WSX09 - Annexes - Base cost adjustment claims

Business plan 2025-2030

Wessex Water
YTL GROUP

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WSX09 - Annexes - Base cost adjustment claims

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This supporting document is part of Wessex Water's business plan for 2025-2030.

Please see 'WSX00 – Navigation document' for where this document sits within our business plan submission.

More information can be found at wessexwater.co.uk.

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Business plan submission

Wessex Water
YTL GROUP

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CAC1 – Increases to efficient costs over time

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Introduction and summary

Introduction to the claim

This claim concerns increases over time in the efficient levels of base costs that Wessex Water faces which are not captured by the allowances derived from Ofwat's base cost econometric models (once these allowances are adjusted for RPEs and ongoing productivity growth and growth-related enhancements).

This document is to be read alongside the completed cost adjustment data tables for this claim. This document provides supporting information in line with Ofwat's assessment criteria for cost adjustment claims as set out in Appendix 9 of the PR24 final methodology.

The efficient levels of base costs faced by Wessex Water have been affected by upwards pressures from a combination of factors which are overlooked or under-estimated in Ofwat's established approach to setting allowances for base costs. These factors are primarily:

- increases in base-plus costs over time to support improvements in performance captured by PCs and subject to financial incentives via ODIs;
- increases in base-plus costs over time as a result of the ongoing operational and capital maintenance associated with past enhancement expenditure; and
- increases in base-plus costs over time from broader sets of increasing regulatory requirements.

There is overlap between these three factors and we have not sought to disentangle them. Our claim relates to the joint effect of these interrelated factors to ensure they are not double counted.

In effect, these relate to the increases over time in base costs to achieve and *sustain* improvements over time in outcomes for customers and the environment.

Our claim concerns increases over time in the efficient levels of costs faced by Wessex Water. Nonetheless, to provide evidence to substantiate the claim, we draw heavily on cross-industry cost benchmarks. This aspect of our approach helps to avoid the risk that any cost increases in costs experienced by, or anticipated by, Wessex Water might be – or might be perceived as – due to inefficiency on the part of Wessex Water. It also recognises that, to some degree at least, the level of base-plus expenditure incurred by any one company may be subject to peaks and troughs over time.

Scope of costs covered by the claim

This claim is focused on modelled base costs. However, we recognise that within what Ofwat calls 'base costs', there is some expenditure that is reported as enhancement expenditure by water companies (including enhancement expenditure which is not simply growth-related, such as expenditure to reduce sewer flooding risk).

In addition, we consider that the expenditure reported to Ofwat as base expenditure is likely to include significant elements of expenditure which is conceptually enhancement expenditure, but which is reported as base expenditure. The issue of hidden or embedded enhancement expenditure is discussed in more detail in the report we commissioned from Reckon in 2022, referred to later in this document.

In this context, this claim concerns "base-plus" expenditure (rather than pure base expenditure). That said, the claim is not concerned with changes over time in base-plus expenditure that are attributable to growth-related enhancements (e.g. to due variations over time and across companies in the rates of housebuilding and in population growth) or other enhancements included within Ofwat's modelled base costs. As at PR19, if Ofwat retains its approach of including growth-related and drainage-/flooding-related enhancement expenditure in its base cost models at PR24, Ofwat will need to make off-model adjustments to capture differences over time and between companies in the drivers of such expenditure. The principle of making such off-model adjustments is now an established part of Ofwat's approach to cost assessment and we have not sought to cover it within our cost adjustment claims. We are keen to have opportunity to engage with Ofwat on the industry-wide methodology for these adjustments, to ensure improvements are made compared to the initial iteration at PR19.

The scope of costs covered in this claim excludes the element of base expenditure which Ofwat treated as unmodelled costs in its April 2023 base cost model consultation and excluded from the econometric benchmarking models (e.g. pension deficit recovery costs, business rates, abstraction and discharge charges and third-party costs). When we present figures for changes over time in base expenditure or base-plus expenditure in this document, we have excluded unmodelled costs from the analysis and comparisons over time.

