PFAS Uncertainty at PR24

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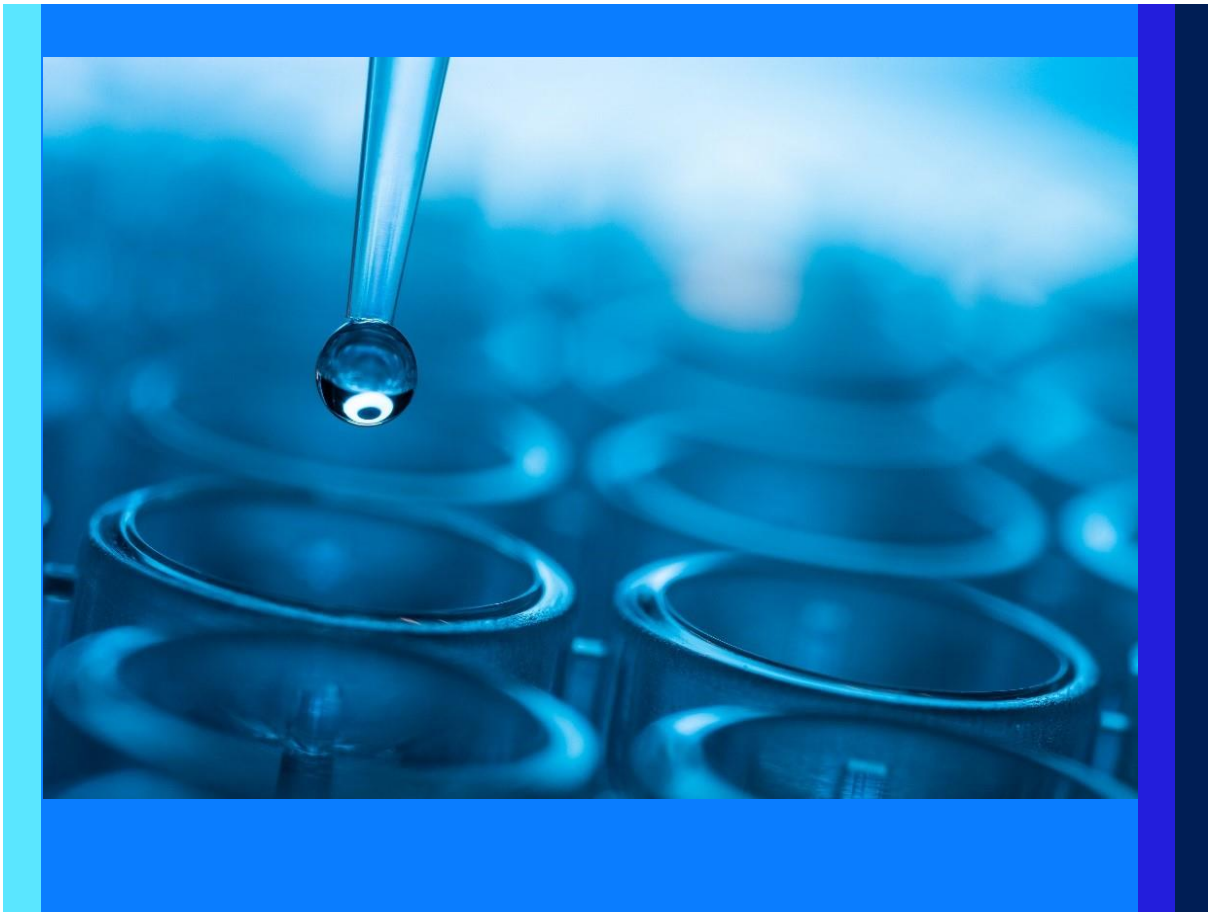
Anglian Water
(with SEW, SRN, SVT, NES, AFW, TMS, WSX, SST, PRT)

PFAS uncertainty
27 August 2024



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PFAS Uncertainty at PR24

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Executive summary

PFAS are emerging contaminants, and as such our scientific understanding continues to evolve, alongside our understanding of how they can be managed and how they can best be regulated. The term PFAS refers to a very large family of chemicals with widely varying behaviours, sources and properties. All feature a carbon-fluorine bond, which is chemically very strong. While giving them properties such as chemical and thermal resistance that make them so useful for industrial purposes, the strong bond also means that they are extremely hard to break down and therefore they are persistent in the environment. Toxicological data are only available for a relatively small number of PFAS but, these show that they can be harmful to human health and the environment at extremely low concentrations. They can be bio accumulative, meaning that they build up in the body over time. Some PFAS are also soluble in water, making them mobile in the environment, but they are also surfactants meaning that they adsorb readily onto semi-permeable materials such as soil and concrete. This combination of properties makes them exceptionally challenging to control and regulate.

As more scientific information has emerged over recent years, regulators around the world have continued to review and update regulatory approaches for managing risks to human health and the environment posed from PFAS, including drinking water supplies and effluent discharges. As information emerges the general direction of travel throughout the world is to increasingly lower acceptance thresholds and consider of a wider number of individual PFAS.

PFAS are of significance to water companies in England and Wales due to their potential presence in drinking water, effluent discharges, and biosolids. This presents significant uncertainty for water companies in planning investments to meet compliance. These uncertainties are a particular focus at this point in time because Ofwat has recently (July 2024) published its draft determination on price control limits for the AMP8 period 2025-2030. Water companies are currently drafting their representations on their individual draft determinations. The representations are due to be submitted to Ofwat by 28th August 2024 and companies are proposing an uncertainty mechanism to protect customers and themselves from the unforeseen costs that may arise from PFAS during AMP8.

This report draws together experience in and evidence from investigation, management and understanding PFAS, across different jurisdictions and industry sector. It brings additional insight to help define and understand the range of possible uncertainties that water companies in England and Wales may face in the coming years. The report sets out the signals from the UK and around the world that indicate potential changes that could arise within AMP8. These includes new science, sampling data and new analytes. International influences and media are considered as amplifiers of these signals and the potential regulatory responses are considered as being a reinterpretation of existing regulations and the introduction of new regulations.

The Water Price Control

In the absence of sufficient consistent toxicological data to allow a robust risk-based approach to regulating exposure pathways relevant to human health, most regulators have opted for a precautionary approach to drinking water standards. The approach adopted by the UK Drinking Water Inspectorate (DWI) has, to date, been a precautionary, evidence gathering approach. This requires the collection of data from a broader suite of analytes than other jurisdictions and has applied a tiered approach to the data concentrations for risk management.

The recent development in drinking water guidance by the DWI has involved using information letters to provide non-statutory guidance. These can be issued without consultation or other notice, and that water companies are nevertheless required to comply with. This approach allows the DWI to develop their approach as more information becomes available but results in massive uncertainty for water companies with the

potential for significant and material change in investment required to manage PFAS as already evidenced within AMP7.

There are scenarios associated with new science or data which could drive additional operating costs, the need for additional investment or loss of resilience without any regulatory change including:

- New sampling data could characterise sites as a higher tier within the current regulatory guidance.
- New catchment knowledge could introduce additional PFAS to the Reg 27 risk assessment, resulting in characterisation of sites into a higher tier.
- Media and campaign group pressure triggers accelerated installation of treatment mitigation by companies.
- Application of the existing environmental quality standard for PFOS to discharge permits leading to PFAS management requirements on discharges from clean water assets.
- Tighter controls on waste disposal (e.g. clean water sludges) leading to alternative disposal routes being required.

New science and data, international influences and pressures from media or campaign groups may drive the regulator to issue new regulations and or guidance. The change in regulations could:

- Result in a step change in the tiers assigned to multiple sites for example, applying a sum of PFAS to the existing tier thresholds.
- Introduce new environmental quality standards, leading to new requirements (for example on discharge permits). This could, if applied unilaterally, cause tighter controls and costs associated with proactive maintenance activities, such as reservoir cleaning and pipe flushing.
- Introduce new persistent organic pollutant (POPs) regulations requiring different waste disposal routes e.g. for clean water sludges.

The Wastewater Price Control

The 2023 Defra 'Plan for Water' (published March 2023) includes specific commitments for future management of PFAS. This includes stated commitments to reduce the amount of PFAS entering the water environment following the recommendations of the PFAS RMOA, update the list of priority substances used to determine chemical status, and to ensure that water companies introduce tighter controls on PFOS to reduce contamination.

The EA approach to regulation, mainly impacting the wastewater sector and also discharges associated with clean water activities, focusses more on implementing changes to existing regulation to adapt to PFAS. This comprises largely reinterpretation and application of current guidance without formal regulatory change. It may also issue new detailed guidance, for example the master list of substances of emerging concern to be considered in new permits for discharge to surface waters, understood to be currently in preparation. Change may also be introduced by new secondary legislation, for example identification of new priority substances (with associated environmental quality standards).

There are scenarios which could drive additional operating costs and the need for additional investment without any regulatory change including:

- Application of the existing environmental quality standard for PFOS to discharge permits leading to PFAS management requirements on discharges from wastewater assets.

- The approach to Industrial Emissions Directive (IED) permit updates evolves to require monitoring and modelling of sludge liquor returns at anaerobic digestion facilities. Continuous improvement requirements under the permits may lead to costly treatment.
- Requirements to complete more wastewater catchment assessments to determine pollution sources with potential opportunity to reduce PFAS in influent.
- Tighter controls on persistent organic pollutants (POPs) on waste disposal (e.g. wastewater sludges) leading to alternative disposal routes being required.

New science and data, international influences and pressures from media or campaign groups may drive the regulator to issue new regulations and or guidance. The change in regulations could:

- Introduce new environmental quality standards, leading to new requirements (for example on effluent discharge permits). This could, if applied unilaterally, cause tighter controls and costs associated with effluent treatment.
- Introduce new persistent organic pollutant (POPs) regulations requiring different waste disposal routes e.g. for tankered wastes.

Bioresources Price Control

We understand that the uncertainty around PFAS in the bioresources arena will be covered by a catch-all uncertainty mechanism proposed in the draft determinations for PR24. Ofwat has allowed a notified item on cost resulting from changes to the legal requirements in respect of sludge spreading.

Economic Mitigation

In light of the significant uncertainty around PFAS needs for the AMP8 period, it is appropriate to seek mitigation against cost escalation through an uncertainty mechanism to be presented within PR24 draft determination representations. Options for uncertainty mechanisms include:

1. Interim determination of K (IDoK)
2. Notified item
3. Modified notified item
4. Bespoke uncertainty mechanism
5. Price control deliverable
6. Gated allowance

A bespoke or hybrid uncertainty mechanism for PR24 may provide suitable protection for companies and customers. Key features of a hybrid mechanism might include:

- Targeted on PFAS interventions only.
- In period modified notified item with a materiality threshold below the IDOK – potentially set as a percentage of the relevant price control totex. In the case of schemes which span more than one price control a lower threshold across combined price controls could be considered.
- Unit costs per Ml/d applied within period potentially based on the modelled supply scheme costs for medium complexity from the PR24 enhancement feeder model.
- End of AMP8 reconciliation based on remodelled / deep dive of efficient costs to provide additional protection for companies and customers. This would be important where companies find novel ways to treat PFAS which results in lower unit costs or are faced with more complex site-specific issues resulting in greater unit costs. an
- Subject to usual cost sharing mechanism requirements.

There are a number of potential uncertainty mechanisms that could be applied to mitigate the uncertainty around PFAS. Uncertainty mechanisms for drinking water will require collaboration across the industry and between the DWI and Ofwat to ensure there is a clear understanding of triggers and impacts. For the wastewater price control area there will need to be collaboration with the Environment Agency for the same reason.

Addendum (at time of publication)

The DWI issued Information Letter (IL) 03/2024 dated 21st August 2024 to water companies along with new guidance[1] on PFAS. The new documents provide consolidated guidance on aspects that water companies should consider when fulfilling their statutory obligations to ensure the safety of drinking water with respect to per- and polyfluoroalkyl substances (PFAS). It is based on a three-tiered, risk-based approach to the protection of water safety. The revised guidance requires companies with sources that fall into Tier 2 (<0.1 µg/L) to design a proactive and systematic risk reduction strategy. This shall include a prioritised mitigation methodology to progressively reduce PFAS concentrations in drinking water.

While the previous guidance was based on the maximum concentration of individual PFAS, in the revised guidance his requirement has been further extended to include combined PFAS on a 'sum of' basis. The DWI acknowledges that, in extending the guidance to include an approach for combined PFAS on a 'sum of' basis, it is conscious of the potential for additional sites to fall into the current Tier 2 or Tier 3 classifications. Where this is the case, it recommends that these sites should be rolled into the existing site prioritisation approach based on their relative classification.

Due to the release of the new guidance being immediately before publication of this report it has not been possible to digest the content, understand the full implications and incorporate it into this report. However, it serves as the latest example of how regulatory guidance can shift unexpectedly.

[1] Guidance on the Water Supply (Water Quality) Regulations 2016 (as amended) for England and Water Supply (Water Quality) Regulations 2018 for Wales specific to PFAS (per- and polyfluoroalkyl substances) in drinking water

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Acronyms and abbreviations

6:2 FTAB	6:2 fluorotelomer sulfonamide alkylbetaine
6:2 FTOH	6:2 fluorotelomer alcohol
8:2 FTOH	8:2 fluorotelomer alcohol
AD	Anaerobic Digestion
AFFF	Aqueous film forming foam
AMP	Asset Management Period
AOF	Adsorbable Organic Fluorine
BAT	Best Available Technique
BBC	British Broadcasting Corporation
BREF	Best Available Technique (BAT) Reference Document
bis-FASI	Bis-perfluoroalkyl sulfonimides
C6 AFFF	Fire fighting foam based on PFAS with no more than 6 fully fluorinated carbons
C604	Perfluoro ([5-methoxy-1,3-dioxolan-4-yl]oxy) acetic acid
CIP	Chemical Investigations Programme
CIP3	Chemical Investigations Programme Phase 3, 2020-2022
CIP4	Chemical Investigations Programme Phase 4, 2024-
CIRIA	Construction Industry Research and Information Association
COT	Committee on Toxicity
DCO	Development Consent Order
DD	Draft Determination
Defra	Department of Environment, Food and Rural Affairs
DPC	Direct Procurement for Customers
DW	Drinking Water
DWD	Drinking Water Directive
DWI	Drinking Water Inspectorate
DWS	Drinking Water Standard
EEA-NH4	Perfluoro(2-ethoxy-2-fluoroethoxy)acetic acid, ammonium salt
EFSA	European Food Safety Authority
EIP	Environmental Improvement Plan

ENDS	Environmental report producing news, analysis and reference
EOF	Extractable Organic Fluorine
EPR	Environmental Permitting Regulations
EQS	Environmental Quality Standard
ERE	Environmental risk evaluation
EU	European Union
FTAB	Fluorotelomer sulfonamide alkylbetaine
FTOH	Fluorotelomer alcohol
GAC	Granular activated carbon
HALT	Hydrothermal alkaline treatment
HSE	Health & Safety Executive
IDOK	Interim Determination of K (factor)
IED	Industrial Emissions Directive
IL	Information Letter
LTDS	Long Term Delivery Strategies
MCL	Maximum Contaminant Level
MCLG	Maximum Contaminant Level Goal
NRW	National Resources Wales
ODI	Outcome Delivery Incentive
OECD	Organisation for Economic Co-operation and Development
OEP	Office for Environmental Protection
OFWAT	The Water Services Regulation Authority (The Office of Water Services and the Director General of Water Services)
PCD	Price Control Deliverables
PFAS	Per- and polyfluoroalkyl substances
PFBS	Perfluorobutane Sulfonic Acid
PFDA	Perfluorodecanoic Acid
PFECHS	Perfluoro-4-ethylcyclohexanesulfonate
PFHxA	Perfluorohexanoic Acid
PFHxS	Perfluorohexane Sulfonic Acid
PFNA	Perfluorononanoic Acid

PFOA	Perfluorooctanoic Acid
PFOS	Perfluorooctane Sulfonic Acid
PFPrA	Perfluoropropanoic acid
PNEC	Predicted No-Effect Concentration
POPs	Persistent Organic Pollutants
PR19	Price Review 2019
PR24	Price Review 2024
PR29	Price Review 2029
R&D	Research and Development
RAPID	Regulators Alliance for Progressing Infrastructure Development
RCC1	Relevant Changes of Circumstance 1
RCV	Regulatory Capital Value
REACH	Registration Evaluation, Authorisation and Restriction of Chemicals
RMOA	Regulatory Management Option Analysis
SCWO	Supercritical Water Oxidation
SERDP	Strategic Environmental Research and Development Program
SRO	Strategic Resource Options
TFA	Trifluoroacetic Acid
TOP	Total Oxidisable Precursor
UCMR	Unregulated Contaminant Monitoring Rule
UK	United Kingdom
UKHSA	United Kingdom Health Security Agency
UKWIR	United Kingdom Water Industry Research
USA	United States of America
USEPA	United States Environmental Protection Agency
WFD	Water Framework Directive
WHO	World Health Organisation
WINEP	Water Industry National Environment Programme
WTW	Water Treatment Works
WW	Wastewater
WwTW	Wastewater Treatment Works

1. Introduction

Per- and Polyfluoroalkyl Substances (PFAS) are of significance to water companies due to their potential presence in drinking water, effluent discharges, and biosolids. Figure 1-1 below shows the many sources of PFAS.

