UUW44

Cost adjustment claim submission - update to claims

October 2023

Chapter 8 supplementary document

This document sets out UUW's cost adjustment claims, with clear marked-up changes to show any updates since the early submission in June 2023. All claim values remain unchanged although we do withdraw UUW_CAC_005 due to confirmation from the Environment Agency that our physico-chemical sites are able to operate under a T21 waste exemption.

United Utilities

Water for the North West

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1. Cost adjustment claims – update to claims

1.1 Key messages

- Our cost adjustment claims are materially unchanged relative to those submitted as part of the early submission in June 2023.
- We have supplemented our early submission by providing a view of our claim values prior to the application of frontier shift assumptions.
- We have withdrawn claim UUW_CAC_005 following confirmation from the EA on its approach to regulation at physico-chemical sites.

1.2 Structure

1.2.1 The purpose of this document is to update the claims set out in the early cost adjustment claim submission in June 2023. We are mindful of Ofwat's guidance that: "*We will treat with caution any claims submitted in business plans that were not included in, or substantially changed from, the early cost claim submission"*[1]. As such, we have made only limited changes. Any changes have been clearly marked in red, with any deleted content being marked with a strikethrough.

1.2.2 This document is structured as follows

- **Section 2** summarises the updates made to our claims since the 9 June 2023 submission.
- **Section 3** to 8 set out 'UUW_CAC_001 – Reservoir dam maintenance'.
- **Sections 9** to 15 set out 'UUW_CAC_002 – Drainage'. Note that this claim would be withdrawn in the event that our proposals for a company-specific PCL for internal sewer flooding.
- **Sections 16** to 21 set out 'UUW_CAC_003 – Phosphorus removal'.
- **Sections 22** to 27 set out 'UUW_CAC_004 – IED compliance'.

[1] Ofwat (2022) *PR24 Final Methodology: Appendix 9.* Available here.

2. Summary of updates to claims since our 9 June 2023 submission

2.1.1 This section sets out a summary of any changes made to our cost adjustment claims since the June submission. We have only made minor changes, in line with Ofwat's guidance that: "*We will treat with caution any claims submitted in business plans that were not included in, or substantially changed from, the early cost claim submission.*"[2]

2.2 UUW_CAC_001 - Reservoir dam maintenance

2.2.1 We have added details of our proposed PCDs, which will ensure that customers are protected from late or non-delivery of ITIOS or PRA projects (see section 8).

2.2.2 We have also provided a valuation for our claim without any frontier shift assumptions applied.

2.3 UUW_CAC_002 - Drainage

2.3.1 There is no change to the value of drainage cost adjustment claim. The claim is valued using an econometric modelling approach, in particular one which adds to Ofwat's recommended model suite an explanatory variable reflecting the combined effect of both urban rainfall and combined sewer prevalence. However, we use a measure of urban rainfall that has been calculated by Ofwat[3] and at the time of business plan submission, this variable had not been updated to include data for the 2022-23 financial year. This means we have not been able to update our claim value. Therefore, we maintain our claim value and, once the latest rainfall data is available, will share any updated value with Ofwat.

2.3.2 We have also provided a valuation for our claim without any frontier shift assumptions applied (see Table 29).

2.3.3 We note that our business plan submission includes our proposal to adjust internal sewer flooding targets according to regional environmental standards. This is set out in supplementary document *UUW30 - Performance commitment document*. We are clear that the claim set out in this document is conditional and we will withdraw it subject to Ofwat accepting our proposals for company-specific targets for internal sewer flooding.

2.3.4 We noticed a slight error in our early cost adjustment submission document. Text in that document references a claim value of £152.6m, whereas the data table and Table 4 references a claim value of £152.1m. We confirm that £152.1m is the correct value and have made corrections within this document.

2.4 UUW_CAC_003 - Ongoing phosphorus removal

2.4.1 There is no material change to our ongoing phosphorus removal cost adjustment claim and we have not updated the claim value.

2.4.2 We have updated some text within this cost adjustment claim to evidence why we have not updated the value of this claim following the publication of 2022-23 APR data. We intended to use data from the 2022-23 APR to carry out a benchmarking exercise to identify an efficient level of ongoing opex relating to the AMP7 phosphorus removal programme. However, our analysis of other companies' table 7F submissions revealed a significant amount of missing cost data, such that we are not confident that a benchmarking exercise would lead to robust results at this stage. For example:

[2] Ofwat (2022) *PR24 Final Methodology: Appendix 9.* Available here.

[3] Ofwat (online) *Urban rainfall calculations.* Available here.

- South West Water's data appears to be incomplete and only contains cost information on four projects: Lapford, St Columb, Kenn & Kennford and Wilmington.
- Southern Water has reported it does not expect any operating expenditure after 2024-25 in its return. This does not align with its permit data, which suggests it will have a substantial number of phosphorus discharge permits below 0.5mg/l.

2.4.3 As this is a cost pressure common across the industry, we would support the implementation of a common adjustment to companies' costs. We note that this adjustment should not be symmetrical but **incremental** to existing base expenditure. This is because the AMP7 phosphorus removal programme is leading to a general increase in companies' base expenditure requirements.

2.4.4 We have also provided a valuation for our claim without any frontier shift assumptions applied (see Table 35)

2.5 UUW_CAC_004 - IED compliance

2.5.1 We have added a PCD section (see section 27) but not made any other change to this claim.

2.5.2 We were not informed of the legal clarification to comply with Industrial Emissions Directive (IED) at the time of our PR19 submission and therefore we did not submit an enhancement case at that time. The timing of the clarification of the legal status of our AD sites will mean that by the end of AMP7, we anticipate that we will have absorbed significant IED compliance costs associated with the EA's 2018 BAT guidance, that are not reflected in AMP7 cost allowances.

2.5.3 We have submitted a cost adjustment claim "Industrial Emissions Directive compliance at anaerobic digestion sites" to address the scope and cost to be compliant with the new requirements.

2.5.4 We note Ofwat's information request on asset health in bioresources across the sector was, *"prompted by concerns that the high-cost estimates for achieving compliance with the Industrial Emissions Directive (IED) could overlap with work that is funded through base expenditure allowances. Some of the estimated high costs might be indicative of insufficient maintenance of assets."*

2.5.5 For the avoidance of doubt, we would like to emphasise that our cost adjustment claim "Industrial Emissions Directive compliance at anaerobic digestion sites", is clear that there is no overlap between our cost estimates and maintenance activity, and that any interventions identified are incremental additions to the existing asset base. Please refer to Table 3 in the cost adjustment claim – "Estimating assumptions for cost adjustment claim", where this is set out in more detail.

2.5.6 We also note that we have excluded other scope items, such as the need to demolish and replace open tanks, covering sludge lagoons, or new liquor treatment plants to improve the quality of discharges back to a wastewater treatment works. These requirements were too uncertain to include in the claim at the time of submission. We also stated we would seek to revise the cost adjustment claim value in future, if further work or scope requirements are confirmed by the EA make it appropriate to do so. We believe that this is appropriate to do in light of the requirement to revisit permit applications and the need to resubmit costs by 20 December 2023, as set out in the meeting of Defra, EA, Ofwat and the Industry on 14 September 2023. This may lead to the inclusion of additional scope and therefore an increase in the cost to meet IED.

2.5.7 The IED requirements facing the sector constitute a significant increase in scope, beyond that represented by the historic trend in expenditure that is reflected in the Bioresources cost assessment model. This is the basis on which we have sought a cost adjustment claim. We recognise it may therefore reasonable to consider a PCD to ensure customer protection over the delivery of the additional scope that is allowed for in final determinations.

2.5.8 We are not, at this stage representing a proposed form of PCD, for two main reasons:

- Ofwat is considering how it will make some allowance for IED, which may be to make cost allowances or to implement an uncertainty mechanism. An uncertainty mechanism such (as the one implemented by CMA) would likely remove the need for a PCD; and
- Requirements are still relatively uncertain until further permits are issued.

2.5.9 Early in 2024, following companies providing further information to Ofwat in December, we will work (if possible with Ofwat) towards a PCD proposal, if it seems likely to be required.

2.6 UUW_CAC_005 - New waste permit obligations at physico-chemical sludge treatment sites that previously had PPC permits

2.6.1 We have withdrawn this cost adjustment claim.

2.6.2 Prior to submitting this cost adjustment claim, engagement with the Environment Agency indicated that operating under waste exemptions would be an unacceptable reduction to the level of environmental protection afforded at these sites, and they therefore required bespoke waste permits. On this basis, we submitted the cost adjustment claim to recover the additional efficient costs of compliance with bespoke wastewater permits.

2.6.3 To support our claim, we had written to the Environment Agency to confirm the regulatory position of the physico-chemical sludge treatment sites that are the subject of the claim, but at the time of submission we had received no response to our letter.

2.6.4 On 28 July 2023, we received a reply from the Environment Agency confirming that these sites are eligible to operate under waste exemptions, rather than requiring bespoke waste permits and a full review against requirements set out in Appropriate Measures guidance. This letter is set out in Appendix G.7. This means we will not need to undertake the activity envisaged within the claim. As such, we have withdrawn the claim.

Reservoir Dam Maintenance Cost Adjustment Claim Submission

Cost adjustment claim submission	
Title:	Reservoir dam maintenance (£186.490 million)
Price Control:	Water resources
Cost adjustment headline:	• Reservoir safety is a legal, social and moral requirement that United Utilities Water (UUW) is entrusted to deliver. As such, dam safety, risk assessment and management is at the heart of our water resources activities and is non-negotiable. This document provides advice to regulators about the appropriate means by which they should calculate and provide for the effective cost recovery of this essential activity in line with all legal and regulatory requirements. • The claim is made up of three parts: – Part 1: The relative historic cost of maintaining and operating reservoir and borehole sources; – Part 2: A rise in the number of statutory actions arising from regulatory safety inspections, since the publication of the 2020 Balmforth Report[4] into the Toddbrook Reservoir emergency; and – Part 3: A change in the Environment Agency (EA) flood risk maps[5] requiring additional work to remain compliant with the Health and Safety at Work Act 1974[6].
Description:	• UUW operates significantly more reservoirs than the average of water companies in England and Wales. Those reservoirs are also, on average, older than other companies. • Reservoirs cost more to operate and maintain than borehole sources, but Ofwat's proposed PR24 water cost models do not differentiate cost allowances based on source type. Costs associated with reservoir maintenance are focused on meeting our obligations under the Reservoirs Act 1975[7]. These costs are increasing due to the implementation of the recommendations of the Balmforth independent enquiry into the Toddbrook reservoir emergency (the 2020 Balmforth Report)[8]. • In addition, UUW has legal obligations under Section 3 of the Health and Safety at Work Act 1974 (H&SWA 1974), which relates to public exposure to industrial risks. In this case, the risk is related to dam failure. UUW manages this H&SWA 1974 obligation using a Portfolio Risk Assessment (PRA) approach, pro-actively reducing risk to the community. The EA has recently updated its flood risk maps which has, in the main, increased population numbers downstream of our reservoirs. This has then increased the consequence of a dam failure and led to increased numbers of UUWs reservoirs falling within HSE defined "unacceptable" risk categories (as described in HSE document Reducing Risk Protecting People (R2P2)[9]). It is important to note that this is not a reflection of the asset health condition of the dams in question, but is purely resulting

[4] Professor David Balmforth (2020) *Toddbrook Part B report*. Available here.

[5] Environment Agency (2022) *Flood risk maps*. Available here. (UUW receives flood risk maps as a GIS shape file)

[6] Health and Safety Executive (1974) *The Health and Safety at Work Act*. Available here.

[7] *The Reservoirs Act (1975)*. Available here.

[8] News report into Toddbrook Reservoir emergency. Available here.

[9] Health and Safety Executive (2001) *Reducing Risk – Protecting People (R2P2)*. Available here.

	from how the change in consequence impacts on the overall risk assessment. This cost adjustment case considers how we will intervene to reduce risk to ensure that our dams are within HSE defined "tolerable" risk categories in future. As a result, UUW must undertake significant additional investment to mitigate this risk. • This cost adjustment claim seeks an efficient adjustment to UUW's allowances to enable required statutory maintenance activity.

Reservoir dam maintenance cost adjustment claim summary

Gate	Summary	Location reference
Need for cost adjustment	• United Utilities operates a much larger fleet of reservoirs than industry average. • Dam operation is a driver of costs, due to the regulated maintenance regime associated with dam safety in the UK, and reservoirs cost more to operate and maintain than boreholes. However the proposed PR24 cost models do not reflect differences in source type, so companies will only receive cost allowances based on an implied presumption that all companies have the industry average mix of source types. This will under-remunerate companies with a relatively high proportion of reservoirs. • Dam maintenance costs are also increasing due to external factors beyond management control, whereas cost models only reflect historic costs. • The number and cost of regulatory maintenance actions has increased since the release of the Independent 2020 Balmforth Report into the Toddbrook Reservoir incident. • United Utilities had a planned programme of dam failure risk reduction. The 2020 Balmforth Report recommended that risk reduction became part of the regulated inspection process for UK dams. This has caused us to accelerate our risk reduction programme, to align with the regulated inspection schedule. In addition, the scope of which reservoirs require risk reduction measures has increased due to the updating of EA's flood risk maps in 2022.	*Paragraph 4.3.10* *Section 4.4* *Section 4.5* *Paragraph 4.5.31*
Cost efficiency	• The future statutory actions element of the programme build is based on outturn unit rates, uplifted for the number of actions received post-2020 Balmforth Report, with frontier shift and catch up efficiencies applied. • For PRA elements of the business case, we have used historic project costs, scaled for the size of the dam, with frontier shift and catch up efficiencies applied.	*Section 5.2* Section *5.3*
Need for investment	• We are seeking investment to deliver regulatory driven activity, and to proactively reduce risk to the community. • The need for investment has increased due to external drivers associated with the national regulatory response to the Toddbrook Reservoir emergency, and arising from changes to the EA's reservoir flood risk maps.	*Section 6.2* Section *6.3*
Best option for customers	• Both reactive engineering interventions (driven by inspections carried out under the Reservoirs Act 1975) and pro-active engineering interventions (driven by the Health and Safety at Work Act 1974) are not discretionary. They are regulatory obligations.	*Paragraph 7.3.3* Section

	• The options we considered as part of our proactive risk reduction programme. • Results of an independent bench-marking exercise. • Customers have indicated a preference for investing now in critical infrastructure assets, with a focus on long life asset replacement in order to reduce the probability of service interruption. The planned programme of reservoir activity matches the customer preferred investment option.	7.2 Paragraph *7.3.5* *Section 7.4*
Customer protection	• We propose that customers will be protected through a price control deliverable mechanism which will link outcomes (risk reduction and / or delivery of statutory actions) to an agreed timescale, with processes to return money to customers in the event of UUW underperformance, or if anticipated actions are not required following reservoir inspections. • ~~Price control deliverables are a new mechanism, which are still under development, and they will mainly apply to enhancement business cases. We propose to submit a suite of price control deliverables (including relating to this cost adjustment business case) covering all relevant business cases as part of our main submission in October 2023. This will ensure consistency of approach across the PR24 business plan.~~ • We propose two Price Control Deliverables to ensure customers are protected from late or non-delivery of our ITIOS and PRA programmes	*Section 8*

3. Introduction

3.1.1 Reservoir safety is a legal, social and moral requirement that UUW is entrusted to deliver. As such, dam safety, risk assessment and management is at the heart of our water resources activities and is non-negotiable. This document provides advice to regulators about the appropriate means by which they should calculate and provide for the effective cost recovery of this essential activity in line with all legal and regulatory requirements.

3.1.2 UUW operates the largest fleet of reservoirs of the water companies in England and Wales, significantly larger than the industry average on a normalised basis. However, PR24 cost models do not fully reflect the dam maintenance requirements associated with an above average reservoir fleet.

3.1.3 The Reservoirs Act 1975 requires that dams are subject to independent safety inspection at least every ten years. The independent Inspecting Engineer (an experienced civil engineer who has passed a Defra selection panel) is empowered to issue dam operators with statutory actions requiring the dam operator to make modifications to a specified scope, and by a specified time. The receipt of statutory actions is not an indication of poor asset health or inappropriate maintenance. It is a normal and regular part of the management of dam safety in England. Every dam operator will expect to receive statutory actions arising from the independent inspections. This process is analogous to a motor car MOT. Actions may arise when the car is subject to its MOT, even if the car has been well maintained and carefully driven.

3.1.4 The number of statutory actions issued, and their scope (and cost) are directly related to the dam in question, not the volume of water being impounded. Since the Toddbrook Reservoir emergency in 2019 UUW has seen an increase of 113% in statutory actions being received due to increasing rigour with which the Reservoirs Act 1975 is being enforced.

3.1.5 The reactive, inspection-led Reservoirs Act 1975 requirements remain a central pillar of UK dam safety management. However this reactive system relies upon an issue being detectable during the inspection process. This may not always be the case, and there have been cases (such as the Toddbrook Dam incident in 2019) where a dam has passed an inspection, only for a structural problem to develop (and potentially cause the dam to fail) before the next scheduled inspection takes place. To overcome this problem, there is a second, proactive pillar of UK dam safety legislation.

3.1.6 Section 3 of the H&SWA 1974 concerns the public exposure to risk from industrial processes (including dam operation). The Health and Safety Executive (HSE) sets risk tolerability thresholds, which operate on a sliding scale dependent upon the number of members of the public exposed to the risk. Industrial operators (in this case dam operators) are required to manage their operations so that their facilities are within the tolerable risk range (set by the HSE). UUW does this through its Portfolio Risk Assessment (PRA) process.

3.1.7 In 2022, the EA published updated reservoir flood inundation risk maps, which indicates more people are living within the inundation zones (where water would flow in the event of a dam failure) of dams than previously. This has created a lower threshold for dam failure risk, requiring us to pro-actively intervene to reduce risk on more dams than we had historically planned for.

3.1.8 These issues disproportionately affect UUW, due to our large reservoir fleet. These Victorian assets continue to give great service, and it is much more cost effective to manage the existing reservoir fleet than construct new reservoirs, or identify other alternative water sources. However, we do need to ensure that we continue to operate this fleet in line with statutory safety obligations.

3.1.9 UUW's cost adjustment claim is comprised of three components:

- **Part 1: The impact of operating reservoirs vs boreholes**. Ofwat's recommended models do not include a driver that reflects source type, meaning UUW does not receive an appropriate allocation of historical costs, commensurate to our large fleet of reservoirs.

- **Part 2: A rise in the number of statutory actions since the publication of the 2020 Balmforth Report.** As we set out in section 4.5.18 to 4.5.20, the 2020 Balmforth Report has led to an enhanced inspection regime, which has increased maintenance costs. These higher costs are not reflected in the historical dataset, which covers the years 2011-12 to 2021-22. This portion of the claim seeks to recover efficient additional maintenance expenditure relating to the stricter legal standards UUW will incur over the course of AMP8.
- **Part 3: A change in the EA flood risk maps requires additional work to remain compliant with the H&SWA 1974.** As a result of changes to the EA's flood risk maps, the H&SWA 1974 requires UUW to undertake additional mitigation at reservoirs deemed to be high risk (in the unacceptable categories). This reflects expenditure incremental to that incurred previously.

3.1.10 These elements along with the implicit allowance for dam maintenance and avoided power are set out in Table 1. We provide a valuation net of frontier shift in Table 16.

Table 1: Summary of UUW's claim valuation

Element of claim	£million, 2022-23 CPIH	Source
Part 1: Pre-Balmforth element (historical cost of operating reservoirs versus boreholes)	36.573	Table 7
Part 2: Post-Balmforth element statutory actions (ITIOS)	65.151	Table 7
Part 3: Post-Balmforth PRA (flood-risk map change)	114.843	Table 12
Implicit allowance for dam maintenance	(12.457)	Table 13
Implicit allowance for avoided power	(17.62)	Table 14
Net claim value	186.49	

Source: UUW early cost adjustment claim submission

3.2 Our PR19 submission

3.2.1 We submitted a cost adjustment business case relating to reservoir dam maintenance at PR19. Ofwat did not accept this claim in full. Table 2 sets out the reasons why full acceptance was not possible at that time, and how this business case addresses these reasons.

Table 2: Ofwat's reasons for rejection at PR19

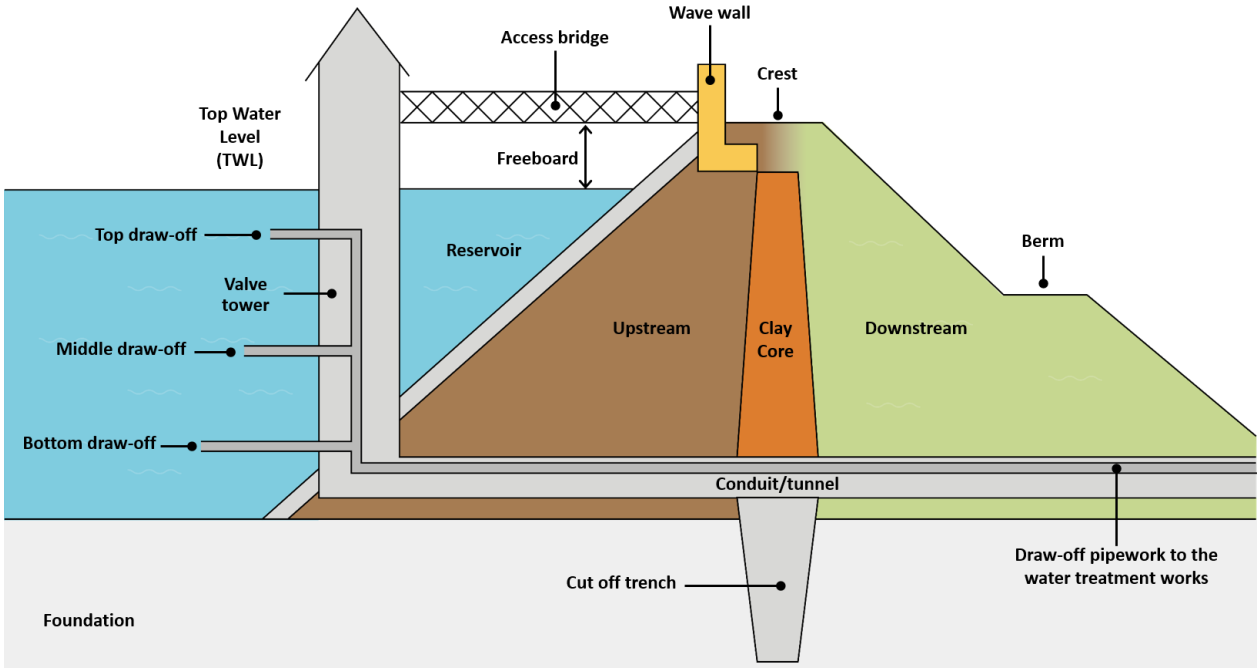
	Reason for rejection at PR19	How we have addressed in this claim
1	[✂]	[✂].10
2	[✂]	[✂]
3	[✂]	[✂]

Source: Ofwat PR19 Final Determinations

[10] Ofwat, 2023, *PR24 Econometric Base Cost Models Consultation, P27,* Available here

3.3 Reservoir schematic and glossary of terms used in this document

Figure 1: Reservoir schematic (cross-section through the dam)



Source: UUW engineering cross section visual

Terms used in schematic

- **Access bridge:** Links the valve tower to the crest.
- **Berm**: A shelf of rock or soil adding weight to anchor the toe of the embankment.
- **Clay core**: The water tight element of the dam. The core holds the water in place. The embankment holds the core in place.
- **Conduit-tunnel:** Joined to the valve tower. Hollow and dry to allow access. Contains pipework.
- **Crest:** The top of the dam. Usually flat, often includes a road or footpath for access.
- **Cut off trench:** Water tight core extended into underlying ground, prevents seepage.
- **Downstream:** The 'dry' side of the dam, beyond the water retaining core.
- **Draw-off pipework (top, middle, bottom):** pipework and valves that takes (abstracts) water from the reservoir and transports it to the water treatment works.
- **Foundation**: The underlying ground/bedrock beneath the reservoir.
- **Freeboard:** Distance between the top water level and the crest of the dam.
- **Reservoir:** Water stored above the level of the surrounding ground, held in place by a dam.
- **Top water level:** Elevation of the overflow weir, the level at which the reservoir begins overflowing.
- **Upstream:** The 'wet' side of the dam, saturated, before the water retaining core.
- **Valve tower:** A hollow, dry tower, with inlet valves to enable us to abstract water at different depths.
- **Wave wall:** Structure at the top of the dam preventing storm waves washing over the crest.

Glossary of terms used in document

- **ALARP** – As Low As Reasonably Practical. A risk category described by the HSE in R2P2 where the risk to the public has been reduced to a point where further investment cannot be justified on a cost benefit basis.
- **Balmforth Report** – An independent report into the Toddbrook Reservoir emergency incident, commissioned by the Department for the Environment, Food and Rural Affairs. Report led by Professor David Balmforth, the President of the Institution of Civil Engineers. This report produced a number of recommendations which led to changes in the application of reservoir safety regulations in the UK. (Link)
- **Environment Agency (EA)** – government agency responsible for the regulation and enforcement of dam safety regulations in England.
- **EA Flood Risk Map** – A series of computer generated maps, produced by the EA, showing areas of England at risk of flooding from different sources. These include maps of the areas that would be flooded in the event of dam failure. (Link)
- **Health and Safety at Work Act 1974 (H&SWA)** – The key UK legislation concerning occupational risk management. Section 3 of this Act places legal obligations on the operators of commercial premises, where an accident could cause offsite consequences, or effect people not directly employed by the site operator. Dam owners are covered by Section 3 of the Act, as flooding could affect the community downstream of the dam. (Link)
- **Health and Safety Executive (HSE) –** government agency responsible for the regulation and enforcement of section 3 of the H&SWA 1974.
- **Impounding reservoirs / reservoir** – Body of water held artificially in place above the level of the surrounding ground, by a dam structure. In the event of a dam failure, water would escape from the reservoir.
- **Inspecting Engineer** – A government appointed senior civil engineer, who has passed a rigorous selection panel, and who is commissioned to carry out independent dam safety inspections under the Reservoir Act. Also known as a Panel Engineer, and an All Reservoirs Panel Engineer (ARPE) and as a Qualified Civil Engineer (QCE) in different reports and publications.
- **(Matters) In The Interests Of Safety (ITIOS or MIOS)** – A legal notice issued by an independent Inspecting Engineer to a dam operator, requiring that the dam operator carries out specified safety improvements to a specified timescale. Also known as Measures In The Interests Of Safety (MIOS) in some publications. There are sub-categories of notices issued by the Inspecting Engineer (actions to be carried out relating to surveillance, actions related to maintenance and so on), these are collectively referred to throughout this document as 'statutory actions'.
- **Metres above ordnance datum (mAOD)** – A reference measure in dam engineering. Heights above mean sea level measured at the Ordnance Survey datum point at Liverpool.
- **Reducing Risks, Protecting People (R2P2)** – HSE statutory guidance document setting out risk tolerability criteria associated with section 3 of the H&SWA. (Link)
- **Portfolio Risk Assessment (PRA)** – A process by which United Utilities reservoirs are risk assessed, compared to HSE risk tolerability guidelines, and used to produce a risk prioritised programme of risk reduction engineering interventions. Aimed at getting all United Utilities reservoirs to the tolerable risk category.
- **Probable Maximum Flood (PMF)** – Probable maximum flood means the flood that may be expected from the most severe combination of critical meteorological and hydrologic conditions that are reasonably possible in the drainage basin. The ability of a dam to safely pass the PMF is a key measure of dam safety. As our knowledge of PMF forecasting evolves over time, dams may require

remedial work to ensure that they can pass a newly calculated (higher than previously thought) PMF.

- **Reservoirs Act 1975** – Key UK legislation related to dam safety. Requires every relevant reservoir to be inspected by an independent, government appointed, Inspecting Engineer at intervals of no more than every 10 years. (Link)
- **Risk tolerability** – Different categories of risk, described by the HSE in R2P2. Based on extensive research carried out by the HSE. Provides a consistent, regulatory approved measure of risk management in the UK.
- **Toddbrook** – A reservoir in Derbyshire owned by the Canal and Rivers Trust. In August 2019 the reservoir experienced a serious dam safety emergency. The subsequent independent inquiry and report by Professor David Balmforth led to changes in dam safety regulation in the UK.
- **UUW** – United Utilities Wholesale, the operational arm of United Utilities.
- **Unacceptable risk** –A risk category described by the HSE in R2P2 where at least one person is exposed to a risk probability of 1 in 10,000 or more.
- **Unacceptable societal risk** - A risk category described by the HSE in R2P2 where more than 100 people are exposed to a risk. The tolerability threshold scales with the number of people exposed.
- **Tolerable risk** - A risk category described by the HSE in R2P2. A risk with an annual probability below 1 in 10,000.
- **Willowstick** – A technology used to identify leakage pathways through a dam. An electrical source is placed in a reservoir, and several receptors are placed downstream. Conductivity maps are then generated, showing lines of high conductivity, which correspond to leakage pathways. A critical technology when scoping dam safety interventions. (Link)

3.4 Structure of Document

3.4.1 We have divided our cost adjustment claim into the following sections:

- Section 4 provides an overview of the need for this cost adjustment. It demonstrates UUW operates and maintains an unusually high number of resources and why this will be associated with materially higher costs. It describes the statutory framework of reservoir safety and risk management with which we must comply. It evidences that the modelled allowance is not sufficient in the round to enable UUW to meet these legal obligations. Finally, it sets out UUW's approach to the symmetrical adjustment.
- Section 5 presents how UUW calculated the value of the cost adjustment for each of the claim's three elements: part 1: the pre-Balmforth Report element; part 2: the post-Balmforth Report Reservoirs Act 1975 element; and part 3: the post-EA flood map change H&SWA 1974 element. It also sets out UUW's approach to the implicit allowance.
- Section 6 evidences the need for investment in dam maintenance. It notes that the statutory framework and the 2020 Balmforth Report has led to a more prescriptive and stringent regime, which has caused associated compliance costs to increase.
- Section 7 demonstrates that this claim and the options set out within it are in the best interests of customers. It evidences that continued operation and maintenance of UUW's reservoir fleet is more economical than the development of alternative sources. It sets out the optioneering process by which UUW optimises its PRA programme and associated solutions. Finally, it shows that customers support continued maintenance of our asset base.
- Section 8 sets out how customers will be protected from non-delivery of the activities set out within this claim. We note that we will submit an associated PCD with our wider business plan in October 2023 to ensure our PCDs are internally consistent.

4. Need for adjustment

4.1 Overview of this section

4.1.1 This section presents evidence on the need for an adjustment to Ofwat's modelled allowances:

- Section 4.2 summarises the three different elements of this cost adjustment claim.
- Section 4.3 sets out evidence to support the uniqueness of UUW's water resources.
- Section 4.4 evidences that the recommended model suite will not provide sufficient cost allocation to deliver its legal obligations.
- Section 4.5 discusses the statutory framework and the safety requirements placed upon reservoir owners.
- Section 4.6 evidences that impounding reservoirs are a material cost driver at a company level.
- Section 4.7 sets out UUW's approach to the symmetrical adjustment. We note that the implicit allowance calculations are included as part of section 5.4.

4.2 The basis of this cost adjustment business case

4.2.1 This cost adjustment case is based on three factors:

- **Part 1: The impact of operating reservoirs vs boreholes.** Ofwat's proposed suite of cost models reflect the extra costs of pumping (via the use of pumping head within the water cost models) for companies who are predominantly fed from groundwater. However, the water resources plus cost models do not reflect the extra costs of dam maintenance for those companies which have a higher than average number of reservoir sources compared to groundwater sources. This situation is inequitable for companies with a relatively high proportion of reservoir sources.
- **Part 2: A rise in the number of statutory actions since the publication of the 2020 Balmforth Report.** The costs associated with the regulatory inspections of dams has increased as a result of the recommendations of the 2020 Balmforth Report into the 2019 Toddbrook Reservoir emergency incident. As these are new costs, they will not be accounted for in models based on historic costs.
- **Part 3: A change in the EA flood risk maps requires additional work to remain compliant with the H&SWA 1974.** One of the regulatory obligations for dam operators is to manage the risk associated with their dams in line with Section 3 of the H&SWA 1974. These requirements include an assessment of the likelihood and consequence of a dam emergency. A change to the EA flood risk maps in 2022 has led to an increase in the predicted consequence of a dam emergency, due to larger areas being forecast to be affected and population growth within that area. It is important to note that this change is not related to any change in asset health condition (the likelihood side of the assessment). The changes to the consequence element of the assessment (the flood maps) means that dams which were previously considered to be HSE risk compliant, now require additional risk reduction intervention in order to remain compliant (again, with no change to the physical condition or performance of the dam). These are new costs; they will not be accounted for in models based on historic costs.

4.3 UUW owns and operates a uniquely large number of reservoirs

4.3.1 UUW operates the largest fleet of reservoirs of the English and Welsh water companies. These reservoirs require regular maintenance and inspection. These reservoirs were inherited at privatisation and drive higher water resources costs in the round. It is efficient to continue to operate and maintain reservoirs because the cost of developing alternative sources is prohibitively high.

4.3.2 There are a number of factors associated with dam and reservoir operation which drive costs. These include:

- **The number of reservoirs operated by a company:** Each reservoir will incur regulatory obligations including inspections under the Reservoirs Act 1975 (and the cost of completing statutory actions arising from those inspections), and requirements for risk management under the H&SWA 1974 (and the costs associated with engineering interventions to ensure that the risk of dam failure is within limits set by the HSE). In addition, each reservoir will be associated with routine maintenance activities such as grounds maintenance, security and anti-vandal precautions, activities to keep visitors and recreational users safe, environmental requirements and so on (we note that these costs are not incurred by companies with boreholes to the same extent). Therefore, having more reservoirs increases costs.
- **The number of dams operated at each reservoir:** Some reservoirs are comparatively simple, and are formed by a dam across a valley impounding a river. By comparison some reservoirs are formed by damming complex shaped valleys in multiple locations. An individual reservoir can therefore have more than one dam. The dams associated with a reservoir will have been constructed at the same time, using the techniques available at the time of construction. As such, these reservoirs often require interventions on all of their dams at the same time. A reservoir with two dams requiring a risk reduction intervention under PRA, will require two separate projects, increasing costs and complexity. Therefore, more dams per reservoir will increase associated costs.
- **The age of the dams:** Construction of UUW's oldest dam was completed in 1800. The construction of the youngest dam in the UUW fleet was completed in 1971. The intervening years have seen the techniques and materials used in dam construction significantly evolve. Older reservoirs and their dams are associated with higher capital and maintenance costs as they were constructed at a time before civil engineering materials could be transported over any distance (before the train or canal network was built) and before any mechanical construction tools were available. These dams were hand built, using locally sourced material (regardless of the quality of the material) and were built before soil mechanics or hydraulic engineering were as well understood. They were also built with some inherent safety design flaws e.g. pipes directly through the embankment, which is a potential seepage risk.

  After 200 years these dams have experienced settling, and the effects of weathering, and therefore require higher levels of maintenance. They have also required modifications to align them with modern safety standards e.g. new spillways (which allow water to pass safely from the reservoir to the downstream watercourse) to accommodate larger rainfall events due to climate change. This can be compared to younger reservoirs and their dams, built in the second half of the twentieth century. These dams were built using a plethora of different construction machinery, construction techniques and used good quality material imported from around the world. More recently built dams were designed by engineers with a full working knowledge of flood forecasting, soil mechanics and material science and, as such, were built to higher quality standards than the older dams. They tend to have wider clay cores to prevent seepage, slacker slopes to reduce stability issues and do not have inherent safety design flaws. They also tend to have large enough spillways to cope with the increasing rainfall events due to climate change. Older dams therefore tend to require more significant risk reduction interventions than younger dams. Therefore, having older dam's increases costs. We provide more detail about how dam construction has evolved over time in Appendix A.
- **The size of the dam (length and height):** The physical size of a dam influences what risk reduction measures can practically be carried out in order to ensure continued compliance with HSE risk reduction measures and statutory actions arising from regulatory inspections. Larger dams have fewer options available due to constructability and access considerations, meaning that comparatively lower cost options are not always available for large dams. Additionally, larger dams mean that more material and time is required to complete work. Therefore, larger dams lead to higher costs.

4.3.3 UUW operates a relatively large and old reservoir fleet, with some reservoirs having multiple dams

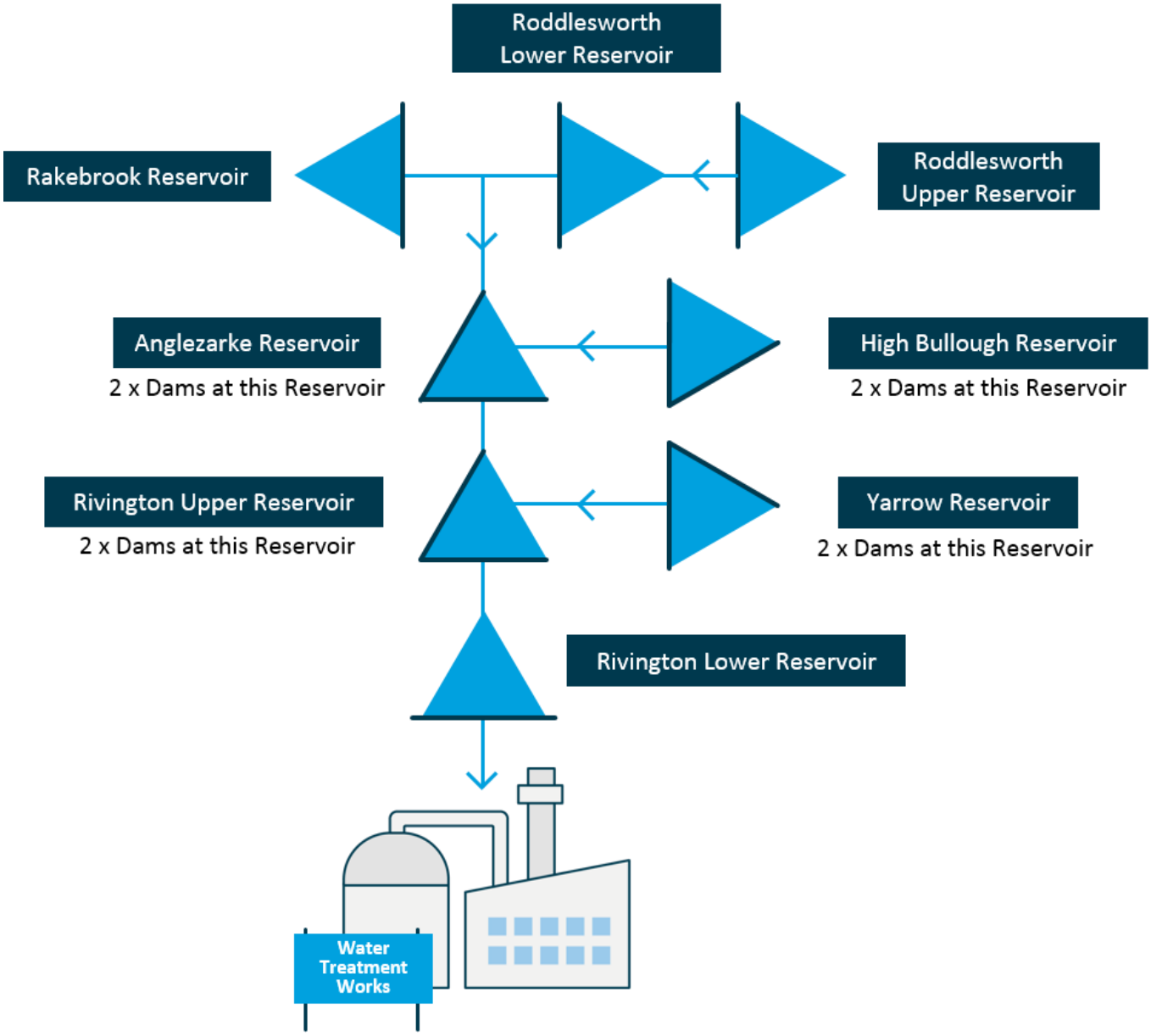
4.3.4 The North West has numerous long sinuous valleys, close to urban areas that began to develop during the Industrial Revolution. This led Victorian engineers to construct chains of reservoirs along a valley to supply the burgeoning urban population with potable water. Upstream reservoirs provide additional water storage and support to the lowest reservoir in the chain, which often feeds a water treatment works and/or supplies water to the downstream watercourse. This asset structure was inherited by UUW at privatisation. This remainder of this section sets out some examples of reservoir chains.

4.3.5 Figure 2 is an aerial image illustrating the chain of reservoirs in the River Douglas Valley. Showing from bottom left is Rivington Lower, Rivington Upper, Yarrow and Anglezarke. Not clearly visible in this image are High Bullough, Roddlesworth Lower, Roddlesworth Upper, and Rakebrook Reservoirs, which are all part of this chain. Only Rivington Lower Reservoir directly feeds a water treatment works and the downstream watercourse although there are a total of eight reservoirs and twelve dams (some reservoirs having more than one dam).

4.3.6 Figure 3 shows the schematic of the whole River Douglas chain of reservoirs.

Figure 2: The River Douglas Valley chain of reservoirs

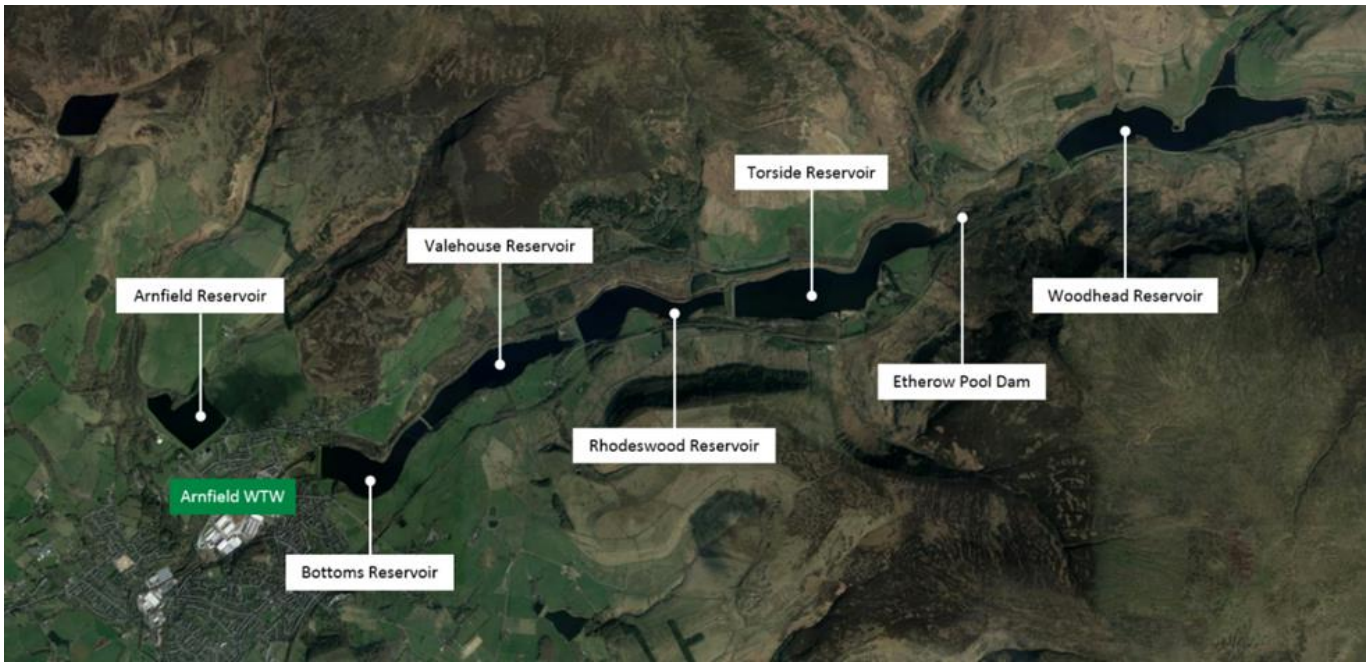
Figure 3: The River Douglas Valley chain of reservoirs schematic



Source: UUW schematic

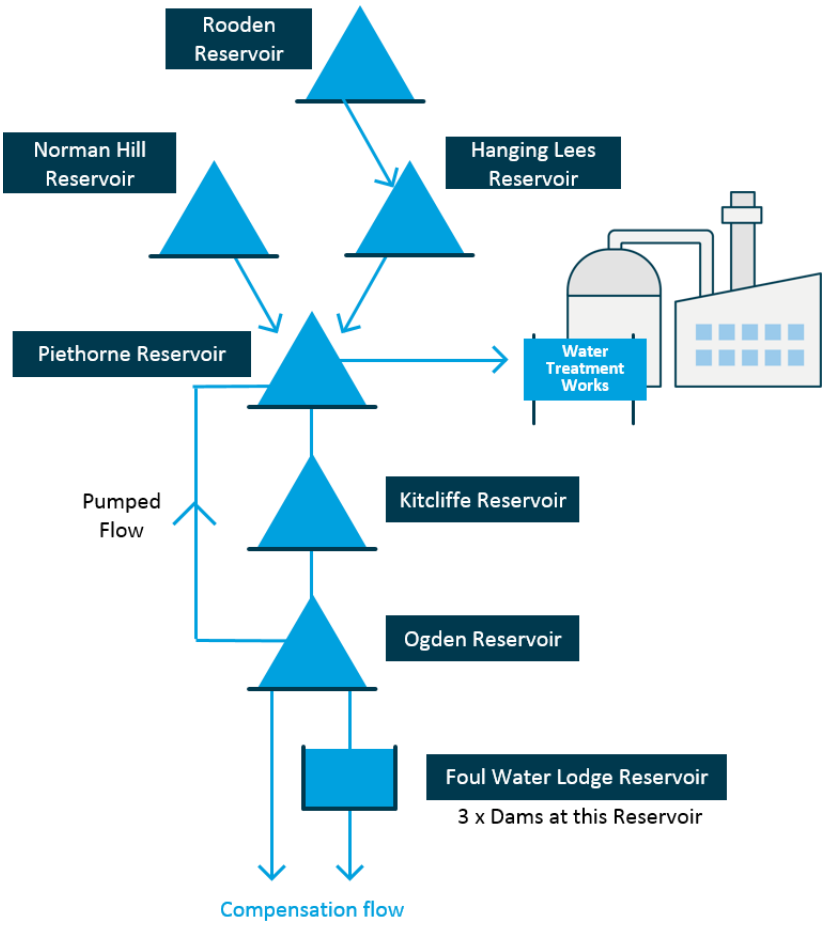
4.3.7 Figure 4 illustrates the chain of reservoirs in the Longdendale Valley. Showing from the left is Arnfield, Bottoms, Valehouse, Rhodeswood, Torside, Etherow Pool, and Woodhead. Only Arnfield and Rhodeswood directly feed Arnfield water treatment works, with Bottoms supplying water to the River Etherow, although there are a total of six reservoirs and ten dams.

Figure 4: The Longdendale Valley chain of reservoirs



4.3.8 Figure 5 shows a schematic of the Piethorne Valley chain of reservoirs. Showing top to bottom is Rooden, Hanging Lees, Norman Hill, Piethorne, Kitcliffe, Ogden and Foul Water Lodge, which has three dams.

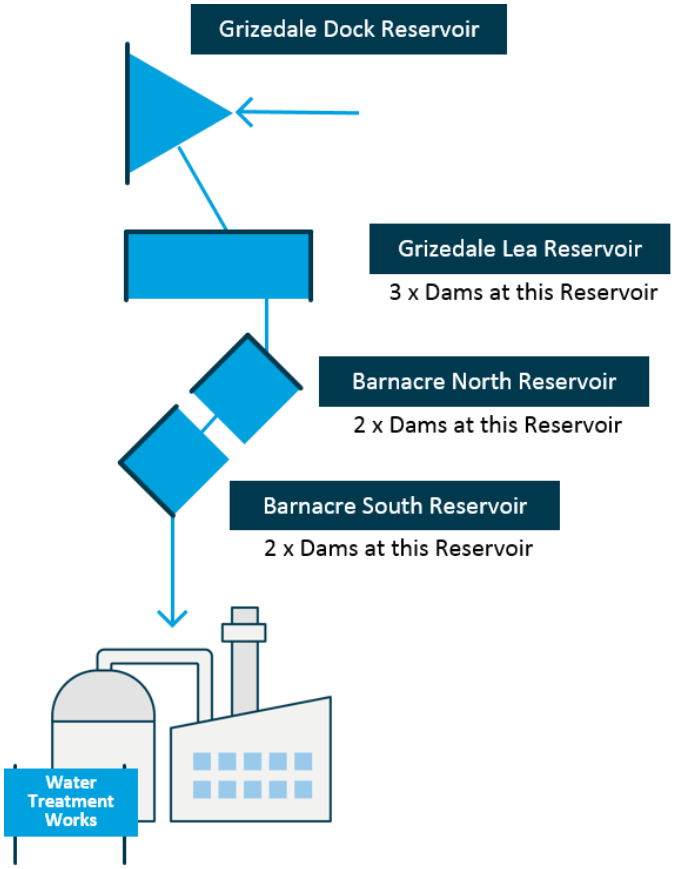
Figure 5: The Piethorne Valley chain of reservoirs



Source: UUW schematic

4.3.9 Figure 6 shows the Grizedale Valley Reservoirs. From top to bottom there is Grizedale Dock, Grizedale Lea, and Barnacre North and South, each of which has two dams.

Figure 6: The Grizedale Valley chain of reservoirs

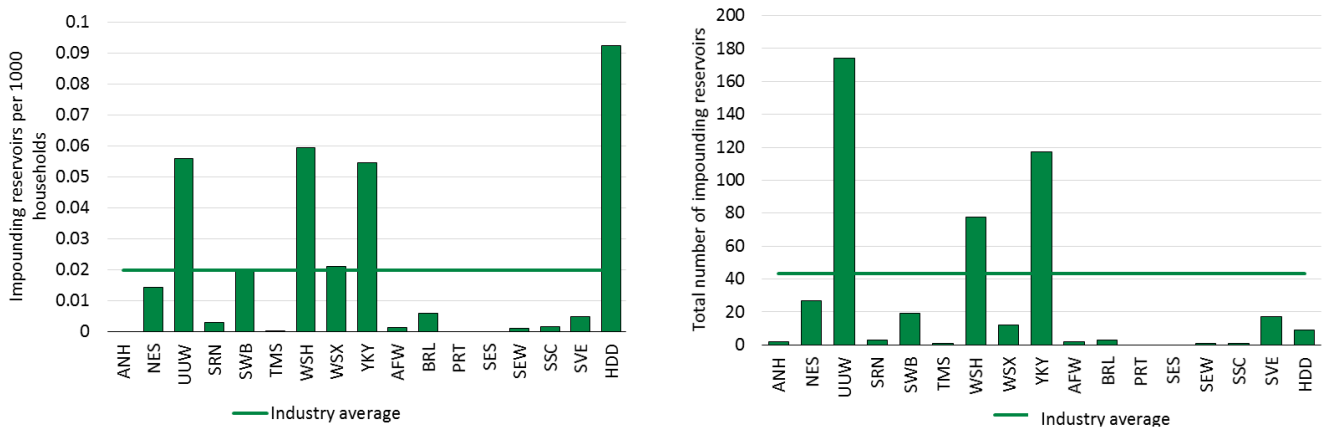


Source: UUW schematic

UUW's historical legacy means we operate and maintain an atypically large number of reservoir dam structures

4.3.10 The historical legacy of the North-West means that UUW operates the largest fleet of reservoirs in the industry and significantly above industry average when normalised by households, as demonstrated by Figure 7. It is also worth noting that some reservoirs have more than one dam.

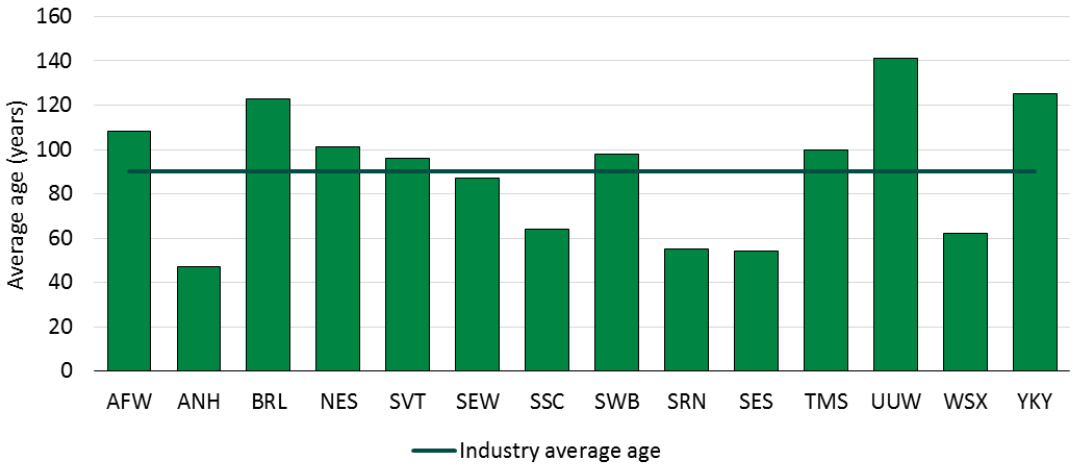
Figure 7: UUW operates an above average number of impounding reservoirs in absolute and relative terms



Source: UUW analysis using Ofwat's cost assessment dataset. Available here.

4.3.11 Additionally, the average age of our reservoir fleet is one hundred and forty one (141) years, with our oldest reservoir being two hundred and twenty three (223) years old. Figure 8 demonstrates that the average age of UUW's reservoir fleet is the oldest in the industry. ~~Section~~ Paragraph 4.3.2 explained why older dams drive higher capital and maintenance costs.

Figure 8: Average age of reservoir fleets across the industry



Source: Environment Agency (2022) Public Register of English Reservoirs

4.3.12 It would not be cost effective in the round to replace our old fleet with a new fleet or develop alternative sources, as discussed in 4.5.3 to 4.5.7, so we consider continued maintenance of our existing older fleet to be the most efficient solution.

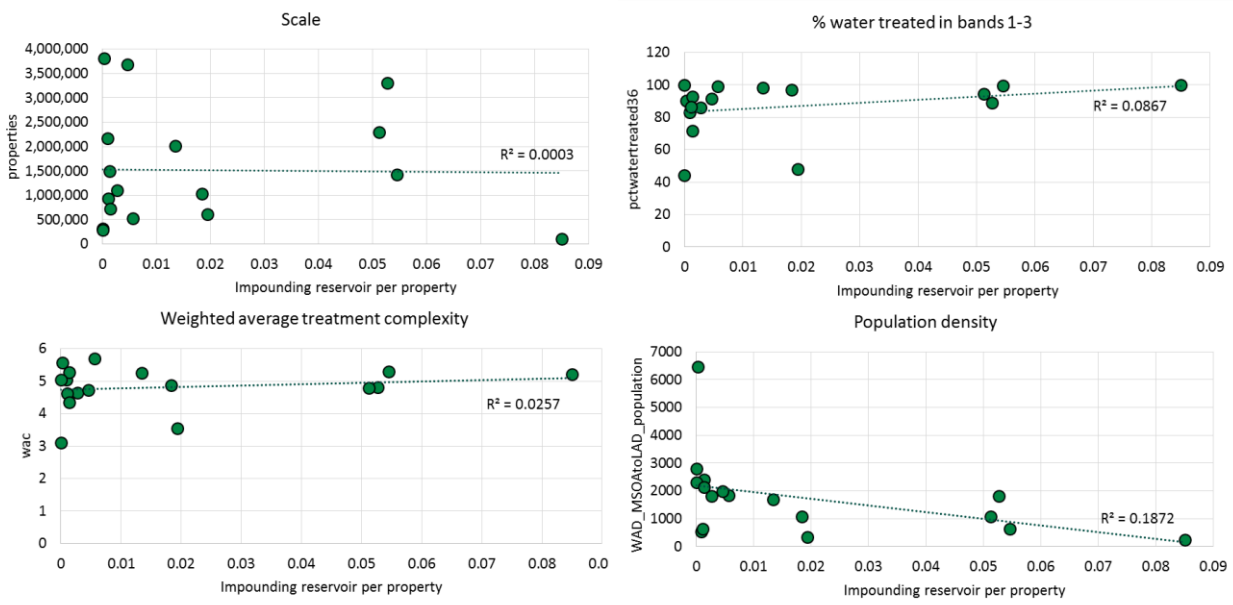
4.4 Ofwat's proposed model suite will not appropriately reflect reservoir maintenance requirements in the round

4.4.1 Ofwat's model suite does not include a cost driver that reflects efficient variation in dam maintenance:

- Ofwat includes a scale driver. However, there is no correlation between company size and number of reservoirs.
- Ofwat includes density drivers. These do not have a strong correlation with reservoirs per property. In fact, there is a slight negative correlation between reservoirs per property and population density. This means that, all else equal, if a reservoir cost driver is excluded then the models would detriment companies with higher than average population density and higher than average reservoirs. This is because population density effectively acts as a weak inverse proxy for reservoirs.
- Ofwat also includes treatment complexity measures. However, these have an extremely weak correlation with reservoirs per property. Additionally, as we discuss in paragraph 4.4.3, the way these measures are calculated places equal weight on surface and groundwater sources. For example, all band one surface water and band one groundwater sources are combined to form an overall band one sources category.

4.4.2 Figure 9 illustrates the lack of correlation between Ofwat's proposed cost drivers and normalised reservoirs. This demonstrates that Ofwat's models will not be capable of allocating sufficient expenditure to companies with dam maintenance requirements.

Figure 9: There is no correlation between Ofwat's proposed cost drivers and reservoirs



Source: UUW analysis using Ofwat's cost assessment dataset. Available here.

4.4.3 The proposed treatment complexity cost drivers do not distinguish between surface water and groundwater source types. This means that they will not be able to reflect the maintenance requirements associated with surface water sources, which is generally composed of reservoir dam maintenance. Table 3 shows the derivation of the weighted average complexity variable, with both surface water and groundwater sources included within each complexity level. This clearly demonstrates that the variable is not able to distinguish between surface water and groundwater sources, because both are given equal weight within the calculation for each complexity band. The same is the case for the alternative treatment complexity variable, percentage of water treated in complexity bands three to six. Therefore, the models will not reflect any differential impact of reservoir maintenance within the treatment complexity variables.

Table 3: Weighted average treatment complexity (WAC) measure calculation

Complexity level	0	1	2	3	4	5	6
Weight	1	2	3	4	5	6	7
% water treated	1%	1%	17%	17%	14%	50%	0%
C = A x B	0	0	0.5	0.7	0.7	3	0
WAC = sum(C)				4.9			

Source: Ofwat (2023) Econometric base cost models for PR24

4.4.4 Further, as we demonstrate later in the document in Table 5, reservoirs per property is a material driver of botex at an industry level, with a positive, statistically significant coefficient.

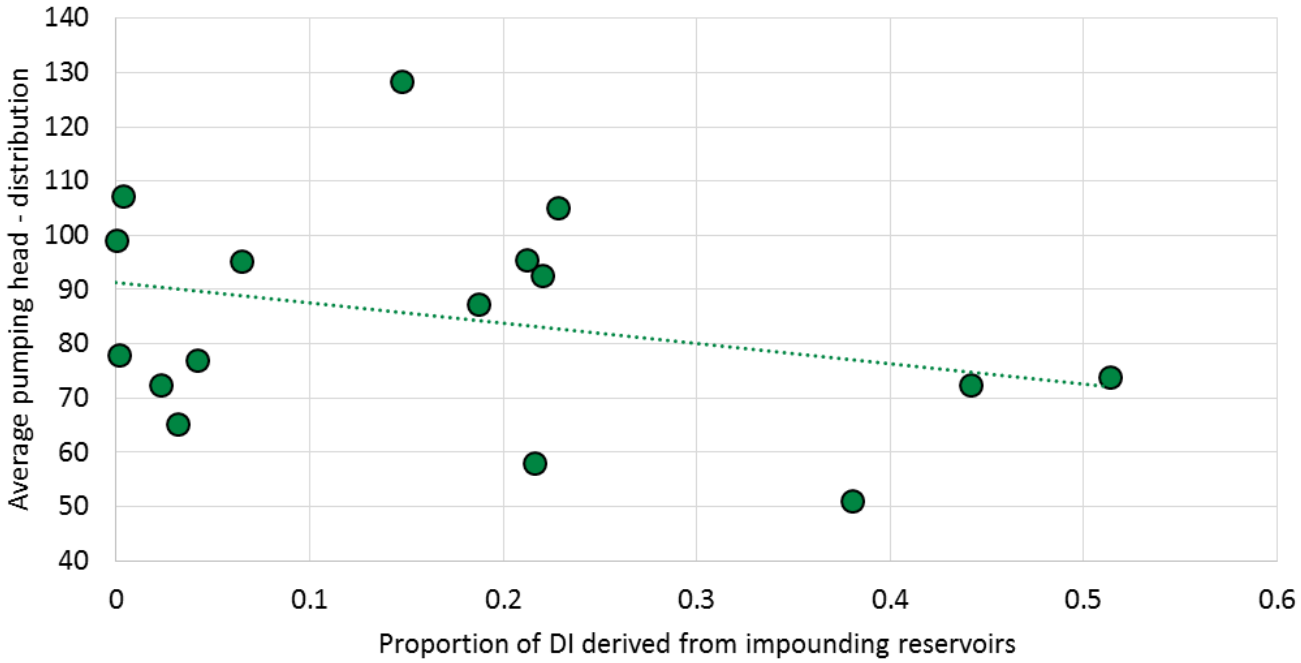
Ofwat's proposed model suite reflects the offsetting benefit of more reservoir sources

4.4.5 Reservoir sources tend to use gravity to move water to the water treatment works, which also helps to pressurise the downstream system to an extent. However, while variation in pumping requirements is reflected within Ofwat's recommended model suite (through the use of topography cost drivers), variation in reservoir maintenance requirements is not. Therefore, the recommended model suite is not appropriately offsetting higher maintenance requirements with lower power costs – the models are only reflecting one side of the equation, lower relative power costs. The remainder of this section evidences this point.

4.4.6 Ofwat's recommended model suite[11] includes a topography cost driver, proxied by two different explanatory variables: booster pumps per length of main; and average pumping head for the distribution element of the value chain. Ofwat uses these variables within both distribution and wholesale water models[12]. The use of topography variables within wholesale water models means that total water power costs are allocated according to pumping requirements. This includes water resources power costs.

4.4.7 Engineering, operational and economic rationale holds that gravity-fed water resources will contribute towards pressure in the downstream system including within the distribution network. This means that companies with a higher proportion of gravity-fed water resources (predominantly impounding reservoirs) will tend to have lower distribution average pumping head. Figure 10 shows a slight negative correlation between distribution pumping head and reservoirs. Assuming that the coefficient on the topography cost driver is positive, this means that econometric models will allocate less botex to companies with a high proportion of reservoir sources. Therefore, the inclusion of topography cost drivers in water cost models means that these companies' allowances will be adjusted downwards to reflect lower power requirements in water resources, without a corresponding increase to reflect higher dam maintenance requirements.

Figure 10: Gravity-fed reservoirs help to pressurise the downstream system



Source: UUW analysis using Ofwat's cost assessment dataset. Available here.

4.4.8 This means that the proposed model suite will reflect UUW's lower downstream power requirements, but the lack of a reservoir cost driver means that it won't reflect the corollary of this – higher upstream reservoir maintenance expenditure.

4.4.9 Therefore, Ofwat's models already account for the offsetting benefits associated with a high proportion of reservoirs sources. We consider that this means netting off the 'avoided power' implicit allowance from the claim could be viewed as representing a double-count of that benefit for companies with a

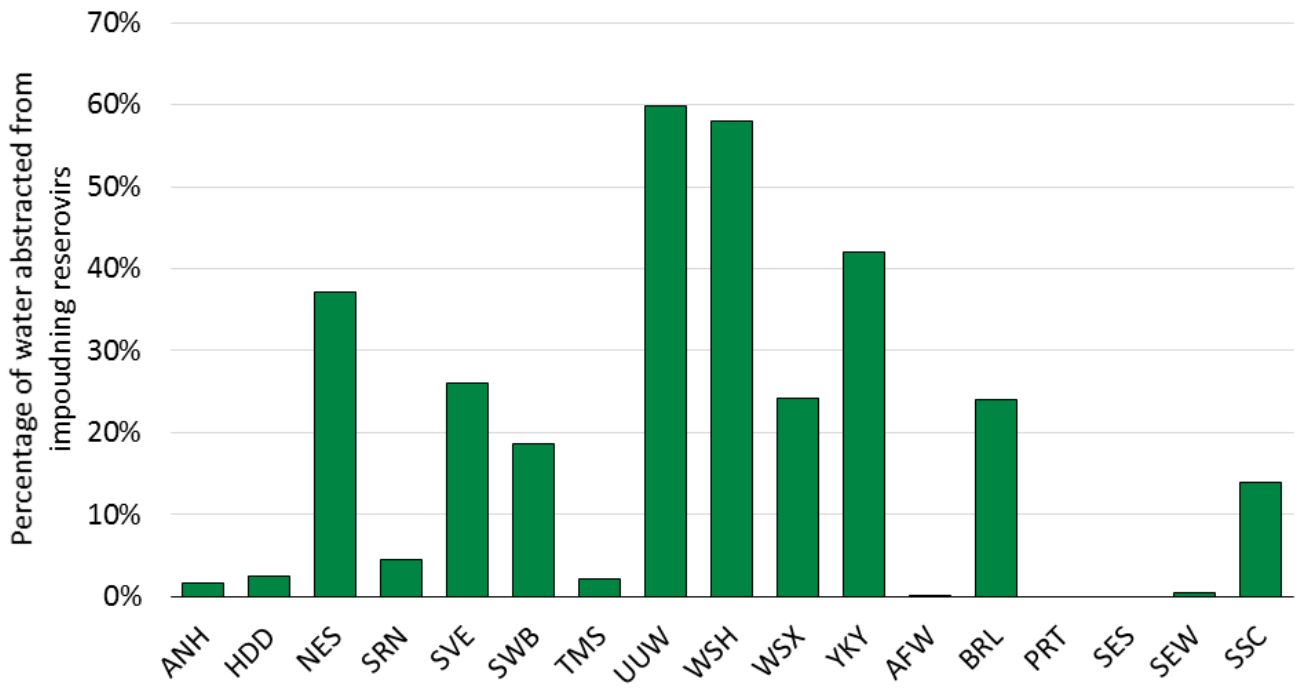
[11] Ofwat (2023) *Econometric base cost models for PR24*. Available here.

[12] As we set out within our response to Ofwat's consultation *"Econometric base cost models for PR24"*, we have significant concerns about the use of average pumping head data within cost assessment due to evidence of poor data quality. As such, we strongly oppose the use of pumping head data within base cost models. However, for the purposes of this cost adjustment claim, we assume average pumping head is used within cost assessment at PR24. This assumption should not be taken as implicit agreement with its use.

high proportion of groundwater sources. However, to demonstrate stretch and ambition we have still included an implicit allowance for the power costs we avoid by operating a higher proportion of impounding reservoir sources.

4.4.10 As Figure 11 shows, UUW abstracts the highest proportion of water from impounding reservoirs sources. This suggests that UUW will be disproportionately affected by the recognition of power requirements but the exclusion of dam maintenance requirements.

Figure 11: UUW abstracts the highest proportion of water from impounding reservoir sources in the industry



Source: Annual Performance Report

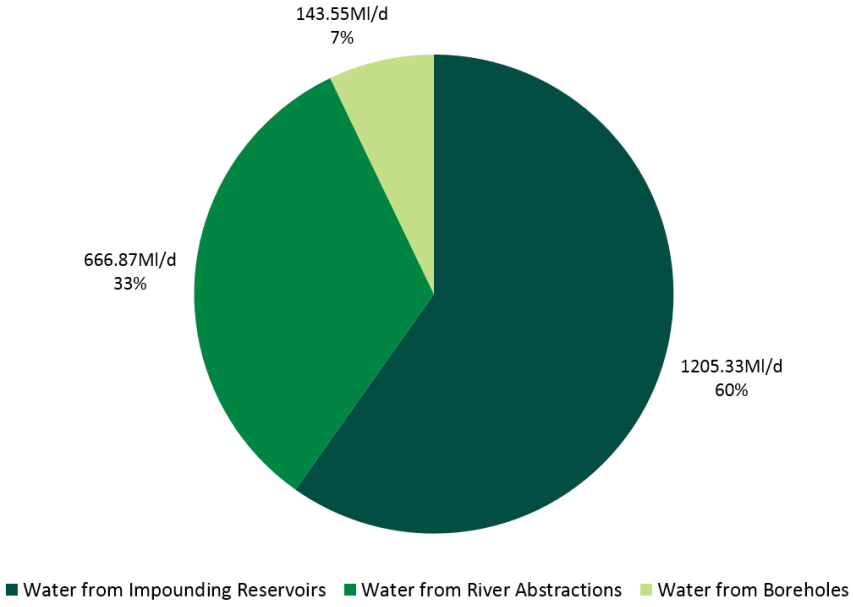
4.5 Management control and the statutory framework surrounding reservoir safety

4.5.1 This section sets out why continued operation and maintenance of reservoirs is the best value for money option. It also discusses the statutory framework surrounding reservoir safety and how this impacts upon UUW.

4.5.2 Operating and maintaining reservoirs represents best value for money

4.5.3 UUW inherited its reservoir fleet at privatisation, which continues to represent the most efficient way to supply customers with water. It would not be cost effective to decommission our reservoir sources, and replace them with lower maintenance cost groundwater sources to attempt to reduce maintenance costs. We abstract approximately 1,200 mega litres per day from our reservoir sources, shown on Figure 12.

Figure 12: Proportion of abstraction from raw water sources



Source: UUW (2022) Regulatory reporting table 5A, lines 1, 3 & 4

4.5.4 We also do not have sufficient groundwater abstraction licence capacity to substitute abstraction from reservoirs with abstraction from boreholes. Furthermore, our Water Resource Management Plan (WRMP24)[13] identified the cost of developing new groundwater sources to be approximately £3.3 million per mega litre of resource capacity. This suggests that, assuming sufficient groundwater sources exist, the cost of replacing our reservoir sources would be in the region of £4 billion. This is likely a conservative estimate because the marginal cost of new water sources would increase as the stock of groundwater sources reduces. This is clearly far in excess of our net claim value of £186.490 million over AMP8.

4.5.5 Additionally, as part of PR24 Water Industry National Environment Programme (WINEP) development the EA is applying sustainability reductions to our abstraction from groundwater sources in order to protect the environment.

4.5.6 Furthermore, our reservoirs are regulated through abstraction licences, issued by the EA. These abstraction licences contain a number of conditions under which the abstraction of water is permitted, usually including the requirement to maintain an even flow of water (environmental compensation flow) to downstream rivers. Without the reservoirs which support compensation flow we would be prevented from abstracting water by the EA. We are also required to provide compensation flows to downstream rivers regardless of whether the reservoir is being used for abstraction. Therefore we would still be required to maintain our reservoir fleet if we ceased to abstract unless we fully decommissioned and removed the reservoirs in question, which would be extremely expensive.

4.5.7 Therefore, we consider that continued operation and maintenance of our reservoir's dams represents best value for money for customers.

Regulatory framework for dam safety in England

4.5.8 Reservoir safety standards have been set by the government via the Reservoirs Act 1975 (as amended by the Flood and Water Management Act 2010[14]) and the Health and Safety at Work Act 1974 (H&SWA 1974) and are none negotiable. These represent legal requirements that UUW must comply with and a failure to act risks legal enforcement.

[13] United Utilities Water (2023) *Water Resource Management Plan WRMP24*. Not published yet.

[14] DEFRA (2010) *Flood and Water Management Act*. Available here.

4.5.9 The EA is responsible for managing, implementing and enforcing, if needed, reservoir safety regulations in England.

Reservoirs Act 1975 (as amended by the Flood and Water Management Act 2010)

4.5.10 The Reservoirs Act 1975 dictates what activity reservoir owners must undertake to ensure dams do not pose a risk to the public.

4.5.11 Reservoirs registered under the Reservoirs Act 1975 must have an appointed independent Inspecting Engineer undertake a detailed inspection and report of findings every ten years, or sooner if required. This is bolstered by the requirement to have a Supervising Engineer that provides supervision through annual inspection and a report on condition. These inspections notify a reservoir owner if they are required to undertake statutory works, maintenance or monitoring in respect of the reservoir in question and within what timescale. These requirements are classed as statutory actions.

4.5.12 The receipt of statutory actions is not an indication of poor asset health or inappropriate maintenance. It is a normal and regular part of the management of dam safety in England. Every dam operator will expect to receive statutory actions arising from the independent inspections. This process is analogous to a motor car MOT. Actions may arise when the car is subject to its' MOT, even if the car has been well maintained and carefully driven.

4.5.13 Statutory actions will only be confirmed as complete if they have been signed off to the satisfaction of the Inspecting Engineer and the EA has been formally notified.

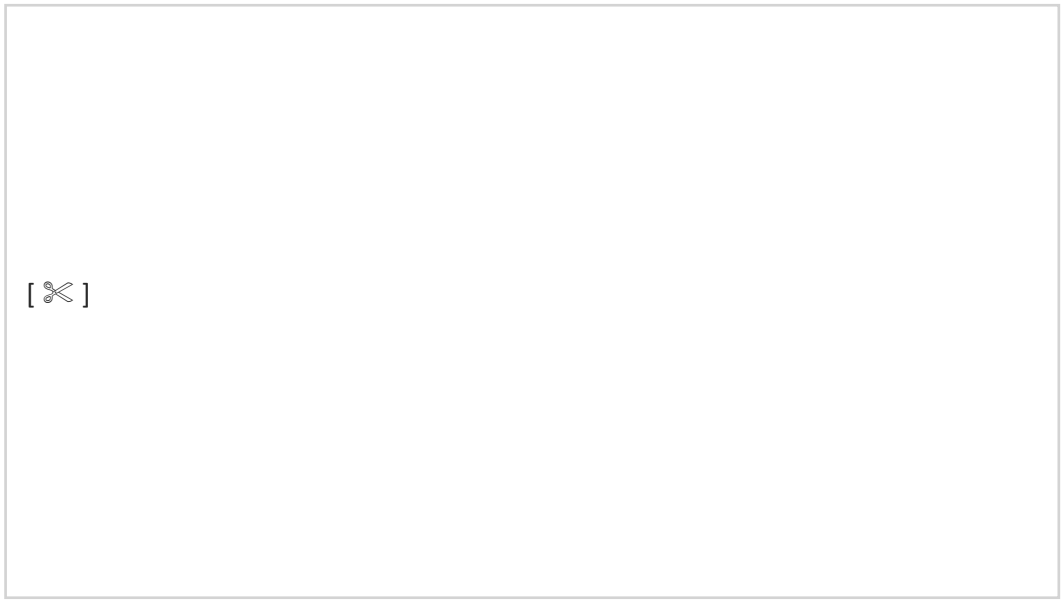
4.5.14 UUW undertakes all inspection and maintenance of the reservoir and associated structures in line with its legal obligations. We note that all reservoirs are subject to the same regulatory risk management regime, regardless of whether: the reservoir is directly connected to a water treatment works; is used to feed reservoirs further down the valley; or is used to provide environmental compensation flow.

4.5.15 There are eighty (80) statutory ten yearly inspections due to be undertaken within the last two years of AMP7 (from January 2023) and the first three years of AMP8 (by 31st March 2028), which will result in statutory actions to be undertaken during AMP8. Additionally statutory inspections undertaken in 2022, which require studies and investigations works, will likely lead to the requirement for capital works to be delivered in AMP8.

The Toddbrook Dam Emergency incident (2019) has increased safety standards

4.5.16 In 2019, following two heavy rainfall events, the auxiliary (secondary) spillway at Toddbrook Reservoir in Whaley Bridge, owned by the Canal and River Trust, failed despite being fully compliant with The Reservoirs Act 1975. See Figure 13. An emergency was declared and 1,500 Whaley Bridge residents were evacuated whilst water levels in the reservoir were reduced and temporary works were undertaken to stabilise the void in the spillway.

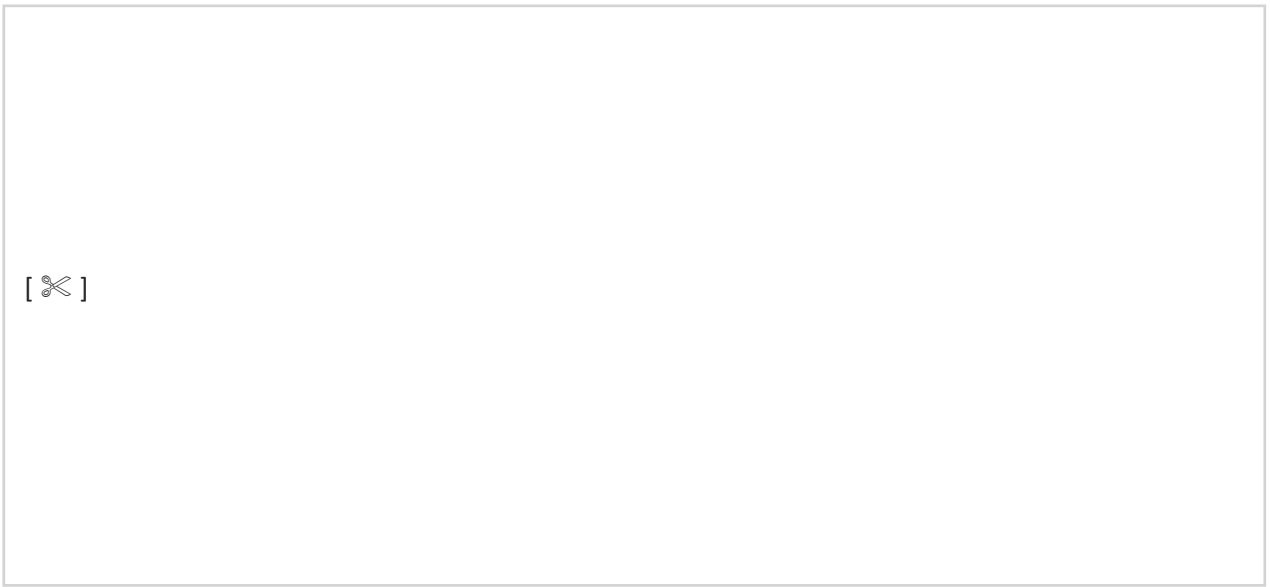
Figure 13: Toddbrook Reservoir - spillway failure - 2019



4.5.17 Following the incident the Government asked Professor David Balmforth to undertake an independent review, to consider the effectiveness of reservoir safety legislation and regulations. The review (The 2020 Balmforth Report) has led to a more risk averse inspection process and more stringent timescales in which reservoir safety regulations are being enforced under the Reservoirs Act 1975. Consequently, this has led to a significant increase in statutory actions which is driving a significant increase in reservoir maintenance costs.

4.5.18 Figure 14 illustrates the effect that Toddbrook has had on statutory actions – those actions identified as legal requirements following a reservoir inspection. It shows the average number of statutory actions per year in AMP7 so far is 115, whereas in AMP6 it was 54 actions. This is an increase of 113%. This average excludes 2019-20, the year of the Toddbrook incident because this year reflects a mix of pre and post-Toddbrook inspections.