On this basis, the scope of costs covered by this claim might more precisely be referred to as “modelled base-plus expenditure”, but to limit drafting complexity we do not use this terminology consistently throughout the document.

In the development of the analysis underpinning the claim, we considered all four wholesale price controls. However, our current analysis indicates that Ofwat's materiality threshold is not met for either water resources or bioresources. So the claim is focused on the water network plus and wastewater network plus price controls.

This claim does not cover residential retail costs, where we observe a significant downward trend in costs over time (relative to CPIH), rather than the increases in base costs over time that we observe for water network plus and wastewater network plus. In our response to Ofwat's PR24 base cost model consultation, we have recommended a time trend is used in the econometric benchmarking of historical residential retail cost models.

Summary of the net value of the claim

In the table below we present our current estimate of the net value of the claim covered by this document. These figures are based on outturn cost data to 2021-22 and the assumptions set out in this document.

Table 1 - Summary of net value of claim

	Water network plus	Wastewater network plus
Net value of the claim: aggregate for 2025-30	**£44m**	**£184m**

The figure is larger for the wastewater network plus price control because of the following:

- Modelled base costs are higher for Wessex Water's wastewater network plus price control compared to its water network plus price control.
- The historical scale of unaccounted for cost pressures that we identified are greater for Wessex Water's wastewater network plus price control compared to its water network plus price control.

We provide more detailed breakdown of the net claim values, as well as figures for implicit allowances and the gross value of the claim in the data tables corresponding to this claim.

We are not proposing that Ofwat make a symmetrical cost adjustment across the industry as part of this claim (i.e. positive adjustments for some companies and negative adjustments for others). Ofwat has recognised in its PR24 final methodology that where cost adjustment claims concern factors causing changes over time, which are not captured in the base cost models, there would not necessarily be a role for symmetrical cost adjustments.

Interactions with other cost adjustment claims

As highlighted above, the claim covered in this document is for a *continuation* to the end of AMP8 of the estimated historical rate of increase in base costs that is attributable to ongoing improvements to outcomes and ongoing enhancements to regulatory requirements - insofar as these cost increases are not already incorporated within Ofwat's modelled cost benchmarks for the 2025-30 period.

Given the broad-ranging nature of the claim covered in this document, it is useful to distinguish between this claim and some other claims that Wessex Water is making for PR24.

We make a separate claim for the additional costs that we expect to be needed during AMP8 to allow for an efficient level of mains renewal. For this separate claim we are seeking an adjustment for increases in efficient costs in AMP8 that apply *over and above* the observed increases over time in modelled base-plus expenditure. In contrast this document concerns a claim for the continuation of historical observed trends in modelled base-plus expenditure.

We make a separate claim relating to energy price increases. To avoid double counting between the claim covered in this document and our separate energy costs claim, we have focused the claim in this document on increases in modelled base-plus expenditure between 2011/12 and 2021/22 and it is intended to capture upward cost pressures due to factors other than the abnormal movements in energy prices experienced recently. We make a separate claim for the operating expenditure from continuation into AMP8 of catchment management and nature-based solutions from AMP7 and previous AMPs. The intention of this claim is to account for additional costs that Wessex Water incurs relative to other companies, due to a greater role for opex-based solutions for which the costs have not been funded via historical enhancement allowances. This separate claim is not intended to capture general industry-wide increases in operating expenditure arising from historical enhancements (this forms part of the claim covered in this document).

We make a separate claim relating to growth at water treatment works. Expenditure on growth at water treatment works is excluded from the scope of modelled costs used for Ofwat's April 2023 econometric models of base costs. It does not overlap with the claim presented in this document.

We make a separate claim relating to the impact of IED on bioresources costs. There is no overlap with the claim covered in this document which does not include bioresources activities within scope.