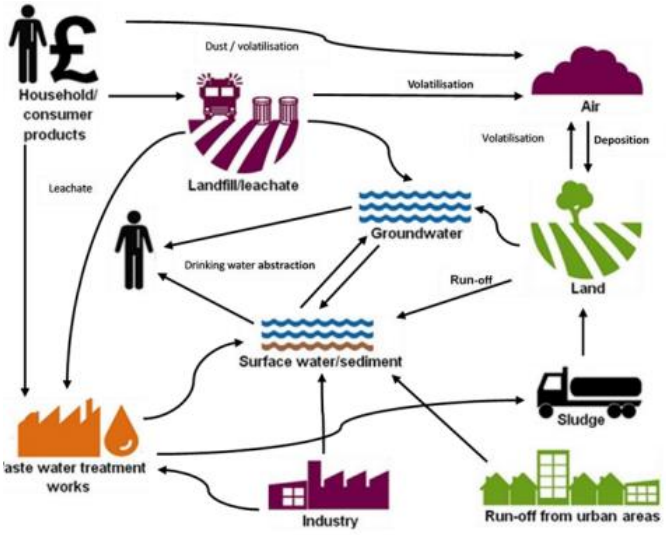

Figure 1-1: The many sources of PFAS and pathways for exposure (EA, 2021)[2]

Regulatory positions around the world are evolving rapidly, with a trend towards increasingly stringent regulations. In England and Wales regulations have been developing since c.2004 but have seen rapid changes in the last 4 years, with updated guidance from the DWI expanding the scope of the guidance from two compounds to 47 named compounds and reducing the concentrations at which specific actions are triggered. A 48th named compound (6:2 fluorotelomer sulfonamide alkylbetaine (6:2 FTAB)) is expected to be added in January 2025.

This presents significant uncertainty for water companies in planning investments to meet compliance. These uncertainties include:

- Interpretation and implementation of existing regulation.
- Introduction of new regulation.
- Advancement in scientific understanding including identification of new individual substances of particular concern, more definitive adverse impacts.
- Increasing awareness driving public pressure for action.
- Changes in catchments and sources leading to increasing PFAS at compliance points.

PFAS represent particular challenges due to the sheer range of possible uncertainties and scenarios. For some of these 'known unknowns' we can reasonably assume that something is likely to happen related to these uncertainties, but at the moment we don't know on what timescale, of what magnitude or even the details of how they may be manifested. Other uncertainties may be considered 'unknown unknowns' where risks come from situations that are so unexpected that they would not generally be considered.

[2] Poly- and perfluoroalkyl substances (PFAS): sources, pathways and environmental data - report (publishing.service.gov.uk)

This paper draws together experience in and evidence from investigation, management and understanding PFAS, across different jurisdictions and different industry sectors, to bring additional insight to help define and understand the range of possible uncertainties that water companies in England and Wales may face in the coming years. There is a particular focus on the AMP8 period 2025-2030 as this is the immediate concern for water companies responding to draft determinations for the 2024 Periodic Review.

In the following sections this report sets out the signals that might drive change, considers amplifiers and the potential regulatory responses. These are considered for each of the price control areas potentially impacted. These factors are summarised in a series of scenarios which consider the potential impact within the AMP8 period. Options for economic remedies within AMP8 to mitigate the uncertainty are presented thereafter.

In producing this report we have engaged with companies across the water sector, collating views on key uncertainties and potential mitigations. We have also engaged with the Drinking Water Inspectorate (DWI) to understand their perspective on PFAS uncertainty.

This report has been written in the context of the current relevant regulations and publicly available guidance from the DWI and Environment Agency (EA). One of the key uncertainties discussed is the reinterpretation of existing guidance and the introduction of new guidance. As such, some of the uncertainties will vary as and when regulations and guidance are updated.

Addendum (at time of publication)

The DWI issued Information Letter (IL) 03/2024 dated 21st August 2024 to water companies along with new guidance[3] on PFAS. The new documents provide consolidated guidance on aspects that water companies should consider when fulfilling their statutory obligations to ensure the safety of drinking water with respect to per- and polyfluoroalkyl substances (PFAS). It is based on a three-tiered, risk-based approach to the protection of water safety. The revised guidance requires companies with sources that fall into Tier 2 (<0.1 µg/L) to design a proactive and systematic risk reduction strategy. This shall include a prioritised mitigation methodology to progressively reduce PFAS concentrations in drinking water.

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[3] Guidance on the Water Supply (Water Quality) Regulations 2016 (as amended) for England and Water Supply (Water Quality) Regulations 2018 for Wales specific to PFAS (per- and polyfluoroalkyl substances) in drinking water

2. Overview

In setting out the uncertainty associated with PFAS for PR24 we have identified a number of signals which could drive change, alongside amplifiers which would potentially accelerate or increase the strength of the signal. We have then set out the potential regulatory response. The signals, amplifiers and responses are discussed in the following sections.

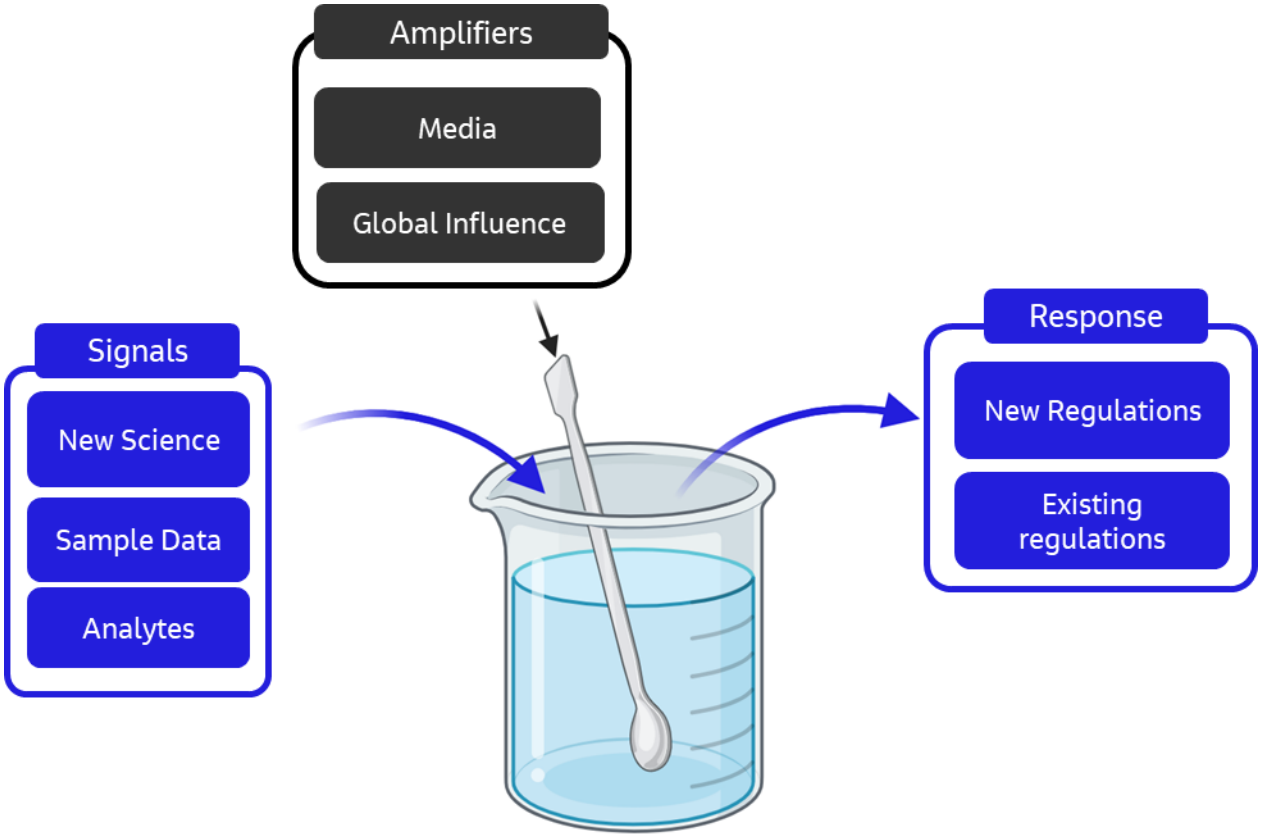

Figure 2-1: The factors influencing PFAS uncertainty

2.1 Signals for change

2.1.1 New science

It is widely acknowledged that PFAS are a complex family of chemicals and there remain extensive scientific uncertainties around their health effects, environmental toxicity, behaviour in the environment, treatment and many other important factors. It is recognized that more scientific research into PFAS is required and there continues to be a huge amount of research underway, in academia, in industry and in government funded studies around the world. As our scientific understanding evolves, this will flow down into guidance and regulation. Of the thousands of papers and reports published every year, it is unlikely that many (if any) individual studies will be substantial game changers, however the cumulative effect of multiple studies is likely to influence the direction of travel.

Epidemiological studies, examining the exposure levels and potential health effects of PFAS in impacted communities, are particularly important for demonstrating health effects and influencing regulatory positions.

The most important advances are likely to be related to expert review of existing data leading to the setting of health-based guideline values, as has already been seen in Australia in 2017, and in the USA with the publication of Maximum Contaminant Levels (MCLs) in April 2024, both of which have set the path for ongoing management of PFAS in those jurisdictions. In the UK, the Committee on Toxicity (COT) is currently considering its position on PFAS but has not indicated a date when an opinion may be published. The World Health Organisation (WHO) has also set up a committee to consider health-based guidance for PFAS and is expected to publish outcomes in the next couple of years. Whether the WHO guidance follows the highly precautionary approach adopted in the US, or the risk-based approach adopted in Australia, or a wide-ranging approach to the PFAS that should be considered, it is expected to be highly influential in regulatory approaches to PFAS around the world.

Other influential scientific advances with the potential to result in substantial change include new understanding of the modes of action of toxicity of chemicals of concern. For example, recent studies of the PFAS sulfonamides which are widely present in association with other better-studied PFAS from fire-fighting foams but behave differently and have the potential to be more harmful even in the smaller molecules usually considered to be lower risk. Such advances have the potential to have significant impact on PFAS mitigation, because they may be less amenable to the treatment methods being developed for the current risk drivers (PFOS and PFOA).

Much scientific study is focused on finding solutions to the PFAS problem, through the development of novel treatment technologies, and improving understanding of the effectiveness of existing treatment technologies on a wider range of PFAS, including short chain PFAS, non-anionic PFAS such as the sulfonamides, novel PFAS such as ethers, and ultrashort PFAS. The media regularly report breakthroughs from academic studies investigating new potential treatment technologies, ranging from using water fleas[4] to concentrate PFAS, to new technologies claiming effective low temperature destruction[5]. The challenge is to translate these academic studies into effective technologies that can be robustly deployed in practical applications. Ongoing studies such as the treatment technology studies currently underway at Cranfield University are an important step to achieve this. While it can be predicted that scientific research will result in new deployable effective treatment solutions for PFAS, the timescale and detail of what those technologies will look like remain highly uncertain.

The responses to new science or authoritative scientific opinions may include:

- Revisions to regulatory positions including DWI guidance;
- Media and public pressure for more stringent standards;
- Revisions to the required lists of analytes for monitoring;
- New options for treatment technologies.

2.1.2 New analytes

Based on the standard Organisation for Economic Co-operation and Development (OECD) definition of PFAS (Wang et al., 2021)[6] there are more than 7 million compounds that could be defined as PFAS (Schymanski et al, 2023)[7], however attention has generally focussed on a very limited number of individual PFAS, for which analytical methods and reference standards are available.

[4] https://www.theguardian.com/environment/2023/sep/26/scientists-use-water-fleas-to-filter-pollutants-out-of-wastewater

[5] https://www.theguardian.com/environment/2022/aug/18/pfas-forever-chemicals-new-method-decompose-drinking-water

[6] https://pubs.acs.org/doi/10.1021/acs.est.1c06896

[7] https://pubs.acs.org/doi/10.1021/acs.est.3c04855

Approaches to PFAS analysis include targeted analysis with a known list of target substances, non-targeted analysis, and non-specific methods such as extractable or adsorbable organic fluorine (EOF, AOF) which aim to quantify 'total PFAS'. Additionally, methods such as total oxidisable precursor (TOP) assay (Houtz & Sedlak, 2012)[8] have been developed to quantify the potential for precursors to break down to a target list of PFAS. Current England and Wales regulation and guidance is based on lists of target substances, with the scope and range of substances on the target list having evolved from just one (PFOS) to 47 and soon 48 (DWI Chief Inspectors Report 2023).

The DWI list of 47 PFAS to be tested for in raw water was introduced in DWI Information Letter 05/21 in October 2021. The 47 compounds were selected due to their known prevalence of use in England and Wales and mirrored the EA monitoring programme list at the time. DWI made clear that it was expected that the monitoring list would develop periodically in line with more information emerging about the attributes of PFAS compounds, as well as further developments in analytical techniques for detecting and quantifying. The addition of a 48th PFAS, 6:2 FTAB, was announced in July 2024 in the 2023 DWI Chief Inspectors Report[9].

Different jurisdictions around the world have identified different lists of PFAS that are required to be monitored by targeted analysis for drinking water, environmental quality standards or for surveillance monitoring (such as the United States Environmental Protection Agency (USEPA) Unregulated Contaminant Monitoring Rule (UCMR) monitoring). The England and Wales DWI list is believed to be the most extensive list in use, however some other regulators have included other PFAS not on the DWI list (notably the EU proposed Environmental Quality Standard (EQS) including 6:2 FTOH, 8:2 FTOH and C604).

As discussed in Section 2.1.1 there is a vast amount of ongoing academic research on PFAS with rapidly increasing numbers of peer reviewed scientific papers from research around the world. This includes studies with non-targeted PFAS analysis identifying prevalent PFAS in environmental media, and studies with targeted PFAS analysis focusing on novel PFAS identified from known product use or other research. These studies have the potential to draw attention to novel PFAS analytes not on the current DWI list.

The impacts of adding new analytes may include:

- Additional analytical costs per sample;
- Additional method development cost including (in some cases) purchase of new laboratory equipment;
- Potential new exceedance of tiers as new analytes are present at higher concentrations than those currently monitored;
- Potential indication of previously unidentified pollutant sources within the catchment.

2.1.3 New sampling results

There is extensive additional sampling planned for the AMP8 period. Each sample increases the knowledge of the prevalence, concentration, and location of PFAS contamination. Such knowledge could either trigger a need for mitigation or provide the evidence base required to justify revising the current regulations. Much of this sampling is mandated, such as in the DWI Information Letter 05/2021, or committed to being gathered through the UK Water Industry Research (UKWIR) Chemical Investigations Programme (CIP), PFAS undertakings catchment investigations, or the environmental assessments required for the Strategic Resource Options (SROs) and other projects. Therefore, the samples will be gathered and the knowledge base increased.

[8] https://pubs.acs.org/doi/10.1021/es302274g

[9] https://dwi-content.s3.eu-west-2.amazonaws.com/wp-content/uploads/2024/08/07103814/E03067866_DWI-Public-water-supplies-in-England-2023_Accessible_v2-1.pdf

Unlike established chemicals of concern to water quality where there is a significant history of regular sampling and the ability to trend and forecast any potential future deterioration PFAS have only been widely monitored for a comparatively short period. Therefore, the AMP8 investment in PFAS mitigation is based on those sites which have been found to be in Tier 2 or Tier 3 since the sampling requirements were established in AMP7 rather than those predicted to become Tier 2 or Tier 3 during AMP8. The risk is that ongoing sampling detects PFAS at Tier 2 or Tier 3 concentrations at new sites in AMP8 triggering mitigation measures in line with the PFAS undertakings that the water companies have entered into with the DWI.