Figure 14: Number of reservoir statutory actions received since 2015-16



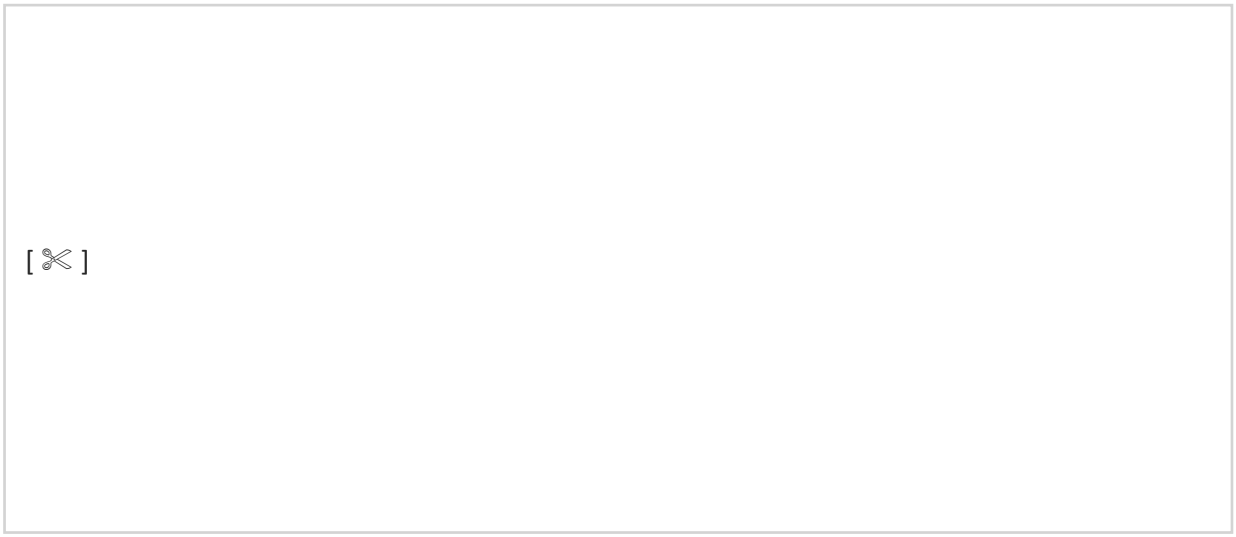
Source: UUW internal data

4.5.19 Additionally, Figure 15 demonstrates the Toddbrook incident has led to a substantial increase in the number of projects requiring studies or investigations as part of the design phase of an engineering intervention. It shows the average number of projects requiring studies per year in AMP7 so far is 31,

whereas in AMP6 it was 7. This is an increase of 343%. This average excludes 2019-20, the year of the Toddbrook incident because this year reflects a mix of pre and post-Toddbrook inspections.

4.5.20 From the studies we currently have on-going so far, post Toddbrook, we are seeing the need for future physical engineering interventions. This additional expenditure will not be reflected within the historical dataset.

Figure 15: There has been a significant increase in the number of studies arising from independent safety inspections



Source: UUW internal data

Health and Safety at Work Act 1974 (H&SWA 1974)

4.5.21 UUW also needs to ensure that it is discharging its risk requirements in accordance with Section 3 of the H&SWA 1974. Following an emergency event in 2002 at Rivington Upper reservoir, owned by UUW, a comprehensive enquiry was held. During the enquiry, UUW was instructed by HSE to comply with the HSE regulatory guidance, entitled "Reducing Risk – Protecting People" (R2P2) 2001.

4.5.22 R2P2 is the UK regulatory guidance for any commercial activity which has the potential to cause non-occupational impacts (affecting members of the general public) if something goes seriously wrong. It is not guidance specific to the water industry, but is used by a wide variety of industries such as chemical manufacturers and fuel storage depots. R2P2 provides a definitive guide on risk "tolerability". A "tolerable" risk can be managed through standard operational procedures, whereas an "intolerable/unacceptable" risk requires the industry in question to make a change, to make the structure in question "tolerable".

4.5.23 This guidance requires UUW, and indeed all other reservoir owners, to take direction from the HSE on the management of risk relating to its reservoir fleet. This entails ensuring we are appropriately mitigating wider societal risk and consequences, including the probability of failure thresholds, set out by the HSE in order to demonstrate the discharge of duties under the H&SWA 1974.

4.5.24 Additionally, the Toddbrook incident and the subsequent 2020 Balmforth Report has impacted upon the way the industry is required to implement HSE guidance:

- Recommendation 10 states: "high risk reservoirs should be managed and operated on the basis of risk to ensure their ongoing safety", as specified in the H&SWA 1974. High risk reservoirs are those where members of the public are potentially exposed to hazards in the unlikely event of a dam failure.
- Recommendation 5c states "Inspecting Engineers (acting under their duties associated with the Reservoirs Act 1975) should undertake or update, as necessary, a risk assessment for the reservoir. Where statutory actions are required as a result of a risk assessment, these should be specified so as

to reduce risk to ALARP (as low as reasonably practicable), and evidence should be provided to demonstrate that".

4.5.25 A dam can be compliant with the Reservoirs Act 1975, (because there is nothing that requires an immediate 'fix' in the opinion of the independent Inspecting Engineer), but the same reservoir can fall within a HSE "unacceptable risk" category based on its forecast future performance under extreme conditions.

4.5.26 The 2020 Balmforth Report's recommendations set out in paragraph 4.5.24 has led Inspecting Engineers to expect reservoir owners to demonstrate a proactive risk management approach to reservoir safety and are requesting this as part of statutory inspections made under the Reservoirs Act 1975. This has effectively made the forward management of reservoir risk a statutory obligation. We provide examples of Inspecting Engineers requiring risk management work in Appendix B.

The HSE risk framework and UUW's PRA process

4.5.27 The HSE risk framework defines the tolerability associated with loss of life and its correlation to an activity, practice or process. The HSE risk framework sets out that, for an individual life, a probability of $<1*10^{-6}$ (0.0001%) is "acceptable", $>1*10^{-4}$ (0.01%) is "unacceptable" with a lower probability threshold for multiple lives at risk categorised as "unacceptable societal". Between these thresholds the risk is "Tolerable" "if ALARP" (as low as reasonably practicable); the ALARP designation depends on the disproportionality ratio (i.e. the benefit of reservoir improvements compared to cost – gross disproportionality being a limit) and the potential loss of life.

4.5.28 In order to comply with the HSE risk framework, UUW has adopted the framework set out in Figure 16, whereby annual probability of failure for a reservoir is plotted against the average predicted loss of life for that reservoir if it were to fail. This is known as our Portfolio Risk Assessment (PRA) process.

4.5.29 In Figure 16 the red area above the solid and dashed red line relates to "unacceptable" risk, the red area to the right below the dashed red line relates to "unacceptable societal" risk based on increasing numbers of lives at risk, the amber area relates to "Tolerable – if as low as reasonably practicable" risk, and the green area relates to "Tolerable" risk.

Figure 16: Risk categories derived from HSE guidance R2P2

[✂]

Source: UUW interpretation of HSE guidance

4.5.30 In order to ensure we are compliant with the HSE risk framework, UUW worked with international experts on dam safety to develop a methodology to calculate the likelihood and impact of dam failure. This process, which we named the Portfolio Risk Assessment (PRA), provides a means of calculating the probability of failure, and consequence of failure, for dams in the fleet. We assess the probability of failure across the four key reservoir failure modes (different scenarios that could lead to a dam failure) - **seepage/internal erosion** (water passing through the dam); **stability** (the ability of the dam to remain upright and holding water); **flood** (the ability of the dam to safely store or discharge water in a flood event); and **seismic** (the ability of the dam to withstand an earthquake). The results of PRA are validated by an independent, government appointed, Inspecting Engineer to provide independent assurance of the findings.

4.5.31 Prior to the 2020 Balmforth Report, we were industry leading in our approach to reservoir risk management (PRA), as we evidence in Figure 26 later in the document. However, the 2020 Balmforth Report has led Inspecting Engineers to require reservoir owners to manage forward-looking risk on a statutory basis. This has effectively brought all companies into line with UUW's approach. Therefore, what was once our industry leading approach, is now an industry standard expected of all dam operators.

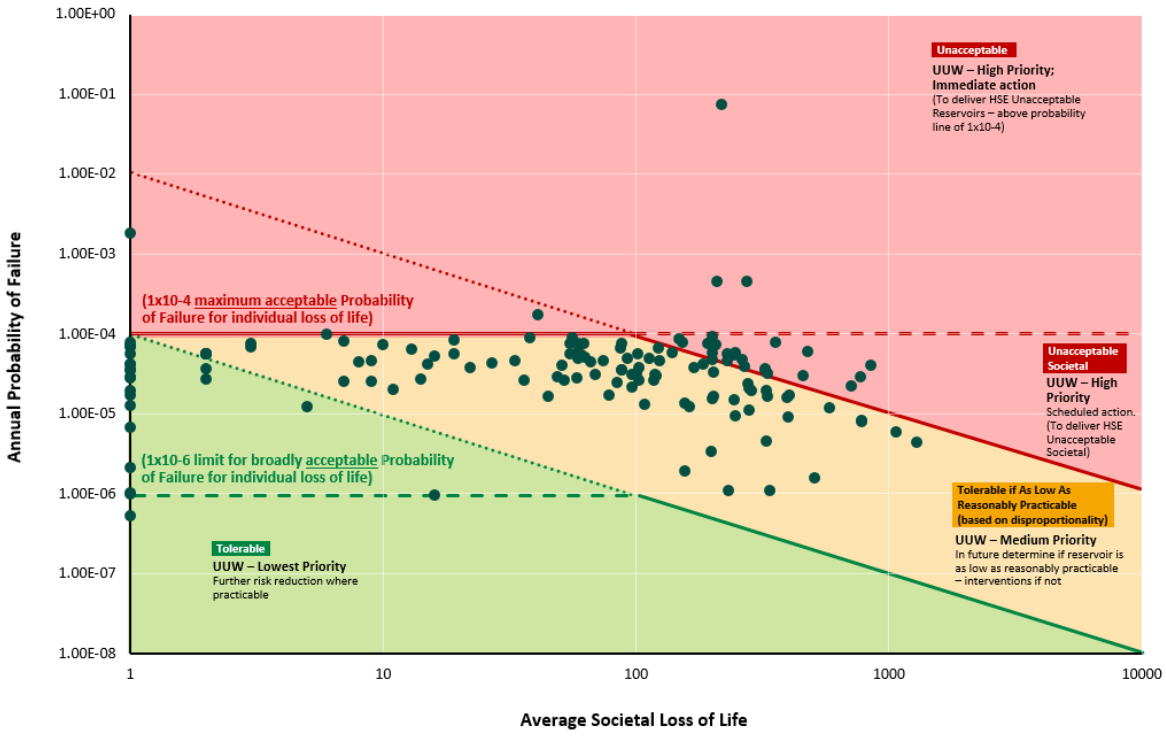
Updates to the EA flood risk maps 2022

4.5.32 The EA flood risk maps are an input to the risk framework (PRA) as it determines the consequence of a dam failure by indicating how many people are classed as 'at risk' downstream of the dam. A change in the EA's flood risk maps may lead to a different risk profile because additional properties (and their occupants) may be judged to be at risk in the event a dam fails.

4.5.33 In 2022, the EA updated its flood risk maps. The update used revised computer modelling and relief maps of topography to improve the forecast of where water would flow in the event of a dam failure. These updates extended the areas at risk. The maps of flood risk areas were compared to household population data, to determine the population that could be affected. Population growth since the last edition of the maps also increased the numbers of people at risk.

4.5.34 As shown in Table 4 and Figure 17, prior to the EA flood risk map changes the majority of UUW's reservoir sat in a "tolerable" risk category (115 reservoirs). However, there were a number sat in an "unacceptable" category that would have required risk reduction measures in AMP7 and AMP8 (26 reservoirs).

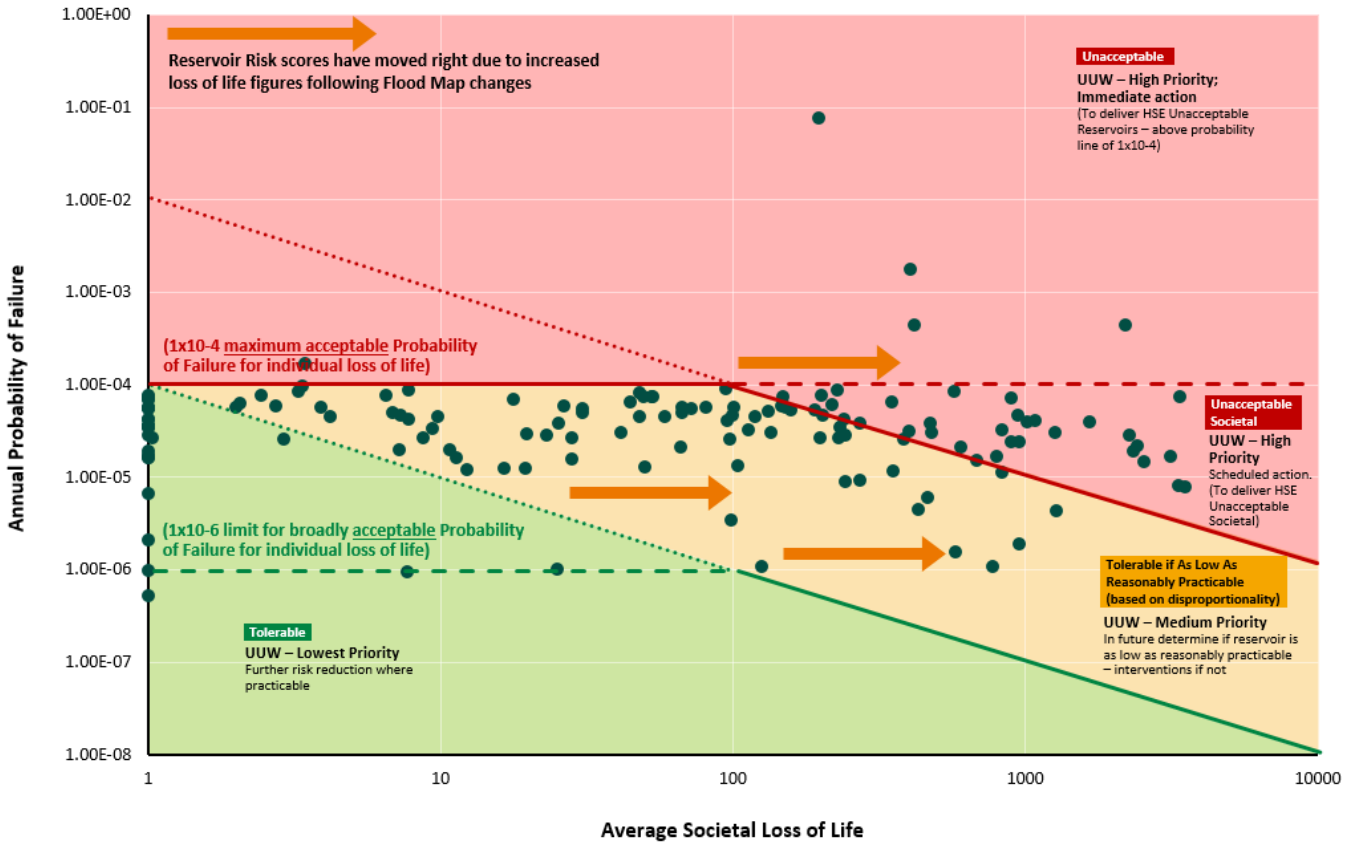
Figure 17: The risk framework prior to the EA's flood risk map update in 2022



Source: UUW internal data

4.5.35 With the update to the EA flood risk maps there are now 37 reservoirs sat within an "unacceptable" risk category and 104 reservoirs in a "tolerable" risk category, see Table 4 and Figure 18. This is due to the consequence of dam failure (impacts downstream) having increased rather than a deterioration of the asset health condition of the dam (not an increase in probability of failure).

Figure 18: HSE risk framework after update to EA's flood risk maps



Source: UUW internal data

4.5.36 UUW reservoirs that sit within the HSE defined "unacceptable" categories are subject to operational risk reduction measures (such as enhanced inspection or a temporary reduction in water level) until a permanent engineering risk reduction measure can be delivered.

4.5.37 Appendix D, Table 56 and Table 57 show the HSE defined risk category status of individual reservoirs in the UUW fleet prior to and post the EA flood risk map changes in 2022.

Table 4: Changes in HSE risk category based on updates to the EA flood risk maps

Risk Category	Pre EA flood risk map changes (No. of Reservoirs)	Post EA flood risk map changes (No. of Reservoirs)	Difference**
Unacceptable	5	5	Same
Unacceptable – Societal	21	32	+11
Tolerable if As Low As Reasonably Practicable (ALARP)	93	75	-18
Tolerable	22	29	+7*

** A number of reservoirs that were in the "Unacceptable / Unacceptable Societal" category prior to the flood risk map changes have now moved to a "Tolerable" category due to changes in loss of life figures.*

*** Reservoir numbers in our PRA tables will not match our APR data as where adjacent reservoirs have an uncontrollable hydraulic link they are assessed as a single potential mode of failure and concrete dams have been excluded as they are not subject to internal erosion failure modes.*

Source: UUW internal data

4.5.38 All our reservoirs are subject to operational mitigation until a permanent engineering fix can be delivered to reduce risk to acceptable levels, this may involve routine 48 hour surveillance, additional monitoring, reduction of water levels etc. These interventions are not appropriate in the long-term for a

number of reasons – operational cost, impacts on water resources for customer supplies and appropriate risk management.

Our intervention type and timing of maintenance activity

4.5.39 For statutory actions falling under the Reservoirs Act 1975, we must abide by third party instruction from independent Inspecting Engineers in line with the Reservoirs Act 1975. The independent Inspecting Engineers set the actions and timescales. This means there is limited scope for UUW to seek alternative strategies such as a stronger risk appetite or adopting a revised maintenance timetable.

4.5.40 When Toddbrook experienced its emergency, it was fully compliant with the Reservoirs Act 1975 regulations. This has led to a change of approach to the enforcement of dam safety regulations. One of Professor Balmforth's recommendations (Recommendation 5c) was that "Inspecting Engineers should undertake or update, as necessary, a risk assessment for the reservoir. Where statutory actions are required as a result of a risk assessment, these should be specified so as to reduce risk to ALARP (as low as reasonably practicable), and evidence should be provided to demonstrate that". This effectively places the responsibility for pro-active risk assessment and risk reduction (PRA activity), as per H&SWA 1974 guidance, in the remit of the independent Inspecting Engineer and their statutory powers under the Reservoirs Act 1975.

4.5.41 For obligations under the H&SWA 1974 (PRA) it was formerly within management control to deal with the highest risks (probability x consequence) first, as part of a long term, multi-AMP approach to the delivery of PRA projects. This allowed UUW to spread the impact of projects (e.g. in terms of customer bill impact and impacts on supply outages) to minimise disruption. That ensured that we were using customer's money to achieve the greatest risk reduction and hence value for money.

4.5.42 However, since the publication of the 2020 Balmforth Report Part B, and the risk assessment duties falling within the remit of the independent Inspecting Engineer, UUW has lost the discretion to be able to take decisions based on risk appetite, for example by deferring PRA projects across multiple AMPs. This means that PRA projects are now timed at the discretion of the independent Inspecting Engineer. This removes our ability to optimise our investment programme as we will have to abide by timescales dictated to us by the Inspecting Engineer. Dates of statutory inspections have been a key driver in determining our AMP8 and AMP9 PRA programme.

4.5.43 In order to avoid double counting, our costings for statutory requirements falling under the Reservoirs Act 1975 do not include PRA requirements falling under the H&SWA 1974.

UUW is unable to balance AMP8 maintenance requirements across multiple AMPs

4.5.44 In some cases, it is possible for a company to balance expenditure over the long-term. For example, higher maintenance requirements now may be offset by lower maintenance requirements later, meaning that an adjustment to current allowances is not necessary.

4.5.45 However, it is not possible to balance reservoir maintenance expenditure over the long-term in this way. As we have demonstrated (see Figure 14 and Figure 15 for example), maintenance requirements are increasing and are not expected to become less stringent in future. This was made explicitly clear by the Parliamentary Under-Secretary of State for Defra, Rebecca Pow, in the foreword to the second report published by David Balmforth on reservoir safety, published in March 2021: *"This Government is committed, now and in the future, to ensure our reservoirs can and do operate safely, without posing a risk to the public… These recommendations provide an opportunity to explore developing a new risk-based approach, engender a continuous improvement culture to safety across the industry and secure a robust, and proportionate regulatory approach"*[15].

4.5.46 Maintenance requirements allocated under the Reservoirs Act 1975 have timescales set by an independent Inspecting Engineer that legally have to be adhered to. Additionally, the age of our reservoir fleet means that we will need to undertake continuous remedial work to mitigate the risk of an

[15] Foreword to Report (2021) *Independent reservoir safety report.* Available here.

issue at the reservoir or the reservoir risks falling into the HSE defined "unacceptable" risk category. Finally, the 2020 Balmforth Report has led inspectors to adopt a more proactive approach (our PRA process) to reservoir safety, which has led to them requiring reservoir owners to manage forward-looking risk as part of the wider statutory framework.

4.5.47 As a result, UUW requires an uplift to its AMP8 base cost allowance to facilitate capital and maintenance activity in AMP8. Further maintenance expenditure will also be required in AMP9.

The difference between statutory actions under the Reservoirs Act 1975 and risk reduction (PRA) interventions under the Health and Safety at Work Act 1974

4.5.48 A dam can be compliant with the Reservoirs Act 1975 (because there is nothing that requires an immediate 'fix' in the opinion of the independent Inspecting Engineer), but the same reservoir can fall within a HSE "unacceptable risk" category based on its' forecast future performance under extreme conditions. This is because the two risk management frameworks aim to achieve subtly different objectives.

4.5.49 Statutory actions under the Reservoirs Act 1975 are actions identified by an independent Inspecting Engineer during their 10 yearly safety check inspection of the dam. Historically these actions have focussed on the proactive maintenance of matters, which are immediately identifiable and visible. The ten yearly safety check inspection is analogous to an MOT test on a motor car; it is an independent check of safety items. We have forecast future statutory actions based on the historic run rate observed since the publication of the 2020 Balmforth Report.

4.5.50 Risk reduction (PRA) measures are not directly concerned with the current condition of the dam. This is an assessment of the forecast future performance of the dam structure under extreme environmental conditions (such as stability during an earthquake). This process uses risk factors such as the steepness of the embankment slope, in comparison to forecast maximum ground acceleration during seismic events. Risk reduction measures are typically engineering changes to the dam, to make it better able to accommodate extreme conditions at some point in the future. This process is analogous to a routine health check-up, it involves making prioritised changes based on risk factors. We have forecast future PRA activity based on the results of risk assessments carried out on dams in the UUW fleet.

4.5.51 We have kept future forecasts of statutory actions separate from forecasts of future PRA activity. Our statutory actions forecast is based on run rate, with no PRA projects included in the historic run rate. Our PRA forecast is based on the results of risk assessments of dams in the UUW fleet. This approach has ensured that no projects are included in both categories.

4.6 Materiality

4.6.1 The costs set out within this claim are driven by the need to maintain UUW's large fleet of relatively old reservoirs. As we set out in 4.3.2, reservoir maintenance is a function of the number of dams a company has within its reservoir fleet and as we set out in 4.5, there are clear legal requirements to ensure our dams are maintained to a safe standard.

4.6.2 We are able to demonstrate that impounding reservoir dam maintenance is a material driver of cost at a company level by including it within Ofwat's proposed water resources plus model from its April 2023 consultation. A positive and statistically significant coefficient demonstrates that dam maintenance is a material cost driver at an industry level, even after offsetting benefits have been accounted for.

4.6.3 We created a reservoir cost driver using the following methodology:

(1) Sum the total number of impounding reservoirs (BON code: BN4830S) and total number of pumped storage reservoirs (BON code: BN4849). This is appropriate because both impounding reservoirs and pumped storage reservoirs have dam maintenance requirements.

(2) Where the calculation in Step 1 returns a zero for a company/year, we replace that instance with the total number of water reservoirs line (BON code: BN10190). This is necessary

because some companies report zero under BN4830S and BN4849 but report a positive value for BN10190. Therefore, this step ensures we do not omit a company's reservoir maintenance requirements due to data quality issues. We note that if Ofwat collects more consistent data on reservoirs (as suggested in its recent consultation), we would use it as part of this analysis in future.

(3) We divide the total number of reservoirs calculated in Step 1 and Step 2 by the total number of properties connected (BON code: BN2221 + BN2161).

4.6.4 Table 5 presents the results of including this reservoirs factor within Ofwat's recommended model suite. It's clear that the coefficient on reservoirs per property is statistically significant and of an intuitive sign. We consider this to be clear evidence that reservoir maintenance drives material costs at an industry level.

4.6.5 We note that there has been a slight deterioration in the statistical results associated with some population density cost drivers e.g. a slight reduction in the t scores. While the robustness of the coefficients' sign means this is not a material issue, it does suggest that there is a slight correlation between our reservoir cost driver and population density. In fact, as we demonstrated earlier in paragraph 4.4.2 there is a slight negative correlation between reservoirs per property and population density. This means that, all else equal, if a reservoir cost driver is excluded then the models would detriment companies with higher than average population density and higher than average reservoirs. This is because population density effectively acts as an inverse proxy for reservoirs.

4.6.6 However, the slight correlation between impounding reservoirs and population density led us to consider it would be inappropriate to value our claim through reference to the models set out in Table 5. We do still consider that the statistically significant results on the reservoirs cost driver provides good evidence that dam maintenance costs are material in the round. We also draw upon the output of this model to determine the relative net effect of dam maintenance on company costs, which forms the basis of our symmetrical adjustment.

Table 5: Impounding reservoirs per property is a statistically significant cost driver

	WRP1	WRP2	WRP3	WRP4	WRP5	WRP6
ln(Properties)	1.052***	1.044***	1.010***	1.007***	1.023***	1.019***
	{0.000}	{0.000}	{0.000}	{0.000}	{0.000}	{0.000}
% water treated in bands 1-3	0.004**		0.003**		0.004**	
	{0.020}		{0.043}		{0.021}	
ln(WAD, MSOA to LAD)	-1.104*	-0.948				
	{0.069}	{0.140}				
ln(WAD, MSOA to LAD) squared	0.075**	0.064				
	{0.050}	{0.115}				
ln(Impounding reservoirs per property)	**0.145****	**0.154*****	**0.181****	**0.185*****	**0.163****	**0.167*****
	{0.016}	**{0.006}**	**{0.014}**	**{0.007}**	**{0.012}**	**{0.005}**
ln(Weighted average treatment complexity)		0.329		0.312		0.332
		{0.213}		{0.239}		{0.191}
ln(WAD, MSOA)			-2.046	-1.824		
			{0.303}	{0.391}		
ln(WAD, MSOA) squared			0.135	0.12		
			{0.247}	{0.338}		
ln(property per km of main)					-5.218*	-4.557
					{0.087}	{0.138}

	WRP1	WRP2	WRP3	WRP4	WRP5	WRP6
ln(property per km of main) squared					0.608*	0.529
					{0.078}	{0.127}
Constant	-3.621	-4.173	10.959	10.149	12.885*	11.508
	{0.102}	{0.188}	{0.229}	{0.346}	{0.089}	{0.205}
Sample size	165	165	165	165	165	165
R squared	0.911	0.912	0.906	0.907	0.908	0.911
RESET test	0.249	0.219	0.526	0.563	0.54	0.249

WAD = weighted average density, MSOA - medium layer super output area, LAD - local authority district
** indicates statistical significance at the 10 percent level, ** indicates statistical significance at the 5 percent level, *** indicates statistical significance at the 1 percent level*
Source: UUW analysis using Ofwat's cost assessment dataset. Available here.

4.7 Adjustment to allowances

4.7.1 UUW's cost adjustment claim is comprised of three components:

- **Part 1: The impact of operating reservoirs vs boreholes**. Ofwat's recommended models do not include a driver that reflects differences in source type, meaning UUW does not receive an appropriate allocation of historical costs, commensurate to our large fleet of reservoirs. However, UUW does avoid an element of (implicitly allowed) power expenditure as we pump less water from groundwater sources than other companies. Additionally, as companies with reservoirs have historically carried out dam maintenance, the models will provide an implicit allowance for this activity - however, the lack of an appropriate cost driver means this is not allocated to companies appropriately. We net off an implicit allowance from this element of the claim to reflect avoided pumping costs and the implicit allowance for dam maintenance provided by Ofwat's recommended model suite.
- **Part 2: A rise in the number of statutory actions since the publication of the 2020 Balmforth Report.** As we set out in section 4.5.16 to 4.5.20, the 2020 Balmforth Report has led to an enhanced inspection regime, which has increased maintenance costs. These higher costs are not reflected in the historical dataset, which covers the years 2011-12 to 2021-22. This portion of the claim seeks to recover efficient additional maintenance expenditure relating to the stricter legal standards UUW will incur over the course of AMP8.
- **Part 3: A change in the EA Flood risk maps requires additional work to remain compliant with the Health and Safety at Work Act 1974.** As a result of changes to the EA's flood risk maps, the H&SWA 1974 requires UUW to undertake additional mitigation at reservoirs deemed to be high risk (in the unacceptable categories). This reflects incremental expenditure on that incurred previously.

4.7.2 We set out how we have calculated the gross value of each element in section 5, Cost Efficiency.

UUW's approach to the implicit allowance and symmetrical adjustment

4.7.3 We provide more detail on our approach to the implicit allowance in section 5.4.

UUW's approach to the symmetrical adjustment

4.7.4 A symmetrical adjustment seeks to mimic the effect of including a cost driver within an econometric model i.e. reallocating historical costs across the industry. For some companies, the resulting re-allocation may be positive, while for others it may be negative. As Ofwat noted in its Final Methodology, the symmetrical adjustment should in principle only apply to costs the industry has incurred in the past.

4.7.5 Therefore, we have based our symmetrical adjustment on the element of the claim that relates to the relative cost of operating boreholes versus reservoir sources because this represents the backwards-

looking element of our claim (i.e. the symmetrical adjustment only applies to part 1 of our claim, but not to parts 2 or 3). We used the following methodology to calculate the symmetrical adjustment:

(1) As per our implicit allowance calculations, we calculated the total water wholesale allowance using Ofwat's recommended model suite. This is the base comparator scenario and is set out in column A in Table 6.

(2) We then supplemented Ofwat's recommended model suite with the reservoir driver we described in paragraph 4.6.3 and calculated the total water wholesale allowance. The results of this model suite were presented in Table 5

(3) The resulting allowance is set out in column B.

(4) We then calculated the difference between the two allowances. This is set out in column C. This difference reflects the relative reallocation in costs that would result from the addition of a reservoirs driver to the model suite. Due to the issues set out in paragraph 4.6.4, we do not use the numbers in column C directly in our claim valuation. However, we do use the relative reallocation suggested in column C as the basis for our symmetrical adjustment.

(5) We express the difference for each company calculated in column C as a percentage of the difference across the entire industry. This calculates each companies' relative cost reallocation. This is set out in column D.

(6) We then multiply each companies' percentage reallocation by the backwards-looking, pre-Balmforth element of our claim (£36.573 million) divided by UUW's percentage reallocation (54%). This has the effect of calculating an adjustment equivalent to UUW's pre-Balmforth cost for each company, calibrated by the relative reallocation suggested by the introduction of a reservoir variable to the model suite. This is set out in column E.

(7) We then subtract the dam maintenance implicit allowance and the avoided power implicit allowances from the symmetrical adjustment. We discuss how we calculate these implicit allowances in section 5.4. The total implicit allowance is set out in column F.

(8) This calculates a net symmetrical adjustment. This approach is set out in Table 6. We consider the overall increase in costs across the industry to be not material (£32 million) so we do not make adjustments to force the overall adjustment to zero as we did in our drainage symmetrical adjustment.

4.7.6 We note that the calculation of symmetrical adjustments is a relatively new idea and as such there is little precedent to base them on. We did consider an approach whereby we calculate a unit cost per reservoir and base the symmetrical adjustment on this, similar to the growth adjustment applied by Ofwat at PR19. However, overall we considered an approach based upon a model reallocation to be most aligned to the underlying rationale behind symmetrical adjustments i.e. it best reflects the relative reallocation of costs resulting from the inclusion of a variable into a model suite.

Table 6: UUW's approach to the symmetrical adjustment

Company	Base comparator allowance	Allowance from model suite in Table 5	Difference	Difference as percentage of total adjustment	Combine backwards-looking element with percentage reallocation	Dam maintenance and avoided power implicit allowance	Net symmetrical adjustment
	a	b	c	d	e	f	g
			a – b	c / sum(c)	d x (37/54%)		e - f
ANH	1,708	1,663	-45	-60%	-41	-4	-38
NES	1,390	1,406	16	21%	15	-3	18
UUW	2,324	2,364	40	54%	37	30	6
SRN	853	862	9	12%	8	-2	11
SWB	830	834	4	6%	4	5	-2
TMS	4,485	4,504	19	25%	17	-14	31
WSH	1,282	1,282	0	0%	0	1	-1
WSX	537	540	2	3%	2	-5	7
YKY	1,688	1,712	24	32%	22	23	-2
AFW	1,227	1,235	8	10%	7	4	3
BRL	415	423	8	11%	8	0	8
PRT	186	183	-3	-4%	-3	0	-3
SES	199	195	-5	-6%	-4	-2	-2
SEW	756	748	-8	-10%	-7	-9	2
SSC	543	548	4	6%	4	2	3
SVE	2,908	2,907	-1	-2%	-1	9	-10
HDD	133	135	1	2%	1	1	0
Total	**21,464**	**21,539**	**75**	**100%**	**68**	**36**	**32**

Source: UUW analysis

5. Cost efficiency

5.1.1 This section sets out how we calculated the value of our cost adjustment claim. Where necessary, please refer back to the reservoir schematic in Figure 1 and associated glossary of terms, as the discussion in the following section involves technical detail.

5.1.2 This section demonstrates how we calculated the value of our cost adjustment claim:

- Section 5.2 sets out how we calculated part one of our claim, the costs associated with Reservoirs Act 1975 compliance, for the pre-Balmforth Report era, which covers the majority of the period covered by the historical data used in the models, and also for part two of our claim, for the post-Balmforth Report era, which we consider is most relevant to our AMP8 costs.
- Section 5.3 sets out how we calculated part three of our claim, the additional costs associated with complying with the Health and Safety at Work Act 1975 following the change to EA's flood maps, which we do through our PRA programme. (We set out how we optioneered our proposed PRA programme in detail in section 7.2.)
- Section 5.4 sets out how we approached the implicit allowance calculations.
- Section 5.5 summarises the value of the three different elements of our claim and the implicit allowances.

5.2 How we calculated the cost of complying with Reservoirs Act 1975 (parts one and two of our claim)

5.2.1 As discussed in section 4.5, reservoirs under the Reservoirs Act 1975, have a ten yearly Statutory Inspection undertaken by the independent Inspecting Engineer, who will then detail out any required statutory works, maintenance or monitoring in respect of the reservoir in question and within what timescale. By its nature, this type of work is reactive and until we receive a statutory inspection report we cannot be fully certain of reservoir safety requirements we will be asked to deliver at a site and within what timescale. However, we are able to form reasoned expectations based upon past experience. (This is discussed further in Appendix C, and through extrapolating the volume of actions we are receiving since the publication of the 2020 Balmforth Report.)

5.2.2 As we have evidenced in Figure 14 and Figure 15, the 2020 Balmforth Report has led to a much more stringent inspection regime. We have observed an increasing number of statutory actions requiring investigations and capital interventions since the report's publication. We have also observed these investigations and capital interventions becoming more expensive as the regime seeks to mitigate as much risk as possible.

How we calculated the statutory actions (ITIOS) resulting from the Reservoirs Act 1975 ~~value~~ element of our claim

5.2.3 To calculate our expected AMP8 expenditure on statutory actions, we have used internal historical cost information to derive an average unit cost for a) investigations and b) engineering works, before and after the 2020 Balmforth Report's publication.

5.2.4 It would be inappropriate to apply a more stretching point estimate than the average for the unit cost (e.g. the upper quartile) because our cost information includes a large number of Very Small Projects (VSPs), which range in cost from <£1,000 to £250,000. These differences in costs aren't reflecting differences in efficiency – they are reflecting differences in scale and/or scope. Therefore, the use of an upper quartile unit rate would not be reflective of upper quartile efficiency but instead reflect the unit costs of smaller size projects. This would be an inappropriate benchmark. Therefore, the use of an average provides an indication of the overall expenditure we can expect to incur across the entire spectrum of statutory actions.

5.2.5 We combine these internal unit costs with the average number of statutory actions we received both before (for part one of our claim) and after the publication of the 2020 Balmforth Report (for part two of our claim) to calculate an expected cost of compliance with the Reservoirs Act 1975 in AMP8. Table 7 sets out this calculation.

Table 7: UUW calculation of AMP8 Statutory compliance cost for ITIOS studies and actions only (excluding all PRA)

	Annual number		*Unit cost (£million)*		*Annual cost (£million)*		Valuation and application of efficiency (£million)		
	Studies	**Engineering Actions**	**Studies**	**Engineering Actions**	**Studies**	**Engineering Actions**	**AMP cost (£m)**	**Catch-up efficiency**	**Frontier shift efficiency**
label	a	b	c	d	e	f	g	h	**I**
calculation					a x c	b x d	f x 5	g * 0.978	h * 0.984
Pre-2020 Balmforth Report	4	32	0.08	0.23	0.31	7.30	38.04	37.186	36.573
Post-2020 Balmforth Report	17	49	0.10	0.40	1.66	19.51	105.81	103.429	101.725
Memo - % change	*344%*	*51%*	*21%*	*77%*	*440%*	*167%*	*178%*	*178%*	*178%*
AMP8 estimate	**17**	**49**	**0.10**	**0.40**	**1.66**	**19.51**	**105.81**	**103.429**	**101.725**

Source: Internal UUW data

Note: Post-2020 Balmforth Report number of studies and actions will not align to those presented in Figure 14 and Figure 15 because these graphs relate to actions received whereas the numbers above relate to projects that have been and/or are being delivered.

5.2.6 It's clear that there has been a substantial increase both in the average number of actions we see each year and in the unit cost of addressing these actions.

- As we evidence in Figure 14 and Figure 15, there is no reason to suspect that statutory actions received by reservoir owners will fall from current levels in the future.
- The higher unit cost is driven by a more stringent inspection regime, with subsequent statutory actions being more detailed and requiring specific fixes. Table 50 in Appendix B sets out clear examples of statutory actions becoming more prescriptive since the 2020 Balmforth Report's publication.

5.2.7 This calculation provides an indication of statutory expenditure before the 2020 Balmforth Report's publication (for part one of our claim - £36.573 million), which forms the backward-looking element of UUW's cost adjustment claim. As discussed in section 4.7, this backwards-looking value is the only element of our claim subject to a symmetrical adjustment.

5.2.8 The calculation also derives an expected cost of statutory compliance in AMP8, by multiplying the annual average number of statutory actions (studies and engineering actions) we are receiving since the 2020 Balmforth Report's publication by the unit cost of addressing these actions. Given this element of the calculation represents an extrapolation into the future, we have applied a catch-up and frontier shift efficiency challenge (for part two of our claim - £65.151 million). This will ensure that we are challenged to deliver statutory compliance actions as efficiently as possible.

5.2.9 We have used the following assumptions for the catch-up and frontier shift efficiency challenges:

- **Catch-up efficiency challenge.** We have implemented an upper quartile catch-up challenge based upon the wholesale models within Ofwat's recommended model suite (as discussed in paragraph 5.3.22). The catch-up challenge relies upon a spread of residuals around the line of best fit estimated by the models. This means that when the catch-up challenged is strengthened, it becomes increasingly influenced by a smaller number of outlier observations. This increases the risk that the catch-up challenge is subject to statistical noise or bias i.e. the benchmark company may be one that is subject to particularly benign regional operating circumstances. As such, we consider the upper quartile is the maximum catch-up challenge that should be considered in cost assessment. The CMA concurred with this view in its redetermination: *"we decide that the upper quartile is the appropriate level of the efficiency benchmark. This balances our objective of setting a challenging benchmark while acknowledging the limitations of the econometric modelling (and the consequent risk that the company will have insufficient allowed revenue)."*[16]
- **Frontier shift efficiency challenge.** We implement a slightly stronger challenge than the mid-point of the range Economic Insight identified in a study[17] it carried out on behalf of a consortium of companies. The PR24-focused range identified by Economic Insight was 0.3% to 0.7%, meaning the mid-point is 0.5% per year. We consider that the mid-point is justified because the frontier shift estimate produced by EU-KLEMS data is potentially subject to both upwards and downwards bias. There is a risk of downwards bias (i.e. the estimate being too low) due to question marks over the extent to which embodied technical change is reflected in the estimate. There is a risk of upwards bias (i.e. the estimate being too high) due to the presence of catch-up efficiencies within the EU-KLEMS data, the presence of which would produce a double count in the catch-up efficiency challenge. However, there is no robust way to quantify these opposing factors. Therefore, we consider the mid-point to be an appropriate and pragmatic estimate for frontier shift. We do not net off any Real Price Effects (RPEs) against the frontier shift challenge. We added an additional stretch to the mid-point to reflect the uncertainty inherent in estimation of the frontier shift, resulting in an

[16] CMA (2021) *Final Report*. Available here.

[17] Economic Insight (2023) *Productivity and frontier shift at PR24. Available here.*

overall frontier shift challenge of 0.55% per year. For final business plan submission, we have provided a claim valuation without a frontier shift assumption applied. This is set out in Table 16.

5.2.10 While we have based our cost of compliance on the observed unit rate of statutory schemes and statutory actions received since the 2020 Balmforth Report[18], we also have expectations on the statutory actions we are likely to receive during AMP8 and the cost of these actions. This is set out in Appendix C.

5.3 How UUW calculated the cost of complying with the Health and Safety at Work Act 1974 (part three of our claim)

5.3.1 Risk categorisation has been derived from HSE guidance, as explained in sections 4.5.27 to 4.5.29. Risk categorisation is not a reflection of current asset health, it is a reflection of the forecast future performance of the dam structure under extreme environmental conditions, and hence is not indicative of the effectiveness of the historic maintenance regime.

5.3.2 A dam can be compliant with the Reservoirs Act 1975, (because there is nothing that requires an immediate 'fix' in the opinion of the independent Inspecting Engineer), but the same reservoir can fall within a HSE "unacceptable risk" category based on its' forecast future performance under extreme conditions.

5.3.3 The adjustment claim arises from a step change in the population at risk assessment imposed by the new EA flood risk maps introduced this AMP, as described in Section 4.5.32. This was the first update by the EA for 13 years and so the change is very significant. The changes indicate more people are living within the inundation zones (where water would flow in the event of a dam failure).

5.3.4 The change in requirement increases the risk category of the majority of our reservoirs and in accordance with our risk based hierarchy we improve resilience and reduce risk of those "Unacceptable" and "Unacceptable Societal" reservoirs first.

5.3.5 The scale of the EA flood risk map changes, will necessitate reduction of risk (PRA work) for about two thirds of the "Unacceptable" and "Unacceptable Societal" reservoirs from 2025-2030, see Table 57; undertaking greater numbers increases risk to water resources for customer supply and consequently adverse customer impact.

5.3.6 The 2020 Balmforth Report has meant that the delivery of the PRA pro-active risk reduction programme is now inextricably linked to the regulatory inspections carried out under the Reservoirs Act 1975, as discussed in paragraphs 4.5.40 to 4.5.43. As dams are inspected at intervals of no more than ten years, all of the UUW fleet of reservoirs will be inspected during the next two AMP periods, and therefore our PRA activities will also need to be delivered across this same timescale.

How UUW derived an efficient cost for delivering PRA in AMP8

5.3.7 Paragraph 0 to 4.5.38 set out the process by which we determined our AMP8 PRA programme. Paragraph 7.2.1 to 7.2.10 in best option for customers section sets out how we arrived at our options for each reservoir. The section below sets out how we calculated the cost of delivering this programme.

5.3.8 Our cost estimate for the PRA programme used the following high-level methodology:

(1) Identify an efficient unit rate of intervention. This assessment used a mix of outturn unit rates from projects we have already delivered, supplemented by a forward-looking assessment where appropriate.

(2) Apply Ofwat's catch-up and frontier shift efficiency challenges from PR19 to provide additional stretch and ambition.

[18] Professor David Balmforth (2020) *Toddbrook Part B report*. Available here.

(3) Identify the scale of works required in AMP8, which we identified through the PRA assessment outlined above.

(4) Multiply the efficient unit rate by the scale of interventions to arrive at a total PRA programme cost.

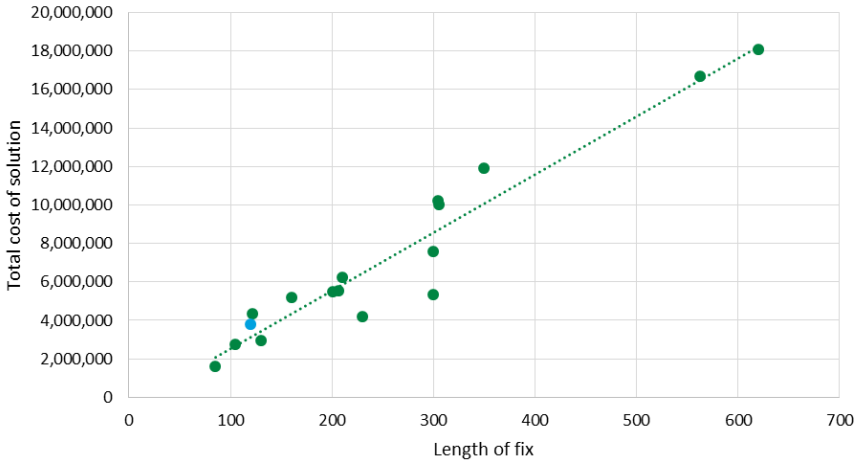
5.3.9 The following sections evidence and justify these separate components.

How we identified an efficient unit rate of intervention

5.3.10 Where possible, we sought to use cost information from similar schemes we have delivered previously to identify an efficient unit rate of intervention. However, as discussed above, the 2020 Balmforth Report has led to the need to implement different solutions to those typically adopted in the past. This has restricted the sample size we can use to identify an efficient cost of intervention. Therefore, where appropriate we have supplemented our historic cost information with forecast engineering estimates. As a general rule, we use whichever approach (i.e. backward-looking only, forward-looking only or a mix) results in a lower unit cost to ensure we are challenging ourselves to deliver our interventions efficiently.

5.3.11 Our unit rates are based upon a cost per metre of fix (e.g. cost per metre grouted or cost per length of slurry trench. This is because the length of fix is the key cost driver, as illustrated in Figure 19.

Figure 19: There is a clear relationship between total cost and total length of fix



Source: UUW internal estimating data

TAM grouting

5.3.12 Table 8 sets out the two historic TAM grouting schemes used in our unit rate calculation, which were implemented in AMP6. We calculated the total cost of each scheme and divided by the length grouted. Finally, we applied an upper-quartile catch-up efficiency challenge and the average frontier shift challenge. The efficiency assumptions we used are the same as those set out in paragraph 5.2.9.

Table 8: Unit costs from historic TAM grouting schemes delivered by UUW

	Units	Torside	Rhodeswood	Chelburn	Overall
Total cost of scheme (2022-23 CPIH prices)	£	2,415,530	991,239	3,247,580	6,654,349
Total length grouted	Metres	80	201	180	300
Unit rate (2022-23 CPIH prices)	£/metre	30,194	4,932	18,042	22,181
Unit rate after catch-up challenge	£/metre	29,515	24,223	17,636	21,682
Unit rate after frontier shift challenge	£/metre	29,352	24,090	17,539	21,325
Calculated unit rate	**£/metre**	**29,352**	**24,090**	**17,539**	**21,325**

Source: UUW internal estimating data

5.3.13 There is a large variance in the unit rate of each scheme. This is because the issue being fixed, geology, and embankment material and make-up of the dam is very site specific. Some embankments sit on fractured rock, which needs a lot more grout to fill the voids than if a dam was sat on finer more compacted material. We recognise this is a material discrepancy so we validated these figures with forward-looking engineering estimates.

5.3.14 Table 9 sets out the Torside, Chelburn and Rhodeswood historic schemes, supplemented by two forecast TAM grouting schemes. We calculated an upper quartile unit cost based upon these schemes. We also applied the frontier shift challenge.

Table 9: Supplementary assessment of efficient TAM grouting unit cost

Reservoir		Length of fix	Cost	Unit cost
Wayoh	forecast	117	1,818,038	15,539
Audenshaw No1	forecast	560	9,253,924	16,525
Torside	outturn	80	2,415,530	30,194
Chelburn	outturn	180	2,750,710	15,282
Rhodeswood	outturn	40	991,239	4,932
Total		977	17,229,441	17,635
Upper quartile unit cost (inc frontier shift)				**15,283**

Source: UUW internal estimating data

5.3.15 The unit rate calculated from the historic schemes in Table 8 was higher than the supplementary calculation in Table 9. Therefore, we use the lower **£15,283 per metre** as the basis for our TAM grouting in AMP8 calculation.

Slurry trench

5.3.16 We followed the same process to calculate an efficient slurry trench unit cost. However, we have only carried out one slurry trench scheme in the past, which reduces the information we have in these calculations. The installation of a slurry trench is intended to prevent seepage from affecting the integrity of the dam in the long term. Following the 2020 Balmforth Report, independent Inspecting Engineers are increasingly including in their focus an assessment of the future performance of the dam over the long term. As a result we are seeing more statutory actions associated with long term

performance that tend to require more substantial interventions than statutory actions that have been visible on the day of inspection. Actions to address long term performance were formerly part of our PRA programme. Table 10 shows the calculation and resulting unit rate. We also apply a catch-up and frontier shift efficiency challenge. The efficiency assumptions we used are the same as those set out in paragraph 5.2.9.

5.3.17 It is clear that the unit rate is significantly higher than for TAM grouting. This is to be expected because slurry trenching is a more expensive intervention as it involves excavating a large amount of material from a dam, the associated disposal costs of the material, and the replacement of excavated material with concrete. This requires a bigger set-up, bigger machinery and generally more material to undertake the work than with TAM grouting. With TAM grouting no material is being excavated and a smaller amount of concrete is being used, as it is only being pumped into the embankment in order to fill voids within the existing embankment material. Despite its higher cost slurry trenching has other benefits that makes it a preferred solution: there is more surety of the fix thereby reducing the potential need to go back in the future for further fixes, and also reservoir water levels do not need to be reduced whilst undertaking the work, therefore not impacting on water resources for customer supplies.

Table 10: Unit costs from historic slurry trench schemes delivered by UUW

	Units	Chapel House
Total cost of scheme (2022-23 CPIH prices)	£	3,751,708
Total length grouted	Metres	120
Unit rate (2022-23 CPIH prices)	£/metre	31,264
Unit rate after catch-up challenge	£/metre	30,561
Unit rate after frontier shift challenge	£/metre	30,057

Source: UUW internal estimating data

5.3.18 We recognise that there may be scope to improve the robustness of this cost estimate. Therefore, we supplemented this backwards-looking assessment with forward-looking engineering estimates of each slurry trench scheme planned in AMP8. This is set out in Table 11.

Table 11: Supplementary assessment of efficient slurry trench unit cost

Reservoir		Length of fix	Cost	Unit cost
Greenbooth	forecast	304	10,202,990	33,562
Anglezarke Heapy	forecast	85	1,619,514	19,053
Woodhead	forecast	206	5,522,543	26,808
Errwood	forecast	305	10,039,054	32,915
Trentabank	forecast	230	4,204,745	18,281
Readycon Dean	forecast	160	5,192,347	32,452
Piethorne	forecast	300	5,325,692	17,752
Swineshaw Buckton Higher	forecast	300	7,605,770	25,353
Rhodeswood	forecast	201	5,474,514	27,236
Ogden Upper	forecast	122	4,328,476	35,479
Dowry	forecast	130	2,953,253	22,717
Fernilee	forecast	210	6,258,009	29,800
Rooden	forecast	620	18,072,008	29,148
Kinder	forecast	350	11,891,715	33,976
Crookgate	forecast	105	2,772,770	26,407
Dovestone	forecast	563	16,685,698	29,648
Chapel House	outturn	120	3,751,708	31,264

Reservoir	Length of fix	Cost	Unit cost
Total	4,311	121,900,804	28,278
Upper quartile unit cost (inc frontier shift)			**24,935**

Source: UUW internal estimating data

5.3.19 We note that while there is some variation in the unit cost, the range is much lower than for TAM grouting. This evidences the higher average cost of slurry trenching.

5.3.20 The unit rate calculated in the supplementary assessment in Table 11 is lower than the unit rate based on outturn schemes in Table 10. Therefore, we use the lower **£24,935 per metre** as the basis for our slurry trench forward-looking cost calculation.

Apply a catch-up and frontier shift challenge

5.3.21 The efficiency challenge is applied as part of the previous step. See the previous section for more details. Our efficiency assumptions are the same as those set out in paragraph 5.2.9.

5.3.22 We found that the large spread of residuals in water resources plus models leads to an upper quartile challenge greater than one when the full triangulated model suite is used in the efficiency assessment. Therefore, we have calculated the upper quartile challenge using models WW1-WW12 in Ofwat's recommended model suite.

5.3.23 For business plan resubmission, we also provide a valuation for the PRA element of the claim that excludes frontier shift. This is set out in Table 16.

Identify the scale of works required in AMP8

5.3.24 The PRA screening and option selection process identified in section 7.2 and 7.2.5 set out the scope of the optimum intervention at each reservoir. The 'length of fix' was detailed in Table 9 and Table 11

Total PRA programme cost

5.3.25 We multiply the appropriate efficient unit cost by the length requiring work at each reservoir to calculate an overall PRA programme cost. This calculation is set out in Table 12.

Table 12: UUW's total PRA programme cost

Reservoir	Intervention	Length of fix	Efficient unit cost	Intervention cost
Anglezarke Heapy	Slurry trench	85	24,935	2,119,459
Audenshaw No1	TAM grouting	560	15,283	8,558,336
Crookgate	Slurry trench	105	24,935	2,618,155
Dovestone	Slurry trench	563	24,935	14,033,312
Dowry	Slurry trench	130	24,935	3,241,525
Errwood	Slurry trench	305	24,935	7,605,117
Fernilee	Slurry trench	210	24,935	5,236,310
Greenbooth	Slurry trench	304	24,935	7,580,183
Kinder	Slurry trench	350	24,935	8,727,184
Ogden Upper	Slurry trench	122	24,935	3,042,047
Piethorne	Slurry trench	300	24,935	7,480,443
Readycon Dean	Slurry trench	160	24,935	3,989,570
Rhodeswood	Slurry trench	201	24,935	5,011,897
Rooden	Slurry trench	620	24,935	15,459,583
Swineshaw Buckton Higher	Slurry trench	300	24,935	7,480,443
Trentabank	Slurry trench	230	24,935	5,735,007

Reservoir	Intervention	Length of fix	Efficient unit cost	Intervention cost
Wayoh	TAM grouting	117	15,283	1,788,081
Woodhead	Slurry trench	206	24,935	5,136,571
Total PRA programme cost				114,843,223
Total PRA programme cost excluding frontier shift				116,767,298

Source: UUW internal estimating data

5.3.26 We note that if any requirements under the Health and Safety at Work Act 1974 are not carried out as part of our PRA programme, then they will be picked up as part of a statutory reservoir inspection and will become a statutory requirement. Therefore, if Ofwat does not allow the PRA element of this cost adjustment claim in full our expenditure on statutory actions, under the Reservoirs Act 1975, will necessarily increase without an appropriate upwards adjustment to our allowances.

5.4 Implicit allowance calculation

5.4.1 We have calculated an implicit allowance for part one of our claim relating to the relative impact of operating reservoirs versus boreholes. We do note that the historical dataset contains two years of expenditure after the publication of the 2020 Balmforth Report. However, our approach to the implicit allowance will account for any increase in dam maintenance expenditure during this period.

5.4.2 Our implicit allowance calculations align to Ofwat's Example 1 in Appendix 9[19] of its Final Methodology (page 160). We calculated the implicit allowance for avoided power and dam maintenance separately. This is because calculating a combined implicit allowance was not possible because removing such a large proportion of expenditure simultaneously from the dependent variable in the water resources plus models caused model instability.

5.4.3 UUW calculated the implicit allowance relating to dam maintenance in the following way:

(1) Calculate the total AMP8 water wholesale allowance using Ofwat's recommended model suite. This is the base comparator scenario.

(2) Calculate an alternative total AMP8 water wholesale allowance by removing all IRE (BON code: BN3391WR) and infrastructure capital maintenance (BON code: BN1012WR) from water resources costs. These cost categories capture all activities relating to reservoir dam maintenance.

(3) Compare the allowance between the base comparator and the alternative scenario. The difference is the implicit allowance for dam maintenance.

(4) This approach suggests UUW's implicit allowance for dam maintenance is £12.46 million over the course of AMP8.

5.4.4 Removing all IRE and infrastructure capital maintenance is appropriate because dam maintenance tends to be the sole source of water resources infrastructure maintenance. This has the effect of removing all dam maintenance costs from the modelled allowance. It will likely include a small element of non-dam maintenance related activity but we do not consider this to be a problem. This is because it will overstate the implicit allowance, which has the effect of reducing the net claim value further.

5.4.5 Additionally, this method estimated a negative implicit allowance for some companies, meaning that these companies received a higher allowance as a result of removing dam maintenance expenditure. This does not make intuitive sense, as removal of costs from the dependent variable should logically reduce all companies' expenditure. However, it appears to be a model stability issue driven by correlations within the model suite. As a result, in order for us to use the recommended model suite

[19] Ofwat (2022) *Appendix 9: Setting expenditure allowances*. Available here.

within these calculations, we have implemented a pragmatic solution to avoid undue upward adjustments to companies' allowances. This solution overrides all instances of a negative implicit allowance with zero.

5.4.6 Our overall approach to the dam maintenance implicit allowance is set out in Table 13.

Table 13: UUW's approach to calculating the implicit allowance relating to dam maintenance

Company	Base comparator	Alternative scenario (minus WR infrastructure maintenance)	Implicit allowance
ANH	1,708	1,688	20
NES	1,390	1,384	5
UUW	2,324	2,312	12
SRN	853	854	0
SWB	830	826	4
TMS	4,485	4,503	0
WSH	1,282	1,269	12
WSX	537	535	2
YKY	1,688	1,679	9
AFW	1,227	1,230	0
BRL	415	417	0
PRT	186	187	0
SES	199	201	0
SEW	756	753	3
SSC	543	545	0
SVE	2,908	2,896	12
HDD	133	133	0
Total	**21,464**	**21,414**	**81**

Source: UUW analysis

5.4.7 UUW developed the implicit allowance relating to avoided pumping costs in the following way

(1) Calculate the total water wholesale allowance using Ofwat's recommended model suite. This is the base comparator scenario.

(2) Calculate an alternative total water wholesale allowance by removing all power costs (BON code: WS01001WR) from water resources costs. This cost category captures all costs relating to pumping from groundwater sources.

(3) The difference in allowances between the base comparator and the alternative scenario provides an estimate of the implicit allowance for power.

(4) However, this is not the implicit allowance for *avoided* power, which is our focus here. Taking the implicit allowance calculated in step (3) would assume that UUW (and other companies with reservoir sources) do not incur any power costs in water resources. This is not true – UUW operates borehole sources (7% of distribution input) and has some abstraction from rivers, lakes and streams (33% of distribution). All these source types require an element of pumping. Additionally, the inclusion of treated water distribution average pumping head within the recommended model suite means that the allowances calculated in (1) and (2) will already include an allocation relating to power requirements. Therefore, there is a significant risk that the implicit allowance calculated in (3) would be a material overstatement of avoided power.

(5) Therefore, to calculate the implicit allowance for avoided power, we calculated average water resources power expenditure over the 2011-12 to 2021-22 period and multiplied this by five to reflect the average power expenditure over an AMP period.

(6) We then subtracted the average power expenditure over an AMP calculated in (5) from the power implicit allowance calculated in (3). This provides an estimate of the avoided power implicit allowance in water resources. We note for some companies this provides a negative implicit allowance. The interpretation of this is that the company is not avoiding power expenditure, but is spending above the industry average. This needs to be taken into account in the calculation, otherwise these companies may receive an unduly low allocation. However, we do note that the use of average pumping head within the recommended model suite does mitigate this risk somewhat – however, as we discuss in 'UUW46 Cost Assessment Proposal', we oppose the use of average pumping head within cost assessment until such time as data inconsistency issues are resolved. Our approach is set out in Table 14.

Table 14: UUW's approach to calculating the implicit allowance relating to avoided power costs

Company	Base comparator	Alternative scenario (minus WR power expenditure)	Power implicit allowance	Average power expenditure over 5 year period	Avoided power expenditure implicit allowance
ANH	1,708	1,685	22	46	-23
NES	1,390	1,360	29	38	-8
UUW	2,324	2,283	42	24	18
SRN	853	835	18	20	-2
SWB	830	815	15	14	1
TMS	4,485	4,418	67	81	-14
WSH	1,282	1,268	14	25	-11
WSX	537	531	6	13	-7
YKY	1,688	1,660	28	15	14
AFW	1,227	1,202	25	22	4
BRL	415	405	11	11	0
PRT	186	180	6	5	0
SES	199	193	6	9	-2
SEW	756	742	13	25	-12
SSC	543	530	13	12	2
SVE	2,908	2,865	43	47	-3
HDD	133	132	1	1	1
Total	21,464	21,105	359	404	-45

Source: UUW analysis

5.4.8 The approach set out in Table 13 and Table 14 suggests there is an implicit allowance of £30.08 million.

5.5 Third party assurance

5.5.1 PWC carried out third party assurance of our claim and cost build up. Its report concluded that:

"As a result of the work performed, we can summarise that the approach followed to develop the cost estimate appears robust. Our high-level review of the supporting narrative which was discussed during walkthroughs with claim authors found it to be detailed and underpinned with a clear rationale".

5.5.2 In particular it found:

- *"Claim authors able to articulate a clear rationale for arriving at the cost estimate across the 3 x key components of the claim.*
- *Logical approach taken to calculate expected expenditure on statutory actions using average unit costs.*
- *Analysis undertaken on site-specific basis to support costs claimed.*
- *Assumptions applied in 'catch-up' and 'frontier shift' efficiency challenges appear reasonable.*
- *AMP8 focus on reservoirs in the "unacceptable" and "unacceptable societal" categories appears reasonable.*
- *Method for calculation of implicit allowance appears in line with Ofwat methodology.*
- *Reasonable inflation factor applied based on available industry reports."*

5.6 Overall claim value

5.6.1 Table 15 sets out a summary of the value of each element of our claim.

Table 15: Our cost adjustment claim valuation

Element of claim	£m, 2022-23 CPIH	Source
Part 1: Pre-Balmforth element (historical cost of operating boreholes versus reservoirs)	36.573	Table 7
Part 2: Post-Balmforth element statutory (ITIOS)	65.151	Table 7
Part 3: Post-Balmforth PRA (flood risk map change)	114.843	Table 12
Implicit allowance for dam maintenance	(12.457)	Table 13
Implicit allowance for avoided power	(17.62)	Table 14
Overall net claim value	186.49	

Source: UUW early cost adjustment submission

5.6.2 For business plan resubmission, we also provide a valuation excluding all frontier shift assumptions. This is set out in Table 16.

Table 16: Our cost adjustment claim valuation excluding frontier shift

Element of claim	£m, 2022-23 CPIH	Source
Part 1: Pre-Balmforth element (historical cost of operating boreholes versus reservoirs)	37.186	Table 7
Part 2: Post-Balmforth element statutory (ITIOS)	66.243	Table 7
Part 3: Post-Balmforth PRA (flood risk map change)	116.767	Table 12
Implicit allowance for dam maintenance	(12.457)	Table 13
Implicit allowance for avoided power	(17.620)	Table 14
Overall net claim value	**190.119**	

Source: UUW analysis

6. Need for investment

6.1.1 This section presents evidence to support the need for investment in reservoir dam maintenance:

- Section 6.2 reiterates our legal obligations surrounding reservoir safety and risk management.
- Section 6.3 shows that the 2020 Balmforth Report has meant that the timing and nature of reservoir maintenance is now largely outside of management control.
- Section 6.4 shows that this investment will not overlap with any other activities funded at this or previous price reviews.
- Section 6.5 presents information that suggests customers support continued maintenance of our assets.

6.2 Dam maintenance is a statutory obligation

6.2.1 UUW has legal obligations related to the management of dams and reservoirs. These were set out in detail in section 4.5.8 and are summarised below.

6.2.2 The Reservoirs Act 1975 requires certain reservoirs to be registered with regulators (the EA in England). Registered reservoirs must be subject to a comprehensive safety inspection by an independent, government appointed Inspecting Engineer at intervals no greater than every ten years.

6.2.3 Independent Inspecting Engineers have the power to issue legal notices to dam owners, concerning matters 'In the Interests of Safety' (ITIOS). These are statutory actions that the dam owner must undertake, within specified timescales, to ensure the ongoing safe operation of the dam. Dam operators have no discretion over the delivery of statutory actions, nor the timescale over which they are delivered. The delivery of actions related to statutory notices are a major driver of costs for all operators of large reservoirs. ITIOS actions are referred to throughout this document as statutory actions, to avoid confusion between ITIOS sub-categories.

6.2.4 In addition, section 3 of the H&SWA 1974, places regulatory obligations on the operators of commercial activities, which have the possibility of affecting people outside of the operator's work force, if something went wrong. Section 3 of the H&SWA 1974 does not specifically apply to dam operation, nor to the water industry. It applies to all industries operating in the legal jurisdiction of the UK, in those circumstances where an accident could have consequences beyond the boundary of the site, or could impact upon people not directly employed by the operator of the site.

6.2.5 In the unlikely event of dam failure, water would escape beyond the boundary of the water company site, and would flow downstream. Such an event would have the possibility to impact upon members of the public who are not working for the water company. It is this set of circumstances that gives rise to the legal obligations for dam operators under Section 3 of the H&SWA 1974.

6.2.6 The H&SWA 1974 is accompanied by a statutory guidance document, "Reducing Risks, Protecting People" (also known as R2P2). R2P2 sets out the extensive research carried out by the HSE into the public tolerability of risk, and codifies this into a set of 'risk tolerability' criteria. R2P2 provides a formula by which the risk to the public can be assessed, based on a sliding scale of the number of people potentially impacted.

6.2.7 In summary, the investment is required due to dam safety regulation, and is not at the discretion of UUW.

6.3 The 2020 Balmforth Report has meant timing of intervention is largely outside of management control

6.3.1 The operators of commercial activities which have the potential to cause offsite, non-occupational impacts, are obliged to assess the probability of an accident occurring, and the likely consequences of such an accident, and to compare the result of that analysis to the risk tolerability criteria in R2P2. Where risks are found to be outside of tolerable categories, the operator must reduce risk by either reducing the probability of an accident occurring, or reducing the impact of any potential accident.

6.3.2 Responsible dam operators have been undertaking pro-active risk assessments, and making interventions to reduce risks to tolerable levels, for many years. Previously, dam operators had the discretion to phase any necessary risk reduction interventions over time, in order to minimise the impact of site outages, and the impacts on customer bills. However, since the publication of the 2020 Balmforth Report into the Toddbrook reservoir emergency, the flexibility around the delivery of risk reduction measures has been narrowed.

6.3.3 In August 2019 the Canal and Rivers Trust owned Toddbrook reservoir in Derbyshire experienced a major dam safety emergency. Following this incident, David Balmforth (the president of the Institution of Civil Engineers) was commissioned by the government to carry out an independent report into dam safety in the UK. The independent 2020 Balmforth Report made a number of recommendations which affected how dam safety was regulated in the UK, from 2020 onwards:

- Recommendation 5c of the 2020 Balmforth Report stated: "For class 1 and 2 reservoirs, Inspecting Engineers should undertake or update, as necessary, a risk assessment for the reservoir (see recommendations 1 and 10). Where MIOS (statutory actions) are required as a result of a risk assessment, these should be specified so as to reduce risk to ALARP, and evidence should be provided to demonstrate that."
- Furthermore, Recommendation 10a to 10c stated "RECOMMENDATION 10. Class 1 and 2 high risk reservoirs should be managed and operated on the basis of risk, to ensure their ongoing safety".
- *a) Reservoir owners should manage the safety of these reservoir(s) by ensuring the risks that they pose are managed to be as low as is reasonably practicable (ALARP). The assessment of risk should include a quantification of the probability of failure of the dam and other significant reservoir structures, based on an appropriate assessment of potential failure mechanisms, the consequences arising from an uncontrolled release of water on the area downstream of the reservoir, and the effectiveness of the RSMP. It should also take the owners competence into account.*
- *b) The risk assessment should be based on recognised good practice. The Environment Agency should give guidance to owners on the appropriate approach to risk assessment, which should include an assessment of uncertainty. However, it should recognise that some owners already have robust risk assessment methods in place. Owners should not be unduly constrained in the methods that they use.*
- *c) MIOS implemented as a result of the risk assessment should be such as to reduce the risk to be both tolerable and ALARP.*" (in this context MIOS refers to "Measures In The Interests Of safety", the term used for statutory ITIOS actions in the 2020 Balmforth Report).

6.3.4 The effect of these recommendations is that the assessment of risk tolerability, (and the issuing of notices to achieve risk tolerability) is now part of the regular independent Inspecting Engineer assessment of dam safety. Dam operators must now deliver risk reduction, to tolerable levels, to timescales set by the independent Inspecting Engineer.

6.3.5 In 2022 the EA's flood risk maps were updated, based on populations downstream of reservoirs. This has increased our reservoirs that sit in the "unacceptable" and "unacceptable societal" categories. See Table 4 coupled with the Balmforth recommendations to risk reduction means we have a large AMP8 PRA programme that needs delivering to reduce reservoir risk.

6.3.6 The risk reduction (PRA) element of this cost adjustment business case covers those reservoirs that are due to receive an independent Inspecting Engineer safety inspection before the end of AMP8.

6.3.7 In summary, the scale and timing of this investment is justified, given the changes in regulations resulting from the 2020 Balmforth Report into UK reservoir safety.

6.4 The cost adjustment claim does not overlap with activities funded elsewhere in PR24 or at previous price reviews

6.4.1 As part of this cost adjustment business case, we have taken into account the likely implicit allowance made for reservoir operation in Ofwat cost models, see section 5.44.7 for details. The investment outlined in this business case does not overlap with any common or bespoke performance commitments, enhancement cases, or other elements of our business plan submission. UUW submitted a separate cost adjustment business case related to the size of our reservoir fleet at PR19, but that claim was not accepted by Ofwat, and did not result in allowance adjustments in relation to this area of activity. **This cost adjustment claim does not overlap with any other activity already funded, or funded through other price Review processes.**

6.5 Customer research suggests that customers support appropriate maintenance of our assets

6.5.1 The maintenance of the UUW reservoirs fleet is in the best interests of customers. There are no alternative sources of water available in the North West to meet customer demand (alternative to the existing reservoir fleet), and costs of developing new sources would be significantly higher than maintaining the existing sources (see section 4.5.4 for details). Customers have also expressed a preference for investing in the maintenance of existing critical assets today, to reduce the probability of major outages and incidents, but in a cost controlled manner that targets the worst performing assets first (see section 7.4.6 for details). **The planned scale of investment in this business case, tied to regulatory obligations likely to arise in AMP8 (and not going further), with investment focussed on critical assets, matches the customer priorities described in the Price Waterhouse Cooper's customer research described in section 7.4.6.**

7. Best option for customers

7.1 Section overview

7.1.1 This section presents evidence that demonstrates this cost adjustment claim represents the best option for customers:

- Section 7.2 demonstrates the process we followed to determine the most appropriate options for our PRA programme. It explores different engineering solutions and their applicability to the reservoirs in question.
- Section 7.3 covers alternative options and why operation and maintenance of our reservoir fleet is the only practicable solution for water resources. It also evidences the results of an independent benchmarking exercise undertaken by Jacobs which explored the advantages of UUW's approach to reservoir safety.
- Section 7.4 discusses customer support for our proposed approach to investment

7.2 How we optimised our PRA programme

7.2.1 PRA is UUW's internal process for risk management of the reservoir fleet aligned to the H&SWA 1974. This process has been independently verified and bench-marked (see Figure 26 and is in line with HSE requirements. It identified, analysed and prioritised the probability and consequence of an issue at a reservoir associated with the four major failure modes: **seepage/internal erosion** (water passing through the dam); **stability** (the ability of the dam to remain upright and holding water); **flood** (the ability of the dam to safely store or discharge water in a flood event); and **seismic** (the ability of the dam to withstand an earthquake).

7.2.2 Risk management, in line with the H&SWA 1974 (UUW's PRA activity), is now enforced as part of the independent Inspecting Engineer assessments of dam safety under the Reservoirs Act 1975. Risk management has become a part of statutory inspection requirements following the 2020 Balmforth Report. This change in approach ensures consistency across dam operators, but it also reduces our ability to prioritise investment based on risk.

7.2.3 The build-up of the PRA block and associated costs has been through a robust process as detailed below:

(1) A review of the updated 2022 EA flood risk maps, indicating numbers of people at risk downstream, was undertaken to understand how this affected our reservoirs' PRA risk scores, as per Figure 18. The updated flood risk maps have increased our reservoirs in the "unacceptable" and "unacceptable societal" categories from 26 to 37 (see Table 4).

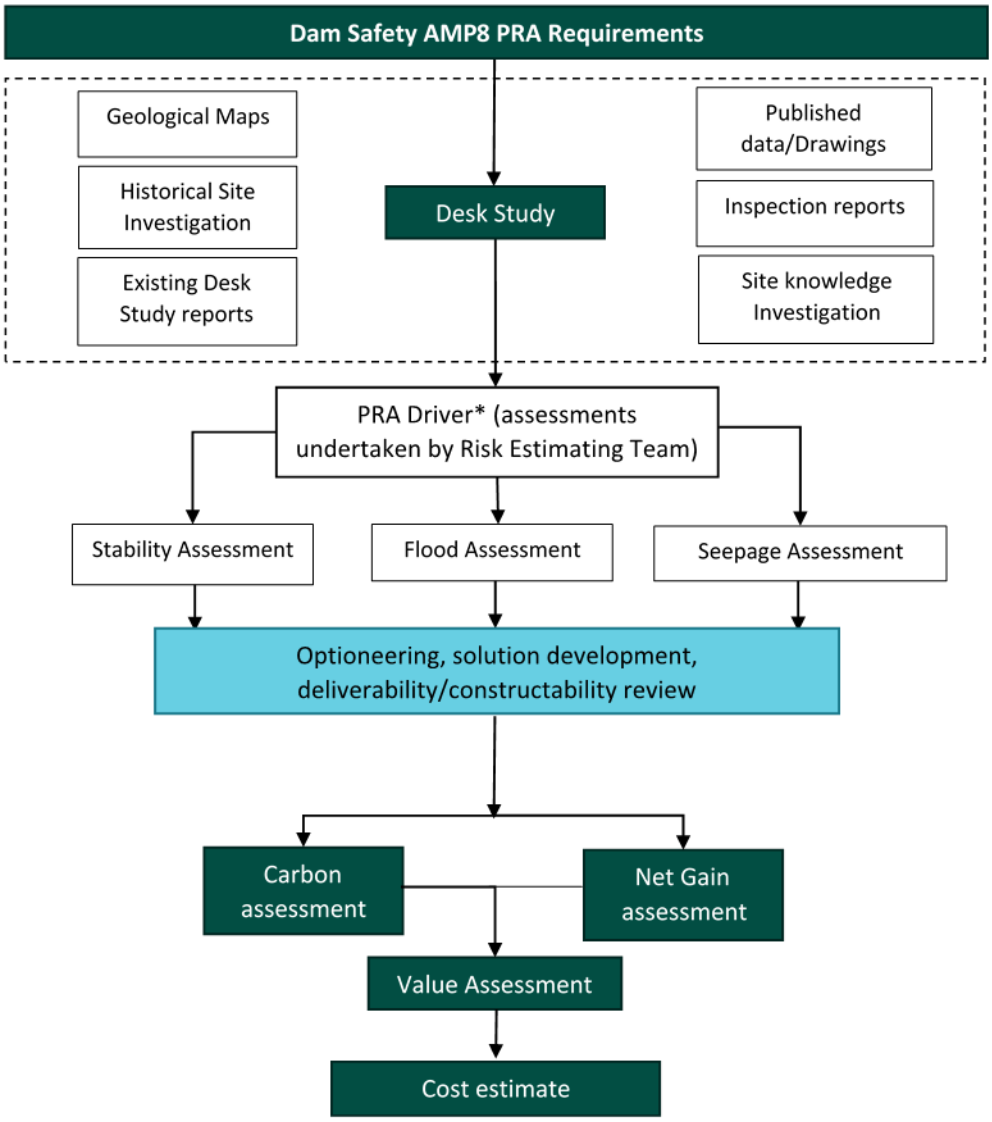
(2) For all reservoirs falling into the "unacceptable" and "unacceptable societal" categories the PRA screening process was initiated in order to review the probability of failure scores, illustrated in Figure 20, which is in line with HSE guidance. The process commences with an engineering assessment undertaken by the appointed Risk Estimating Team comprised of, The Reservoir Safety Manager, the Reservoir Supervising Engineer, the Project Geotechnical Engineer and the Reservoir Inspecting Engineer, all of which have a detailed knowledge of the reservoir being reviewed.

(3) The engineering assessment evaluates the probability of failure of a reservoir against the four failure modes: **seepage/internal erosion** (water passing through the dam); **stability** (the ability of the dam to remain upright and holding water); **flood** (the ability of the dam to safely store or discharge water in a flood event); and **seismic** (the ability of the dam to withstand an earthquake).

(4) Each failure mode assessment follows a robust risk assessment methodology that is industry best practice, for example, for seepage/internal erosion the University of New South Wales

Method (UNSW)[20] is used. This method rates the various attributes and conditions of the dam (type of dam, materials making up the dam, it's construction, the geology it is sat on, frequency of inspections/monitoring etc.) against the following failure mechanisms: piping (water eroding and displacing material) through the dam; piping through the foundations; and piping from the dam into the foundation. Alongside the UNSW method the Stanford Method (McCann et al 1985)[21] is used to estimate the probability of piping along the pipework that runs through the dam.

Figure 20: The PRA screening process



Source: UUW PRA screening process

7.2.4 The outcome of the PRA driver assessments indicates which failure mode(s) the reservoir is at risk of. The main drivers for remedial solutions in AMP8 all relate to:

[20] University of New South Wales (2004) *Methods for Estimating the Probability of Failure of Embankment Dams by Internal Erosion and Piping through the Embankment*. Available here.

[21] McCann et al (1985) *Preliminary Safety Evaluation of Existing Dams, volume I*. Available here.