Comments on completion of data tables

In the data tables corresponding to this document, we have completed information on the net value and gross value of the claim and implicit allowances for the period from 2025/26 to 2029/30 (i.e. AMP8), which is the focus of the claim. We explain how we have done this in the section headed "Methodology and key results". We have not completed figures for the remaining years in AMP7 (e.g. 2023/24): given the nature of the claim, this would add what seems to be unnecessary complexity to the calculations and to this methodology document.

We have not completed the data table lines CW18.18 and CWW18.18, which are described in the Ofwat guidance as "Historic base expenditure related to the proposed cost adjustment claim". This claim concerns increases over time in costs and hence costs which were not incurred historically so this line did not seem to be applicable. While we could have put a value of zero for the historical figures we were concerned that this could be misinterpreted when compared against the proposed adjustment for AMP8 and so we have left it blank.

Structure of this document

This document is structured as follows.

The next section describes the methodology we have adopted to assess the need for a cost adjustment and for quantification of the adjustment. It presents evidence to support the claim and summarises key results.

The subsequent sections respond to specific questions from Ofwat's cost assessment criteria, referring back to the earlier material in places. These sections are organised as follows:

- Need for adjustment.
- Cost efficiency.
- Need for investment.
- Best option for customers.
- Customer protection.

The appendix provides further information and evidence relating to the methodology we have used.

Methodology and key results

In this section we describe and apply our methodology to (a) assess the need for the cost adjustment for Wessex Water and (b) quantify the adjustment. We also provide supporting evidence and summarise some key results.

In subsequent sections we address each of Ofwat's criteria for cost adjustment claims, referring back to this section or other evidence as appropriate. This section is most directly relevant to Ofwat's criteria relating to need for adjustment but also covers issues falling under some of the other criteria.

Our high-level methodology has four main steps, with further steps and elements of analysis within some of these. The four main steps are as follows:

- **Step 1: Estimation of historical unaccounted for cost pressures**. In this step, we compare (a) the annual average change in modelled base-plus expenditure over the 2011/12 to 2021/22 period which is implied by Ofwat's recent suite of base-plus econometric models, adjusted for assumptions on ongoing productivity growth and RPEs; and (b) the annual average change in observed modelled base-plus expenditure across the industry, over the same period, adjusted to remove the estimated impact of changes over time in growth-related expenditure. The difference between the two represents observed historical growth in modelled base-plus expenditure across the industry which is not accounted for by Ofwat's approach to base cost assessment (in the absence of this cost adjustment claim).
- **Step 2: Assessment of drivers of unaccounted for cost pressures**. In this step, we summarise our analysis and evidence on the factors that may help to explain the unaccounted for cost pressures identified in step 1.
- **Step 3**: **Judgement on the implications for efficient costs in AMP8**. In this step, we draw on the assessment under step 2, and some further considerations, to form a judgement on the extent to which the historical scale of unaccounted for cost pressures estimated for the period 2011/12 to 2021/22 should be extrapolated into AMP8, for the purposes of base cost assessment at PR24.
- **Step 4: Calculation of adjustment to apply to modelled costs**. In this step, we use the estimates of the historical average annual rate of growth in modelled base-plus expenditure which is not accounted for by Ofwat's models/approach (from step 1) and the judgement on the extent to which this should be extrapolated into AMP8 (step 3) and combine these with estimates of modelled costs for Wessex Water

over the 2025-30 period (derived from Ofwat's April 2023 econometric models) to calculate a corresponding adjustment to apply to modelled costs for Wessex Water in AMP8.

We take in turn each of the steps in the subsections below. We provide further evidence and analysis in the appendix relating to the assessment under step 2.

All monetary figures are in 2022-23 prices unless otherwise identified.

The approach and assumptions used in this section reflects our understanding of Ofwat's likely methodologies and approaches for wholesale cost assessment at PR24, based on current information, as well as its April 2023 base cost models. This is an appropriate approach for submissions at this stage of the PR24 process, but there may be a case for updating the calculations in light of any material developments in Ofwat's approach, models and assumptions for PR24, as well as for new data that becomes available during the remainder of the PR24 process.