Each environmental sample obtained through CIP, SROs investigations, catchment investigations or other projects adds to the PFAS prevalence knowledge base. This knowledge can instigate the identification of new priority compounds by the EA or additions to the DWIs list of named compounds.

2.2 Amplifiers

2.2.1 New International Guidance and Regulations

Jurisdictions around the world are all under pressure to take action to protect human health and the environment from the risks associated with PFAS, whether that is through restrictions on future use of PFAS, or through setting standards for drinking water and effluent or clean-up standards for the management of PFAS contamination from past use.

With the exception of the Stockholm Convention on Persistent Organic Pollutants (POPs), and the WHO review of drinking water standards, the majority of activity around PFAS regulation and guidance is happening on a national level (e.g. USA, Australia) or a European level, with further local regulation being implemented on a more local state or member state level. There is no consistent regulatory approach to PFAS between different nations with the type of regulatory approach adopted varying widely, in part depending on the general approach to chemical regulation within those countries.

This means that, even within a relatively straightforward regulatory standard such as drinking water, there are a huge number of different approaches and values that have been adopted around the world, with multiple new approaches being published every year. These approaches tend not to be driven by new science, and many acknowledge the continuing uncertainty around the health effects of PFAS, but they are the outcome of the regulatory need to take action protective of human health even while the scientific understanding evolves. One commonality is that the direction of travel of drinking water guidance for PFAS is almost invariably towards lower thresholds of acceptability and towards inclusion of an increasing number of individual PFAS. For example, during the period of preparation of this document in August 2024, Health Canada has announced a new PFAS drinking water standard[10] based on the sum of 25 PFAS not exceeding 30 ng/l.

The publication of each new standard around the world has the potential to increase media pressure on UK regulators to review and update the existing standards. Where there is a big jump in the standards, as seen with the publication of the USEPA draft Maximum Contaminant Level Goals (MCLGs) in March 2023 and final MCLs and MCLGs in April 2024 to levels well below the current DWI 'wholesomeness' threshold, there will be particular pressure to respond. This has been seen for example in campaigns from the Royal Society of Chemistry and may also be reflected in DWI's requirement for water company PFAS strategies to include the objective of achieving Tier 1 (<10 ng/l) in any mitigation.

[10] https://www.canada.ca/en/health-canada/services/environmental-workplace-health/reports-publications/water-quality/water-talk-per-polyfluoroalkyl-substances-drinking-water.html

Publication of new international guidance may also act as an amplifier where it can be seen by the regulators as a practical example of a regulatory approach which has been adopted elsewhere and aligns with England and Wales thinking.

The publication of new guidance on PFAS in drinking water from WHO is expected to be a specific amplifier, as DWI may respond to that new guidance on a precautionary basis, without waiting for opinions from United Kingdom Health Security Agency (UKHSA) or COT. The timescale for the production of new guidance from WHO is not clear, the most recent statement on their website (dated November 2023) does not provide a timeline.

The UK is a signatory to the Stockholm Convention on Persistent Organic Pollutants which is an international treaty aimed at eliminating or restricting the production and use of persistent organic pollutants, including certain PFAS substances. The UK has an obligation to implement amendments to the Stockholm Convention through its own domestic legislation. PFOS has been a named POP since 2009. The POPs review committee continues to review the list of POPs, including PFAS, and new PFAS were added in 2019 (PFOA and related compounds) and 2022 (PFHxS and related compounds). Long-chain perfluorocarboxylic acids are currently being considered for addition to the list. These changes at an international treaty scale will impact UK regulation of PFAS.

2.2.2 Media

The media, campaigning groups, and public opinion / social media activity have the potential to amplify and impact signals for change and otherwise influence regulatory activity.

This includes media activity campaigning for more action to reduce pollution and the impacts of PFAS, for example the Guardian, ENDS and the Royal Society of Chemistry. These organisations are being increasingly vocal in raising awareness, obtaining data through freedom of information requests and campaigning for further action.

The high profile of PFAS in the media also appears to be fuelling some social media activity suggesting that the environmental campaigns around PFAS are scaremongering, denying the science and pushing for less regulation. Examples include the guardian's article[11] titled "*Second Trump term could boost toxic 'forever chemicals', experts warn*" and the recent social media backlash against the August 2024 PFAS segment on BBC Countryfile.

2.3 Regulatory Response

PFAS are emerging contaminants and as such regulatory response is continuing to evolve to enable their effective management. This includes not only the development and publication of new regulation, but also the interpretation of how existing regulation may apply to PFAS, and how it is implemented. The timeline of these potential responses can vary from virtually instantaneous with little forewarning (for example DWI information letter 05/21 requiring testing of 47 PFAS), to a longer period of evidence gathering, consultation and staged implementation (for example proposed restrictions to PFAS use through the Health & Safety Executive Regulatory Management Option Analysis (HSE RMOA)). The timeline by which regulators may start to implement existing regulation with regard to PFAS also varies by sector and context and may change in response to various signals and amplifiers. For example, the majority of discharge permits were issued prior to recognition of PFOS (or any other PFAS) as chemicals of widespread concern and are therefore silent on PFAS. This potential variability in timeline leads to massive uncertainty for regulated industries.

It is noted that the general mode of regulatory response to PFAS is varied within different sectors. In the drinking water sector, regulation is largely via the DWI, and implemented through the Water Supply (Water

[11] https://www.theguardian.com/us-news/article/2024/jul/28/trump-second-term-pfas-forever-chemicals-pollution

Quality) Regulations 2016 (as amended) with periodic guidance updates and information letters providing PFAS specific procedural advice to water companies, in advance of formal legislation change.

Within the water industry, the Water Industry National Environment Programme (WINEP) provides a funding mechanism for a comprehensive set of actions required to be undertaken to meet environmental obligations within each AMP. AMP8 WINEP includes some PFAS activities and future AMP WINEP programmes are a mechanism by which water companies are likely to be required to undertake longer term environmental improvements to enhance PFAS management in the same way that nutrient improvements are now being implemented. However, not all regulatory environmental enhancement activities are directed through WINEP. For example, the regulatory position change described above results in wastewater treatment works falling within the remit of the Industrial Emissions Directive.[12]This change has caused major enhancement needs to comply with the Industrial Emissions Directive (IED) regulations and has had repercussions through the industry as these enhancements are unfunded in the AMP7 business cases.

The Office for Environmental Protection (OEP) is responsible for holding the government to account for their environmental policies and actions. Media pressure or a campaign group challenge my drive OEP to take a view on current policies and drive regulatory change.

In the following discussion and throughout this report we have attempted to differentiate between regulatory responses which are reinterpretation and implementation of existing regulation or guidance, and potential new regulatory responses which comprise new legislation, guidance and procedural advice.

2.3.1 Reinterpretation of Existing Regulations

One of the biggest challenges about PFAS is that they are different to most other chemical contaminants of concern in a number of ways. This includes behaviour, occurrence and characterisation. This difference has particular implications for the application of existing regulation which was not developed with PFAS in mind. The literal application of existing legislation to PFAS has the potential to have major consequences which would not have been foreseen when the legislation was drafted and may not align with the intention of that legislation. The continuing developing scientific understanding of PFAS is expected to continue to raise such challenges as legislation develops.

There are a number of regulations and directives currently in force across both clean and wastewater sectors, which water companies are already subject to controls under. Principally, these have been implemented via the Environmental Permitting Regulations 2016 (as amended) in England and Wales. While the underlying structure of the regulations is known, the guidance and interpretation of the regulations is subject to update, potentially with limited wider consultation, by the EA.

We have seen during AMP7, through the implementation of the IED to wastewater sites undertaking anaerobic digestion, that the EA and Natural Resources Wales (NRW) can reinterpret regulations and guidance and require implementation of regulations on water companies, including large capital requirements outside of the AMP funding cycle. The IED permits do not explicitly cover PFOS and PFAS treatment or monitoring, but requirements imposed by the new permits will lead to additional sampling and potential identification of these substances and may lead to permit compliance issues if they are not treated.

Other existing regulations may fall outside of those regulations normally considered by the water industry, but could impact on it, if the EA decided to issue specific guidance around those regulations. A key potential existing regulation whose implementation could change is the POP Regulations 2007, which include specific PFAS within their scope. New guidance over the last 18 months has raised awareness of these regulations within the waste industry around the disposal of domestic soft furnishing, requiring implementation of

[12] Directive 2010/75/EU of the European Parliament and of the Council of 24 November 2010 on industrial emissions (integrated pollution prevention and control) (Recast)

operational changes within six months. As the regulations apply to wastes, this may impact on clean water sludges from drinking water treatment works as well as wastewater treatment works.

For drinking water, Regulation 4 of the Water Supply (Water Quality) Regulations includes a catch all stipulation in Regulation 4(2)(ii) which requires that the water does not contain any substance at a concentration or value which could constitute a potential danger to human health. As the research continues on PFAS, in particular the toxicological studies, this regulation may become increasingly influential in the use of enforcement notices, prohibiting supply.

2.3.2 New Regulations

Increasing public, political and media concern has substantially influenced regulation on emerging contaminants, including PFAS in recent years. The change in regulations in the US, Australia and in England and Wales has been fast-moving, evolving from monitoring for PFOS and PFOA to risk-based programmes for multiple PFAS compounds that determine the levels of consultation, controls and enforcement action required. Since leaving the European Union, the EU Directives, including for example the Drinking Water Directive (DWD) and the Water Framework Directive (WFD), no longer drive regulations in England and Wales. The decisions are now governed solely by the UK government through the EA, NRW and the DWI who determine suitable requirements for PFAS. The 2023 Defra 'Plan for Water'[13] is a government policy paper laying out an integrated plan for delivering clean and plentiful water, and includes specific commitments for future management of PFAS, including ensuring '*water companies go faster to introduce tighter controls on certain chemicals, including perfluorooctane sulfonic acid (PFOS), to ensure we reduce contamination from these substances as soon as possible*'.

In England and Wales, PFAS procedural advice from DWI has changed swiftly through AMP7 and has continued to shift in the PR24 consultation phase in response to public concern and new emerging research evidence. The changes in regulation have not aligned with the PR24 process or timeline for business plan submissions, therefore, leaving uncertainty for the AMP8 period should further requirements or restrictions come into place.

[13] https://www.gov.uk/government/publications/plan-for-water-our-integrated-plan-for-delivering-clean-and-plentiful-water/plan-for-water-our-integrated-plan-for-delivering-clean-and-plentiful-water

3. Water price control areas

3.1 Signals

3.1.1 New science

As discussed in Section 2.1.1 there are acknowledged to be large gaps in scientific understanding of PFAS but there is also a huge amount of ongoing scientific research into PFAS. It is not possible to predict when significant scientific breakthroughs will arise and how quickly they will move from being academic findings to implemented regulatory change. It is also difficult to use past experience as an indicator of future action, as the rate of generation of new scientific material around PFAS is unprecedented, and the amplification effect of growing media and public interest in PFAS also has the potential to accelerate change.

Examples of new science with potential to be a signal for change in drinking water operations include:

- New epidemiological and toxicological studies providing more certainty on the adverse effects of either individual PFAS, or PFAS as a group. Currently, while there is substantial literature on toxicity for several PFAS, it is difficult to make conclusive recommendations. An example is the recently updated paper supporting the COT assessment of the toxicological assessment of PFAS, providing evidence on in vivo thyroid toxicity (Introduction and Background - PFAS/2023/03[14]). This was based on review studies of seven PFAS (PFBS, PFHxS, PFOS, PFHxA, PFOA, PFNA and PFDA). The paper concludes "*Overall, the in vivo evidence indicates that low doses of PFAS can produce adverse effects on levels of thyroid hormones (without affecting thyroid stimulating hormone levels), and at higher doses, can produce morphological alterations in the thyroid. However, some of the findings are inconsistent, sex-specific and difficult to interpret in terms of adversity and human relevance*." This difficulty in translating available evidence of adverse impact into a specific health-based guidance is typical of the challenges and uncertainty inherent in PFAS risk assessment.
- New academic research into PFAS use, and the pathways by which they may be released to the environment: The publication in 2020 of a comprehensive overview of the many use categories for which PFAS have been employed (Gluge et al, 2020)[15] was an important step forward in furthering understanding of the breadth of activities in which PFAS are used and underpins all subsequent assessments of potential PFAS sources.
- UK government funded research such as the Chief Scientist's PFAS Evidence Review[16] (and the EA PFAS Risk Screening Project (ongoing) is also advancing knowledge of PFAS sources and substances in the UK, including landfills and problem sites. Outcomes of this work have helped influence DWI guidance.
- The UK construction organisation Construction Industry Research and Information Association (CIRIA) is expected to publish new guidance on PFAS in soil and water environments in late summer 2024. This guidance has been in preparation since 2022 and is expected to provide practical advice to industry.
- While focussed on regulation of ongoing use of PFAS under Registration Evaluation, Authorisation and Restriction of Chemicals (REACH), the recommended programme of work arising from the UK HSE RMOA includes further evaluation and investigation of substances that have been highlighted to be of concern including TFA, EEA-NH4, perfluoroalkanes and perfluorocycloalkanes.
- Scientific research leading to new analytical methods and new treatment technologies: As these new technologies develop into deployable techniques, this may alter the perception of what can reasonably

[14] https://cot.food.gov.uk/Introduction%20and%20Background%20-%20PFAS/2023/03; last updated 14/8/24; accessed 16/8/24

[15] https://pubs.rsc.org/en/content/articlelanding/2020/em/d0em00291g

[16] https://assets.publishing.service.gov.uk/media/611e31fbd3bf7f63b19cea2d/Poly-_and_perfluoroalkyl_substances_-sources_pathways_and_environmental_data_-_report.pdf

be achieved using Best Available Techniques (BAT), both in terms of detection and also treatment. It must be recognised that the deployment of new treatment techniques may be constrained by the Regulation 31 restrictions on material in contact with drinking water, where being deployed within the WTW process rather than wastewater disposal.

Uncertainty	Outcome of Ongoing Reviews of Toxicological Data by COT
	The UK COT is currently reviewing data on PFAS but so far has been unable to reach a conclusive outcome allowing translation of available evidence of adverse impact into specific health-based guidance. A COT opinion on PFAS toxicology would be expected to be a strong driver for change in UK regulation.

3.1.2 New analytes

The England and Wales drinking water guidance is based on a tiered system with concentration thresholds that apply to a specific list of named PFAS, plus 'any PFAS' that are found in analysis and exceed the tier thresholds. While it is understood that the intention of the guidance is not to mandate mitigation action based on results for PFAS other than those in the named list, the wording of the guidance is open to interpretation. Where water companies choose to analyse for other PFAS, the tiers may also apply.

The drivers by which new PFAS may be added to the list to be analysed are uncertain and may include evidence of prevalence of specific PFAS in the UK environment, or evidence of UK use of PFAS known to be persistent in the environment.

New analytes may be introduced either by:

- Water companies voluntarily including additional analytes into their monitoring suites (where, depending on interpretation, they may then be picked up in the 'any PFAS' clause within the existing DWI guidance); or
- DWI adding additional analytes to the required minimum list for testing for raw water sources.

The introduction of the new analytes has the potential to result in material change to the management of sources, where they result in new exceedance of the existing tiers, as a result of the prevalence of the individual PFAS in the source water.

Case Study	6:2 FTAB – an example of a new analyte triggering change in AMP7
	Initially 6:2 FTAB was tested for voluntarily by one water company and found to be the most prevalent PFAS; it has since been tested for by other companies and found to be exceeding the Tier 3 threshold. DWI have recently announced that it will be required to be tested for from January 2025. 6:2 FTAB is of particular interest, as it has been recognised in academic studies as a major 'precursor' in some firefighting foams for some time, but its environmental persistence at high concentrations and consequent presence in UK water supply sources has only been recognised more recently.

Future new analytes relevant to drinking water regulation may be related to:

- Identification of prevalent PFAS of concern from other monitoring programmes, such as EA national monitoring. These could include 'ultrashort' C2 and C3 PFAS such as TFA and PFPrA which it is believed

are being included in future monitoring, and novel PFAS such as the ether EEA-NH4 which is known to be used and discharged from the AGC Chemicals Europe (AGCCE) facility in Thornton Cleveleys[17], [18].

- Addition of PFAS of potential concern which are included in other national guidance, for example Fluorotelomer alcohols and the PFAS ether C604 currently included in the EU proposed surface water EQS. If monitoring against this standard in Europe identifies these determinands as prevalent risk drivers then there may be reason to add them to the DWI list. They may also be added to laboratory standard suites.
- Identification of PFAS of concern related to specific industrial uses that have not previously been identified as of potential significance to the UK environment, but for which new evidence arises of widespread use, pathways for release to the environment, and persistence in the environment. These could include specialist applications of novel PFAS such as bis-FASI widely used as electrolytes in lithium ion batteries and recently identified as present and persistent in the environment in Europe[19].