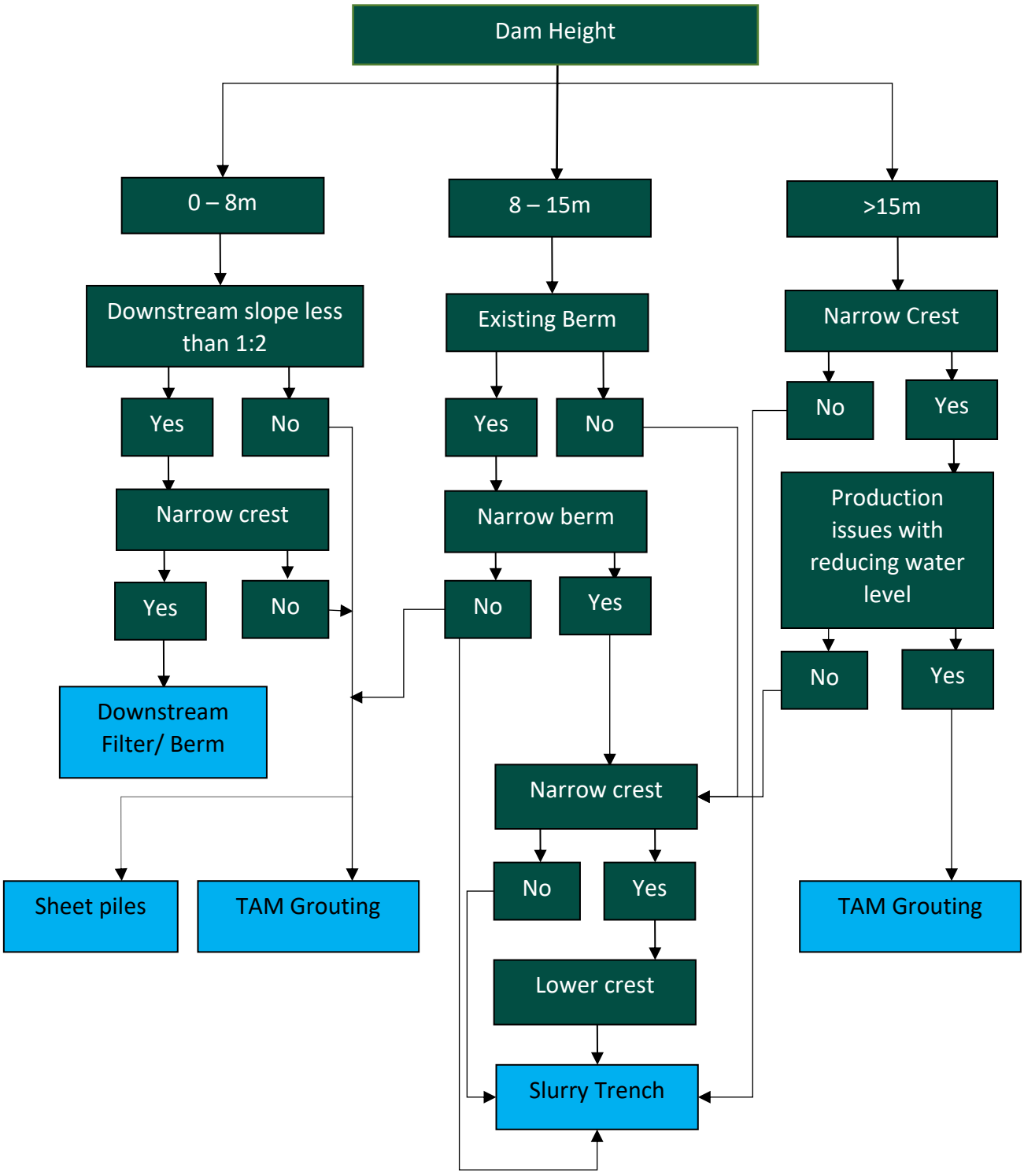
- Internal erosion risk/seepage – specifically the failure mode related to poorly compacted or highly permeable layer in the dam structure (indicating a risk that water can travel through the dam and cause erosion through it)
- Slope stability, an assessment of the potential for the embankment to suffer a landslip under extreme conditions.

7.2.5 Figure 21 indicates how the solution for each reservoir has been arrived at based on the relevant solutions available for internal erosion and slope stability risks. The aim of the optioneering process is to identify the best solution to achieve the risk reduction that is required for that site. There are many factors which are taken into account when determining the preferred solution, namely the relative cost efficiency of the risk reduction interventions being considered, site specific characteristics, such as constructability issues etc. and impact on water resources etc.

7.2.6 We provide a description of the relevance of each of the stages of the optioneering process below. After the figure, we provide a description of each type of solution and the activities involved.

- **Dam height.** The height of the dam helps to determine the type of interventions available as certain techniques become less effective or unviable over certain heights i.e. the maximum height for undertaking sheet piles is around 15m and the installation of a filter berm is only viable up to circa 8m. Whereas slurry trench and TAM (Tube-a-manchette, a process of deep grouting under pressure using very long steel syringes) grouting solutions are feasible on dams over 8m. Slurry trenching is more expensive than other options so if a dam was lower in height a cheaper technique would be used. However for tall dams cheaper solutions are not viable so this narrows down the options to slurry trenching or TAM grouting. Slurry trenching is more costly than TAM in the main however it does have other benefits – there is more surety of the fix and reservoir water levels do not need to be reduced while undertaking the work, therefore reducing the need to return in the future for further fixes and not impacting on water resources for customer supplies.
- **Narrow crest.** Certain techniques require a wide crest in order to have a suitable working area and room to utilise the equipment required for the fix. Therefore a narrow crest will limit the options available to be used i.e. slurry trenching requires a certain crest width as the fix requires large machinery and room to pile the excavated material as it comes out of the trench. Therefore in some circumstances a narrow crest and limited working areas / access to site would drive us to use a TAM grouting solution over slurry trenching.
- **Downstream slope less than 1:2.** A downstream filter berm solution is only viable for low height, shallow sloped embankments. This is to ensure the material can be placed (within the extent of the reach of a machine arm) and stay in place (so the material does not roll off the slope)
- **Existing berm.** A berm is a shelf of additional material laid at the bottom of the dam in order to improve stability. It also provides a benefit of an additional flat surface up the dam where machinery can be placed in order to undertake work. This effectively reduces the overall working height of the dam, which may allow lower height techniques to be utilised on tall dams.

Figure 21: Flow chart to determine appropriate solution based on characteristics of the reservoir



Source: UUW process

7.2.7 We now provide a description of each type of intervention:

- **Downstream filter berm**. See Figure 22. This is where three layers of granular material (in a sandwich arrangement – sand, gravel, sand) are placed on the downstream (i.e. not the water side) dam face in order to prevent erosion of the dam by capturing any eroding dam material and holding it in place. This solution is the last in line defence i.e. mitigating the effects of the erosion problem rather than fixing the source of the issue. Therefore this is not always a preferred fix.

Figure 22: Downstream filter berm installation

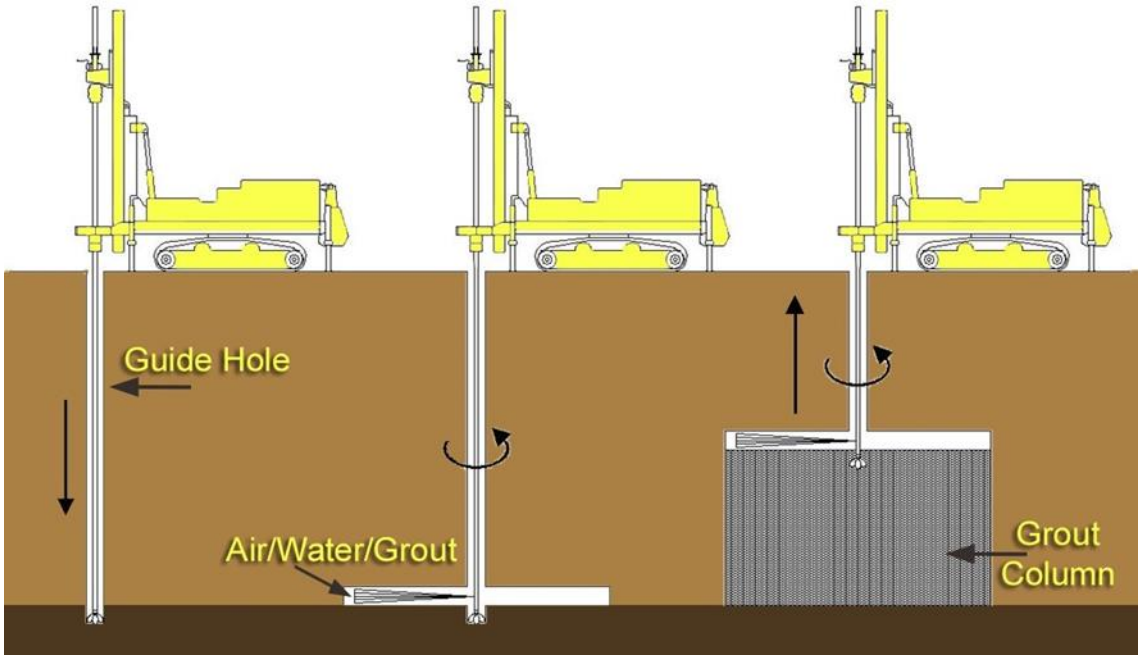
- **Sheet piles**. See Figure 23. These are interlocking steel sheet piles that are gently vibrated down into the clay core of the dam to strengthen it and prevent material eroding through the dam. This solution fixes the erosion and stability issue at source.

Figure 23: Sheet pile installation

- **TAM (Tube-a-manchette) grouting.** See Figure 24. This is targeted injection of grout into an embankment on the upstream side of the core (water side of embankment), downstream side of the core (dry side of embankment) and into the embankment core itself. A guide hole (borehole) is drilled into the dam, which then allows the grout to be injected. The grout fills the voids within the

embankment material. Grouting is usually undertaken at 1m spacing in 3 offset rows for the length and depth of the fix required. This solution fixes the issue at source by preventing material eroding through the dam.

Figure 24: TAM grouting diagram



- **Slurry trench**. See Figure 25. This is where material is excavated out of the core of the reservoir in a 600mm trench and as deep as is required for the fix. The excavated material from the core is then replaced with a strong concrete mix, which forms the new core of the reservoir. This solution fixes the erosion issue at source by strengthening the core of the reservoir and preventing material eroding through it.

Figure 25: Slurry trench installation

7.2.8 A small number of other solutions are available for internal erosion and slope stability fixes i.e. diaphragm walls and secant piles. However these options were discounted due to the high cost of the works and the potential for damage to the dam, due to the very large machinery that is required for these fixes.

7.2.9 Equally sheet piles could have been picked as a solution over TAM grouting. However, our optioneering determined that the quantity of sheet piling needed at our reservoirs meant it was not a cost effective solution and therefore TAM grouting was taken forward as the solution.

7.2.10 Table 17 sets out the optimal solution at each reservoir in the AMP8 PRA programme based upon the process outlined above.

Table 17: The optimum solution for each PRA scheme planned in AMP8

[✂]	[✂]
[✂]	[✂]
[✂]	[✂]
[✂]	[✂]
[✂]	[✂]
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[✂]	[✂]
[✂]	[✂]
[✂]	[✂]

Source: UUW optioneering

7.3 Alternative options to continued maintenance of our reservoirs

7.3.1 UUW reservoir fleet continues to provide great service, enabling us to reliably abstract over 1,000 mega litres per day for supplies to homes and businesses across the North West. While the operation of the reservoir fleet does lead to dam maintenance costs, the continued operation of our reservoirs is a much more cost effective option than swapping to alternative sources.

7.3.2 As described in section 4.5.4 the development of new groundwater sources as an alternative to the existing reservoir fleet would incur in excess of £4 billion construction costs. In addition, there is insufficient groundwater abstraction licence headroom available across the North West, to enable us to meet customer demand by switching to groundwater sources.

7.3.3 We have always carried out statutory actions issued under the Reservoir Act 1975 by independent Inspecting Engineers, to the timescale set by the Inspecting Engineer. We have previously been mindful of the cost impact to customers of our pro-active PRA risk reduction programme, and we planned to deliver that programme across multiple AMP periods in order to minimise those impacts. However, the 2020 Balmforth Report (Recommendation 5c) stated that "Inspecting Engineers should undertake or update, as necessary, a risk assessment for the reservoir. Where statutory actions are required as a result of a risk assessment, these should be specified so as to reduce risk to ALARP, and evidence should

be provided to demonstrate that". This effectively places the responsibility for the timing of pro-active risk assessment and risk reduction (PRA activity) in the remit of the independent Inspecting Engineer.

7.3.4 Following the changes to dam safety regulation, (brought about as a result of the 2020 Balmforth Report), UUW sought independent assurance that our approach to dam safety management was still appropriate. In 2022 we commissioned Jacobs UK to carry out an exercise to benchmark our approach to dam safety against the revised regulations, along with the approaches taken by other water companies.

7.3.5 The benchmarking exercise found that the UUW approach was considered thus "the approach taken by UUW, using quantitative PRA to direct the capital works programme alongside statutory measures is considered current best practice and aligns with Recommendation 10 from the Toddbrook Part B Report" (2020 Balmforth Report).

7.3.6 Figure 26 shows the result of the Jacobs 2022 UK benchmarking exercise. The UUW approach was found to be meeting all of the requirements of the revised regulations. In the table below ITIOS refers to actions 'In The Interests Of Safety' (statutory actions issued to dam operators by the Inspecting Engineer) and ARPE refers to All Reservoirs Panel Engineers (the full title of Panel Engineers, the independent government appointed Inspecting Engineers).

Figure 26: Overview of the different approaches to reservoir safety taken across the industry

Approach	Examples	Consistent approach	Efficient programming	Funding justification to Ofwat	Reputation risk / compliance with H&S at Work Act	Compliance with Toddbrook Part B report recommendation 10	
						(a) & (b)	(c)
ITIOS / themed studies	• Dam Owner A • Dam Owner B	Can depend on individual ARPE	First 2 years predictable for each reservoir but not beyond	Hard to manage within 5 year cycle	Wholly reactive approach	No PRA	Impossible without quantitative RA
ITIOS plus informed by qualitative PRA	• Dam Owner C • Dam Owner D • Dam Owner E • Dam Owner F					No quantitative RA	Impossible without quantitative RA
ITIOS plus informed by quantitative PRA	• Dam Owner G • Dam Owner H	PRA may help manage S10 ITIOS recommendations / timescales				Quantitative PRA	No evidence
ITIOS plus directed by quantitative PRA	• United Utilities • Dam Owner I • Dam Owner J	PRA may help manage S10 ITIOS recommendations / timescales	Provides 5 year base programme	Resulted in funded regulated programme	Robust approach	Quantitative PRA	Working towards this

Source: Jacobs (2023) Internal Benchmarking Report

7.4 Customer support for investment timing

7.4.1 UUW also sought customer views on our approach to the timing and phasing of investment to ensure the operability of our dams. UUW commissioned Price Waterhouse Coopers LLC (PwC) to carry out research into customer priorities. UUW reservoir safety activity is undertaken to ensure that assets can continue to safely provide good service for customers, for generations to come. The ongoing safe operation of critical physical assets is a key activity for UUW across a number of service areas. In order to facilitate easier dialogue with customers, the safe operation of critical assets was given the shorthand description of "Pipes and Pumps" in the PwC facilitated customer research. In the research it was made clear that this topic covered all critical assets, not just pipes and pumps.

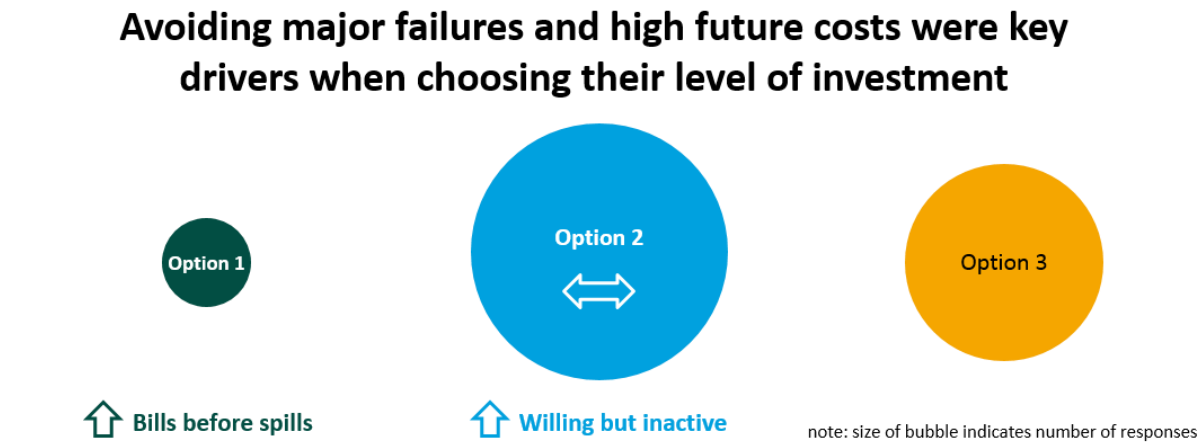
7.4.2 In the PwC facilitated research, customers were shown UUW plans in different thematic areas, and were then asked to comment on those plans, and were given a range of spend and delivery profiles to choose from.

7.4.3 The plans related to critical asset maintenance were described as; "Help maintain their efficiency and condition. Reduce costly and disruptive failures. Maintain consistent supply to household and businesses."

7.4.4 Customers consistently identified critical asset maintenance as a core, high priority. The maintenance of a broad range of critical assets also had the potential to help with other ambitions too (i.e. water quality, lead pipe removal, leaks etc.) and was therefore important to invest in.

7.4.5 Customers were offered three spend profile options, from deferred investment resulting in ageing assets, to moderate investment focussing on long life asset replacement / maintenance, to accelerated investment. Customers indicated a preference for moderate investment, with interventions on some long life assets. This is shown in Figure 27.

Figure 27: Internal UUW customer research relating to investment priorities



Maintaining our Pipes and Pumps		
Option 1	**Option 2**	**Option 3**
Some investment today in pumps and pipes, although on average these will be getting older.	More investment today in pumps and pipes, targeting the worst assets and starting to replace some of our long life assets.	Significantly more investment today in pumps and pipes, fairly large new programmes of asset replacement.
No increase	££	£££
High future costs and increasing risk of major failure likely	Slowly increasing future costs and stable risk of major failures	Stable future costs and reducing risk of major failures

Source: UUW (2023) Internal customer research data

7.4.6 The proposed UUW reservoir safety programme matches the option favoured by customers for critical asset maintenance. The proposed programme would see only modest bill impacts, would be focussed on the worst performing assets, and would involve interventions on long life reservoir assets, to secure their safe operation for the future.

8. Customer protection

8.1 Introduction

8.1.1 It is important that customers have confidence that we will deliver the increased scope of schemes that get reflected in our PR24 final determinations and they are suitably protected in the event of non-delivery, or if there are material changes to deliverables (including changes to dates), which leads to a change in cost (including changes in the timing of required expenditure). Ofwat proposes that, if companies fail to deliver or are late delivering improvements to customers, then price control deliverables (PCDs) should, where appropriate, be used to compensate customers. In our PR24 *Chapter 8 – Delivering at Efficient Cost, section 8.8.9* we have proposed an approach to PCDs that aims to provide customer protection, such that customers are fairly compensated for non-delivery (such as due to a change in regulatory requirements) or late delivery (including as a result of a change to a regulatory date), between PCDs, any related ODI underperformance payments, and cost sharing arrangements.

8.2 Price control deliverable

Table 18: PCD summary

Scheme delivery expectations	
Description of deliverable	Achieve reservoir safety risk reduction points of 15.46 by 31st March 2030. As part of a programme of reducing risk in line with Health and Safety Executive guidelines, though our PRA (Portfolio Risk Assessment process). This excludes our ITIOS actions, which are statutory remedial actions, for which it is not possible to represent on a common measurement basis as the PRA actions. The statutory itios actions also have a very low risk of non-delivery.
Output measurement and reporting	We have an existing ODI in AMP7 for reservoir risk reduction points. For AMP8 delivery will be reported through the APR process based on the AMP7 ODI reporting methodology. Additional detail necessary can be set out as appropriate in table commentary to table CW18. Risk reduction points are the difference in annual probability of failure between the pre-project state of the reservoir, and the post-project state of the reservoir (pre-project is when the reservoirs is in an 'intolerable risk' category as defined by the HSE, post-project is when the reservoir risk has been reduced to an 'acceptable' risk category as defined by the HSE). Risk reduction is achieved through engineered changes to the dam structure, operational changes to water level, changing information about risk state arising from detailed geophysical surveys, and so on. Pre-project annual probability of failure (intolerable risk) – Post-project annual probability of failure (acceptable risk) = risk reduction points
Assurance	Calculation done by multi-disciplinary technical team. Independent third party assessment of completed milestones undertaken through the APR assurance process.
Conditions on scheme	None
Impact on PCs	None

8.2.1 In our PCD template *UUW32-PCD Excel Sheet* we have assumed a wholesale WACC of 3.23%, in line with Ofwat's guidance. We have assumed a 50% totex cost sharing rate, which is applied before calculating PCDs. We have applied a further 50% for Bioresources (where applicable), to ensure that only 25% of Bioresources totex is at risk from PCDs, given the lack of RCV guarantee, and general uncertainty in cost recovery from future Bioresources price controls. For late delivery we have applied a proportionate value of annual opex, and assumed 3.5% of capex, which provides a fair reflection of the time value of money of any related deferred capital spend.

Table 19: PCD delivery profile

	Unit	AMP8	2024	2025	2026	2027	2028	2029	2030	Ultimate delivery
Cumulative delivery target for PCD	risk points		0.00	0.00	0.00	2.44	5.70	8.95	15.46	15.46
AMP8 Capex (22/23 pb)	£	98,901,907	0	0	£ 19,780,381	£ 19,780,381	£ 19,780,381	£ 19,780,381	£ 19,780,381	
AMP8 Opex (22/23 pb)	£	0	0	0	0	0	0	0	0	
ODI impact per unit of PCD volume	£/risk points	0.00								

Table 20: Price Control Allocation

Price Control	Unit	Price Control Allocation
Water resources	%	100.00%
Water network+	%	0.00%
Wastewater Network+	%	0.00%
Bioresources	%	0.00%

Table 21: PCD Incentive rates

	Unit	WR	WN+	WwN+	BR
Overall delivery	£/risk points	3,198,639	0	0	0
Time value rate	£/risk points	103,316	0	0	0
Late delivery	£/risk points	215,268	0	0	0

Table 22: Summary of UUW's claim against Ofwat's assessment criteria

Assessment gate	Assessment gate question	Summary of evidence	Reference
Need for adjustment	a) Is there compelling evidence that the company has unique circumstances that warrant a separate cost adjustment?	We provide a substantial body of evidence that demonstrates the unique circumstances that has led to our operation of an unusually large reservoir fleet.	Section 4.3
Need for adjustment	b) Is there compelling evidence that the company faces higher efficient costs in the round compared to its peers (considering, where relevant, circumstances that drive higher costs for other companies that the company does not face)?	We evidence that increases in safety standards following the publication of the Balmforth Report has led to a marked increase in the number of statutory actions such that historical levels of expenditure are no longer appropriate. The offsetting benefit from lower pumping requirement is (naturally) relatively constant over time. Therefore, there is a large difference between the modelled allowance and our efficient expenditure in AMP8.	Section 4.5 Paragraphs 0 to 4.4.8
Need for adjustment	c) Is there compelling evidence of alternative options being considered, where relevant?	We provide evidence that continued operation and maintenance of our dam fleet is the most efficient operational solution.	Paragraphs 4.5.2 to 4.5.7
Need for adjustment	d) Is the investment driven by factors outside of management control?	We demonstrate that statutory inspections have led to a higher number of statutory actions since the publication of the Balmforth Report.	Paragraphs 4.5.16 to 4.5.20 Appendix B
Need for adjustment	e) Have steps been taken to control costs and have potential cost savings (eg spend to save) been accounted for?	For statutory actions falling under the Reservoirs Act 1975, we must abide by third party instruction from independent Inspecting Engineers in line with the Reservoirs Act 1975. The independent Inspecting Engineers set the actions and timescales. This means there is limited scope for UUW to seek alternative strategies such as a stronger risk appetite or adopting a revised maintenance timetable.	Paragraphs 4.5.41 to 4.5.46
Need for adjustment	f) Is there compelling evidence that the factor is a material driver of expenditure with a clear engineering / economic rationale?	We set out the engineering rationale to explain why dam maintenance drives cost in our 'need for adjustment' and 'cost efficiency' sections.	Section 4 Section 5
Need for adjustment	g) Is there compelling quantitative evidence of how the factor impacts the company's expenditure?	Our 'cost efficiency' section sets out our cost build up, based upon historic outturn cost information. This demonstrates the costs of reservoir maintenance on a bottom-up basis. We also show that an impounding reservoirs per property variable is statistically significant, proving it is also a material driver of cost at an industry level.	Table 5 Section 5
Need for adjustment	h) Is there compelling evidence that the cost claim is not included in our modelled baseline (or, if the models are not known, would be unlikely to be included)? Is there compelling evidence that the factor is not covered by one or more cost drivers included in the cost models?	We provide evidence that the recommended model suite will not reflect dam maintenance requirements e.g. through a lack of correlation with existing cost drivers.	Section 4.4

Assessment gate	Assessment gate question	Summary of evidence	Reference
Need for adjustment	i) Is the claim material after deduction of an implicit allowance? Has the company considered a range of estimates for the implicit allowance?	Our implicit allowance calculations align to Ofwat's Example 1 in Appendix 9 of its Final Methodology (page 160). We calculated the implicit allowance for avoided power and dam maintenance separately. This is because calculating a combined implicit allowance was not possible because removing such a large proportion of expenditure simultaneously from the dependent variable in the water resources plus models caused model instability. Our claim is material after the deduction of an implicit allowance.	Section 5.4
Need for adjustment	j) Has the company accounted for cost savings and/or benefits from offsetting circumstances, where relevant?	We demonstrate that the benefit we receive from lower water resources pumping requirements is outweighed by higher costs associated with dam maintenance.	Section 5.2 Paragraphs 0 to 4.4.8
Need for adjustment	k) Is it clear the cost allowances would, in the round, be insufficient to accommodate the factor without a claim?	We evidence that increases in safety standards following the publication of the Balmforth Report has led to a marked increase in the number of statutory actions such that historical levels of expenditure are no longer appropriate. The offsetting benefit from lower pumping requirement is (naturally) relatively constant over time. Therefore, there is a large difference between the modelled allowance and our efficient expenditure in AMP8.	Section 4.5 Paragraphs 0 to 4.4.8
Need for adjustment	l) Has the company taken a long-term view of the allowance and balanced expenditure requirements between multiple regulatory periods? Has the company considered whether our long-term allowance provides sufficient funding?	We demonstrate that dam maintenance is driven by statutory actions, which prevents us from balancing our activity over multiple AMPs.	Paragraphs 4.5.44 to 4.5.47
Need for adjustment	m) If an alternative explanatory variable is used to calculate the cost adjustment, why is it superior to the explanatory variables in our cost models?	N/a - our claim is not based upon an alternative explanatory variable.	
Cost efficiency	a) Is there compelling evidence that the cost estimates are efficient (for example similar scheme outturn data, industry and/or external cost benchmarking, testing a range of cost models)?	We set out an approach which utilises outturn data on similar schemes. Where our forecast costs are lower than outturn costs, we use these instead. We apply efficiency challenges to add additional stretch to our cost base.	Section 5
Cost efficiency	b) Does the company clearly explain how it arrived at the cost estimate? Can the analysis be replicated? Is there supporting evidence for any key statements or assumptions?	We provide substantial detail to ensure that our claim valuation methodology is clear. We provide supporting information for key assumptions e.g. the increase in statutory actions post publication of the Balmforth Report.	Section 5 Section 4 Appendix C
Cost efficiency	c) Does the company provide third party assurance for the robustness of the cost estimates?	Our submission and cost build was assured by PWC.	Section 5.5
Need for investment	a) Is there compelling evidence that investment is required?	We set out clear evidence that investment in dam maintenance is a statutory obligation	Section 4.5 Section 6.2
Need for investment	b) Is the scale and timing of the investment fully justified?	We demonstrate that the change in inspection regime since the 2020 Balmforth Report means that the timing of intervention is largely outside of management control.	Section 6.3 Appendix B

Assessment gate	Assessment gate question	Summary of evidence	Reference
Need for investment	c) Does the need and/or proposed investment overlap with activities already funded at previous price reviews?	The investment outlined in this business case does not overlap with any common or bespoke performance commitments, enhancement cases, or other elements of our business plan submission.	Section 6.4
Need for investment	d) Is there compelling evidence that customers support the need for investment (both scale and timing)?	We present evidence that the investment proposed in this cost adjustment matches customer priorities.	Section 6.5 Section 7.4
Best option for customers	a) Did the company consider an appropriate range of options to meet the need?	We demonstrate that we optimised our PRA programme and set out a robust method for identifying the appropriate solution. We also evidence that continued operation and maintenance of our dam fleet is the best option for customer.	Section 7.2 Section 7.3
Best option for customers	b) Has a cost–benefit analysis been undertaken to select proposed option? There should be compelling evidence that the proposed solution represents best value for customers, communities and the environment in the long term? Is third-party technical assurance of the analysis provided?	We demonstrate that we optimised our PRA programme and set out a robust method for identifying the appropriate solution. We also evidence that continued operation and maintenance of our dam fleet is the best option for customer.	Section 7.2 Section 7.3
Best option for customers	c) Has the impact of the investment on performance commitments been quantified?	N/a – there are no relevant performance commitments.	
Best option for customers	d) Have the uncertainties relating to costs and benefit delivery been explored and mitigated? Have flexible, lower risk and modular solutions been assessed – including where utilisation will be low?	N/a – this claim relates to a statutory obligation.	
Best option for customers	e) Has the company secured appropriate third-party funding (proportionate to the third party benefits) to deliver the project?	N/a – this claim relates to a statutory obligation.	
Best option for customers	f) Has the company appropriately presented the scheme to be delivered as Direct Procurement for Customers (DPC) where applicable?	N/a – DPC is not applicable.	
Best option for customers	g) Where appropriate, have customer views informed the selection of the proposed solution, and have customers been provided sufficient information (including alternatives and its contribution to addressing the need) to have informed views?	N/a – this claim relates to a statutory obligation.	
Customer protection	a) Are customers protected (via a price control deliverable or performance commitment) if the investment is cancelled, delayed or reduced in scope?	We set out details of our proposed price control deliverables to ensure that customers are protected.	Section 8
Customer protection	b) Does the protection cover all the benefits proposed to be delivered and funded (eg primary and wider benefits)?	N/a – this claim relates to a statutory obligation.	
Customer protection	c) Does the company provide an explanation for how third-party funding or delivery arrangements will work for relevant investments, including the mechanism for securing sufficient third-party funding?	N/a – there are no third parties involved.	

Drainage Cost Adjustment Claim Submission

Cost Adjustment claim submission	
Title:	*Combination of exogenous factors driving increased drainage costs across the North West*
Price Control:	Wastewater Network Plus
Claim Value:	~~£152.6~~ £152.1 million
Cost adjustment headline:	Ofwat's proposed base cost model suite for PR24 does not adequately capture the effect of United Utilities Water's (UUW) unique operating circumstances, including 40% higher than average urban rainfall and the highest proportion of legacy combined sewers in the industry, on the cost to convey wastewater. While we welcome Ofwat's proposal to *potentially* include urban rainfall in a subset of sewage collection and wastewater network plus models, we consider this only a partial representation of UUW's compounding cost drivers. UUW considers that urban rainfall should be included in *all* sewage collection and wastewater network plus cost models, and that the effect of urban rainfall should also be considered alongside (and in combination with) the proportion of combined sewers. As Ofwat's proposed models (April 2023) do not sufficiently capture these factors, UUW proposes a net symmetrical adjustment of ~~£152.6~~ £152.1 million to the modelled allowance if such models are not adjusted in line with our proposals set out within our econometric base cost model consultation response[22].
Description:	*It should be noted from the outset that this is a* ***conditional cost adjustment claim****. In our main PR24 submission and Future Ideas Lab Paper[23], we present compelling evidence that the best option for customers is to set an environmentally adjusted PCL for internal sewer flooding that reflects the operating circumstances of a given region. If an appropriate environmentally-adjusted PCL is adopted, UUW will withdraw this cost adjustment claim. If, however, the sewer flooding PCL is not adjusted in this way, we consider this cost adjustment claim to be the next best option for customers. While this claim will not enable us to achieve Ofwat's view of upper quartile performance (as that would require several billions of pounds of investment in surface water separation), the costs included in this claim would better reflect the differential costs of operating and maintaining drainage assets between different regions. Appendix E provides more details of our position, and our proposal for an environmentally adjusted PCL for internal sewer flooding.* This document sets out the case for an upward cost adjustment of ~~£152.6~~ £152.1 million to reflect the additional costs of conveying surface water in a region where: (a) urban rainfall is 40% higher than the national average for England and Wales. Ranked by rainfall, 17 out of the top 26 cities in England and Wales are in the North West, resulting in higher volumes of surface water runoff entering the sewers in the North West; and (b) the proportion of combined sewers is the highest in the industry, with over 54% combined as a proportion of legacy public sewers versus an industry average of 33%.

[22] UUW (2023) *Base Cost Modelling Submission.* Available here

[23] UUW (2022) *Future Ideas Lab: What lessons can we learn from cost assessment at PR19?* Available here

Combined sewers are highly responsive to rainfall and have less hydraulic capacity during storms, increasing the risk of sewer flooding.

UUW considers that these exogenous factors are largely outside of management control and are material drivers of expenditure, yet their impact is not fully accounted for within Ofwat's botex models. This is especially significant as the interaction between these exogenous factors compounds their individual impact. Ofwat's proposed base cost models therefore do not adequately reflect the impact of exogenous factors upon drainage costs, with the implication that customers of some other WaSCs are paying too much for the level of service they receive.

We therefore set out the case for an upward adjustment of the base allowance. To calculate the level of adjustment required, we supplemented Ofwat's model suite[24] with an interaction term that reflects the interrelationship between urban rainfall and combined sewers. Statistical analysis demonstrated that the interaction term has a material and statistically significant impact upon modelled botex, and there is no deterioration in model performance as a result of its inclusion.

We did not introduce the term into Ofwat's models that include an urban rainfall variable (models SWC4-SWC6 and WWNP5-WWNP8), instead basing the claim on models SWC1-SWC3 and WWNP1-WWNP4 with the interaction term added. We did use Ofwat's recommended model suite to calculate the implicit allowance resulting from the proposed partial adoption of an urban rainfall factor. Following the removal of the implicit allowance and proportional adjustments to ensure the claim is symmetrical, the net adjustment is ~~£152.6~~ £152.1 million.

There are several additional factors that compound the effect of the above but are not reflected in the value of the claim. This is to ensure the claim has a clear focus upon the most significant factors and thereby limit the impact on customer's bills. UUW thus proposes absorbing the impact of these factors to limit the impact on customer's bills. These other factors include:

(c) low permeability soils and below industry average potential evapotranspiration (PET) compound to increase the overland flow of surface water into the sewer network;

(d) food service establishment (FSE) density is significantly higher than the national average – FSEs have been demonstrated to be a major cause of flooding events due to the discharge of fats, oil and grease (FOG) into the sewer network increasing the risk of blockages. Although we actively engage with food service establishments to mitigate any adverse impacts, we cannot influence the number and location of FSEs; and

(e) unique local topographies interact with surface water runoff to increase system surcharging and flood risk, especially in areas of high cellar density.

Collectively, these factors would likely result in an additional efficient cost adjustment to base expenditure of tens or hundreds of millions of pounds. However, by not seeking - at this stage - to reflect all of these factors within the determination of the claim value, UUW is demonstrating a level of stretch and ambition in its plan and only seeking an adjustment for the highest priority factors that have the largest impact on the provision of drainage services.

[24] Ofwat (2023) *Econometric base cost models for PR24.* Available here

Drainage cost adjustment claim summary

Gate	Summary	Location reference
Need for cost adjustment	• UUW provides services to a region in which multiple exogenous factors interact to make our drainage system both more susceptible to flooding and overflow activations. These factors include: (a) urban rainfall 40% higher than the industry average (b) the highest proportion of legacy combined sewers in the industry (54% vs industry average of 33%) (c) low soil permeability and below industry average potential evapotranspiration (PET) (d) an above average density of food service establishments (118.2 per 100,000 population vs national average of 90.8 per 100,000 population) and (e) unique local topographies • These exogenous factors are largely outside of management control. Nevertheless, UUW has taken multiple steps to mitigate flood and spill risk, including: implementation of our pioneering system of dynamic network management (DNM), transformation of our blockage resolution model, installation of over 1600 flood mitigation devices and a programme of sustained engagement with high risk food service establishments. Despite these efforts, an upward adjustment to the modelled allowances remains necessary to allow UUW to further mitigate the impact of these exogenous factors upon the services we deliver to customers. • The combined interaction of these exogenous factors drives higher base costs through multiple mechanisms with the implication that UUW will incur higher costs in moving towards a common PCL. These mechanisms include: (a) higher surface water flows into the system necessitate larger diameter assets which cost more to operate and maintain (b) more frequent and longer duration storm events necessitate greater reactive expenditure on incident response and (c) a higher flood risk exposure means UUW must spend more on mitigating flood risk than other companies. • To adequately capture the effect of these material drivers, we set out the case for a symmetrical cost adjustment. To calculate the level of adjustment required, we supplemented Ofwat's proposed model suite with a factor that reflects the combined effect of urban rainfall and combined sewers. Following the removal of the implicit allowance resulting from Ofwat's partial adoption of an urban rainfall factor, the net modelled adjustment for UUW is ~~£152.6~~ £152.1 million. We also set out the impact that an upward adjustment to our modelled cost allowance would have on cost allowances for other companies.	*Section 11.1* *Section 11.2* *Section 11.3* *Section 11.4*
Cost efficiency	• UUW's proposed costs are highly efficient. Indeed, multiple layers of efficiency have been incorporated into the claim, including: – We have derived this claim using a modelled approach aligned to Ofwat's PR19 allowance calculations, which incorporates an upper quartile catch-up and frontier shift efficiency challenge. This means that our adjustment value is in line with the efficiency benchmark and includes an element of productivity growth throughout AMP8; and	*Section 12*

	– A number of factors that compound the effect of urban rainfall and combined sewers, including FSE density, soil permeability and PET, are not reflected in the modelled value in order to simplify this cost adjustment claim and to limit the impact to customer bills.	
Need for investment	• As we are requesting an adjustment to our cost baselines and not proposing discrete investment/interventions, we do not consider this section applicable. Ofwat also deemed the equivalent section to be N/A during its PR19 Final Determination assessment of UUW's claim.	*Section 13*
Best option for customers	• Customer research demonstrates that sewer flooding performance is a key priority for customers. We are therefore committed to stretching ourselves to the limits of what is achievable within the constraints imposed by our unique operating circumstances. • It is for this reason that we will propose that the PCLs for internal sewer flooding are set at the maximum level of performance modelled to be achievable within the constraints imposed by the unique operating circumstances in the North West. UUW considers that PCLs adjusted for a region's operating circumstances represents the best option for customers, meaning that customers across the country are paying for an equivalently efficient and stretching level of service. Appendix E sets out more detail regarding how UUW considers the regulatory framework can be adjusted to reflect the regional challenges wastewater companies face, specifically through the adoption of PCLs that are adjusted to companies' regional operating circumstances. • If, however, our PCLs are not adjusted for our unique operating circumstances, we present compelling evidence to demonstrate that UUW will incur higher costs in moving towards a common level of flooding incidents (without any normalisation for key environmental factors) because of those circumstances. We consider the next most appropriate outcome for customers would therefore be for an interaction term reflecting urban rainfall and combined sewers to be included within all sewage collection and wastewater network plus models. • If this does not occur, we consider this cost adjustment claim to be the next best option for customers.	*Section 14*
Customer protection	• This claim would ensure that customers are protected by cost allowances being better allocated based on the key exogenous factors that affect the cost of providing drainage services. Customers would only pay more in areas where the need for higher cost was greatest, and customers would avoid overpaying in areas where the drainage environments are favourable. • Customers are also protected from partial or non-delivery of this investment through a number of performance commitments, including internal sewer flooding, external sewer flooding, storm overflows, pollution and sewer collapses. These measures have over and underperformance payments associated with them. Failure to deliver the additional botex will result in underperformance payments on this suite of PCs.	*Section 15*

9. Preface: Strategic context

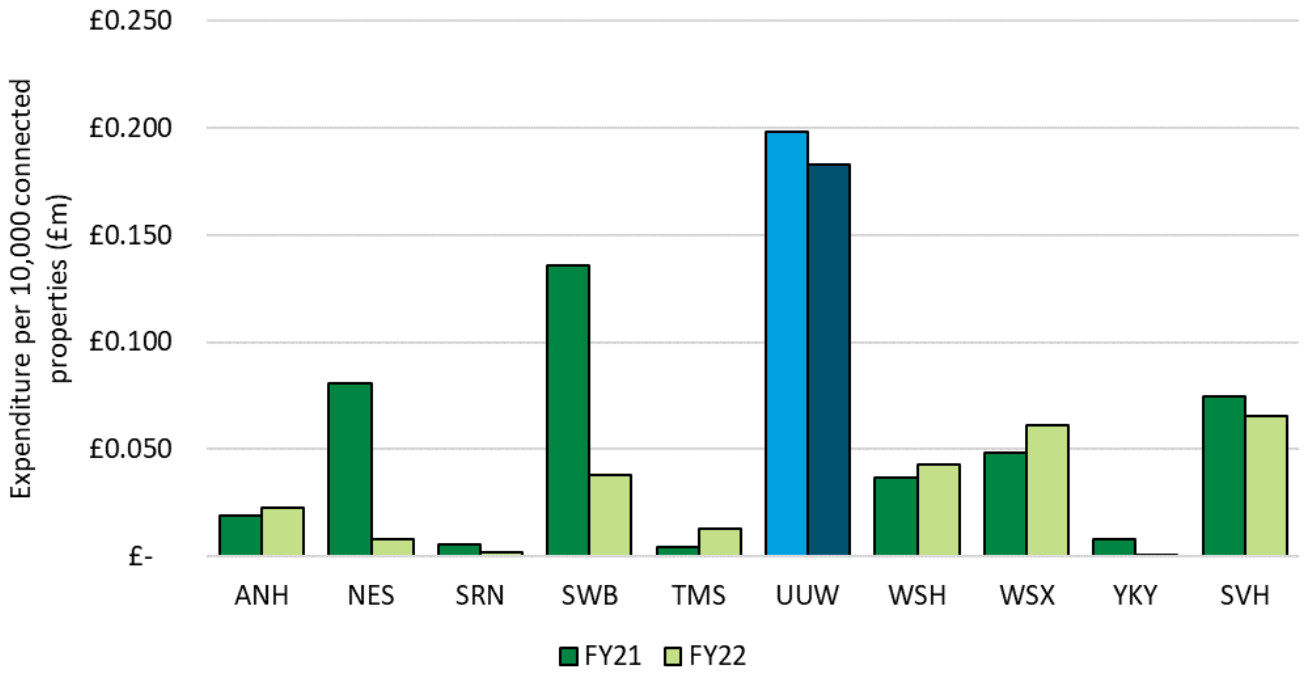
9.1 Historical expenditure and approach to setting PCLs

9.1.1 This claim must be understood within the wider context of UUW's drainage ambitions and Ofwat's approach to cost modelling and setting performance commitment levels (PCLs) for sewer flooding.

9.1.2 At PR19, Ofwat presented graphs of industry botex allocated to 'sewage collection' to conclude that *'it is far from clear that on a per kilometre basis United Utilities spends unusually high amounts on operating or maintaining its underground assets'.*

9.1.3 UUW considers that it is more appropriate to take a rounded view of expenditure, including comparing total enhancement expenditure on 'reducing flood risk for properties'; an allowance for which is included within Ofwat's wastewater network plus base cost models and by extension, within this claim. Indeed, UUW has had by far the largest total expenditure on 'reducing flood risk for properties' per 10,000 sewer connections (Figure 28) within AMP7 to date and expenditure 27.9% above the industry average over the period 2011-12 to 2021-22. As will be outlined in Section 11.2: 'Management Control', UUW has invested significantly in deployment of our industry-leading dynamic network management (DNM) initiative, utilising a network of over 17,500 sensors to proactively identify and resolve blockages before flooding can occur, as well as implementing a large-scale property-level flood mitigation programme.

Figure 28: Expenditure on 'reducing flood risk for properties' per 10,000 sewer connections for FY21 and FY22.



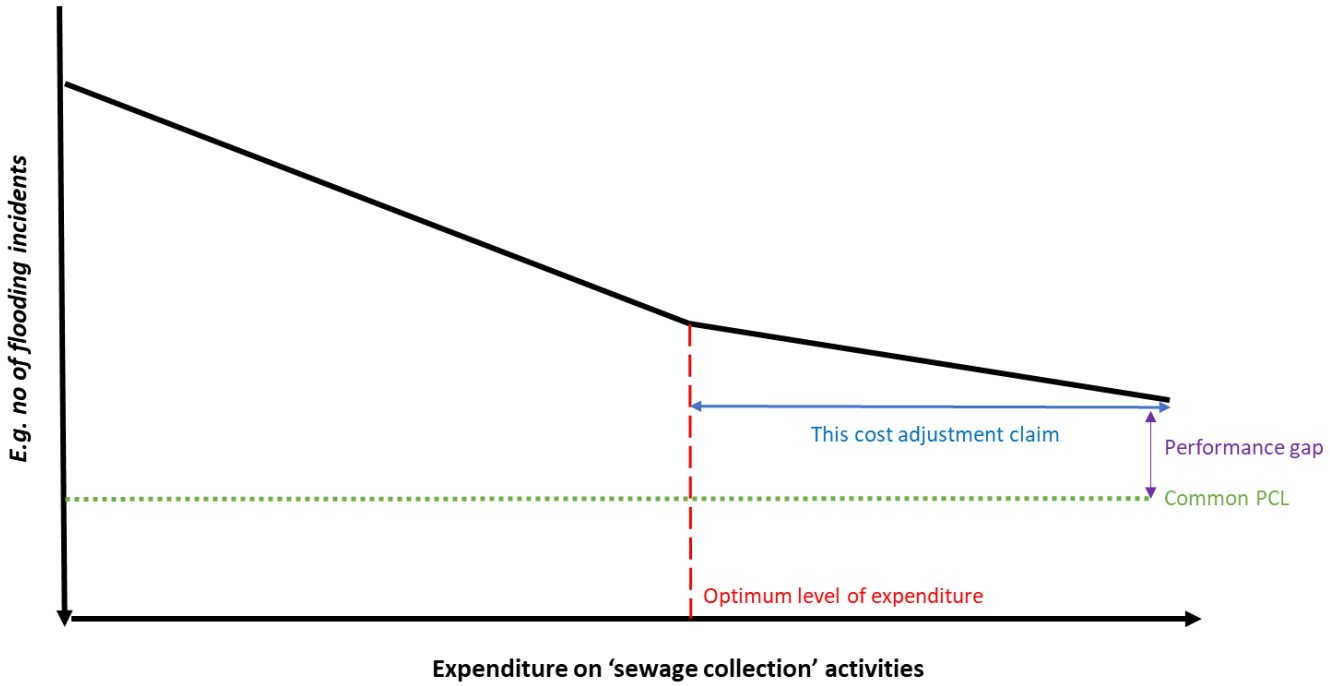
Source: Ofwat, PR24 wastewater cost assessment master dataset. Available here.

9.1.4 Further, we consider our expenditure on sewage collection to be efficient within the constraints imposed by the unique operating circumstances in the North West. Indeed, as published in our Future Ideas Lab paper[25], we set out an econometric modelling approach to predict performance based upon companies' regional operating circumstances. If measured in this way, in FY23 UUW achieved an upper quartile level of performance for internal sewer flooding; for example, *where the UQ is subject to an appropriate environmental adjustment that reflects urban rainfall, combined sewers and FSE density*.

[25] UUW (2022) *Future Ideas Lab: What lessons can we learn from cost assessment at PR19?* Available here

9.1.5 Given these operational constraints, we consider we are spending an appropriate level of botex on sewage collection. Increasing base expenditure beyond this point would not yield a cost beneficial improvement in performance. Significant and sustained enhancement expenditure, far beyond that witnessed historically (e.g. to substantially reduce the proportion of combined sewers by surface water separation), would be required to move to the common PCL position. Above our current level of botex expenditure on sewage collection, we judge that the performance improvements delivered by a given unit of expenditure begin to plateau, and thus expenditure above this optimum level becomes inefficient and uneconomic for customers. Such a relationship is demonstrated theoretically in Figure 29, whereby above the 'optimum level of expenditure', the performance gains decrease.

Figure 29: A theoretical graph used to demonstrate that as the expenditure on 'sewage collection' increases above the 'optimum level of expenditure', the performance improvements (black line) from a given unit of expenditure decreases.



Source: UUW analysis

9.1.6 It is for this reason that we consider an internal sewer flooding PCL that takes into account our unique operating circumstances to be a more appropriate outcome for both UUW and customers. UUW will therefore be proposing that our AMP8 PCLs are set at the maximum level of performance modelled to be achievable *within the constraints imposed by our unique operating circumstances*. While this represents an extremely stretching position, we believe that it is possible to achieve this level of performance economically without the need for a further uplift to the modelled botex allowance (this approach is set out in Appendix E).

9.1.7 If, however, our PCLs are not adjusted for our unique operating circumstances, this cost adjustment claim will be necessary to allow UUW to reasonably recover the higher costs that will be incurred as a result of operating in a challenging environment for providing drainage services. Owing to the cost-performance relationship outlined above, the claim will only allow UUW to make incremental improvements and will not enable us to achieve an upper quartile level of performance (Figure 29). This is because the cost models are based upon re-allocation of historical actual expenditure levels. Therefore, as no company with UUW's exogenous characteristics has achieved performance consistent with Ofwat's upper quartile target, the costs of hitting the upper quartile target will not be reflected within the historical dataset and therefore cannot be reallocated by the cost models, even if a factor reflecting urban run-off and combined sewer was to be adopted.

9.1.8 In order to achieve the common sewer flooding PCL, a fundamental reconfiguration of our system would be necessary, including large-scale separation of combined sewer systems. These activities would inevitably cost several billions. While we will be proposing large-scale investment in downstream storage solutions to reduce overflow spill frequency through our WINEP (section 9.2.2), this conventional investment will have a negligible impact on flooding risk – therefore necessitating further billions of pounds of investment in upstream surface water separation to achieve a common internal sewer flooding PCL.

9.1.9 Within this context, we recommend that Ofwat consider our proposals for environmentally adjusted PCLs for internal sewer flooding which will be set out within our PR24 business plan. PCLs adjusted to account for the exogenous circumstances across operating regions would ensure customers across the country are paying for an equivalently stretching level of service. Appendix E sets out more detail regarding how UUW considers the regulatory framework can be adjusted to reflect the regional challenges wastewater companies face, specifically through the adoption of PCLs that are adjusted to companies' regional operating circumstances. Further detail regarding how our proposed PCLs for internal flooding were set will be set out in our main PR24 business plan submission.

9.1.10 However, should Ofwat not support our proposal for an environmentally adjusted PCL for internal sewer flooding, we set out the compelling evidence for the need for an upward adjustment to the modelled botex allowance in this document.

9.2 Other investment programmes and absence of double counting

WINEP and Advanced WINEP

9.2.1 Within our PR24 business plan, we will be submitting a regulatory enhancement case to deliver upon our environmental obligations and reduce spills at storm overflows as outlined in the Water Industry National Environment Plan (WINEP). We do not consider that this enhancement expenditure overlaps with this cost adjustment claim, as this claim pertains to the additional botex required for managing existing drainage services in our region, which will not support the delivery of additional hydraulic capacity to reduce spill frequency. Indeed, the storage solutions delivered through the WINEP will increase future expenditure requirements for asset maintenance and operation rather than having a mitigating influence.

9.2.2 Furthermore, our proposed WINEP solutions have a minor impact on reducing flood risk and therefore will not have an impact on our expenditure to reduce flood risk for properties. Grey storage solutions simply prevent spills from storm overflows to watercourse by capturing them within a tank and **therefore do not provide upstream flood alleviation beyond that offered by the existing storm overflow.** Alongside these traditional solutions, we are proposing an ambitious programme of blue-green or hybrid solutions to attenuate rainwater, including the removal over 160 ha of impermeable area. However, as the WINEP is optimised for spills drivers, the locations proposed demonstrate limited overlap with our highest areas of hydraulic flooding risk. Best estimates of modelled annualised flood risk reduction as a by-product of the WINEP overflows investment are therefore small: 2.77 internal sewer flooding incidents and 3.44 external sewer flooding incidents.

9.2.3 Alongside our main WINEP submission, we will also be submitting our c. £199 million 'Advanced WINEP'. The Advanced WINEP accelerates a sample of future drivers into AMP8 to demonstrate how rainwater management is critical to delivering multiple benefits and efficient spend, when partnership funding can be leveraged to change grey to green**.** The programme is therefore entirely comprised of hybrid or blue-green solutions and is specifically targeted at delivering wider environmental outcomes alongside spill reduction, including hydraulic flooding benefits. However, the scale of the reduction is ultimately limited by the geographical area to which the Advanced WINEP is constrained as an innovative new framework for delivering upon regulatory enhancement. It is therefore estimated that the annualised flood risk benefit is 4.84 internal sewer flooding incidents and 0.93 external sewer flooding incidents.

9.2.4 We therefore do not consider it necessary to adjust the value of this claim to reflect these flooding benefits. However, we do recognise that our WINEP programme is still subject to change. If these benefits change materially between submission of this cost adjustment claim in June 2023 and submission of our PR24 business plan in October 2023, the value of this claim will be adjusted accordingly.

Rainwater management enhancement case

9.2.5 Finally, in alignment with our long-term ambitions set out within the Drainage and Wastewater Management Plan (DWMP), we will be submitting a £132 million enhancement case for rainwater management. This will set out our plans for large-scale investment in Sustainable Drainage Systems (SuDS), to secure long-term resilience against the effects of climate change. However, this investment is only aimed at protecting against the risk of future performance deterioration due to climate change. The scale of the operational change and total investment necessary to fundamentally reconfigure our network and control rainwater at source means that rainwater management investment must be staggered across multiple AMPs. It will thus take multiple AMPs for any benefits to be realised at a regional scale.

9.2.6 Thus, this cost adjustment case solely concerns the additional maintenance and short-term flood mitigation measures needed to cope with the unique operating circumstances of the North West whilst our longer-term vision to reduce rainwater entering combined systems is enacted. We therefore anticipate that the value of this claim may diminish in future price control periods as combined sewers are gradually separated and urban rainfall is better attenuated.

10. Introduction

10.1 Overview

10.1.1 This document sets out a claim for an upward cost adjustment of ~~£152.6~~ £152.1 million to reflect the additional costs of operating and maintaining a drainage system in an area in which multiple exogenous factors interact to increase volumes of surface water entering the sewer network.

10.1.2 Ofwat's current botex models[26] do not adequately capture the effect of UUW's unique exogenous factors, including 40% higher than average urban rainfall and the highest proportion of legacy combined sewers, on the costs to operate and maintain our wastewater system. Whilst we welcome Ofwat's proposal to *potentially* include urban rainfall in a subset of sewage collection and wastewater network plus models, we consider this only a partial representation of UUW's compounding cost drivers.

10.1.3 Specifically, we consider that the effect of rainfall cannot be considered independently of the proportion of combined sewers. As combined sewers convey both foul and surface water flows, they have less hydraulic capacity than separate systems during periods of heavy rainfall, making them a greater risk of service impact (such as sewer flooding). Clearly, this effect will be particularly pronounced in areas of higher urban run-off, whereby the presence of combined sewer compounds the impact of storm events. The interaction between these two factors is, in our view, the largest single impact on drainage cost and performance, and (unless Ofwat agrees to setting environmentally adjusted sewer flooding PCL targets) should be reflected in all sewage collection and wastewater network plus models. If Ofwat imposes a simple common target for flooding incidents, the absence of this interaction factor results in an inequitable stretch across the industry, with the implication that customers of companies operating in a relatively benign environment may pay too much for the service they receive.

10.1.4 While we are sympathetic to Ofwat's view that companies have been seen to deliver good performance and cost efficiency simultaneously, we consider that the exogenous operating circumstances present in the North West place an unattainable stretch on UUW when Ofwat's botex models exclude these factors. We are therefore proposing a symmetrical cost adjustment. As part of this, we provide evidence demonstrating how an upward adjustment to the modelled cost allowance would affect cost allowances for other companies.

10.1.5 At PR19, UUW submitted a cost adjustment claim for drainage. Whilst Ofwat largely accepted the principle of the argument, namely that 'higher volumes of surface water runoff enter the sewers in the North West…compared with most other regions'[27], the claim was rejected due to two key reasons outlined in Table 23. Since PR19, we have undertaken numerous activities to materially improve our evidence base and we present such compelling evidence against the assessment criteria outlined in Appendix 9 of the PR24 Final Methodology. Furthermore, Ofwat's publication of its base cost models has allowed us to submit a claim that is of a higher quality and fully supported by econometric modelling analysis, including the removal of any implicit allowance from the claim value. Table 23 details the reasons for rejection at PR19 alongside the evidence we have since gathered to address these claims.

[26]Ofwat (2023) *Econometric base cost models for PR24.* Available here

[27]Ofwat (2019) *PR19 final determinations. United Utilities – Cost efficiency additional information appendix.* Available here

Table 23: Ofwat's reasons for rejection of UUW's drainage cost adjustment claim at PR19 alongside how we have since addressed these

Ofwat's reasons for rejection at PR19	How we have addressed these in this claim
"Owing to the relief provided by combined sewer overflows (CSOs), we are not persuaded that higher surface water runoff necessarily means that larger assets are needed to manage the resulting flows"	Analysis of PR14 business plan data, the latest available industry-wide data, demonstrates that UUW has the highest proportion of sewers > 626 mm in diameter and the second highest proportion of sewers > 321 mm in diameter. Further, Ofwat should now recognise, given the current focus and future expectations on CSO spill frequency, that CSOs cannot be assumed to be provide the level of "relief" against the need for larger assets that Ofwat claimed at PR19. It is also important to note that the significant enhancement investment required to reduce CSO spill frequency, will in future lead to increased maintenance requirements. Indeed, in its econometric modelling consultation, Ofwat states, "The greater the volumes of inflow into drainage and sewerage networks, the larger network and storage assets need to be"[28], suggesting this argument has since been accepted.
"It is far from clear that on a per kilometre basis United Utilities spends unusually high amounts on operating or maintaining its underground assets. In fact, as can be seen in figures(), PR19 business plan data indicates than in the last two years United Utilities' unit costs have been at or just below the industry average"	A full overview of our response is provided in the preface. In summary: Ofwat presented graphs of industry botex allocated to 'sewage collection' to reach this conclusion. UUW considers that it is more appropriate to take a rounded view of expenditure. Indeed, UUW has had - by far - the largest total expenditure on 'reducing flood risk for properties' per 10,000 sewer connections in AMP7 to date (Figure 28) and expenditure was 27.9% above the industry average over the period 2011-12 to 2021-22. Further, we consider our expenditure on 'sewage collection' activities to be efficient within the constraints imposed by our unique operating circumstances. It would not be an efficient use of resources to spend significantly above the industry average on 'sewage collection', to improve our sewer network in an attempt to achieve a level of sewer flooding incidents that is not attainable within our unique operating circumstances, i.e. a common internal sewer flooding PCL. It is for this reason that we are proposing an environmentally adjusted PCL for sewer flooding as the best option for customers (as set out in Appendix E).

Source: Ofwat PR19 Final Determinations

10.1.6 Our claim is underpinned by robust engineering, operational and economic rationale as informed by work UUW commissioned at PR19[29], the outputs from our 'flooding hackathon' and submissions to the Future Ideas Lab[30].The flooding hackathon was a multi-disciplinary sprint that brought together subject matter experts, developers, interface designers and others to improve our understanding of the risk drivers for flooding using new and pre-existing datasets, including open data where available. The results demonstrated that a multiplicity of factors that compound to result in UUW incurring additional costs to operate and maintain sewerage infrastructure and to mitigate flood risk. The outputs of our flooding hackathon have been shared with Ofwat through a number of sessions leading up to the Price Review submission.

10.1.7 We have calculated UUW's proposal for an adjustment to the allowance by reference to a model suite that reflects the issues we face in a region with high volumes of urban rainfall and a high prevalence of combined sewers. This model suite is identical to Ofwat's consultation model suite but introduces an 'interaction term', which reflects the inter-relationship between urban rainfall and combined sewers, into sewage collection models SWC1-SWC3 and wastewater network plus models WWNP1-WWNP4. The claim value of ~~£152.6~~ £152.1 million therefore represents the difference between the modelled allowance resulting from models with and without this factor, minus the implicit allowance £48.3 million

[28] Ofwat (2023) *Econometric base cost models for PR24.* Available here

[29] Arup and Vivid Economics (2017) *Understanding the exogenous drivers of wholesale wastewater costs in England and Wales.* Available here.

[30] UUW (2022) *Future Ideas Lab: What lessons can we learn from cost assessment at PR19?* Available here

associated with Ofwat's proposed adoption of an urban rainfall factor in a *subset* of its models (models SWC4-SWC6 and WWNP5-WWNP8).

10.2 Structure of this document

10.2.1 We have structured this document according to Ofwat's assessment gates for cost adjustment claims as outlined in the PR24 Final Methodology Appendix 9[31]. The claim is therefore divided as follows:

(a) Section 11 'need for investment' outlines the compelling evidence that Ofwat's proposed econometric models do not adequately capture the unique operating circumstances of the North West and this has material implications for company expenditure:

  (i) Section 11.1 outlines the key exogenous factors that affect drainage performance in the North West;

  (ii) Section 11.2 outlines how such factors are largely outside of management control and demonstrates that UUW has invested efficiently to manage such risks;

  (iii) Section 11.3 demonstrates how such exogenous factors are material drivers of expenditure and as such, UUW will incur higher costs in moving towards common PCLs than other companies; and

  (iv) Section 11.4 provides evidence that the cost claim is not included in Ofwat's modelled allowance, including an explanation for why our proposed explanatory variable, namely an interaction term for urban rainfall and combined sewers, is superior to the explanatory variable in Ofwat's cost models.

(b) Section 12 'cost efficiency' demonstrates that our cost estimates are efficient, including an explanation for how the cost estimates were derived and the efficiency assumptions applied. Third party assurance of the robustness of the cost estimates was also provided by PwC. An extract from their report is provided in paragraph 12.1.7.

(c) Section 13 'need for investment' details why we do not consider this criteria to be appropriate for this case as per Ofwat's guidance set out in Appendix 9.

(d) Section 14 'best option for customers' explains why UUW considers the best option for customers of all companies to be PCLs for internal sewer flooding that are adjusted to the operating circumstances of that region.

(e) Section 15 'customer protection' demonstrates that customers of UUW are fully protected via a range of performance commitments should UUW fail to fully deliver upon the additional expenditure set out in this claim.

[31] Ofwat (2022) *Appendix 9 Setting expenditure allowances.* Available here

11. Need for adjustment

11.1 Unique circumstances

11.1.1 UUW provides services in a unique operating environment, whereby a number of compounding factors interact to increase operation and maintenance costs.

11.1.2 The value of this claim has been determined through the introduction of an interaction term into Ofwat's cost model suite that reflects the combined impact of two key exogenous factors, namely:

(i) urban rainfall; and

(ii) proportion of combined sewers

11.1.3 We apply these terms when deducing the claim value as we consider that Ofwat has a consistent dataset for both factors across all operating regions and therefore a symmetrical cost adjustment can be achieved. Furthermore, these variables, and specifically the interaction between them, were found to be robust and highly statistically significant in econometric models.

11.1.4 There are also several additional factors that compound the effect of the above but are not reflected in the value of the claim, primarily due to inconsistent data and/or concerns regarding the impact on customers' bills. UUW thus proposes to absorb the impact of these factors to limit the impact on customers' bills and focus the cost adjustment claim. These other factors include:

(i) soil permeability and potential evapotranspiration (PET)

(ii) food service establishment (FSE) density; and

(iii) local topography and cellar density

11.1.5 We outline the impact of these exogenous factors below to reflect the additional layer of stretch that UUW is taking on. Indeed, Table 24 shows that no other company has the same combination of unfavourable exogenous factors as UUW.

Table 24: UUW has a unique combination of exogenous factors

Company	High proportion of combined sewers (> 40%)	Urban Rainfall > industry average (9.5 m3 per 10,000 connected props)	PET < industry average (600.34 mm)	Low soil permeability*	High FSE density?**
ANH	×	×	×	×	×
NES	✓	×	✓	✓	✓
SRN	×	×	×	×	×
SVE (inc. HDD)	×	×	×	×	×
SWB	✓	✓	×	×	×
TMS	×	×	×	×	✓
UUW	✓	✓	✓	✓	✓
WSH	✓	✓	✓	×	×
WSX	×	×	×	×	×
YKY	✓	✓	✓	×	✓

Source: UUW analysis of APR data

**Visual representation based on the dominant soil type characteristics across the UK (Figure 5). Low soil permeability characteristics: Slowly permeable seasonally wet acid loamy and clayey soils; slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils; slowly permeable wet very acid upland soils with a peaty surface; blanket bog peat soils; loamy and clayey floodplain soils. Source: Cranfield University Soilscapes Data*
***Where high is considered to be 107-232 outlets per 100,000 population and medium to high 87-106 outlets / 100,000 population based on PH (2018 data)*

11.1.6 While these factors will be considered here separately for ease of understanding, it must be emphasised that it is their interaction that compounds to disadvantage UUW. The impact of these unique factors on company expenditure will be explored in more detail in Section 11.3: Materiality.

Urban Runoff

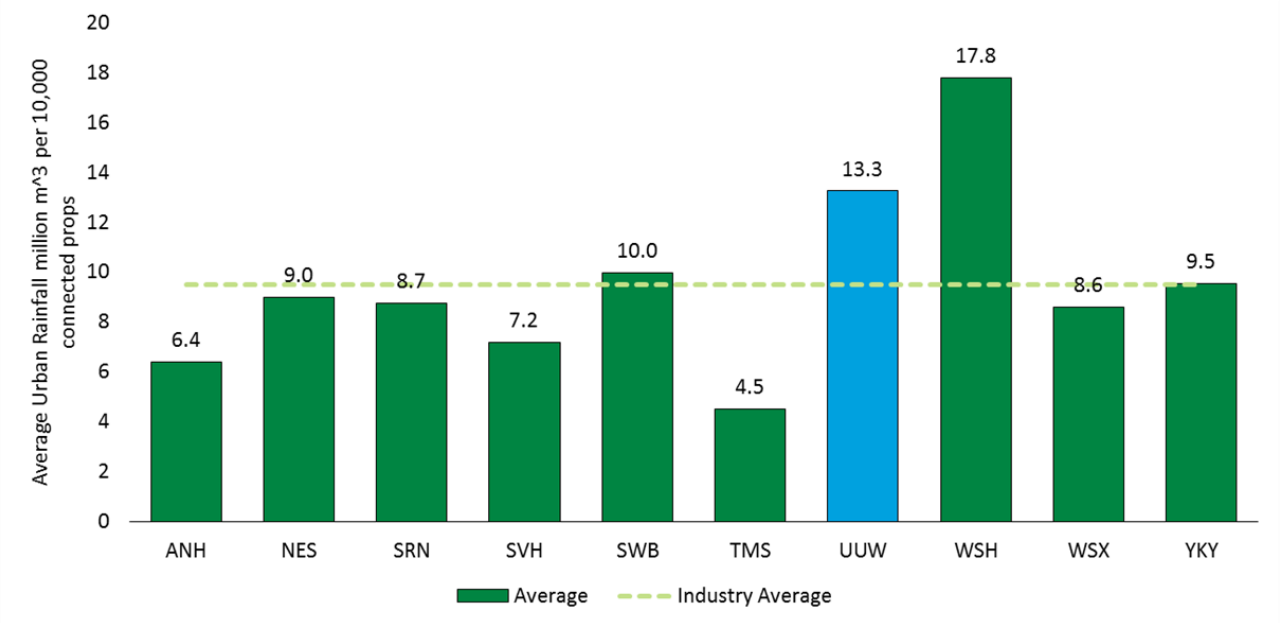
11.1.7 The North West has 40% more urban rainfall than the industry average and therefore greater volumes of surface water enter the sewer network.

11.1.8 UUW's position to the west of the UK results in a high exposure to prevailing winds from the south west bringing warm air that is laden with moisture from the Atlantic Ocean. This air cools as it is forced to rise over high ground of the west Pennines resulting in large totals of orographic rainfall[32]. Indeed, as acknowledged by Ofwat at PR19[33], ranked by average annual rainfall, 17 out of the top 26 cities in England and Wales fall within UUW's operating area.

11.1.9 Furthermore, Ofwat's own 'urban rainfall calculations (October 2022) dataset[34] (BN4505) demonstrates that, when normalised per 10,000 sewer connections, UUW's urban rainfall is 40% higher than the industry average (Figure 30). Therefore, as high rainfall coincides with the urban conurbations of the North West, it can be deduced that more rainwater falls onto hard, impermeable urban surfaces and so enters the sewer system relative to in other companies' areas. High rainfall results in higher flooding risk and drives the increased activation of overflows to alleviate such risk.

11.1.10 We note that we do not consider the difference between ourselves and Welsh Water to be entirely reflective of differences in urban rainfall. Instead, our analysis has found urban rainfall in Welsh areas may be systematically overstated due to potential differences in the way geographical areas are measured between the two countries. We present evidence of this in Appendix F. While we consider that the addition of an urban rainfall variable to the recommended model suite is a positive development and we consider the calculation to be pragmatic and generally appropriate, we do consider that any resulting comparative analysis should be viewed in context of the underlying systematic differences between England and Wales set out in Appendix F.

Figure 30: Urban rainfall (million m3) (wastewater – LAD) per 10,000 connected properties



Source: Ofwat, urban rainfall calculations. Available here.

[32] Orographic rainfall is formed when air is forced to cool when it rises over hills or mountains.

[33] Ofwat (2019) *PR19 final determinations. United Utilities – Cost efficiency additional information appendix.* Available here

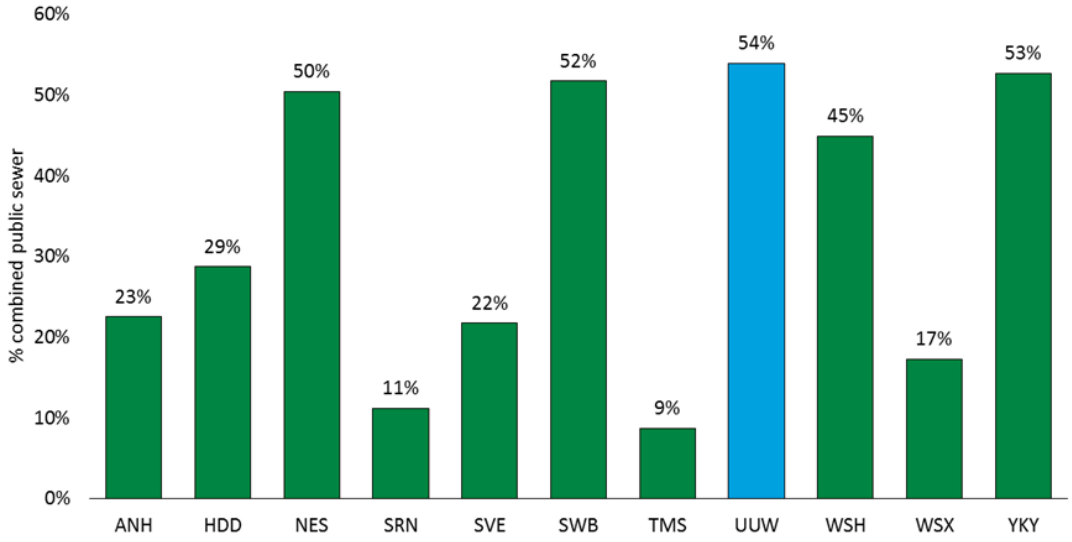
[34] Ofwat (2022) *Urban rainfall calculations.* Available here

Proportion of combined sewers

11.1.11 UUW has the highest percentage of combined public sewers in the industry. Combined sewers convey both foul and surface water flows, resulting in a reduced hydraulic capacity in periods of high rainfall and increased risk of sewer flooding relative to other companies.

11.1.12 UUW has the highest percentage of combined public sewers in the industry at 54% (Figure 31) compared to an industry average of 33%. Combined sewers are highly responsive to rainfall and have less hydraulic capacity during storms, increasing the risk of sewer flooding. Indeed, analysis completed as part of UUW's flooding hackathon demonstrated that, per kilometre of sewer, the likelihood of internal surcharge incidents, internal overland incidents and external incidents are 26.5%, 52.1% and 2.7% higher, respectively, in combined sewers compared to foul-only sewers.

Figure 31: UUW has the highest % of combined public sewers in the industry.



Source: Ofwat, PR24 wastewater cost assessment master dataset. Available here.

11.1.13 Engineering and operational rationale therefore dictates that there is a strong interrelationship between rainfall and combined sewers: combined sewers have a lower hydraulic capacity during periods of heavy rainfall, amplifying the effect of urban rainfall on sewer flooding and storm overflow risk. Indeed, the hackathon was able to demonstrate that WaSCs with higher proportions of combined sewers have higher numbers of flooding incidents as urban rainfall increases.

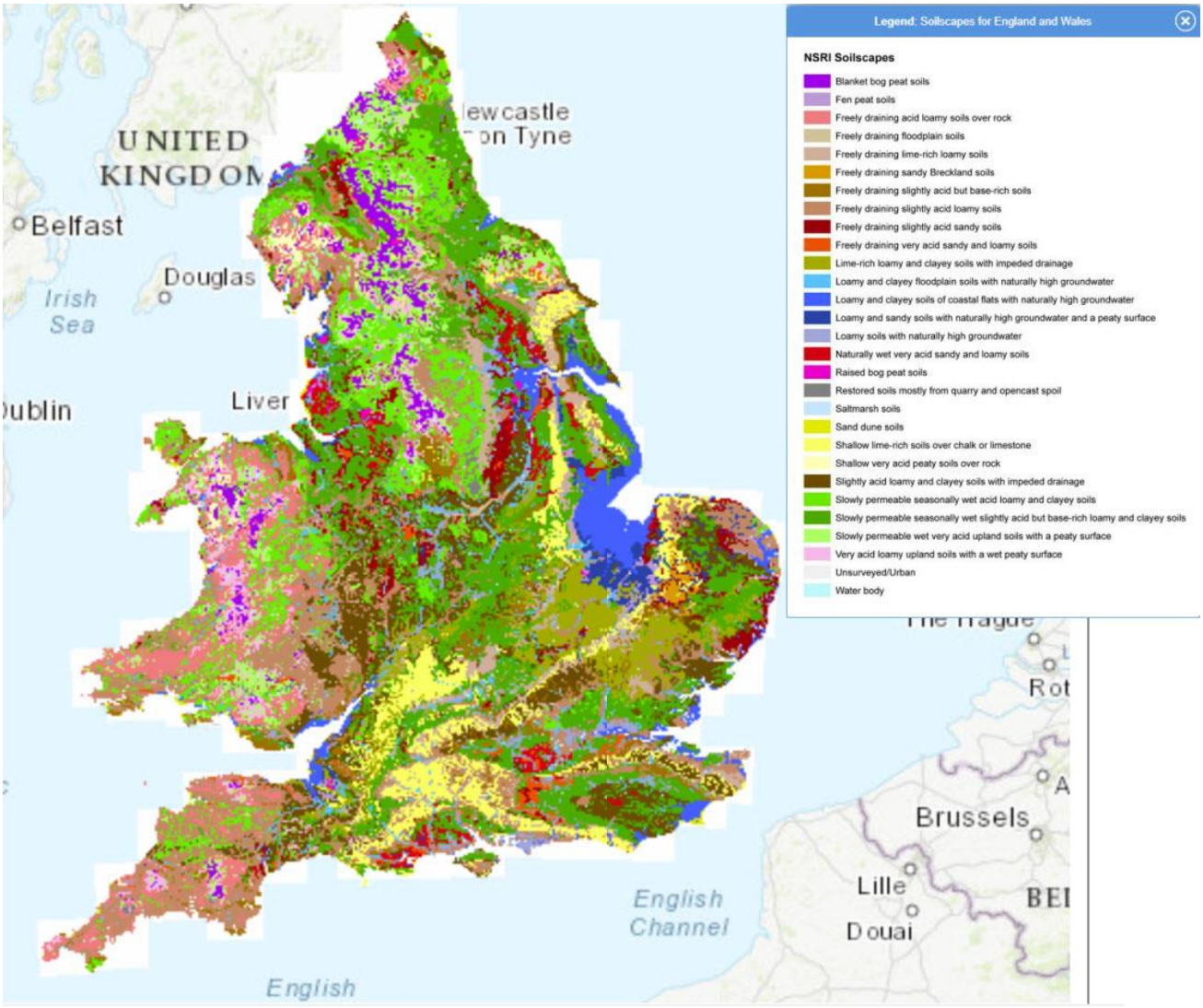
Soil Permeability and potential evapotranspiration

11.1.14 The North West has large areas of low permeability soils and potential evapotranspiration (PET) that is below the industry average. These two factors reduce the ability of water to be lost from the system via infiltration and evaporation/transpiration, respectively. Therefore, this suggests that more of the rainfall falling in the North West flows overland into the sewer network.

11.1.15 Compounding the effect of urban rainfall is soil permeability and potential evapotranspiration (PET). Much of the North West has large swathes of slowly permeable soils with a low infiltration potential. Indeed, analysis of Soilscapes data, a freely accessible dataset published by Cranfield University[35], demonstrates that significant areas of the North West, including surrounding major urban centres such as Manchester, are covered by slowly permeable seasonally wet loamy and clayey soils (Figure 32). In contrast, the operating areas covered by Welsh Water and South West Water, regions that are similarly exposed to Atlantic depressions, are dominated by freely draining loamy soils. The implication is that rainfall that falls in UUW's operating region is more likely to flow overland into our sewer network.

[35] Cranfield Soil and Agrifood Institute (N/A) *Soilscapes.* Available here

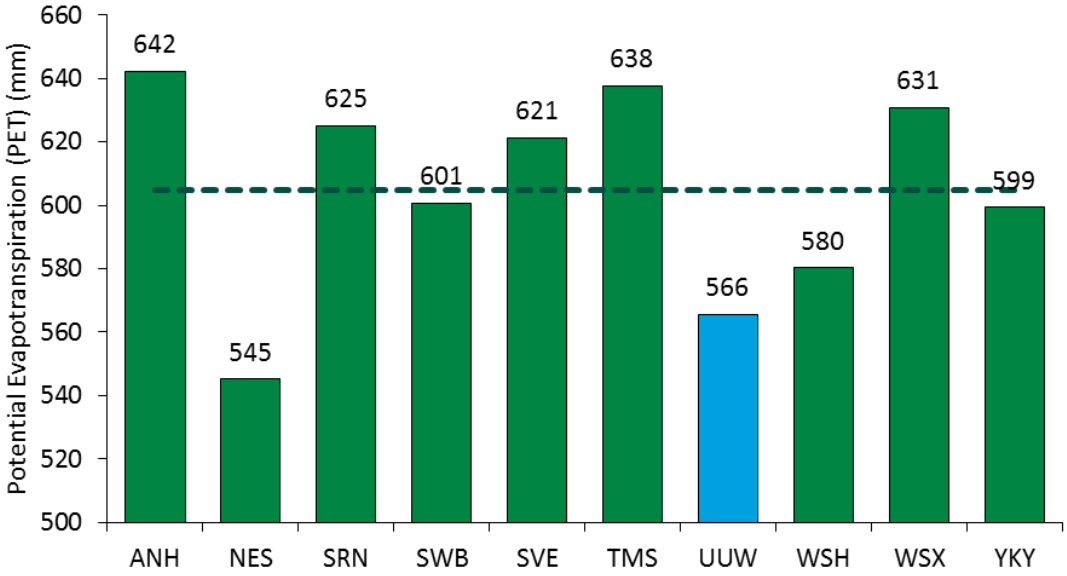
Figure 32: Large areas of the North West are covered by 'slowly permeable seasonally wet acid loamy and clayey soils' (bright green) and 'slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils' (dark green).



