gas
CA	Competent Authority	MAPP	Major accident prevention policy
CAS	Chemical Abstracts Service	MILSPEC	Military Specification
CAFS	Compressed Air Foam System	MSDS	Material Safety Data Sheets
CDOIF	Chemical and Downstream Oil Industries Forum	NAPL	Non Aqueous Phase Liquid
CIMAH	Control of Industrial Major Accident Hazards	NCM	Nordic Council of Ministers
CIP	Chemicals Investigations Programme	NIHHS	Notification of Installations Handling Hazardous Substances Regulations
CLP	Classification Labelling and Packaging	NORM	Naturally occurring radioactive material
CO_2	Carbon dioxide	OECD	Organization for Economic Cooperation and Development
COMAH	Control Of Major Accident Hazards	ONR	Office for Nuclear Regulation
CPI	Confederation of Paper Industries	PCM	Paper and Cardboard Manufacturing
DoD	Department of Defence (Australia)/Defense (USA)	PNEC	Predicted No-Effect Concentrations
DoE	Department of Environment	PPB	Parts Per Billion
DWS	Drinking Water Standards	PPE	Personal protective equipment
ECF	Electrochemical fluorination	RAAF	Royal Australian Air Force
EOF	Extractable Organic Fluorine	REACH	Registration, Evaluation, Authorization and Restriction of Chemicals
EPA	Environmental Protection Agency (for Denmark)	STM	Surface treatment of metals
EPR	Environmental Permitting Regulations	TOP	Total Oxidisable Precursor
EQS	Environmental Quality Standard	TULAC	Textiles, Upholstery, Leather, Apparel and Carpets
EU	European Union	UBA	Umwelt Bundesamt (German Environment Agency)
FCM	Food Contact Material	UK WIR	United Kingdom Water Industry Research
FFF	Fire-Fighting Foam	UMD	University of Maryland
FFFP	Film-Forming Fluoroprotein	US EPA	United States Environmental Protection Agency
FP	Fluoroprotein	WWTP	Waste Water Treatment Plant
FPP	Fire Prevention Plans	WWTW	Waste Water Treatment Works
FRS	Fire and Rescue Service		

PFAS Site Profile

ACRONYMS AND ABBREVIATIONS

Note: this list of acronyms and abbreviations includes those used across all the site profiles and therefore may include some acronyms and abbreviations not used within this profile.