Uncertainty	Regulatory approach to TFA and other ultrashort PFAS
	The regulatory approach to ultrashort PFAS such as TFA could have a major impact on drinking water treatment requirements. Media awareness of TFA is increasing. TFA and other ultrashorts are different to other PFAS, including in their sources, migration and transfer pathways and treatment technologies.

New analytes introduced to effluent and wastewater suites requirements are discussed in Section 3.1.2. It is noted they may also be relevant to drinking water providers where they are applied to effluents from clean water processes as in the scenarios discussed in Section 6.

3.1.3 New sampling results

Each water company in England and Wales has entered into an undertaking with the DWI to implement their PFAS strategies. These undertakings include commitments to:

> "For all sources that fall into Tier 3, design and develop mitigation to reduce PFAS concentrations in drinking water to at least Tier 1 concentrations, with a high priority." and
>
> "For all sources that fall into Tier 2, design a proactive and systematic risk reduction strategy which shall include a prioritised mitigation methodology to progressively reduce PFAS concentrations in drinking water."

Due to the limited sample history, the lack of understanding of the source to receptor pathways for the groundwater contamination and the lack of targeted observation boreholes, there is a significant lack of foresight to predict which sources are likely to see increasing contamination and may cross the thresholds into Tier 2 and Tier 3. The potential for identifying new sites requiring mitigation according to the undertaking at any point in AMP8 is significant and potentially material.

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[17] https://assets.publishing.service.gov.uk/media/6421a7aefe97a8001379ecf7/8._Environmental_risk_evaluation_report_Perfluoro_2-ethoxy-2-fluoroethoxy_-acetic_acid__ammonium_salt.pdf

[18] https://www.endsreport.com/toxic#:~:text=In%20this%20documentary%2C%20ENDS%20Report,to%20uncover%20the%20toxic%20truth

[19] Lithium-ion battery components are at the nexus of sustainable energy and environmental release of per- and polyfluoroalkyl substances | Nature Communications

Case Study	**New data have triggered Tier 2 exceedances since PR24 submission**
	In preparing this report we provided a questionnaire to water companies, of the seven responses two water companies state that they have sources where the sampling since submission of PR24 has increased the PFAS tier to either Tier 2 or Tier 3. According to the undertaking with the DWI these sites will require additional mitigation not currently allowed for in PR24.

The DWI mandated PFAS sampling to date has been quantitative spot sampling, with the frequency of the sampling being determined by the risk assessment of the source. By the nature of the spot sampling, transient contamination, of particularly surface waters, will only be observed by chance. Until enough samples have been collected to provide a statistically robust data set there is a significant risk that such events have not been detected, and for example that a future sample may identify a periodic discharge from an industrial site.

In addition to the ongoing source sampling in accordance with DWI Information Letter 05/2022 there are additional routes by which the water companies may gather environmental samples in the source catchments. These include specific PFAS catchment investigations as identified in the PFAS strategy undertakings, sampling for new discharge consents, and more general industry sampling programmes such as CIP4 or in support of environmental impact assessments. Each sample has the potential of finding additional PFAS compounds in the source catchment, changing the risk assessment for the drinking water catchment, and promoting new requirements for mitigation. Some of the catchment studies proposed in response to the requirements of the PFAS strategy include passive samplers that will detect the longer-term average concentrations and may identify compounds not found in the spot sampling history. The identification of additional, transient, PFAS compounds poses a significant risk of increasing the sampling frequency, with a cost impact, to determine the concentrations of short-term peaks. Once captured and quantified, there is a further risk of increasing the tier of the source and requiring additional mitigations.

Finally, the sample information from environmental impact assessments in support of planning or DCO applications will be made public and potentially be amplified by campaign groups and the media who object to specific local options.

3.2 Regulatory Response

3.2.1 Existing Regulations

The existing regulations relevant to drinking water include:

- The Water Industry Act 1991 (makes provision for the powers allowing a water company to discharge waters from a pipe, reservoir, well or borehole into any available watercourse when undertaking specified activities).
- The Water Supply (Water Quality) Regulations 2016 (as amended) defines the list of prescribed concentrations and values that limit contaminants in drinking water, while also establishing the broader concept of Wholesomeness and the activities that a water company shall undertake to ensure that the drinking water remains wholesome).

The DWI provide procedural advice on the application of these regulations in the following guidance:

- Guidance on implementing the Water Supply (Water Quality) Regulations Parts 1 - 11
- Guidance on the Water Supply (Water Quality) Regulations 2016 specific to PFOS (Perfluorooctane Sulphonate) and PFOA (Perfluorooctanoic acid) concentrations in drinking water, (initially published in

2009, and revised in 2019, it is indicated that a further revision to incorporate the subsequent information letters is expected to be published imminently).

Since 2021, the DWI have published a series of information letters and guidance specifically related to PFAS.

- October 2021 – IL 05/2021 Requirements for Poly and Perfluorinated Alkyl Substances (PFAS) monitoring by water companies in England and Wales – includes list of 47 substances to be included in monitoring.
- July 2022 – IL 03/2022 PFAS Guidance - Requirements for PFAS monitoring by water companies in England and Wales - includes updated tiers, applicable to any PFAS.
- September 2022 - Annex to IL 03/2022 – clarification to IL 03/2022.
- March 2023 – 11 02/2023 - Inspectorate expectations for PFAS activity in AMP8.

The 2009 guidance introduced a tiered approach to PFAS risk assessment and responses, the tiers and the concentrations that correspond to the tiers have been revised in 2019 and 2022 with the current approach being as detailed in Table 3-1.

Table 3-1. PFAS final water tiers and actions (from DWI IL 03/2022)

Tier	Concentration of any PFAS in final water	Action
Tier 1	Less than 0.01 µg/L	▪ Continue to monitor for PFAS. Initially this may be as frequently as quarterly, until a baseline is established which accounts for temporal variation, and a robust risk assessment is complete, at which point the frequency could be reduced to a level sufficient to periodically validate that risk assessment. ▪ Ensure PFAS considered as part of statutory risk assessment. ▪ A hazard line for PFAS should be submitted in the regulation 28 report with a DWI risk category of A or H for every site in this tier.
Tier 2	Less than 0.1 µg/L	▪ Continue to monitor for PFAS. For medium risk sites which may not yet be Tier 2, and Tier 2 sites, a frequency between monthly and quarterly should be sufficient to enable predictive modelling. Frequencies may need to be increased if Tier 3 is predicted to be breached. ▪ Review any control measures, such as blending procedure including the efficiency, control and monitoring of that measure. ▪ Ensure relevant risk assessment is up to date and under constant review. ▪ Discuss with Liaison Inspector in working hours if final water result exceeds company's internal limit. ▪ Discuss with Liaison Inspector in working hours if there is an increasing PFAS trend, which could lead to a breach of the wholesomeness level (Tier 3). ▪ The purpose of notifying the Liaison Inspector under this tier is to discuss whether the occurrence should be a reportable event, which will depend on each individual circumstance. ▪ Prepare measures to prevent the supply of water to consumers with >0.1 µg/L PFAS. ▪ Consult/discuss with UKHSA and local health authorities.

Tier 3	Greater than or equal to 0.1 µg/L	Wholesomeness concentration in final water. ▪ Notify as an event for any results greater than or equal to 0.1 µg/L in water supplied to consumers, or any raw water results that are likely to produce results >0.1 µg/L in water supplied to consumers. ▪ Notify UKHSA and local health authorities. ▪ Resamples as a minimum from raw water sources, blended or combined raw water point, and final water for water treatment works. Resamples should be fast tracked. Frequencies should be established to understand the impact in the specific supply situation, and to inform decision making. ▪ Check and review control measures, such as blending procedure including the efficiency, control and monitoring of that measure. ▪ Prepare emergency contingency measures to prevent the supply of water to consumers with >0.1 µg/L PFAS if the control measures employed become inadequate. ▪ Fast track sampling at treated water blending point (if applicable) and/or in water quality zones. ▪ A minimum of monthly samples in monitoring programme for raw and final water points for a minimum of 12 months, timed to take account of any changes in hydrological conditions, such as droughts, deluges or changes in pumping regimes. ▪ Review catchment and PFAS sources information within 10 working days of receiving result and provide an update to the regulation 28 report as part of the event report. ▪ This list of actions is not exhaustive; all necessary actions to investigate the source of the PFAS and reduce concentrations below 0.1 µg/L in water supplied to consumers must be taken.

Other regulations potentially relevant to PFAS which may also impact water resource and treatment works include:

- Environmental Permitting Regulations (EPR) 2016 (as amended) (covers permitting and consenting including discharge from treatment works)
- The Water Framework Directive (Standards and Classification) Directions (England and Wales) 2015 – which include the EQS for PFOS of 0.65 ng/l (annual average)
- The Persistent Organic Pollutants Regulations 2007[20]

PFAS are also of increasing relevance in assessment of land contamination, soil and other material re-use in the context of construction, maintenance, demolition and other infrastructure development to which the Land Contamination Risk Management[21] approach applies.

[20] https://www.gov.uk/guidance/using-persistent-organic-pollutants-pops

[21] https://www.gov.uk/government/publications/land-contamination-risk-management-lcrm

3.2.2 Reinterpretation of Existing Regulations

3.2.2.1 EPR

EPR (2016) covers the permitting of activities including environmental permits for discharge to surface and groundwater, as well as waste management activities such as imports of tanker trade waste, and industrial processes such as sludge treatment by anaerobic digestion or thermal treatment.

At present, the EA provides two excel spreadsheets[22] listing chemicals which need to be considered when carrying out Risk Assessments. These spreadsheets are labelled one as 'priority hazardous substances, priority substances and other pollutants' and the other as 'specific pollutants', with the note that *'hazardous chemicals and elements are also known as specific substances*' . Both spreadsheets include relevant EQS for the chemicals included, with some chemicals on both lists. In total there are around 150 chemicals listed, which include PFOS.

These documents are EA guidance, although based on secondary legislation. There is the potential for the EQS values to be updated, or additional chemicals included, following a consultation and passing of secondary legislation.

In the event that the spreadsheets are updated, they would be applicable to all new and current applications going forward, although it would be unusual for the EA to require existing permits to carry out new risk assessments based on the revised values. The EA has indicated that it is working on a new master list of substances of emerging concern and these are likely to include some PFAS.

Case Study	**New discharge permit required for drinking water treatment.**
	At one existing groundwater resource Anglian Water are proposing a new surface water discharge to prevent returning PFAS from the dirty wash water back to the unconfined aquifer. This requires a new discharge permit leading to additional treatment installations on the discharge point and increased operational costs.

New discharge consents, such as those required for new SRO schemes, are likely to be heavily impacted by implementation of the current standards surrounding the EQS and permanent discharge requirements which have not been retrospectively applied to existing permits.

3.2.2.2 Water Industry Act

Temporary discharges by water companies for operational purposes are governed by Sections 165 and 166 of the Water Industry Act (1991), under Part 3 of section 165 these discharges are required to be as free as reasonably practical from polluting substances. If regulators chose to determine that PFOS (or any other PFAS) is a 'polluting substance' then even potable water meeting Tier 1 drinking water standards (<0.01µg/l) might not be permitted for discharge to surface waters without treatment to bring the downstream receiving watercourse below the PFOS EQS standard of 0.65 ng/l. This would lead to unforeseen costs for simple and necessary operations, such as proactive preventative maintenance of water mains for the prevention of discolouration, reservoir draining, and mains commissioning, and could present challenges in water quality event scenarios should it be implemented. Should the EA choose to adopt this interpretation of the regulations the impacts on water company operations has the potential to be material due the extensive number of activities affected.

[22] https://www.gov.uk/guidance/surface-water-pollution-risk-assessment-for-your-environmental-permit

3.2.2.3 Water Supply (Water Quality) Regulations

Further pressures are likely to be presented through the SROs which may test the boundaries and limits of current Water Supply (Water Quality) Regulations as they are introduced as new water sources. For example, any new source being introduced must undergo a Regulation 15 assessment and approval from the DWI. We have already observed challenges for those new works sources assessed as part of the accelerated AMP8 schemes where PFAS has been detected at concentrations breaching Tier 2 and higher. For these sites the DWI has placed prohibition of supply notices on the works preventing use of high-risk raw waters. As new strategic schemes come up for assessment it is probable that more prohibitive enforcement is likely in response to PFAS detections, particularly for those sources downstream of multiple wastewater treatment works effluent points. In addition, complications may arise from those SROs being procured under the Direct Procurement for Customers (DPC) arrangement which is likely to present risk and challenge for incumbent companies and the regulators who, under the Water Industry Act hold powers over licenced water undertakers or sewerage undertakers for areas of England and Wales only.

Case Study	**DWI enforcement on PFAS is increasing**
	When completing upgrades to a water treatment works, as part of an accelerated programme of work, Severn Trent identified the additional raw water sources that had been planned for use presented a PFAS risk. Following correct notification to the DWI an enforcement notice (SVT-2023-00002) was served preventing the two new sources from being used for the supply of drinking water until the company has completed and verified a solution.

3.2.2.4 Persistent Organic Pollutants Regulations

As discussed in Section 2.2.1, some PFAS are named as specific POPs under the Stockholm Convention, and as the UK is a signatory to the Stockholm Convention, it is obliged to implement the Stockholm Convention through its own domestic legislation. This includes control on the use and disposal of POPs, including a requirement to destroy POPs in waste.

As discussed in more detail in Section 4.2.2.2 the EA has been reviewing POPs in waste streams, including implementing actions targeting certain waste sectors. The regulatory approach does not yet appear to have been developed for waste streams containing detectable POPs which have not been intentionally added, which could apply to PFAS in water treatment sludges and soil.

3.2.2.5 Land Contamination and Material Re-use

Any infrastructure works, including construction, demolition and maintenance, should take into account the potential for contamination to have arisen from past activities. While the contamination status of operational sites may be well established for conventional contamination, as PFAS are emerging contaminants they have generally not been included in previous ground investigation and other site characterisation. The persistence of PFAS means that they may still be present impacting the ground decades after the contamination occurred. As well as being contaminants of concern for soil, PFAS also have potential to be absorbed to semi-permeable materials such as concrete and asphalt, and to be desorbed later, presenting an ongoing source. PFAS are now recognised as potential contaminants of concern for many activities including landfill and wastewater treatment works. Methods for characterising, risk assessing, managing and remediating PFAS in construction projects are developing fast, but continue to evolve as understanding of PFAS grows. CIRIA has been working on new PFAS guidance since 2022 and it is expected to be published late Summer 2024. As relatively few sites have as yet come forward for regulatory approval, regulatory approaches for the implementation of existing regulation with respect to PFAS remain immature and open to uncertainty of interpretation.

This means that PFAS have the potential to result in uncertainties in new development projects (including water industry projects) including increased costs and delays, due to the presence of PFAS contamination that was unforeseen at the time of project planning and is more time-consuming and costly to manage. This includes ground and groundwater contamination, and material re-use or off-site disposal.

3.2.3 New Regulations

3.2.3.1 New DWI regulation or guidance

New regulations (or procedural advice around the implementation of regulations) within the water price control are most likely to come from the DWI as the water quality regulator for England and Wales. The evolution of new regulatory requirements for PFAS have been substantial in recent years as detailed in Section 3.2.1.This has included moving from limited monitoring at the start of AMP7 to additional analysis and monitoring of 47 PFAS compounds in 2021 (DWI Information Letter 05/2021) to monthly submission of raw and final water samples and adherence to a tiered system in July 2022. Under this tiered system the highest risk sites (Tier 3) were required to have treatment solutions implemented (DWI Information Letter 03/2022). In March 2023 the DWI issued information letter IL 02/2023 building in further guidance on expectations for companies to develop PFAS strategies which should be implemented and kept under continuous review. The pace of change across AMP 7 with new requirements coming in for PFAS has been substantial.

Between October 2023 and July 2024 the DWI have increased their expectations on Tier 2 sites, requesting water companies PFAS Strategies to consider the risks and take appropriate actions to mitigate the site to a consistent Tier 1 level or below. In addition, enforcement action was taken on a number of water companies with Section 19 Undertakings including action for risk reduction on Tier 2 sites. The DWI continues to maintain a focus on PFAS with their Standards Board expected to enter into consultations on PFAS requirements in 2025.