Source: Cranfield University Soilscapes Data. Available here

11.1.16 Furthermore, UUW has a below average PET (Figure 33). PET is a measure of the rate of the maximum potential loss of water via evaporation from the land surface and transpiration by plants. A low PET thus means that less water is being lost from the surface via these routes and is therefore available to run overland into UUW's sewer network.

Figure 33: Annual average potential evapotranspiration (PET) (2001-22) by company. The dashed black line represents the industry average. Source: Available here.



Source: Ofwat, PR24 wastewater cost assessment master dataset. Available here.

11.1.17 Therefore, together, low permeability soils and below average PET compound the effect of above average urban rainfall by allowing less of the rainfall falling on a surface to be removed via infiltration and evapotranspiration, respectively. The result is that a greater proportion of rainfall is therefore available to runoff into sewer systems.

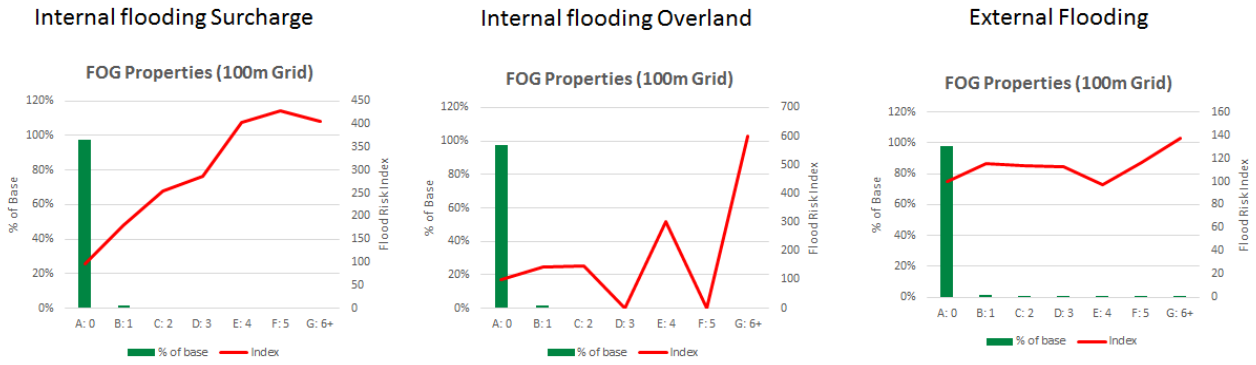
Food service establishment (FSE) density

11.1.18 FSE density in the North West is well above the national average, increasing the risk of flooding caused by fat, oil and grease (FOG) blockages.

11.1.19 The North West has a higher FSE density (118.2 per 100,000 population) than the national average (90.8 per 100,000 population)36. Our flooding hackathon demonstrated that the risk of internal flooding risk significantly increased with the number FOG discharging premises located within a 100 m grid square (Figure 34). As a result, it can be concluded that UUW faces a higher risk of flooding caused by FOG discharges from FSEs than most other companies, necessitating higher expenditure on blockage clearance as well as engagement with, and monitoring of, FSEs.

[36] Public Health England (2018) *Fast food outlets: density by local authority in England.* Available here.

Figure 34: Flood risk increases as FOG property (i.e. FSE) density increases for surcharge, overland flow and external flooding mechanisms. Source: UUW internal data (flooding hackathon)



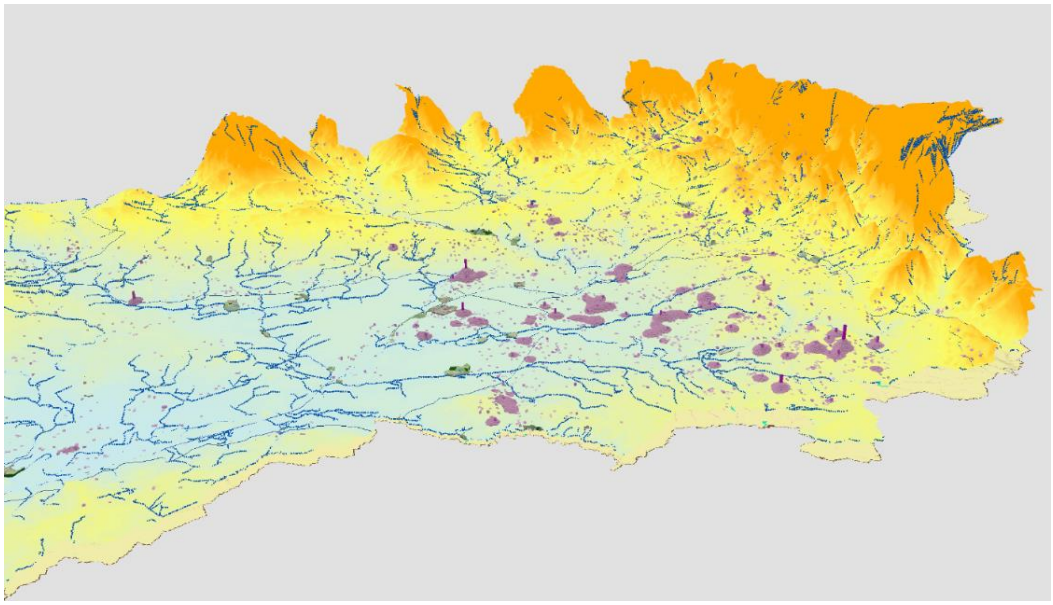
The x-axis displays the FOG property density within a 100 m grid square, grouped into bins of increasing density. The green bar shows the percentage of grid squares that fall within each category. The red line shows the flood risk index increasing with the FOG property density.

Local topography

The interaction of runoff with unique local topographies acts to exacerbate the risk of flooding in certain urban centres.

11.1.20 UUW considers that unique local topographies can further increase runoff into local systems. Specifically, our flooding hackathon demonstrated that Manchester's geography and its topography as a 'bowl' holds water and directs it towards our network (). Manchester is situated at the base of the Pennines and therefore, when moist air from the Atlantic hits the Pennines, the moisture condenses to produce orographic rainfall that then flows back into the 'bowl' over saturated ground. Once this rainwater enters the network, as the base of the bowl is flat, hydraulics dictate that the system remains surcharged for longer following rainfall and pumping stations and wastewater treatment works (WwTWs) remain at high level. As a result, the entire system has much less spare capacity for an extended period of time, increasing the risk of service deterioration.

Figure 35: A 3D topographic representation of the Manchester Drainage Are



The Manchester drainage area has a 'bowl' topography whereby orographic rainfall generated by the Pennines is forced to runoff and enter the sewerage system in the urban centre of Manchester. Purple areas represent internal flooding clusters.

11.1.21 Additionally, Manchester has a high cellar density (Figure 36). Our flooding hackathon demonstrated that increased cellar density significantly increases risk of internal flooding via both surcharge and overland flow mechanisms (Figure 37). The high cellar density in Manchester therefore exacerbates the effect of topography on flood risk, as cellar locations coincide with low spots on the network in flat base of the 'bowl'.

Figure 36: Cellar density across the UK. Red clusters correspond to areas of high cellar density. Source: 2001 census data. Available here.

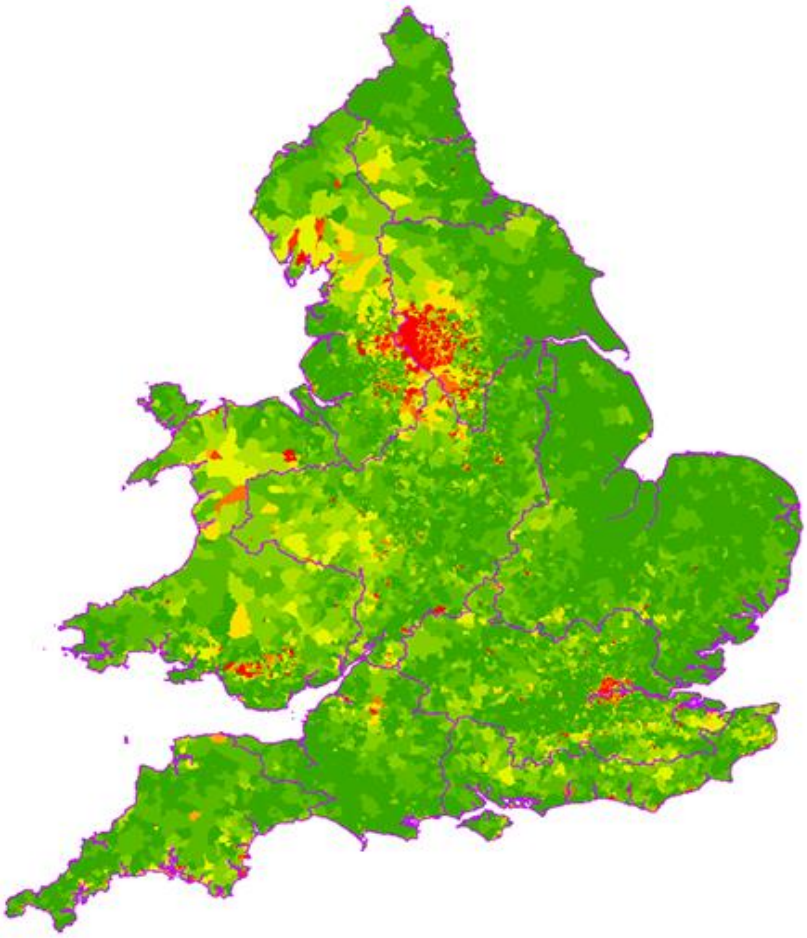
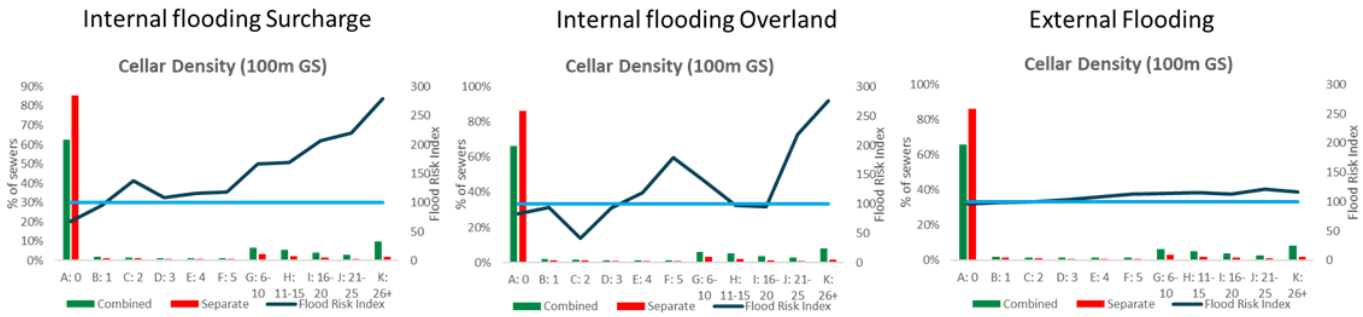


Figure 37: Our flooding hackathon demonstrated that Internal flooding surcharge and internal flooding (overland) risk indices increase as cellar density increases. Source: UUW internal data (flooding hackathon)



Source: UUW internal data (flooding hackathon)

The x-axis displays the cellar density within a 100 m grid square, grouped into bins of increasing density. For each bin, the bars show the proportion of combined (green) and separate (red) sewers. The dark blue line shows the flood risk index (right-hand axis) increasing with the cellar density, relative to the average

(i.e. 100) (light blue line). For example, a flood risk index of 300 represents a 3x increase in overall risk based on the number of cellars.

11.1.22 The result of these factors is that Manchester has an especially high flood risk. Indeed, in FY21, a particularly wet year, 47.2% of UUW's internal flooding events occurred in the Manchester drainage area. To mitigate this risk, over 1100 property-level flood mitigation devices have been installed in the Manchester drainage area since 2017 at a cost of over £9 million.

11.1.23 However, owing to the ~~logistical~~ practical difficulty of accounting for any unique local topographies across the industry and the insufficient confidence in the accuracy of cellar data nationally, we do not propose such factors for inclusion within Ofwat's botex models.

Higher costs in the round

11.1.24 As outlined in Table 2, UUW provides services to an operating region in which multiple exogenous factors interact to increase ongoing operation and maintenance costs. We have looked across a comprehensive range of drivers of maintenance costs and flood risk and UUW sits unfavourably for each factor. Indeed, we fail to identify a single factor that has a mitigating influence for UUW relative to other companies. These material drivers compound to disadvantage UUW and will increase the costs incurred in moving towards a common PCL above those incurred by other companies. Section 4.3: Materiality explores the relationship between our exogenous factors and cost in more detail.

11.1.25 One argument could be that higher runoff into our sewer network could afford UUW an advantage with regards to improved flushing and blockage clearance. However, research conducted by WRc on behalf of UUW demonstrates that this assumed relationship does not always hold true[37]. This report concluded that, in some circumstances, high rainfall can actually increase blockage numbers. Therefore, any inferred advantage from UUW's unique operating circumstances cannot be considered to offset the compounding impact of the material drivers, resulting in higher costs in the round.

11.2 Management control

11.2.1 The above factors are all entirely, or largely, outside of management control:

- **Urban rainfall** – Management cannot control the amount of rainfall falling within a region, nor the degree of urbanisation. We do, however, exert some degree of control over the way in which rainwater is managed. Part of our long-term ambition is therefore to increase attenuation of rainwater, within both urban areas and the wider catchment, through measures such as SuDS and natural flood management (NFM). However, the scale of the operational change and total investment necessary to fundamentally reconfigure our network and control rainwater at source means that rainwater management investment must be staggered across multiple AMPs. Urban rainfall is therefore outside of short-term management control.
- **Proportion of combined sewers** – Our combined sewers are legacy assets inherited at privatisation. We could not control the asset base we inherited and whilst we are looking to increase surface water separation, this is an expensive and complex process to conduct at scale. Indeed, Defra's consultation on the Government's Storm Overflows Discharge Reduction Plan[38] states *"This evidence project estimates that the complete elimination of all storm overflows at coastal and inland waters by completely separating the sewer network would cost between £350 billion and £600 billion. It would also cause significant disruption. For example, most of the combined system runs under our towns and cities and would have to be dug up".* We therefore consider that separation at the scale necessary to reduce the combined sewer variable in this claim would be prohibitively expensive and disruptive for customers and therefore this variable is outside of short to medium term management control.

[37] WRc (2023) *Understanding the Impact of Rainfall and Drainage Area Features on Blockages.* Available upon request.

[38] Defra (2022) *Consultation on the Government's Storm Overflows Discharge Reduction Plan.* Available here

- **Local topography** – Topography is entirely outside of management control.
- **Soil permeability and PET** – Both factors are entirely outside of management control.
- **FSE density** – Numbers and location of FSEs are outside of management control, although we do have an active programme of engagement with FSEs to improve their understanding of appropriate FOG disposal practices and thereby decrease discharges to the network.

11.2.2 While acknowledging these exogenous factors fall outside of management control, we have nevertheless invested significantly in managing the risk, including:

- Deployment of our industry leading Dynamic Network Management (DNM) initiative. The DNM approach allows UUW to manage our wastewater network more proactively and is believed to be the largest integrated solution of its kind globally. DNM has involved the installation of over 17,500 intelligent sensors, alongside enhanced monitoring on more than 1,500 point assets, across 160 drainage areas. By improving the monitoring capabilities in our network and applying predictive analytics and machine learning to spot deviations from 'normal' flow signatures, we have been able to identify and resolve key causes of flooding and spills, such as blockages, before customers are even aware of the problem/before a spill can occur. The proactive alerts generated by this network of sensors have detected over 2100 sewer blockages since August 2021.
- Introduction of a robust blockage resolution model, including: mandating post blockage clearance CCTV surveying to better understand root cause and raise further works accordingly; a targeted planned cleaning programme in areas identified as susceptible to repeat blockages and enhanced targeting of proactive CCTV surveying and defect resolution as part of our Flying Start initiative for AMP7. We have also implemented a 'high risk asset plan', performing proactive walkovers of assets susceptible to blockage formation, such as interceptor traps[39] and pitch fibre sewers[40].
- Installation of over 1,600 flood mitigation devices, such as flood barriers and non-return valves, over the first three years of AMP7 at properties where flooding has previously occurred, significantly reducing the incidence of repeat flooding. Additionally, we have invested heavily in our 'hydraulic flood risk resilience' schemes to reduce the impact of hydraulic incapacity through cut and pump solutions as well as planned installation of 9,945m^3 of storage by the end of AMP7.
- Partnering with ECAS to conduct over 8,500 site visits to high-priority FSEs since October 2019, providing education and advice regarding grease removal equipment and kitchen best practice. This work has resulted in the installation of over 500 grease traps, preventing an estimated 1,242 tonnes of FOG from entering UUW's sewer network.
- Launching regional 'What not to Flush' and 'Stop the Block' customer campaigns, as well as conducting more targeted engagement with communities in 'hotspot' areas, including the distribution of fat traps. As a result, we outperformed our bespoke 'raising customer awareness to reduce the risk of flooding' performance commitment by 13.4% in FY22.
- Promoting, driving and supporting planning for flood risk reduction throughout all levels of planning, from a strategic level at Regional Flood and Coastal Committees to operational Making Space for Water meetings in all regional council areas.
- Maturing our partnerships framework through place-based plans such as the Integrated Water Management Plan for Manchester developed through the trilateral partnership with the EA and Greater Manchester Combined Authority (GMCA).

[39] Interceptors traps can be found on drains serving pre-1937 properties, often terraced, and are owned or maintained by whoever is responsible for the drain on which they are found. They are designed like a u-bend, maintaining a constant water level and preventing any odours venting from the public sewer. The nature of the design allows rags, solids and silt to build up, meaning blockages are common.

[40] Pitch fibre is a material that was a popular lower cost alternative to traditional clay pipes in the 1950s-70s. However, this material is highly susceptible to breaking and collapsing.

11.2.3 Throughout, we have taken all necessary steps to control costs and take advantage of any spend to save opportunities. For example, the large-scale deployment of DNM is allowing us to scale back our planned serviceability programme in some locations, such that it is no longer necessary to clean blockage-prone locations on a pre-defined cyclic basis but rather cleaning is only carried out when we are alerted to a deviation in flow signature. Further, transitioning to an operating model that is driven by sensor alerts as a means of identifying a problem, rather than customer contact, has reduced reactive callouts by 10% and 25% for infrastructure and non-infrastructure jobs, respectively.

11.3 Materiality

11.3.1 As acknowledged in Ofwat's Econometric Base Cost Models Consultation[41]: "*The greater the volumes of inflow into drainage and sewerage networks, the larger network and storage assets need to be, and the greater the amount of pumping and capital maintenance costs are needed to avoid sewer flooding incidents and discharges of wastewater from storm overflows, and maintain good asset health*". While this is stated specifically with regard to urban rainfall, UUW contends that the impact of combined sewers exacerbates the above costs as combined sewers have less hydraulic capacity than separate systems during periods of heavy rainfall. As a direct result of our exogenous factors, UUW will therefore incur additional costs in moving towards common PCLs.

11.3.2 This section outlines evidence to support the relationship identified above between our exogenous factors and cost, specifically via the following example mechanisms:

(a) Higher surface water flows into the system necessitate larger diameter assets. Larger assets cost more to operate and maintain;

(b) Higher sewer flooding risk exposure increases expenditure on incident response;

(c) UUW must spend more than other companies on managing flood risk

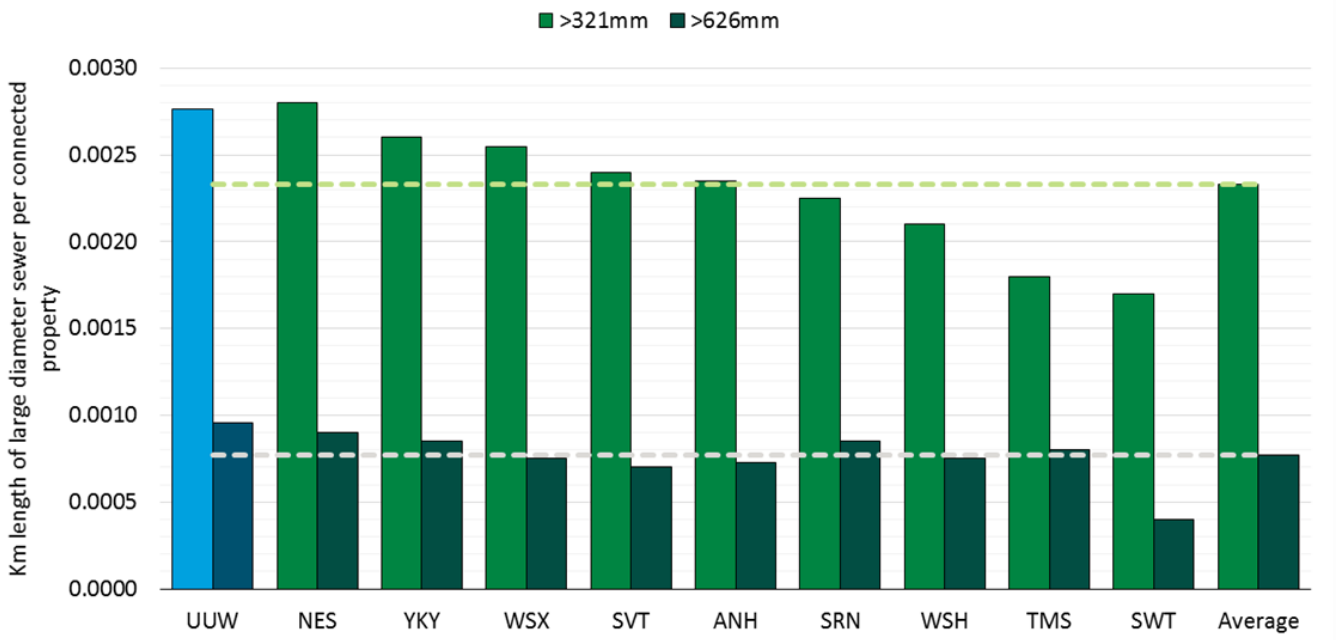
Larger assets drive higher costs

11.3.3 Large volumes of surface water entering the system necessitates a larger asset base to cope with such inflows. UUW has the highest proportion of sewers > 626 mm in diameter in the industry. Large assets require greater expenditure on inspection, rehabilitation and cleaning.

11.3.4 Larger flows into the system necessitate larger assets to avoid upstream hydraulic overloading. Analysis of PR14 business plan data, the latest available industry-wide data, demonstrates that UUW has the highest proportion of sewers > 626 mm in diameter and the second highest proportion of sewers > 321 mm in diameter (Figure 38). This is despite UUW having the lowest proportion of surface water sewers, which are typically larger in diameter, suggesting that the discrepancies in the size distribution profile would be even more pronounced if combined sewers only were considered. We consider that the use of PR14 data is appropriate as there is no evidence to suggest that the size distribution of assets among companies has changed significantly in the past two AMPs.

[41] Ofwat (2023) *Econometric base cost models for PR24.* Available here

Figure 38: UUW has above average proportions of sewers >321 mm and >626 mm in diameter based on PR14 business plan data (with UUW error corrected as per PR19 claim)



Source: PR14 business plan data.

11.3.5 This is the latest available industry data. It can reasonably be assumed that the size distribution of assets has not changed significantly across the industry since PR14 owing to the long lives of infrastructure assets.

11.3.6 A review of our competitively tendered contracts and cost database unequivocally demonstrates that larger diameter sewers cost more to maintain. For example, sewer cleaning rates from our framework suppliers demonstrate that unit rates increase as sewer diameter increases, especially so in sewers above 900 mm in diameter (Figure 39). Sewer cleaning is fundamental in optimising available storage capacity by reducing siltation and preventing blockage formation, particularly in flat locations such as the base of the 'Manchester bowl'.

Figure 39: Average sewer cleaning rates across our framework contractors by sewer diameter. The cost per m increases with sewer diameter. Source: UUW contractor rates.

[✂]

11.3.7 A similar relationship is also observed for structural assessments (Figure 40.) and sewer rehabilitation (Figure 41). Both of these activities are imperative in maintaining good asset health, especially as combined sewers experience more variable flows and are therefore subject to increasing stresses and strains. However, it can be clearly seen that the cost of structural assessments and sewer repair increase with the diameter of the sewer. As UUW has a greater proportion of larger sewers, and owing to the stresses placed upon combined sewers in accommodating a wide range of flows, it therefore costs UUW more to maintain good asset health.

Figure 40: Average cost of a structural assessment across our framework contractors by sewer diameter. The cost per m increases with sewer diameter. Source: UUW contractor rates.

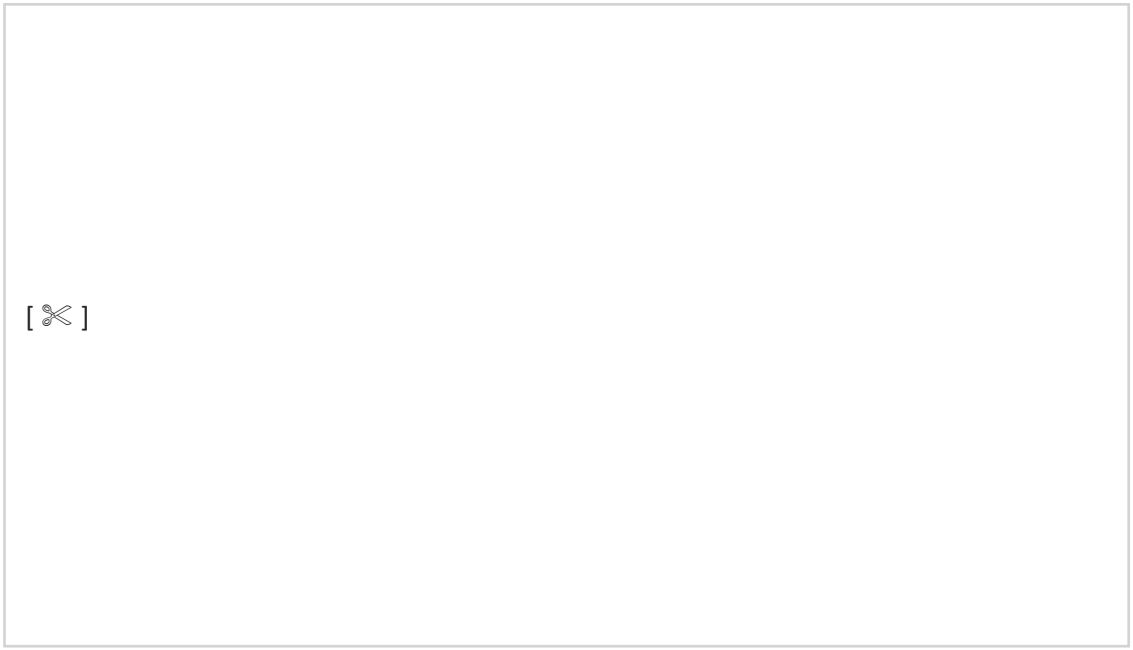
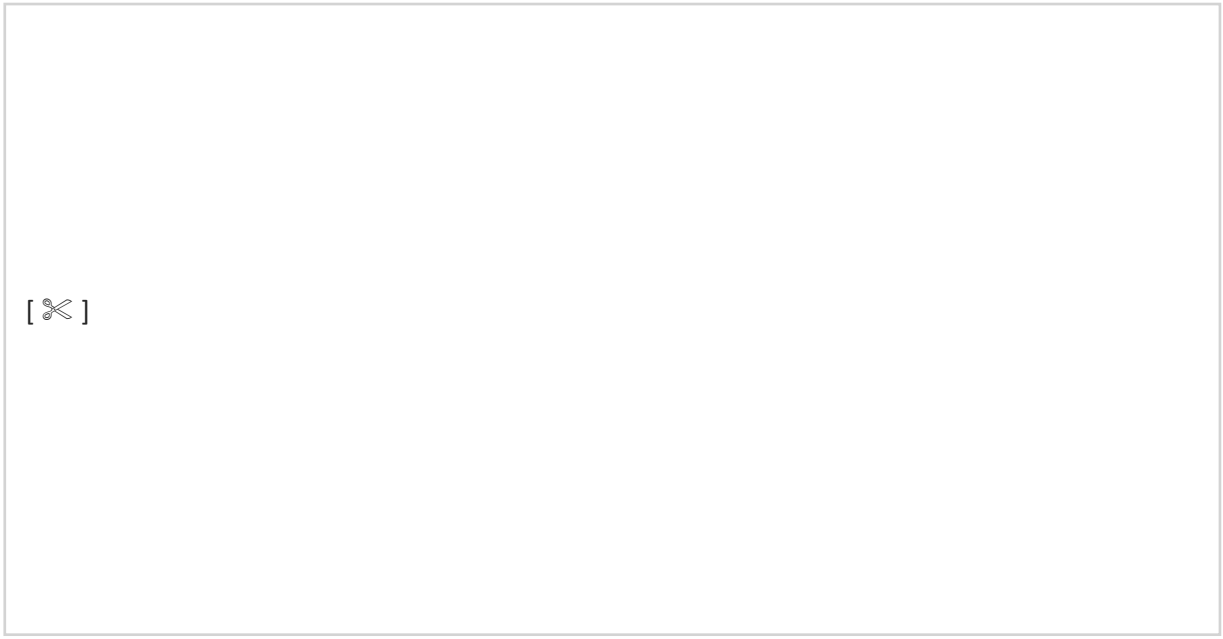


Figure 41: Average cost of a sewer repair across our framework contractors by sewer diameter. The cost per m increases with sewer diameter and this is compounded by depth. Source: UUW contractor rates.



11.3.8 Thus, as UUW has a greater proportion of larger diameter assets than other companies (and with our high proportion of combined sewers), UUW requires additional costs to maintain the same level of sewer serviceability. In increasing sewer serviceability activities in order to manage drainage services in our region, UUW will therefore incur disproportionately high costs.

11.3.9 Additionally, as CSOs act as relief points on the network during periods of high rainfall, operational rationale dictates that, due to our higher urban runoff rate and percentage of combined sewers, current frequency of CSO spills should be expected to be higher than for other companies. As a direct result of our unique circumstances, UUW must therefore install more storage than most other companies to meet customers' and regulators' expectations regarding spill reduction – this storage will also require maintenance in future periods.

11.3.10 Additional storage brings with it additional maintenance requirements that are not accounted for in Ofwat's botex models, including the need for cyclic cleaning and desilitation, as well as inspection of powered assets. Indeed, a review of tank cleaning rates shows that above 500m^3 the cost of tank cleaning increases rapidly as the costs of enabling works, including traffic management and confined space entry procedures (Figure 42); 51% of UUW's tanks exceed this size.

Figure 42: Average cost of tank cleaning across our framework contractors by tank volume. The cost increases with volume. Source: UUW contractor rates.

[✂]

11.3.11 For instances in which UUW must inspect tanks that exceed 5000m^3, costs for cleaning increase exponentially, as a result of the need to implement even more complex traffic management, lifting and safety procedures (Figure 43). Indeed, for an instance in which UUW need to clean a 21,205 m^3 tank, the cost estimate is over £600,000.

Figure 43: Costs of cleaning tanks >5000 m3 can be exceptionally high as a result of the complex traffic management and H&S procedures. Source: UUW contractor rates.

[✂]

11.3.12 Therefore, it is clear that as a result of the need to store and convey more surface water, UUW has larger than average assets. The cleaning, inspection and rehabilitation of these larger assets is more costly and therefore, as a direct result of our unique operating circumstances, UUW incur higher costs that are not accounted for within Ofwat's cost models. UUW therefore requires an upward adjustment to the botex allowance for maintenance of these larger than average assets.

11.3.13 In addition to our existing maintenance needs, this will be exacerbated by the future maintenance that will result from the significant enhancement investment required to meet customer's and regulators' expectations regarding CSO spill reductions. Reducing CSO spill frequency will substantially increase UUW's grey storage volume, and specifically their associated maintenance needs, relative to other companies.

More frequent storms increase incident response costs

11.3.14 As a result of the exposure of the North West to incoming westerly Atlantic depressions42, UUW is highly susceptible to periods of intensive rainfall; an effect that is amplified by the lower hydraulic capacity of combined sewers during such rainfall events. It can therefore be concluded that UUW has greater costs associated with incident response than regions that are less susceptible to such storms.

11.3.15 [✂

]

Higher flood risk requires more expenditure on mitigation

11.3.16 As a result of the interaction between the exogenous factors outlined in this claim, UUW has a higher sewer flooding risk exposure than most other operating regions. We must therefore spend more than other companies on the installation, inspection and maintenance of flood mitigation devices. Expenditure on flood mitigation programmes will increase further in moving towards a common PCL.

[42] Burt and Howden (2013) *North Atlantic Oscillation Amplifies Orographic Precipitation and River Flow in Upland Britain.* Available here

11.3.17 Over the first three years of AMP7, as a direct result of our higher flood risk, we have invested significantly in flood mitigation, installing over 1600 flood mitigation devices, such as flood barriers and non-return valves, at customers' properties. Additionally, we have invested £36 million in our 'hydraulic flood risk resilience' schemes to reduce the impact of hydraulic incapacity through cut and pump solutions as well as planned installation of 9,945 m^3 of storage by the end of AMP7.

11.3.18 Indeed, as outlined in Figure 28 in the preface for this document, UUW has had by far the largest total expenditure per 10,000 sewer connections on 'reducing flooding risk for properties' over the first two years of AMP7 and expenditure 27.9% above the industry average over the period 2011-12 to 2021-22. Thus, UUW incurs more costs on the installation of flood mitigation measures, as well as their inspection, maintenance and replacement, than Ofwat's current cost models allow for. In moving towards a common PCL, these costs will only increase further.

Materiality: Summary

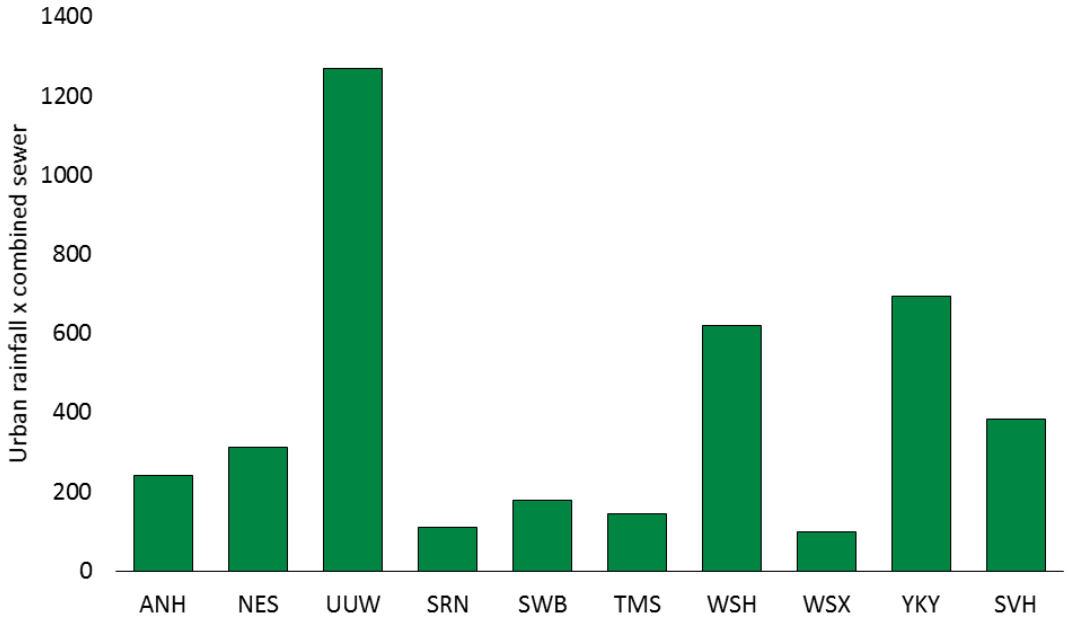
11.3.19 UUW presents compelling evidence that exogenous factors are material drivers of expenditure. As outlined in Section 11.1, these factors are not distributed evenly across operating regions. As a result, relative to other companies, UUW will experience higher ongoing baseline costs on sewage collection activities and additional growth in expenditure on 'reducing flood risk for properties' in moving towards a common PCL.

11.4 Adjustment to allowances (including implicit allowance)

11.4.1 As we set out in 11.2.1, there are key exogenous factors that drive additional costs and performance challenges in the North West. In UUW's submission to Ofwat's econometric model consultation, UUW proposed a set of sewage collection models that reflected these exogenous factors and which drew upon UUW's prior work in this area. In Ofwat's consultation model suite, Ofwat has included urban rainfall across a subset of its sewage collection and wastewater network plus models. It did not choose to reflect combined sewer prevalence or the interaction effects between urban rainfall and combined sewers.

11.4.2 We have calculated the value of this cost adjustment claim by reference to a model suite that reflects the issues that prevail, namely high volumes of urban rainfall and a high prevalence of combined sewers. This model suite is identical to Ofwat's consultation model suite but includes an 'interaction term' across all sewage collection models SWC1-SWC3 and wastewater network plus models (WWNP1-WWNP4). We do not use models SWC4-SWC6 or WWNP5-WWNP8 because these models include an urban rainfall term – we do use these models as part of Ofwat's full recommended model suite to calculate the implicit allowance. The interaction term was calculated by multiplying urban run-off with the percentage of combined sewers (Figure 44). This variable is uncorrelated with scale; the correlation between the interaction term and number of properties is 0.09 and length of sewers 0.16.

Figure 44: Creating a combined variable allows us to consider the joint effect of urban run-off and combined sewers

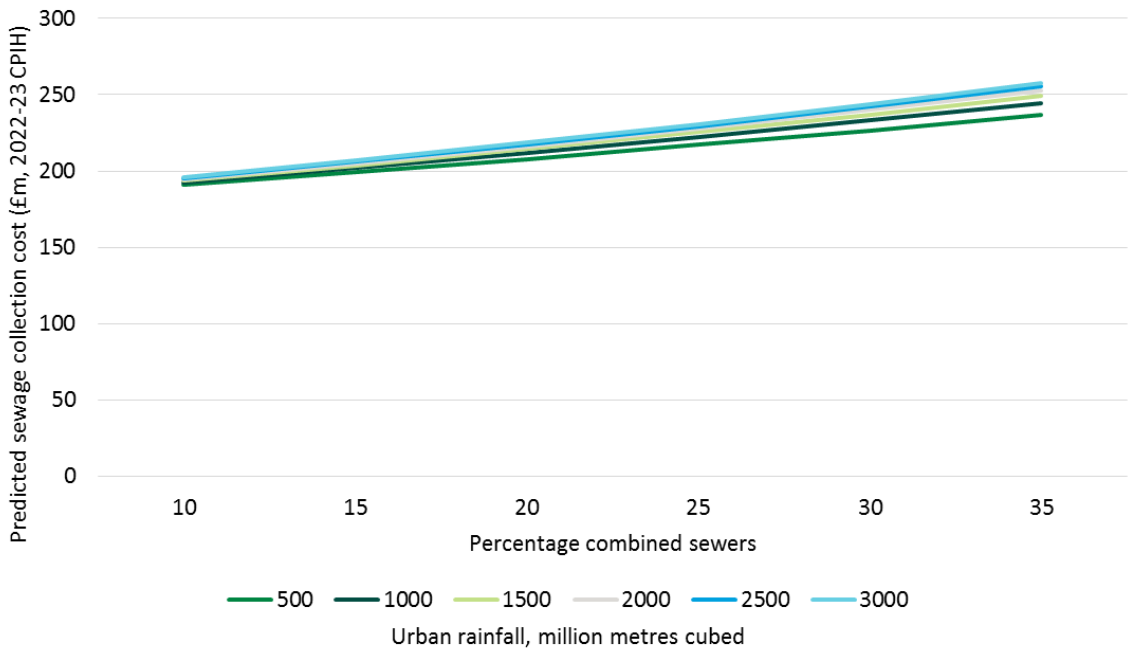


Source: UUW analysis using APR data

11.4.3 We consider that this interaction term represents the most appropriate way to reflect the engineering, operational and economic rationale set out in Section 11.1 than a standalone urban rainfall or combined sewers variable. This is because the interaction term is better able to capture the sensitivity of combined sewers to urban rainfall, and also avoids overstating the impact of high run-off in areas with significant amounts of surface water separation (i.e. low levels of combined sewers). For example, in an alternative model where urban rainfall and combined sewers are included as individual independent variables, the interpretation of the coefficient on the urban rainfall variable would be 'the marginal effect of urban rainfall on cost, holding all other factors constant - including combined sewers'. However, this does not align with our engineering priors, which demonstrate an inter-relationship between these variables i.e. the impact of one variable upon cost depends upon the relative size of the other. The use of an interaction term allows us to introduce this inter-relationship into the cost assessment framework.

11.4.4 The effect of the interaction term can be intuitively understood through a graph. Figure 45 illustrates how the effect of combined sewers on sewage collection costs changes as the volume of urban rainfall changes. At lower levels of urban rainfall, the marginal effect of combined sewers on costs is lower whereas at higher levels of urban rainfall, the marginal effect increases. We consider that the range of marginal effects set out in Figure 45 represents a credible range of the impact of combined sewers and urban rainfall on sewage collection costs.

Figure 45: The effect of the interaction term in model SWC2



Source: UUW analysis

11.4.5 We added this interaction term into Ofwat's recommended model suite. For the purposes of this claim, we did not consider Ofwat's models that include an urban rainfall variable (models SWC4-SWC6 and WWNP5-WWNP8), as these models are reflected in our implicit allowance calculations.

11.4.6 Table 25 shows the model results. It is clear that the interaction term has a material and statistically significant impact upon modelled botex, and there is no deterioration in model performance as a result of its inclusion.

Table 25: Model suite we used to value the cost adjustment claim

	SWC1	SWC2	SWC3	WWNP1	WWNP2	WWNP3	WWNP4
ln(sewer length)	0.849***	0.922***	0.900***				
	{0.000}	{0.000}	{0.000}				
ln(pumping capacity per km)	0.426***	0.711***	0.657***	0.453***	0.487***	0.464***	0.383***
	{0.002}	{0.000}	{0.000}	{0.000}	{0.000}	{0.000}	{0.000}
ln(property density)	1.028***						
	{0.000}						
% combined sewers x ln(urban rainfall)	0.066**	0.138***	0.137***	0.080***	0.088***	0.097***	0.074***
	{0.028}	{0.000}	{0.001}	{0.002}	{0.000}	{0.000}	{0.001}
ln(WAD – MSOA to LAD)		0.275***					
		{0.002}					
ln(WAD – MSOA)			0.435***				
			{0.000}				
ln(load)				0.692***	0.791***	0.787***	0.745***
				{0.000}	{0.000}	{0.000}	{0.000}
pctbands13					0.025***		
					{0.000}		
				0.005***	0.005***	0.005***	0.005***

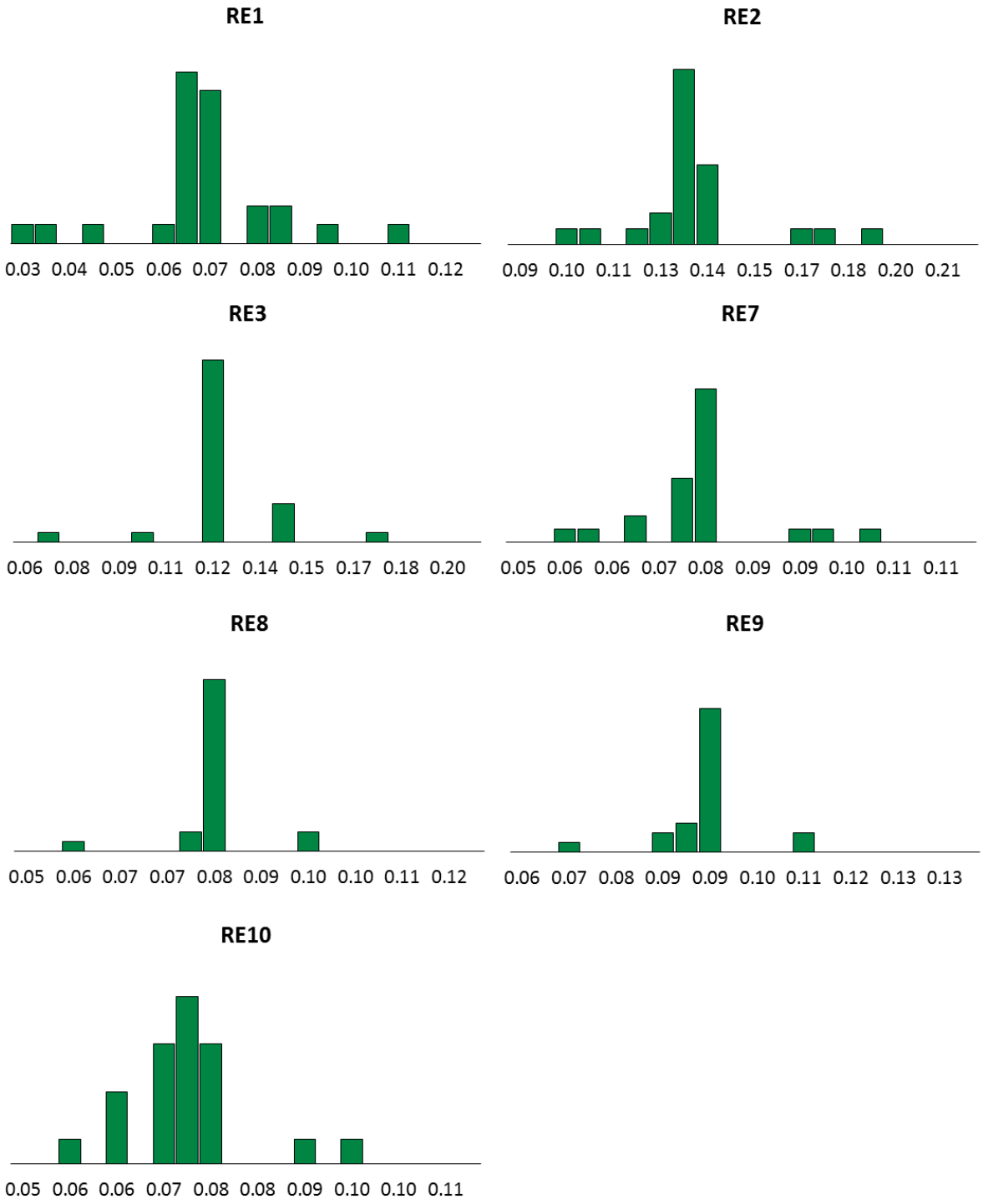
	SWC1	SWC2	SWC3	WWNP1	WWNP2	WWNP3	WWNP4
% load with ammonia consent less than 3mg/l				{0.000}	{0.000}	{0.000}	{0.000}
% STWs larger than 100k						-0.004***	
						{0.000}	
ln(WATS)							-0.078***
							{0.000}
Constant	-8.357***	-7.526***	-8.713***	-3.548***	-4.919***	-4.543***	-3.432***
	{0.000}	{0.000}	{0.000}	{0.000}	{0.000}	{0.000}	{0.000}
R squared	0.921	0.913	0.913	0.96	0.967	0.966	0.966
RESET test	0	0.189	0.271	0.154	0.214	0.888	0.837

Source: UUW analysis

11.4.7 We have also found this variable to be robust to changes in the underlying dataset. We systematically dropped companies and years and re-estimated the models. Figure 46 shows how the coefficient on the interaction term responds to these changes. The tight grouping around the coefficient's central value demonstrates that the variable is robust to underlying changes in the dataset. This is strong evidence that the variable reflects underlying engineering priors and is not affected by outlier observations.

11.4.8 Therefore, the strong engineering, operational rationale underpinning this variable (as set above) combined with its robust model performance supports its use within our claim valuation.

Figure 46: The interaction term's coefficient is robust to changes in the underlying dataset



Source: UUW analysis

How we calculated the claim value and proposed symmetrical adjustment

11.4.9 There are four stages to UUW's calculation of the proposed symmetrical adjustment:

(1) Gross claim. First, we calculated an allowance using models SWC1-SWC3 and WWNP1-WWNP4 in Ofwat's recommended model suite. These models do not include an urban rainfall variable and so the resulting allowance acts as the base comparator. We then calculated the allowance from the models set out in Table 25 above. The difference between them represents the AMP8 allowance for all companies as a result of including the interaction term in Ofwat's model suite. We used an upper quartile catch-up efficiency

challenge combined with a frontier shift assumption of ~~0.6%~~ 0.55% to generate these allowances. We provide justification for these assumptions in Section 12.

(2) Implicit allowance. Ofwat's recommended model suite contains an urban rainfall factor across a subset of models. This means that it contains an implicit allowance for urban rainfall. To calculate this implicit allowance, we calculate the difference in total allowances between Ofwat's consultation model suite and a version of the model suite with no urban rainfall variable.

(3) Gross claim minus implicit allowance. We subtract the implicit allowance from the raw adjustment to calculate a net raw adjustment.

(4) Net symmetrical adjustment. We alter the 'net raw adjustment' to ensure that the overall industry adjustment equals zero. To do this, we subtract the net raw adjustment for each company from the average raw adjustment for all companies. This has the effect of adjusting all companies' allowances downwards.

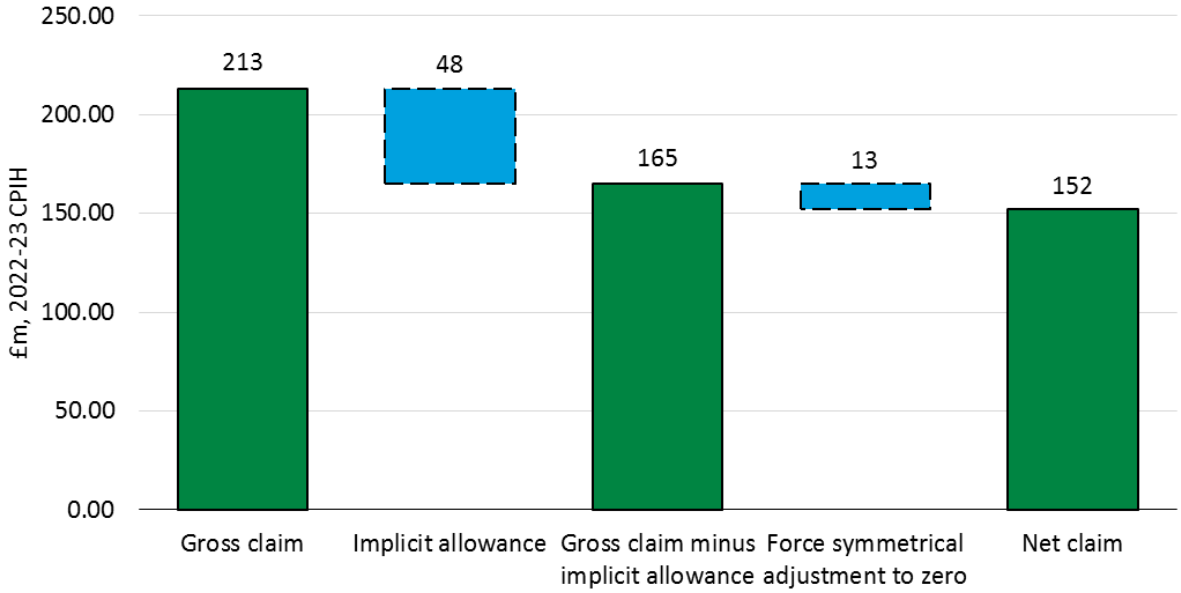
Table 26: UUW's proposed symmetrical adjustment for drainage (£ millions)

Company	Gross claim	Implicit Allowance	Net claim minus implicit allowance	Net Symmetrical Adjustment
ANH	-9.75	-16.9	7.2	-5.6
NES	18.10	-3.1	21.2	8.4
NWT	213.15	48.3	164.9	152.1
SRN	-0.39	11.4	-11.8	-24.5
SVH	-29.67	6.2	-35.8	-48.6
SWB	5.87	-1.6	7.5	-5.3
TMS	-127.95	-12.7	-115.3	-128.1
WSH	46.19	30.1	16.1	3.4
WSX	-58.49	0.6	-59.1	-71.9
YKY	145.78	13.0	132.8	120.0
Total	**202.86**	**75.19**	**127.67**	**0.00**

Source: UUW analysis

11.4.10 The adjustment to UUW's claim as a result of these calculations is illustrated in Figure 47.

Figure 47: Adjustment to UUW allowances



An adjustment to the model suite will not be sufficient for UUW to achieve Ofwat's upper quartile target.

11.4.11 As we stated in section 9.1.7., we do not consider that this amount is sufficient to hit Ofwat's upper quartile target for internal sewer flooding. The cost models allocate historical expenditure. However, no company with UUW's characteristics (high levels of urban rainfall, high prevalence of combined sewers) has achieved performance consistent with Ofwat's upper quartile target. This means that the costs of hitting the upper quartile target are not present within the historical dataset and therefore cannot be allocated by the cost models even if a factor reflecting urban run-off and combined sewer is adopted. This is why we consider the most appropriate outcome is for an environmentally adjusted PCL for internal sewer flooding.

11.4.12 Furthermore, this proposed cost adjustment is wholly independent of the enhancement investment proposed through the WINEP to reduce overflow spill frequency from our current level (which reflects compliance with existing permits). It also does not support Ofwat's proposed 2025 target of an average of 20 spills an overflow. A 2022 update of the EDM return data set out in our Future Ideas Lab paper 'Storm Overflow Incentives for PR24'[43], shows that only 21% of spills from overflows identified as spilling over the Storm Overflow Assessment Framework (SOAF) thresholds of >60x annually are due to operational and maintenance issues (***Table 27***), with the remainder being due to hydraulic capacity. Meeting such a target is therefore entirely unachievable from base expenditure and will require large-scale investment in storage and rainwater management solutions through successive WINEP programmes.

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[43] UUW (2022) *Storm overflow incentives for PR24.* Available here

Table 27: 2022 Overflow performance by company. UUW has the joint highest percentage of spills (79%) that are due to hydraulic capacity. Addressing such spills will require large-scale enhancement investment in storage and rainwater management solutions.

Source		WSX	ANH	TMS	SRN	NES	WSH	SVT	SWB	UUW	YKY	Total/average
Table 1	Total no. storm overflows listed in the annual return 2022	1300	1552	777	978	1564	126	2466	1342	2254	2221	14580
Table 1	Average no. spills per storm overflow with spill data in 2022	18.5	15.3	17	17.8	20.3	23.3	18.4	28.5	35.1	25.6	21.98
Table 2	Total duration (hrs) of monitored spill events in 2022	129957	89514	74693	146819	107536	9470	249116	290271	425491	232054	1754921
Table 5	Of those that spilt over SOAF thresholds of >60x in one year, what % is due to operational?	44%	48%	39%	0%	9%	0%	1%	11%	21%	26%	20%
Table 5	Of those that spilt over SOAF thresholds of >60x in one year, what % is due to hydraulic capacity?	13%	17%	58%	0%	79%	0%	38%	55%	79%	69%	41%

Note: Percentages do not always add up to 100 as the table does not show instances where the root cause is listed as N/A.

Source: EA EDM Annual Returns. Available here

12. Cost efficiency

Our claim valuation includes both a catch-up and frontier shift efficiency challenge

12.1.1 As set out in section 11.4, our claim value is derived using a modelled approach. This approach draws upon the framework implemented by Ofwat during PR19 to derive efficient cost allowances, namely generate allowances from econometric models based upon companies' data and then apply a catch-up and frontier-shift efficiency challenge. This process is set out in Table 28. This table also reproduces the adjustments set out in Table 26 in Section 11.4 to demonstrate how the gross claim value is adjusted to account for the implicit allowance and to force the symmetrical adjustment to zero to arrive at the net claim value of ~~£152.6~~ £152.1 million.

Table 28: The effect of the catch-up and frontier-shift efficiency challenges

	Triangulated wholesale allowance, pre-efficiency	Upper quartile catch-up challenge	Frontier shift challenge	Efficient allowance
Ofwat's base comparator model suite (excluding SWC4-6 and WWNP5-8)	2,244	-38	-36	2,170
Introduce interaction term between urban rainfall and combined sewers	2,442	-19	-40	2,383
Gross claim value	198	19	-4	213
Implicit allowance				48
Gross claim value minus implicit allowance				165
Force symmetrical adjustment to zero				13
Net claim value				152

Source: UUW analysis

12.1.2 As part of our main business plan submission, we provide a claim valuation excluding frontier shift. This is set out in Table 29.

Table 29: Drainage claim valuation without frontier shift challenge

	Triangulated wholesale allowance, pre-efficiency	Upper quartile catch-up challenge	Frontier shift challenge	Efficient allowance
Ofwat's base comparator model suite (excluding SWC4-6 and WWNP5-8)	2,244	-38	0	2,207
Introduce interaction term between urban rainfall and combined sewers	2,442	-19	0	2,423
Gross claim value	198	19	0	217
Implicit allowance				49
Gross claim value minus implicit allowance				168
Force symmetrical adjustment to zero				13
Net claim value				155

12.1.3 This demonstrates that the gross adjustment is post-efficiency challenges so is efficient~~, as per Ofwat's PR19 cost assessment framework. We have supplied the supporting documentation and files that~~

~~generate the claim value alongside this document~~. We supplied the supporting documentation and files that generated the claim value alongside our early cost adjustment submission.

12.1.4 Table 26 in Section 11.4 ~~demonstrates~~ demonstrated how the gross claim value is adjusted to account for the implicit allowance and to force the symmetrical adjustment to zero to arrive at the net claim value of ~~£152.6~~ £152.1 million.

12.1.5 We have used the following assumptions for the catch-up and frontier-shift efficiency challenges:

- **Catch-up efficiency challenge.** We have implemented an upper quartile catch-up challenge. The catch-up challenge relies upon a spread of residuals around the line of best fit estimated by the model. This means that when the catch-up challenged is strengthened, it becomes increasingly influenced by a smaller number of outlier observations. This increases the risk that the catch-up challenge is subject to statistical noise or bias i.e. the benchmark company may be one that is subject to particularly benign regional operating circumstances. As such, we consider the upper quartile is the maximum catch-up challenge that should be considered in cost assessment. The CMA concurred with this view in its redetermination: *"We decide that the upper quartile is the appropriate level of the efficiency benchmark. This balances our objective of setting a challenging benchmark while acknowledging the limitations of the econometric modelling (and the consequent risk that the company will have insufficient allowed revenue)."*[44]
- **Frontier-shift efficiency challenge.** We implement a slightly stronger challenge than the mid-point of the range Economic Insight identified in a study[45] it carried out on behalf of a consortium of companies. The PR24-focused range identified by Economic Insight was 0.3% to 0.7%, meaning the mid-point is 0.5% per year. We consider that the mid-point is justified because the frontier shift estimate produced by EU-KLEMS data is potentially subject to both upwards and downwards bias. There is a risk of downwards bias (i.e. the estimate being too low) due to question marks over the extent to which embodied technical change is reflected in the estimate. There is a risk of upwards bias (i.e. the estimate being too high) due to the presence of catch-up efficiencies within the EU-KLEMS data, the presence of which would produce a double count in the catch-up efficiency challenge. However, there is no robust way to quantify these opposing factors. Therefore, we consider the mid-point to be an appropriate and pragmatic estimate for frontier shift. We do not net off any Real Price Effects (RPEs) against the frontier shift challenge. We added an additional stretch to the mid-point to reflect the uncertainty inherent in estimation of the frontier shift, resulting in an overall frontier shift challenge of 0.55% per year. For final business plan submission, we have provided a claim valuation without a frontier shift assumption applied. This is set out in Table 29.

12.1.6 In addition to these explicit efficiency challenges, we are also subject to a number of implicit efficiency challenges. Section 11.1 of this claim sets out the regional factors that impact on the costs and performance. However, this claim only relates to the impact of urban rainfall and combined sewers. Therefore, the effect of the other regional factors act as a source of implicit efficiency challenge.

Third party assurance of our claim value

12.1.7 We have sought external assurance from PwC for the methodology and information used to derive our claim value. An extract from PwC's report is provided below.

"As a result of the work performed, we can conclude that management has developed a detailed and logical methodology for producing each cost build and the approach followed to develop the cost estimates appears robust. We have undertaken detailed walkthroughs to understand the source of the cost data and rationale for assumptions and estimates made. We have not identified any priority actions which require attention in advance of the submission."

[44] CMA (2021) *Final Report*. Available here.

[45] Economic Insight (2023) *Productivity and frontier shift at PR24. Available here.*

13. Need for investment

13.1.1 As we are requesting an adjustment to our cost baselines and not proposing discrete investment/interventions, we do not consider this section applicable. Indeed, in their Final Methodology Ofwat state *"But need for investment… may only be required for specific cost adjustment claims (e.g. a large, atypical investment which may not be included in our cost baselines)".* We do not consider this claim to be an atypical investment. Ofwat also deemed the equivalent section to be N/A during its PR19 Final Determinations for this reason:

Assessment gates		
Need for investment	N/A	Adjustment to cost baselines.

14. Best option for customers

Note: We do not expect all of Ofwat's questions for this assessment gate to be directly relevant to the case, as this claim pertains to an adjustment to cost baselines to reflect ongoing operation and maintenance costs rather than discrete interventions. Indeed, Ofwat also determined this assessment gate to be 'N/A' during the PR19 Final Determinations for this reason. However, we choose to use this section to reflect our preferred hierarchy of options for reflecting exogenous factors, as well as provide justification for why a one-off claim for system reconfiguration was discounted.

14.1.1 Customer research demonstrates that sewer flooding performance is a key priority for customers. We are therefore committed to stretching ourselves to the limits of what is achievable within the constraints imposed by our unique operating circumstances. In the first instance, we therefore consider that PCLs adjusted for a region's operating circumstances are the most appropriate way to achieve this while limiting impact on customers' bills (this is set out in Appendix A). If, however, Ofwat rejects our proposal for an environmentally adjusted PCL, then this cost adjustment claim will ensure UUW's cost allowances better reflect the challenging operating environment we face for managing drainage services.

14.1.2 UUW recognises that internal sewer flooding is one of the worst service failures that customers can experience. Indeed, qualitative joint research conducted by CCW and Ofwat shows that any type of sewer flooding has a significant negative impact on customers irrespective of severity, with feelings of stress, anxiety, hopelessness and disempowerment reported by customers[46]. UUW's own customer research into sewer flooding experiences further confirms the scale of the long-term psychosocial impact of flooding[47].

14.1.3 We are therefore committed to stretching ourselves to the limits of what is achievable within the constraints imposed by our unique operating circumstances. It is for this reason that we propose that the PCL for internal sewer flooding is set at the maximum level of performance modelled to be achievable within the constraints imposed by our unique operating circumstances (i.e. at the frontier level of performance predicted by our sewer flooding PCL model). While this represents an extremely stretching position, we believe that it is possible to achieve this level of performance economically without the need for a further uplift to the modelled **botex** allowance. In this way, we can limit the impact to our customer's bills.

14.1.4 Furthermore, we consider that PCLs adjusted for a region's operating circumstances present the best outcome for customers of all WaSCs. Ofwat's existing approach of setting common PCLs for sewer flooding distorts incentives between companies, leading to suboptimal outcomes for customers. In our PR24 business plan submission, we ~~will~~ therefore recommend an environmentally adjusted PCL for internal flooding for all WaSCs. In this way, all companies receive a challenge that is as equally stretching, meaning that customers across the country are paying for an equivalently efficient and stretching level of service. UUW therefore considers that environmentally adjusted PCLs are the best option for customers nationally. Appendix E sets out more detail regarding how UUW considers the regulatory framework should be adjusted to adequately reflect the influence of exogenous factors and thereby provide the best outcome for customers of all WaSCs.

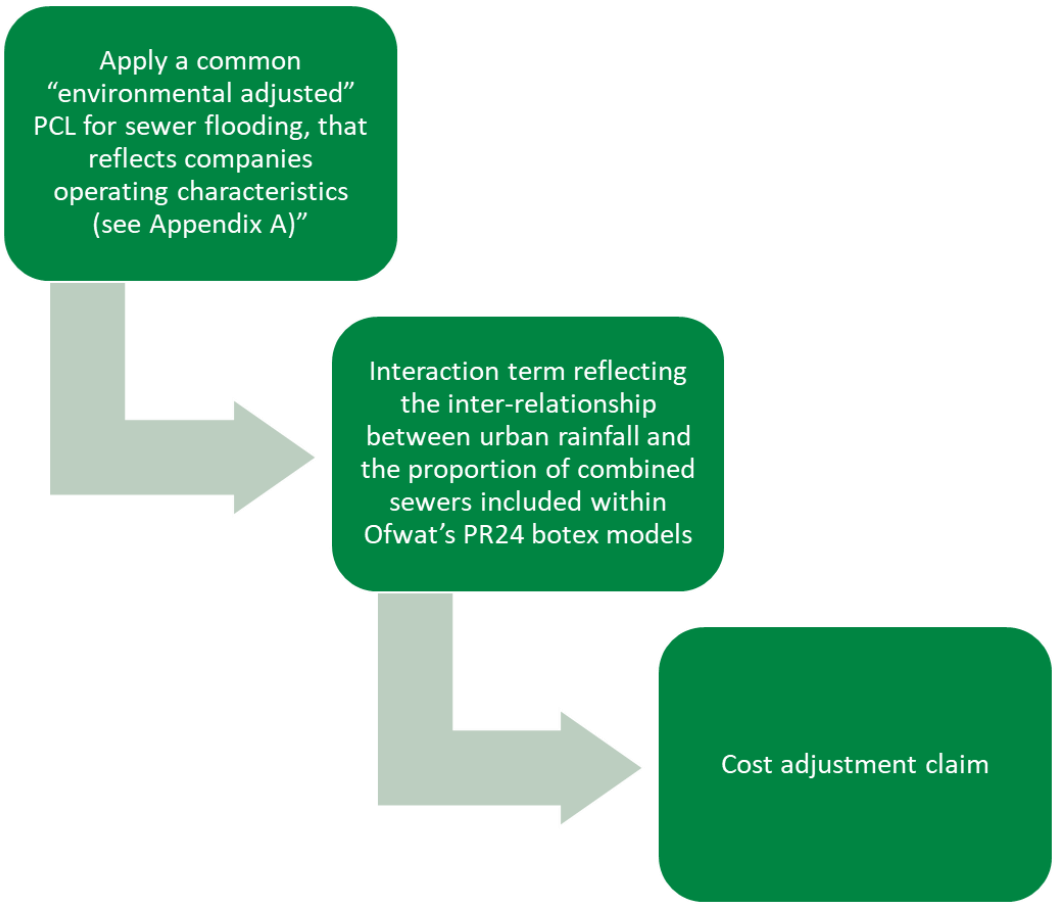
14.1.5 If, however, our PCLs are not adjusted for our unique operating circumstances (Figure 48), we have presented compelling evidence to demonstrate that UUW will incur higher costs that reflect the challenging environment in which we are managing drainage services. We consider the next most appropriate outcome for customers would therefore be for an interaction term reflecting urban rainfall and combined sewers to be included within all sewage collection and wastewater network plus models. We have made representations to this effect in our response to the PR24 Econometric Base Cost Models

[46] Ofwat (2022) *Customer experiences of sewer flooding: A joint report by CCW and Ofwat.* Available here.

[47] UUW (2021) *Sewer Flooding Experience.* Available here

Consultation. If this does not occur, we consider this cost adjustment claim to be the next best option for customers.

Figure 48: In developing the best option for customers, we considered a range of options for how the exogenous circumstances at play within companies' operating regions could be accounted for.



14.1.6 In the short to medium-term, if our proposal for an environmentally adjusted PCL for internal sewer flooding is not accepted, we consider this claim to be the most appropriate option for customers, whilst our longer-term vision to reduce rainwater entering combined systems is enacted. In this way, bill impacts can be kept to a minimum.

15. Customer protection

15.1.1 This claim is proposing a more appropriate allocation of botex costs that better reflects the operating circumstances facing companies in delivering drainage services. As such this better protects customer in more favourable regions from overpaying for services, and protects customers in adverse regions from the risks associated with companies being underfunded for operating and maintenance activities.

15.1.2 Customers are also protected from partial or non-delivery of this investment through the many drainage related PCLs that will apply to companies during AMP8, including internal sewer flooding, external sewer flooding, storm overflows, total and serious pollution and sewer collapses.

15.1.3 Table 30 outlines how each of these performance commitments would be affected by failure to deliver the investment outlined in this claim.

Table 30: An outline of the performance commitments that provide protection if the investment is cancelled, delayed or reduced in scope

Performance Commitment	How Does this Protect Customers?
Internal Sewer Flooding	The claim value includes both operation and maintenance costs allocated to 'sewage collection' activities, as well as an allowance for 'reducing flood risk for properties'. If UUW fails to deliver the expenditure set out within this claim, we can therefore expect to observe both FoC (flooding other causes) and hydraulic flooding incidents in areas where we would have otherwise avoided them. For example, additional properties that could have benefitted from flood mitigation measures may flood without this investment. This will be reflected in underperformance payments for those incidents.
External Sewer Flooding	
Storm Overflows	While the majority of spills are caused by hydraulic inadequacy and can only be addressed by enhancement investment in storage solutions/hybrid interventions outside of the scope of this botex claim, this claim will support the ongoing maintenance and management of our existing storage availability. Underinvestment in this area will put at risk our ability to achieve the spill reduction performance that is expected to be delivered from our enhancement programme. If key storage assets cannot perform as designed, spill performance will deteriorate and will be reflected in underperformance payments for the 'storm overflows' performance commitment.
Pollution	While not direct drivers for this claim, these measures reflect the underlying performance of our asset base. If the additional botex is not spent on the operation and maintenance activities outlined in this claim, including sewer cleaning and structural assessments (serviceability), the benefits for these measures will not be realised and underperformance payments may be incurred.
Sewer Collapses	

Table 31: Summary of UUW's claim against Ofwat's assessment criteria

Assessment gate	Assessment gate question	Summary of evidence	Reference
Need for adjustment	a) Is there compelling evidence that the company has unique circumstances that warrant a separate cost adjustment?	We set out extensive evidence of the regional factors that make UUW unique.	Section 11.1
Need for adjustment	b) Is there compelling evidence that the company faces higher efficient costs in the round compared to its peers (considering, where relevant, circumstances that drive higher costs for other companies that the company does not face)?	We demonstrate that UUW faces a unique mix of regional factors that other companies do not face. We refer to third party work that demonstrates offsetting benefits are immaterial or non-existent.	Section 11.1 Table 24
Need for adjustment	c) Is there compelling evidence of alternative options being considered, where relevant?	N/a – the claim relates to general ongoing operational complexity.	
Need for adjustment	d) Is the investment driven by factors outside of management control?	We set out extensive evidence of the regional factors that make UUW unique. It is clear that these factors are outside of management control.	Section 11.1 Section 11.2
Need for adjustment	e) Have steps been taken to control costs and have potential cost savings (eg spend to save) been accounted for?	We evidence a range of interventions we have implemented to minimise the impact of the regional exogenous factors. We also restrict our claim to two key regional factors and accept the detrimental influence of the remaining factors as an implicit efficiency challenge.	Paragraph 11.2.2
Need for adjustment	f) Is there compelling evidence that the factor is a material driver of expenditure with a clear engineering / economic rationale?	We demonstrate that an interaction including urban rainfall and combined sewers is statistically significant within an industry model. We also present extensive evidence that market-tested contractor rates increase as the asset size increases.	Table 25 Section 11.3
Need for adjustment	g) Is there compelling quantitative evidence of how the factor impacts the company's expenditure?	We demonstrate that an interaction including urban rainfall and combined sewers is statistically significant within an industry model. We also present extensive evidence that market-tested contractor rates increase as the asset size increases.	Table 25 Section 11.3
Need for adjustment	h) Is there compelling evidence that the cost claim is not included in our modelled baseline (or, if the models are not known, would be unlikely to be included)? Is there compelling evidence that the factor is not covered by one or more cost drivers included in the cost models?	Ofwat's recommended model suite provides an implicit allowance relating to urban rainfall. However, it does not provide an allowance for the other regional factors highlighted in this claim. Our claim reflects the implicit allowance for urban rainfall within its net value.	Section 11.4
Need for adjustment	i) Is the claim material after deduction of an implicit allowance? Has the company considered a range of estimates for the implicit allowance?	Ofwat's recommended model suite provides an implicit allowance relating to urban rainfall. However, it does not provide an allowance for the other regional factors highlighted in this claim. Our claim reflects the implicit allowance for urban rainfall within its net value and is still material.	Section 11.4
Need for adjustment	j) Has the company accounted for cost savings and/or benefits from offsetting circumstances, where relevant?	We demonstrate that UUW faces a unique mix of regional factors that other companies do not face. We refer to third party work that demonstrates offsetting benefits are immaterial or non-existent.	Section 11.1 Table 24
Need for adjustment	k) Is it clear the cost allowances would, in the round, be insufficient to accommodate the factor without a claim?	We demonstrate that UUW faces a unique mix of regional factors that other companies do not face. We refer to third party work that demonstrates offsetting benefits are immaterial or non-existent.	Section 11.1 Table 24

Assessment gate	Assessment gate question	Summary of evidence	Reference
Need for adjustment	l) Has the company taken a long-term view of the allowance and balanced expenditure requirements between multiple regulatory periods? Has the company considered whether our long-term allowance provides sufficient funding?	N/a - our claim relates to general ongoing higher operating and maintenance costs driven by our regional operating environment. As such expenditure cannot be balanced over the long-term.	
Need for adjustment	m) If an alternative explanatory variable is used to calculate the cost adjustment, why is it superior to the explanatory variables in our cost models?	We demonstrate that the interaction term reflecting both urban rainfall and combined sewers better aligns with engineering and operational rationale as it is able to reflect their joint effect on costs.	Section 11.4
Cost efficiency	a) Is there compelling evidence that the cost estimates are efficient (for example similar scheme outturn data, industry and/or external cost benchmarking, testing a range of cost models)?	We derived our claim value based upon Ofwat's recommended model suite with efficiency challenges applied. This means that our claim value reflects the costs of the benchmark efficient company.	Section 11.4
Cost efficiency	b) Does the company clearly explain how it arrived at the cost estimate? Can the analysis be replicated? Is there supporting evidence for any key statements or assumptions?	This document clearly sets out how we valued our claim. We also supplied all supporting analytical files as part of our early cost adjustment submission.	Section 12
Cost efficiency	c) Does the company provide third party assurance for the robustness of the cost estimates?	PwC provide third party assurance for our claim and cost estimates.	Paragraph 12.1.7
Need for investment	a) Is there compelling evidence that investment is required?	N/a – this claim does not relate to a discrete investment.	
Need for investment	b) Is the scale and timing of the investment fully justified?	N/a – this claim does not relate to a discrete investment.	
Need for investment	c) Does the need and/or proposed investment overlap with activities already funded at previous price reviews?	N/a – this claim does not relate to a discrete investment.	
Need for investment	d) Is there compelling evidence that customers support the need for investment (both scale and timing)?	N/a – this claim does not relate to a discrete investment.	
Best option for customers	a) Did the company consider an appropriate range of options to meet the need?	N/a – this claim does not relate to a discrete investment. However, we consider a more preferable option to a cost adjustment is to reflect the regional factors highlighted within this claim through environmentally-adjusted performance targets.	Section 14
Best option for customers	b) Has a cost–benefit analysis been undertaken to select proposed option? There should be compelling evidence that the proposed solution represents best value for customers, communities and the environment in the long term? Is third-party technical assurance of the analysis provided?	N/a – this claim does not relate to a discrete investment.	
Best option for customers	c) Has the impact of the investment on performance commitments been quantified?	N/a – this claim does not relate to a discrete investment.	
Best option for customers	d) Have the uncertainties relating to costs and benefit delivery been explored and mitigated? Have flexible, lower risk and modular solutions been assessed – including where utilisation will be low?	N/a – this claim does not relate to a discrete investment.	

Assessment gate	Assessment gate question	Summary of evidence	Reference
Best option for customers	e) Has the company secured appropriate third-party funding (proportionate to the third party benefits) to deliver the project?	N/a – this claim does not relate to a discrete investment.	
Best option for customers	f) Has the company appropriately presented the scheme to be delivered as Direct Procurement for Customers (DPC) where applicable?	N/a – DPC not appropriate for this claim.	
Best option for customers	g) Where appropriate, have customer views informed the selection of the proposed solution, and have customers been provided sufficient information (including alternatives and its contribution to addressing the need) to have informed views?	N/a – this claim does not relate to a discrete investment.	
Customer protection	a) Are customers protected (via a price control deliverable or performance commitment) if the investment is cancelled, delayed or reduced in scope?	We demonstrate that full customer protection is provided by performance commitments.	Table 30
Customer protection	b) Does the protection cover all the benefits proposed to be delivered and funded (eg primary and wider benefits)?	We demonstrate that full customer protection is provided by performance commitments.	Table 30
Customer protection	c) Does the company provide an explanation for how third-party funding or delivery arrangements will work for relevant investments, including the mechanism for securing sufficient third-party funding?	N/a – there is no third party funding relating to this claim	

Ongoing Phosphorus Removal Cost Adjustment Claim Submission

Cost Adjustment claim submission	
Title:	Ongoing phosphorus removal operating expenditure in AMP8, resulting from AMP7 WINEP investment (£85.2m)
Price Control:	Wastewater Network Plus
Cost adjustment headline:	The AMP7 WINEP requires UUW to comply with phosphorus removal permits at or near the technically achievable limit – less than or equal to 0.5mg/l – at 43 of our WwTWs. The operating expenditure associated with ongoing compliance at these sites is material and will not be reflected in the historical cost record used to inform the efficient benchmark. Therefore, UUW requires an uplift of £85.2m to its costs to facilitate ongoing compliance with its legal obligations.
Description:	The AMP7 WINEP includes 78 new phosphorus removal requirements. Of these, 43 include permit limits of 0.5mg/l or less, which requires a step change in technology compared with historic schemes. The AMP7 P removal programme is reflected within APR table 7F. Complying with P consents at or near the technically achievable level requires substantially higher quantities of chemicals (with the marginal impact of a unit of ferric diminishing in effect as P removal nears the technically achievable level) and additional processes. This acts to increase operating costs significantly relative to those seen historically. This increase in operating costs will not be reflected in the modelled allowance for AMP8. Ongoing operating expenditure relating to the majority of schemes will not start to be incurred until the final year of AMP7, which means this expenditure will not feed through into the efficient benchmark. Therefore, an out-of-model adjustment is required. Ofwat's acceptance of this claim would enable UUW to recover the efficient costs associated with compliance with its statutory obligations under the AMP7 WINEP.