PFAS Acronym / Abbreviation	PFAS Definition	PFAS Acronym / Abbreviation	PFAS Definition
10:2 FTOH	10:2 Fluorotelomer alcohol	HFPO-DA	Hexafluoropropylene oxide-dimer acid
10:2 FTS	10:2 Fluorotelomer sulfonate or sulfonic acid	HFPO-TA	Hexafluoropropylene oxide-trimer acid
10:2 FTUCA	10:2 Fluorotelomer unsaturated carboxylic acids	MeFOSAA	Methylperfluorooctanesulfonamidoacetic acid
11Cl-PF3OUdS	11-Chloroeicosafluoro-3-oxaundecane-1-sulfonic acid (F-53B Minor)	PAP	Polyfluorinated alkyl phosphates
12:2 FTS	12:2 Fluorotelomer sulfonate or sulfonic acid	PASF	Perfluoroalkane sulfonyl fluoride substances
14:2 FTS	14:2 Fluorotelomer sulfonate or sulfonic acid	PFA	Perfluoralkoxy polymer
12:2 FTAB	12:2 Fluorotelomer sulfonamido betaine	PFAA	Perfluoroalkyl acid
4:2 FTS	4:2 Fluorotelomer sulfonate or sulfonic acid	PFAS	Perfluoroalkyl and Polyfluoroalkyl Substances
5:3 FTCA	5:3 Fluorotelomer carboxylic acid	PFBA	Perfluorobutanoate or Perfluorobutanoic acid
6:2 FTAB	6:2 Fluorotelomer sulfonamidoalkyl betaine (see also CMDFPAH)	PFBS	Perfluorobutyl sulfonate or Perfluorobutyl sulfonic acid
6:2 FTCA	6:2 Fluorotelomer carboxylic acid	PFC	Perfluorinated Compound
6:2 FTOH	6:2 Fluorotelomer alcohol	PFCA	Perfluoroalkyl carboxylic acid
6:2 FTS	6:2 Fluorotelomer sulfonate or sulfonic acid (see also TDFOSA)	PFDA	Perfluorodecanoate or Perfluorodecanoic acid
6:2 FTUCA	6:2 Fluorotelomer unsaturated carboxylic acids	PFDoA	Perfluorododecanoate or Perfluorododecanoic acid
6:2 diPAP	6:2 Fluorotelomer phosphate diester	PFECA	Perfluoroalkyl ether carboxylic acid
8:2 Cl-PFESA	8:2 Chlorinated perfluoroalkyl ether sulfonic acid	PFECHS	Perfluoroethylcyclohexane sulfonate
8:2 FTOH	8:2 Fluorotelomer alcohol	PFESA	Perfluoroalkyl ether sulfonic acid
8:2 FTS	8:2 Fluorotelomer sulfonate or sulfonic acid	PFHpA	Perfluoroheptanoate or Perfluoroheptanoic acid
8:2 FTUCA	8:2 Fluorotelomer unsaturated carboxylic acids	PFHpS	Perfluoroheptane sulfonate or Perfluoroheptane sulfonic acid
9Cl-PF3ONS	9-Chlorohexadecafluoro-3-oxanonane-1-sulfonic acid (F-53B Major)	PFHxA	Perfluorohexanoate or Perfluorohexanoic acid
ADONA	4,8-Dioxa-3H-perfluorononanoic acid	PFHxS	Perfluorohexane sulfonate or Perfluorohexane sulfonic acid
CMDFPAH	Carboxymethyldimethyl-3-[[(3,3,4,4,5,5,6,6,7,7,8,8,8-tridecafluorooctyl)sulphonyl]amino]propylammonium hydroxide; a synonym of 6:2 FTAB used in UKWIR reports	PFNA	Perfluorononanoate or Perfluorononanoic acid
EtFOSA	N-ethyl-perfluorooctane sulfonamide	PFOA	Perfluorooctanoate or Perfluorooctanoic acid
EtFOSAA	N-ethyl-perfluorooctane sulfonamido acetic acid	PFOS	Perfluorooctane sulfonate or Perfluorooctane sulfonic acid
EtFOSE	N-ethyl-N-(2-hydroxyethyl) perfluorooctane sulfonamide	PFOSA	Perfluorooctane sulfonamide (FOSA)
F-53B	Trade name for chlorinated polyfluoroalkyl ether sulfonic acids (9Cl-PF3ONS and 11Cl-PF3OUdS)	PFOSE	Perfluorooctane sulfonamido ethanol
FASA	Perfluoroalkane sulfonamide	PFPA	Perfluoropentanoate or Perfluoropentanoic acid
FBSA	Perfluorobutane sulfonamide	PFPE	Phosphate ester salts
FOSA	Perfluorooctane sulfonamide	PFPeA	Perfluoropentanoic acid
FOSAA	Perfluorooctane sulfonamidoacetic acid	PFPeS	Perfluoropentane sulfonate or Perfluoropentane sulfonic acid
FOSE	Fluorooctane sulfonamido ethanol	PFPS	Perfluoropentane sulfonate
FTCA	Fluorotelomer carboxylic acid	PFSA	Perfluoralkane sulfonic acid
FTMAC	Fluorotelomer methacrylate	PFUnDA	Perfluoroundecanoate or Perfluoroundecanoic acid
FTOH	Fluorotelomer alcohol	POSF	Perfluorooctane sulfonyl fluoride
FTS	Fluorotelomer sulfonate	PTFE	Polytetrafluoroethylene
FTSA	Fluorotelomer sulfonic acid	TDFOSA	3,3,4,4,5,5,6,6,7,7,8,8,8-Tridecafluorooctane-1-sulfonic acid; a synonym for 6:2 FTS used in UKWIR reports
Gen-X	Trade name for HFPO-DA		