Case Study	**Proactive AMP 8 enforcement from the DWI is already in place**
	Following the submission of PFAS Strategies by water companies in 2023, the DWI proceeded to put in place Section 19 Undertakings for a number of companies. Taking Northumbrian Water's as an example (NES-2023-00009) the undertaking, that the company volunteered to enter, includes requirements associated with; risk assessment of individual and total PFAS, sampling and analysis, actions to undertake catchment characterisation and identification of PFAS sources and relevant stakeholder engagement. Importantly, the Undertaking requires that for all sources that fall into Tier 3, the company will design, develop and implement mitigation to reduce concentrations to Tier 1 with high priority.

The Guidance on PFAS from the regulator is continually evolving and the risk of new information letters requiring water companies to complete further actions/ mitigations is likely through AMP8. Indeed, it has been indicated that new guidance is to be issued in August 2024 but has not been seen at the time of writing of this paper.

The DWI is reliant on a number of sources to determine regulatory shift associated with PFAS, this includes the EA environmental monitoring programme, UKWIR CIP monitoring and outputs of reviews of toxicological studies including WHO, UK COT and UKHSA. Should substantial evidence on toxicological data be provided that brings confidence to decision making it is possible that Regulations would change within a six month timeframe from reports being available. Ongoing reviews of PFAS toxicology by both WHO and the UK COT are the most likely to trigger changes within AMP8.

Based on the Chief Inspectors report, published July 2024[23], it is understood that a 48th PFAS compound (6:2 FTAB) is going to be introduced to the target test list in January 2025. The regulator has also stipulated that PFAS tiers apply to any PFAS chemicals detected in raw and final waters where no treatment is in place and should be notified to the Inspectorate. Due to the nature of the monitoring being risk-based and defining all PFAS compounds as one whole class, this leaves a wide spectrum of chemicals to potentially influence future regulatory changes. If the DWI were to introduce a "sum of" PFAS standard this would lead to a combination impact and further sites progressing up the tier levels.

There is a risk that regulatory changes and tighter concentration standards will result in a need for treatment installations through AMP8. As risk-based monitoring and research leads to further identification of PFAS chemicals more sites will move into, and up, the tiers. Cost increases for treatment and operations will have both capital and operational cost impacts in addition to base costs associated with sampling and laboratory costs. As companies risk assessments lead to more PFAS chemicals being monitored, the cumulative effect on costs becomes significant.

3.2.3.2 New HSE Chemicals Regulations

The PFAS RMOA[24] submitted under the UK REACH framework will enhance understanding on his group of chemicals and also set further action and proposals for new regulatory controls. The restriction proposal was published in March 2023 and forms a catalyst for further activities. The next stages will be to take forward recommendations for action. These will likely aim to address the manufacture, market placement and use of PFAS in the UK whilst a similar restriction proposal is being assessed under the European REACH framework[25]. It is probable that the European consultation will come to a resolution more swiftly due to the political pressures from several member states including Germany and the Netherlands. Alongside these restriction proposals is the EU Chemical Strategy[26] which aims to develop an action plan to eliminate all non-essential use of PFAS. This may include the introductions of an essential use concept as a tool for chemical risk management across a broad range of chemicals including PFAS. The UK Chemical Strategy was due for publication in 2023 but is still awaited. Possible restrictions may take the form of a full ban after an 18-month transition period or a phased ban with specific time-restricted derogations applying for particular PFAS uses. Any restrictions that come to fruition in the European community could serve as a precedent for England and Wales regulations and have positive impacts to both water and waste price controls. European restrictions could also have impacts with PFAS reduction on the wider supply chain and imported materials.

Opportunity 	**Actions on Restrictions on PFAS should lead to reduction on new PFAS** The ongoing activities to restrict PFAS use in the UK and Europe are expected to have the effect of reducing the load of new PFAS entering the environment, not only when the restrictions come into force, but also in advance as users and supply chains review their use of PFAS and implement alternatives.

3.2.3.3 New Environmental Regulations

BAT are currently applied in wastewater IED permits requiring consideration for the design, build, installation, operation, maintenance and decommissioning of facilities to reduce emissions to air and water. For drinking

[23] https://dwi-content.s3.eu-west-2.amazonaws.com/wp-content/uploads/2024/08/07103814/E03067866_DWI-Public-water-supplies-in-England-2023_Accessible_v2-1.pdf

[24] https://www.hse.gov.uk/REACH/rmoa.htm

[25] https://echa.europa.eu/hot-topics/perfluoroalkyl-chemicals-pfas

[26] https://environment.ec.europa.eu/strategy/chemicals-strategy_en

water treatment works, discharges are based upon EA permits with specified EQS. Alongside this, the deployable output for supply is regulated under the Water Supply (Water Quality) Regulations (2016 as amended) Schedule 1 and 2 parameter requirements. Should BAT be applied to water treatment works using a similar approach as to that observed for wastewater treatment sites, there would be more regulatory stipulation on the use of BAT to limit the risk associated with PFAS contamination. In March 2024 we saw the USEPA publish the best available technologies and small system compliance technologies for PFAS in drinking Water[27] setting out evaluations for GAC, ion exchange, reverse osmosis and nanofiltration. Consideration should be given for the possibility of regulators increasing expectations around treatment techniques and technologies in order to ensure requirements are met. The precedent set by the IED permits for wastewater sites could form a pivotal point for water treatment if regulators chose to adopt this approach in future years.

Currently the only PFAS for which there is an EQS is PFOS. It is expected that, within the period of AMP8, the EA will propose revisions to the WFD list of priority substances, including additional PFAS and new EQS. These will then be applicable to new environmental permits and will be subject to consideration in review of existing permits. It is feasible that the current, very stringent EQS for PFOS of 0.65 ng/l could be increased in a review, but new EQS are generally expected to be lower. The EU has already proposed revisions to EQS for PFAS, advocating an approach using toxic equivalency with an EQS based on a sum of PFAS of 4ng/l PFOA equivalent.

UK POPs regulations may change in response to updates to the Stockholm Convention including the addition of extra PFAS currently being considered. This could have implications for waste disposal.

3.3 Outcomes

In summary the potential outcomes that may arise from the uncertainties in the water resources and treatment price control area include:

- Requirement for additional unfunded catchment investigations, in accordance with the PFAS Undertakings.
- Requirement that additional source(s), determined to be in Tier 3 within AMP8, are removed from supply, as uneconomic to mitigate the PFAS concentrations through treatment or blending. This has the associated costs of supplying water from other sources and the reduction in the resilience of the supply system, with potential Outcome Delivery Incentives (ODI) impacts.
- Requirement that source(s), determined to be in Tier 3 within AMP8, are temporarily removed from supply until unfunded mitigations can be designed and installed.
- Requirement that unfunded changes to operational deployment of source(s), determined to be in Tier 3 within AMP8, to achieve sufficient mitigation, through blending, either as the most efficient mitigation, or until mitigation can be installed.
- Additional, unfunded, analytical laboratory costs and potentially research costs to develop suitable analytical methods for the detection of new analytes.
- Additional, unfunded, waste disposal operational costs for water treatment sludges.
- Requirement for additional temporary, and mobile, treatment on temporary discharge consents to comply with environmental requirements. This treatment is unfunded within the existing programmes of work.

[27] Best Available Technologies and Small System Compliance Technologies for Per- and Polyfluoroalkyl Substances (PFAS) in Drinking Water (epa.gov)

- Unfunded increases in construction costs for planned investment where previously unidentified PFAS contaminated materials cannot be reused and appropriate disposal routes are required.

4. Wastewater price control areas

4.1 Signals

4.1.1 New scientific data

New scientific data with the most potential to impact wastewater treatment relates to treatment methods and demonstration of their effectiveness and viability. While current technologies do exist to remove most PFAS, there are challenges to their deployment to treat urban wastewater effluent. There are concerns that they are unsustainable, mainly due to their technical complexity, resource intensity (water, energy, treatment chemicals etc.) and the generation of PFAS-containing residues.

There is ongoing scientific research around the world to identify and improve new treatment technologies that are practical for large scale wastewater treatment, or can form part of an effective treatment train, for example the destruction of PFAS concentrate.

The developers of PFAS treatment technologies have frequently focussed on long chain PFAS, in particular PFOS and PFOA as these have been the regulatory and risk drivers. As attention turns to short chain PFAS, which may become regulatory drivers where a wider range of PFAS are regulated, the efficiency of existing technologies for treating short chain PFAS are being examined.

Ultrashort PFAS such as TFA present a further challenge as many commonly applied treatment techniques used for water treatment like ozonation and filtration with activated carbon are not capable of removing TFA. Ion exchange or reverse osmosis may be applied to remove TFA from contaminated waters. Reverse osmosis shows a much better efficiency compared to ion exchange. Both technologies, however, have to be further evaluated with respect to economic and ecological criteria.

Uncertainty	**Effectiveness of existing treatment technologies for new PFAS of concern** The introduction of new PFAS of concern may lead to questions around the effectiveness of existing technology to treat them. Furthering the need for more study and monitoring to understand efficacy. Orientation to more frequent regeneration of current treatments or advanced applications may be likely in future with risk of increasing costs.

There are emerging treatment technologies with the potential to enable destruction of PFAS and other emerging contaminants. However, there is uncertainty around whether they can be developed to be effective at field scale.

The US Department of Defense Strategic Environmental Research and Development Program (SERDP) is currently funding research including developing and demonstrating treatment technologies to remediate PFAS containing materials. Two such workstreams include:

- Supercritical Water Oxidation (SCWO) – SCWO processing is a transformative treatment technology that utilises the unique properties of water above its critical point (374 °Cand 22.1 MPa). At these conditions, when air is injected, all organics are rapidly oxidized to carbon dioxide and water, without a catalyst, and without the formation of harmful by-products[28].

[28] Supercritical Water Oxidation (SCWO) for Complete PFAS Destruction (serdp-estcp.mil)

- Hydrothermal alkaline treatment (HALT) – This is a thermochemical process in which reactions are catalysed in liquid water at temperatures and pressures approaching its critical point (374 °C, 22.1 MPa), conditions advantageous for treating PFAS-impacted liquid and high moisture content solids, including sorbents used to concentrate PFAS earlier within a treatment train[29].

Opportunity	**Treatments for PFAS may also remove other Emerging Contaminants of Concern** PFAS are not the only contaminants of emerging concern in wastewater effluent, and introduction of treatment methodologies for PFAS also presents the opportunity for effective reduction of other chemicals of concern such as pharmaceuticals and POPs.

4.1.2 New analytes

Currently only one individual PFAS (PFOS) is subject to a regulatory standard relevant to wastewater effluent, via the WFD EQS. It is expected that, within the next 5 years, the EA will develop a revised list of Priority Substances which will include a wider suite of PFAS, for which EQS will also be set. The PFOS EQS could also be reviewed or revised when this happens. The change, introducing new analytes, could be implemented quite quickly, with a period of consultation prior to introduction of secondary legislation. The scope of PFAS analyses which would be included in such legislation is uncertain. It seems unlikely that England would simply follow in the footsteps of Europe who are in the process of confirming revised surface water EQS for PFAS, based on the sum of 24 PFAS calculated as 'PFOA equivalents' using relative potency factors. It is noted that the EU EQS suite includes 3 PFAS not commonly analysed in the UK – 6:2 FTOH, 8:2 FTOH and C604.

Uncertainty	**New Environmental Quality Standards – which PFAS and what levels?** The EA are expected to update the list of priority substances and environmental quality standards to include more PFAS but the approach to which PFAS will be included, and the relative risks posed by different PFAS are unknown.

The EA is currently developing an approach to assessing hazardous substances and substances of emerging concern. The approach 'conforms with Environment Agency permitting guidance and ensures all substances known to be present in the discharge and are liable to cause pollution are assessed and controlled fairly and consistently'. The EA are understood to be currently (summer 2024) producing a master list of substances of emerging concern, and sourcing and validating predicted no-effect concentrations (PNECs) for a number of substances to determine the concentration at which the compound has no adverse effect in an ecosystem. It is understood that this master list will include PFAS but it is not known which PFAS will be included. This list is expected to be applied to all new applications for discharge permits.

[29] Hydrothermal Technologies for On-Site Destruction of Site Investigation Wastes Impacted by PFAS (serdp-estcp.mil)

Uncertainty	New Master List of Chemicals of Emerging Concern – which PFAS and what PNECs?
	It is known that the EA are working on a master list of substances of emerging concern but it is highly uncertain which PFAS will be included and what the PNECs will be.

The CIP programme has been gathering data for PFAS in Wastewater Treatment Works (WwTW) influent, effluent, and upstream and downstream receiving waters. Initially at CIP2 only PFOS and PFOA were monitored, this was expanded to19 PFAS at CIP3 (including short and long chain sulfonic and carboxylic acids 6:2 FTS and 6:2 FTAB). The suite of PFAS to be considered at CIP4 is not known. The findings of the CIP programme are expected to influence the regulatory approach to WwTW.

The EA national surveillance monitoring is also gathering data for PFAS in surface waters and groundwater throughout England. The Water Quality Monitoring Archive[30] includes monitoring results for a wide range of PFAS.

Impacts of inclusion of new analytes in permit or effluent monitoring include:

- Costs of providing new analysis including method development, equipment purchase, reference standards;
- Analytical costs of monitoring once methods are developed;
- Potential for new failures triggering additional treatment requirements;
- Uncertainty of compliance as no history of previous similar sampling / trend data on which to base expectations.

4.1.3 New sampling results

Some effluent reuse schemes under development through the SROs are sampling for a large number of substances including PFAS. If those substances are found in WwTW effluent, then further treatment is deemed necessary for that discharge to be permitted. Additionally, it may be more efficient to treat at the WwTW to reduce the need for further treatment after downstream abstraction. However, this additional treatment on the WwTW outlet may cause the public or regulators to ask why additional treatment is not needed for other WwTW that discharge to rivers where people fish, swim, and water is taken for private or public abstraction. Through this the SROs may highlight an issue and bring it to the forefront of public consciousness.

Case Study	A probable single point source within a catchment
	In developing a new surface water source under an SRO, it has been identified that the source is Tier 3 for one particular PFAS compound rarely encountered in other monitoring in England. As an unusual detection, upstream catchment sampling has identified that this PFAS is entering the river in the same reach as a WwTW outfall. This suggests release from a single user within the sewerage catchment. Management at the point of release may be the most efficient solution rather than treating at the WwTW.

[30] https://environment.data.gov.uk/water-quality/view/landing#:~:text=About%20this%20service,%2C%20ponds%2C%20canals%20or%20groundwaters.

For sampling in relation to bioresources treatment centres, those that discharge liquor returns back to a WwTW are required to sample for any substances that might be present. As part of this they must undertake a surface water risk assessment to determine if emission limits are required for any substance as part of the IED permit. The list of substances and risk assessment process is still undefined by the EA and therefore presents an uncertainty for wastewater/ bioresources operators.

4.2 Regulatory Response

4.2.1 Existing Regulations

Relevant existing regulations include:

- Environmental Permitting Regulations (EPR) 2016 (as amended) (covers permitting and consenting)
- Industrial Emissions Directive (IED) (covers sludge treatment centres, and discharges from sludge treatment centres back into WwTW; also covers tanker trade imports to works and intra company sludge transfers)
- Urban Wastewater Treatment Directive (sets standards for effluent treatment based on size of works, but not for chemicals, just for nutrients and sanitary dets, and implemented through EPR)
- Water Framework Directive (sets standards, including environmental EQS, but implemented through EPR)
- Habitats regs (sets requirements and standards for discharges, but implemented through EPR)
- Persistent Organic Pollutants Regulations 2007 (as amended) (includes some PFAS)

The relevance of these is discussed in the sections below.

4.2.2 Reinterpretation of Existing Regulations

4.2.2.1 IED

The IED permits (implemented under EPR 2016) which are being issued to those WwTW that operate anaerobic digestion, includes an improvement condition which requires operators to carry out monitoring of liquor returns from the sludge processes on site, back to the inlet. The requirements refer to the EA guidance on priority hazardous pollutants and specific pollutants, and following the monitoring the outputs need to be modelled using the EA H1 risk assessment tool to demonstrate that there are no impacts on the receiving water body at the final effluent release point for the works. The specified lists currently include PFOS, but as the lists are guidance not legislation, these could be amended with no notice. A discussed in Section 4.1.2 the EA is developing a master list of substances of emerging concern expected to include more PFAS, and these will be required to be analysed for as part of the SRO programme.

In the event that the output of the H1 model shows a significant emission from the process, the permit requires operators to propose and implement additional measures or abatement to prevent or minimise the emissions. This means that should a significant emission be identified, there is an expectation that remedial works will be implemented to reduce the emission. The ubiquity of PFOS and the very low EQS means that the presence of PFOS may drive the need for additional measures.