Ongoing phosphorus removal cost adjustment claim summary

Gate	Summary	Location reference
Need for cost adjustment	• The AMP7 WINEP requires UUW to comply with phosphorus removal permits at or near the technically achievable limit – less than 0.5mg/l – at 43 of our WwTWs. Meeting these standards requires substantial volumes of chemicals and/or the installation of new, additional treatment processes. This will drive additional operating costs, materially higher than those incurred historically, for the following reasons: – More load needs to be removed and therefore more iron is required to precipitate it. The quantities of iron required to meet standards below 1mg/l are significantly higher than for standards of 1mg/l and higher; – A greater quantity of iron is required to remove each mole of phosphorus below 1mg/l than is required above 1mg/l; and – Higher quantities of iron requires an alkalinity correction, particularly where waters are soft. This prevents acidity having an undue effect on subsequent processes and assets. • Where appropriate and economic, UUW is seeking to mitigate these higher costs by delivering phosphorus reductions through innovative interventions. For example: – through nutrient catchment balancing in the River Petteril catchment; – through the River Irwell flexible phosphorus permit; – through catchment permit balancing at Bowdon and Macclesfield WwTW; – through biological nutrient removal at our Nereda plants; and – through installation of biological nutrient removal using mobile organic biofilm (MOB) technology at Macclesfield WwTW. • Despite UUW's best efforts at mitigation, the AMP7 WINEP will result in materially higher ongoing costs than seen historically. As the modelled cost benchmark is based upon the historical cost record, the higher ongoing costs associated with P removal at/near the technically achievable limit will not be reflected within the modelled allowance. This is demonstrated by reference to companies' APR22s, which show that the majority of ongoing opex relating to AMP7 WINEP P removal will be incurred from 2024-25 onwards.	*Section 17.1* *Section 17.2* *Section 17.4*
Cost efficiency	• We derive our claim value using APR table 7F, ~~which is due to be~~ published as part of UUW's 2022-23 APR. ~~We supply a copy of this table alongside this claim, ahead of its publication in July 2023~~. • This year's APR represents a more mature view of ongoing opex than that first published in last year's APR. This year's APR is based upon the final operating plans of each project, whereas last year's was largely based upon best expectations at the time of our PR19 business plan submission. Over time, the delivery route of our programme has matured. This has resulted in higher	*Section 18.2* *Section 18.2*

	expected costs than those set out in APR22. We evidence the difference in cost across each of our sites as part of this claim. • We would support the use of 7F data to identify an efficient benchmark for P removal opex, subject to the data being robust and of high quality. However, this data was not available to UUW at the time of this submission.	*Table 36*
Need for investment	• We do not consider this gate to be applicable to this claim because the claim relates to higher ongoing expenditure due to our AMP7 WINEP.	*Section 19*
Best options for customers	• We engaged extensively with the Environment Agency in the lead up to PR19 to appropriately shape the AMP7 WINEP. • We implemented a comprehensive optioneering process to ensure we implemented the most efficient and effective solution. We identified the most cost effective way of meeting the future permit requirements by following the high level solution hierarchy, which demonstrates we only implement relatively expensive solutions when absolutely necessary: (1) Do nothing (2) Operations and Maintenance (3) Optimise Asset (4) Partnership/catchment solution (5) Refurbish asset (6) New asset • Customer research clearly demonstrates that customers support continued compliance with environmental obligations.	*Section 17.2* *Section 20.1* *Section 20.2*
Customer protection	• Customers are protected by the following ODIs in AMP8: (1) Discharge Permit Compliance (2) River Water Quality (Phosphorus) • UUW is liable to prosecution if it does not meet its environmental obligations.	*Section 21.1*

16. Introduction

16.1.1 Phosphorus is a nutrient which is essential to life and as such, is found in high concentrations in wastewater. However, if too much phosphorus is released into the environment within the final effluent from a wastewater treatment works (WwTW), its nutritional properties can cause excessive plant or algae growth and lead to an alteration of the ecosystem from the natural state. It can also cause blue-green algal blooms in some waterbodies, which can prevent people and animals from using the waterbody and can damage the wider ecology of the habitat.

16.1.2 Reducing the concentrations of phosphorus in the final effluent reduces the risk of adverse environmental impacts. The AMP7 WINEP requires us to meet new low phosphorus limits at many treatment works in order to meet the targets of the Water Framework Directive.

16.1.3 Following the national phosphorus removal trials[48], the technically achievable limit for phosphorus was set by the Environment Agency at 0.25mg/l. The AMP7 WINEP includes 43 permit limits less than 0.5mg/l, which require a step change in technology compared with schemes that have been delivered historically. Of these, 16 permits limits are at the boundary of technical feasibility at 0.25mg/l. 39 of these schemes are due for completion in December 2024, of which 14 are at the technically achievable limit (the scheme at Kendal WwTW has a March 2025 regulatory date).

16.1.4 Chemical solutions are the most common intervention because they tend to have the lowest whole-life cost. However, we are seeking to deliver phosphorus reductions through innovative interventions where appropriate and economic. For example:

- Through nutrient catchment balancing in the River Petteril catchment;
- Through the River Irwell flexible phosphorus permit;
- Through catchment permit balancing at Bowdon and Macclesfield WwTW;
- Through biological nutrient removal at our Nereda plants; and,
- Through installation of biological nutrient removal using mobile organic biofilm (MOB) technology at Macclesfield WwTW.

16.1.5 Meeting phosphorus permit limits at or near the technically achievable limit is a relatively new requirement for water companies. This means that the industry has not incurred the associated costs in the past and that the historical record used to inform the cost benchmark will not be reflective of future expenditure requirements. Therefore, a cost adjustment is required to enable the industry to meet its statutory obligations as set out in the WINEP.

16.1.6 We note that Ofwat has raised the possibility of using APR data to benchmark efficient ongoing phosphorus removal opex. While consistent and robust data was not available to UUW at the time of writing this claim, we would support the use of data in table 7F as part of a benchmarking exercise.

16.1.7 This document sets out the evidence to support our proposed cost adjustment relating to the higher ongoing costs we will incur as a result of the WINEP programme in AMP7. Specifically, we are only seeking the efficient costs incurred within AMP8 relating to meeting permit limits less than or equal to 0.5mg/l established as part of the AMP7 WINEP.

16.2 Outline of this document

16.2.1 We have divided our cost adjustment claim into the following sections:

(a) Section 17 provides an overview of the need for this cost adjustment, explaining the Water Industry National Environment Programme at PR19 and the inclusion of very low phosphorus permit limits.

[48] UKWIR (2018) *The National Chemical Investigations Programme 2015-2020, Volume 3 wastewater Treatment Technology Trials; Annex – CIP2 P Trails Innovation results synthesis report.* Available here

The operation of wastewater treatment works to these very low permit requirements is not reflected in the historical data set or within the cost assessment framework so the modelled allowance will be insufficient to maintain our legal obligations to comply with these permit limits.

(b) Section 18 provides evidence that our costs to maintain compliance with very low phosphorus limits are efficient and that all costs are derived from the regulatory reporting table 7F. We also evidence any changes in operating plans since the submission of our PR19 business plan. This is relevant because table 7F in the 2021-22 APR tended to be based upon the PR19 submission due to solutions not being fully mature at the time of last year's APR.

(c) Section 19 sets out why the 'need for investment' test gate is not applicable to this claim. The cost pressure reflected within this claim is a result of the AMP7 WINEP, which represents an ongoing statutory obligation.

(d) Section 20 sets out our approach to optioneering and optimising solutions to demonstrate we have considered a range of options for complying with the very low phosphorus permits, from 'do nothing' where we are able to balance permits across a catchment, to the installation of new assets.

(e) Finally in Section 21 we explain how customers are protected if we are unable to comply with permits.

17. Need for adjustment

17.1 Unique circumstances

17.1.1 This claim does not primarily relate to differences in operating circumstances across company regions, however it does warrant ~~a separate~~ an out of model cost adjustment. The AMP7 WINEP included requirements to meet phosphorus permits at or near the technically achievable limit (below or equal to 0.5mg/l). Meeting phosphorus permits at this level is a new cost driver that isn't materially present in the historical period covered by the dataset. We expect all companies to incur additional operating expenditure relating to phosphorus removal projects set out in the AMP7 WINEP, meaning the industry as a whole requires an expenditure uplift, relative to historical levels.

17.1.2 However, UUW's region does have some features that mean the opex impact of the WINEP is more pronounced:

- Water in the North-West tends to be softer making it harder to balance the pH in the wastewater treatment process.
- Soft water is more acidic than hard water. The dosing of ferric for phosphorus removal further lowers the pH and therefore additional pH correction (in the form of caustic[49] dosing) is required to protect our assets from deterioration (for example, acidic effluent can erode concrete structures). This is particularly the case at sites with low ammonia permits as nitrifying bacteria are sensitive to pH. The nitrifying bacteria consume ammonia within the wastewater. Without appropriate conditions for these bacteria the ammonia permit at the wastewater treatment works is unable to be met. Correction is therefore needed post-ferric dosing to maintain effective denitrification.

17.1.3 Although we have a large number of stringent phosphorus permits within our AMP7 WINEP, UUW is not the only company impacted by the opex growth caused by phosphorus removal. All companies with low phosphorus permit limits are affected by ongoing phosphorus removal opex to some extent, although some companies may be more affected than others, depending upon their AMP7 environmental programmes.

17.1.4 The WINEP is a statutory obligation which requires us to remove phosphorus in line with the permit limit. There are two main interventions available to companies: chemical solutions and biological solutions.

17.1.5 Chemical precipitation of phosphorus is the most common approach as it has the lowest totex whole life cost when it is the sole driver at a treatment works. The technology installed to achieve very low phosphorus permits (below 0.5mg/l) requires a significant amount of iron salts to precipitate the phosphorus as well as alkalinity correction to ensure there is no detrimental impact on the process or undue degradation of concrete structures.

17.1.6 Although biological treatment to remove phosphorus does have the potential for lower chemical operational costs, it does have a relatively high initial capital outlay. Where there are no other environmental drivers, investment in biological phosphorus removal is not the preferred solution as it has a higher whole life cost than chemical precipitation. Also, to robustly achieve the technically achievable limit of 0.25mg/l phosphorus, a chemical 'trim' plus tertiary solids removal may be needed in addition to the biological removal process. An additional challenge is that many of the low phosphorus permits in AMP7 are on smaller more rural sites, where the secondary treatment process tends to be trickling filters. However, creating the conditions for biological phosphorus removal would require an activated sludge process. Therefore a biological phosphorus removal process would require a complete rebuild of the secondary treatment process and therefore significantly greater capital costs.

[49] Caustic soda also known as sodium hydroxide or NaOH is an alkaline used for pH correction in wastewater treatment works

17.1.7 As we discuss in paragraph 17.2.5, we continue to seek innovative solutions to minimise associated costs, as evidenced by our involvement in a related Ofwat innovation fund project - alternatives to chemical dosing for phosphorus removal on small sites [50].

17.1.8 We discuss our approach to selecting the most efficient option in more detail in section 20.

17.2 Management control

17.2.1 The WINEP (Water Industry National Environment Programme) and its predecessor, the National Environment Programme (NEP), states what actions water companies must take to meet their environmental legislative requirements. The environmental policy that needs to be delivered through the WINEP is determined by the UK Government and identified through legislation such as Water Framework Directive and Urban Wastewater Treatment Directive. The WINEP defines the programme of actions required to meet statutory environmental obligations, non-statutory environmental requirements or delivery against a water companies statutory functions[51].

17.2.2 Detail of the UUW AMP7 phosphorus removal programme was set out within our PR19 business plan submission[52]. Throughout AMP7, our programme has matured and, with the agreement of the Environment Agency, our programme has evolved from that submitted at PR19 as we have explored innovative ways of delivering environmental improvements. The current view of the phosphorus removal programme is included in the regulatory reporting table 7F.

17.2.3 In developing our PR19 programme we engaged extensively with the EA in the lead up to PR19 and throughout AMP7 to ensure the WINEP delivers significant environmental improvements as efficiently as possible. However, while we have appropriately engaged with the EA to shape our WINEP to the extent possible, ultimately the WINEP is a statutory obligation with which UUW must comply.

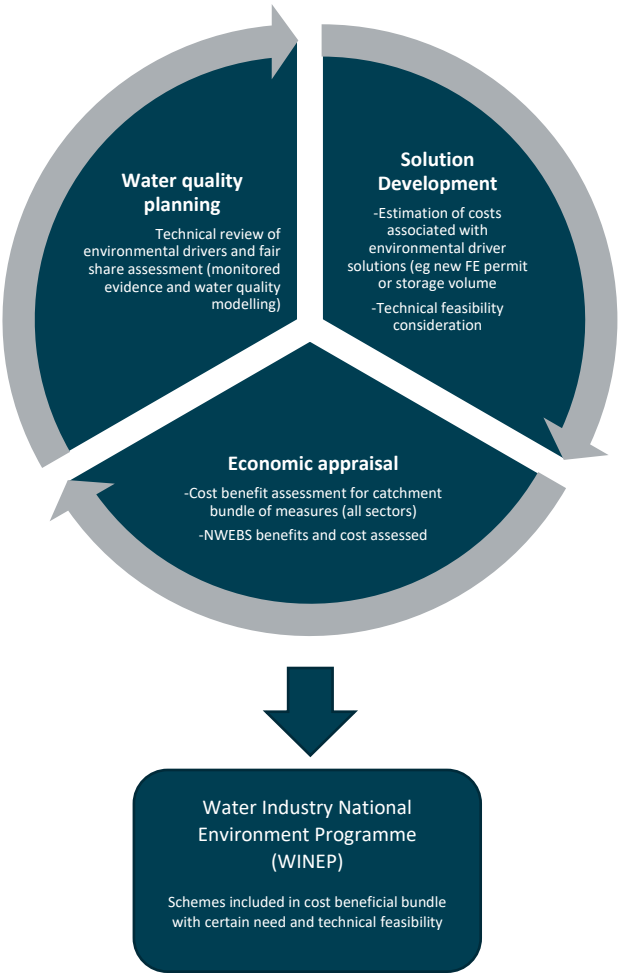
17.2.4 The process used for PR19 development illustrated in Figure 49 shows the cycle of engagement with the Environment Agency for solution development at PR19. Here we undertook a technical review of the environmental drivers and a fair share assessment which was used to develop the solution. We then carried out an economic appraisal which was critical at PR19 to ensure catchment bundles of measures were cost beneficial. The outputs of this were then shared back with the EA. Schemes identified as cost beneficial were included in the AMP7 WINEP, these had a confirmed need and were assessed as technically feasible.

[50] Ofwat (2022) *Alternative approaches to phosphorus removal on rural wastewater treatment works.* Available here

[51] Environment Agency (2022) *Water industry national environment programme (WINEP) methodology.* Available here

[52] UUW (2018) *Enhancement expenditure: WINEP - Phosphorus and sanitary determinants*. Available here

Figure 49: Process used with the Environment Agency to ensure that requirements included in the AMP7 WINEP were appropriately justified



Source: UUW process

17.2.5 We have also sought to control costs in the following ways:

- We have trialled the use of ferric rich water treatment residuals (sludge) using those from Wybersley water treatment works, instead of virgin ferric salts to achieve phosphorus permits. Results of these trials so far have concluded that we were unable to achieve low phosphorus of 0.4mg/l at Knutsford, so an alternative solution at this site is needed, but we were able to achieve lower than the UWWTD permit of 2mg/l at Hazel Grove WwTW where this has now been implemented as the solution. We will continue to explore this approach to deliver further efficiencies. The use of water treatment sludge in this way is also a good example of circular economy.
- We have considered whether there are catchment offsetting opportunities with agreement of the Environment Agency to relax permit requirements at WwTW such as in the Petteril catchment[53]. We are also leading on an Ofwat innovation fund project looking into alternatives to chemical dosing for phosphorus removal on small sites. We will implement the learning from this within our AMP8 plans.
- We have explored and adopted permit balancing in agreement with the EA in the Bollin catchment. As part of this agreement, we accepted a tightening of the proposed permit at Macclesfield WwTW from 0.4mg/l phosphorus to 0.3mg/l which has allowed a no-build, and therefore, no additional opex, solution at Bowden WwTW.

[53] 7UU100007b Greystoke WwTW, 7UU100012b Motherby WwTW, 7UU200449b Southwaite incorporated into Project Eden Integrated Catchment (U.80061540)

- We have followed a risk and value approach for the solution development through AMP7. This process is aimed at positively challenging our projects to ensure we have sufficient evidence behind decisions. It provides us with confidence that solutions are correct and maximises the value for customers from investments. This comprises three stages:
  - RV0 Verify requirements: What is the purpose of the scheme?
  - RV1 Asset review: What are the current issues?
  - RV2 Solution and cost review: Does the solution meet the requirement?

17.2.6 An example of this process driving efficiency is where, following the optimisation of chemical dosing at sites such as Bury WwTW and Rochdale WwTW, we have not required the installation of a tertiary solids removal process despite the solution meeting the requirement.

17.2.7 We work extremely hard to control our chemical costs. Our procurement teams have worked extensively with suppliers and along with the other WaSCs have shared our predicted volumes for these chemicals with the chemical manufacturers so that they have visibility to increase their production capacity. As a result of this process, all three UK ferric sulphate manufacturers have built or are building new production facilities to meet the increasing demand from the water industry. The last exercise to get the latest UK's forecasted AMP7 and AMP8 volumes was submitted on 12th May 2023 and the industry is meeting again in early June. Following this meeting we will be supplying a further update to the manufacturers. We have also had several meetings with Water UK on this matter.

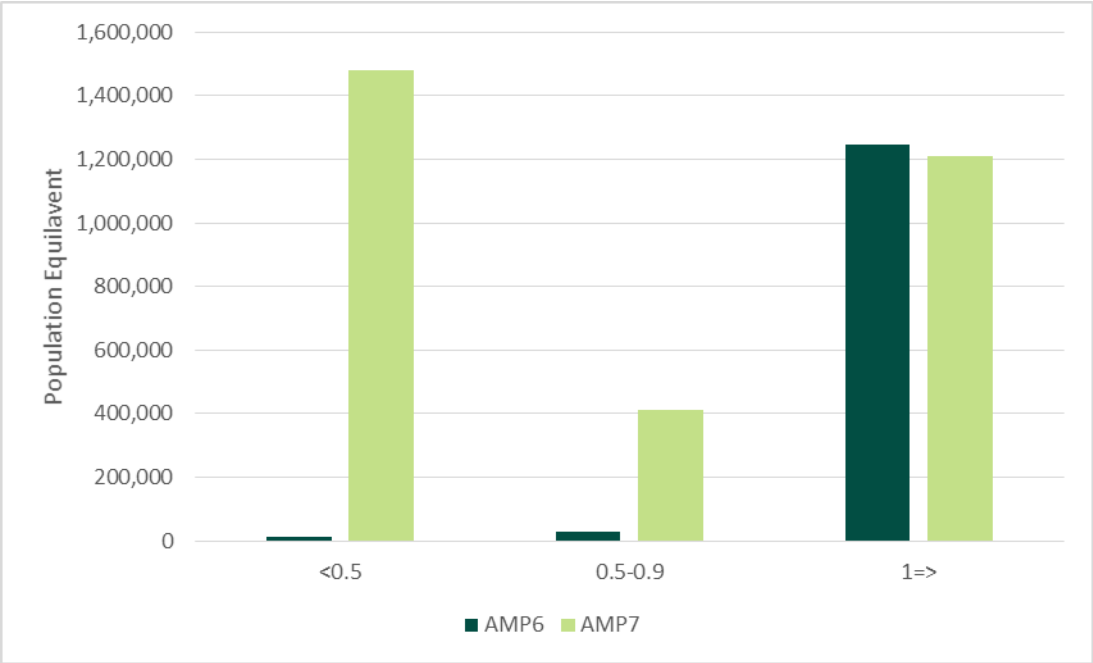
17.2.8 Prior to confirming our ferric sulphate strategy we issued a PIN (Periodic Indicative Notice) to the market to ask the manufacturers how we can get the best overall package for ferric sulphate, for example, through longer-term contracts or guaranteed volumes. We have used the manufacturers' responses to optimise our procurement strategy. As a result of this process, a long-term contract with guaranteed volumes and three suppliers (to ensure security of supply) was agreed. This agreement will be in place by the end of June 2023 and will give a predicted 0.9% efficiency on costs.

17.2.9 To control our caustic costs, we have framework agreements with three suppliers and will carry out mini-competitions for additional work up to twice per year. This approach helps to ensure that prices we pay remain competitive.

17.3 Materiality

17.3.1 Prior to AMP7 most phosphorus removal schemes across the industry were driven by the Urban Wastewater Treatment Directive which has comparatively relaxed limits of either 1 or 2mg/l. This means that historic costs are a poor indicator of the cost of many Water Framework Directive schemes as achieving lower permits requires a change in technology/process which is associated with higher ongoing operating costs. Figure 50 shows the step change in permit limits for UUW from those we held at the end of AMP6, usually 1 or 2mg/l to 39 permits at 0.5mg/l or below by the end of AMP7.

Figure 50: Distribution of phosphorus permit standards currently compared with AMP7 permit limits



Source: UUW internal permit database and APR table 7F

17.3.2 The implementation of solutions to meet phosphorus limits below 1mg/l in particular leads to a significant increase in operating costs. This is for three key reasons:

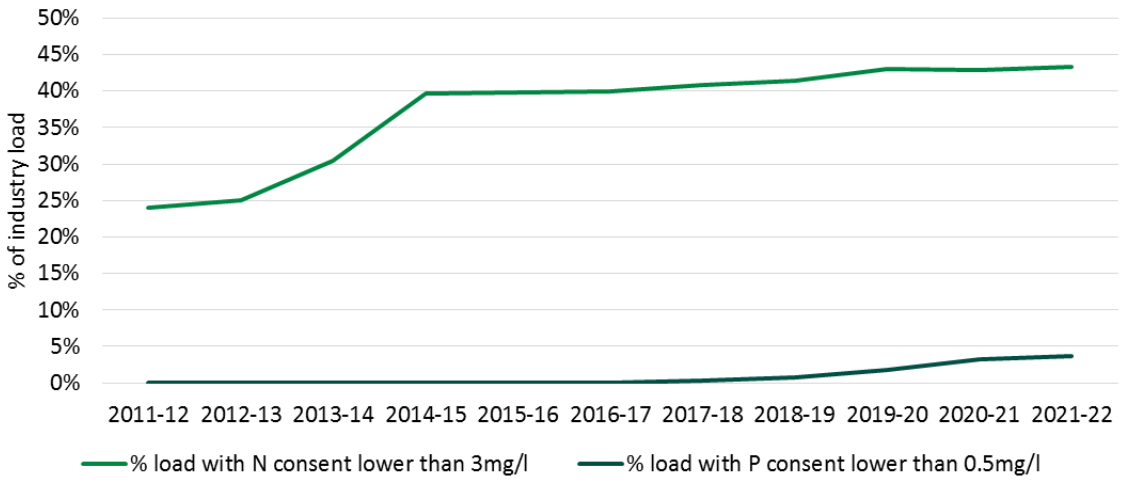
- More load needs to be removed and therefore more iron is required to precipitate it. The quantities required to meet standards below 1mg/l are significantly higher than for standards of 1mg/l and higher;
- Higher quantities of iron require an alkalinity correction, particularly where waters are soft. This prevents acidity having an undue effect on subsequent processes and assets. If we fail to sustain alkalinity at adequate levels it leads to a risk of an adverse impact on the ammonia performance of the treatment works and/or degradation of the concrete structures. As iron dosing can make the effluent more acidic, without correction through caustic dosing we can also be at risk of not complying with the final effluent pH permit at sites. We have a significant number of sites with 1mg/l ammonia permits - for these, more alkalinity is needed in the chemical reactions to achieve the low ammonia limit. The need for alkalinity correction is heavily influenced by i) whether the water is soft and ii) the amount of iron salts used. As we have a predominance of soft waters in the North West and low phosphorus limits which require significant amounts of iron to be used, the extent of alkalinity correction is significant;
- The discharge of particulate matter must be kept to an absolute minimum as phosphorus will be associated with the solids and thus in most cases it is necessary to have a tertiary solids capture process in place. Solids management and capture is key in ensuring we comply with our iron permits.

17.4 Adjustment to allowances (including implicit allowance)

17.4.1 AMP7 was the first period in which companies have been required to meet stringent phosphorus permits at a large scale. Figure 51 shows at an industry level the percentage of load subject to i) an ammonia permit lower than 3mg/l and ii) a phosphorus permit lower than 0.5mg/l over the period covered by Ofwat's cost assessment dataset. It's clear that a significant proportion of the industry's load was subject to a relatively stringent ammonia permit and that this proportion has been relatively stable from AMP6 onwards. Importantly, there are almost no historical instances of load being subject to the stringent phosphorus permits now required as a result of the AMP7 WINEP – the percentage of load

with a permit less than 0.5mg/l is zero for the majority of the historical period considered by the models. This means there is no meaningful correlation between the two and therefore we cannot assume that the ammonia variable acts as a proxy for phosphorus removal.

Figure 51: There is very little cost data in the historical dataset relating to stringent P

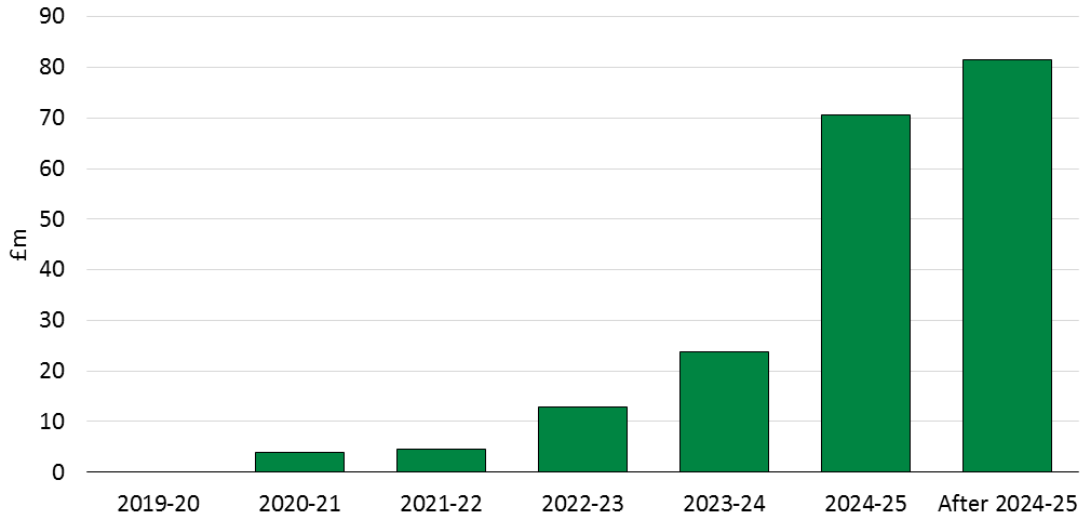


Source: UUW analysis based upon Ofwat's cost assessment dataset (available here)

17.4.2 The fact that there is no evidence within the historical dataset of companies meeting the AMP7 phosphorus permits means that the models will not make an appropriate allowance. This was recognised by Ofwat in its econometric model consultation[54]: *"We recognise that the additional ongoing cost associated with more stringent phosphorus removal programmes across the sector may not be fully captured in our proposed base cost models."*

17.4.3 Additionally, as Figure 52 illustrates, the majority of opex resulting from the AMP7 WINEP will start to be incurred towards the end of AMP7. This is too late for the models to be able to properly reflect higher ongoing opex in AMP8 – the last year of data Ofwat will have available at the time of the FD will be 2023-24 and it is clear that this year is not reflective of the ongoing opex companies will incur in AMP8.

Figure 52: Industry operating expenditure from AMP7 Phosphorus removal projects (APR table 7F, 2021-22 return)



Source: APR table 7F, 2021-22 reporting year

[54] Ofwat (2023) *Econometric base cost models for PR24*. Available here.

17.4.4 Finally, there is no crossover between phosphorus removal and ammonia removal. Removing each type of nutrient requires fundamentally different interventions. In fact, as discussed in section 17.3, implementing both ammonia and phosphorus removal can lead to operational challenges due to the need to balance and optimise between the two chemicals and the resulting reactions within the treatment process. Therefore, the presence of ammonia removal activity within the historical dataset should not be assumed to provide any form of implicit allowance for phosphorus removal.

17.4.5 Therefore, we consider that it is clear Ofwat's models will not provide sufficient allowance for ongoing opex resulting from the AMP7 WINEP.

17.4.6 We have calculated the implicit allowance using opex data in table 7F. We used table 7F in APR22 to collect all companies' operating expenditure relating AMP7 WINEP P removal projects because this is the only data available to us at the time of writing this claim. This dataset is set out in Table 32. It would be appropriate to use an updated version of this table as newer years' of data becomes available.

Table 32: P removal operating expenditure from Table 7F in APR22

Company	2019-20	2020-21	2021-22	2022-23	2023-24	2024-225	After 2024-25
ANH	0.000	2.387	0.177	1.420	6.516	10.588	12.266
HDD	0.000	0.000	0.000	0.000	0.010	0.043	0.043
NES	0.000	0.000	0.000	0.000	0.000	1.851	3.044
NWT	0.000	0.108	1.363	3.279	5.737	9.982	12.262
SRN	0.000	0.000	0.000	0.499	0.499	0.499	0.000
SVE	0.000	0.162	0.928	1.571	2.946	10.199	13.138
SWB	0.000	0.000	0.061	0.144	0.144	0.144	0.144
TMS	0.000	0.000	0.000	0.000	0.000	0.000	0.000
WSH	0.000	0.865	1.010	1.230	1.420	2.640	3.120
WSX	0.000	0.450	0.944	4.259	4.431	5.302	5.885
YKY	0.000	0.000	0.081	0.412	2.112	29.256	31.589

Source: Table 7F in APR22

17.4.7 We used Ofwat's recommended model suite, as set out in its 2023 consultation[55] and Ofwat's latest wastewater cost assessment dataset[56] to calculate a botex plus allowance for Wastewater Network Plus. We then subtracted the costs set out in Table 33 from sewage treatment botex plus and re-calculated the allowance using the same model suite and underlying cost data. The difference between these allowances is the implicit allowance for this claim.

Table 33: Implicit allowance calculation

	2025-26	2026-27	2027-28	2028-29	2029-30	Total
Base comparator	443.07	442.18	441.29	440.39	439.49	2,206.43
Base comparator minus 7F	442.97	442.08	441.19	440.29	439.39	2,205.93
Implicit allowance	0.101	0.100	0.100	0.100	0.099	0.50

Source: UUW analysis

17.4.8 This suggests that the implicit allowance is £0.5m. We have deducted this from the gross claim value.

17.4.9 While this implicit allowance may appear small, we consider that this is entirely expected, given the lack of industry expenditure on P removal at sites with a permit less than 0.5mg/l in the period up to 2021-

[55] Ofwat (2023) *Econometric base cost models for PR24*. Available here.

[56] Available on Ofwat's website here.

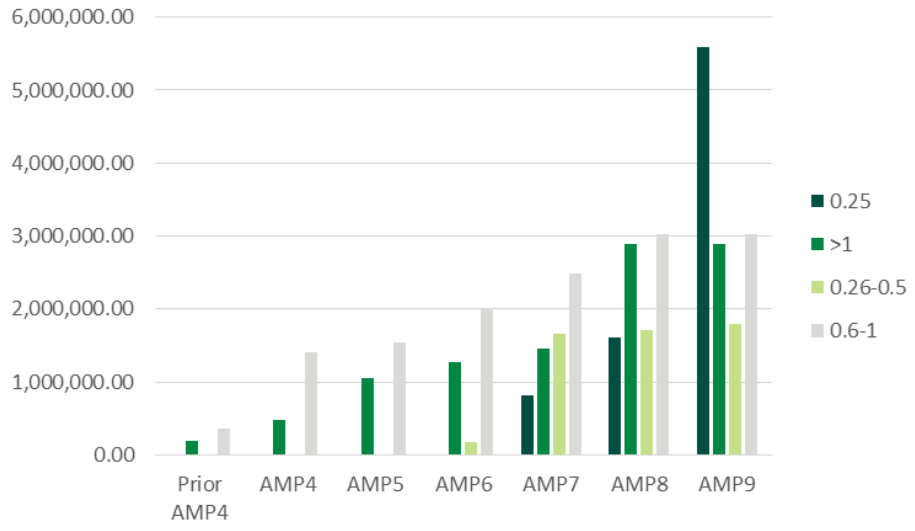
22, and is in line with the cost data set out in Table 32. For example, while UUW spent £1.363m on ongoing opex in 2021-22, the historical dataset covers 2011-12 to 2021-22, a period of 11 years. This means that UUW's expenditure of £1.363m in 2021-22 will receive a weight of 1/11 in the cost allowance, which equates to £0.12m a year (i.e. £1.363m divided by 11), which is roughly in line with our implicit allowance. This calculation assumes that UUW receives the full allocation of opex incurred in 2021-22, £1.363m, from the modelling process. However, the lack of a P removal cost driver which reflects 0.5mg/l within the recommended model suite[57] means that this £1.363m will not be allocated in full to UUW – other companies will likely receive a share. Therefore, while this calculation suggests that the £1.363m is contributing around £0.12m to UUW's allowance, in actual fact it is almost certainly contributing less than this. Therefore, we consider that our implicit allowance calculation is appropriate and robust.

17.4.10 UUW will not benefit from any offsetting circumstances related to this claim. This is because higher ongoing phosphorus removal opex represents an incremental cost pressure on UUW's existing cost base.

17.4.11 Higher ongoing phosphorus removal opex is an incremental cost, additional to the current cost base. Given the WINEP is a statutory obligation, it would be inappropriate to expect UUW to absorb associated ongoing opex as an efficiency challenge. Therefore, allowances are insufficient in the round to accommodate the factor.

17.4.12 UUW will not be able to balance this additional expenditure over the long-term because ongoing opex cannot be expected to reduce in future. We can see this through the development of the AMP8 WINEP where there is currently a requirement to improve an additional 22 sites, increasing the population equivalent to 1.6 million meeting a 0.25mg/l phosphorus limit within AMP8. Due to the requirements of the Environment Act an additional 31 sites, increasing the population equivalent served by works with the technically achievable limit of 0.25mg/l to 5.5million, by 2038 (Figure 53).

Figure 53: Population equivalent of WwTW with total phosphorus permits by AMP (Source: UUW internal data and draft WINEP at 2nd May 2023)



Source: UUW internal data and draft WINEP (2 May 2023)

17.4.13 We do not use an alternative explanatory variable to value this claim. It would be inappropriate to value the claim by adding a phosphorus treatment complexity cost driver. This is because the ongoing costs of achieving the AMP7 permits is not fully reflected in the historical dataset (as demonstrated in Figure 51 above).

[57] We agree with Ofwat's decision not to use a treatment complexity driver reflecting P consents less than 0.5mg/l at PR24. The historical cost data may be better able to accommodate such a driver at PR29.

18. Cost Efficiency

18.1.1 We have valued our claim using Table 7F from the 2022-23 APR reporting year. ~~At the time of submission, we do not have access to other companies' 2022-23 7F submissions, meaning we have not been able to benchmark our costs against the industry.~~ We note that ongoing P removal opex is likely to be a cost driver for the majority of the industry. As such, we would support Ofwat's use of 7F data, as reported in companies' 2022-23 APR submissions, to identify an efficient benchmark for the sector.

18.1.2 However, after reviewing table 7F in other companies' 2022-23 APR submissions we have chosen not to adopt a comparative benchmarking approach to update our claim value. This is because a large proportion of cost data appears to be missing from some companies' returns. For example:

- South West Water's data appears to be incomplete and only contains cost information on four projects: Lapford, St Columb, Kenn & Kennford and Wilmington.
- Southern Water has reported it does not expect any operating expenditure after 2024-25 in its return. This does not align with its permit data, which suggests it will have a substantial number of phosphorus discharge permits below 0.5mg/l.

18.1.3 This creates a risk that any subsequent change in our claim value is based upon incomplete and potentially inaccurate data. Therefore, we have not updated our claim value. It may be necessary for Ofwat to seek to ensure the entire industry has reported costs consistently within table 7F if it plans to make a common industry-wide adjustment for ongoing P removal opex.

18.2 How we calculated our claim value

18.2.1 Our claim value is derived from table 7F in the regulatory accounts. This table contains information on the opex, capex and cost drivers at each WINEP phosphorus removal project in AMP7. The cost driver information includes data on the population equivalent served, current permit limit and enhanced permit limit i.e. the permit limit in place once the project has concluded. Cost data is available for each year from 2019-20 to 2024-25 with a value reflecting ongoing expenditure after 2024-25.

18.2.2 Costs in 7F exclude business rates, which is appropriate because business rates are separately assessed as an un-modelled cost item. Where there are multiple drivers of expenditure, we have allocated costs proportionately to ensure that we only include costs related to P removal within the table.

18.2.3 Table 7F allows us to directly calculate the ongoing costs attributable to the P removal elements of UUW's AMP7 WINEP. We did this by summing the ongoing opex post-2024-25 for each scheme with an enhanced phosphorus permit equal to or less than 0.5mg/l. This shows that UUW will need to spend £87.64m over the course of AMP8 on phosphorus removal. We have appended table 7F and associated calculations to this claim.

18.2.4 We then applied a frontier shift assumption of 0.55% to calculate a post-frontier shift cost of £85.7m. We applied the frontier shift before subtracting the implicit allowance because the implicit allowance calculation includes frontier shift. We implement a slightly stronger frontier-shift challenge than the mid-point of the range Economic Insight identified in a study[58] it carried out on behalf of a consortium of companies. The PR24 focused range identified by Economic Insight was 0.3% to 0.7%, meaning the mid-point is 0.5% per year. We consider that the mid-point is justified because the frontier shift estimate produced by EU-KLEMS data is potentially subject to both upwards and downwards bias. There is a risk of downwards bias (i.e. the estimate being too low) due to question marks over the extent to which embodied technical change is reflected in the estimate. There is a risk of upwards bias (i.e. the estimate being too high) due to the presence of catch-up efficiencies within the EU-KLEMS data, the presence of which would produce a double count in the catch-up efficiency challenge. However, there is no robust way to quantify these opposing factors. Therefore, we consider the mid-point to be an appropriate and

[58] Economic Insight (2023) *Productivity and frontier shift at PR24.* Available here.

pragmatic estimate for frontier shift. We do not net off any Real Price Effects (RPEs) against the frontier shift challenge. We added an additional stretch to the mid-point to reflect the uncertainty inherent in estimation of the frontier shift, resulting in an overall frontier shift challenge of 0.55% per year.

18.2.5 We then subtracted the implicit allowance to calculate the net claim value of £85.2m. The implicit allowance calculation is described in section 17.4.

Table 34: How we calculated our claim value

	2024-25	2025-26	2026-27	2027-28	2028-29	2029-30	AMP8
Ongoing opex at sites <=0.5mg/l	12.262	17.529	17.529	17.529	17.529	17.529	87.643
Frontier shift assumption	0.55%	0.55%	0.55%	0.55%	0.55%	0.55%	
Compounding frontier shift	0.55%	1.10%	1.66%	2.22%	2.78%	3.35%	
Efficient gross claim value	12.194	17.335	17.238	17.140	17.041	16.942	85.697
Implicit allowance		0.101	0.100	0.100	0.100	0.099	0.500
Net claim value		17.234	17.137	17.040	16.942	16.843	85.196

Source: UUW analysis

18.2.6 For final business plan submission, we also provide a claim valuation net of frontier shift. This is set out in Table 35.

Table 35: Our P removal claim value net of frontier shift

	2024-25	2025-26	2026-27	2027-28	2028-29	2029-30	AMP8
Ongoing opex at sites <=0.5mg/l	12.262	17.529	17.529	17.529	17.529	17.529	87.643
Frontier shift assumption							
Compounding frontier shift							
Efficient gross claim value							
Implicit allowance		0.101	0.1	0.1	0.1	0.099	0.5
Net claim value		17.428	17.429	17.429	17.429	17.43	87.145

18.2.7 While 7F was published as part of last year's APR, the data quality was not sufficient to use in a robust benchmarking exercise as part of this claim. For example, companies appeared to take different approaches to filling in cost driver data, with some companies not reporting any cost driver information despite reporting expenditure at a project. We note that this appears to have been recognised by Ofwat because it recently carried out a data collection exercise that sought to improve data quality reported within 7F.

18.2.8 Additionally, it is also important to note that our expectations of ongoing opex costs following AMP7 have changed since last year's APR. While costs at some projects have come down, costs have generally increased within table 7F. This is because we have a much better understanding of the ongoing delivery at each site. Table 7F last year was largely based upon our expectations at the time we submitted the PR19 business plan. We set out the differences in delivery plans at a site level in Table 36. We note that this means that a benchmarking exercise using data from 7F published in APR22 would result in an unrealistically low view of ongoing opex requirements in AMP8.

18.2.9 As well as indicating the FY22 and FY23 table 7F ongoing operating costs and any variance, Table 36, Table 37 and Table 38 include the anticipated solution at PR19, on which the FY22 version of 7F was largely based. Table 36 shows project level information where there has been an increase in opex costs from PR19, Table 37 shows where the cost is not significantly varied and Table 38 shows where there is a decrease in opex cost.

18.2.10 These tables also include the current view of the solution for the sites and the updated operating costs from the most recent operating plan. Solutions identified for installation are the lowest whole life cost, most resilient option assessed using both the capital and ongoing operational cost using the solution hierarchy as discussed in section 20.1.

18.2.11 In some cases there is a significant variance (both above and below) the anticipated costs at PR19. The table has been split to show the schemes where there has been an increase in cost, those where the costs are not significantly varied and those where the anticipated opex is significantly below that estimated at PR19, the most significant of which is Blackburn WwTW where the solution of Nereda optimisation for biological phosphorus removal has reduced anticipated opex by over £1m per annum. This is not only from the change in solution e.g. where the addition of a pump would increase power costs, but also from a change in the anticipated quantity of chemicals required. This change is associated with the learning from the installation of more of these very low phosphorus solutions. At PR19 we had very little experience in maintaining such low permits and the operational cost of doing so, this experience is growing and we are reflecting this in operating plans and hence costs in table 7F.

Table 36: Project level information regarding increases in ongoing costs (all costs stated in 2022-23 prices)

Project ID	Site	PR19 opex cost (£m pa)	PR19 solution	APR23 opex cost (£m pa)	Variance PR19/APR23 (£m pa)	Updated solution	Justification
U.80061365	Burnley WwTW - WFD - AMP7	0.718	Installation of an additional primary settlement tank, integrated fixed film activated sludge (IFAS) process a cloth pile filter (Mecana), additional final settlement tank chemical dosing and storm storage. Not all elements of this are associated with the phosphorus removal requirement	1.841	1.122	Through solution development this has evolved to comprise an increase in flow to full treatment through the works to 1295l/s, an additional primary settlement tank, an interstage pumping station, Biomag for tertiary solids removal, surplus activated sludge thickening, final settlement tank refurbishment, chemical dosing, odour control and 12,000m3 storm storage.	Changes in solution increasing the flow through the works has led to an increased chemical dosing requirement, the interstage pumping station requires additional power, these are reflected in higher ongoing operational costs
U.80062052	Bolton WwTW	0.000	Bolton was not included in the original PR19 submission	0.757	0.757	Installation of chemical dosing for phosphorus removal	Late addition to programme not included in PR19 costs
U.80061381	Rossendale WwTW - WFD - AMP7	0.269	Installation of a cloth pile filter (Mecana) and chemical dosing to achieve low phosphorus	0.812	0.542	The solution has been updated to reflect the stretch permit requirement at this site. It has been assessed as not requiring the tertiary solids removal originally identified at PR19. Chemical dosing (Ferric Sulphate) point into the humus tank feed. Also additional sludge consolidation process capacity of at least 462m3 to supplement the existing capacity on site is included in the solution. A pumping station to supply the existing screens with washwater is also included in the solution	Cost increase from PR19 due to the rising costs of chemicals. This increase is not as high as expected.
U.80061943	Glossop WwTW - Q and X Requirements AMP7	0.365	Installation of a cloth pile filter (Mecana) and two stage ferric chemical dosing to achieve low phosphorus and alkalinity dosing. Also the addition of nitrifying trickling filters (NTF)	0.850	0.485	Through solution development the cloth pile filters (Mecana) and NTF were assessed as not being required. However the dosing for phosphorus removal and pH correction are required for the solution.	Changes in solution has led to an increased chemical dosing requirement and therefore higher costs

Project ID	Site	PR19 opex cost (£m pa)	PR19 solution	APR23 opex cost (£m pa)	Variance PR19/APR23 (£m pa)	Updated solution	Justification
U.80061421	Leigh WwTW - WFD - AMP7	0.317	Installation of a cloth pile filter (Mecana) and chemical dosing	0.795	0.478	Through solution development the requirements to meet the revised permit are polymer, caustic and ferric chemical dosing, the installation of a floc tank with mixers to ensure good mixing of the chemical into the wastewater to allow for the most efficient phosphorus removal and installation of water quality instrumentation.	Changes in solution has led to an increased chemical dosing requirement and therefore higher costs
U.80061826	Chorley WwTW - WFD - AMP7	0.217	Installation of a cloth pile filter (Mecana) and chemical dosing	0.614	0.397	Chorley WwTW was part of a batch of schemes where the chemical dosing for phosphorus removal was delivered ahead of the regulatory date to give adequate time to assess the requirement for tertiary solids removal. There are 5 WwTW sites within the batch (Bury, Rochdale, Tyldesley, Worsley and Chorley)	Changes in solution have led to an increased chemical dosing requirement and therefore higher costs
U.80061379	Castleton WwTW - WFD - AMP7	0.001	Close Castleton WwTW and transfer flow to Rochdale WwTW through a pipeline	0.393	0.391	Through solution development the solution has been updated to an on-site solution rather than a close and transfer. The updated solution comprises an additional primary settlement tank, new activated sludge plant with integrated fixed film activated sludge (IFAS), two new final settlement tanks (FST) and three tertiary pile cloth filters. Installation of dual point ferric dosing and alkalinity dosing for pH correction	The significant change in solution from close and transfer to an on-site chemical dosing solution has led to an increase in operational costs

Project ID	Site	PR19 opex cost (£m pa)	PR19 solution	APR23 opex cost (£m pa)	Variance PR19/APR23 (£m pa)	Updated solution	Justification
U.80061410	Holmes Chapel WwTW	0.070	Installation of a cloth pile filter (Mecana), secondary point chemical dosing and monitoring Instrumentation	0.417	0.346	Installation of new chemical delivery, storage, transfer and duel point dosing facilities for chemical phosphorus removal. Also new chemical storage and dosing facilities to provide caustic dosing for alkalinity adjustment. The solution also includes a new tertiary solids removal feed pumping station to transfer flows to the new FilterClear system for tertiary solids removal. A new potable water system to support new chemical area is also to be installed.	Increase in the quantity of chemicals required to meet the new permit as well as an increase in chemical costs, tertiary solids removal process also requires an increase in power
U.80061413	Sandbach WwTW - WFD - AMP7	0.209	Installation of a cloth pile filter (Mecana) and duel point chemical dosing and alkalinity dosing for pH correction	0.539	0.329	Installation of a cloth pile filter (Mecana) and duel point chemical dosing and alkalinity dosing for pH correction	Increase in operating cost aligns with increase in chemical costs
U.80061948	Macclesfield WwTW - UWWTD & WFD - AMP7	0.263	Installation of a Nerada and chemical dosing	0.592	0.329	This solution includes a new inlet works, single point ferric dosing, new mobile organic biomass pumping station, new mobile organic biomass treatment process for biological phosphorus removal, new tertiary solids removal (pile cloth filters), new backwash return pumping station from the tertiary solids removal, new sludge treatment with polymer dosing, and disposal assets for surplus activated sludge, including use of the existing gravity belt thickeners to treat primary, chemical and imports sludge.	Changes in solution has led to an increased operational costs due to the additional power required for the mobile organic biofilm plant
U.80061409	Congleton WwTW - Ammonia - AMP7	0.162	Installation of cloth pile filter (Mecana) and chemical dosing	0.469	0.307	Installation of cloth pile filter and chemical dosing	Increase in operating cost aligns with increase in chemical costs
U.80061954	Whaley Bridge WwTW - Q and X Requirements - AMP7	0.295	Installation of cloth pile filter (Mecana) and chemical dosing	0.572	0.277	Installation of cloth pile filter and chemical dosing	Increase in operating cost aligns with increase in chemical costs

Project ID	Site	PR19 opex cost (£m pa)	PR19 solution	APR23 opex cost (£m pa)	Variance PR19/APR23 (£m pa)	Updated solution	Justification
U.80061947	Knutsford WwTW - WFD Drivers - AMP7	0.162	Installation of dual point ferric dosing, alkalinity dosing and cloth pile filters (Mecana)	0.438	0.276	Installation of dual point ferric dosing, alkalinity dosing and cloth pile filters	Increase in operating cost aligns with increase in chemical costs
U.80061422	Westhoughton WwTW - WFD - AMP7	0.139	Installation of a cloth pile filter (Mecana) and chemical dosing	0.414	0.276	The solution includes the installation of duel point ferric dosing, alkalinity dosing and polymer dosing for sludge thickening, It also includes the installation of tertiary cloth filter plant and a sludge storage tank.	Increase in the quantity of chemicals required to meet the new permit as well as an increase in chemical costs

Source: UUW project level source data

Table 37: Project level information regarding low level changes in ongoing costs (all costs stated in 2022-23 prices)

Project ID	Site	PR19 opex cost (£m pa)	PR19 solution	APR23 opex cost (£m pa)	Variance PR19/APR23 (£m pa)	Updated solution	Justification
U.80061411	Kidsgrove WwTW - WFD - AMP7	0.141	Conversion of the existing continuously operating upflow filter (COUF) to a BluePro process with chemical dosing points	0.339	0.198	The solution includes new primary dose ferric chloride pumps and additional ferric chloride dosing and storage rig to dose into the existing continuously operated upflow filter (COUF) feed. Also a new rapid pump mixing chamber pre primary settlement tanks and a new air mix and flocculation chamber post COUF feed pump station to ensure good mixing of ferric with the wastewater flow into the COUF. We are also using 'sand cycle' to give insight into the current operation of the sand filters to gain understanding ahead of refurbishment	Increase in the quantity of chemicals required to meet the new permit as well as an increase in chemical costs
U.80061397	Alderley Edge WwTW - WFD & UWWTD P Removal AMP7	0.177	Installation of cloth pile filter (Mecana) and chemical dosing	0.372	0.196	New chemical dosing and storage facilities, new flocculation tank, new final settlement tank, new filter clear (tertiary solids removal), new sludge storage and odour control	Increase in operating cost aligns with increase in chemical costs

Project ID	Site	PR19 opex cost (£m pa)	PR19 solution	APR23 opex cost (£m pa)	Variance PR19/APR23 (£m pa)	Updated solution	Justification
U.80061424	Helsby WwTW - Q - AMP7	0.096	Installation of chemical dosing and BluePro	0.287	0.191	Reduction in the permitted dry weather flow at Helsby has allowed a more relaxed phosphorus permit limit of 0.45mg/l. Although below 0.5mg/l the tertiary solids removal is not required at this site to achieve this revised permit limit. The solution now comprises ferric dosing.	Increase in operating cost aligns with increase in chemical costs
U.80061425	Tarvin WwTW - WFD P Removal AMP7	0.095	Installation of cloth pile filter (Mecana) and chemical dosing	0.241	0.146	Installation of cloth pile filter and chemical dosing	Increase in operating cost aligns with increase in chemical costs
U.80061418	Glazebury WwTW - WFD - AMP7	0.127	Installation of cloth pile filter (Mecana) and chemical dosing	0.271	0.144	The new works at Glazebury will comprise polymer, caustic and ferric dosing a floc tank with mixers to ensure adequate mixing of the wastewater with the ferric and water quality instrumentation.	Increase in the quantity of chemicals required to meet the new permit as well as an increase in chemical costs
U.80061408	Biddulph WwTW - WFD - AMP7	0.111	Installation of cloth pile filter (Mecana) and chemical dosing	0.250	0.139	Installation of cloth pile filter and chemical dosing	Increase in operating cost aligns with increase in chemical costs
U.80061956	Saddleworth WwTW	0.108	Installation of chemical dosing, refurbishment of the activated sludge plant and cloth pile filter (Mecana)	0.232	0.124	Installation of cloth pile filter, two point chemical dosing, percolating filters and intermediate settlement tank refurbishment	Increase in operating cost aligns with increase in chemical costs and duel point dosing
U.80061392	Bunbury WwTW - WFD Drivers - AMP7	0.039	Installation of two point ferric dosing and cloth pile filter (Mecana)	0.163	0.124	Installation of new chemical storage and dosing facilities to provide two-point ferric dosing for chemical phosphorus removal.	Increase in operating costs associated with increase in quantity of chemical dosed and increased chemical costs

Project ID	Site	PR19 opex cost (£m pa)	PR19 solution	APR23 opex cost (£m pa)	Variance PR19/APR23 (£m pa)	Updated solution	Justification
U.80061407	Alsager WwTW - WFD Drivers - AMP7	0.160	Installation of tertiary ammonia removal, continuously operating upflow filters (COUF) for tertiary solids removal and chemical dosing	0.282	0.122	Installation of new ferric storage tank and dosing point, Caustic dosing and storage for alkalinity correction. New primary tank distribution chamber. Installation of a new moving bed biofilm reactor (MBBR) and associated pumping station and blowers. To ensure good mixing of the chemicals and the wastewater rapid mixing flocculation has also been installed. Instead of installation of a COUF as outlined at PR19, tertiary pile cloth filters have been installed to capture solids and a new sludge storage tank has been installed.	Increase in operating cost aligns with increase in chemical costs
U.80061393	Madeley WwTW WFD P AMP7	0.135	Installation of chemical dosing for phosphorus removal	0.240	0.104	Installation of new chemical storage, transfer and duel point dosing facilities for chemical phosphorus removal also new chemical storage and dosing facilities to provide Sodium Hydroxide dosing for alkalinity adjustment. Also the installation of new primary settlement tank de-sludge pumps and a new tertiary solids removal feed pumping station to transfer flows to the new Filterclear system for tertiary solids removal. New mixer upstream of the Filterclear plant for mixing ferric chloride with the wastewater.	Increase in operating cost aligns with increase in chemical costs
U.80061412	Lawton Gate WwTW - WFD - AMP7	0.155	Installation of dual point ferric dosing and alkalinity dosing for phosphorus removal and pile cloth filter (Mecana)	0.256	0.101	Installation of new chemical storage and dosing facilities for chemical phosphorus removal for dual point ferric chloride dosing also new chemical storage and dosing facilities to provide caustic dosing for alkalinity adjustment. Also a new tertiary solids removal feed pumping station to transfer flows to the new Filterclear system for tertiary solids removal.	Increase in operating cost aligns with increase in chemical costs

Project ID	Site	PR19 opex cost (£m pa)	PR19 solution	APR23 opex cost (£m pa)	Variance PR19/APR23 (£m pa)	Updated solution	Justification
U.80061828	Worsley WwTW & Inlet - WFD - AMP7	0.060	Installation of cloth pile filters (Mecana) with additional ferric dosing and alkalinity dosing	0.153	0.092	Installation of cloth pile filter and chemical dosing (ferric and alkalinity)	Increase in operating cost aligns with increase in chemical costs
U.80061939	Chapel-en-le-Frith WwTW - WFD - AMP7	0.134	Installation of dual point ferric dose with refurbishment of the pH alkalinity dosing and installation of cloth pile filters (Mecana)	0.225	0.091	The solution comprises a new inlet works, duel point ferric dosing, modifications to the alkalinity dosing and the installation of a tertiary cloth pile filter.	Increase in operating cost aligns with increase in chemical costs
U.80061415	Mere Brow WwTW - WFD - AMP7	0.057	Installation of cloth pile filter (Mecana) and chemical dosing	0.139	0.083	Installation of cloth pile filter and chemical dosing	Increase in operating cost aligns with increase in chemical costs
U.80061399	High Legh WwTW - WFD Drivers - AMP7	0.020	Closure of High Legh WwTW and transfer of flows to Bowden WwTW	0.102	0.082	A change in solution to on-site treatment rather than a close and transfer. This comprises of new submerged aerated filter (SAF), chemical dosing (ferric and alkalinity correction) and cloth pile filters for tertiary solids removal	Changes in solution from a close and transfer to an on-site chemical phosphorus removal solution has led to an increased chemical dosing requirement and therefore higher costs
U.80061395	Tarporley WwTW - WFD P Removal AMP7	0.069	Installation of cloth pile filters (Mecana) with pre-filter ferric dosing	0.149	0.081	Current solution is the installation of cloth pile filters with pre-filter ferric dosing	Increase in operating cost aligns with increase in chemical costs
U.80061945	Mossley WwTW	0.069	Installation of new final settlement tanks, chemical dosing for phosphorus removal, cloth pile filters (Mecana) for tertiary solids removal and new storm tank	0.146	0.078	Installation of new final settlement tanks, chemical dosing for phosphorus removal, cloth pile filters for tertiary solids removal and new storm tank	Increase in operating cost aligns with increase in chemical costs
U.80061427	Waverton WwTW - WFD P Removal AMP7	0.033	Installation of chemical dosing and BluePro for tertiary solids removal	0.081	0.048	Installation of chemical dosing and BluePro for tertiary solids removal	Costs are not significantly different from PR19
U.80061405	Middlewich WwTW and Network - Supply Demand - AMP7	0.206	Refurbishment of existing continuously operating up flow filters (COUF) to provide BluePro Tertiary Treatment	0.247	0.042	Installation of new ferric and caustic dosing and a new sludge storage tank	Costs are not significantly different from PR19
U.80061420	Horwich WwTW - WFD - AMP7	0.255	Refurbishment of existing ferric dosing system and installation of cloth pile filter (Mecana)	0.287	0.032	Addition of Biomag proves for phosphorus removal, and caustic dosing for alkalinity correction.	Costs are not significantly different from PR19

Project ID	Site	PR19 opex cost (£m pa)	PR19 solution	APR23 opex cost (£m pa)	Variance PR19/APR23 (£m pa)	Updated solution	Justification
U.80061371	Wilpshire WwTW - WFD Drivers - AMP7	0.109	Refurbishment of continuously operating upflow filter (COUF) to BluePRO and chemical dosing for phosphorus removal	0.117	0.007	Installation of ferric and caustic dosing for phosphorus removal	Costs are not significantly different from PR19
U.80061946	Kendal WwTW - WFD Drivers - AMP7	0.159	Installation of a cloth pile filter (Mecana) and dual point chemical dosing (ferric and caustic)	0.165	0.005	Optimisation of the Nereda for biological phosphorus removal	Costs are not significantly different from PR19
U.80061368	Barnoldswick WwTW - AMP7	0.318	Installation of cloth pile filter (Mecana) and new humus tank	0.323	0.005	Installation of cloth pile filter and new humus tank	Costs are not significantly different from PR19

Source: UUW project level source data

Table 38: Project level information regarding reductions in ongoing costs (all costs stated in 2022-23 prices)

Project ID	Site	PR19 opex cost (£m pa)	PR19 solution	APR23 opex cost (£m pa)	Variance PR19/APR23 (£m pa)	Updated solution	Justification
U.80061942	Failsworth WwTW - WFD Phosphorus AMP7	0.090	Installation of a cloth pile filter (Mecana) after the Nereda	0.074	-0.016	Optimisation of the Nereda for biological phosphorus removal	Costs are not significantly different from PR19
U.80061948	Bowdon WwTW – WFD – AMP7	0.023	Chemical dosing for phosphorus removal	0.000	-0.023	Catchment permit balancing with Macclesfield WwTW has resulted in no work needed at Bowdon WwTW	Catchment permit balancing has resulted in no additional opex required at Bowdon WwTW
U.80061391	Audley WwTW - WFD Drivers - AMP7	0.312	Installation of a new Biological aerated flooded filter (BAFF), chemical dosing and a cloth pile filter (Mecana)	0.287	-0.024	Installation of new chemical dosing for phosphorus removal, an additional humus tank, new sludge storage, moving bed biofilm reactor (MBBR) and tertiary pile cloth filters	Costs are not significantly different from PR19
U.80061825	Rochdale WwTW	0.847	Installation of cloth pile filters (Mecana) for tertiary solids removal	0.781	-0.067	Revised solution does not include a tertiary pile cloth filter as it was not required. The chemical dosing has been replaced to achieve the new permit.	Changes in solution have led to reduced costs
U.80061404	Kingsley WwTW - WFD Drivers - AMP7	0.149	Installation of a new activated sludge plant and chemical dosing to meet the revised permit	0.024	-0.126	The solution comprises of moving bed biofilm reactor, chemical dosing and cloth pile filter	Changes in solution have led to reduced costs

Project ID	Site	PR19 opex cost (£m pa)	PR19 solution	APR23 opex cost (£m pa)	Variance PR19/APR23 (£m pa)	Updated solution	Justification
U.80061824	Bury WwTW - ND - AMP7	0.694	Installation of cloth pile filters (Mecana) for tertiary solids removal	0.568	-0.126	Revised solution does not include a tertiary pile cloth filter as it was not required. The solution is chemical dosing only to meet the revised permit.	Changes in solution have led to reduced costs
U.80061941	Blackburn WwTW - WINEP Requirements - AMP7	1.188	Installation of cloth pile filters (Mecana) for tertiary solids removal	0.119	-1.069	Optimisation of the Nereda for biological phosphorus removal	Changes in solution have led to significant reduction in costs

Source: UUW analysis

18.3 The approach to our cost build has been assessed by a third party

18.3.1 We have sought external assurance from PwC for the methodology and information used to derive our claim value. An extract from PwC's report is provided below.

"As a result of the work performed, we can conclude that management has developed a detailed and logical methodology for producing each cost build and the approach followed to develop the cost estimates appears robust. We have undertaken detailed walkthroughs to understand the source of the cost data and rationale for assumptions and estimates made. We have not identified any priority actions which require attention in advance of the submission."

19. Need for investment

19.1.1 We do not expect that the 'need for investment' assessment is likely to be applicable to this claim. The cost pressure reflected within this claim is a result of the AMP7 WINEP, which represents a statutory obligation. The claim does not seek discrete additional cost allowances for discrete interventions but rather seeks to reflect that incremental ongoing operating expenditure is reflected within the cost allowance at PR24.

20. Best option for customers

20.1 Our AMP7 WINEP programme was informed by extensive optioneering

20.1.1 At PR19 we worked closer than ever before with the Environment Agency to challenge, agree and shape the content of the AMP7 WINEP programme in order to ensure it delivers significant environmental improvements as efficiently as possible. The engagement process with the Environment Agency that was used had three key elements – water quality planning, solution development and economic appraisal (see Figure 49) There was therefore a high degree of confidence that scheme would go ahead in AMP7. This has been the case, with only a small number of changes to the WINEP as the programme has matured.

20.1.2 As part of our scoping and solution development process at PR19 we introduced a risk and value (R&V) assessment across all our major projects which has supported better challenge of our expenditure requirements, including enhancements. This ensures that when we decide projects are necessary, we only do what we need to do, that our decisions are based on strong evidence, and the value to both business and customers is clear. The process ensures that we keep challenging and validating both the need for our projects and the way we deliver them. This process has continued through project development in AMP7 giving a robust framework to enhancement delivery.

20.1.3 This risk and value assessment ensures we identify the most cost effective way of meeting the future permit requirements by following the high level solution hierarchy:

(a) Do nothing

(b) Operations and Maintenance

(c) Optimise Asset

(d) Partnership/catchment solution

(e) Refurbish asset

(f) New asset

20.1.4 Where there is no existing phosphorus removal technology on a site this rules out many of the options as there is no existing treatment capability to be optimised or refurbished. Some sites do have current phosphorus removal capabilities, however the standards we are required to meet in AMP7, due to the Water Framework Directive, mean that additional treatment is required.

20.1.5 This then leads to the consideration of the most appropriate new asset or catchment solution. Where the phosphorus permit standard is above 1mg/l the preferred solution is generally chemical dosing as this is a proven technology. The relatively low capital costs of this technology make exploring biological phosphorus removal uneconomic as it would require significant changes to civil structures.

20.1.6 Where phosphorus limits are below 1mg/l we have explored a number of innovative technology options which combine dosing with iron salts and tertiary solids removal in order to meet both the phosphorus and iron permit limits. The phosphorus removal technology trials undertaken as part of the industry wide Chemical Investigations Programme 2 (CIP2)[59] provided the best source of evidence around the effectiveness of a range of phosphorus removal technologies which are aiming to achieve the low standards required to meet Water Framework Directive. As we have moved through AMP7 and our experiences of achieving these very low limits have increased we have been able to modify our approach from our learning. Where there is already tertiary solids removal at a WwTW we have reused this and optimised it as part of the project. Where we have assessed that there is a need for installation

[59] UKWIR, The National Chemical Investigations Programme 2015-2020, Volume 3 Wastewater Treatment Technology Trials.

of tertiary solids removal, we follow a robust process selection procedure to select the technology with the lowest whole life cost.

20.1.7 As mentioned in section 3.1, where biological phosphorus removal represents an economic option, we have pursued it. Examples of this are the Nereda at Kendal, Failsworth and Blackburn WwTW constructed for other environmental drivers defined in the AMP6 NEP. These sites are being optimised in AMP7 to maximise biological phosphorus removal to meet AMP7 WINEP requirements and drive down totex. We have one biological phosphorus removal site in AMP7 where we are installing mobile organic biofilm (MOB) at Macclesfield WwTW. This will be first time installation of this biological phosphorus removal technology in Europe.

20.1.8 The following table sets out some examples of schemes assigned to each level of hierarchy.

Table 39: Examples of AMP7 WINEP projects within the hierarchy

Hierarchy	Project	Comment
Do nothing	Bowdon WwTW	Catchment permit balancing with Macclesfield WwTW has resulted in no work needed at Bowdon WwTW
Operations and maintenance	Bury WwTW	Focused maintenance and optimisation of existing assets has reduced the requirement to add additional assets
Optimise asset	Kendal WwTW	Optimisation of Nereda for P removal
Partnership/catchment solution	Eden integrated catchment project	Catchment offsetting to allow more relaxed limits at WwTW
Refurbish asset	Kidsgrove WwTW	We are using 'sand cycle' to give insight into the current operation of the sand filters to gain understanding ahead of refurbishment
New asset	Alderley Edge WwTW	New chemical dosing and storage facilities, new flocculation tank, new final settlement tank, new filter clear (tertiary solids removal), new sludge storage and odour control
	Macclesfield WwTW	Installation of mobile organic biofilm (MOB) for biological phosphorus removal

20.1.9 Nereda is process based on granular activated sludge; a novel way of treating wastewater (which has not otherwise changed for over 100 years). Nereda technology encourages biomass to form in granules, which are dense and compact in form. These 'granules' are heavy and settle much more quickly than conventional activated sludge which means the process needs a smaller footprint than conventional activated sludge. The compact nature of the granules also offers a significant advantage over the conventional processes as this allows different zones to develop of varying oxygen content. This allows treatment of different components of the sewage in the same process stage. Crucially one of these components is phosphorus.

20.1.10 When solutions for new permit limits are being designed our engineering teams use the UUW asset standards. These are guidance documents which are used to design solutions including both what needs to be constructed, but also the quantity of power and chemicals required to achieve various permit limits. As discussed in section 18.2.8 at PR19 we did not have the experience of low phosphorus permits that we have now and that learning is growing through this AMP and is reflected in our asset standards.

20.1.11 Within our asset standard for chemical phosphorus removal we have a table which details how the dosing rate for chemicals for the various limits of phosphorus and associated assets are calculated. This is used as a starting point, as sites do operate differently depending on assets and incoming phosphorus concentrations. As can be seen from Table 40 the molar ratio (how much chemical is required to remove the quantity of phosphorus) increases where a secondary dose is required pre-tertiary solids removal (TSR), this is used for permit limits <0.75mg/l for trickling filters (TFs) and <0.5mg/l for activated sludge plants (ASP). For example, a wastewater treatment works which has a trickling filter process and a

permit of 0.25mg/l would require a molar ratio of between 4 and 6 before the primary settlement tanks and a molar ratio of between 8 and 12 before a tertiary solids removal process.

Table 40: Chemical dosing for phosphorus removal design parameters for permit limits <0.75mg/l for trickling filters and <0.5mg/l for activated sludge plants. NOTE: 'P' refers to Total Phosphorus

Parameter		Typical Molar Ratio (Fe^{3+}:P)		Maximum Molar Ratio (Fe^{3+}:P)		Expected average Total P load removal (%)	
Secondary Treatment Stage		Activated sludge plant	Trickling Filter (or other)	Activated sludge plant	Trickling Filter (or other)	Activated sludge plant	Trickling Filter (or other)
Dose Location	Pre Primary settlement tanks	2	4	4	6	85	85
	Pre Secondary Treatment	2	Not Recommended	4	Not Recommended	90	Not Recommended
	Pre tertiary solids removal	8	8	12	12	90	90

Source: UUW internal asset standards

20.1.12 Jar tests at the pre-design stage are performed on all projects to establish if chemical precipitation is feasible for the site and which chemical coagulant gives best performance. Jar tests replicate the wastewater treatment system at a much smaller scale using representative samples from the wastewater treatment works and testing the quantity of chemical needed to achieve the required permit levels. These tests are conducted under a range of flow conditions and influent phosphorus concentrations and also consider metal concentration and pH. The jar tests are used to indicate the required dose rate (in terms of molar ratio), but due consideration of the WwTW type is required. Jar tests establish if there is variability in the optimum dose and should have sufficient resolution to identify this accurately. Given the variability in accuracy of jar testing, the dosing equipment is designed to be able to dose between 50-200% of the optimum determined molar ratio for all flow conditions. For example, if jar testing determines that the optimum required molar ratio is 4, the dosing equipment shall be sized so that any molar ratio between 2 and 8 can be dosed under all flow and load conditions.

20.1.13 The designer determines the optimum dosing configuration for dual dosing systems, this is usually required for limits less than 1mg/l. This determination is based on the following factors:

- Dosing upstream of primary settlement tanks will give rise to a greater volume of sludge;
- The effect of increased suspended solids and BOD removal at the primary sedimentation stage on downstream biological processes;
- The need for and location of alkalinity dosing;
- The risk of metal carry-over; and
- Special design consideration are given to WwTWs with total influent phosphorus concentrations higher than typical domestic (10 mg/l).

20.2 Customer research indicates protecting the environment is a key priority

20.2.1 Research for the Drainage and Wastewater Management Plan and Water Resources Management Plan carried out in April 2021 showed that 21% of those customers surveyed ranked removal of wastewater

in the top 3 greatest long term challenges. It was also noted that aspects such as maintaining the network and wastewater treatment are often fairly easy for people to envisage, but happen in the background. When asked what people themselves feel is important; 'the impact on the environment is a constant concern' and customers 'love living in an area with lots of countryside and green space (perhaps heightened by Covid) and want this to be preserved'. We consider this to be evidence that customers support UUW's continued compliance with its environmental obligations.

20.2.2 At PR19, through multiple pieces of research, customers demonstrated a strong preference to protect the environment from deterioration and 60% surveyed also support improvements in service to enhance river quality, the highest of any service area in our choice experiment (Willingness to Pay June 2017). As part of this research customers stated that of ten attributes which dictate their service priority choices, the cleanliness of rivers and lakes and the cleanliness of the sea ranked 3rd and 4th respectively. Additionally, when we conducted immersive research with customers discussing ecosystem services within the River Irwell catchment (August 2017), one of the most popular service areas for improvement was 'A heathy river to support wildlife' with 57% selecting a desire for improvements.

21. Customer Protection

21.1 Customers are protected through Ofwat's common PCs and EA enforcement

21.1.1 Within AMP8 customers are protected through the following ODIs:

- **Discharge permit compliance** - If we are unable to comply with our permits we will incur penalty under this ODI.
- **Improving river water quality P** – it is anticipated that the phosphorus reduction projects will be built into the baseline of this performance commitment, therefore if they are not delivered or not achieved the works will not achieve the required P load removal and we will incur an underperformance payment through this ODI.

21.1.2 The Environment Agency ensures that the environment is protected on behalf of customers and monitor performance of companies through the Environmental performance assessment (EPA) for treatment works compliance. If we fail to comply with permits at wastewater treatment works we will not achieve the current 99.0% compliance required as a core measure for EPA. If we fail to comply with this we are unable to achieve 4* within the EPA even if all other measures are green.

21.1.3 Consequences of phosphorus compliance failure include:

- **Prosecution and fines** – if we are consistently unable to achieve the required permit limits the resulting non-compliance may result in prosecution by the EA. If non-compliance is through deliberate actions by the company this is likely to influence the scale of any fines issued.
- **Reputational impact** – As discussed above, treatment works compliance is a core metric within the EPA, if we are unable to achieve 99.0% we are unable to achieve 4*rating. The 4* rating which we have achieved in two out of the past three years, builds trust with the Environment Agency, loss of this trust will lead to less support for innovative approaches to delivering environmental improvements.
- **Loss of trust** – If we are unable to comply with these very low phosphorus permits customers and stakeholders will lose their trust in us protecting the environment.

Table 41: Summary of UUW's claim against Ofwat's assessment criteria

Assessment gate	Assessment gate question	Summary of evidence	Reference
Need for adjustment	a) Is there compelling evidence that the company has unique circumstances that warrant a separate cost adjustment?	This claim does not relate to unique circumstances. Rather, it relates to an increase in ongoing incremental expenditure due to our AMP7 WINEP interventions. We do provide evidence that our costs may be higher relative to other companies due to the pH of our water.	Section 17.1
Need for adjustment	b) Is there compelling evidence that the company faces higher efficient costs in the round compared to its peers (considering, where relevant, circumstances that drive higher costs for other companies that the company does not face)?	This claim does not relate to unique circumstances. Rather, it relates to an increase in ongoing incremental expenditure due to our AMP7 WINEP interventions. We do provide evidence that our costs may be higher relative to other companies due to the pH of our water.	Section 17.1
Need for adjustment	c) Is there compelling evidence of alternative options being considered, where relevant?	Ultimately, the WINEP is a statutory obligation. However, we provide evidence that we appropriately engaged with the EA to help shape the WINEP and that we take steps to control related costs.	Section 17.2
Need for adjustment	d) Is the investment driven by factors outside of management control?	Ultimately, the WINEP is a statutory obligation. However, we provide evidence that we appropriately engaged with the EA to help shape the WINEP and that we take steps to control related costs.	Section 17.2
Need for adjustment	e) Have steps been taken to control costs and have potential cost savings (eg spend to save) been accounted for?	We provide evidence that we appropriately engaged with the EA to help shape the WINEP and that we take steps to control related costs.	Section 17.2
Need for adjustment	f) Is there compelling evidence that the factor is a material driver of expenditure with a clear engineering / economic rationale?	We set out clear engineering rationale for why P removal increases expenditure.	Paragraph 17.3.2
Need for adjustment	g) Is there compelling quantitative evidence of how the factor impacts the company's expenditure?	We provide clear quantitative evidence that P removal is a material, industry-wide cost pressure.	Table 32 Figure 52
Need for adjustment	h) Is there compelling evidence that the cost claim is not included in our modelled baseline (or, if the models are not known, would be unlikely to be included)? Is there compelling evidence that the factor is not covered by one or more cost drivers included in the cost models?	We demonstrate clear evidence that the costs of removing phosphorus to a concentration less than 0.5mg/l are not contained in the historical cost record upon which the botex models are based.	Section 17.4
Need for adjustment	i) Is the claim material after deduction of an implicit allowance? Has the company considered a range of estimates for the implicit allowance?	We demonstrate that there is a very limited implicit allowance as the industry has not historically had to comply with permits approaching the technically achievable level. However, we use data in table 7F to remove the limited level of associated expenditure from the models to calculate an implicit allowance.	Section 17.4
Need for adjustment	j) Has the company accounted for cost savings and/or benefits from offsetting circumstances, where relevant?	N/a – this claim reflects an incremental increase on base operating expenditure.	
Need for adjustment	k) Is it clear the cost allowances would, in the round, be insufficient to accommodate the factor without a claim?	Higher ongoing phosphorus removal opex is an incremental cost, additional to the current cost base.	Paragraph 17.4.11

Assessment gate	Assessment gate question	Summary of evidence	Reference
Need for adjustment	l) Has the company taken a long-term view of the allowance and balanced expenditure requirements between multiple regulatory periods? Has the company considered whether our long-term allowance provides sufficient funding?	UUW will not be able to balance this additional expenditure over the long-term because ongoing opex cannot be expected to reduce in future.	Paragraph 17.4.12
Need for adjustment	m) If an alternative explanatory variable is used to calculate the cost adjustment, why is it superior to the explanatory variables in our cost models?	N/a – we do not value our claim using an alternative variable	
Cost efficiency	a) Is there compelling evidence that the cost estimates are efficient (for example similar scheme outturn data, industry and/or external cost benchmarking, testing a range of cost models)?	We value our claim using table 7F from our 2022-23 APR submission. We would support an appropriate common industry adjustment, given this is an industry-wide cost pressure.	Section 18
Cost efficiency	b) Does the company clearly explain how it arrived at the cost estimate? Can the analysis be replicated? Is there supporting evidence for any key statements or assumptions?	We clearly state how we arrived at our cost estimate. The value can be replicated using our 2022-23 APR submission. We set out full details of assumptions made, along with reasons for changes relative to our 2021-22 APR submission.	Section 18
Cost efficiency	c) Does the company provide third party assurance for the robustness of the cost estimates?	PwC provide third party assurance for our claim and cost estimates.	Section 18.3
Need for investment	a) Is there compelling evidence that investment is required?	N/a – this claim relates to ongoing expenditure due to our AMP7 WINEP	
Need for investment	b) Is the scale and timing of the investment fully justified?	N/a – this claim relates to ongoing expenditure due to our AMP7 WINEP	
Need for investment	c) Does the need and/or proposed investment overlap with activities already funded at previous price reviews?	N/a – this claim relates to ongoing expenditure due to our AMP7 WINEP	
Need for investment	d) Is there compelling evidence that customers support the need for investment (both scale and timing)?	N/a – this claim relates to ongoing expenditure due to our AMP7 WINEP	
Best option for customers	a) Did the company consider an appropriate range of options to meet the need?	We provide evidence that we appropriately engaged with the EA to help shape the WINEP and that we take steps to control related costs. We also show how we implement a solution hierarchy to ensure we implement the most effective solution to future permits.	Section 17.2 Section 20.1
Best option for customers	b) Has a cost–benefit analysis been undertaken to select proposed option? There should be compelling evidence that the proposed solution represents best value for customers, communities and the environment in the long term? Is third-party technical assurance of the analysis provided?	We provide evidence that we appropriately engaged with the EA to help shape the WINEP and that we take steps to control related costs. We also show how we implement a solution hierarchy to ensure we implement the most effective solution to future permits.	Section 17.2 Section 20.1
Best option for customers	c) Has the impact of the investment on performance commitments been quantified?	N/a – there will be no impact on performance commitments. Relevant performance commitments will measure UUW's compliance against the more stringent permit not the step change in permit.	