The collection of 12 months of data must be within 15 months of the permit issue date and the modelling including proposals for any necessary improvements are within a further 6 months. All IED permits should be issued by the end of March 2025, which means that completion of this improvement condition will fall within AMP8. Due to the lack of previous monitoring data on liquor returns, it is not clear at present how large this risk is.

4.2.2.2 Persistent Organic Pollutants

The POP Regulations have been in force since 2007, although the list of substances falling within their scope has increased over time and now includes PFOS and PFAS related compounds. The regulations impose control on the use and disposal of POPs, including a requirement to destroy POPs in waste, normally by thermal treatment.

The EA has, within the last 18 months, started targeting specific enforcement of POPs in waste streams, including domestic soft furnishing, waste electrical and electronic related plastics and also plastics from lead acid battery recycling. These materials may not be landfilled and in some cases, not recycled, and must instead be destroyed.

This could be applied to wastewater sludges in several ways:

- Sites which are permitted under the IED (see 4.3.2.1) are classified as waste treatment plants, and therefore, controls could be imposed on releases from the IED process including produced cake;
- The IED permits include a list of acceptable wastes for import to the works, including sludges imported from satellite works for digestion. The IED permits list of permitted wastes has a specific exclusion for wastes containing POPs, although there is no threshold specified. This could be implemented by requiring digestion sites to test incoming sludges from satellite works for the presence of POPs and exclude those that accept them. This would impact on the efficiency of digestion sites, including a reduction in biogas utilisation value; and also require a new outlet for impacted sludges.
- Some permitted IED sites also include within their scope tanker trade imports to the works inlet. The same restriction on POPs in imported wastes is within the acceptable waste code table for these imports, so acceptance testing could be implemented for these. This may lead to a drop of commercial income for works.

4.2.2.3 EPR Implementation

At present, there are no known plans by the EA to review existing wastewater discharge consents from WwTW. However, the EA, could if they had a reason to do so, issue a Regulation 61 notice on permit holders to request information, which may include information such as analytical data they do not currently hold. These notices tend to be used when guidance has been updated and is to allow the EA to vary existing permits to current standards. There is theoretically, therefore, a risk that the EA could serve such a notice on specific works to examine their discharge permits.

However, in the event that an existing discharge from a treatment works needs to be re-permitted, for example due to a requirement for an increased flow, changes to emission limits following site upgrades or relocation of the discharge point, the discharge would require modelling. Based on the modelling requirements for the water reuse SRO projects, the suite of analytes requiring modelling would be wider than the current discharge consents and may identify compounds not currently included in the original site environmental discharge permit as requiring treatment and or monitoring prior to issue of the permit. It is known that some water reuse projects are including additional treatment for PFOS / PFAS to meet new discharge permit requirements.

Under the current discharge consent requirements, any other 'polluting substance', not explicitly detailed in the permit, that is found in the effluent, is classified as pollution. Therefore, if a new EQS list of substances is implemented and any substance is found in an effluent, outside of the specific permit stated for that effluent this could be deemed as a pollution and a new permit applied. Should the EQS in England and Wales be expanded to include more listed substances the requirements put upon water and waste utilities will be likely to increase in AMP8 and play out in AMP9 as part of new statutory WINEP requirements.

4.2.2.4 Land Contamination and Material Re-use

As discussed in 3.2.2.5 any infrastructure works, including construction, demolition and maintenance, should take into account the potential for contamination to have arisen from past activities. As emerging contaminants, PFAS are unlikely to have been considered in previous ground investigations at a development site. PFAS have the potential to result in uncertainties in new development projects including increased costs and delays, due to the presence of PFAS contamination that was unforeseen at the time of project planning and is more time-consuming and costly to manage. This is an uncertainty potentially relevant for most water industry improvement projects.

4.2.3 New Regulations

The regulators increasingly expect compliance with new duties within the business plan period rather than in the subsequent plan period. Whilst incumbents were required to submit Long Term Delivery Strategies (LTDS) as part of Price Review 2024 (PR24) which looked ahead to 2050 (AMP12) there still remains limited assessment of planned regulatory change from both regulators and incumbents outside of the immediate 5-year price control period.

4.2.3.1 Current Policy and Direction of Travel

The Environmental Improvement Plan (EIP)[31] (published January 2023) indicated increasing targets that are likely to be stretching. The Environmental Improvement Plan, looking ahead to improvements across the next 25 years, included specific reference to PFAS and the government has set new priorities which include cleaning up British rivers, lakes and seas. The first EIP annual progress report[32] (published July 2024) details actions taken to March 2024 including those relating to PFAS, and those relating to improving water quality.

The 2023 Defra 'Plan for Water' (published March 2023) includes specific commitments for future management of PFAS. This includes stated commitments to reduce the amount of PFAS entering the water environment following the recommendations of the PFAS RMOA, update the list of priority substances used to determine chemical status, and to ensure that water companies introduce tighter controls on PFOS to reduce contamination. While some of these commitments require new regulation, others may be implemented by actions under existing legislation.

4.2.3.2 Restrictions on New PFAS Use / Chemical Regulation

As discussed in Section 3.2.3.2 the recommendations of the PFAS RMOA include action to restrict PFAS use in firefighting foams and in other dispersive uses. The process for enacting such restrictions under REACH includes evidence gathering, consultation and impact assessment and the likely timescale on which such restrictions may come into force is likely to be well beyond AMP8. However, the initiation of the process is already encouraging operators to look at their use of PFAS, and to move towards PFAS-free alternatives. This will have a gradual effect of reducing new PFAS entering the environment. The life cycle of products that use PFAS is such, even if a restriction on new use of PFAS was enabled today, PFAS from current use would continue to enter the environment for decades to come. This can be seen in the case of PFOS, where although use was restricted under the Stockholm Convention in 2009, it continues to be present in wastewater influent today.

[31] https://assets.publishing.service.gov.uk/media/64a6d9c1c531eb000c64fffa/environmental-improvement-plan-2023.pdf

[32] https://assets.publishing.service.gov.uk/media/66a8cf3ece1fd0da7b592f6c/Environmental_Improvement_Plan_annual_progress_report_2023_to_2024.pdf

4.2.3.3 New Standards Applicable to Environmental Permitting – EQS

An update to the list of Priority Substances and related EQS would require new secondary legislation and is anticipated within AMP8 in line with commitments in the 'Plan for Water'. This is likely to involve a new list of PFAS for which EQS are applicable as well as new applicable concentration limits. The EQS for PFOS could go up or down, and the approach could include a sum of PFAS, and may take into account the relative risk posed by different PFAS. There is likely to be a period of consultation prior to implementation.

The current EQS for PFOS was implemented under the Water Framework Directive prior to departure from the European Union. The EU is currently progressing an update to the EQS for PFAS and has adopted an approach involving the sum of 24 PFAS reported as PFOA equivalents. The EU had previously considered adopting the same EQS levels for groundwater as for surfacewater but the most recent mandate (June 2024) proposes that groundwater EQS for PFAS should align with drinking water standards. It seems likely that the English government will want to develop its own approach to developing the EQS rather than simply adopting the EU approach.

4.2.3.4 New guidance and regulation related to EPR

For larger facilities undertaking specific types of activity, BAT are required to be used to reduce emissions to air, water and land. This applies for techniques and technology that are consistent with best practice for preventing or minimising emissions and impacts on the environment. It includes the way the installations are designed, built, maintained, operated and decommissioned[33]. The BAT reference documents (BREFs)[34] were developed for a number of industrial activities, including a specific BREF for the monitoring of emissions to air and water from installations under the IED[35]. This was published in July 2018 and is likely to be reviewed and updated in 2028 under the current 10-year review regime. It is therefore likely that new BAT guidance will feature in PR29. Currently BAT only applies to IED sites and therefore only impacts certain WwTW regulated under the IED. BAT does not currently apply to WwTW waste discharges.

Opportunity 	**Bringing together waste and water price controls** Should the EA amend legislation as discussed in section 4.3.4 for wastewater, there is a possibility WwTW discharges may be required to meet stricter discharge consent requirements, this would bring together the water and waste price controls.

4.2.4 Wastewater influencing downstream abstraction

Historically wastewater and drinking water areas of businesses have been fairly siloed remaining separate in operations and regulatory price controls. It is likely that new drinking water regulations in the future will have a knock-on effect on the wastewater price control. For example, if a WwTW is a source of PFAS that causes compliance challenges or a loss of a drinking water source, mitigation is likely to be required at the source of the pollution. This may be via removal of the substance at source, for example the trade effluent input into the sewerage network or providing additional treatment at the WwTW in order to remove the substance from the effluent discharge. This could become challenging where a water abstraction point is influenced by upstream company discharges.

[33] Industrial emissions standards and best available techniques - GOV.UK (www.gov.uk)

[34] BAT reference documents | EU-BRITE (europa.eu)

[35] Monitoring of Emissions to Air and Water from IED Installations | EU-BRITE (europa.eu)

Opportunity	**Collective pollution management**
	There is an opportunity for both regulators and companies to consider the best holistic approach to collectively manage point sources and discharge risks considering upstream and downstream vulnerabilities

This is particularly prominent for SROs that involve water recycling. Where the WwTW is more closely linked to the water treatment works (WTW) for water resource dependencies. There is a need for regulators to consider how best to apply EQS in order to protect the downstream works and the environmental quality of the receiving waters. As SROs progress through RAPID Gates 3 and 4 in AMP8 we are expecting to see more orientation towards regulatory controls associated with these more complex schemes.

Case Study	**Switzerland – National Investment for Wastewater Treatment Works Upgrades**
	Switzerland is an example[36] of one country that has decided to invest nationally in action to upgrade WwTWs to manage micropollutants including PFAS. In 2014 the Water Protection Ordinance was revised to require provision of micropollutant removal at all wastewater plants serving more than 80,000 inhabitants, at all treatment plants serving more than 24,000 inhabitants and discharging into lakes, and at treatment plants serving more than 8000 inhabitants and discharging into rivers, if the discharge represents more than 10% of the minimum flow. The deadline for implementation is 2035. In all, around 100 of the country's 700 WwTWs need additional treatment. The investment costs for this have been put at around CHF 1200 million (£1.075B), with a CHF 9 (£8) annual tax per person connected to a treatment plant would be introduced to provide a fund to cover 75% of the investment costs.

4.3 Outcomes

In summary the potential outcomes that may arise from the uncertainties in the wastewater price control area include:

- Requirement for unfunded investigations (eg trade effluent permit investigations) driven by water price control issues (loss of water source due to PFAS issues).
- Identification of problematic trade effluent imports, whether via sewer or tanker trade, and preventing those imports occurring will impact on commercial income.
- Requirement for unfunded investigations (eg trade effluent permit investigations) driven by Bioresources price control industrial emissions directive issues (sampling of PFAS in liquor returns).
- Implications of and cost of R&D and piloting new treatment trials (eg. New research suggesting current methods of treatment are not optimal, and cost of redesign of anything currently in design, plus the cost of piloting those new processes)
- Cost of additional risk of EA imposing new permit conditions requiring new treatment processes for new EQS. Whilst there is an increasing desire by the EA to see new regulations met within the plan period

[36] https://www.aquastrategy.com/article/switzerlands-progress-micropollutants-sewage#:~:text=According%20to%20the%20Ordinance%2C%20micropollutant,discharging%20into%20rivers%2C%20if%20the

rather than in the next plan period, it is probable that this requirement would be funded through WINEP and PR29.

- Cost/resource implications of additional monitoring at WwTW driven by Water price control supply issues
- Cost/resource implications of additional monitoring at WwTW driven by regulatory requirements (eg. New EQS - although this would most likely be funded through WINEP at PR29)
- Potential to reduce acceptability of sludge transfers into digestion sites which will impact on biogas utilisation income and require a new sludge outlet identifying.
- The implication of new regulations or standards happening late in AMP8 that frustrates the development of LTDS, DWMP or PR29, and requires late changes.

5. Bioresources price control area

We understand that the uncertainty around PFAS in the bioresources arena will be covered by a catch-all uncertainty mechanism proposed in the draft determinations for PR24. Ofwat has allowed a notified item on cost resulting from changes to the legal requirements in respect of sludge spreading. This is explored in section 7.

6. Summary of uncertainty scenarios

Potential uncertainty scenarios are presented in Table 6-1 (water resources and treatment), Table 6-2 (wastewater) and Table 6-3 (both water resources and wastewater).

For each scenario, changes and triggers are identified, based on the examples and reviews described in previous sections of the report. The outcomes of the scenarios are summarised, and the potential materiality of the scenarios in AMP8 is assessed. It should be noted that the scenarios detailed in the following tables represent a gross simplification of complex events and uncertainties.

Table 6-1. Potential Uncertainty Scenarios – Water Resources and Treatment

	Scenario	Example change	Example trigger	Outcome	Likely Scale at AMP8
1	The regulator changes the rules in a way which results in a step change in the tiers assigned to multiple sites.	New analytes (e.g. TFA) New approach (e.g. Sum of PFAS) Numeric change in tiers	New scientific opinion (e.g. COT, WHO) New scientific data (e.g. PFAS prevalence)	Mitigation required at more sites. May include temporary removal of source from supply	Material At any individual site, multiple updates could trigger this scenario more than once in AMP
2	New data characterises sites as higher tier (without regulatory change)	New monitoring data with longer timeline identifies changes in aquifer / river conditions. New analytes (e.g. TFA)	New PFAS use in the catchment results in new discharge of PFAS not picked up in previous monitoring. New sampling methods e.g. passive samplers pick up transient elevated PFAS. More data with longer timeline. Major fire in catchment with loss of containment of fluorinated foams.	Mitigation required at more sites. May include temporary removal of source from supply	Material At any individual site, multiple updates could trigger this scenario more than once in AMP
3	New catchment knowledge introduces additional PFAS to the Reg 27 risk assessment (drinking water)	Water company determines it prudent to sample for analytes beyond the DWI 47 e.g. 6:2FTAB	New scientific data (e.g. PFAS prevalence from CIP4, EA monitoring or other sources). New academic papers describe detected presence of novel PFAS in UK catchments.	Increased analytical costs; increased method development and equipment purchase costs; May also trigger Scenario 2 - mitigation required at more sites	Not Material (unless it triggers Scenario 2)
4	Media and campaign group pressure triggers enhanced action ahead of regulatory change (drinking water)	Media and public response to new PFAS scientific research or opinion	WHO publish scientific opinion with DWS for PFOS / PFAS < circa 10 ng/l.	Customer pressure for action over and above DWI; accelerated mitigation required. Public relations management explaining existing mitigation.	Potentially Material
5	The regulatory situation changes such that wastewater discharges (from existing processes other than WwTW effluent) require new PFAS management (clean water)	Implementation of permit review to enforce existing EQS on existing permits. Introduction of new Priority Substances / EQS (and therefore introduction to existing permits).	Secondary legislation introducing new Priority Substances / EQS. Increased media pressure on enforcement of PFOS EQS	See 5a, 5b, 5c	See 5a, 5b, 5c
5a	As 5, requiring installation of new treatment plant	As 5	As 5	Additional treatment plant installation	Material
5b	As 5, requiring alternative waste disposal route (e.g. trade effluent)	As 5	As 5	Increased operational costs. Potential Capex for new infrastructure e.g. sewer connections	Potentially Material
5c	As 5, requiring additional monitoring in AMP8, may lead to further actions in AMP9	As 5	As 5	Increased analytical costs; increased method development and equipment purchase costs. May also trigger 5a or 5b.	Not Material
6	The regulator implements requirements to meet existing or new PFAS EQS for all new discharge permits (including waste from clean water treatment, operational activities etc) such that PFAS management is required (clean water).	Regulator interpretation / implementation of existing regulations for new permits	See 6a, 6b	See 6a, 6b	See 6a, 6b
6a	As 6, for Permanent Discharge Requirements	As 6	Already being seen for SROs.	Increased operational costs.	Material

			Already known to be being seen at one groundwater source requiring a new surface water discharge to protect the source aquifer.	Additional treatment plant installation	
6b	As 6, for Temporary Discharge Consents under Water Industry Act	As 6. If implemented, water meeting Tier 1 drinking water standards (10 ng/l PFOS) might not be permitted for discharge to surface waters without treatment to bring it below PFOS EQS of 0.65 ng/l.	Regulator chooses to determine that PFOS / PFAS is a 'polluting substance' under part 3 of section 165 of the Water Industry Act 1991. For example, water mains commissioning or service reservoir drain down for inspection.	Unforeseen costs for apparently simple operations such as discharging water suitable for drinking.	Potentially Material but probably not within AMP8. Could be considered manifestly unreasonable/ disproportionate implementation until other greater sources of discharge are being managed.