Assessment gate	Assessment gate question	Summary of evidence	Reference
Best option for customers	d) Have the uncertainties relating to costs and benefit delivery been explored and mitigated? Have flexible, lower risk and modular solutions been assessed – including where utilisation will be low?	We provide evidence that we appropriately engaged with the EA to help shape the WINEP and that we take steps to control related costs. We also show how we implement a solution hierarchy to ensure we implement the most effective solution to future permits.	Section 17.2 Section 20.1
Best option for customers	e) Has the company secured appropriate third-party funding (proportionate to the third party benefits) to deliver the project?	N/a – third party funding is not appropriate for this claim.	
Best option for customers	f) Has the company appropriately presented the scheme to be delivered as Direct Procurement for Customers (DPC) where applicable?	N/a – DPC is not appropriate for this claim.	
Best option for customers	g) Where appropriate, have customer views informed the selection of the proposed solution, and have customers been provided sufficient information (including alternatives and its contribution to addressing the need) to have informed views?	N/a – the solution is shaped by the WINEP. However, customer research does show that environmental protection is a key priority.	Section 20.2
Customer protection	a) Are customers protected (via a price control deliverable or performance commitment) if the investment is cancelled, delayed or reduced in scope?	We demonstrate that customers are fully protected via performance commitments.	Section 21
Customer protection	b) Does the protection cover all the benefits proposed to be delivered and funded (eg primary and wider benefits)?	We demonstrate that customers are fully protected via performance commitments.	Section 21
Customer protection	c) Does the company provide an explanation for how third-party funding or delivery arrangements will work for relevant investments, including the mechanism for securing sufficient third-party funding?	N/a – third party funding is not appropriate for this claim.	

IED Compliance Cost Adjustment Claim Submission

Cost adjustment claim submission	
Title:	Industrial Emissions Directive compliance at anaerobic digestion sites A cost adjustment claim to reflect higher than historical costs, arising from changes in regulatory requirements across the industry at anaerobic digestion sites, to operate under the Industrial Emissions Directive and comply with Appropriate Measures guidance.
Price control:	Bioresources
Total value of cost adjustment claim for AMP8	£172.594 million
Cost adjustment headline:	This document sets out the case for a cost adjustment to reflect the additional costs of complying with the Industrial Emissions Directive (IED) at our 13 anaerobic digestion sites. We have a new requirement to comply with Appropriate Measures statutory guidance that was published in 2022. This goes over and above the previously understood requirements of IED compliance, which the company is absorbing at a cost of £66.030 million in AMP7. The Environment Agency (EA) clarified in 2019 that all water industry anaerobic digestions sites would now be regulated under the IED. The guidance governing the requirements to comply with IED was revised in 2022, which will result in additional actions we will have to take in AMP8, on top of the 2018 guidance. Bioresources cost models are based on historical expenditure (pre-imposition of more stringent regulatory standards), and do not reflect the additional costs associated with meeting the IED and Appropriate Measures. We consider that Ofwat's modelled allowance will not allow us to fulfil our legal obligations, and therefore we consider a cost adjustment claim to be the most appropriate way to ensure we are able to recover efficiently incurred expenditure relating to enhanced IED compliance, as set out in the 2022 guidance.

Industrial Emissions Directive compliance cost adjustment claim summary

Gate	Summary	Location reference
Need for cost adjustment	• The EA clarified in 2019 that all water industry Anaerobic Digestion (AD) sites would now be regulated under the Industrial Emissions Directive (IED). This has ongoing implications for our compliance costs at 13 sites to comply with IED. • In September 2022 the standards of environmental protection to meet IED compliance were raised once again, with the publication of Appropriate Measures for the Biological Treatment of Waste. The EA has adopted a precautionary principle approach in setting the Appropriate Measures guidance, which has resulted in many requirements being more onerous than previous standards. • As bioresources cost models are based on historical expenditure (pre-imposition of more stringent regulatory standards), they do not reflect the additional costs associated with meeting the IED, and therefore an allowance is required in addition to modelled costs in AMP8. We are unaware of any companies incurring any significant monies to date to deliver IED compliance. There is, therefore, no element of costs in historical data. • We were not informed of the legal clarification to comply with IED at the time of our PR19 submission and therefore we did not submit an enhancement case at that time. The timing of the clarification of the legal status of our AD sites will mean that by the end of AMP7, we anticipate that we will have absorbed £66.030 million IED compliance costs associated with the EA's 2018 BAT guidance, that are not reflected in AMP7 cost allowances. • As IED compliance is a pre-existing obligation dating from 2019 (or even earlier for a subset of our sites) we anticipate that it will be appropriate for compliance costs to be recognised as a cost adjustment claim, rather than an enhancement case (albeit, this position is somewhat ambiguous).	Section 22.5 Section 22.6 Table 43 Section 23.4 Section 22.5 Figure 63
Cost efficiency	• We have undertaken a significant programme of surveys, site assessments, modelling and engineering design and estimating to derive costs for AMP8 IED compliance, which are highly site-specific and variable. We have extrapolated learning from the AMP7 IED permitting process to develop assumptions for developing cost estimates and to understand what proposals will be acceptable to the EA under the new requirements for 2022 Appropriate Measures guidance. • Costs for compliance across the sector are as yet unknown, however high level assessment by an independent consultant has indicated that our proposed compliance costs are consistent with industry norms. We have sought third party assurance of our costs to ensure that our cost estimates are robust. • We have taken steps to control costs for customers and have pursued and promoted the use of a risk assessment approach with the EA. We seek to use management and monitoring techniques to demonstrate compliance in preference to capital investment works. Acceptance of these measures has been limited by the EA which is pursuing a precautionary and risk-averse approach to setting requirements.	Section 24 Table 45 Section 24.2 Section 24.4

		Section 24.3
Need for investment	• Publication of Appropriate Measures guidance has raised the level of environmental protection to be delivered at our AD sites. • The significant capital interventions that are required to meet latest standards include: – Reduction in fugitive emissions through retrospectively covering open tanks and cake stores – Provision of secondary containment in the event of catastrophic failure of assets. Sewage sludge treatment facilities are now considered 'high risk sites' increasing the level of protection required. – New requirements for monitoring sludge liquor returns. • Costs to comply with our IED permits at 13 AD sludge treatment centres are a pre-existing obligation. Expenditure incurred to comply with IED post 2022 Appropriate Measures publication is an additional £172.594 million. These are new and more onerous service standards on top of those required to comply with the 2018 BAT guidance, reflecting a step change in regulatory expectations for waste treatment.	**Section 25** Figure 58 Figure 63
Best options for customers	• We have considered a range of options including 'do nothing'. We are presenting the lowest cost compliance option on behalf of customers. • The benefits delivered through the investment will be compliance against our statutory obligations. The investment will increase the level of protection for the environment from the harmful effects of industrial activities. This will reduce the environmental impacts of releases to land, air and water from our sludge treatment activities. • We have proposed a pragmatic timescale to deliver waste treatment compliance, based on feasibility and deliverability challenges, and recognising the scale of investment required. We have sought to align investment with other works on sites, and ensure sites can remain operational during the works. • So far as possible, we have ensured that our proposed investment is efficient through alignment with our bioresources long-term delivery strategy. We have closed several aging AD sites, where it was more cost efficient to cease digestion and convert sites to dewatering centres, rather than updating the sites to comply with IED standards.	**Section 26: Best option for customers** Table 48 23.2.5
Customer protection	• The IED requirements facing the sector constitute a significant increase in scope, beyond that represented by the historic trend in expenditure that is reflected in the Bioresources cost assessment model. This is the basis on which we have sought a cost adjustment claim. We recognise it may therefore reasonable to consider a PCD to ensure customer protection over the delivery of the additional scope that is allowed for in final determinations. • We are not, at this stage representing a proposed form of PCD, for two main reasons: – Ofwat is considering how it will make some allowance for IED, which may be to make cost allowances or to implement an uncertainty mechanism. An uncertainty mechanism such (as the one implemented by CMA) would likely remove the need for a PCD; and – Requirements are still relatively uncertain until further permits are issued.	**Section 27.: Customer protection.** 27.1.1 27.1.4 27.1.7

	• Early in 2024, following companies providing further information to Ofwat in December, we will work (if possible with Ofwat) towards a PCD proposal, if it seems likely to be required. • There are also three main areas of additional uncertainty where scope could increase based on further review with the EA and detailed design to confirm solutions. This is estimated at an additional circa £180 million and is not currently included in this claim pending further review with the EA and detailed design to confirm solutions. • Given the potential scale of scope and cost increases, we will, through our Business Plan submission, promote management of these compliance scope risks through an uncertainty mechanism. We may seek to revise the cost adjustment claim value in future, if further work or scope requirements are confirmed by the EA make it appropriate to do so. • The EA will ensure that the environment is protected in this area on behalf of customers through the AMP8 introduction of a common industry Environmental Performance Assessment (EPA) metric for waste treatment compliance. Moreover, non-delivery of the outputs will likely incur prosecution and fines by the EA. If non-compliance is through deliberate actions by the company this is likely to influence the scale of any fines issued.	27.1.8

22. Introduction

22.1 Document purpose

22.1.1 Evolving and more stringent regulation of sewage sludge treatment is leading to increasing environmental protection requirements across our sludge treatment sites. The change in requirements is driving higher than historical sludge treatment costs and as such we are submitting ~~two~~ one cost adjustment claim~~s~~:

(1) **Industrial Emissions Directive compliance at anaerobic digestion sites**. This is an industry-wide adjustment (as it impacts on all companies) with a claim value for United Utilities Water (UUW) of £172.594 million. This claim is specific to regulatory changes at our (biological) sludge digestion sites.

~~(2) **New waste permit obligations at physico-chemical sludge treatment sites that previously had PPC permits**. This is a company-specific adjustment with a claim value of £78.086 million. This claim is specific to regulatory changes at our (non-biological) sludge thickening and dewatering sites (hereafter "physico-chemical" sludge treatment sites).~~

22.1.2 This document relates to Claim 1: Industrial Emissions Directive (IED) compliance at Anaerobic Digestion (AD) sites only. We set out the costs to comply with the additional requirements emanating from the 2022 'Appropriate Measures' statutory guidance in AMP8, as an ongoing consequence of regulation under the IED, and why additional cost allowance is required, in addition to modelled costs. The scope of this claim is separate and distinct, and over and above AMP7 IED compliance costs, which result from the 2018 BAT guidance. Allowances made through this cost adjustment claim will ensure full regulatory compliance for a defined scope of requirements to meet environmental protection standards.

~~22.1.3 Claim 2 is set out in cost adjustment claim document, *UUW_CAC_005: New waste permit obligations at physico-chemical sludge treatment sites that previously had PPC permits*. We have only included costs for the bioresources price control in the cost adjustment claim (£78.086 million). We have not included the costs for the physico-chemical sludge treatment sites in the wastewater network plus price control in the cost adjustment claim (£11.319 million).~~

22.1.4 There is also significant change in the regulation of sludge disposal activities that may further impact the bioresources price control. The regulation of sludge to land activities is outside the scope of this document, which addresses sludge treatment activities only.

22.1.5 Through our Business Plan submission we will promote management of these other significant regulatory risks through an uncertainty mechanism.

22.2 Structure of this document

22.2.1 We have divided our cost adjustment claim into the following sections:

(a) The remainder of this section provides background on the evolving regulation of sewage sludge treatment and how this is leading to the need for two separate cost adjustments.

(b) **Section 23** provides an overview of the need for this cost adjustment, explaining that the new requirements at our AD sites will increase our operating costs and capital investment requirements. This activity is not reflected in the historical dataset or within the cost assessment framework and Ofwat's modelled allowance is insufficient to fulfil our legal obligations.

(c) **Section 24** provides evidence that our costs to comply with IED and 2022 Appropriate Measures guidance are efficient. We explain the opportunities, through innovation and alternative solutions, we have explored with the Environment Agency (EA) to seek to reduce compliance costs.

(d) **Section 25** provides clear evidence of the investment need. We use evidence gathered by independent consultants, on behalf of the water industry, to demonstrate that Appropriate

Measures compliance in AMP8 is driving additional costs, over and above those required to meet IED compliance in AMP7 to previous standards.

(e) **Section 26** sets out our approach to optioneering to demonstrate that we have considered a range of options, including 'do nothing', to deliver IED and Appropriate Measures compliance.

(f) Finally, in **Section 27**. we explain how customers are protected if the investment is cancelled or reduced in scope.

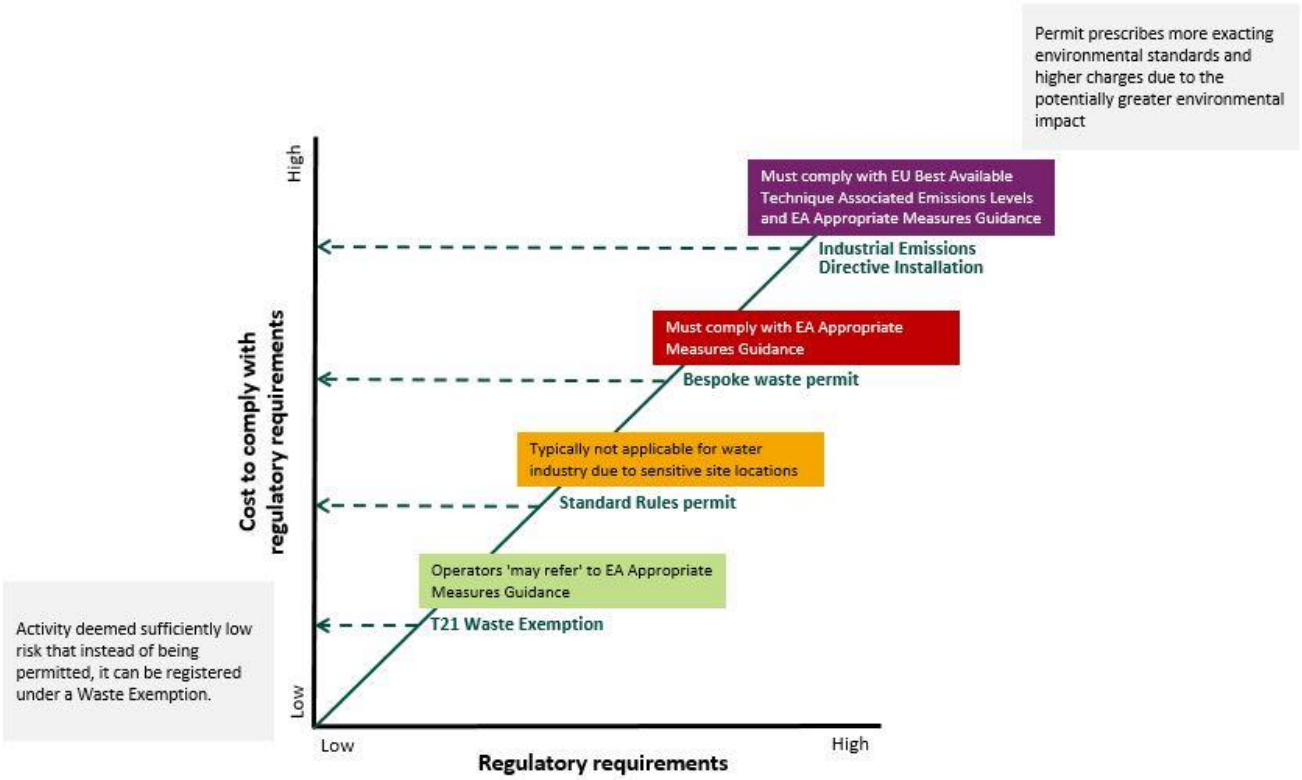
22.3 Environmental Regulatory Framework

Background

22.3.1 We present in this section the context detailing the evolution of the regulation of sewage sludge treatment at both physico-chemical and AD sites, common across both cost adjustment claims. We explain that the regulation of sewage sludge treatment is undergoing significant transformation. Activities are becoming more stringently regulated with ever increasing requirements for environmental protection.

22.3.2 The EA implements environmental permitting through the Environmental Permitting Regulations (EPR) framework, which uses a risk-based approach, dependent on the environmental risk of the activity. Regulation ranges from sufficiently low risk activities, that can be registered at no cost under a waste exemption, to installations under the Industrial Emissions Directive (IED), that are required to comply with more exacting environmental standards and incur high operational charges. A schematic to show these tiers of regulation is presented in Figure 54.

Figure 54: Tiers of waste regulation that may be applied through the EPR framework



Source: UUW interpretation of regulatory requirements

22.3.3 Historically, there have been different regulatory regimes for sludge treatment sites based on the ultimate outlet of the sludge they treat, rather than the process operating on-site. Operations are classed as either:

(a) **Recovery**: Supplying sludge to a recovery outlet (operations are classified as having a principal objective to ensure that the waste serves a useful purpose i.e. biosolids recycling to agricultural or land restoration).

(b) **Disposal**: Supplying (or the potential to supply) sludge to a disposal outlet (operations are classified as being primarily aimed at getting rid of waste i.e. landfill or incineration).

22.3.4 Disposal operations have historically been regulated more onerously, reflecting the greater environmental impact associated with the ultimate disposal outlet. The consequence of which is that two equivalent sites, carrying out the same processes, may be permitted under different regulatory regimes and incur different operating costs.

22.3.5 In Figure 55, and the remainder of this section, we set out a timeline to summarise regulatory changes at both disposal and recovery operations.

How the Waste Framework works differently

22.3.6 Since 2019 sludge treatment activities are regulated through the EU Waste Framework Directive. Prior to this, regulation of sludge treatment was covered by the Urban Wastewater Treatment Directive (UWWTD), which governs wastewater treatment activities in England.

22.3.7 An implication of regulation under the Waste Framework Directive, is that the Bioresources price control operates under unique water industry circumstances. Significant environmental investment needs can arise, but these needs are not being recognised in the Water Industry National Environment Programme (WINEP), and nor do they originate through primary legislative change (but through updated guidance). The waste treatment compliance needs set out in this cost adjustment claim, have arisen in exactly these circumstances: Guidance detailing how to comply with primary legislation has changed, rather than the legislation itself.

22.3.8 In these circumstances we consider that a cost adjustment claim would seem to be an appropriate way to ensure that we are able to recover efficiently incurred expenditure relating to enhanced waste treatment compliance standards. As IED compliance is a pre-existing obligation dating from 2019 (or even earlier for a subset of our sites) we do not consider an enhancement claim would be appropriate. However, we do recognise that significant parts of the AMP8 investment need may be considered typically as enhancement expenditure. The main issue for the company is that we are facing a significant increase to costs of compliance resulting from the 2022 guidance, which will need to be recovered from customers.

22.3.9 Under the Waste Framework Directive there is a requirement to comply with 'Best Available Technique' or 'BAT' standards. Importantly, it is implicit that BAT standards will continue to evolve, as improvements in BAT are developed, driven by changes in technology and tightening of standards, and therefore these sites will continue to attract periodic investment needs. The Waste Framework Directive is specifically designed to allow for these continuous updates to standards, and frequent and numerous changes to the EPR framework can be made within the EA's control, rather than requiring primary legislative change.

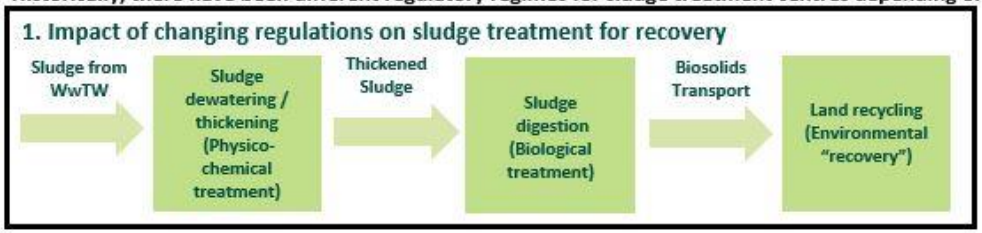
22.3.10 The EA can make changes to government websites and guidance without the need for public consultation. This can lead to new or tighter standards being implemented with a quick turnaround and these types of changes cannot always be predicted or accounted for in water company planning cycles. This can leave the operator with limited time to respond, especially if multiple facilities are impacted by the changes, and it poses challenges in terms of the practicality and funding of delivery. Moreover, within the Waste Framework Directive, there is no 'hands-off period', unlike for wastewater discharge permits that prevent further guidance or permit changes for four years following a change. There is a possibility that investment decisions could be out of date before they are delivered, creating an additional level of investment risk.

22.3.11 Guidance documents under the Waste Framework Directive, although termed 'guidance', are legally enforceable through the waste permitting process. While guidance itself is not law and does not operate

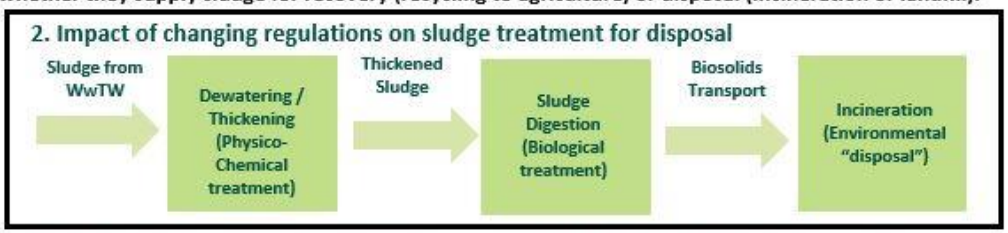
to override legal duties or obligations, government advice and guidance, may in practice, have the "force of law" and the EA Appropriate Measures guidance makes it clear that the standards are enforceable, and these measures are likened to Environmental Permit conditions and associated compliance with those.

Figure 55: Summary of the evolution of regulation of sludge treatment*

Historically, there have been different regulatory regimes for sludge treatment centres depending on whether they supply sludge for recovery (recycling to agriculture) or disposal (incineration or landfill).



Permitting regime	Sludge dewatering / thickening (Physico-chemical treatment)	Sludge digestion (Biological treatment)
Pre-2019	Sites operate under T21 exemption from waste legislation. Activity already covered under the UWWTD and therefore excluded from the IED scope (known as the "UWWTD exclusion")	Sites operate under T21 exemption from waste legislation Activity already covered under the UWWTD and therefore excluded from the IED scope (known as the "UWWTD exclusion")
2019	No change	July 2019 EA confirm implementation of the IED with respect to sewage sludge, having concluded that sewage sludge is not an activity covered by the UWWTD and is therefore within the scope of the IED. IED compliance requirements set out in European Commission 2018 BAT reference (BREF) document. (per Green Recovery requirements)
2022	No change	September 2022 EA issues their guidance on IED compliance for the sector, Appropriate Measures for the Biological Treatment of Waste. Requirements go significantly beyond those set out in BREF.
Additional costs claimed	-	Cost of additional work required by 2022 guidance, above that expected from 2018 guidance (i.e. the work in excess of the Green Recovery requirements)
Which Cost Adjustment Claim?	N/A	Industrial Emissions Directive compliance at anaerobic digestion sites **UUW_CAC_004**



Permitting regime	Sludge dewatering / thickening (Physico-chemical treatment)	Sludge digestion (Biological treatment)
Pre-2019	Sites permitted under the former PPC Directive (which was subsumed into IED). IED implementation deferred by the EA whilst legal clarification over the applicability of the "UWWTD exclusion" sought.	Sites permitted under the former PPC Directive (which was subsumed into IED). IED implementation deferred by the EA whilst legal clarification over the applicability of the "UWWTD exclusion" sought.
2019	July 2019 EA confirm implementation of the IED with respect to sewage sludge, having concluded that sewage sludge is not an activity covered by the UWWTD and is therefore within the scope of the IED. Existing PPC permits to be varied to IED permits. IED compliance requirements set out in European Commission 2018 BAT reference (BREF) document (per Green Recovery requirements)	July 2019 EA confirm implementation of the IED with respect to sewage sludge, having concluded that sewage sludge is not an activity covered by the UWWTD and is therefore within the scope of the IED. Existing PPC permits to be varied to IED permits. IED compliance requirements set out in European Commission 2018 BAT reference (BREF) document (per Green Recovery requirements)
2022	EA confirm sites are no longer above the IED threshold (as incineration has ceased). Sites to operate under Bespoke Waste Permits and not the IED. Introduces a requirement to comply with Appropriate Measures Guidance.	September 2022 EA issues their guidance on IED compliance for the sector, Appropriate Measures for the Biological Treatment of Waste. Requirements go significantly beyond those set out in BREF.
Additional costs claimed	Cost of additional work required by Bespoke Waste Permit and Appropriate Measures, above that to comply with baseline PPC permit	Cost of additional work required by 2022 guidance, above that expected from 2018 guidance (i.e. the work in excess of the Green Recovery requirements)
Which Cost Adjustment Claim?	New waste permit obligations at physico-chemical sludge treatment sites that previously had PPC permits **UUW_CAC_005**	Industrial Emissions Directive compliance at anaerobic digestion sites **UUW_CAC_004**

Source: UUW analysis

*UUW has withdrawn UUW_CAC_005. See section 2.6 for more details.

22.4 Regulation of sewage sludge treatment prior to 2019

- Pre-2019 the majority of sludge treatment centres operated under exemptions from waste legislation.
- Only those sites that supplied (or had the potential to supply) sludge to a disposal outlet (i.e. incinerator) were regulated under permits.
- Sites were permitted under PPC (later subsumed into IED). IED permitting was deferred while the EA sought legal clarification over whether it applied.
- At PR19 we were allowed £8.4 million of costs in addition to modelled costs in the Bioresources price control, to account for the increased operating cost of complying with PPC permits.

22.4.1 Sewage sludge treatment for **recovery** benefitted from an exclusion from the EU Waste Framework Directive and did not need to comply with IED:

- Regulation of sludge treatment was already covered by the UWWTD (known as the 'UWWTD exclusion').
- Sites typically operated under a T21 exemption and permitting was not required.
- This applied regardless of whether sites were undertaking AD or physico-chemical treatment.

22.4.2 Sewage sludge treatment for **disposal** was regulated under Pollution Prevention and Control (England and Wales) Regulations 2000[60]. A 2006 court ruling[61] deemed that any intermediate sludge treatment before the sewage sludge reached the disposal outlet for incineration should be included in the permitting regime. The implication of this determination resulted in us requiring a significant number of physico-chemical sludge treatment centres, as well as AD sites, to be permitted under PPC.

22.4.3 PPC was subsumed into IED[62] and in 2013 the EA led a variation process that sought to change PPC permits to IED permits. We appealed the permit variations, as at the time there was much disagreement about whether the treatment of sewage sludge was an activity covered by the UWWTD exclusion. We also challenged that, should they become IED permitted, then the PPC permits had been incorrectly classified by the EA as 'disposal' as opposed to a 'mix of recovery and disposal'. The impact of this was that all physico-chemical sludge treatment centres supplying sludge would also need to be permitted as IED Installations.

22.4.4 In July 2014 the EA issued the "Industrial Emissions Directive – Waste Sector update" which formally deferred permitting requirements to allow time for further consideration of the regulations and the interpretation of the UWWTD exclusion clause[63]. While legal clarification was being sought, these sites continued (and still continue) to operate under PPC permits (held in abeyance).

22.4.5 It has been recognised in previous price reviews that our physico-chemical sites are uniquely regulated in the sector, and have incurred higher costs than equivalent sites operated under T21 waste exemptions.

[60] The PPC regulations were made in order to transpose into domestic law the Integrated Pollution Prevention and Control Directive (96/61/EEC) or IPPC.

[61] England and Wales Court of Appeal (Civil Division), "United Utilities Water Plc V Environment Agency for England and Wales," 19 05 2006.

[62] Directive 2010/75/EU on industrial emissions (IED) entered into force on 6 January 2011 and was transposed into UK regulations on 20 February 2013.

[63] Environment Agency, Briefing: Industrial Emissions Directive – Waste Sector, July 2014.

22.5 IED implementation in 2019

- In 2019 the EA confirmed implementation of IED for sludge treatment. This captured:
  - All industry AD Sites (regardless of whether previously exempt or PPC permitted)
  - Uniquely, our physico-chemical sites which held existing PPC permits. All other recovery physico-chemical sites continued to operate under a T21 waste exemption.
- All sites captured by IED were now required to comply with the measures set out within 2018 BREF Conclusions
- In 2021 we submitted a Green Recovery proposal which was rejected as the EA confirmed that IED compliance was an AMP7 obligation (albeit unfunded). IED compliance with the 2018 BREF was estimated to cost:
  - £59.8 million at our AD Sites
  - £7.4 million at our physico-chemical treatment sites

22.5.1 The regulatory position over IED implementation was clarified in July 2019, when the EA wrote to companies[64] to inform us that it was now implementing IED with respect to sewage sludge. This marked the first time that the IED regulations had been formally confirmed to apply to any of our (and the whole water industry's) sludge treatment activities. The regulatory compliance date for IED permitting was set as August 2022.

22.5.2 Following notification by the EA of its intent to commence implementation of IED we identified the sites requiring IED permits:

- Nine AD sites required a permit variation from existing PPC permits
- Seven AD sites required permits for the first time
- Fifteen physico-chemical sludge treatment sites required a permit variation from existing PPC permits.

22.5.3 Implementation of IED has had significant implications for the whole water industry in AMP7. It introduced a requirement for sites, now regulated under IED, to increase environmental protection to meet Best Available Techniques (BAT) for waste treatment for the first time. The European Commission defines BAT to be applied for the specific installations covered within the IED scope, which means the best economically and technically viable techniques to prevent, minimise and reduce emissions to air, water, and land. These BAT conclusions were established in 2018 when the Commission Implementing Decision (EU) 2018/14476[65] BAT reference document (BREF) was published.

22.5.4 We were not informed of the legal clarification to comply with IED at the time of our PR19 submission. Therefore we did not submit an enhancement claim at PR19 to ensure provision of adequate resources to comply with the IED. Companies which challenged their PR19 determination with the Competition and Markets Authority and included for IED were awarded an allowance to comply with the IED in AMP7. This has created a distortion in the bioresources market in AMP7.

22.5.5 Our understanding is that Ofwat considers those companies that did not challenge their PR19 determination with the Competition and Markets Authority should meet the AMP7 IED costs. However, if through the PR24 process AMP7 costs for IED are to be allowed, then this will need to be a consistent approach applied across the industry.

[64] Letter from EA to water industry, *Industrial Emissions Directive*, 8 July 2019

[65] https://eur-lex.europa.eu/legal-content/EN/TXT/?toc=OJ:L:2018:208:TOC&uri=uriserv:OJ.L_.2018.208.01.0038.01.ENG

22.5.6 In 2021 we submitted a Green Recovery proposal[66] to seek funding to deliver compliance with the IED. This was unsuccessful as the EA declared that IED is an AMP7 obligation. The Green Recovery proposal identified the estimated costs to comply with the 2018 BREF:

- £59.8 million across our 16 AD Sites
- £7.4 million across our 15 physico-chemical treatment sites

22.5.7 While IED compliance should have been an AMP7 enhancement allowance, we have continued to undertake work to comply with IED. We anticipate by the end of AMP7 this situation will have led us to absorb £66.030 million of unfunded IED compliance costs.

22.6 Updated regulatory requirements in 2022

AD sites (this claim):

- All industry AD Sites are now required to additionally comply with 2022 Appropriate Measures for the Biological Treatment of Waste.
- Appropriate Measures has further raised the bar in the level of environmental protection required creating an additional investment need, over and above 2018 BREF requirements.
- Compliance costs at AD sites have risen by £172.594 million.

Physico-chemical treatment sites:

- Our sites no longer meet the threshold to be regulated as IED waste installations.
- ~~Existing permits are to be varied to bespoke waste permits, introducing a requirement to comply with statutory Appropriate Measures guidance.~~
- ~~Compliance costs at physico-chemical treatment sites have risen by £89.405 million across bioresources and Wastewater Network plus.~~
- ~~We have only included costs of £78.086 million for the bioresources price control in the cost adjustment claim.~~
- The EA has confirmed that these sites can operate under T21 exemptions.

At AD sites (this claim)

22.6.1 The gap to raise existing sites to meet IED compliance at AD sites has been further compounded by the publication of "Appropriate Measures for the Biological Treatment of Waste" on 21st September 2022[67], (hereafter "Appropriate Measures"). The EA, as the competent authority for implementing IED in England, has provided interpretation of the BAT conclusions for England. This document, although termed 'guidance', is legally enforceable through the IED permitting process.

22.6.2 Appropriate Measures has further raised the bar in the level of environmental protection required, setting out new and more onerous standards to be achieved. It has led to significant IED compliance scope creep, and moreover the timing of the publication, after our initial IED applications had been made, has generated significant re-design and re-engineering of solutions.

22.6.3 There are three core aspects to the 2022 Appropriate Measures that create an additional investment need, over and above 2018 BREF requirements:

(i) More stringent and onerous compliance requirements (based on specified Technical Reference Documentation)

(ii) Prescriptive compliance criteria: The 2018 BREF Document includes terminology that is open to flexibility and practicability, whereas the EA's "Biological Waste Treatment: Appropriate

[66] https://www.unitedutilities.com/globalassets/z_corporate-site/about-us-pdfs/main-documents/gr0005---emissions-regulations-and-the-journey-to-zero-carbon-redacted.pdf

[67] https://www.gov.uk/guidance/biological-waste-treatment-appropriate-measures-for-permitted-facilities

Measures for Permitted Facilities" uses terminology such as 'you must'. This limits the use of risk assessment to demonstrate that an equivalent level of environmental protection is being or can be achieved to capital investment, particularly when seeking to apply these standards retrospectively.

(iii) Additional sludge treatment activities covered by the document including storage of digestate material.

22.6.4 A detailed assessment and comparison of 2018 BREF requirements versus 2022 Appropriate Measures has been independently undertaken by Atkins[68]. This report clearly sets out the evidence for the additional circa £2.0billion of investment needs across the industry. The majority of additional scope is associated with secondary containment and covering of storage, both driven by Appropriate Measures requirements. The consequence of the scope increase of the Appropriate Measures is summarised below:

- IED compliance cost prior to Appropriate Measures: Our Green Recovery proposal quantified the cost of complying with IED for AD sites based on the 2018 BREF and review with the EA was £59.8 million.
- Since our Green Recovery proposal we have reduced our number of AD sites from 16 to 13. This rationalisation has been accelerated due to the significant capital investment needed to comply with Appropriate Measures in AMP8.
- The accelerated rationalisation of sites enables us to avoid wasteful investment in meeting Appropriate Measures guidance standards at sites that would ultimately have been closed in the medium term as we implement our long-term delivery strategy.
- The total cost of compliance for the scope over and above the 2018 BREF compliance scope is £172.594 million.

22.6.5 This activity is not reflected in the historical dataset or within the cost assessment framework and Ofwat's modelled allowance is insufficient to fulfil our legal obligations. The AMP7 green recovery proposal was rejected as Ofwat considered this an existing requirement and therefore expected to be funded from base expenditure. Recognising this, we are submitting a cost adjustment claim rather than an enhancement case to meet the additional AMP8 costs of IED compliance at our AD Sites.

At physico-chemical sludge treatment sites

22.6.6 With respect to our physico-chemical treatment sites operating under PPC permits the aim of the EA was to vary the existing permits to IED permits. The EA-led permit variation process commenced in 2021 when we were issued with Notices Requiring Information under Regulation 61(1) of the Environmental Permitting Regulations 2016. The information requests aimed to inform the EA about the current operation of the sites and compliance with BAT, to inform the EA review of permits.

22.6.7 At the time we submitted our Regulation 61 responses the disposal outlet at our incineration plant had ceased day-to-day operation. Following submission of our Regulation 61 responses, which outlined the latest operating position, we received a letter from the EA in March 2022 stating[69]:

"you confirmed your facilities will operate below the IED threshold and you will vary the permits to reflect the ongoing activities in the near future. On this basis, we agreed not to progress with the permit reviews."

22.6.8 The letter agreed that for these sites because they no longer supplied sludge to a disposal outlet, they did not meet the threshold to be regulated as IED Waste Installations. Permits at these sites should instead be varied to a tier within the EPR regulatory framework known as "Bespoke Waste Permits".

[68] Atkins, Industrial Emissions Directive Supporting Document, 31 May 2023 (for Water UK).

[69] Letter from the EA, *Reg 61 – WaSC sludge treatment BAT review,* 4 March 2022.

This tier has no requirement to comply with 2018 BREF. Costs of £7.4 million in AMP7 to comply with IED, and as set out in our Green Recovery proposal were therefore negated.

~~22.6.9 Varying the existing PPC permits to bespoke waste permits will, however, introduce a requirement to comply with statutory Appropriate Measures guidance[70]. As we have set out to the EA, we believe that these sites should be eligible to operate under T21 waste exemptions[71]. We are concerned that 13 of our physico-chemical sites are being subjected to more onerous regulatory requirements, and greater waste treatment compliance costs, than at other equivalent sites across the water industry, which are operating under T21 exemptions. The EA has stated that operating under T21 exemptions would be an unacceptable reduction to the level of environmental protection afforded at these sites, and they require bespoke waste permits.~~

~~22.6.10 The change in requirements to operate under bespoke waste permits and comply with Appropriate Measures guidance is driving higher than historical sludge treatment costs. We have incurred higher costs in the past due to the specific application of the regulatory framework to these sites, but these are expected to increase in AMP8 as a consequence of needing to comply with Appropriate Measures. This is set out in our cost adjustment claim for £78.086 million in document *UUW_CAC_005: New waste permit obligations at physico-chemical sludge treatment sites that previously had PPC permits.*~~

~~22.6.11 Compliance costs at physico-chemical treatment sites have risen by £89.405 million across bioresources and Wastewater network plus price controls. The impact of this is specific to ourselves and cost models do not reflect this activity. These are not IED compliance costs, so cannot be assumed to have been part of previously rejected IED claim for AMP7.~~

~~22.6.12~~ The EA has subsequently confirmed that our physico-chemical sites will be subject to T21 exemptions. As such, we have withdrawn our related cost adjustment claim, UUW_CAC_005. Please see Appendix G.7 for a copy of this letter.

22.7 Summary of the need for cost adjustment

22.7.1 As set out above, there have been significant changes to the regulation of sewage sludge treatment that will lead to additional sludge treatment costs being incurred in AMP8 and beyond. The change in requirements is driving higher than historical sludge treatment costs and as such we are submitting two separate cost adjustment claims.

22.7.2 We expect all companies to be seeking to recover costs at PR24 as there will need to be some form of adjustment to account for greater regulatory compliance costs. We consider a cost adjustment to be the most appropriate mechanism to recover costs, as IED is a pre-existing obligation, although we recognise that a lot of the investment will fall in AMP8 and may be considered enhancement.

(1) Industrial Emissions Directive compliance at anaerobic digestion sites (this claim).

22.7.3 A cost adjustment claim to reflect higher than historical expenditure requirements at 13 AD sites to comply with Appropriate Measures guidance. This is an industry wide adjustment with a claim value for UUW of £172.594 million.

22.7.4 This cost adjustment claim is valid because:

- The additional expenditure requirements result from the 2022 publication of new statutory guidance and are outside of our control.
- This activity isn't reflected in the historical dataset or within the cost assessment framework and Ofwat's modelled allowance is insufficient to fulfil our legal obligations.

[70] Which Appropriate Measures Guidance is unclear. We have asked the EA to clarify requirements between, *Chemical waste: appropriate measures for permitted facilities (*https://www.gov.uk/guidance/chemical-waste-appropriate-measures-for-permitted-facilities) or *Non-hazardous and inert waste: appropriate measures for permitted facilities* (https://www.gov.uk/guidance/non-hazardous-and-inert-waste-appropriate-measures-for-permitted-facilities). The Compliance requirements do not vary significantly between the two documents.

[71] UUW letter to EA 26 May 2023.

- The scope of this claim is over and above the prior IED Green Recovery proposal that Ofwat has already rejected for AMP7.

~~**(1) New waste permit obligations at physico-chemical sludge treatment sites that previously had PPC permits.**~~

~~22.7.5 A company-specific cost adjustment claim to reflect higher than historical costs, arising from changes in regulatory requirements for 13 physico-chemical sludge treatment sites, to operate under bespoke waste permits and comply with Appropriate Measures guidance. The requirement arises from a legacy of the sites ever having supplied (or had the potential to supply) sludge for disposal at our incineration plant and the specific EA approach to implementing the EPR framework. Claim value of £78.086 million.~~

~~22.7.6 To be clear, our cost adjustment claim only includes costs of £78.086 million for activity in the bioresources price control.~~

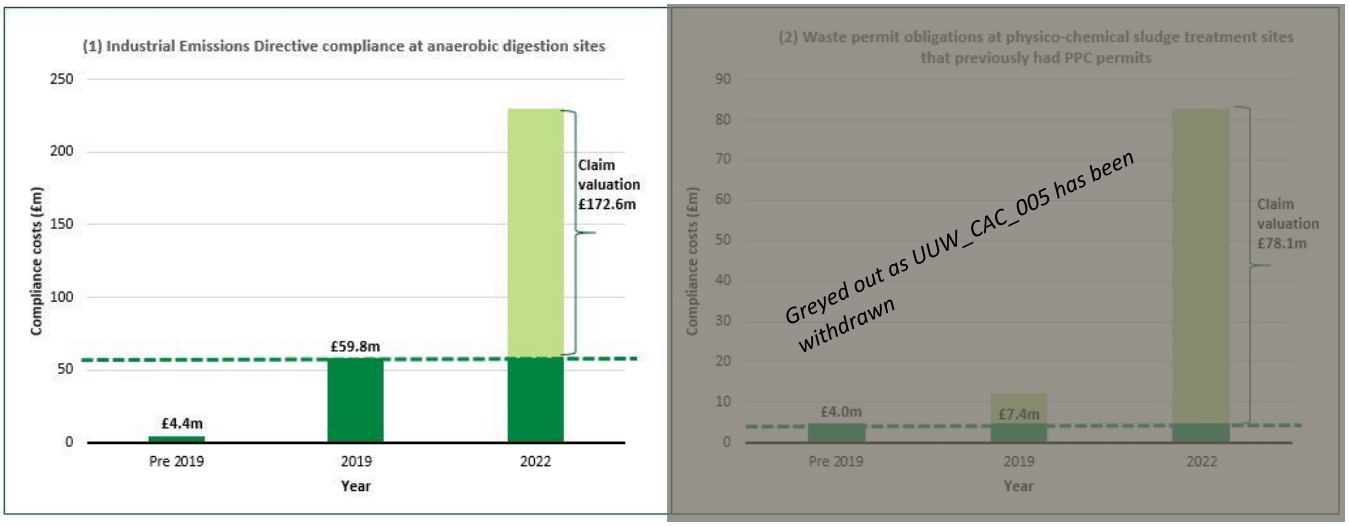
~~22.7.7 We will incur further costs at four physico-chemical sludge treatment sites that are within the Ofwat boundary for Wastewater network plus. We consider that under the PR24 methodology this cost does not meet the materiality threshold for a cost adjustment claim relating to the Wastewater network plus price control. Therefore, we have not included the costs to comply with appropriate measures at physico-chemical sludge treatment sites in the Wastewater network plus price control in the cost adjustment claim (£11.319 million).~~

~~22.7.8 This cost adjustment claim is valid because:~~

- ~~The additional expenditure requirements arise from changing regulatory requirements to comply with bespoke waste permits and are outside of our control.~~
- ~~The impact is specific to ourselves and cost models do not reflect this activity. Ofwat's modelled allowance is insufficient to fulfil our legal obligations.~~
- ~~We have incurred higher costs in the past due to the nature of the regulatory framework applied to these sites, but costs are expected to increase significantly in AMP8 as a consequence of needing to comply with Appropriate Measures.~~
- ~~These sites are no longer required to comply with IED and therefore, the scope cannot be assumed to have been part of previously rejected IED claim for AMP7.~~

22.7.9 Presented in Figure 56 is a summary of the valuation for ~~each of the two~~ our IED cost adjustment claim~~s~~. Cost estimates have been developed through a bottom-up engineering assessment at each site.

Figure 56: Cost adjustment claim valuations



Source: UUW analysis

22.8 Scope of this cost adjustment

22.8.1 This claim is for a £172.594 million cost adjustment to base totex across 13 AD sites. Anticipated expenditure to comply with the IED at our AD sites in AMP8 results from the investment needed to meet new and more onerous service standards, reflecting a step change in regulatory expectations for waste treatment.

22.8.2 Despite in 2019 all sites now being required to have IED permits and comply with standards set out in the 2018 BREF, these sites have never before been required to comply with 2022 Appropriate Measures standards. The more onerous service standards will result in significantly increased waste treatment costs than incurred historically. The value of this cost adjustment claim is for scope over and above AMP7 IED compliance scope.

22.8.3 In Table 42 we present a summary of the AMP8 cost adjustment claim. A build-up of the costs by site and scope item is presented in section 24 (Cost efficiency). The cost models, based on the volume of sludge processed, do not reflect the additional costs associated with meeting more stringent tiers of regulation and therefore, an allowance is required in addition to modelled costs. Our cost allowance is not sufficient to deliver the substantial investment required in AMP8 to maintain IED compliance.

Table 42: Summary of cost adjustment claim

Number of Sites	Totex (£m)					
	FY26	FY27	FY28	FY29	FY30	AMP8
13	£51.916	£41.840	£33.192	£28.480	£17.167	£172.594

Source: UUW analysis

~~22.8.4 The cost adjustment claim for £78.086 million of costs incurred at our physico-chemical sludge treatment sites is in document, *UUW_CAC_005: New waste permit obligations at physico-chemical sludge treatment sites that previously had PPC permits*.~~

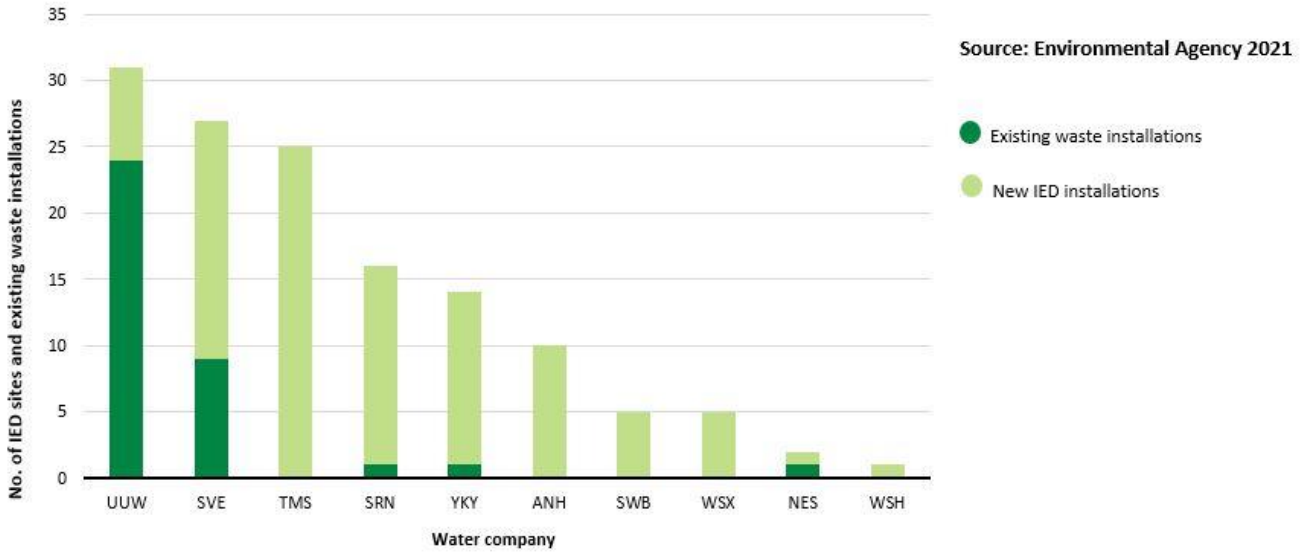
23. Need for adjustment

23.1 Unique circumstances

23.1.1 The obligation to comply with the IED at AD sites applies across the industry, and from 2019 when the EA confirmed their intention to implement the IED with respect to sewage sludge.

23.1.2 The impacts across the industry are highlighted in Figure 57. It can be seen that we have a greater number of sites captured by the regulations than any other company. This is a legacy of use of a disposal outlet, meaning that not only are our AD sites within the remit, but also includes the upstream physico-chemical sludge treatment sites (undertaking sludge thickening or dewatering) that once supplied (or had the potential to supply) sludge to our incineration plant. ~~Compliance requirements at our Physico-chemical sludge treatment sites is discussed in cost adjustment claim, "*UUW_CAC_005 - New waste permit obligations at physico-chemical sludge treatment sites that previously had PPC permits*", and are outside the scope of this document.~~

Figure 57: Number of sites requiring IED permits by company (as per 2021 data[72])



Source: Environment Agency

23.1.3 This cost adjustment claim relates to AD sites, which is a consistent requirement across the industry. Of our 13 AD sites now to be regulated under the IED:

- Seven AD sites requiring a permit variation (from existing PPC permits); and,
- Six AD sites require permits for the first time.

23.1.4 Sites that already hold a PPC permit face as large an upgrade in levels of environmental protection to meet IED and Appropriate Measures standards, as sites to be newly permitted, and there are no efficiencies gained from already holding a PPC permit. Until the need was confirmed for these sites to comply with the IED in 2019, existing permits had not been varied to IED permits, nor had they ever before been required to comply with BAT standards.

23.1.5 Implementation of IED has had significant implications for the whole water industry in AMP7. It introduced a requirement for sites, now regulated under IED, to increase environmental protection to meet BAT for waste treatment for the first time, as set out in 2018 BAT reference document (BREF).

[72] Data Source, EA, 2021 and presented in https://assets.publishing.service.gov.uk/media/60702370e90e076f5589bb8f/Final_Report_---_web_version_-_CMA.pdf (pg382)

23.1.6 We were not informed of the legal clarification to comply with IED at the time of our PR19 submission. Therefore we did not submit an enhancement claim at PR19 to ensure provision of adequate resources to comply with the IED. Our unsuccessful 2021 Green Recovery proposal sought £59.8 million of funding to deliver compliance with the IED at our AD sites: This was the estimated cost to comply with the 2018 BREF.

23.1.7 In September 2022, the standards of environmental protection to meet IED compliance were raised once again, with the publication of Appropriate Measures for the Biological Treatment of Waste. The EA has adopted a precautionary principle approach in setting the Appropriate Measures guidance, which has resulted in many requirements being more onerous than those in the 2018 BREF. This position reflects a step change in regulatory expectations for waste treatment and generates significant, additional investment needs at the industry's AD sites.

23.1.8 A detailed assessment and comparison of 2018 BREF requirements versus 2022 Appropriate Measures has been undertaken, on behalf of the water industry, by Atkins[73]. It demonstrates, in Atkins' expert opinion, where Appropriate Measures requirements go beyond, or even significantly exceed, those of BREF.

23.1.9 Overall, it was found that Appropriate Measures tends to set out blanket requirements for all equipment / procedures using terminology such as 'you must', whereas BAT implements a more risk-based approach including terminology that is open to flexibility and practicability. BAT gives more leniency for existing facilities in implementing the full range of best practices, recognising the constraints posed by existing layout and infrastructure.

23.1.10 The report clearly sets out the evidence for the additional investment needs across the industry resulting from the publication of Appropriate Measures guidance. In Table 43 we present a summary of the additional scope requirements in the Appropriate Measures guidance, above and beyond 2018 BREF at our AD sites.

23.1.11 Atkins' has summarised and classified their assessment as follows:

- If the requirements of BREF and Appropriate Measures are very similar, these are coloured green;
- If Appropriate Measures requirements go above those set out by BREF these are coloured amber; and,
- If Appropriate Measures requirements significantly exceed those of BREF these are coloured red.

[73] Atkins, Industrial Emissions Directive Supporting Document, 31st May 2023 (for Water UK)

Table 43: Additional scope requirements in Appropriate Measures guidance, above and beyond 2018 BREF[14]

Focus Area	Sub-Areas
Covering / Storage	Volume / residence time
	Storage areas
	Covering
	Storage tank design
	Lagoons
	Handling / transfer
Primary Containment / Failure Modelling	Monitoring
	Maintenance planning
	Operational areas
Secondary Containment	Minimising risk
Emissions Control / Monitoring	General
	Bioaerosols
	Point source emissions
	Biofilters
	Pre-treatment abatement scrubbers
	Fugitive emissions
Liquor Sampling	Sample analysis
Surface Water / Liquor Drainage	Infrastructure and inspection
Anaerobic Digestate Stability	Parameter monitoring/maintenance

Source: Atkins

23.1.12 Where scope is very similar between BREF and Appropriate Measures these items are being delivered and funded outside this cost adjustment claim. The scope of this cost adjustment claim is only for the additional scope, now required as a direct result of the publication of Appropriate Measures guidance.

23.1.13 ~~In, we~~ Table 45 in section 24 sets out the total cost of Appropriate Measures compliance for these additional scope items, over and above the 2018 BREF compliance scope is £172.594 million.

Higher costs in the round

23.1.14 In 2019, when the EA first notified the water industry of its intent to implement the IED with respect to sewage sludge, we identified 16 AD sites that would be required to comply with IED. As we started on the permitting journey in AMP7, it rapidly became apparent that compliance costs were material. To ensure efficient expenditure in the long-term, we have accelerated the closure of small, ageing AD sites to minimise the risk of potentially wasteful IED investment at sites that would ultimately have ceased digestion in the medium term as we implement our long-term delivery strategy. This site rationalisation has now reduced the number of AD sites requiring IED permits to 13.

23.1.15 The efficiencies gained from ceasing digestion at three digestion sites impacts our regional treatment capacity. We will absorb the costs for the premature write-off of assets ~~prematurely~~; digester clean-outs and decommissioning of AD assets. We will also absorb the cost to either install sludge thickening assets or undertake additional liquid sludge transport for sludge treatment at an alternative site in base costs.

23.1.16 We expect that by the end of AMP7 we will have absorbed £66.030 million of unfunded IED costs, either through investment on site or prematurely ceasing digestion at digestion sites.

23.1.17 The cost of Appropriate Measures compliance will result in higher costs in the round, even when any efficiency from rationalisation of assets is taken into consideration.

23.2 Management control

23.2.1 The investment required at our AD sites to comply with IED results from the application of the regulatory framework in England, and is outside of our control.

23.2.2 When the EA first sought to apply the IED to our AD sites in 2013 we challenged its position, arguing that regulation of our sludge treatment activities was an activity already covered by the UWWTD. This deferred the implementation of IED until 2019, at which time agreement between all UK regulators was reached. At that time, on the basis of legal advice provided to WaterUK, it was felt there was no remaining uncertainty in our statutory obligations, and no recourse for further legal action.

23.2.3 Moreover, the application of Appropriate Measures guidance through IED permitting is not subject to cost-benefit assessment and any alternative measures we may propose are subject to EA approval. The EA has ultimate control over the standards set for each of our sites through the permitting processes.

23.2.4 While acknowledging that the increased regulatory obligations results from factors outside of management control, we have taken steps to control costs for customers:

- By the end of AMP7 we will have absorbed £66.030 million of unfunded IED costs. These costs have not been passed on to customers.
- In AMP7 we have accelerated the rationalisation of our small, aging AD sites. This has reduced the scope of this cost adjustment claim from 16 to 13 sites, reducing costs for customers as we are not seeking Appropriate Measures compliance costs for the three sites which stopped digestion in AMP7.
- At a further two sites, in AMP8 we seek reduced appropriate measures compliance costs, associated with a reduced scope once sites are converted to sludge thickening centres, as this is a lower cost option than making the existing AD assets Appropriate Measures compliant. (See Section 26: Best option for customers).
- As we set out in section 26, we will ensure that we deliver investment to meet new obligations, as efficiently as possible. We will seek to re-use available information and data, such as odour modelling, air quality modelling, CCTV surveys and structural surveys. Through re-use of this company information we will minimise the work required to demonstrate compliance and the costs to customers.
- As far as possible we will use management and monitoring techniques to demonstrate Appropriate Measures compliance in preference to capital investment works. However, acceptance of these risk-based measures is reliant on EA agreement. Through permitting to date, the EA has pursued a precautionary and risk-averse approach to setting requirements.

23.2.5 We have tried so far as possible to ensure that our costs are efficient, by aligning our investment with our bioresources long-term delivery strategy. However, the EA has limited support for deferral of compliance investment at sites with a finite lifespan (i.e. Blackburn wastewater treatment works), citing concerns over the level of risk being carried in the intervening years. We wrote to the EA in January 2022 seeking to defer implementation of IED investment at Blackburn wastewater treatment works until 2027, to minimise the risk of inefficient and abortive investment, when a planned expansion and re-build of the site was expected to come on-line. The EA did not support this deferral and wrote to us in July 2022[74] to state:

"we would still be requiring any operational site to be delivering a high level of environmental protection regardless of whether it was proposed to cease operations in 2027".

23.2.6 The letter goes on to confirm:

[74] EA Letter to UUW, ***Industrial Emissions Directive Permitting – 7 July 2022***

"Where improvement conditions are used they will specify deadlines for compliance between now and the end of 2024."

23.2.7 We acknowledge the EA's position and continue to endeavour to meet timescales so far as possible for IED compliance, but recognise that Appropriate Measures requirements add further to the risk of abortive expenditure. Our solutions will seek to minimise the level of abortive spend at these sites. Two of the sites will be converted to thickening and/or dewatering sites to minimise the risk of abortive investment.

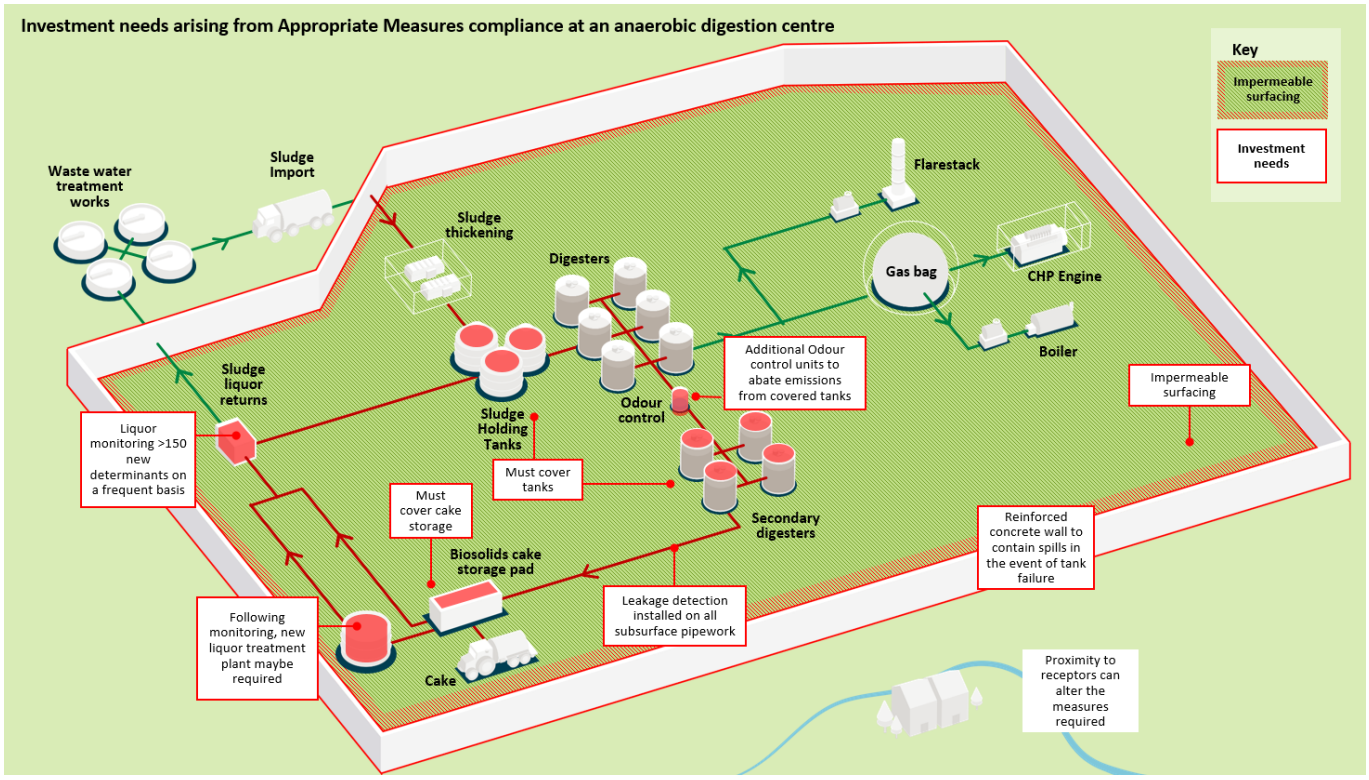
23.2.8 No potential cost savings (i.e. spend to save opportunities) are anticipated from these improvements. The improvements will not deliver any benefits to sludge quality or efficiencies in the operating process. The types of interventions, to cover tanks, reduce odour emissions, provide secondary containment of potential spills and binding of assets are solely in place to reduce the risk of pollution from site activities.

23.3 Materiality

23.3.1 This claim is for a £172.594 million cost adjustment to base totex. Costs are driven by the requirement to meet the latest standards for waste treatment, as set out in Appropriate Measures guidance.

23.3.2 We present in Figure 58 the explicit requirements of the Appropriate Measures guidance, over and above 2018 BREF compliance at our AD sites.

Figure 58: Material investment needs arising from Appropriate Measures guidance, over and above 2018 BREF at an AD site



Source: UUW visual representation

23.3.3 The precautionary principle approach adopted by the EA in setting the Appropriate Measures guidance, has resulted in many requirements being more onerous than those in the 2018 BREF. The standards represent a step change in requirements at our existing sites, and these sites must be retrofitted to meet entirely new service standards, driving material additional costs.

23.3.4 The scale of investment required to meet these new service standards is material, and cannot be absorbed through existing cost allowances. To put the scale of the investment need into perspective, the entire Bioresources price control for AMP7 was £357 million, but the investment required to meet

the latest standards at AD sites alone is £172.594 million. It is clear that this level of investment cannot be met through existing cost allowances and the cost models do not provide sufficient resources to enable us to comply with legal obligations.

23.3.5 The latest best estimate of the investment required by the industry to comply with Appropriate Measures and 2018 BREF is a total capex and one-off-opex expenditure of circa £2.0 billion (Atkins, 2023[75]). Much of this investment need is driven by requirements to cover tanks, silos, cake pads or secondary digesters to prevent fugitive emissions; and secondary containment of spills (driven by CIRIA 736 compliance[76]). Both of these requirements are directly attributable to Appropriate Measures requirements, and are over and above 2018 BREF requirements (See Table 43). This represents an additional investment requirement, at a scale of more than 75 per cent of the entire industry Bioresources price control in AMP7.

23.3.6 2022 Appropriate Measures compliance costs have not yet been incurred, and will only be in evidence once we complete the permitting process at each of the sites and start to comply with the new requirements. We have developed an efficient cost to deliver a clear scope of works using independent consultancy expertise to understand the latest EA permitting requirements to make a quantitative assessment of the expenditure requirements.

23.3.7 The industry programme to ensure that all AD sites have IED permits requires the permitting of over 100 sites. The permit application process started in April 2020. However, at the time of writing we are aware of only two sites that have had permit applications determined (both in May 2023). This delay to the process is partially due to much uncertainty over the improvements that will be acceptable to the EA. We are therefore unaware of any companies incurring any significant monies to date to deliver Appropriate Measures compliance. There is, therefore, no element of Appropriate Measures costs in historical data.

23.4 Adjustment to allowances (including implicit allowance)

23.4.1 At PR19, ongoing costs arising from maintenance of our existing PPC permits at a subset of our AD sites were acknowledged to be outside cost models and were allowed as unmodelled IED costs.

23.4.2 The PR24 methodology also recognises that IED compliance costs, due to sites being regulated at a higher regulatory tier, are not included in the cost models. The PR24 methodology refers only to the ongoing permit administration costs of IED compliance.

23.4.3 Our understanding is that Ofwat considers those companies that did not challenge their PR19 determination with the Competition and Markets Authority should meet the AMP7 IED costs. However, if through the PR24 process, AMP7 costs for IED are to be allowed, then this will need to be a consistent approach applied across the industry.

23.4.4 The costs set out within the cost adjustment claim are the capital costs (and future ongoing opex resulting from this investment) to comply with Appropriate Measures guidance. We consider that these costs should also be recognised as additional to the modelled allowance.

23.4.5 The bioresources cost models include no cost drivers that consider the additional costs incurred when sites are permitted at a more stringent regulatory tier. The cost models are based only on the volume of sludge processed and sparsity factors, neither of which is a determining factor of the costs of regulatory compliance at AD sites.

23.4.6 All companies will incur costs to comply with Appropriate Measures guidance at their AD sites. However, as established by Atkins in its 2023 assessment, compliance costs are highly site-specific. Costs will be

[75] Atkins, Industrial Emissions Directive Supporting Document, 31 May 2023 (for Water UK)

[76] The CIRIA 736 guidance "Containment systems for the prevention of pollution: Secondary, tertiary and other measures for industrial and commercial premises", was published in 2014.

influenced by site-specific factors such as proximity to receptors, underlying geology, and existing assets on sites.

23.4.7 This was reflected in the CMA decision of 2021, which with reference to IED compliance requirements (pre-Appropriate Measures publication) stated:

"In general, the CMA observes that IED compliance costs appear highly sensitive to the assessment of detailed requirements at specific sites. This accords with the Environment Agency's view that 'accurate estimates of the costs attributable to IED will only be available once all the site and company specific factors have been assessed and the review or issue of permits has been completed."[77]

Implicit allowance

23.4.8 There is no implicit allowance for compliance with more stringent regulations as these requirements are an addition to base service provision. The costs set out within the cost adjustment claim are the capital costs (and consequential ongoing opex) for compliance with the latest statutory Appropriate Measures guidance. These represent a step-change in acceptable waste treatment standards in England and are over and above standards set out in 2018 BREF.

23.4.9 The scope of works within this cost adjustment claim relates to new assets, not replacement or refurbishment of existing assets. We present in Table 44 a summary of our cost estimating assumptions to demonstrate that there is no implicit allowance for any of the individual scope elements that make up the cost adjustment claim.

[77] https://assets.publishing.service.gov.uk/media/60702370e90e076f5589bb8f/Final_Report_---_web_version_-_CMA.pdf (pg382)

Table 44: Estimating assumptions for cost adjustment claim

Bespoke waste permit compliance element	Estimating assumptions	Included in cost adjustment
Odour control	Cost estimates are for new odour control units, associated with abatement of vented emissions from covering tanks. Any refurbishment or maintenance of existing units to meet new standards have been excluded from the cost adjustment claim.	Costs included for new odour control units only
Leak detection	Cost estimates are for flow meters at the start and finish of pipe runs. No costs have been included to replace or maintain existing pipework. There is a possibility that once capital works commence maintenance issues will be uncovered and repairs will be undertaken through base allowances.	Costs included
Containment: Walls, kerbing, access and impermeable surfacing	Costs are for new areas of containment only, including walls, kerbing, access and hardstanding. Repairs to existing areas of hardstanding will be undertaken through base allowances.	Costs included for new containment only
Covering of tanks	Costs have been assumed to cover existing tanks only. No costs have been allowed to repair or replace existing tanks. It has been assumed that it is possible to retrospectively fit covers to existing tanks.	Costs included for covering tanks only
Covering of cake pads	Costs estimates are for new covered cake store (aka 'Dutch Barn'). The structure is new and the existing cake pad will be re-used.	Costs included for Dutch Barn
Additional instrumentation	Costs excluded from scope, to be delivered in AMP7	Costs not included
Liquor monitoring	Laboratory analysis costs included for >150 new determinants over and above existing requirements. No associated personnel costs have been included.	Costs included
Surplus activated sludge plants	Costs excluded from scope, to be delivered in AMP7	Costs not included
Site closures (two sites in AMP8)	Reduced Appropriate Measures compliance costs, associated with a reduced scope once sites are converted to sludge thickening/dewatering centres, are included in the lines above. Costs to install new sludge thickening/dewatering assets, to write-off AD assets prematurely and clean-out and decommission AD assets are all excluded from the claim.	Costs included in lines above Costs not included

Source: UUW cost adjustment valuation

23.4.10 As explained in sections 23.1.14 to 23.1.17 accelerated rationalisation of small, aging AD sites will incur ongoing maintenance efficiencies. However, these efficiencies are more than offset by the one-off capital and operational costs absorbed; to write-off assets prematurely; clean-out and decommission AD assets; and either install sludge thickening assets or undertake additional liquid sludge transport. The cost of Appropriate Measures compliance will result in higher costs in the round, even when any efficiency from rationalisation of assets is taken into consideration.

Timing of expenditure

23.4.11 Expenditure to ensure compliance with Appropriate Measures at our AD sites cannot be accelerated to be delivered in AMP7: The scale of the investment required is so complex and significant, and too great a proportion of botex to be absorbed.

23.4.12 The EA has set out an expectation that work to be IED compliant is due by December 2024, and we anticipate this date to be written into our IED permits when we receive them. We have sought a pragmatic discussion with the EA about timescales for implementation of IED. The delays to permitting across the industry will necessarily delay compliance timescales. We will endeavour to comply as soon as practicable but actual compliance dates will take considerably longer, once feasibility and deliverability challenges are taken into account.

23.4.13 Specific timescales for compliance with Appropriate Measures guidance at existing facilities are not set out within the guidance. The EA has signalled its intent to also assign December 2024 dates into permits for items resulting from requirements from Appropriate Measures. With publication of the guidance in only September 2022, we consider these compliance timescales are infeasible to meet.

23.4.14 We note that other Appropriate Measures guidance, for other wastes, treatment types or industries, set out a common expectation on timescales for compliance with long-term and capital-intensive improvement:

"Operators should complete these improvements as soon as practicable and within 3 years[78]".

23.4.15 We understand for sites being permitted to meet these requirements for the first time, this 'within three year' period would commence at the time the site permit is issued and not apply retrospectively, from the time the guidance was published.

23.4.16 In contrast, the Appropriate Measures for the Biological Treatment of Waste, with regard to long-term and capital-intensive improvements, states:

"Operators should periodically review, modify and update management, process systems or equipment in line with existing permit conditions. This may include periodic capital investment"[79].

23.4.17 No evidence or reasoning has been provided as to why this guidance takes a different approach but it appears to be deliberately intended. If a long stop or a shorter compliance period had been intended the guidance could have stated this. The deliberate omission of a long-stop indicates that no long stop was intended and that the timescales for implementation must be flexible and depend on the specifics of each case (e.g. the nature and complexity of the works).

23.4.18 We seek to deliver Appropriate Measures compliance as soon as practicable in AMP8.

[78] https://www.gov.uk/guidance/non-hazardous-and-inert-waste-appropriate-measures-for-permitted-facilities/1-when-appropriate-measures-apply section 1.3

[79] https://www.gov.uk/guidance/biological-waste-treatment-appropriate-measures-for-permitted-facilities/1-when-appropriate-measures-apply section 1.3

24. Cost efficiency

Development of efficient cost estimates

24.1.1 In this section we demonstrate that our cost estimates for delivering compliance with Appropriate Measures guidance are efficient. Appropriate Measures is a prescriptive set of guidance, not subject to cost benefit assessment and therefore, there are limited opportunities to make efficiencies in the scope that can be delivered. However, as we demonstrate in this section, we are doing as much as possible to reduce costs for customers.

24.1.2 We have undertaken a significant programme of surveys, site assessments, modelling, engineering design and estimating to derive bottom-up costs for Appropriate Measures compliance. We have extrapolated learning from AMP7 IED permitting to developing Appropriate Measures compliance cost estimates and to understand what alternative proposals (if any) will be acceptable to the EA.

24.1.3 We have limited the scope of this cost adjustment claim to only the scope items where we have certainty in requirements, and explicit standards set out in Appropriate Measures guidance.

24.1.4 We have excluded other scope items, such as the need to demolish and replace open tanks, covering sludge lagoons, or new liquor treatment plants to improve the quality of discharges back to a wastewater treatment works (see section 27.1.3 to 27.1.5 for more details). These requirements are too uncertain at present to include within this claim. However, given the potential scale of scope and cost increases, we will, through our Business Plan submission, promote management of these compliance scope risks through an uncertainty mechanism. We may seek to revise the cost adjustment claim value in future, if further work or scope requirements are confirmed by the EA make it appropriate to do so.

24.1.5 In Table 45, we present a summary of our efficient costs by site, based on delivery of this scope. There are four key scope items that are driving the uplift in required capital expenditure (as we present in Figure 58). These items are all specific requirements in Appropriate Measures Guidance, over and above the requirements set out in 2018 BREF. The majority of the cost relates to secondary containment and tank covering scope items.

24.1.6 The majority of the Opex relates to the emissions control and abatement related to the covering of open storage tanks.

Table 45: Summary of cost adjustment claim scope by site

Site	Capacity TDS	Existing PPC permit or new application	Permit application (£m)	Leak detection (£m)	Secondary containment (£m)	Tank covering (£m)	Cake pad covering (£m)	Total capex (£m)	Opex total (£m)	Totex total (£m)
Blackburn	11,003	New	-	£0.269	£4.790	£3.346	£5.521	£13.926	£1.552	£15.478
Burnley	3,938	New	-	£0.270	£2.192	-	£0.866	£3.328	£0.587	£3.916
Ellesmere Port	11,005	New	-	£0.378	£2.839	£0.794	£0.343	£4.353	£1.008	£5.361
Lancaster	8,692	New	£0.100	£0.372	£2.822	£0.848	-	£4.142	£0.197	£4.339
Leigh	5,986	New	-	£0.149	£3.195	-	-	£3.345	£0.700	£4.045
Southport	3,676	New	£0.100	£0.083	£2.957	-	-	£3.140	£0.321	£3.461
Bolton	8,257	PPC Variation	-	£0.277	£3.070	-	-	£3.346	£0.854	£4.201
Bury	9,456	PPC Variation	-	£0.270	£2.984	£6.070	-	£9.325	£1.787	£11.112
Manchester Bioresource Centre	91,000	PPC Variation	-	£0.403	£20.989	£40.644	-	£62.036	£8.495	£70.531
Liverpool	18,031	PPC Variation	-	£0.534	£7.937	-	-	£8.471	£0.847	£9.319
Oldham	4,994	PPC Variation	-	£0.270	£3.622	£3.040	-	£6.932	£1.082	£8.014
Stockport	8,665	PPC Variation	-	£0.271	£2.750	£2.410	£1.269	£6.700	£1.440	£8.140
Warrington North	5,572	PPC Variation	-	£0.272	£4.403	£16.720	-	£21.395	£3.283	£24.678
Total	**190,275**		**£0.200**	**£3.818**	**£64.550**	**£73.873**	**£8.000**	**£150.441**	**£22.153**	**£172.594**

Source: UUW cost adjustment claim valuation

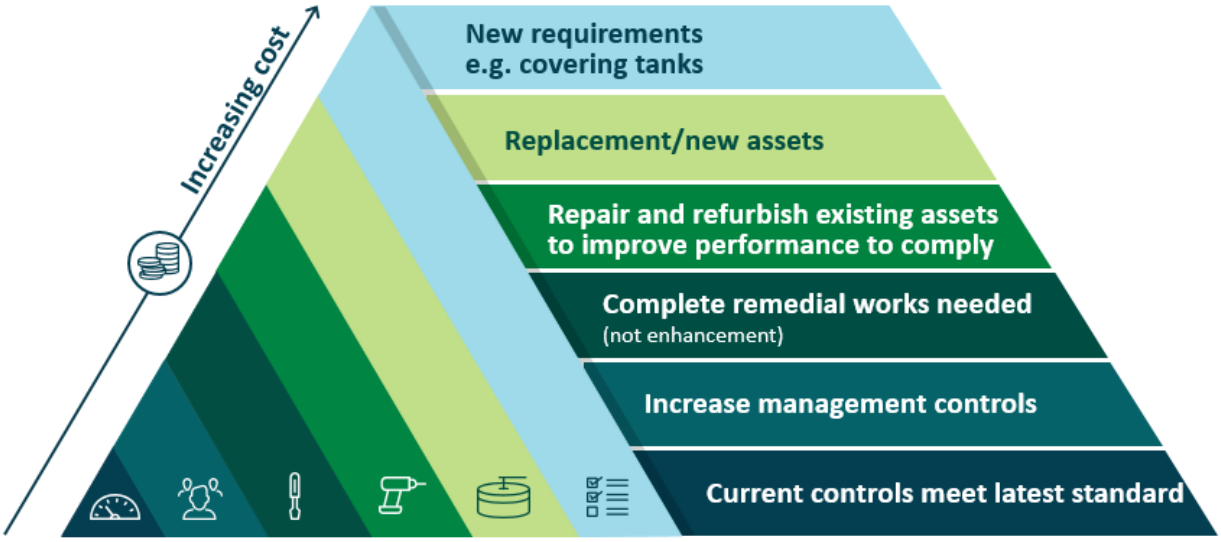
24.1.7 The scope for complying with Appropriate Measures is highly site specific as it depends on the design and configuration of assets operating on site, as well as site sensitivity factors, such as proximity to watercourses, underlying geology and the distance to nearby receptors.

24.1.8 In the absence of finalised IED permits, a series of assumptions have been made over the likely works that will be required, and is based on learning from our AMP7 IED programme. As well as relying on our own experience, we have collaborated with other WaSCs to understand their experience of IED permitting, and sought the support of technical expertise from multiple consultants to understand best practice outside the sector.

24.1.9 In developing measures to demonstrate compliance with Appropriate Measures guidance we will use management and monitoring techniques in preference to capital investment works. We will seek to minimise scope wherever possible in order to ensure we are efficient in delivering compliance. This hierarchy of interventions, to ensure delivery of efficient solutions, is presented in

24.1.10 ***Figure 59***.

Figure 59: Hierarchy of interventions to demonstrate appropriate measures compliance



24.2 Cost benchmarking

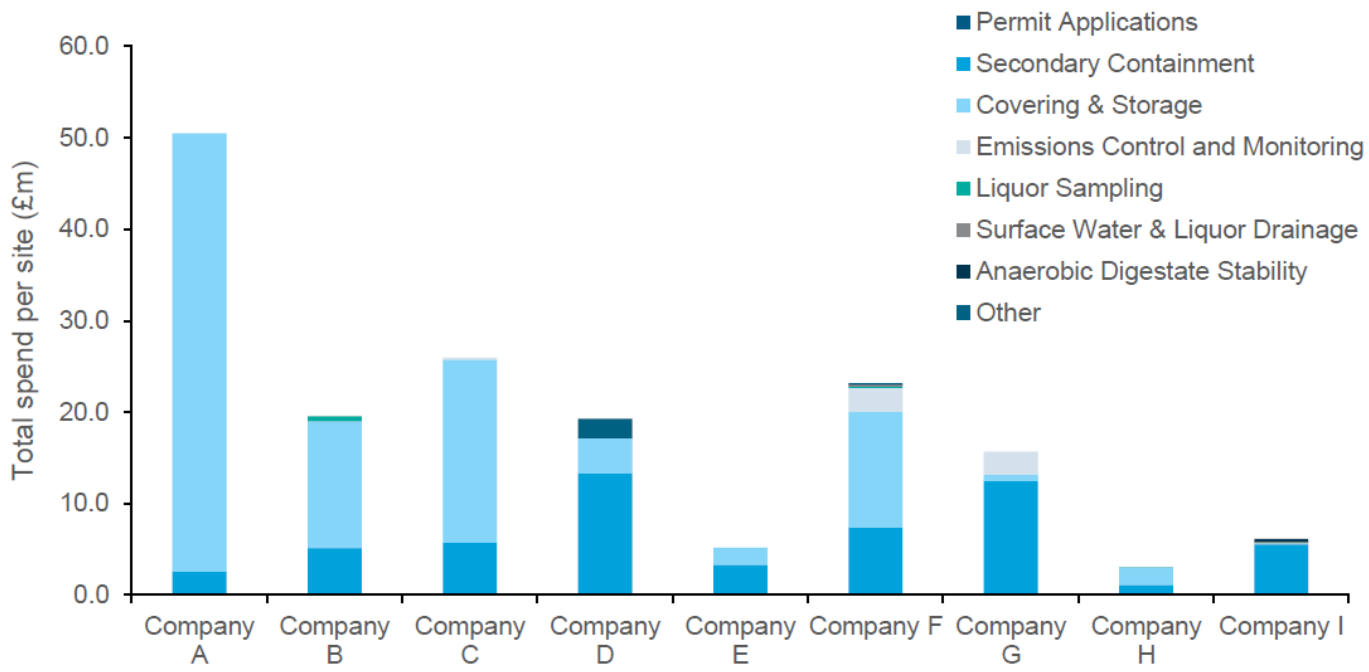
24.2.1 There are currently no agreed industry benchmarks for cost of compliance against the 2022 Appropriate Measures guidance as this is a new regulatory requirement.