Table 6-2. Potential Uncertainty Scenarios – Wastewater

	Scenario	Example change	Example trigger	Outcome	Likely Scale at AMP8
7	Regulator requires update to WwTW discharge permit to meet existing regulatory standards triggering new treatment requirement prior to discharge	PFOS added to existing permit; would need to have a change in precedent to allow discharge at EQS (not 10% of EQS) due to analytical limitations	Media or political pressure. Change of stance within the regulator.	See 7a, b, c	See 7a, b, c
7a	7a: as 7, existing permit, within WINEP; existing procedural approach continues	As 3	Some planned enhancements under WINEP in AMP8; more expected in AMP9	Enhanced R&D expenditure to prepare for AMP9 investment	AMP8 enhancements already funded. Potentially Material (depends on number of sites; technology etc)
7b	7b: as 7, existing permit, not within WINEP	As 3	Media pressure initiates expedited review of permits. Water reuse projects where differing treatment trains/ permit requirements are being used for new discharge locations triggering review of existing permits. Step change in EA interpretation of regs. This would be unprecedented. Unlikely to be limited just to PFOS but extend to other hazardous and priority substances on existing EA Surface water pollution risk assessment guidance.	Additional sites requiring investment at AMP8. Investigation, design, construction of treatment.	Material Would be unprecedented.
7c	7c: as 7, new permit, existing WwTW	New permit required to meet current regulations where permit for existing site is grandfathered and silent on PFOS.	Already happening on reuse SROs. Could apply if installation of new disinfection processes for bathing water objectives relocates outfall from existing WwTW. Apply if volume of discharge changes.	Need for consideration of H1 risk assessment determinands and emerging substances which will include PFOS and may include other PFAS. Likely to require additional treatment before permit will be issued.	Material
8	Regulator introduces new regulatory standards and requires review of WwTW discharge permit triggering new treatment requirement prior to discharge	New PFAS added to List of Priority Substances, and EQS defined	Regulator delivering Defra 'Plan for Water' and incorporating existing scientific data. New scientific opinion (e.g. COT, WHO) New scientific data (e.g. PFAS prevalence)	More WwTW may require treatment than for PFOS alone (Scenario 3) as some WwTW may have other non PFOS sources in their catchment (e.g. replacement PFAS such as C6 AFFF or ethers)	Material
8a	As 8, existing permit, within WINEP	As 8	See 7a	As 7a, 8	As 8
8b	As 8, existing permit, not within WINEP.	As 8	See 7b	As 7b, 8	As 8
9	IED permit requiring monitoring of sludge liquor returns at AD facilities finds PFOS triggering new requirement for treatment at existing larger WwTWs.	Improvement condition in all IED wastewater permits requires liquor return monitoring, and modelling of impacts downstream of final discharge point.	IED liquor return monitoring improvement condition, including requirement to address significant impacts identified. Data to be collected within 15 months of permit issue.	Additional treatment processes needed at AD sites for treatment of the sludge liquors before return to head of works (or in final effluent).	Material. May also trigger 12.
10	A WwTW is identified as a major contributor to drinking water catchment risk, requiring action to address the source.	Identification of specific WwTW as a PFAS pollution source impacting a water supply.	New information arising from drinking water source monitoring and catchment studies or CIP investigations.	WwTW catchment studies, influent monitoring, trade effluent surveys, potential loss of income through refusal of trade effluent. Potential **opportunity** for mitigation treatment at the drinking water treatment works to be only temporary/short term	Catchment studies unlikely to be material. Opportunity unlikely to be Material because it is unlikely to be a deliverable benefit within AMP8.

				(Scenario 2) until catchment management is demonstrated to be effective. However, water companies undertaking source protection have limited mechanism to control originating PFAS user and source (if not the same undertaker for DW and WW).	
10a	As 10 – within same undertaker; requiring treatment	As 10	As 10. Catchment activities fail to improve effluent.	New treatment required at WwTW or at the WTW – undertaker to evaluate which is most efficient; proven technologies more likely to be at the WTW so Scenario 2 likely to apply.	If occurs, most likely to arise in AMP8 as Scenario 2 (drinking water)
10b	As 10 - but with different undertakers; requiring treatment	As 10	As 10. Catchment activities fail to improve effluent.	Pressure from drinking water company to pass responsibility to WwTW but may not have leverage to make this happen.	Potentially material.
11	A WwTW is identified as a major contributor to WFD failure, requiring action to address the source (wastewater).	Identification of specific WwTW as a PFAS pollution source impacting WFD receptor.	New information arising from ongoing surveillance monitoring. New information from academic studies. Media pressure targeting specific sites.	WwTW catchment studies, influent monitoring, trade effluent surveys.	Unlikely in AMP8 except through WINEP
12	The Environment Agency require monitoring for POPs in sludge.	The Environment Agency decides to enforce waste acceptance checks on sludge transfer to IED sites in accordance with Schedule 2 of existing IED permits.	Environment Agency widen their control of persistent organic pollutants using regulatory position statements.	Sludge being transferred for digestion or processing through the head of the works will need to be proven not to contain persistent organic pollutants.	Material, both in relation to additional monitoring requirements and also new sludge outlets will be needed.

Table 6-3. Potential Uncertainty Scenarios – Both Water Resources and Wastewater

	Scenario	Example change	Example trigger	Outcome	Likely Scale at AMP8
13	Availability of new technology for analysis enables lower or quicker detection and thus changes regulatory expectation of what is reasonably achievable (both drinking water and wastewater).	Regulatory drive to lower standards (see e.g. USEPA MCLs v. MCLGs) Real time monitoring triggering new tier exceedances through the detection of transient events.	Technology allowing robust monitoring to picogram level. Technology allowing real time inline monitoring.	Existing treatment cannot meet new requirements. Additional treatment requirements.	Unlikely to be at a deployable technology readiness level in AMP8. For future consideration.
14	Availability of new technology for treatment enables lower outcomes and thus changes regulatory expectation of what is reasonably achievable (both drinking water and wastewater).	Regulatory drive to achieve lower standards.	Readily available efficient technology allowing better outcomes.	Existing treatment cannot meet new requirements. Additional treatment requirements.	Unlikely to be at a deployable technology readiness level in AMP8. For future consideration.
15	Ground investigation at infrastructure construction sites finds previously unidentified PFAS soil and concrete contamination.	PFAS widely recognised as a potential contaminant of concern associated with legacy activities including effluent and landfill.	Increasing industry awareness (e.g. new CIRIA guidance) of PFAS as a land contamination and material re-use issue.	Additional construction costs for projects in the capital programme; potential delays related to regulatory approval of immature material management techniques.	Potentially material if widely encountered in the construction programme.

7. Economic Mitigation

In light of the significant uncertainty around PFAS needs for the AMP8 period it is appropriate to seek mitigation against cost escalation through an uncertainty mechanism to be presented within DD Representations. Options for uncertainty mechanisms include:

1. Interim determination of K (IDoK)
2. Notified item
3. Modified notified item
4. Bespoke uncertainty mechanism
5. Price control deliverable
6. Gated allowance

An overview of the key pros and cons of each approach is in the table below.

Table 7-1: High level summary of pros and cons of uncertainty mechanism approaches

Mechanism	Description	Pro	Con
1. Interim determination of K (IDoK)	Companies can ask Ofwat to reset their price limits between five-yearly price reviews if specific changes lead to a significant reduction in their revenue or increase in their costs. Materiality and triviality thresholds apply.	Can be tailored to scheme costs	Proof of evidence of need / Materiality
2. Notified item	A Notified Item is an item that Ofwat notifies a water company has not been allowed for (either in full or in part) when setting price controls. The materiality and triviality thresholds above would apply.	Can be tailored to scheme costs	Onerous process/ Materiality
3. Modified notified item	The principles of the notified item would remain unchanged but the materiality threshold could be linked to the individual price control. The materiality threshold would therefore be lower.	Can be tailored to scheme costs	Requires bespoke cost assessment
4. Bespoke uncertainty mechanism	An automatic adjustment based on non-delivery of schemes which were uncertainty at the Final Determination or the addition of new schemes within the AMP.	Mechanistic – low effort	Unable to handle variable nature of scheme costs

5. Price control deliverable	Price Control Deliverables (PCD's) are linked to commitments to deliver investments with associated penalties for non-delivery.	Mechanistic	Ofwat policy not to use these for uncertainty mechanisms. Requires companies to know what they are expected to deliver.
6. Gated allowance	In cases where companies are unable to demonstrate sufficient evidence of need, do not have reliable cost estimates, lack evidence of cost efficiency or are investigating options a gated process can offer protection for customers through a framework of additional scrutiny. Funding is approved in stages based on evidence of completion of each phase and ongoing need.	Highly tailored to scheme specifics	Onerous process

In the following sections we illustrate each type of uncertainty mechanism with examples. A summary of potential precedents to use when selecting an uncertainty mechanism is included in Appendix A.

7.1 Uncertainty mechanisms

7.1.1 IDoK

All companies can ask Ofwat to reset their price limits between five-yearly price reviews. They can ask for this if specific changes lead to a significant reduction in their revenue or increase in their costs. This is known as an **interim determination**. The items that can be considered in an Interim Determination are the Relevant Changes of Circumstance specified in the licence and Notified Items. Importantly, the change that causes the increase in costs must qualify as RCC1 (being the result of a new law, or change in the law, applying specifically to water cos). Companies can only apply for IDoKs using RCC1.

An application from a company must meet the materiality threshold set out in its licence.

- **Materiality** – changes in costs, receipts or revenues must be at least equal to 10% of the company's turnover. A company can add together a number of specific changes.

In the past Ofwat has applied a Triviality threshold of two percent of the company's turnover to one issue. The triviality threshold is not defined in the licence or the Act and could potentially be challenged.If the company has an application that passes the test of materiality, Ofwat will examine the application and may adjust its price limits.

7.1.2 Notified item

A Notified Item is an item that Ofwat notifies a water company has not been allowed for (either in full or in part) when setting price controls. Under this option, the Notified Item would cover circumstances driving a change in the costs associated with compliance with PFAS standards which did not qualify anyway under the definition of an RCC. The materiality and triviality thresholds above would apply. Once that event had happened, the water company would then refer the Notified Item to Ofwat for an interim determination. The trigger for the notified item could be based on external drivers (signals, amplifiers, responses as described in this report) as summarised in the table below.

The main disadvantage of the notified item approach would be the materiality threshold as noted above.

Table 7-2: Potential triggers for a notified item for PFAS

Issue	Trigger / Driver	Comment
1	EA / DWI notify companies of additional requirements in respect of PFAS to be implemented within AMP8: • Changes to DWI thresholds for tiers • Inclusion of additional compounds • Introduction of a cumulative threshold This would likely be covered by an RCC	Companies undertake a risk assessment of impacts and costs to determine materiality. In the case of PFAS, the scale of the potential costs will vary greatly from one site to another and the solution required. It will also depend on the number of sites impacted. It is not clear whether an efficient unit rate for PFAS treatment has been revealed in PR24 submissions for solution types which could be agreed with Ofwat as part of confirming the notified item process. If unit costs were not pre-agreed detailed evidence would be required to demonstrate proposed costs are efficient and Ofwat would explore via a deep dive review. Only if costs exceed materiality threshold would a notified item be triggered.
2	Changes in raw water quality	This could be due to third party activity and have isolated and quantifiable impact.
3	Improved detection techniques	This could identify PFAS where previously it was below the detection threshold or result in a change in tier.
4	Combination of above	Triggers 1, 2 and 3 could occur at any time and potentially repeatedly within the AMP8 period. The cost impact of the first instance of any may not breach the materiality threshold. Consideration of cumulative impact may be required.

At PR19, Ofwat allowed notified items for several areas where costs were uncertain. These included a notified item for Direct Procurement for Customers (DPC) schemes (for those companies with DPCs in their PR19 determinations), a potential ban on metaldehyde (Anglian and Affinity only) and notified items for specific large scale investment schemes.

For PR24 Draft Determinations, Ofwat has specified a notified item for all companies for land sales and a notified item for water and sewerage companies for costs resulting from changes to the legal requirements in respect of sludge spreading. These notified items have the standard materiality and triviality requirements and the IDoK would take into account any costs reasonably incurred and not avoidable through prudent management control. The land sales proceeds are shared 50:50 between shareholders and customers.

A notified item for PFAS could be defined as any increase in costs efficiently incurred in order to comply with PFAS standards for actions which were not foreseen and allowed for at PR24.

7.1.3 Modified notified item

The principles of the notified item would remain unchanged but the materiality threshold could be linked to the individual price control rather than the whole appointed business. The advantage of a modified notified item would be a lower threshold allowing less risk for companies. However, this would not remove the cumulative effect across the AMP as the first few instances may not meet the threshold and therefore would

have to be delivered before a notified item could be applied. Ofwat would need to ensure a consistent approach to determining the threshold across companies.

7.1.4 Bespoke uncertainty mechanism

At PR19, Ofwat included an uncertainty mechanism for WINEP schemes, which applied to 'Amber' schemes which were unconfirmed at the time of the Final Determination. This mechanism involved an automatic adjustment to costs at the next price review for each 'Amber' scheme which was not required during the period. Ofwat committed to applying a unit rate (either p.e or per m3 or per scheme). The adjustments are based on the company's totex estimates (after reallocations) as adjusted by company specific efficiency factor or, in the case of wastewater schemes, by the ratio of final totex allowance for the WINEP programme to the company's estimate (after reallocations).

In its PR24 Business Plan, Anglian Water proposed several uncertainty mechanisms to Ofwat, one of which related to inland bathing waters – this would be triggered by the designation of new bathing water sites by Defra. The company proposed specific capital allowances for individual schemes and an annual opex allowance, which would be applied in-period if the designation occurred before 31st March 2028.

Like some of the other possible uncertainty mechanisms a bespoke uncertainty mechanism could be linked to the PFAS tiers in the DWI requirements or any change in the tiers and would need to be applied consistently across all companies.

For these bespoke uncertainty mechanisms there is a lower level of discretion than for an IDOK. A formula is pre-determined and the allowance is found by dropping figures into it. This type of mechanism works well if you are fairly clear about what risk might materialise and how much it would cost if it did.

Section 7.3 explores an option for a bespoke or hybrid uncertainty mechanism for PFAS for PR24 in more detail.

7.1.5 Price control deliverables

At PR24, Ofwat has required companies to propose Price Control Deliverables (PCD's). For example, Anglian Water has proposed a PCD for storm overflows. In this instance, the company commits to make non-delivery payments to customers, which apply a unit rate to the number of undelivered schemes. The unit rate in this case is the total investment divided by the unit of improvement and is measured against completion dates agreed by the Environment Agency. There is also a late delivery payment of 3.5% of the average cost of the scheme. PCD payment rates are adjusted in the Draft Determinations for the relevant cost sharing rates. In this instance the PCD relates to funding which is included in the determination but may not be required. For PFAS the uncertainty is not about whether funding included in the determination will be spent it relates to funding not currently included.

It could be possible to design a common PCD for PFAS for all companies to create a level playing field. However, it requires companies to know what they are expected to target and in this case, it is uncertain e.g. there may be enforcement notices served mid AMP that may skew PCD targets and original expectations. If the PCD were to be linked to DWI notices there would be an additional burden on DWI to segregate between PFAS enforcement and other notices that might be linked to the same high risk works.

7.1.6 Gated allowance

In cases where companies are unable to demonstrate sufficient evidence of need, do not have reliable cost estimates, lack evidence of cost efficiency or are investigating options a gated process can offer protection for customers through a framework of additional scrutiny.

For PR19 a gated process was introduced by RAPID for the Strategic Resource Options (SRO). There are four gates, with gates 3 and 4 in AMP8. At each gate, companies submit information about their work on a solution, which is assessed to ensure companies are making progress on investigation and development of

solutions. Ofwat also decides whether companies should continue to be allowed funding to further investigate and develop a solution to the next gate. The purpose of the gated process is to ensure at each gate that:

- companies are progressing strategic water resource solutions that have been allocated funding at PR19;
- costs incurred in doing so are efficient; and
- solutions merit continued investigation and development during the period 2020 to 2025.

For AMP8 Ofwat has also introduced across a number of companies a gated process for large enhancement schemes with high levels of optioneering, scope and cost uncertainty, or novel technologies. This process is generally aligned with the process operating in 2020-25 (and continuing into 2025-30) for SROs via RAPID. However, some changes to the funding and submission process to reflect the smaller scale of these large schemes compared to RAPID SROs and their timetable for delivery are proposed. The process has 3 gates but gates 1 and 2 are combined for these schemes. At the gate 3 decision stage, allowance revenues would be logged-up based on any differences to the revised agreed view of efficient costs to deliver the scoped scheme to the original development allowances for an adjustment to the RCV at the end of the period. Anything beyond this would be subject to normal cost sharing.

For PR24 Ofwat has proposed an Asset Improvement gated allowance for Thames Water. Ofwat proposes to build on the approach used both for the London resilience and London Water Network Conditional gated allowances in PR19. In addition to the gates used in that process, they are proposing that the stages are split in to seven gates. They are proposing a new Gate 0 followed by five gates that record the progression of schemes from initial concept stage through to completion, with a Gate 6 to indicate when a project has been 'stopped' at any gate in the process and is not being progressed to completion. The figure below provides a summary of the proposed gated process.

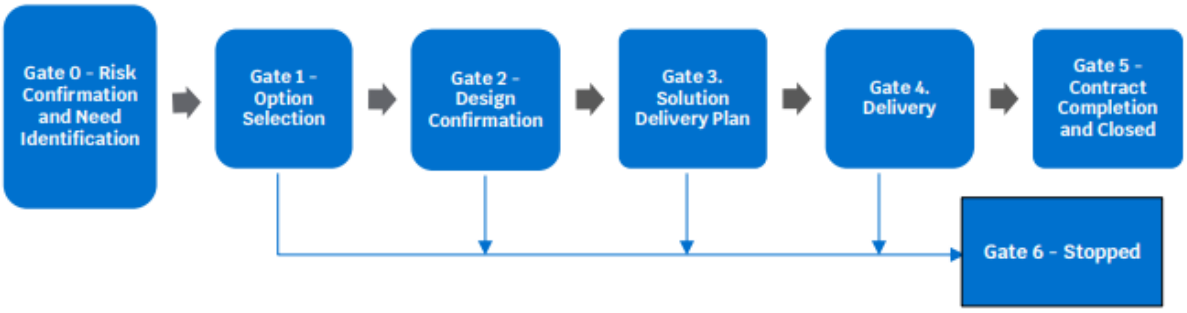

Figure 7-1: Proposed Thames Water asset improvement gated process

Thames Water is required to propose a price control delivery incentive at Gate 1 to incentivise the timely and efficient completion of the work through gates 2 and 3. This will apply an underperformance payment on the value of work to be delivered at each gate for unsatisfactory and/or late delivery. Ofwat will review and assess in-period the deliverables for each gate. Ofwat will confirm the appropriate allowance based on the agreed value of the programme, progression through the gates and the value of the work completed. In particular, where the conditions of the first gate ('Gate 0') are not met, Ofwat propose to return the allowance, in full or in part, to customers. The final end of period reconciliation mechanism decision will reflect these earlier decisions but will ultimately be taken as part of PR29.

Gated allowances relate to funding which is fully or partially allowed for in determinations. For PFAS the uncertainty relates to funding which is not currently included.

In the case of PFAS uncertainty funding could be included in the final determination to allow initial investigation and scheme design to continue for sites in lower tiers which are considered at high risk of moving into higher tiers requiring mitigation. Further funding for implementation could be released through a gated mechanism if the trigger of moving to a higher tier occurred. A gated process like this would have the benefit of not waiting for DWI to confirm a change in interpretation of existing regulations or the introduction of new regulations before optioneering and scheme design commences.

7.2 Unit rates

A key feature of any uncertainty mechanism is the basis of cost. An uncertainty mechanism is to provide mitigation against uncertainty for both the company and customers and as such it should be based on efficient costs. As seen in the examples above costs could be based on modelled unit rates or deep dive analysis. For modelled unit rates there must be sufficient data points to give confidence in the model. Costs based on deep dive analysis can be onerous for Ofwat and companies.

Within the supply schemes enhancement feeder model published by Ofwat as part of the draft determination for PR24 a range of unit costs are presented based on scheme data submitted by companies. The costs have been modelled based on complexity of scheme. These unit costs are shown in the chart below.

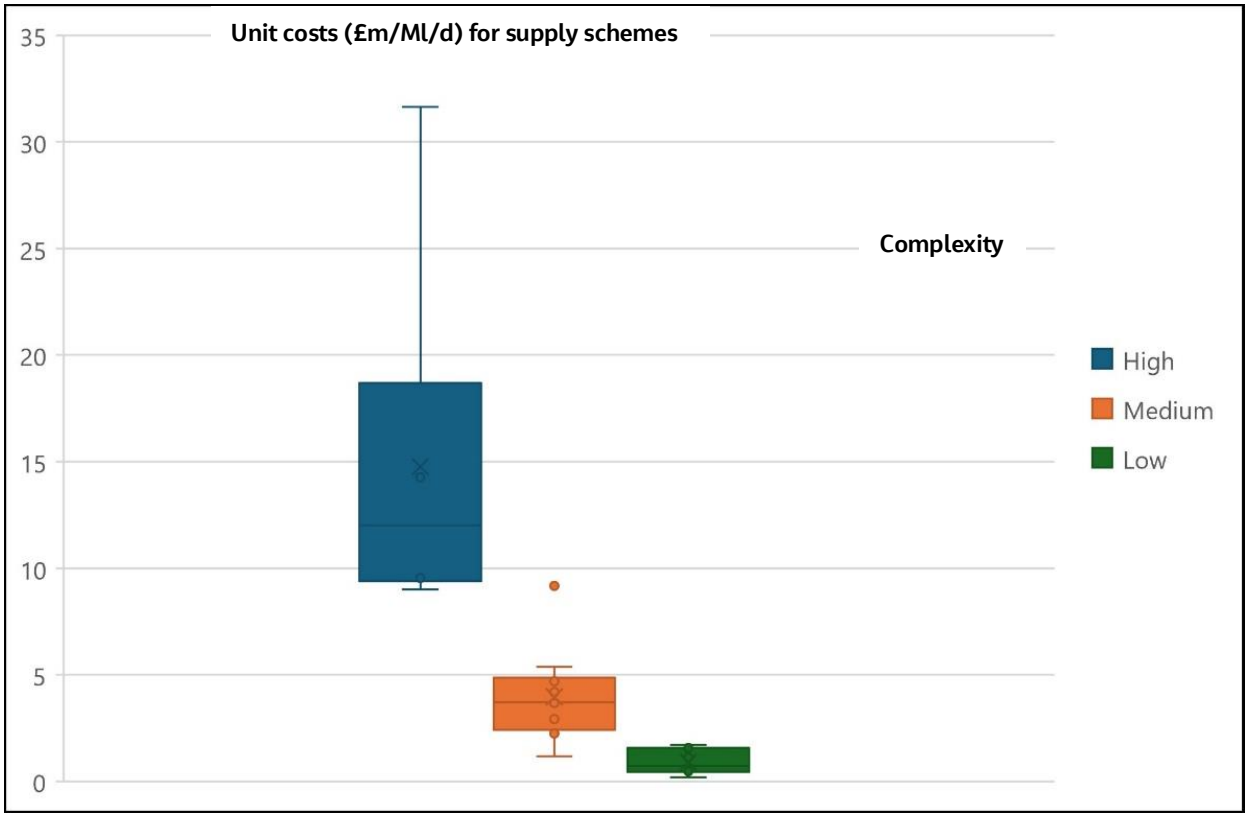

Figure 7-2: Unit costs for supply schemes, PR24 enhancement feeder model

As part of this project on PFAS uncertainty three companies have shared the costs of their proposed PFAS schemes for AMP8, some at the individual scheme level and some as averages per type of source and intervention. These data have been separated into surface water and groundwater with and without presence of existing GAC treatment on site. These are plotted on the chart below.

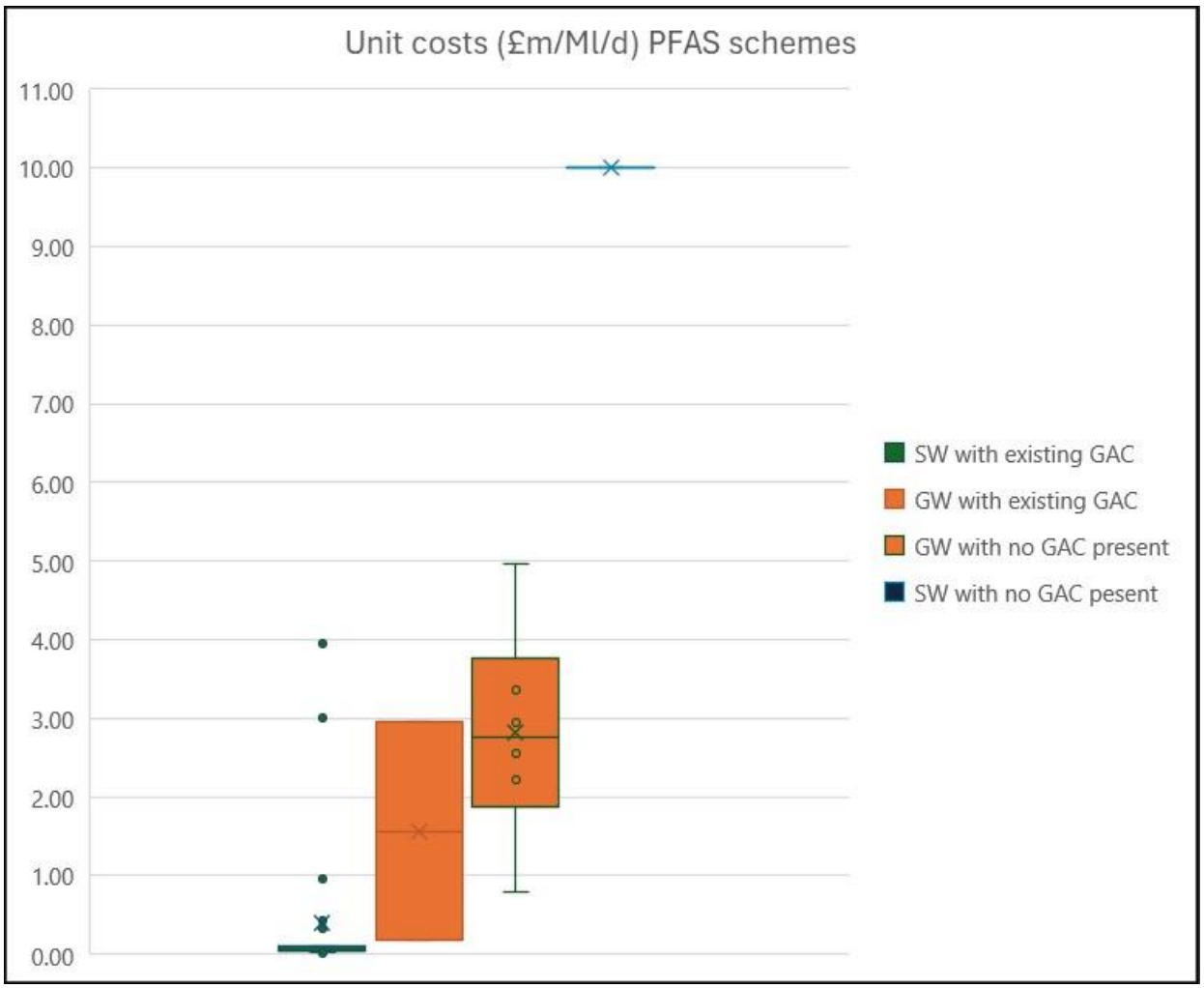

Figure 7-3: Unit costs for PFAS schemes based on data from 2 water companies for PR24

The majority of the data points fall within the equivalent category for medium complexity for supply schemes with some in the low complexity category and some in the high complexity. There may be a case for the supply schemes enhancement feeder model unit rates to be applied for PFAS. However, we note that the supply scheme rates are capex (not totex), thereby excluding ongoing annual maintenance costs and that some companies may argue the costs are under-represented by the model and the complexity assigned may not be representative of all schemes.

7.3 Hybrid approach

As demonstrated in this report there are several potential drivers for uncertainty regarding PFAS and a great deal of uncertainty around the potential scale of resulting impact, solution required and therefore costs. A bespoke or hybrid uncertainty mechanism for PR24 may provide suitable protection for companies and customers. Key features of a hybrid mechanism might include:

- Targeted on PFAS interventions only.
- In period modified notified item with a materiality threshold below the IDOK – potentially set as a percentage of the relevant price control totex. In the case of schemes which span more than one price control a lower threshold across combined price controls could be considered.
- Unit costs per Ml/d applied within period potentially based on the modelled supply scheme costs for medium complexity from the PR24 enhancement feeder model.

- End of AMP8 reconciliation based on remodelled / deep dive of efficient costs to provide additional protection for companies and customers. This would be important where companies find novel ways to treat PFAS which results in lower unit costs or are faced with more complex site-specific issues resulting in greater unit costs. an
- Subject to usual cost sharing mechanism requirements.

7.4 Summary

There are a number of potential uncertainty mechanisms that could be applied to mitigate the uncertainty around PFAS. Uncertainty mechanisms for drinking water will require collaboration across the industry and between the DWI and Ofwat to ensure there is a clear understanding of triggers and impacts. For the wastewater price control area there will need to be collaboration with the Environment Agency for the same reason.

Appendix A. Potential precedents to use in selecting an uncertainty mechanism

Mechanism	Trigger	Materiality/triviality threshold	Process for applying mechanism	In/end of AMP	Basis of costs	Cost-sharing rates	Other options consulted on and dismissed	Other notes	Source
AMP8 Bioresources notified item - Costs resulting from changes to the legal requirements in respect of sludge spreading.	Any increase in costs in the period from 1 April 2025 that is reasonably attributable to any new or changed legal requirement in relation to the application to agricultural land of fertiliser derived from sludge.	Normal IDoK threshold but can include other NI's or relevant change of circumstance. Materiality - 10% of turnover. Triviality for individual schemes to be included in materiality test - 2%	Company applies through standard IDoK process	In-period	No - any costs reasonably incurred and not avoidable through prudent management action.	Normal rates as per price review			Notification-of-the-draft-determination-of-price-controls-for-Anglian-Water-Services-Limited.pdf (ofwat.gov.uk)
AWS proposed UM for loss of landbank due to changes in bioresources regulation (not in DD)	Headroom of land availability over landbank requirement drops below 20%	Not specified	Not specified.	In-period if trigger occurs before 31/03/2028	Capex values of investment schemes for the number of years remaining in AMP8	Not specified			
AWS proposed UM for inland bathing waters (not in DD)	Designation of new bathing water site by Defra.			In-period if trigger occurs before 31/03/2028	Specific capex allowance and annual opex contribution for each bathing water				anh01-our-plan-2025-2030.pdf (anglianwater.co.uk)
AWS PCD on overflows	Non-delivery of schemes	1% of totex	Reconciled at end of control period.	End of period	Non-delivery payment rate: unit rate= total investment/unit of improvement. Measured by completion dates as agreed by EA. Late delivery payment:	PCD payment rates adjusted in DD for cost sharing rates.			ANH37-Price-control-deliverables.pdf (anglianwater.co.uk)

					3.5% of average cost of scheme.				
PR19 WINEP uncertainty mechanism	Amber schemes unconfirmed.	None	Automatic adjustment at price review	End of period	Unit rates (p.e. or m3 or scheme total) by scheme. Adjustments based on the company's totex estimates (after reallocations) as adjusted by company specific efficiency factor or, in the case of wastewater schemes, by the ratio of final totex allowance for the WINEP programme to the company's estimate (after reallocations).	N/A		Adjustment to allowed totex	PR19-final-determinations-United-Utilities-Water---Cost-efficiency-final-determination-appendix.pdf (ofwat.gov.uk)
PR19 DPC notified item	Can be triggered by Ofwat or companies. Company identifies material unfunded costs and applies for IDoK.	Normal IDoK threshold but can include other NI's or relevant change of circumstance. Materiality - 10% of turnover. Triviality for individual schemes to be included in materiality test - 2%	Company applies through standard IDoK process	In-period	No - IDoK based on efficient costs.	Normal rates as per price review	Scheme costs incurred considered at next price review and efficient costs added to RCV.	Ofwat to consider amendment to condition B with bespoke criteria for DPC	https://www.ofwat.gov.uk/wp-content/uploads/2019/12/PR19-final-determinations-Delivering-customer-value-in-large-projects.pdf
Land sales notified item	Ofwat / company can trigger IDoK					50:50 shareholder: customers			