24.2.2 Atkins' collation of company investment programmes to meet IED and Appropriate Measures has provided an indication of the range of investment required per site across companies. Variability in expenditure is significant, both between companies and at different sites within a company. The assessment noted that site-by-site variability was driven by different starting points in terms of technologies employed, standards at the time the site was constructed, local receptors and the varying guidance given by area teams at the EA to individual companies.

24.2.3 The average costs of compliance across the industry is in the order of £18 million per site, noting the significant site-by-site variability.

24.2.4 A summary of the total 'one-off' spend by site, per company is presented in Figure 60. It is not possible to directly compare our Appropriate Measures compliance costs, as we are uncertain of the assumptions used to build up compliance costs at other companies. However, we note that the average cost to comply across our sites is below the average presented across the industry. Our cost build-up is also similar to that of the wider industry, costs are predominantly being driven by the prescriptive requirements within Appropriate Measures to provide secondary containment to CIRIA 736 standards and provide covering of open tanks and cake bays.

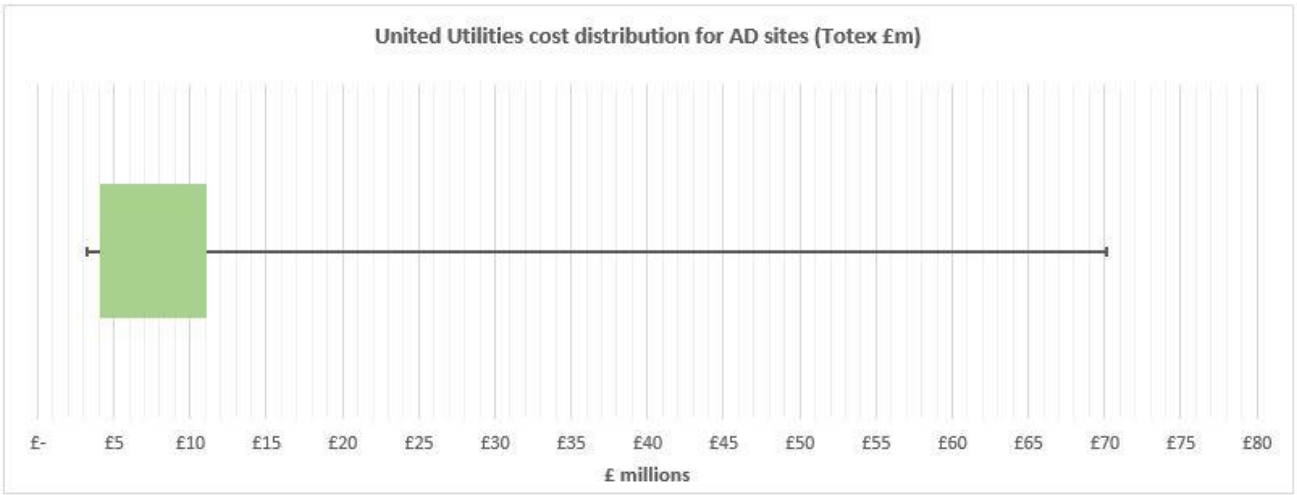
Figure 60: Anonymised total one-off expenditure per site by company



Source: Atkins[80]

24.2.5 There are significant cost outliers ~~without~~ within our own dataset. For example, our largest sludge treatment centre (Manchester Bioresource Centre or "MBC") has compliance costs of over £70.5 million alone. Leigh and Burnley, our most recently constructed advanced AD sites, have compliance costs of only £4.0 million each, well below industry average costs. A box and whisker chart showing this data variability is presented in Figure 61. The green box represents the 25 to 75 percentile range.

Figure 61: Distribution of UUW Appropriate Measures compliance cost by site Totex(£m)



Source: UUW analysis

24.2.6 The significant costs at MBC are being driven by a combination of the large number of secondary digester tanks on site, and a sensitive location in an urban area with immediate adjacency to a water course. The unique arrangement of assets means that secondary digestion for Oldham, Bury and Bolton's sludge all occurs at MBC. This large number of secondary digester tanks creates two significant

[80] Atkins, Industrial Emission Directive Supporting Document, 31 May 2023, Figure 6-4 (page 30)

Appropriate Measures compliance costs, firstly to cover and abate emissions from all tanks, and secondly to contain 25 per cent of the total tank volume in the risk of catastrophic failure.

24.2.7 Excluding MBC from our site costs our site average cost reduces to £8.5 million, and we consider that our costs are efficient when compared with others in the sector. We have a high confidence in the costs from the extensive assessment and design work already completed. We have also sought third party assurance of our costing methodology to ensure our cost estimates are robust and efficient (see section 24.5).

24.2.8 Our PR24 capital cost estimating approach has been based on data collected over AMP3 to AMP7 and updated to reflect the present market conditions under which we and the UK water industry are operating. Mott Macdonald (MM) has provided us an estimating service over AMP6 and AMP7. They also provide an estimating service to a number of other UK water companies, which allows them to provide a benchmarked approach to our PR24 capital cost estimates.

24.2.9 The capital costs consist of Contractor Direct Costs, Contractor Indirect Costs, UUW Risk, UUW Costs to Serve and UUW Corporate Overhead. MM have benchmarked UUW's direct costs and cost curves and assessed the water industry construction inflation based on their Construction Industry Basket of Goods index.

24.2.10 Delivery of this scheme will be across a portfolio of multiple projects, across multiple sites. We have experience of delivering work at all of these sites, and project managing the work to ensure that it is delivered effectively and efficiently, and as such we are confident that we have the technical skills and capabilities to deliver this work. Furthermore, we will drive delivery efficiencies through batching at a programme level or with other ongoing projects at site level.

24.3 Developing alternative solutions with the EA

24.3.1 We have held multiple PPC permits since at least 2013. As such we have developed considerable internal capability in order to deliver the additional compliance work set out in this submission. We have experience in developing permit applications, undertaking risk assessments to avoid unnecessary capital investments and ensuring that we continue to comply with our permits. However, despite this experience, through the AMP7 IED permit application process at our AD sites, it has proven challenging to come to agreement with the EA over the deployment of any alternative or risk-based proposals that provide equivalent environmental protection at lower costs for customers.

24.3.2 For example, to demonstrate compliance with spill containment requirements, our existing permit applications were determined using our Environmental Quantitative Risk Assessment (EQRA) approach. This looked at asset condition, and the source-pathway-receptor methodology to prioritise the risk to the environment from tanks and pipework. This significantly reduced the capital requirements at the time.

24.3.3 The EA, through Appropriate Measures, requires that all assessments are undertaken using the ABDA tool and CIRIA 736 methodology[81] and has rejected our EQRA approach. The EA response to our IED application at Ellesmere Port stated:

"The EQRA report is not an equivalent to a CIRIA 736 assessment and does not demonstrate BAT"

24.3.4 The response goes on to state:

[81] The CIRIA guidance "Containment systems for the prevention of pollution: Secondary, tertiary and other measures for industrial and commercial premises" was published in 2014 and is described as being "*applicable to the containment of a wide range of inventories and to all sizes of site from small commercial premises with a single storage tank, through to large chemical and petrochemical sites.*". In 2016, the Anaerobic Digestion and Bioresources Association (ADBA) produced a spreadsheet tool and associated guidance document[81] as a "*guide to secondary containment at anaerobic digestion (AD) plants"* that drew "*upon the principles and methodologies within CIRIA 736.*"

"CIRIA 736 is considered the industry standard of choice and is based on the source-pathway-receptor-approach to risk assessment. It proves a clear methodology for demonstrating BAT, appropriate measures and compliance with permit conditions".

24.3.5 There are several significant factors in using the ABDA tool and CIRIA 736 methodology that drive additional costs:

- While not explicitly stated, the ADBA guidance is aimed at smaller, new build Anaerobic Digestion developments rather than existing wastewater treatment works. The guidance does not reflect that in retrospective application to existing sites, the costs of upgrading existing facilities might outweigh the environmental benefits, and therefore are not viable.
- The CIRIA assessment process leads to all sites as having a "high" environmental hazard rating, as the default classification under CIRIA 736. Applying a "high" environmental hazard rating all but guarantees an overall site classification of Class 2 (equivalent to a petrochemical or cyanide facility). The Class then determines the quality/integrity of the surface that needs to be impermeable to provide the containment volume. For example, Class 2 would typically require reinforced concrete, whereas Class 1 may be achieved with impermeable membranes or good underlying geology. It is recognised that specific areas of a site may require a higher level of integrity but these should be identified by risk assessment and area-specific measures proposed, proportionate to the risk, not a default classification of the entire site.
- CIRIA guidance considers two scenarios for secondary containment volume; whichever is the greatest of 110 per cent of the volume of the largest tank within the bund; or 25 per cent of total capacity of all tanks within the bund. For the 25 per cent rule to apply there must be a credible scenario(s) where multiple tanks could fail catastrophically at the same time. The EA require use of the 25 per cent rule, which is driving additional costs at applicable sites.
- Furthermore, when retrospectively applying the 25 per cent rule to existing sites, the only practical location to install a bund, is often towards the boundary of a site. In this case, all tanks across a sites are contained within the same bund. Having to contain 25 per cent of total capacity of all tanks within a single bund can result in a much greater containment volume (and cost) than bunding smaller areas.
- A further consideration in developing containment solutions is the increased carbon cost (embedded and operational), which is not considered against the risks associated with retaining permeable areas i.e. consideration of the environment as a whole through this methodology.

24.4 Thinking differently: Developing more efficient solutions

24.4.1 Although Appropriate Measures sets out a prescriptive set of compliance requirements, we have challenged all areas of scope using our Minimum Viable Product (MVP) methodology to ensure our solutions are as efficient as possible, while delivering compliance. Our totex costs capture opportunities discussed in this section (where they are likely to be acceptable to the EA) and have reduced the overall costs of compliance for customers.

24.4.2 We present in Table 46 a summary of the opportunities considered to ensure our solutions are as efficient as possible. We have assessed a wide-range of scope solutions and approaches and our engineering team has ranked and developed these opportunities to identify potential efficiencies in the capital programme. Where we consider the opportunities have a likelihood of acceptance by the EA as compliant solutions we have included these efficiencies in cost estimating.

24.4.3 Given the large costs to meet CIRIA 736, the largest efficiency opportunities stem from the potential to reduce the areas of impermeable surfaces and spill volume to be contained. We have proposed through our IED permit applications to reduce the amount of impermeable surfacing contained within a bund. We suggest that at site locations with impermeable underlying geology, the likelihood of pollution reaching a receptor (and given the speed of any clean-up of lost material) is sufficiently low to not

require hardstanding across the site. The ADBA tool doesn't reflect ground conditions and therefore this solution would require a deviation from Appropriate Measures.

24.4.4 We have considered opportunities for alternatives to cast in-situ reinforced concrete walls, to bund a site and provide spill containment in the event of catastrophic tank failure. The alternatives considered included plastic barriers, sand bags, earth bunds, or legato blocks. All were considered to be only applicable to sites with a Class 1 site classification.

24.4.5 Our innovation team is seeking to identify alternative approaches to leak detection on sub-surface infrastructure. We are trialling Artificial Intelligence Leak Detection in partnership with FIDO Tech Ltd at Blackburn wastewater treatment works as an alternative to installing flow meters for leak detection. This is a low cost solution deployed on our water network. This is a fully automatic process that analyses thousands of acoustic sound files instantly, providing standardised daily outputs to deliver leakage detection efficiency improvements. The greater accuracy from acoustic monitoring can also inform repair prioritisation through its innovative leak sizing capability.

Table 46: Summary of cost efficiency opportunities already assumed

Opportunity	Rationale	Value of opportunity	Likely EA position+
Covering tanks	Retrospectively fitting covers and emissions abatement to tanks rather than full tank replacement	c. £130 million	Accept – approach accepted through EA permitting to-date
Covering cake pads	Cost estimates are for covered cake stores (aka 'Dutch Barn'). Costs exclude fully enclosed storage with ventilation.	c. £15 million	Accept – approach accepted through EA permitting to-date
Flow meter installation	Installation of flow meters on either end of subsurface pipework, in preference to moving all subsurface pipework above ground.	Not costed	Accept – approach accepted through EA permitting to-date
FIDO leak detection	Lower cost alternative to flow meter installation in below ground pipework	C. £4 million	Uncertain if approach will be accepted by the EA. Further trials required at Blackburn. Efficiency cannot be assumed to be accepted.
Reduction in total containment volume within bunds	Reducing height of concrete walls and areas of impermeable surfacing by containing 110 per cent of the volume of the largest tank, rather than 25 per cent of total capacity of all tanks within the bund. Higher walls also incur high cost per linear meter.	C. £20 million	Unlikely the approach will be accepted by the EA as a non-compliant solution. Efficiency cannot be assumed to be accepted.
Reduction in impermeable surfacing area within bunds	Use of risk assessment at sites with impermeable underlying geology to reduce the areas of hardstanding required.	Not costed	Unlikely the approach will be accepted by the EA as a non-compliant solution. Efficiency cannot be assumed to be accepted.

Opportunity	Rationale	Value of opportunity	Likely EA position+
Alternatives to cast in-situ reinforced concrete walls	Lower costs alternatives to provide bunding around tanks	Up to 25 per cent reduction against reinforced concrete wall costs	Unlikely the approach will be accepted by the EA as a non-compliant solution. Alternatives only suitable for 'Class 1' sites. All sludge treatment centres classed as 'Class 2' sites by default under CIRIA methods.

+ Where an opportunity is marked as 'Accept', the cost savings have already been included in the overall costs presented, and demonstrates how we have built up efficient costs.

24.5 Assurance of this submission

24.5.1 We have sought external assurance from PwC for the methodology and information used to derive our claim value. An extract from PwC's report is provided below.

24.5.2 "As a result of the work performed, we can conclude that management has developed a detailed and logical methodology for producing each cost build and the approach followed to develop the cost estimates appears robust. We have undertaken detailed walkthroughs to understand the source of the cost data and rationale for assumptions and estimates made. We have not identified any priority actions which require attention in advance of the submission."

25. Need for investment

25.1 New regulatory requirement

25.1.1 Publication of Appropriate Measures guidance has raised the level of environmental protection to be delivered at our AD sites. We have not, to date, been required to invest in our sites to meet Appropriate Measures standards. In 2019 following clarification of the regulatory position of the industry's AD sites, we were required to comply with the environmental protection standards set out in the 2018 BREF. Compliance costs for the 2018 BREF were set out within our 2021 Green Recovery proposal. This claim was rejected as IED Compliance with 2018 BREF was considered to be an AMP7 requirement.

25.1.2 The scope requested in this cost adjustment claim result from explicit requirements set out in Appropriate Measures. Evidence provided by the 2023 Atkins assessment[82] clearly demonstrates the additional scope requirements.

25.1.3 Atkins' assessment has identified that the EA, through its statutory duty to reduce potentially harmful emissions, has adopted a precautionary principle approach in setting their Appropriate Measures guidance. This has resulted in many requirements being more onerous than those in the existing 2018 BREF. The EA has deemed the risk posed by permitted facilities that handle sewage sludge are higher than the original BAT conclusions in 2018 BREF.

25.1.4 In Table 47, we summarise the new requirements within Appropriate Measures that are driving the significant capital investment requirements at our sites.

[82] Atkins, Industrial Emission Directive Supporting Document, 31 May 2023

Table 47: Additional scope requirements driven by the publication of 2022 Appropriate Measures

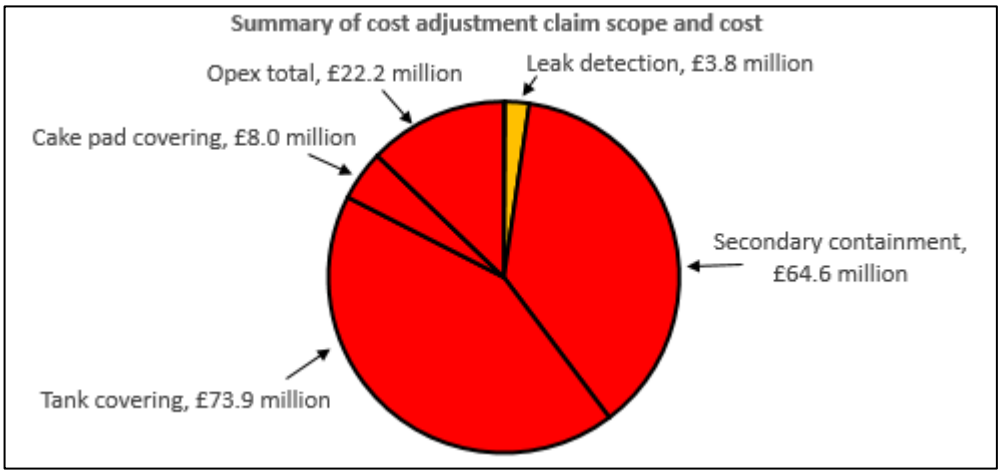
Focus Area	Sub-Areas	New requirements resulting from Appropriate Measures (2022)	Induded within scope of Cost Adjustment Claim?	Costs Adjustment Claim Scope
Covering / Storage	Volume / residence time	N/A	No	
	Storage areas	See Covering	Yes	We will address emissions from tanks across 8 sites through retrospective tank covering and abatement through new odour control units.
	Covering	You must cover all bulk storage tanks. Where possible you must contain and vent tanks and vessels through suitable abatement, or direct emission to a gas recovery system. Section 7.1		
	Storage tank design	See Covering		
	Lagoons	- Existing lagoons must be risk-assessed by a suitably qualified engineer. You must maintain the structural integrity of the lagoon. You must address and resolve any problems identified during the assessment. '- Existing lagoons can use floating covers or a crust (formed where there is a high dry matter content) to manage emissions. Coverage must be sufficient to minimise the surface to air ratio to prevent emissions. Section 7.3	No	
	Handling / transfer	N/A	No	
Primary Containment / Failure Modelling	Monitoring	N/A	No	
	Maintenance planning	N/A	No	
	Operational areas	You must have the following measures in place in operational areas: an impermeable surface, spill containment kerbs, sealed construction joints, connection to a contained drainage system. Section 11.13 Scope included in Secondary Containment.	Yes	We will address containment by constructing new secondary containment bunds for the greater of 110% of the largest tank or 25% of the total volume of tanks, with new impermeable surfaces, spill containment curbs, sealed construction joints and connection to a contained drainage system at 13 sites.
Secondary Containment	Minimising Risks	Secondary containment (bunds) must: be constructed to CIRIA 736 (Section 7.1). - CIRIA guidance considers two scenarios for secondary containment volume; whichever is the greatest of 110% of the volume of the largest tank within the bund; or 25% of total capacity of all tanks within the bund. - The CIRIA assessment process leads to all sites as having a "high" environmental hazard rating, as default classification under CIRIA 736. - Assuming a "high" environmental hazard rating all but guarantees an overall site classification of Class 2 which would typically require reinforced concrete walls, whereas Class 1 containment may be achieved with impermeable membranes or good underlying geology.	Yes	
		For subsurface structures, you must: -provide secondary containment and leakage detection for sub surface pipework, sumps and storage vessels (Section 11.13)	Yes	We will install flow meters on underground pipework at multiple points per site to evaluate the integrity of the sub-surface pipework through measuring losses over the system at 13 sites.
Emissions Control / Monitoring	General	N/A	No	
	Bioaerosols	N/A	No	
	Point source emissions	N/A	No	
	Biofilters	N/A	No	
	Pre-treatment abatement scrubbers	N/A	No	
	Fugitive emissions	You must effectively minimise fugitive emissions from dewatered digestate fibre and digested sewage sludge cake. This applies to all stored material. For example, you must store it: -under a suitable cover -in an enclosed building fitted with an air ventilation and extraction system -in field stores in line with farming rules for water (Section 9.4)	Yes	We will address emissions from storage by covering cake storage bays including monitoring across 4 sites.
Liquor Sampling	Sample analysis	Sampling of return liquors prescribed by the EA. Reference to 'Surface water pollution risk assessment for your environmental permit'. Liquor characterisation expanded to >150 determinands	Yes	We will undertake routine monitoring of appropriate liquor returns to assess the required parameters at 13 sites.
Surface Water / Liquor Drainage	Infrastructure and inspection	N/A	No	
Anaerobic Digestate Stability	Parameter monitoring / maintenance	N/A	No	

Source: adapted from Atkins[83]

[83] Atkins, Industrial Emission Directive Supporting Document, 31 May 2023, Table 4-1 (page 12). Where BREF and Appropriate Measures are very similar (coloured green); where Appropriate Measures requirements go above those set out by BREF (coloured amber); or where Appropriate Measures requirements significantly exceed those of BREF (coloured red).

25.1.5 Figure 62 illustrates the relative cost by scope item, and used the Atkins' red, amber, green, categorisation of requirements, to demonstrate how it aligns to the 2022 Appropriate Measures guidance requirements, over and above the requirements of the 2018 BREF. The scope associated with red coloured sectors of the pie chart are all new scope items to meet new obligations in Appropriate Measures, so all the costs for these scope items are included in the cost adjustment claim. The small scope associated with amber coloured sector of the pie chart is leak detection, which was identified as an item where Appropriate Measures requirements go above those set out by BREF. In our Green Recovery proposal to meet BREF 2018 we included £6.8 million for leak detection. The cost to meet Appropriate Measures requirements is £10.6 million. We have only included the cost of £3.8 million in this cost adjustment claim to deliver the scope that goes above the requirements set out in BREF 2018. This shows that our scope clearly aligns with those areas where Appropriate Measures requirements significantly exceed those of the 2018 BREF, in Atkins' assessment.

Figure 62: Pie chart showing the cost adjustment claim scope and cost, aligned to Atkins' (red, amber, green assessment) comparison of requirements between the 2018 BREF and the 2022 Appropriate Measures guidance



Source: UUW analysis of cost adjustment claim

25.1.6 We seek to deliver Appropriate Measures compliance as soon as practicable in AMP8, and have profiled our forecast expenditure accordingly.

25.1.7 We have proposed a pragmatic timescale for Appropriate Measures, based on feasibility and deliverability challenges, and recognising the scale of investment required. We have sought to align investment with other works on sites, and ensure sites can remain operational during the works. In addition, needs must be considered under wider planning regulations and Construction Design and Management (CDM) Regulations which have the potential to add necessary delays to construction completion.

25.1.8 Specific timescales for compliance with Appropriate Measures guidance at existing facilities are not set out within the guidance. The EA has signalled its intent to assign December 2024 dates into permits for items resulting from requirements from Appropriate Measures. With publication of the guidance in only September 2022, and the scale of work required, these compliance timescales are considered infeasible to deliver.

25.1.9 The timescales set out are dependent on EA acceptance of our proposals. In this context it is important to recognise that over two years has elapsed since UUW's first submission of an application but as of 1st June 2023, we have yet to have a permit determined. The industry programme to ensure all AD sites have IED permits, requires the permitting of over 100 sites. The permit application process started in April 2020. However, at the time of writing we are aware of only two sites that have had permit applications determined (both in May 2023). This delay to the process is partially due to much uncertainty over the improvements that will be acceptable to the EA.

25.1.10 It is not in customers' interest to invest before the requirements and scope are agreed through the permitting process. We will not start to invest to deliver capital improvements to meet Appropriate Measures standards until we have certainty in the scope required by the EA to avoid inefficient spend on behalf of customers.

25.2 Allowance for IED compliance in previous price reviews

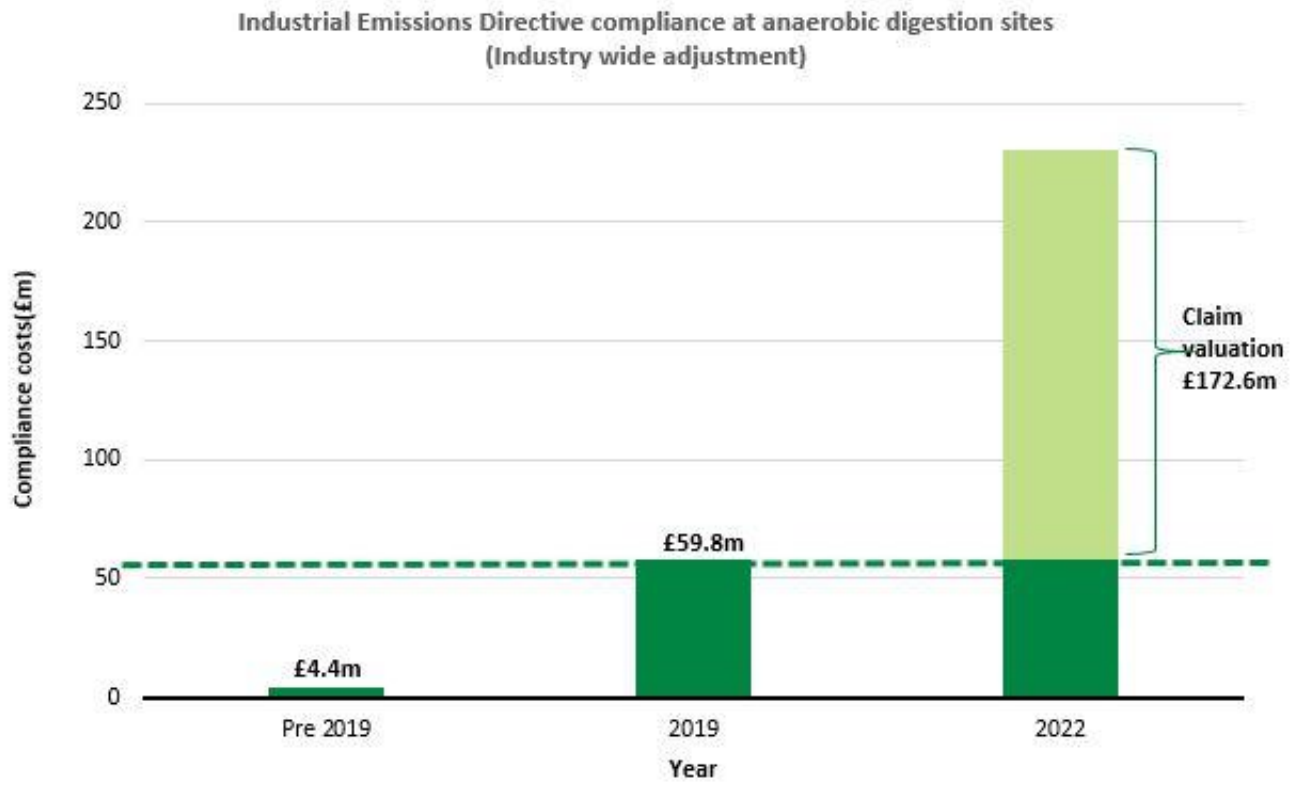
25.2.1 It has been recognised in previous price reviews that our existing PPC permitted sites, have incurred higher costs than equivalent AD sites that do not hold permits. In Figure 63, we illustrate how this cost adjustment has been valued, recognising allowances in previous price reviews:

(a) **Pre 2019:** These sites were regulated under the existing PPC permits. Minimal costs were incurred, relating only to the administration of those permits. We were allowed unmodelled costs of £4.4 million associated with this requirement at PR19.

(b) **2019**: Post-PR19 submission we received notification that the EA was to implement IED with respect to sewage sludge. At the time we understood that the EA would vary the existing PPC permits to IED permits. This would require compliance with the requirement set out in the 2018 BREF. Through our Green Recovery proposal we sought £59.8 million of costs for compliance with BREF. This claim was not successful as the EA stated that compliance was an AMP7 requirement.

(c) **2022:** Publication of Appropriate Measures guidance in 2022 drives additional costs, over and above the 2018 BREF, to comply with Appropriate Measures guidance. This cost adjustment claim of £172.594 million is for scope above the £59.8 million of costs to comply with the 2018 BREF.

Figure 63: Valuation of cost adjustment claim



Source: UUW analysis

25.2.2 The change in requirements to meet 2022 Appropriate Measures guidance is driving higher than historical sludge treatment costs. Although we have incurred higher costs in the past due to the

regulation of these sites under PPC and then IED, costs are expected to increase by £172.594 million in AMP8.

25.2.3 We are seeking financial resources through a cost adjustment claim as IED compliance is an existing obligation, but this is the latest iteration of standards that we must comply with. As these are new compliance standards, costs are not reflected in econometric models and there is no provision in Ofwat's Final Methodology to fund compliance at these sites. These costs are over and above the 2018 BREF compliance costs, so cannot be assumed to have been part of previously rejected IED claim for AMP7.

25.3 Customer support for investment

25.3.1 Customers and regulators expect that we are compliant with our regulatory and legal obligations and it is our non-negotiable responsibility. We need to be fully compliant with our statutory commitments in order to maintain our trusted brand reputation with customers, communities and our regulators.

25.3.2 We have not commissioned specific customer research associated with this cost adjustment claim as it would not drive change in the programme we are delivering, as we are proposing compliance at the lowest cost for customers.

26. Best option for customers

26.1 Options assessment

26.1.1 The focus of optioneering has been to identify the lowest cost and best value approach to delivering Appropriate Measures compliance.

26.1.2 The following options were identified and discounted at the early stages of the optioneering process:

(1) **Do nothing**: this option was discounted as we must operate our assets to meet legal requirements and 'do nothing' would result in environmental non-compliance.

(2) **Alternative treatment for all sludge**: this option was discounted as the additional costs involved in delivering IED compliance are small when compared to the cost of building all new assets to treat the sludge.

26.1.3 In Table 48 we set out the options we have considered to meet the need.

Table 48: Options considered to meet Appropriate Measures compliance

Option	Rationale	Select/reject	Reason
Options to comply with our IED permits			
Deliver IED Compliance at all 13 sites	Deliver our IED compliance requirements at all 13 AD sites individually	Reject	Higher cost solution. This would lead to inefficient investment at aging anaerobic digestion sites that are reaching the end of their asset life.
Deliver IED Compliance at a reduced number of sites by rationalising aging AD sites	Deliver IED compliance at a smaller number sites through site rationalisation. • Deliver IED compliance at 11 anaerobic digestion centres. • Convert two sites, which have high IED compliance costs per/TDS of sludge processed, to sludge thickening or dewatering centres. Avoids IED compliance costs. • Incurs write-off costs, costs to convert sites, one-off decommissioning costs and reduces regional treatment capacity.	Select	Preferred solution. More efficient expenditure that aligns with our bioresources long-term delivery strategy to consolidate larger treatment hubs over time.
Options to comply with Appropriate Measures			
Minimum Viable Product (MVP) Solution	All efficiencies in capital programme realised. We successfully agree with the EA: • Acceptance of containment of 110 per cent of the volume of the largest tank within the bund (not 25 per cent of total capacity of all tanks) • Sites rating downgraded to Class 1 under CIRIA assessment, minimising impermeable surfacing areas, and use of alternatives to reinforced concrete walls	Reject	It is considered unlikely that solutions are acceptable to the EA, as they deviate from Appropriate Measures requirements.

Option	Rationale	Select/reject	Reason
Limited risk assessment approach to demonstrate compliance with Appropriate Measures	Efficiencies realised where we have high confidence in EA acceptance: • Full compliance with CIRIA 736, and no opportunities to reduce requirements. • Assume it is possible to retrospectively cover tanks, rather than replace. • Efficiency benefits through flow monitoring approach to leak detection.	Select	A balanced approach that minimises costs as far as possible, while having a high confidence in acceptance of the proposals by the EA
Full compliance with Appropriate Measures	Risk averse capex proposals guaranteed to comply with Appropriate Measures standards. Include full costs to replace assets (i.e. tanks) and provide fully enclosed and ventilated cake storage.	Reject	Inefficient capital expenditure for no additional environmental benefit.

26.1.4 Compliance with Appropriate Measures standards is prescriptive and there are limited options to meet compliance. We have sought to propose alternative measures to the EA to deliver equivalent benefit. To control costs for customers we seek to use management and monitoring techniques to demonstrate compliance in preference to capital investment works. Acceptance of these measures is limited as the EA are pursuing a precautionary and risk-averse approach to setting requirements.

26.1.5 Our preferred solution is a balanced approach that minimises costs as far as possible, while having a high confidence in acceptance of the proposals by the EA. We are meeting customers' expectations by delivering our regulatory obligations as efficiently as possible. As we are selecting the lowest cost, feasible option, we have not sought customer views on selection of the preferred solution.

26.1.6 The benefits delivered through this investment are full regulatory compliance with our obligations, and enable upgrade and improvement to meet evolving standards specified under EA statutory guidance. These are designed to achieve a high level of protection for the environment, reducing the risk of pollution or environmental harm from our activities.

26.1.7 We aim to seek the lowest cost to comply to deliver these benefits. There will be no benefit to operational efficiencies or any AMP8 performance commitments through implementation of these measures. Through our options development process we have sought to minimise the increased carbon cost (embedded and operational) of the proposed solutions.

26.2 Delivery of this scheme

26.2.1 Compliance requirements are highly site specific and the exact requirements will not be known until we progress each individual permit variation. We have utilised knowledge gained through our AMP7 IED permitting process to understand what proposals will be acceptable to the EA and minimise the uncertainty. In addition, we have engaged support from multiple independent consultancies to understand best practice and take learning from outside the water industry.

26.2.2 We will not start to invest to deliver improvements to meet Appropriate Measures standards until we have certainty in the scope required by the EA to avoid inefficient spend on behalf of customers.

26.2.3 The nature of the work; multiple disparate compliance works; entwined with day-to-day operations; and across a large number of existing operational sites, makes it inappropriate to seek to deliver through a market solution. There are no opportunities for third-party funding through this cost adjustment claim, as the works are entirely restricted to our asset base.

26.2.4 For completeness and for the avoidance of doubt, this scheme has not been identified to be delivered as Direct Procurement for Customers (DPC), as this is not applicable for projects within the bioresources price control.

27. Customer protection

27.1 Price Control Deliverable

27.1.1 The IED requirements facing the sector constitute a significant increase in scope, beyond that represented by the historic trend in expenditure that is reflected in the Bioresources cost assessment model. This is the basis on which we have sought a cost adjustment claim. We recognise it may therefore reasonable to consider a PCD to ensure customer protection over the delivery of the additional scope that is allowed for in final determinations.

27.1.2 We are not, at this stage representing a proposed form of PCD, for two main reasons:

(a) Ofwat is considering how it will make some allowance for IED, which may be to make cost allowances or to implement an uncertainty mechanism. An uncertainty mechanism such (as the one implemented by CMA) would likely remove the need for a PCD; and

(b) Requirements are still relatively uncertain until further permits are issued.

27.1.3 Early in 2024, following companies providing further information to Ofwat in December, we will work (if possible with Ofwat) towards a PCD proposal, if it seems likely to be required.

27.1.4 Compliance requirements are highly site specific and the exact requirements will not be known until we progress each individual permit variation. As such, there is an element of uncertainty over the full and final scope of works for Appropriate Measures compliance.

27.1.5 We have minimised this risk, by ensuring that the scope of this cost adjustment claim, is for items where we have certainty in requirements, and there are explicit standards set out in Appropriate Measures guidance. In developing our scope we have had to make specific assumptions to define the cost which are presented in document.

27.1.6 There are three main areas where scope could increase based on further review with the EA and detailed design to confirm solutions. These are:

(a) Increase in scale of containment;

(b) Fully enclosing cake pads and fitting odour control; and,

(c) We cannot cover existing open tanks and these need to be replaced and fitted with appropriate abatement.

27.1.7 We estimate the maximum cost increase for these three items is an additional circa £180 million and is not currently included in this claim, pending further review with the EA and detailed design to confirm solutions.

27.1.8 We have also excluded other scope items from this claim, such as the need for new liquor treatment plants or covering lagoons, which we also consider scope items that are presently too uncertain to include within this claim.

27.1.9 We will work with the EA to realise the efficiencies included in our scope of work for this claim. However, given the potential scale of scope and cost increases, we will, through our Business Plan submission, promote management of these compliance scope risks through an uncertainty mechanism. We may seek to revise the cost adjustment claim value in future, if further work or scope requirements are confirmed by the EA make it appropriate to do so.

27.1.10 The EA ensures that the environment is protected in this area on behalf of customers and will monitor performance through a common industry Environmental Performance Assessment (EPA) metric for Waste Compliance. This is a new EPA measure in AMP8 and reflects the increased regulatory scrutiny and increasing regulator expectations for our waste treatment activities.

27.1.11 If we fail to deliver the improvements outlined in this cost adjustment claim we will fail to achieve 100 per cent compliance with our statutory obligations under the EPA Waste Treatment Compliance metric.

27.1.12 Moreover, non-delivery of the improvements may also incur the following additional penalties:

- **Prosecution and fines** – If a scheme is not delivered it is very likely that our resulting non-compliance may result in prosecution by the EA[84]. If non-compliance is through deliberate actions by the company this is likely to influence the scale of any fines issued.
- **Reputational impact of EPA** – We have received a leading four star rating under the Agency's EPA for five out of the last seven years. The assessment currently consists of seven metrics, six of which must be green (including the core metric), with no red metrics to achieve four star performance. In AMP8 we expect the EPA to include a waste treatment compliance metric, and the requirements to achieve a four star performance rating to become increasingly stringent.
- **Additional cost** – There is no cost sharing mechanisms with customers in the bioresources price control and the additional cost to dispose of any non-compliant biosolids to alternative outlets such as restoration would be for the company to accept.

[84] EA Letter to UUW 7 June 2023

Glossary

Abbreviation	Name	Description
AD	Anaerobic Digestion	Anaerobic digestion is a biological process through which bacteria break down organic matter.
AAD	Advanced AD	A biological process designed to extract a greater quantity of biogas and produce enhanced quality biosolids for recycling.
ADBA	Anaerobic Digestion and Bioresources Association	Anaerobic Digestion and Bioresources Association represent over 300 organisations involved in the UK anaerobic digestion and bioresources industry.
AMP	Asset Management Plan (or Period)	An AMP is a water company's detailed description of its investment plans for its assets. AMP is often used as a shorthand name for the companies' business plans. See also Business Plan.
AMP7	Asset Management Plan 7	Refers to the planning period between 2020 and 2025.
AMP8	Asset Management Plan 8	Refers to the planning period between 2025 and 2030.
Appropriate Measures for the Biological Treatment of Waste	Appropriate Measures for the Biological Treatment of Waste	Guidance published in 2022 impacting Anaerobic Digestion sites providing EA interpretation of the BAT conclusions for England.
Appropriate Measures standards	Appropriate Measures standards	Appropriate Measures are the standards that operators should meet to comply with their environmental permit requirements.
APR	Annual Performance Report	Annual data collection provided to Ofwat by companies.
BAT (standards)	Best Available Techniques	BAT means the available techniques that are the best for preventing or minimising emissions and impacts on the environment. 'Techniques' include both the technology used and the way the installation is designed, built, maintained, operated and decommissioned.
Bespoke Waste Permit	Bespoke Waste Permit	A type of site environmental permit within the Environmental Permitting Regulatory framework
Bioresources		Name for sewage sludge
Biosolids	Biosolids	Organic matter recycled from sewage, and used in agriculture as fertiliser.
Biological Treatment	Biological Treatment	Biological treatment methods use microorganisms, mostly bacteria, in the biological decomposition of wastes to stabilise end products
BREF	Best Available Technique Reference Documents	BREFs bring together users' real-world experiences of BAT to provide reference information for regulators to use when determining permit conditions.
CCTV	Closed Circuit Television	A TV system in which signals are not publicly distributed but are monitored, primarily for surveillance and security.
CIRIA	Construction Industry Research and Information Association	CIRIA is the Construction Industry Research and Information Association, a neutral, independent and not-for-profit body. They work collaboratively across the construction industry to identify good practice.
CIRIA 736	CIRIA 736	Guidance with respect to containment systems for the prevention of water pollution from industrial incidents produced by CIRIA and referenced in Appropriate Measures.

Abbreviation	Name	Description
CDM	Construction Design and Management Regulations	The Construction (Design and Management) Regulations (CDM 2015) are the main set of regulations for managing the health, safety and welfare of construction projects. CDM applies to all building and construction work and includes new build, demolition, refurbishment, extensions, conversions, repair and maintenance.
CMA	CMA	Competition and Markets Authority
EA	Environment Agency	The Environment Agency is a Non-Departmental Public Body (NDPB) and carries out its statutory and regulatory functions with technical expertise, impartiality and transparency, principally across England and at arm's length from its principal sponsor, Defra. In addition, the Environment Agency also works with, and delivers duties on behalf of, a range of other UK Government departments.
EPA	EPA	Environmental Performance Assessment conducted annually by the EA to evaluate water company's' environmental performance.
EPR	EPR	Environmental Permitting Regulations
EQRA	EQRA	Environmental Qualitative Risk Assessment
EU	EU	European Union
Green Recovery	Green Recovery	Water companies were invited to propose investment to support the country's green economic recovery from the COVID pandemic.
IED	Industrial Emissions Directive	A European Union Directive which commits European Union member states to control and reduce the impact of industrial emissions on the environment.
IED Installation	IED Installation	A type of environmental permit for a site required to comply with IED.
MM	Mott Macdonald	Mott Macdonald independent consultant
MVP	MVP	Minimum Viable Product
Net zero	Net Zero Carbon	Means that any carbon emissions are balanced by absorbing an equivalent amount from the atmosphere in order to meet the 1.5°C global warming target in the Paris Agreement
Ofwat	Ofwat	Water Services Regulation Authority
physico-chemical	physico-chemical	Physico-chemical treatment involves using chemicals or physical properties to provide thickening or dewatering.
PPC	PPC	Pollution prevention and control.
PR19	Ofwat's Price Review for AMP7 2021-2025	The process of setting appointed water companies' price limits.
PR24	Ofwat's Price Review for AMP7 2026-2030	The process of setting appointed water companies' price limits.
Regulation 61	Regulation 61	A provision for regulators to obtain information to support a review of conditions in environmental permits.
T21	T21 exemption	The T21 exemption allows you to recover wastes such as sewage grits, screenings and sewage sludge at a waste water treatment works.
tCO2e	Tonnes of carbon dioxide equivalent	Unit of measurement for greenhouse gas emission reporting.
TDS	TDS	Tonnes dry solid a unit of measurement for biosolids (TTDS thousand tonnes dry solids).
UUW	UUW	United Utilities Water.
Urban Waste Water Treatment Regulations	Urban Waste Water Treatment Regulations	Regulations for the treatment and discharge of urban waste water, and the treatment and discharge of waste water from certain industrial sectors.
UWWTD	UWWTD	Urban Wastewater Treatment Directive

Abbreviation	Name	Description
WaSCs	WaSCs	Water and sewerage companies
Waste Framework Directive	Waste Framework Directive	The Waste Framework Directive is a European Union Directive concerned with "measures to protect the environment and human health by preventing or reducing the adverse impacts of the generation and management of waste and by reducing overall impacts of resource use and improving the efficiency of such use.
WINEP	WINEP	Water Industry National Environment Programme
WISER	Water Industry Strategic Environmental Requirements	WISER is issued jointly by the Environment Agency and Natural England to describe the environmental, resilience and flood risk obligations that must be taken into account when developing business plans.
WwN+	WwN+	Wastewater Network plus
WwTW	WwTW	Wastewater Treatment Works

Table 49: Summary of UUW's claim against Ofwat's assessment criteria

Assessment gate	Assessment gate question	Summary of evidence	Reference
Need for adjustment	a) Is there compelling evidence that the company has unique circumstances that warrant a separate cost adjustment?	We set out the legal requirements for investment in IED compliance as a result of the 2022 Appropriate Measures guidance. This is a common cost pressure across the industry.	Section 23.1 Section 25.1
Need for adjustment	b) Is there compelling evidence that the company faces higher efficient costs in the round compared to its peers (considering, where relevant, circumstances that drive higher costs for other companies that the company does not face)?	We set out the legal requirements for investment in IED compliance as a result of the 2022 Appropriate Measures guidance. This is a common cost pressure across the industry, though costs are site-specific.	Section 23.1 Section 25.1
Need for adjustment	c) Is there compelling evidence of alternative options being considered, where relevant?	We demonstrate that the 2022 Appropriate Measures guidance is prescriptive and as such precludes the use risk assessment to guide interventions. We have closed sites where possible to avoid intervention. We have appropriately engaged with the EA to seek efficient reductions in scope.	Section 23.1 Section 23.2 Section 23.3
Need for adjustment	d) Is the investment driven by factors outside of management control?	We demonstrate that investment is a result of regulatory action and that we have appropriately engaged with the EA to seek efficient reductions in scope where possible.	Section 23.1 Section 23.2
Need for adjustment	e) Have steps been taken to control costs and have potential cost savings (eg spend to save) been accounted for?	We have closed sites where possible to avoid intervention. We have appropriately engaged with the EA to seek efficient reductions in scope.	Section 23.2 Section 24.3 Section 24.4
Need for adjustment	f) Is there compelling evidence that the factor is a material driver of expenditure with a clear engineering / economic rationale?	We provide extensive evidence of the step-up in regulatory requirements necessitated by the 2022 Appropriate Measures guidance. The nature of intervention is site-specific but is capital intensive. This has been confirmed by a third party, Atkins.	Section 23 Paragraph 23.1.11
Need for adjustment	g) Is there compelling quantitative evidence of how the factor impacts the company's expenditure?	A third party, Atkins, has assessed how the appropriate measures guidance affects each company in the industry and identified material investment requirements across all companies. We provide a detailed cost breakdown of the investment requirements at our affected sites.	Paragraph 23.1.11 Section 24
Need for adjustment	h) Is there compelling evidence that the cost claim is not included in our modelled baseline (or, if the models are not known, would be unlikely to be included)? Is there compelling evidence that the factor is not covered by one or more cost drivers included in the cost models?	The 2022 Appropriate Measures guidance relates to a new, incremental cost pressure that is not reflected in the historical cost record. UUW anticipates it will have absorbed £66m of costs relating to compliance with 2018 BAT measures within AMP7.	Section 22.6 Section 23.1 Paragraph 22.5.7
Need for adjustment	i) Is the claim material after deduction of an implicit allowance? Has the company considered a range of estimates for the implicit allowance?	We have valued the claim specifically to ensure that it excludes any overlap with base maintenance activities.	Paragraphs 23.4.8 to 23.4.10

Assessment gate	Assessment gate question	Summary of evidence	Reference
Need for adjustment	j) Has the company accounted for cost savings and/or benefits from offsetting circumstances, where relevant?	We have closed sites where possible to avoid IED compliance intervention. However, The 2022 Appropriate Measures guidance relates to a new, incremental cost pressure that is not reflected in the historical cost record. UUW anticipates it will have absorbed £66m of costs relating to compliance with 2018 BAT measures within AMP7. As such, there are no related offsetting benefits	Paragraph 22.5.7 Section 24.3 Section 24.4
Need for adjustment	k) Is it clear the cost allowances would, in the round, be insufficient to accommodate the factor without a claim?	The 2022 Appropriate Measures guidance relates to a new, incremental cost pressure that is not reflected in the historical cost record. UUW anticipates it will have absorbed £66m of costs relating to compliance with 2018 BAT measures in AMP7. It is not feasible for the Bioresources price control to absorb further cost pressure.	Section 22.6 Section 23.1 Paragraph 22.5.7
Need for adjustment	l) Has the company taken a long-term view of the allowance and balanced expenditure requirements between multiple regulatory periods? Has the company considered whether our long-term allowance provides sufficient funding?	The 2022 Appropriate Measures guidance relates to a new, incremental cost pressure that is not reflected in the historical cost record. UUW anticipates it will have absorbed £66m of costs relating to compliance with 2018 BAT measures within AMP7.	Section 22.6 Section 23.1 Paragraph 22.5.7
Need for adjustment	m) If an alternative explanatory variable is used to calculate the cost adjustment, why is it superior to the explanatory variables in our cost models?	N/a – alternative explanatory variable is not used.	
Cost efficiency	a) Is there compelling evidence that the cost estimates are efficient (for example similar scheme outturn data, industry and/or external cost benchmarking, testing a range of cost models)?	IED compliance costs are highly site-specific. However, we provide evidence that a third party, Atkins, agrees with our assessment of cost. We also provide details on how our costs have been calculated, along with evidence we have excluded any element of maintenance costs. We also evidence we have appropriately engaged with the EA and are seeking cost reductions through innovation.	Section 24 Section 23.4
Cost efficiency	b) Does the company clearly explain how it arrived at the cost estimate? Can the analysis be replicated? Is there supporting evidence for any key statements or assumptions?	IED compliance costs are highly site-specific. However, we provide evidence that a third party, Atkins, agrees with our assessment of cost. We also provide details on how our costs have been calculated, along with evidence we have excluded any element of maintenance costs. We also evidence we have appropriately engaged with the EA and are seeking cost reductions through innovation.	Section 24 Section 23.4
Cost efficiency	c) Does the company provide third party assurance for the robustness of the cost estimates?	Third party assurance is provided by PwC. We note that Atkins' report provides third party confirmation that the scale of costs reflected in our claim is appropriate.	Section 24.5
Need for investment	a) Is there compelling evidence that investment is required?	We set out the legal requirements for investment in IED compliance as a result of the 2022 Appropriate Measures guidance. This is a common cost pressure across the industry, though costs are site-specific.	Section 23.1 Section 25.1
Need for investment	b) Is the scale and timing of the investment fully justified?	We set out the legal requirements for investment in IED compliance as a result of the 2022 Appropriate Measures guidance. This is a common cost pressure across the industry, though costs are site-specific.	Section 23.1 Section 25.1

Assessment gate	Assessment gate question	Summary of evidence	Reference
Need for investment	c) Does the need and/or proposed investment overlap with activities already funded at previous price reviews?	2022 Appropriate Measures guidance is a new cost pressure in AMP7. UUW anticipates it will have absorbed £66m of costs relating to compliance with 2018 BAT measures within AMP7.	Section 22.6 Section 23.1 Paragraph 22.5.7
Need for investment	d) Is there compelling evidence that customers support the need for investment (both scale and timing)?	We have not commissioned specific customer research associated with this cost adjustment claim as it would not drive change in the programme we are delivering, as we are proposing compliance at the lowest cost for customers.	Section 25.3 Section 26.1
Best option for customers	a) Did the company consider an appropriate range of options to meet the need?	We set out our approach to optioneering in detail. We also evidence we have appropriately engaged with the EA and are seeking cost reductions through innovation.	Section 26.1 Section 24.4
Best option for customers	b) Has a cost–benefit analysis been undertaken to select proposed option? There should be compelling evidence that the proposed solution represents best value for customers, communities and the environment in the long term? Is third-party technical assurance of the analysis provided?	We set out our approach to optioneering in detail, which focused upon the lowest cost option. We also evidence we have appropriately engaged with the EA and are seeking cost reductions through innovation.	Section 26.1 Section 24.4
Best option for customers	c) Has the impact of the investment on performance commitments been quantified?	N/a – there is no impact on performance commitments	
Best option for customers	d) Have the uncertainties relating to costs and benefit delivery been explored and mitigated? Have flexible, lower risk and modular solutions been assessed – including where utilisation will be low?	We also evidence we have appropriately engaged with the EA and are seeking cost reductions through innovation. We have closed sites where possible to avoid IED compliance intervention.	Section 24.4 Paragraph 22.6.4
Best option for customers	e) Has the company secured appropriate third-party funding (proportionate to the third party benefits) to deliver the project?	N/a – third party funding is not applicable.	
Best option for customers	f) Has the company appropriately presented the scheme to be delivered as Direct Procurement for Customers (DPC) where applicable?	N/a – DPC is not applicable.	
Best option for customers	g) Where appropriate, have customer views informed the selection of the proposed solution, and have customers been provided sufficient information (including alternatives and its contribution to addressing the need) to have informed views?	N/a – we demonstrate the 2022 Appropriate Measures guidance is prescriptive, leaving little scope for alternative solutions, other than site closure where feasible.	
Customer protection	a) Are customers protected (via a price control deliverable or performance commitment) if the investment is cancelled, delayed or reduced in scope?	We set out UUW's position on a PCD for this CAC	Section 27.1
Customer protection	b) Does the protection cover all the benefits proposed to be delivered and funded (eg primary and wider benefits)?	All elements of scope are covered by our PCD.	Section 27.1
Customer protection	c) Does the company provide an explanation for how third-party funding or delivery arrangements will work for relevant investments, including the mechanism for securing sufficient third-party funding?	N/a – third party funding is not appropriate for this claim.	

Appendix A Evolving dam construction over time

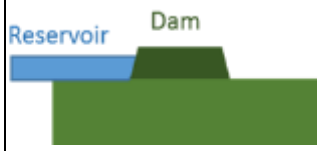
A.1.1 Construction on our oldest dam began in 1775, at the height of the Georgian era, before industrialisation and mechanical construction methods were available. Our youngest dam was completed in 1971, using highly technical design processes and the full range of modern construction techniques.

A.1.2 While all earth embankment dams look superficially similar, their internal construction will vary very considerably depending upon the era in which the dam was built. The nature of the internal construction will have a significant effect upon the resilience of the dam, the level of risk it poses, and the costs that we will incur to bring the dam within HSE tolerable risk limits.

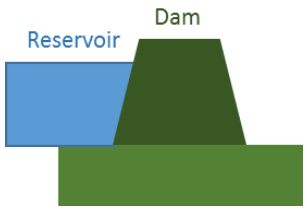
A.1.3 Figure 64 shows (over a number of pages) how dam construction has evolved over time, and how this will influence our risk management activity.

Figure 64 Dam construction over time

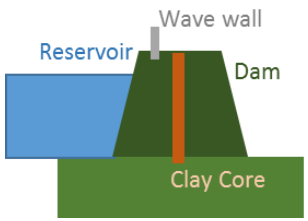
A.2 (Over 200 years old)

Cross section	Construction technique	Purpose of structure	Events that influence the construction	Construction / legal standards	Maintenance costs
	Embankment material gathered from the immediate location. Hand construction. Homogenous embankments, no core, no foundation cut off trench, no wave wall. Typically <2m high. Often no formal spillway, no facility to empty the reservoir in an emergency.	Dams of this era are typically built to form ornamental lakes, on country estates or large urban parks.	During this period most public water supply was drawn from local wells, very little institutional water supply infrastructure. Very few structures of this age are operated by water companies.	No construction standards apply.	Extreme. Facilities of this age will require very extensive modification to bring them up to modern safety standards, (would require wavewall, draw down facility, spillway). Reservoirs of this age are usually taken 'off line' from a water course to reduce the risk of flood overtopping (filled by piped supply)

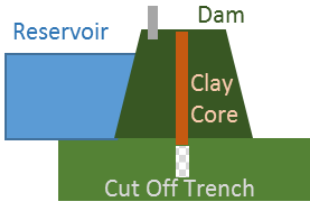
A.3 (150 to 200 years old)

Cross section	Construction technique	Purpose of structure	Events that influence the construction	Construction / legal standards	Maintenance costs
	Embankment material gathered from the immediate location. Hand construction. Homogenous embankments, no core, no foundation cut off trench, no wave wall. Dams of this era can be up to 5m high, impounding large reservoirs. Drawdown and wavewall usually present, but do not meet modern standards.	Dams are constructed to feed the developing canal network (some of these reservoirs are now used by water companies)	The beginning of industrialisation. Earliest large commercial water supply reservoirs.	No construction standards apply.	High. Facilities of this age will require very extensive modification to bring them up to modern safety standards, (improved wavewall, draw down facility, spillway). As these reservoirs are 'homogenous' (no core) they are often found to have very high risk of leak induced failure (internal erosion).

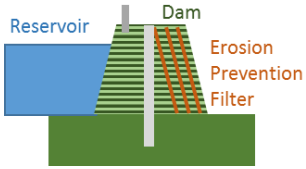
A.4 (100 to 150 years old)

Cross section	Construction technique	Purpose of structure	Events that influence the construction	Construction / legal standards	Maintenance costs
	Canal network allows importation of material from elsewhere. First use of clay cores to improve water retention. Some examples now have shallow foundation cut off trenches to improve prevention of leakage between dam and ground interface. Dams still typically hand built without construction machinery, resulting in poor material compaction and high risk of leakage.	Rapid expansion of industrial towns in the North West. First widespread construction of water supply reservoirs.	1848 the Bold Venture dam in Darwen fails (12 dead), during flood. First detailed study of flood overtopping related dam failure. 1864 Dale Dyke fails due to internal erosion leakage (244 dead). Second deadliest flood in British history.	1838 Sir Thomas Telford publishes first design standards for clay cores, specifying a 3:1 hydraulic gradient across the core. In response to the Dale Dyke disaster, 1866 Waterworks Act introduces dam design requiring oversight by a civil engineer approved by a panel of experts (Panel Engineers).	Medium. Earth embankment dams of this age have typically experienced some settlement, and due to poor compaction will have established leakage pathways (high internal erosion risk). Draw down and spillway capacities, and wavewall heights are usually not up to modern standards, and require improvement following regulatory inspections.

A.5 (50 to 100 years old)

Cross section	Construction technique	Purpose of structure	Events that influence the construction	Construction / legal standards	Maintenance costs
	Introduction of rail transport and powered machinery allows concrete to be used in the foundation cut off trench. Experience from the mining industry applied to make far more deep and effective cut off trenches. However embankments still hand built.	Establishment of town 'Water Boards'. Large cities such as Liverpool and Manchester begin very large dam projects (Vyrnwy and Thirlmere).	1860 Ainsworth Mill Reservoir fails flooding neighbouring Rylands mine workings (0 dead). 1925 Egiau and Dolgarrog dams fail in chain (16 dead). Construction paused during WW2 and 1950s austerity period. First use of wholly concrete dams, which have very good (low) leakage performance.	Landmark 'Rylands versus Fletcher' legal case setting 'liability' into British Law. Dam operators now legally strictly liable for the effects of dam failure, regardless of cause or blame. Reservoirs (Safety Provisions) Act 1930, introduced in response to the Dolgarrog disaster. Dams must be safety inspected every ten years by independent Inspecting Engineers.	Medium. Draw down and spillway capacities, and wavewall heights are usually not up to modern standards, and require improvement following regulatory inspections. Risks of internal erosion still high due to poor core and embankment compaction.

A.6 (0 to 50 years old)

Cross section	Construction technique	Purpose of structure	Events that influence the construction	Construction / legal standards	Maintenance costs
	Widespread use of roller compacted concrete and other technical innovations to significantly improve water retention. Soil mechanics applied in detail, with embankment filter media to prevent internal erosion.	Some large reservoirs constructed in the late twentieth century for mixed use, to feed water supply, industry and hydro-power (e.g. Dovestone).	1970 Warmwithens dam near Oswaldtwistle fails during maintenance. Disaster narrowly averted (0 deaths) as a reservoir immediately downstream was drawn down and held the flood waters.	In response to Warmwithens, the Reservoir Act 1975 introduced. All significant dam maintenance requires Panel Engineer oversight. Floods and Reservoir Safety guidance introduced 1978.	Low. Typically good leakage (internal erosion) performance, due to advanced construction techniques. Auxiliary dam structures (spillways, draw down, wave walls etc.) usually up to modern standards, little further upgrade needed.

Appendix B Examples of a more stringent inspection regime since the 2020 Balmforth Report

Table 50: The inspection regime has become more exacting since the publication of the 2020 Balmforth Report

Reservoir Name	Statutory actions arising from independent inspection under Section 10 of the Reservoir Act 1975 (pre-2020 Balmforth Report)	Cost of actions	Statutory actions arising from independent inspection under Section 10 of the Reservoir Act 1975 (post-2020 Balmforth Report)	Cost of actions
[✂]	[✂	£340,056	[✂	[✂]
	]		]	

Reservoir Name	Statutory actions arising from independent inspection under Section 10 of the Reservoir Act 1975 (pre-2020 Balmforth Report)	Cost of actions	Statutory actions arising from independent inspection under Section 10 of the Reservoir Act 1975 (post-2020 Balmforth Report)	Cost of actions
[✂]	[✂]	[✂]	[✂]	[✂]

Reservoir Name	Statutory actions arising from independent inspection under Section 10 of the Reservoir Act 1975 (pre-2020 Balmforth Report)	Cost of actions	Statutory actions arising from independent inspection under Section 10 of the Reservoir Act 1975 (post-2020 Balmforth Report)	Cost of actions
[✂]	[✂]	[✂]	[✂]	[✂]

Reservoir Name	Statutory actions arising from independent inspection under Section 10 of the Reservoir Act 1975 (pre-2020 Balmforth Report)	Cost of actions	Statutory actions arising from independent inspection under Section 10 of the Reservoir Act 1975 (post-2020 Balmforth Report)	Cost of actions
[✂]	[✂	[✂]	[✂	[✂]

]

]

[✂] [✂] [✂] [✂]

]

Reservoir Name	Statutory actions arising from independent inspection under Section 10 of the Reservoir Act 1975 (pre-2020 Balmforth Report)	Cost of actions	Statutory actions arising from independent inspection under Section 10 of the Reservoir Act 1975 (post-2020 Balmforth Report)	Cost of actions

]

Source: ETOS inspection reports

Appendix C Our expectations of ITIOS expenditure in AMP8

C.1.1 While we have based our cost of compliance on the observed unit rate of statutory schemes and statutory actions received since the 2020 Balmforth Report, we also have expectations on the statutory actions we are likely to receive during AMP8 and the cost of these actions. This expectation is set out in Table 51 and explained in further detail below, split across the different programmes of work. This reveals that there is a gap between our expectations and the amount we are seeking as part of this cost adjustment claim. However, we consider that this is appropriate as it will provide additional incentives for us to deliver risk reductions as efficiently as possible.

Table 51: UUW expectations of statutory compliance in AMP8

Cost Driver Block	Total value (million)
Wavewall	£24.5m
Drawdown	£17.5m
Spillways	£25m
Valve Tower Refurbishment	£5.4m
Statutory Very Small Projects (VSPs) (<£250k)	£12m
Statutory Major Capital Projects (MCPs) (>£250k)	£18.1m
Studies	£5m
ITIOS Total	£107.5m

Source: UUW claim valuation

C.1.2 There are eighty statutory ten yearly inspections due to be undertaken within the last two years of AMP7 (from January 2023) and the first three years of AMP8 (by 31st March 2028), which may require statutory work to be undertaken during AMP8. Additionally statutory inspections undertaken in 2022, which required further investigation works may lead to the requirement for capital works to be delivered in AMP8.

C.1.3 The statutory requirements cost build up represented in Table 51 is the best assessment of likely project drivers from current updates to guidance in relation to reservoir safety and the future ten yearly Statutory Inspection requirements.

C.1.4 We note that if any requirements under the H&SWA 1974 are not carried out as part of our PRA programme, then they will be picked up as part of a statutory reservoir inspection and will become a statutory requirement. Therefore, if Ofwat does not allow the PRA element of this cost adjustment claim in full, our expenditure on statutory actions under the Reservoirs Act 1975 will necessarily increase without an appropriate upwards adjustment to our allowances.

C.2 Wavewall block

C.2.1 Works required to increase in height and/or strengthen reservoir wavewalls that sit on top of the dam in order to contain flood surcharges and waves. This is as they have a water level rise above the top of the dam by more than 100mm and significant wave surcharge on the wavewall, during a Probable Maximum Flood (PMF) – the maximum flood that modelling techniques indicate is possible at this location. This is as a result of the Cumbria floods in 2016, which led to the Flood and Water Management Act 2010 accompanying guidance increasing the PMF, taking into account climate change.

C.2.2 Since the updated guidance UUW have undertaken investigations and works, as required, on the majority of wavewalls affected. Studies and investigations have removed the need to undertake capital works at nine sites in AMP8 as they have proven the reservoirs can hold the PMF.

C.2.2.1 [✂

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Table 52: Review of potential Wavewall requirements based on existing freeboard

Reservoir	Reservoir Top Water Level (mAOD)	Crest Level (Top of Dam) (mAOD)	Flood Surcharge Level (mAOD) – water level the reservoir would rise too in a PMF based on inflows/outflows	Freeboard (m) – space between top of crest and top of flood surcharge level? (100mm space required. Negative number means there is not enough room to hold the PMF)
Piethorne	250.60	252.16	252.46	-0.30
Readycon Dean	386.10	387.30	387.65	-0.35
Torside	198.73	201.98	202.02	-0.04
Wayoh	174.65	176.21	176.27	-0.06

Source: UUW internal costing

C.3 Drawdown block

C.3.1 Works likely required for emergency drawdown (lowering of water levels) improvements following on from the publication of the *"Guide to drawdown capacity for reservoir safety and emergency planning"85* published by the EA in 2017, which requires the ability to drawdown (reduce the water level) a reservoir by 1 metre a day (subject to size).

C.3.2 The needs build-up is based on where we already have a confirmed requirement to undertake work (two sites – Entwistle and Stocks); on-going AMP7 investigations (four sites – Grizedale Lea, Piethorne, Barnacre North and South), and a preliminary assessment of ten dams, see Table 53, that are due to be inspected before 31st March 2028.

Table 53: Preliminary assessment of drawdown capacity

Reservoir	Installed drawdown depth per day (metre)	Drawdown capability required as per guidance (cumec)	Sufficient drawdown capability	Shortfall in installed drawdown capability (cumec)
Castle Carrock	0.06	1.23	No	1.06
Harlock	0.27	1.33	No	0.84
Piethorne	0.63	1.94	No	0.70
Grizedale Lea	0.66	1.61	No	0.55
Heaton Park Open	0.63	2.82	No	0.53
Rumworth	0.10	0.61	No	0.43
Springs	0.28	0.73	No	0.40
Chew	0.78	1.90	No	0.40
Barnacre North & South	0.15	0.37	No	0.17
Dilworth Upper	0.00	0.10	No	0.10

[85] Environment Agency (2017) *Guide to drawdown capacity for reservoir safety and emergency planning*. Available here.

Reservoir	Installed drawdown depth per day (metre)	Drawdown capability required as per guidance (cumec)	Sufficient drawdown capability	Shortfall in installed drawdown capability (cumec)
Blea Tarn	0.16	0.27	No	0.08
Damas Ghyll	0.38	0.19	No	0.07
Pennington	0.80	1.08	No	0.04

Source: UUW internal costing

C.3.3 At reservoirs where the required drawdown cannot be achieved using installed assets the shortfall is currently accommodated utilising temporary pumps.

C.3.4 From an initial assessment it is likely that temporary pumps could continue to be utilised at the majority of sites, with investigations planned to confirm this.

C.3.5 Therefore we have assumed the requirement in AMP8 for four sites to have improvements to installed drawdown facilities with Stocks and Entwistle already confirmed needs.

C.3.6 [✂

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C.4 Spillways block

C.4.1 Works required to increase the capacity and integrity of spillways (channel allowing the safe passage of water out of a reservoir when it is full) in order to allow a reservoir to safely pass flood surcharges during a PMF. This is as a result of the Cumbria floods in 2016, which led to the Flood and Water Management Act 2010 guidance increasing the PMF thresholds associated with climate change.

C.4.2 Flood studies and other site investigations will need to be undertaken to understand which sites require spillway works.

C.4.3 [✂

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C.5 Valve tower refurbishment

C.5.1 This block is for the refurbishment of valve towers and associated assets. Valve towers house the pipes and valves required for taking water out of the reservoir. Valve towers go down into the dam and in some cases also traverse through the dam. Therefore Valve towers have ladders and landings that go down the tower to allow personnel to inspect, maintain and operate assets.

C.5.2 As stated in section 4.3.3 we have an aging fleet of reservoirs with an average age of one hundred and forty one years. In many cases the pipework, valves, ladders and landings are all original and were built before health and safety was a key priority. Therefore the assets may require maintenance, replacement and upgrading to current safety standards.

C.5.3 [✂

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C.6 Statutory Very Small Projects (VSPs) (<£250,000)

C.6.1 There is potential for low cost actions of statutory works capturing replacement of valves, installation of new values, lining of pipes and other smaller repairs to the dams and associated assets. These actions will not be known until we have received the statutory inspection reports.

C.6.2 We have therefore assumed a required pot of £12 million based on current likely outturn costs for AMP7.

C.7 Statutory Major Capital Projects (MCPs) (>£250,000)

C.7.1 There is also the potential for high cost actions of statutory works being requested from statutory inspections. These actions could include things like installation / improvements to embankment drainage, installation of debris barriers, installation of monitoring equipment etc. These actions will not be known until we have received the statutory inspection reports.

C.7.2 We have therefore assumed a required pot of £18.1 million based on current likely outturn costs for AMP7.

C.8 Studies and investigations

C.8.1 In order to support and optimise planned works for delivery in AMP8 and AMP9 studies are required at sites where they have not yet been undertaken, details and costs of which are summarised in Table 54 (for AMP8) and Table 55 (for AMP9). Costs are based on outturn costs for studies in previous AMPs.

C.8.2 The total for this block is approximately £5 million.

Table 54: Estimated cost of studies to inform AMP8 delivery

Reservoir	Ground investigation cost (on-site intrusive investigation techniques)	Willowstick costs (Willowstick is a technique used to trace leaks through a dam)	Toolbox costs (£) (a full risk assessment based on site investigation findings)
Ogden Upper	£72,034.94	£108,588.75	£12,000
Audenshaw No 1	£241,801.30	£143,635.00	£12,000
Swineshaw Buckton Higher	£118,537.13	£108,588.75	£12,000
Lower Rivington Horwich	£257,153.69	£136,625.75	£12,000
Lower Rivington Millstone	£287,635.99	£108,588.75	£12,000
Crookgate	£117,202.13	£108,588.75	£12,000
Woodhead	£128,104.56	£108,588.75	£12,000
Sub Total	**£1,222,469.74**	**£823,204.50**	**£84,000.00**
Total	**£2,129,674.24**		

Source: internal UUW analysis

Table 55: Estimated cost of studies in AMP8 to inform AMP9 delivery

Reservoir	Ground investigation cost (on-site intrusive investigation techniques)	Willowstick costs (Willowstick is a	Toolbox costs

		technique used to trace leaks through a dam)	(£) (a full PRA assessment based on site investigation findings)
Cant Clough	£170,824.27	£99,101.04	£12,000
Rooden	£314092.30	£111,894.71	£12,000
Chew	£171,825.52	£99,101.04	£12,000
Cowpe	£186,287.92	£99,101.04	£12,000
Ogden Haslingden	£162,814.33	£99,101.04	£12,000
Greenfield	£118,537.13	£99,101.04	£12,000
Naden Higher	£118,537.13	£99,101.04	£12,000
Coldwell Upper	£163,036.83	£99,101.04	£12,000
Walkerwood	£122,319.60	£99,101.04	£12,000
Ridgegate	£178,890.90	£111,894.71	£12,000
Sub Total	**£1,707,165.93**	**£1,016,597.74**	**£120,000**
Total	**£2,843,763.67**		

Source: internal UUW analysis

Appendix D UUW Reservoirs individual HSE defined risk categories pre and post EA flood risk map changes in 2022

Table 56: Reservoirs in the HSE Unacceptable / Unacceptable Societal category prior to EA flood risk map changes (26 reservoirs total)

[✂]	[✂]	[✂]	[✂]
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Source: UUW (2023) Internal Data

*Table 57: Reservoirs in the HSE unacceptable / unacceptable societal category after EA flood risk map changes (37 reservoirs total)**

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*Concrete dams have been excluded from this as they are not subject to internal erosion failure modes.

** The risk associated with Anglezarke Reservoir is being effectively mitigated through operational activity, including enhanced surveillance, a substantial reduction in water level, and increased monitoring (including instrumentation). Whilst these operational interventions are effective at managing the risk of failure, they are not sustainable for the long term, as this reservoir is part of a strategic source for Merseyside and Wigan. We plan an engineering intervention that will enable us to safely refill the reservoir back to top water level, enabling full serviceability of the source once again.

Source: UUW internal data

Appendix E Challenges in wastewater service provision vary regionally

E.1 Two distinct services are provided within wastewater

E.1.1 First of all, as we stated, in our Future Ideas Lab paper[86], it is important for the cost assessment and performance framework to recognise the different services that companies provide, and to recognise the different factors that drive cost in providing those services. The wastewater value chain provides two distinct services:

- Foul sewage collection and treatment; and
- Surface water and highways drainage collection and treatment.

E.1.2 Each of these services is associated with different cost drivers and performance challenges. Importantly, the extent to which these pressures vary between company regions is also different – i.e. by reflecting the drivers of one of these services (e.g. within cost assessment) that does not automatically also reflect the regional differences impacting on the other service.

Characteristics of the foul sewerage service

E.1.3 Providing a foul sewage service requires the following elements:

- Companies must transport foul sewage through their network to a wastewater treatment works;
- Companies are expected to meet discharge permits at their wastewater treatment works; and,
- Companies are required to treat and appropriately dispose of sewage sludge received from the wastewater treatment process, as part of their Bioresources activities.

E.1.4 Historically, cost assessment models have reflected the associated pressures within cost assessment e.g. through the use of a treatment complexity cost driver. PR19 models used a treatment complexity driver relating to ammonia and the same approach is proposed for PR24. Ofwat has also suggested it is considering how best to recognise the efficient higher ongoing costs associated with phosphorus removal, implemented as part of the AMP7 WINEP[87]. All these factors focus on cost differentiation within the wastewater treatment process alone – i.e. there is no differentiation in cost or performance assumed within the wastewater network.

E.1.5 Additionally, foul sewage is associated with relatively steady and predictable volumes, so it may be reasonable to assume that this service does not (in of itself) result in any differentiated impact within the wastewater network.

Characteristics of the surface water and highways drainage sewerage service

E.1.6 Providing a surface water collection and treatment service is fundamentally different to providing a foul sewerage service:

- Companies need to provide and manage network system capacity to deal with periods of high rainfall;
- Customer flooding in the upstream network can only be mitigated through appropriate operation and maintenance within the network assets. Where further operational interventions aren't possible/economic, companies are required to implement capital interventions such as cellar disconnections and schemes to increase capacity in targeted areas; and,

[86] UUW (2021) *The principles of regulatory cost assessment.* Available here.

[87] Ofwat (2023) *Econometric base cost models for PR24*. Available here.

- Companies are legally required to ensure storm overflows operate in compliance with permits.

E.1.7 Factors that impact on surface water costs and performance include rainfall that enters the sewer network (which varies between regions, both the volume of rainfall, and the scale of urban areas that are connected to the sewer networks), and the proportion of combined sewers (which also varies significantly between companies) which are associated with a greater risk to service performance (e.g. sewer flooding)

E.1.8 Historically, cost assessment has not reflected the pressures associated with dealing with surface water. At PR19, we proposed that an "urban rainfall" driver be included within botex plus model suite but this was not adopted. Additionally, UUW's drainage-related cost adjustment claim was rejected.

E.1.9 At PR24, Ofwat is proposing to apply common performance targets for wastewater network performance measures. The next section demonstrates that regional pressures impact upon the ability of companies to provide a common service level.

E.2 There are significant regional differences between wastewater companies

E.2.1 The wastewater system is susceptible to environmental impacts. However, these environmental impacts affect the foul and surface water services in different ways.

The WINEP enables companies to achieve comparable performance for the foul sewerage service

E.2.2 Foul sewage is associated with regularly constant flows and these can be reasonably expected to be comparable on a per customer basis across the industry.

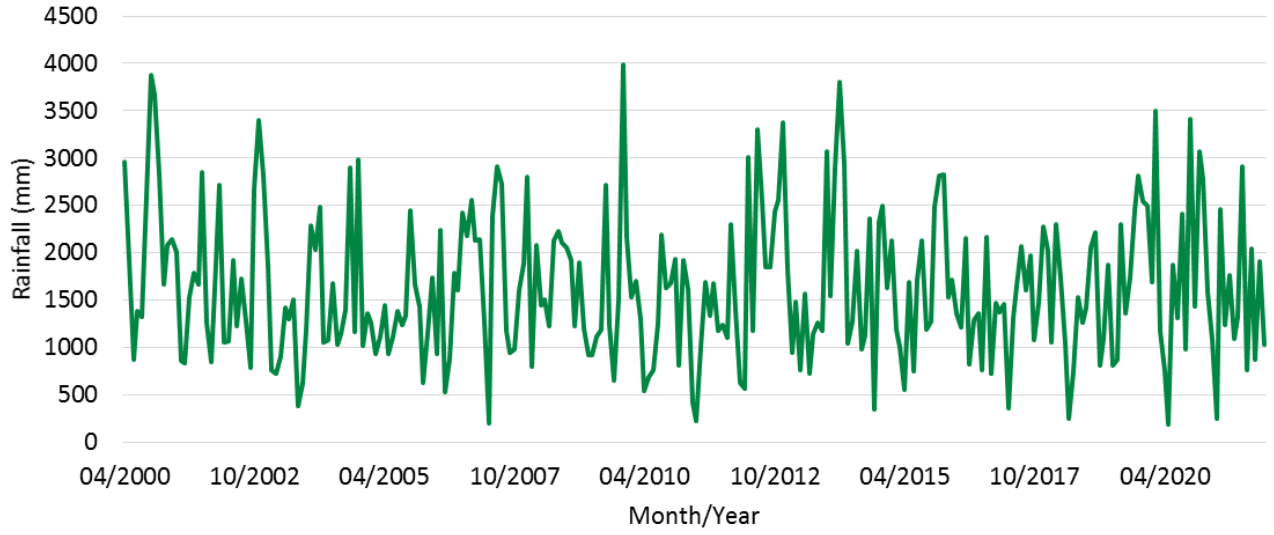
E.2.3 Additionally, improvements in the quality of foul sewerage provision are managed through the WINEP process. The WINEP places a statutory obligation on companies to meet better quality environmental standards and the regulatory framework ensures companies have sufficient enhancement allowances to move towards these better standards.

E.2.4 Once companies have invested sufficiently to meet these new standards, it is reasonable to have a common target for treatment works compliance. This is because the WINEP has enabled companies to make the company specific levels of investment required to meet compliance and hence to move towards and operate on a level playing field. As a result it is entirely appropriate to test and incentivise compliance in accordance with this level playing field i.e. through a common target.

There is no surface water equivalent of the WINEP to allow companies to invest sufficient to achieve equal levels of sewer flooding incidents

E.2.5 However, unlike foul sewage, the surface water service is associated with extremely variable volumes. This can clearly be seen in ***Figure 65***, which illustrates total rainfall across all areas of England and Wales since 2000.

Figure 65: Total monthly rainfall across England and Wales

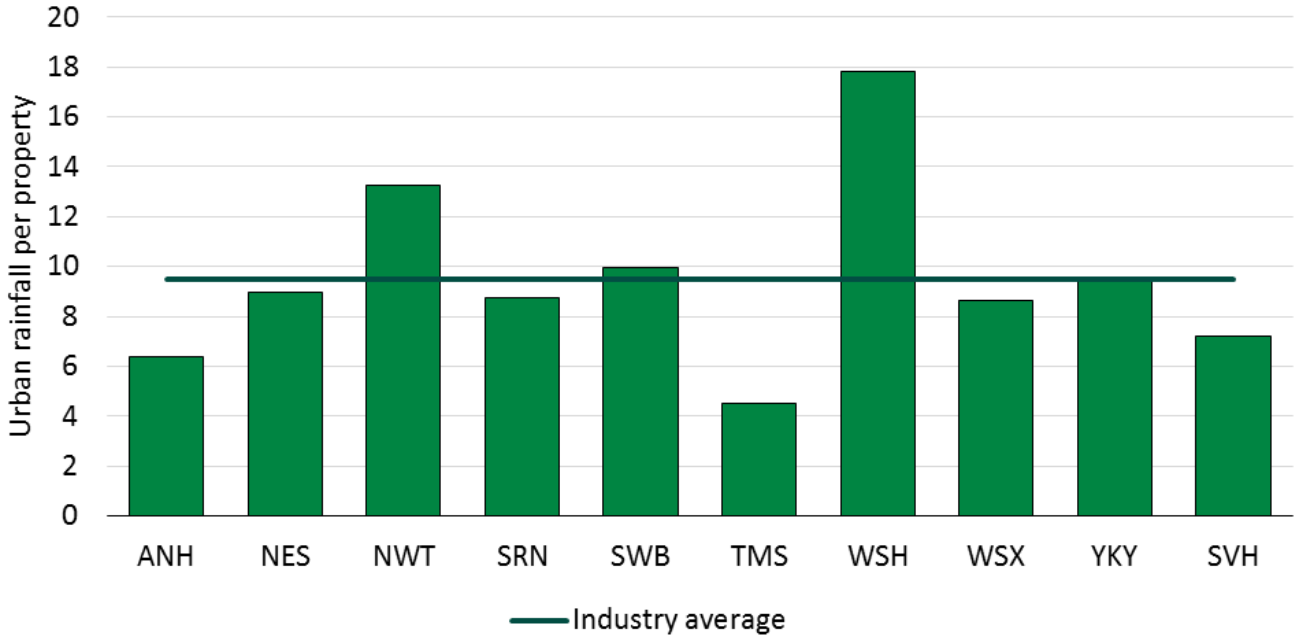


Source: Met Office

E.2.6 Whereas foul sewerage is defined by consistent and predictable demand, a wide range of environmental factors impact upon companies' ability to deliver equal performance for the surface water service:

- Rainfall, but particularly urban rainfall because rainfall onto urban areas tends to be directed into the sewer system. ***Figure 66*** illustrates average urban rainfall per property over the period 2011-12 to 2021-22.
- The North West is clearly significantly above average. We also note that the value for Wales may be overstated due to the apparent difference in classifying the "urban areas" between England and Wales (see appendix B)

Figure 66: Average urban rainfall per property (2011-12 to 2021-22)

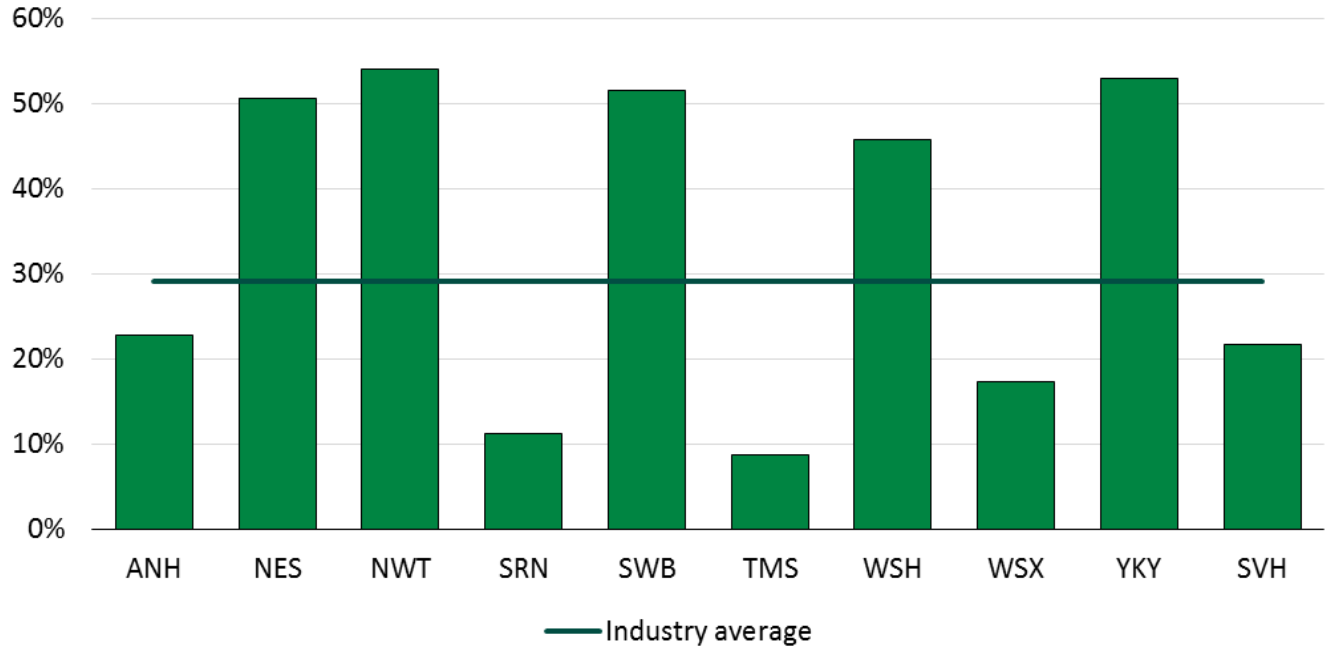


Source: Ofwat's cost assessment dataset

E.2.7 **Combined sewers** convey both foul sewage and surface water sewage. This means that the hydraulic capacity within combined sewers is very sensitive to periods of rainfall. Indeed, in our experience, the key challenge in operating and maintaining combined sewers is the large, and often rapid, change in

flow. Managing large variations of inflow into drainage and sewerage networks leads to a need for significantly larger network and storage assets, if they are to support the same level of sewer flooding incidents as separated sewer systems. Combined sewers tend to be legacy assets, inherited at privatisation. Whereas surface water only sewers are able to convey urban run-off to a nearby watercourse, combined sewers must transport sewage to a treatment works. ***Figure 67*** shows the average prevalence of combined sewers as a percentage of the 'legacy' network.

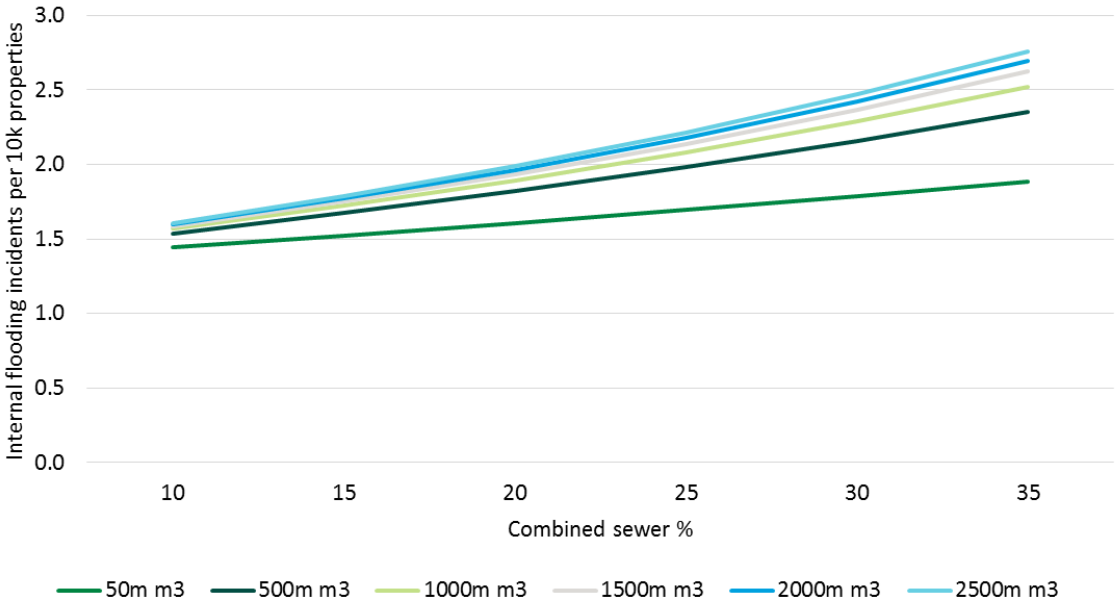
Figure 67: Combined sewers as % of legacy sewers (2011-12 to 2021-22)



Source: Ofwat's cost assessment dataset

E.2.8 As stated above, urban rainfall can lead to rapid, material swings in the hydraulic capacity of combined sewers. Urban rainfall effectively reduces the capacity of combined sewers relative to an equivalent separated system that carries foul and surface water in separate pipes. In dry weather, this is not usually an issue. However, in times of heavy rainfall, the lack of hydraulic capacity relative to a separated system means that combined sewers are more likely to become overloaded and create operational challenges. This means that there is a compounding effect between urban rainfall and combined sewers - each factor acts to worsen the impact of the other. This engineering prior is borne out by industry level data. Figure 68 illustrates the relationship between combined sewer prevalence and internal flooding incidents, conditioned on urban rainfall. It's clear that the negative impact of combined sewers on internal flooding incidents increases as the volume of urban rainfall in a region increases.

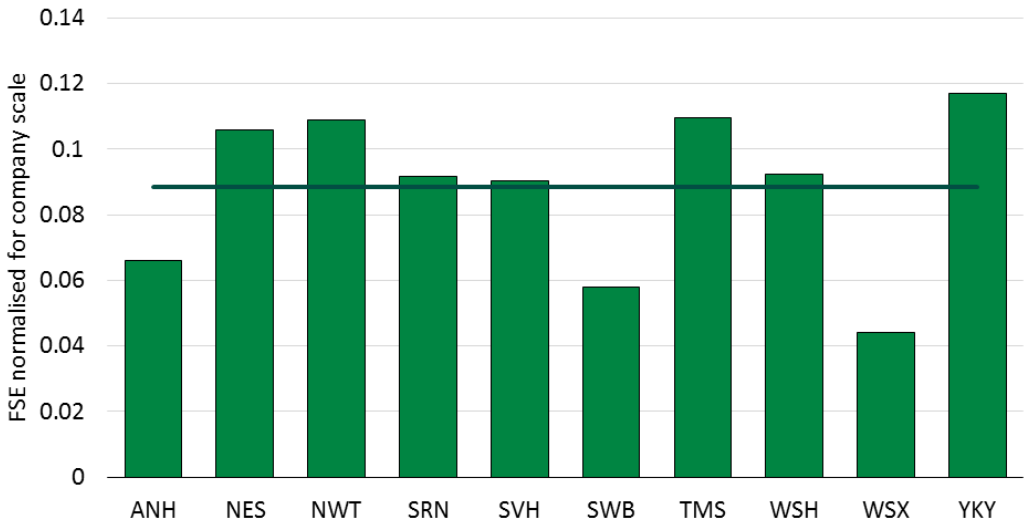
Figure 68: A high prevalence of combined sewers makes the impact of urban rainfall worse



Source: UUW analysis

E.2.9 A number of other factors can also act to increase the risk of blockages. For example, a high Food Service Establishment (FSE)[88] density is associated with a higher incidence of fats, oils and greases being introduced into the sewer network and leading to blockages and other operational issues, which further impacts on sewer flooding performance. Similar issues can be caused by a high property density, as a higher density of people increases the risk that unsuitable items are introduced into the network. ***Figure 69*** uses data published by Public Health England to demonstrate the relative density of FSEs across the industry.

Figure 69: Food Service Establishment density across the industry



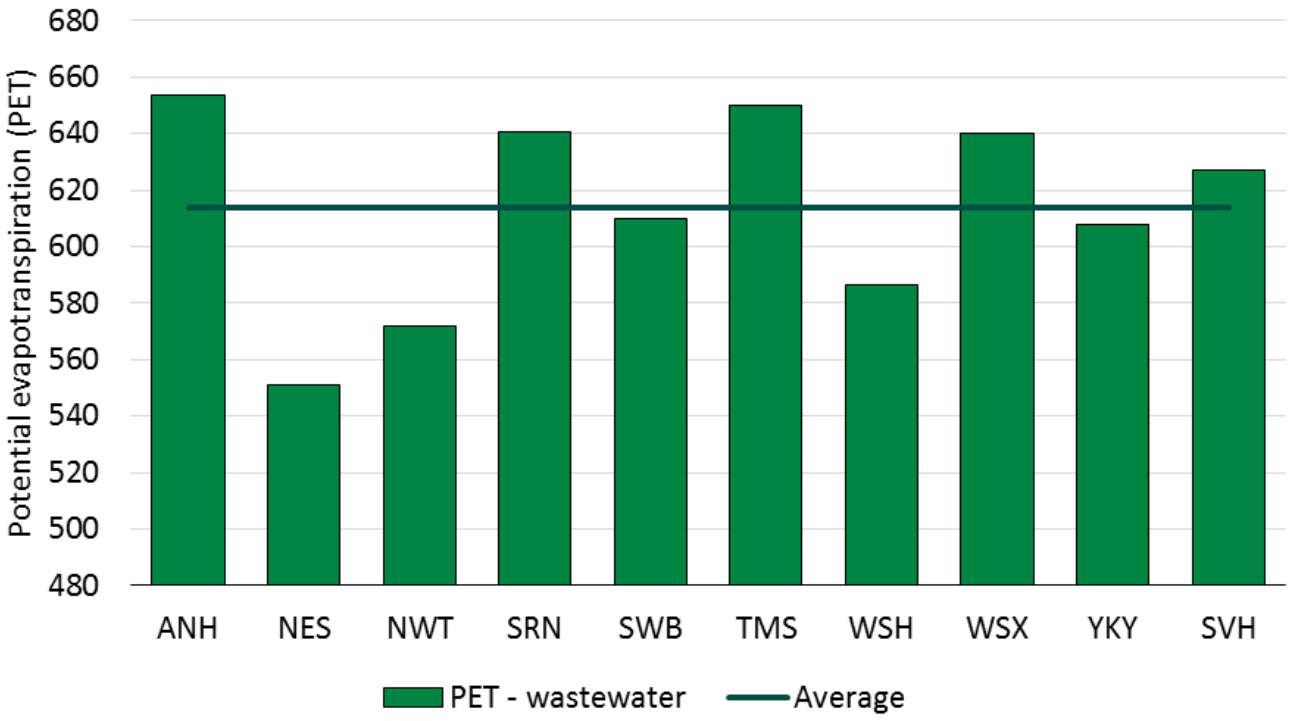
Source: Public Health England

E.2.10 **Potential evapotranspiration** (PET). PET is a measure of the rate of the maximum potential loss of water via evaporation from the land surface and transpiration by plants. A low PET means that less water is being lost from the system via these routes and therefore a greater proportion of surface runs overland

[88] Loosely defined as takeaways.

into the sewer network (and UUW has a particularly low PET score). Relative PET across the industry is illustrated in Figure 70.

Figure 70: Potential evapotranspiration across the industry



Source: Ofwat's cost assessment dataset

E.2.11 As the preceding analysis shows, these environmental factors vary significantly across the industry, which will impact upon companies' ability to deliver equal levels of performance – in particular, it is clear that UUW operates in an area of high urban run-off, high proportion of combined sewers, high levels of food service establishments, and a low PET score – all of these factors combine to make it impossible for UUW to achieve an equivalent level of sewer flooding incidents as companies that operate in areas that are more favourable for surface water drainage. The only way this would be possible would be to invest billions of pounds in surface water disconnection – we believe this would be inefficient, a view supported in the Government's Strategic Policy Statement, which did not consider complete separation of surface water to be a viable economic option[89] .

E.2.12 Historically, the regulatory framework has allowed expenditure to improve the surface water service in two way

- Moving UIDs back into compliance with existing permits (i.e. without any specified maximum spill frequency) – however, this investment has been downstream, and does not provide any reduction in sewer flooding risk; and
- Some marginal improvements to sewer flooding, but this has not been sufficient to move companies to equivalent levels of service. As we discuss later, for UUW to achieve a simple upper quartile level of sewer flooding incidents would require very significant levels of investment.

E.2.13 This demonstrates that there is no WINEP equivalent for the surface water drainage service that would allow companies to i) move towards; ii) operate on; and iii) be measured against a level playing field for sewer flooding incidents.

[89] UK Government (2022) *Storm overflows discharge reduction plan.* Available here.

E.2.14 Furthermore, we do not agree that setting company targets based on a simple upper quartile of flooding incidents between companies is targeting an equivalent level of performance. It is, in fact, setting an unachievable level of performance for some companies, whilst setting a relatively easy target for others.

It's clear that performance/compliance is facilitated and measured differently across foul and surface water services.

E.2.15 For the foul service, company specific investment requirements to achieve service quality are facilitated and funded via the WINEP process and botex is then assumed to be sufficient to maintain performance in line with existing service quality at each company. A cost driver is typically included to account for differences in treatment complexity.

E.2.16 Performance and compliance is then measured by reference to the permit level i.e. companies are penalised if they are not compliant with the performance level facilitated by the WINEP. Additionally, the average performance level against which companies are measured will vary, depending upon the requirements set out in that companies' WINEP.

E.2.17 In contrast, in the surface water service, while (historically) the WINEP process has enabled companies to address unsatisfactory overflows, the intention of this has not been for it to enable companies to achieve comparable service levels – neither flooding incidents, nor overflow spill frequency. In effect, the current framework is asking companies to go further, and achieve a common industry target for performance both downstream (overflows) and upstream (sewer flooding) without any recognition of the investment that would have been required to achieve that equivalent service level. There has been no surface water WINEP driver to identify and recognise the investment required to achieve an equal level of customer flooding incidents, or (historically) to achieve an equal level of spills from overflows.

E.3 The implication of a common target on sewer flooding and overflows

E.3.1 The factors set out above will require that companies operating in adverse regions will need to implement a different number and type of interventions relative to a company in a less adverse region, for example:

- More surface water separation;
- Increased network capacity;
- Increased storage; and,
- More SuDS and rainwater management.

E.3.2 These are clearly significant infrastructure requirements, which would cost a substantial amount to deliver and would, by nature, be extremely disruptive to local residents. Conversely, companies operating in less adverse regions would not need to adopt these solutions and would find the common target relatively easy to hit as a result.

E.3.3 For overflows, the AMP8 (and beyond) WINEP programmes will be aimed at identifying the company specific investment requirements to achieve the long term common spill frequency targets. However, each company will have its own company specific trajectory of spill frequency reduction, from the modelled level of expected spills achievable by their existing assets.

E.3.4 Also, given the Government's Strategic Policy Statement did not consider complete separation of surface water to be a viable economic option[90], spill frequency reductions will mostly be achieved via increases in downstream storage. Whilst this will reduce overflow spill frequency, it will not support any improvement in sewer flooding risk in the upstream network. Therefore the different challenges faced by companies in achieving a common level of sewer flooding incidents will remain.

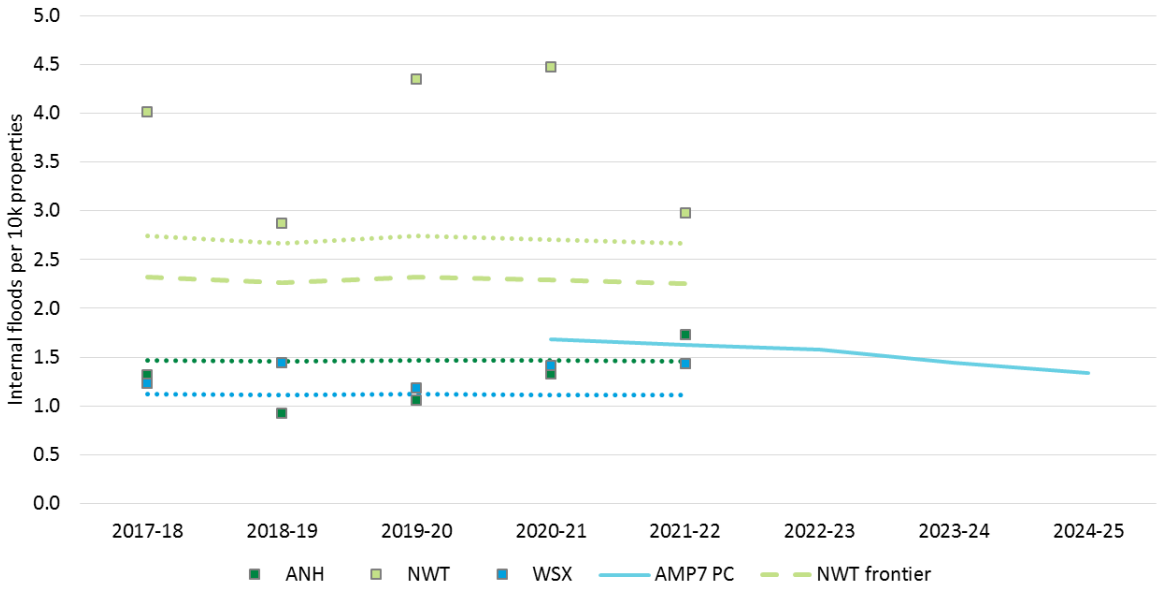
[90] UK Government (2022) *Storm overflows discharge reduction plan.* Available here.

E.3.5 This difference in the relative challenges faced by companies in achieving a common level of sewer flooding incidents was generalised and set out in more detail in our FIL paper[91]. We established that the investment required to achieve a common level of flooding incidents (adjusted for scale) would be excessive, and therefore the most efficient way to manage the impact of companies facing different environmental challenges would be to set sewer flooding targets in a way that also normalised for the impact of some of those environmental factors (notably urban run-off, combined sewers and food service establishments). In our view, such a normalisation is warranted because (a) there has been no prior mechanism (e.g. WINEP) to support companies to invest in sewer network assets in a way that enables common flooding incidents to be achieved, and (b) the cost of doing so would be excessively prohibitive (as recognised in the Government's Strategic Policy Statement, which did not consider complete separation of surface water to be a viable economic option[92]).

E.3.6 Using normalisations in setting performance targets is already applied extensively, in normalising for company scale. It is therefore justifiable for other normalisations to be used, to ensure that service performance targets are set on a common basis for all companies, in a way that ensures that targets are equally stretching for all companies operating in different regions and facing different challenges in achieving those performance levels.

E.3.7 This impact of this is illustrated in Figure 71. The dotted lines indicate the performance predicted by our internal sewer flooding performance model[93] for each company, overlaid with the PR19 upper quartile target for internal sewer flooding. Actual performance is denoted using the square dots. It's clear that Wessex and Anglian are predicted to achieve a lower level of incidents than the PR19 upper quartile, and they do in fact outperform this target in most years. In contrast, UUW does not hit the common target in any year. Furthermore, the frontier level of performance for UUW is above the common target. This suggests that UUW's regional characteristics make it impossible for UUW to achieve the level of performance required by the PR19 common target.

Figure 71: The PR19 upper quartile target for internal sewer flooding is beyond the modelled frontier for a company with UUW's regional characteristics



Source: UUW analysis

[91] UUW (2022) *What lessons can we learn from cost assessment at PR19?* Available here.

[92] UK Government (2022) *Storm overflows discharge reduction plan.* Available here.

[93] This model was first developed within our FIL paper referenced above. We will submit an updated version as part of our business plan submission.

E.4 Equivalent performance is not possible for companies in different regions

E.4.1 The PR19 approach of setting a common target for wastewater network performance measures suggests that equivalent numbers of flooding incidents equates to companies having equivalent performance, regardless of companies operating in areas with very different regional characteristics. However, in reality, achieving a level playing field will require substantial infrastructure investment. It cannot be achieved through simple changes to operating models.

E.4.2 On overflows, due to the factors listed above, UUW will need to invest billions of pounds to achieve performance levels on overflows currently being achieved by some companies that are operating in more benign environments. Because of this, we consider that Ofwat should recognise that it is appropriate for UUW to have a company-specific trajectory to the long-term spills target of 10, with other companies in more beneficial circumstances having their own trajectory.

E.4.3 On sewer flooding, further billions of pounds of investment would be required in order to achieve an equivalent level of sewer flooding incidents to companies in more benign regions. We consider that the lack of a legal requirement for sewer flooding means that this level of expenditure and the associated disruption would be uneconomic and not in the best interests of customers. For this reason it would be more appropriate to modify the way that common performance levels are set for sewer flooding, to normalise for the key factors that impact on the level of flooding incidents.

E.5 A company-specific target is the most appropriate solution

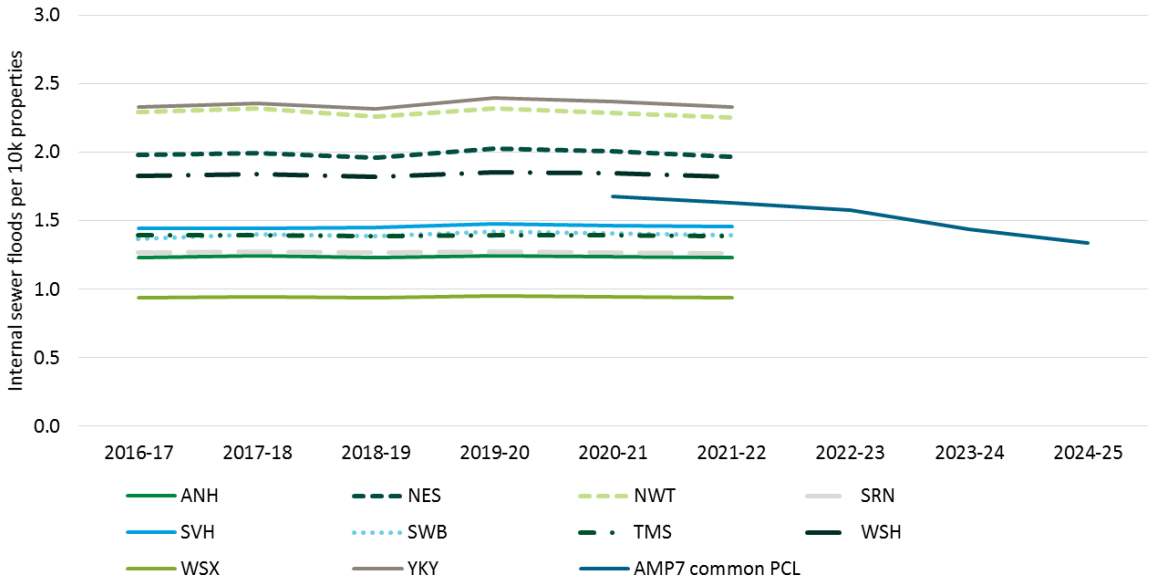
E.5.1 Given the preceding discussion, we consider that the most appropriate solution is to set sewer flooding targets in a way that normalises for certain environmental factors, as well as normalising for scale. We are not seeking a company specific "easier target", but we are seeking for Ofwat to apply "environmentally normalised" (i.e. not just normalising for scale) sewer flooding targets to better reflect the different environments in which companies operate, so that they better reflect what is equally achievable and equally stretching for each company. We summarise our proposals below, but we will explain the proposed adjustments in more detail in our business plan submission.

E.5.2 An environmentally normalised target will prevent companies in less challenging areas benefitting from relatively achievable targets, and enable companies operating in more challenging environments to compete on a level playing field of performance.

E.5.3 We propose that sewer flooding targets are established using an econometric model that reflects scale, urban run-off, combined sewer and food service establishments (as set out in our FIL paper[94]). Figure 72 illustrates predicted frontier performance for each company relative to the PR19 AMP7 internal sewer flooding target. It's clear that some companies will find the PR19 common target comparatively easy to achieve, while for others this level of performance is impossible. This disparity in performance stretch is due to the environmental factors set out in section E.2.

[94] UUW (2022) *What lessons can we learn from cost assessment at PR19?* Available here.

Figure 72: The PR19 common AMP7 PCL is relatively easy to hit for some companies while for others, the common target is not achievable



Source: UUW analysis

E.5.4 It is important to make clear that an environmentally normalised target is not letting companies off the hook for bad performance because performance must be considered relative to the operating area. Ofwat already implicitly recognises this because it normalises the target for company scale. Indeed, as ***Figure 72*** demonstrates, a common target is also letting companies in benign regions off the hook with a relatively easy to achieve target.

E.5.5 Additionally, as the EA makes clear, weather has a noticeable impact upon surface water drainage related performance: *"The 2022 EDM data shows a decrease in spills, which reflects last year's drier than average weather"*[95].

E.5.6 As set out, regional characteristics make it impossible to achieve the equivalent incidents target without substantial infrastructure investment. An environmentally normalised PCL ensures that incentives to outperform are equal across all companies. It will reflect a reallocation of effort such that the overall target is equally stretching for all companies.

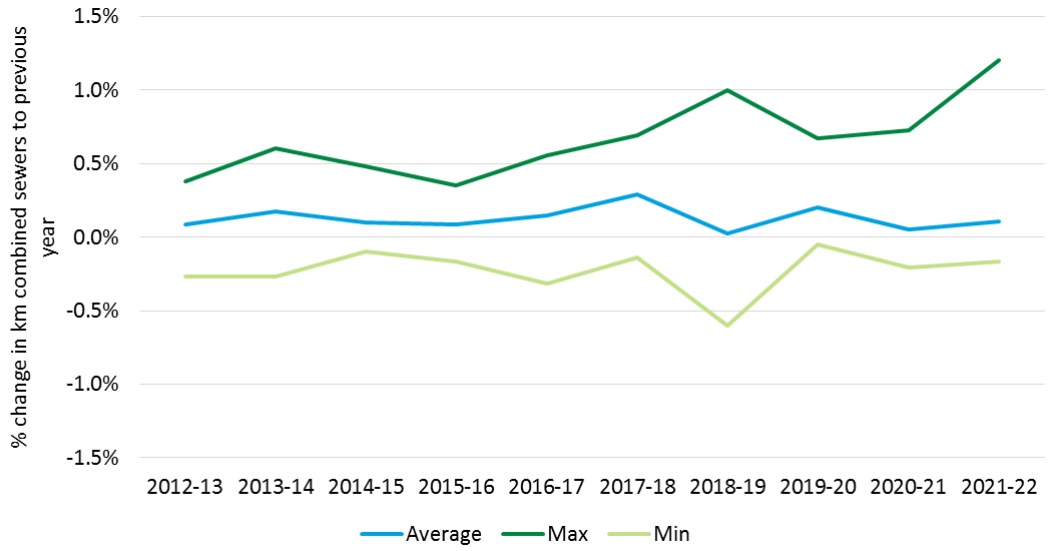
Our preference is for environmentally normalised performance targets which reflect differences in regional operating circumstances between companies

E.5.7 While the preceding discussion is based upon objective facts, we recognise that Ofwat may be minded to reject an environmentally normalised PCL. If this this case, then it is important that there is a suitable adjustment to our costs. However, it is important to recognise that this adjustment would still be insufficient to hit a simple UQ common target. This is because a cost allowance based upon backwards-looking information wouldn't reflect the extent of intervention of investment that would be needed in adverse operating regions.

E.5.8 For example, surface water separation would require the extensive replacement of the combined sewer network. However, as Figure 73 shows, no company has carried out a sustained and significant programme of reducing the prevalence of combined sewers. The data suggests that the length of combined sewers is actually slightly increasing over time.

[95] EA blog. Available here.

Figure 73: Industry average rate of change in combined sewers in historical dataset

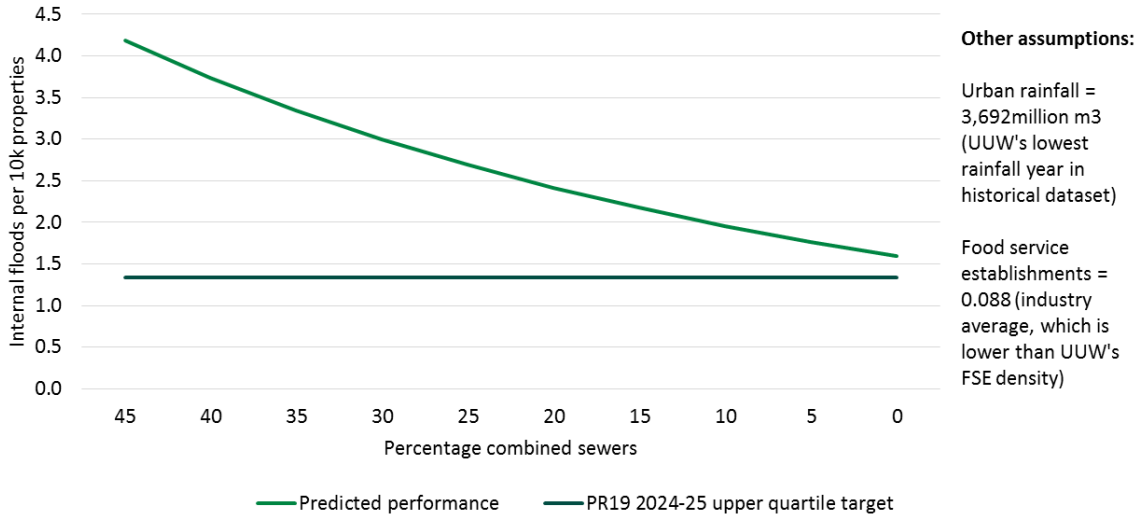


Source: APR data

E.5.9 Figure 74 uses the relationship predicted by our internal sewer flooding performance model to analyse what happens to performance when the prevalence of combined sewers is reduced. It's clear that removing combined sewers is expected to have a positive impact upon performance. However, as Figure 73 demonstrates, there is no evidence in the historical record of this scale of combined sewer removal.

E.5.10 This means that while a cost uplift would provide some support in managing the higher cost of operating in a more adverse environment, it still cannot be expected to enable companies to achieve a simple UQ common level of performance, because it would constitute a relocation of historical costs. As Figure 73 demonstrates, the lack of relevant activity means that these costs will not be reflected in the historical cost record.

Figure 74: How reducing the prevalence of combined sewers moves UUW towards the common target



Source: UUW analysis

E.5.11 This means that facilitating a move towards equal flowing incidents will require a substantial uplift to the backwards-looking benchmark. Additionally, such a move will involve activity that would be extremely disruptive to customers and the local economy. This was recognised in the Government's

Strategic Policy Statement, which did not consider complete separation of surface water to be a viable economic option[96].

E.6 Conclusion and recommendations

E.6.1 It is clear that a number of exogenous regional factors drive relative wastewater network performance across the industry. The influence of these factors means that it would not be economic to reflect these factors by making adjustments to cost allowances in PR24, unless there is a clear legal driver.

E.6.2 Our Future Ideas Lab paper[97] provides a clear framework by which Ofwat can set an environmentally normalised performance target for sewer flooding. These environmentally normalised targets will ensure that all companies operate on a level playing field and customers do not pay for the uneconomic levels of investment required to achieve equal performance on non-statutory measures.

E.6.3 However, if this option is not adopted, then UUW considers the interaction term, representing the combined impact of urban rainfall and combined sewers, should be added to all relevant econometric models. We do note that the lack of sustained and substantial flood mitigation activity within the historical cost record will mean that any reallocation of historical cost will always underestimate the efficient costs a company with UUW's characteristics would incur in achieving a common performance measure as stretching as that included within the PR19 FD.

E.6.4 If the performance targets are not appropriately adjusted (as we propose), then UUW will seek a cost adjustment to recover efficient additional costs. The cost adjustment claim set out within the main part of this document represents this option.

[96] UK Government (2022) *Storm overflows discharge reduction plan.* Available here.

[97] UUW (2022) *What lessons can we learn from cost assessment at PR19?* Available here.

Appendix F How urban areas are reflected within urban rainfall

F.1 Background

F.1.1 Urban rainfall results in run-off into the wastewater network, which increases the costs of operating and maintaining wastewater assets and has a detrimental impact upon aspects of performance. As a result, United Utilities strongly supports the use of an urban rainfall variable within cost assessment. We were greatly encouraged to see that Ofwat has developed an urban rainfall variable, building upon Arup and Vivid Economics' work during PR19[98]. We strongly support this positive development, which will result in a more robust cost assessment.

F.1.2 The urban rainfall variable has two key inputs, which are combined in the following way:

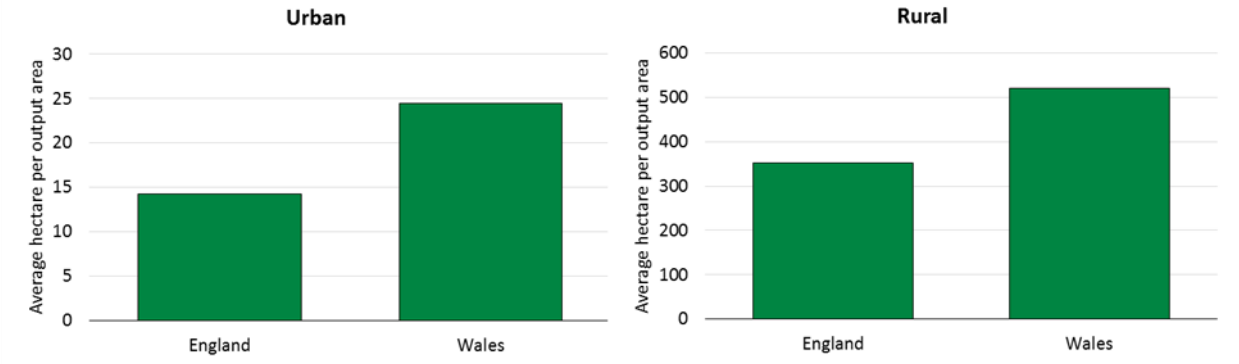
$$urban\ rainfall = rainfall \times urban\ area$$

F.1.3 We have closely examined Ofwat's methodology for calculating urban rainfall and consider that it is generally appropriate. We have, however, identified one particular aspect where we consider a slight bias is introduced into the calculation – in particular, how urban areas are reflected within the urban rainfall variable and possible methodological differences in how these are captured across England and Wales. In identifying this issue and possible ways to address it, we have drawn upon our previous work in this area, in particular Arup and Vivid Economics' work commissioned by UUW at PR19, our sewer flooding 'hackathon'[99] and submissions to Ofwat's Future Ideas Lab[100].

F.1.4 The systematic difference in the size of geographical areas can be seen from the average size of an output area in England and Wales, illustrated in Figure 75.

F.1.5 It's clear from this that the average urban area in Wales is larger. Given the calculation of urban rainfall scales with urban area, this shows that urban rainfall within Wales is likely overestimated to a degree, relative to urban rainfall in England.

Figure 75: Output areas are systematically bigger in Wales relative to England



Source: UUW analysis of ONS Rural-Urban Classification data

F.1.6 To be clear, we are not seeking to discredit either the RUC or Ofwat's urban rainfall variable; the RUC provides a well-understood and well-established methodology that allows a wide variety of users to consistently compare population characteristics across different areas of England and Wales while the urban rainfall variable represents a pragmatic way to capture variances in urban run-off across the

[98] Arup and Vivid Economics (2017) *Understanding the exogenous drivers of cost in England and Wales.* Available here.

[99] The 'hackathon' brought together a range of business experts, analysts and data scientists to explore the drivers of internal sewer flooding performance, using a wide range of internal and external datasets. We have previously presented the outcome of this work to Ofwat.

[100] UUW (2022) *What lessons can we learn from cost assessment at PR19?* Available here.

industry. Our overriding ambition for this appendix is not to criticise Ofwat's pragmatic approach to calculating urban rainfall but to note some possible reasons as to why Welsh Water appears to have substantially larger volumes of urban rainfall relative to other companies and ask that any resulting comparative analysis be viewed in this context.

F.1.7 This appendix exclusively focuses on the 'urban area' element of this equation:

- **Section F.2 discusses the Rural Urban Classification (RUC)**, which is used by Ofwat to define the "urban area" element of the equation about. The ONS uses RUC to categorise geographic areas using physical settlement characteristics and we have examined the ONS's approach. This section highlights some methodological features of the RUC that mean it might not accurately reflect areas that drain to a wastewater company's assets.
- **Section F.3 presents some real-life examples of areas classed as "urban" by the RUC, but which comprise mostly undeveloped rural land.** We provide both quantitative and visual GIS analysis. This provides evidence that the methodological issues highlighted in Section F.2 are impacting upon the definition of urban conferred by the RUC.
- **Section F.4 demonstrates that while urban areas may be overstated as a whole across England and Wales, Welsh geographical areas appear to be systematically larger than English areas.** This would tend to overstate the level of urban areas in Wales relative to England. In turn, this would tend to overstate the level of urban rainfall in Wales relative to England.

F.2 The Rural Urban Classification

F.2.1 The Rural Urban Classification (RUC) categorises a range of statistical and administrative geographic areas on the basis of physical settlement characteristics. The statistical and administrative units range in size from the smallest (Output Area) to larger areas (like Local Authority Districts or Electoral Wards). The RUC was created by the Department of Town and Regional Planning at the University of Sheffield on behalf of a government working group and was designed to allow social and economic analysis to account for rural and urban areas in a consistent manner.

How the ONS classifies geography

F.2.2 In order to understand how the RUC works, we first need to understand how the ONS classifies and aggregates geographic areas within England and Wales.

F.2.3 The ONS has divided all of England and Wales into around 180,000 small geographic parcels known as Output Areas (OA)[101]. Output areas were introduced for the 2001 Census and are used to measure and compare population characteristics for different geographic areas. They were designed to have roughly similar population sizes (roughly 125 households), which means that less populated Output Areas may contain large areas of undeveloped land and/or be bigger geographically than others.

F.2.4 Figure 76 shows an example of Output Area boundaries. It's clear that there is substantial variation in the geographical size. The smaller Output Areas cover the northern edge of Bolton (a densely populated area), while the larger Output Areas cover the beginning of the West Pennine Moors (a sparsely populated area).

[101] ONS (online) *Introduction to Output Areas – the building blocks of geography.* Available here.

Figure 76: Example of differences in the size of Output Areas

Source: ONS

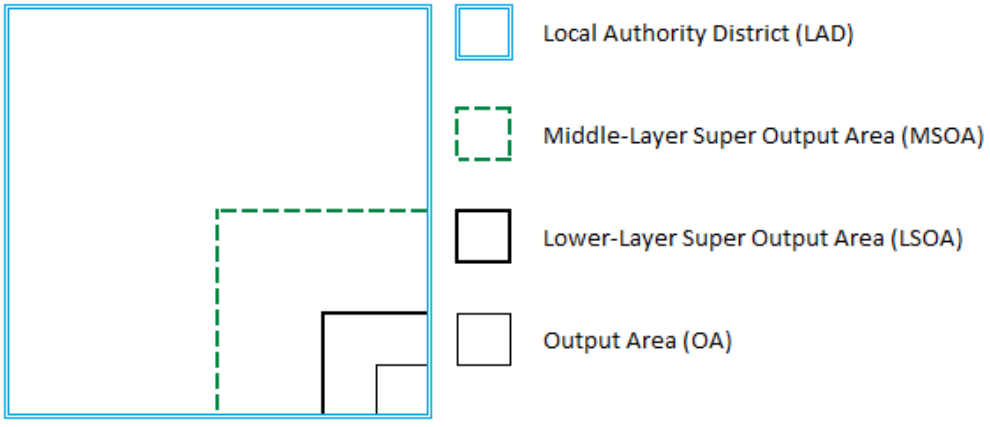
F.2.5 Output Areas are aggregated into larger geographic parcels:

- Several Output Areas can be aggregated into a Lower-layer Super Output Area (LSOA). These have roughly 650 households in them.
- The next largest parcel is known as a Middle-layer Super Output Area (MSOA). These have roughly 4,000 households in them.
- The next largest parcel is a Local Authority District (LAD), which can vary substantially in size.

F.2.6 The aggregation of an Output Area to larger geographic parcels (LSOA and MSOA) is determined algorithmically by the ONS.

F.2.7 Figure 77 is a stylised example of how these geographical parcels relate to each other. It's clear that an Output Area can be considered a building block of all other geographical parcels. Note that this example is illustrative only and not to scale.

Figure 77: Stylised example of the geographical hierarchies used by the ONS (not to scale)



Source: UUW styalised example

How the RUC classifies Output Areas as urban or rural

F.2.8 The RUC defines an Output Area as either urban or rural depending upon whether its population-weighted centre point sits within a built-up area where over 10,000 people live[102], where 'built-up area' is determined by the Ordnance Survey[103].

Note that the use of a population-weighted centre point means that Output Areas can cover a section of countryside but still be considered urban if the majority of the population lives in a built-up area. In this way, the RUC prioritises settlement type, rather than other elements of land cover[104]. This slight weakness is recognised by the RUC's creators: "More critically in practice, RUC takes no explicit account of any aspect of the land cover typical of a statistical unit other than settlement"[105].

Aggregating the RUC from an Output Area to larger geographical units

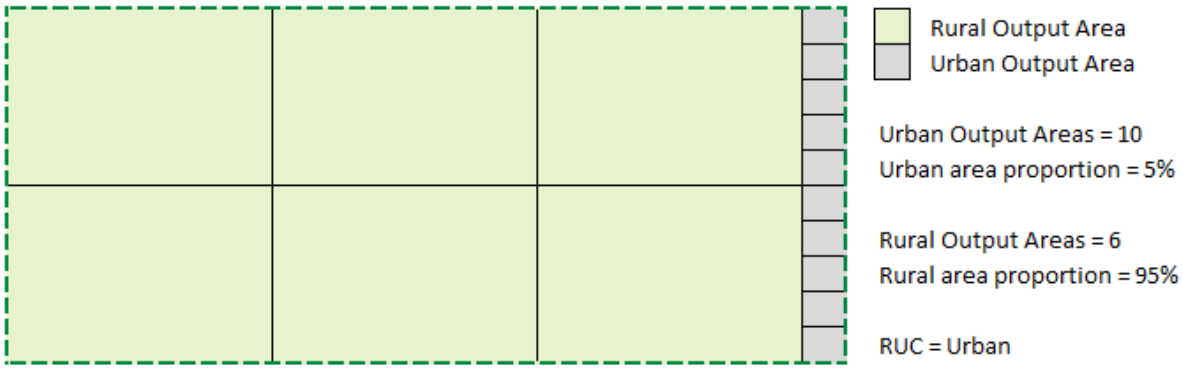
F.2.9 As set out in section 0, a number of Output Areas can be aggregated to form an MSOA. Under the RUC, **whether this MSOA is classed as rural or urban depends upon whether a majority of its constituent Output Areas are rural or urban.**

F.2.10 At this point, it's important to note that as Output Areas are aggregated to higher geographic parcels, there is a corresponding loss in granular detail. We will return to the implications of this loss of granularity later.

F.2.11 We now present a stylised example of how this aggregation occurs in practice. We then hypothesise that this could lead to possible perverse results. Section F.3 will then present evidence that this has occurred in practice.

F.2.12 ***Figure 78*** shows an example MSOA with 16 constituent Output Areas, six of which are considered by the RUC to be rural and ten of which are considered urban. The six rural Output Areas are larger because they are sparsely populated (as discussed in section 0). Clearly, the majority of the MSOA's land coverage is rural. However, because there are ten Output Areas classed as urban and only six classed as rural, the entire MSOA is classed as urban.

Figure 78: An MSOA classed as 'urban' despite most of its land coverage being 'rural'



Source: UUW stylised example

F.2.13 This might be considered to be an extreme case. However, it is relatively easy to find real world examples of this happening and analysis of all MSOAs suggests that a significant proportion of their land cover is made up of rural Output Areas (we discuss this further in section F.3).

F.2.14 This means that using the RUC at an MSOA level for the purposes of deriving a measure of urban rainfall could overestimate the amount of urban rainfall in each region by overestimating the amount of urban area in each region. This is because applying RUC at the MSOA causes a loss in granularity. For example,

[102] ONS (2015) *The 2011 rural-urban classification for output areas in England.* Available here.

[103] ONS (2015) *2011 Built up areas – methodology and guidance*. Available here.

[104] Bibby and Brindley (2013) *Urban and rural area definitions for policy purposes in England and Wales: methodology*. Available here.

[105] ONS (2013) *RUC user guide.* Available here.

under Ofwat's current approach of applying RUC at the MSOA level, the entirety of the MSOA in Figure 78 would be reflected in the measure of urban rainfall. Clearly, this would probably include a large amount of undeveloped land which inputs minimal flow into the local sewer network.

F.2.15 Importantly, this effect should not be expected to cancel out between companies due to the significant differences in population density and conurbation types across the industry. Section 4 presents evidence that supports this expectation.

F.2.16 We should acknowledge that this issue also exists at an Output Area level, due to the use of a population-weighted centre when applying the RUC to Output Areas. As discussed previously, it's possible for an Output Area to consist of areas of undeveloped land and still be considered urban. However, the much greater granularity conferred by the use of Output Areas significantly reduces the degree to which this systematic bias influences the result at a company level.

F.2.17 The next section presents real world examples of the use of MSOAs overstating urban areas. Section F.4 then demonstrates that this also occurs generally across England and Wales but that areas in Wales will be particularly affected by this overstatement.

F.3 Examples of urban MSOAs with large areas of rural land

F.3.1 This section presents some real life examples of largely rural MSOAs being classified as urban because a majority of their constituent Output Areas are classed as urban. Section F.4 then shows that Welsh areas are bigger in general.

F.3.2 Table 58 sets out each of the MSOAs considered in this section. We have identified these particular MSOAs through cursory analysis of each companies' area; there are many more examples that we could have picked. The table includes information on the number of output areas within each MSOA, split by those considered urban and rural by the RUC. We can see how RUC aggregation works; each MSOA has a majority of Output Areas classed as urban, which under the RUC methodology means the MSOA is classed as urban (the one exception is South Kesteven 007 which is evenly split between urban and rural MSOAs. Under the RUC's methodology, in these cases the MSOA is classed as urban). Table 58 also sums up the geographic area of the MSOA's constituent Output Areas, again split by Output Areas classed as urban and those classed as rural. As discussed in section F.2, Output Area boundaries are drawn to contain roughly the same number of households/population. This means that rural Output Areas tend to be bigger geographically, which is clearly demonstrated in Table 58.

Table 58: Analysis of the urban/rural make-up of MSOAs classed as urban (all these MSOAs are classed as urban by the RUC)

MSOA	Number of urban Output Areas within the MSOA	Number of rural Output Areas within the MSOA	Size of urban Output Areas within the MSOA (hectares)	Size of rural Output Areas within the MSOA (hectares)	Share of MSOA's area made up of urban Output Areas	Share of MSOA's area made up of rural Output Areas
South Kesteven 007	17	17	195	20,199	1%	99%
Monmouthshire 001	19	8	881	13,612	6%	94%
Northumberland 034	13	11	571	10,149	5%	95%
Shropshire 029	18	16	883	14,131	6%	94%
South Hams 001	11	8	261	8,390	3%	97%
Test Valley 001	15	8	313	6,678	4%	96%
South Oxfordshire 004	13	10	439	5,164	8%	92%
South Lakeland 005	19	8	387	19,018	2%	98%
Mendip 012	16	10	802	5,327	13%	87%

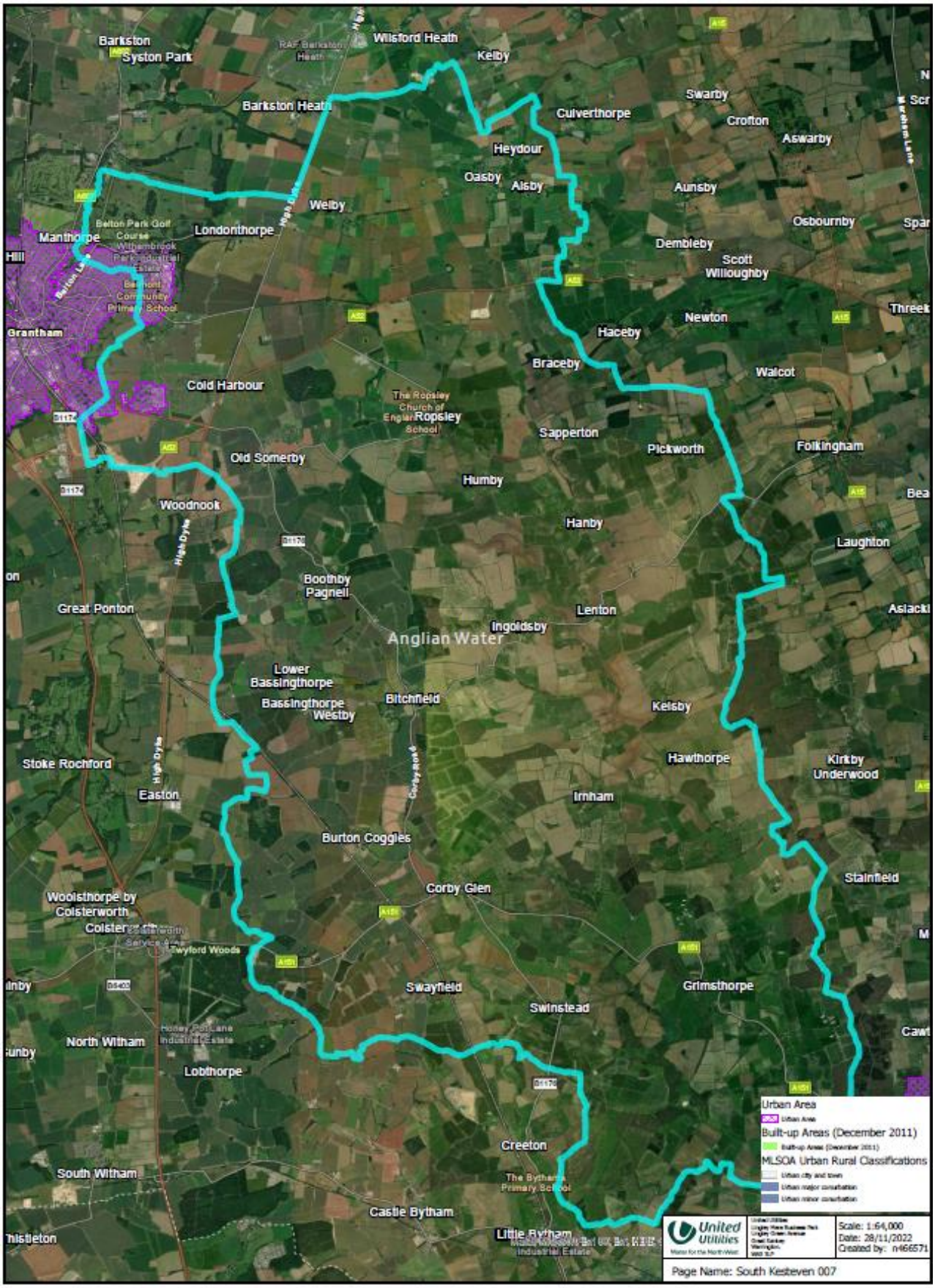
MSOA	Number of urban Output Areas within the MSOA	Number of rural Output Areas within the MSOA	Size of urban Output Areas within the MSOA (hectares)	Size of rural Output Areas within the MSOA (hectares)	Share of MSOA's area made up of urban Output Areas	Share of MSOA's area made up of rural Output Areas
East Riding of Yorkshire 044	13	11	720	5,962	11%	89%

Source: UUW analysis of ONS Rural-Urban Classification

27.1.13 Overall, it's clear that these urban MSOAs are mostly comprised of land that is considered rural by the RUC and is very unlikely to drain to the company's sewer system. The following pages contain maps that illustrate the boundary of selected MSOA set out in ***Table 58***, along with clear markings surrounding built-up areas with a population of 10,000 or more (this information feeds into the RUC's urban classification). This confirms that the scale of rural areas within each MSOA suggested in Table 58 is accurate.

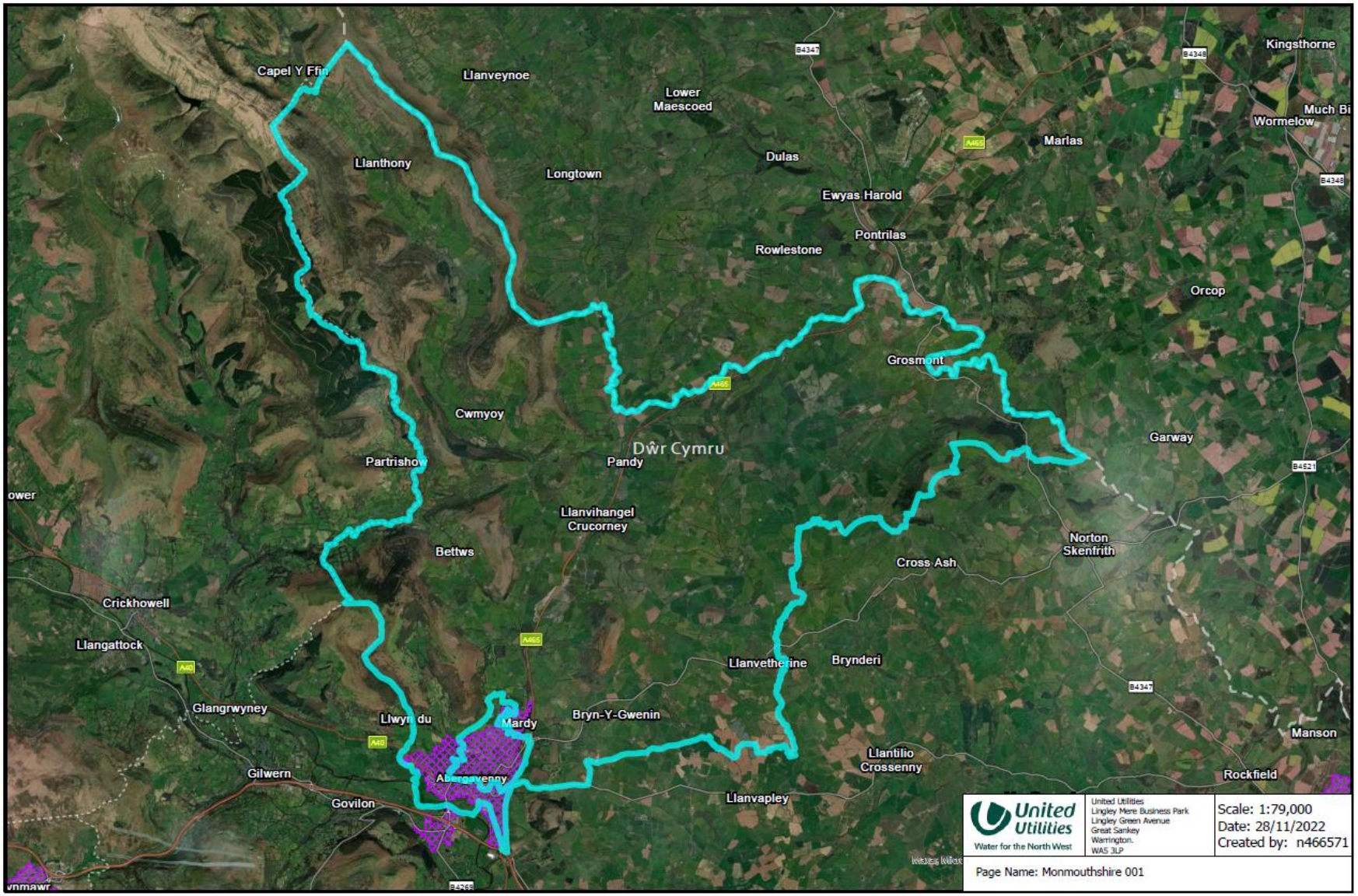
27.1.14 The extent of the MSOA is illustrated in blue shading or a blue boundary, while the built up area with a population greater than 10,000 is set out in purple. All these MSOAs will be included within an urban rainfall variable that applies the RUC at an MSOA level.

Figure 79: South Kesteven 007



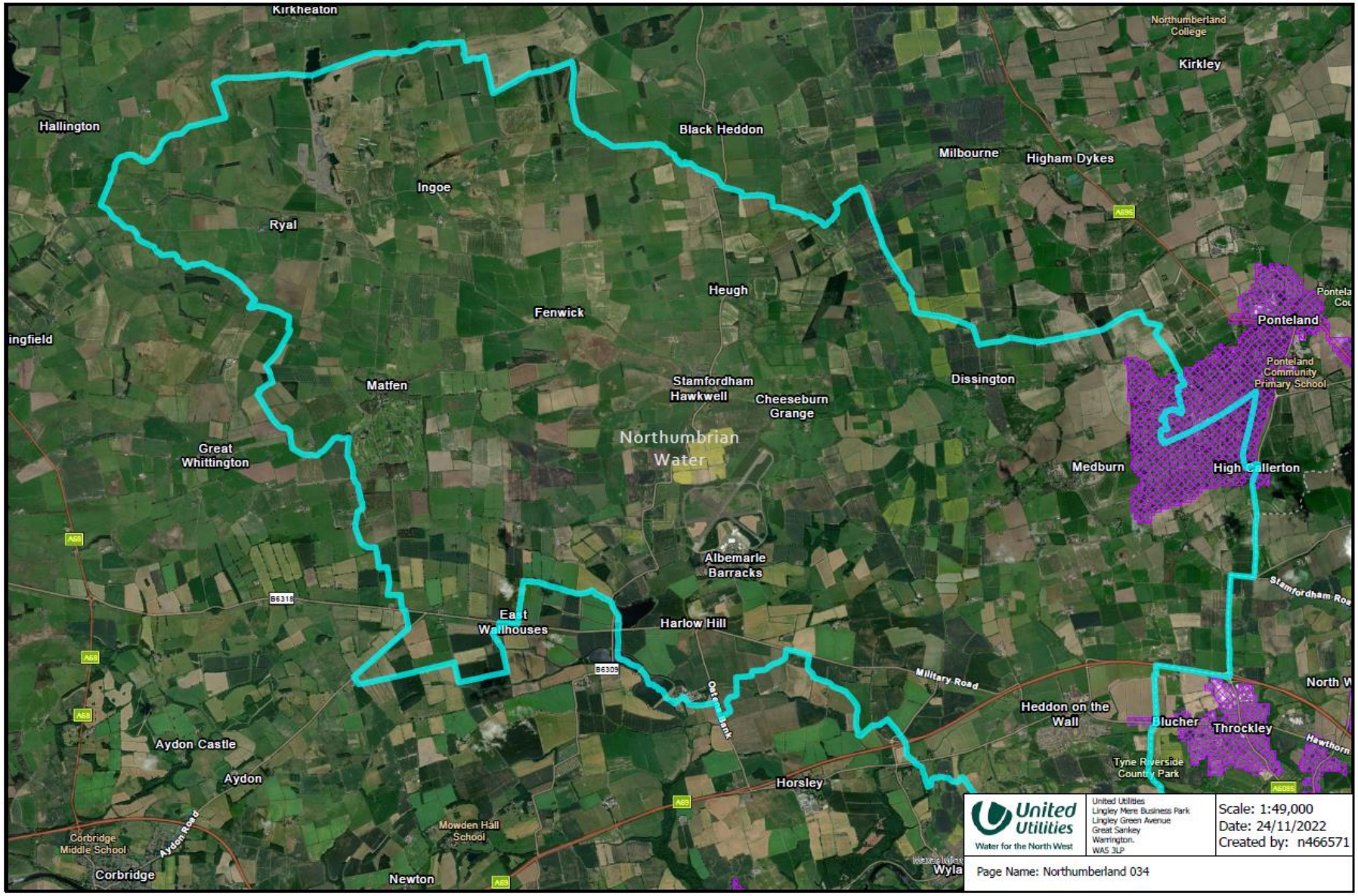
Source: UUW GIS analysis

Figure 80: Monmouthshire 001



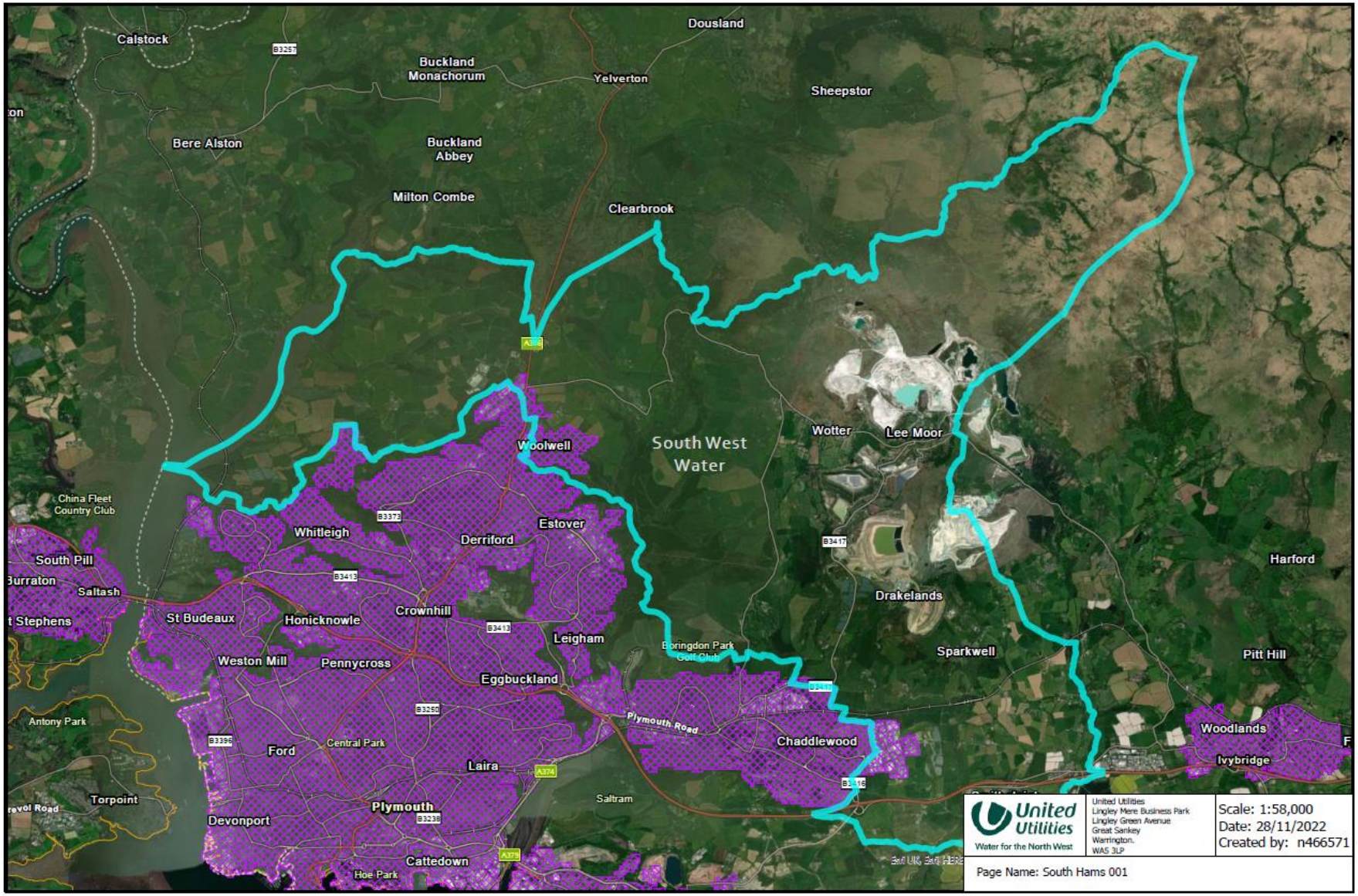
Source: UUW GIS analysis

Figure 81: Northumberland 034



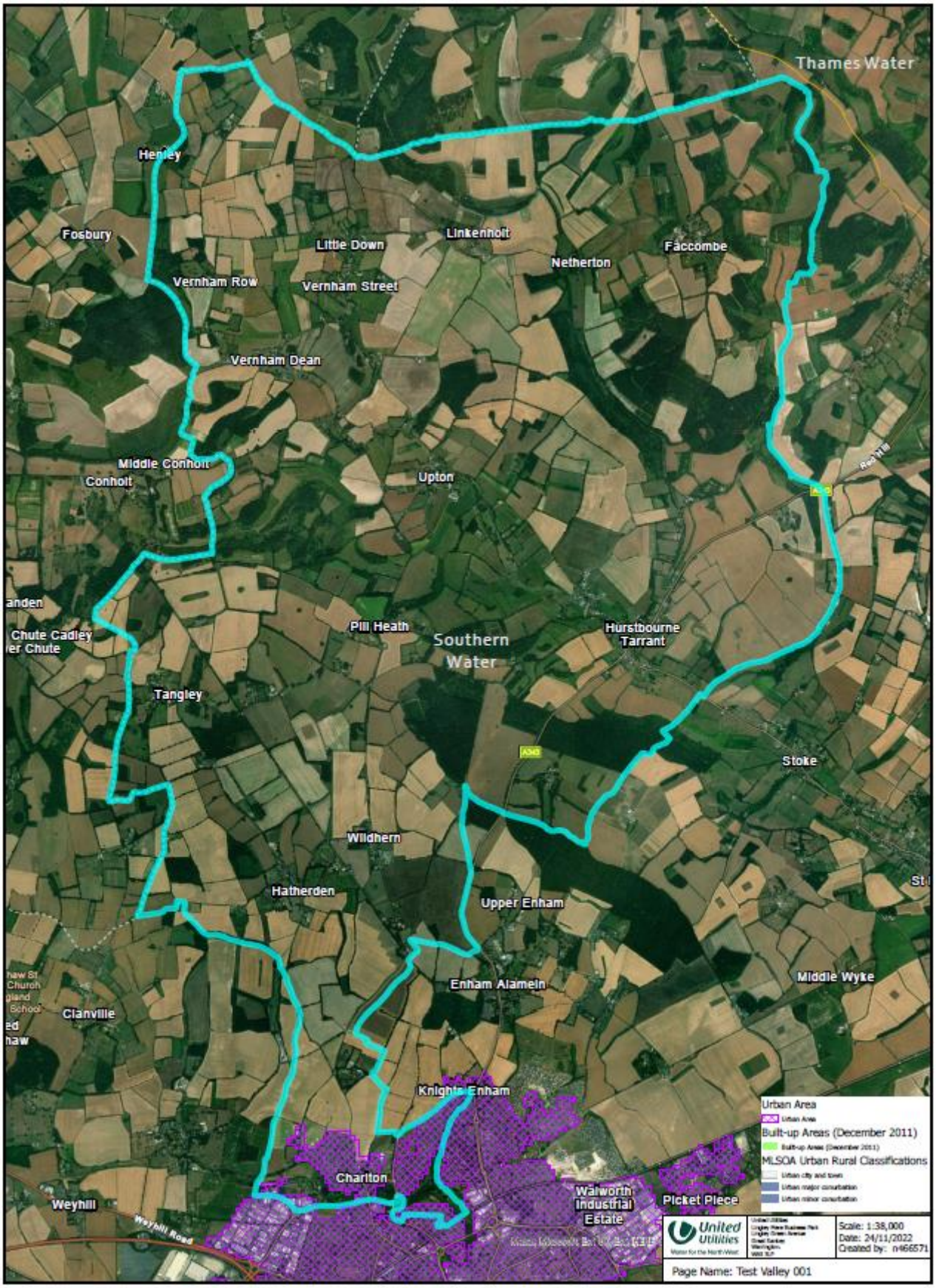
Source: UUW GIS analysis

Figure 82: South Hams 001



Source: UUW GIS analysis

Figure 83: Test Valley 001



Source: UUW GIS analysis

F.4 Using the RUC to define urban rainfall will overstate urban rainfall in Welsh areas

F.4.1 Section 2 hypothesised that defining urban areas by applying the RUC to MSOAs could overstate urban areas. Section 3 presented some examples of this happening in practice in each company's area. This section presents evidence that this happens in a systematically different way between England and Wales.

F.4.2 We can carry out similar analysis to that set out in Table 58 in the previous section for all MSOAs. Table 59 looks at the make-up of all MSOAs in England and Wales by RUC classification. As section F.2 explained, the RUC for an MSOA depends upon the RUC of a majority of its constituent Output Areas. This means that an urban MSOA can include rural Output Areas (and vice versa). Crucially, because rural Output Areas tend to be bigger (due to being more sparsely populated), this means that a large proportion of the land coverage of MSOAs classed as urban by the RUC can be made up of rural areas.

F.4.3 As ***Table 59*** shows, despite there only being 3,507 Output Areas classed as rural contained within MSOAs with an overall urban RUC classification, those 3,507 Output Areas comprise 38% of the land coverage of MSOAs classed as urban, across all of England and Wales. This demonstrates that using the RUC at the MSOA level is overstating urban areas by around 38% across England and Wales. This is an issue for the purposes of defining urban rainfall because rural areas will tend not to drain to sewer networks, which means including such areas within the analysis will overstate the demand put onto a company's asset base.

Table 59: Analysis of the make-up of urban/rural MSOA in England and Wales

MSOA RUC classification	Number of urban Output Areas within MSOAs	Number of rural Output Areas within MSOAs	Size of urban Output Areas within MSOAs (hectares)	Size of rural Output Areas within MSOAs (hectares)	Share of MSOAs comprised of urban Output Areas	Share of MSOAs comprised of rural Output Areas
Urban	144,570	3,507	2,002,502	1,240,810	62%	38%
Rural	1,910	31,421	159,309	11,718,541	1%	99%

Source: UUW analysis of ONS Rural-Urban Classification

F.4.4 We also considered whether this happens at more granular definitions of urban. However, we have found that using the RUC at the next most granular (LSOA) level will still tend to overstate urban areas. Table 60 carries out the same analysis as Table 59, but at the LSOA level rather than the MSOA level. It's clear that the greater granularity of an LSOA has improved the definition of urban because the share of urban areas made up of rural Output Areas has decreased from 38% at the MSOA level to 23% at the LSOA level. However, this does still mean that defining urban areas at the LSOA level will overstate urban areas by around 23%.

Table 60: Analysis of the make-up of urban/rural LSOAs

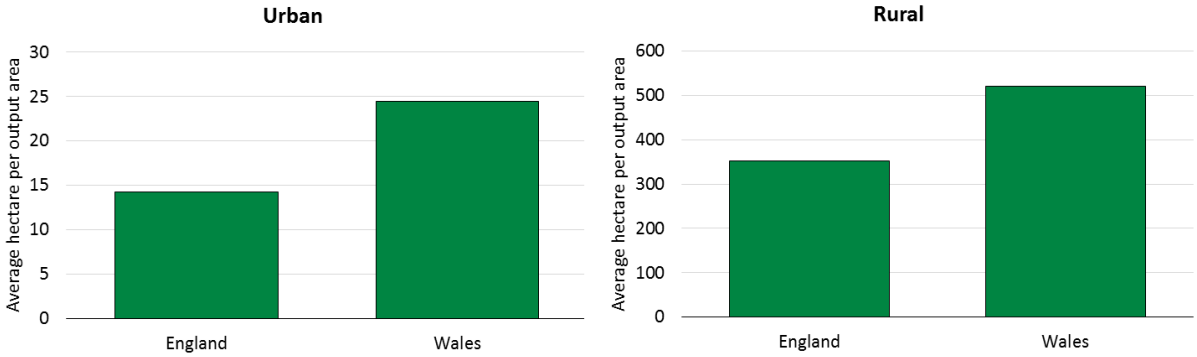
LSOA RUC classification	Number of urban Output Areas within LSOAs	Number of rural Output Areas within LSOAs	Size of urban Output Areas within LSOAs (hectares)	Size of rural Output Areas within LSOAs (hectares)	Share of LSOAs comprised of urban Output Areas	Share of LSOAs comprised of rural Output Areas
Urban	145,922	1,477	2,078,741	604,336	77%	23%
Rural	558	33,451	83,069	12,355,015	1%	99%

Source: UUW analysis of ONS Rural-Urban Classification

F.4.5 To an extent, this may not affect industry comparisons, **assuming that urban areas are equally overstated across all areas of England and Wales**. However, on average, the size of geographic parcels

between England and Wales appears to be systematically different – Welsh areas appear to be larger. This can be seen in Figure 84.

Figure 84: Both urban and rural areas in Wales tend to be larger



Source: UUW analysis of ONS Rural-Urban Classification

F.4.6 The fact that urban areas in Wales are substantially larger than those in England means that the inclusion of 'urban areas' within the equation set out in 230 will mean that when rainfall is multiplied by urban area to calculate urban rainfall, on average, urban rainfall in Wales is calculated as being larger than urban rainfall in England.

F.4.7 Therefore, we do not consider that industry comparison of urban rainfall set out in Figure 30 is entirely reflective of actual differences in urban run-off between companies in England and companies in Wales. Instead, we consider that the systematic differences between how geographical area are measured between the two countries (as set out in ***Figure 84***) is a major reason behind Welsh appearing to have the largest level of urban rainfall.

F.4.8 While we consider that the addition of an urban rainfall variable to the recommended model suite is a positive development and we consider the calculation to be pragmatic and generally appropriate, we do consider that any resulting comparative analysis should be viewed in context of the underlying systematic differences between England and Wales set out in this appendix, rather than being viewed as entirely reflective of differences in urban rainfall.

Appendix G Correspondence between UUW and the EA

G.1 Footnote 63

[✂]

G.2 Footnote 64

[redacted]

G.3 Footnote 69

[redacted]

[✂]

G.4 Footnote 71

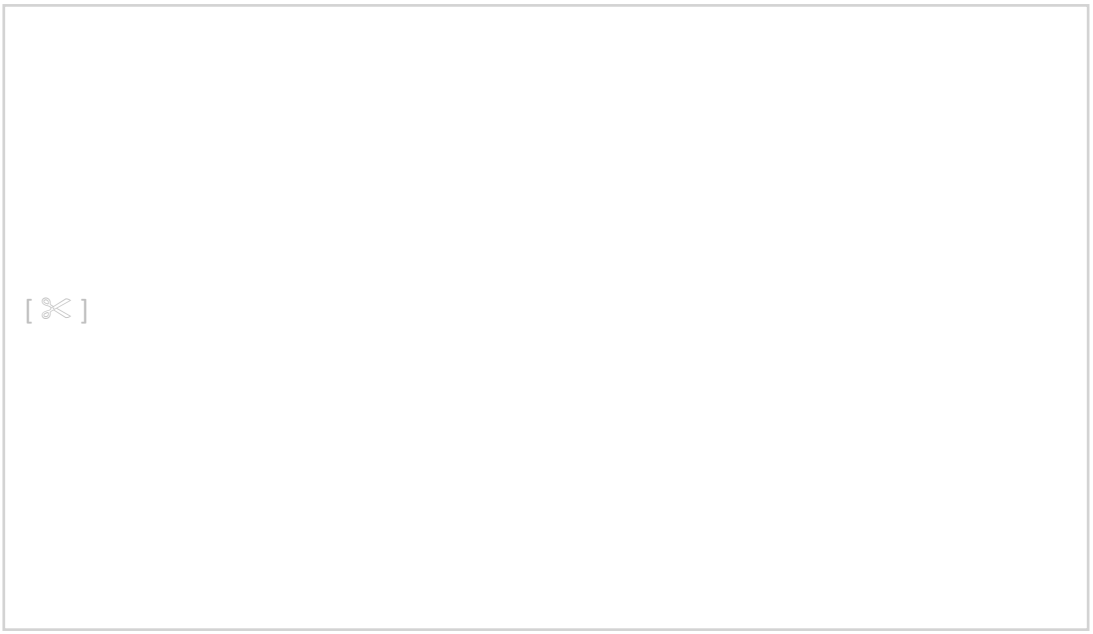
[redacted]

[✂]

[✂]

G.5 Footnote 74

[redacted]



G.6 Footnote 84

[✂]

[✂]

G.7 EA confirmation relating to physico-chemical sites

[✂]

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