We have not changed the methodology, assumptions or figures used for this cost adjustment claim relative to what we submitted to Ofwat in June 2023 as part of the early cost adjustment claims.

Since the submission of the early cost adjustment claim we carried out sensitivity analysis for the impacts of updates relating to the following factors:

- updating the CPIH financial year average assumption from the provisional figure used for the early submission in June 2023 to the figure used for our business plan submission;
- revising the calculation of the modelled costs for Wessex Water (see step 4) so that these draw on our business plan forecast explanatory variables for AMP8 rather than being calculated based on an extrapolation of Wessex Water modelled costs from previous years; and
- revising the assumption used to split modelled costs for wholesale water between (i) water resources and water network plus (see step 4), so that this drew on figures from our business plan split of base expenditure for AMP between these two price controls.

We found that, across water network plus and wastewater network plus, the cumulative impact of these revisions on the net value of the claim was less than 1%. Given (a) the small impact from this sensitivity analysis and (b) the potential need for further updates to the figures in the future (e.g. to reflect Ofwat's draft determination model suite rather than the full set of April 2023 consultation models, and its PR24 catch-up adjustments), we did not consider that it was proportionate to update the figures and assumptions used for this submission relative to what we used for the early cost adjustment claim in June 2023.

We also considered whether to update the analysis under our step 1 for 2022/23 data. We decided against this, due to two main factors. First, at a practical level, it is far from straightforward to compile, from individual companies' APR data, figures on expenditure and cost drivers for 2022-23 which are on a fully consistent basis with the data we had used for 2011/12 to 2021/22 (which came from the industry-wide cost assessment datasets published by Ofwat in April 2023). Second, and as highlighted earlier, we were concerned about risks of double counting across this cost adjustment claim and our separate claim on energy costs if the expenditure increases observed in 2022/23 were incorporated into the analysis for this claim. In principle, the potential for double counting might be tackled by using an RPE estimate for 2022/23 under step 1 that reflects *industry-wide* impacts from the above-CPIH increases to wholesale energy prices. But doing so is challenging and subject to considerable uncertainty (e.g. due to different companies' energy hedging and generation positions affecting the extent to which 2022/23 expenditure data reflected increases in wholesale energy prices). Overall, and given the need for a proportionate approach across different aspects of this and other cost adjustment claims, we considered that it was more appropriate to retain the original focus on expenditure data up to 2021/22 than to try to extend the analysis in step 1 to include 2022/23 data. We did however carry out some analysis using indicative data for companies' base expenditure in 2022/23, which showed significant real-term cost increases on average across companies from 2021/22 to 2022/23.

Step 1: The historical impact of unaccounted for cost pressures

In this step, we present our analysis of the scale of increases in base expenditure experienced on average across water companies that are left unexplained by Ofwat's base cost econometric models and its broader approach to cost assessment. In this step we focus on the quantification of those increases; in step 2 we consider what may have driven them.

Overview of our approach to step 1

For the analysis in step 1 we looked at changes over time between 2011/12 and 2021/22. There are three main reasons for this choice of time period.

- It is the same time period used for Ofwat's latest base cost econometric models (from its April 2023 consultation). Ofwat refers to the data running back to 2011/12 as the "full historical data series" in the context of its base cost modelling. Related to this, it is the time period covered by the cost assessment datasets that Ofwat published in April 2023 which have been the main data source under step 1.
- This choice of start point and end point helps to limit the influence on the calculations of any cyclical pattens of specific companies' expenditure over the price control cycle by considering two complete cycles. Our calculations are for the change in expenditure between the second year of AMP5 and the second year of AMP7.
- For the reasons set out in the subsection above, we did not consider it appropriate to try to extend the analysis to cover data to 2022-23.

For our analysis we looked at the average across companies in the growth rates in modelled base costs and in base expenditure and over time. Our approach has the following features:

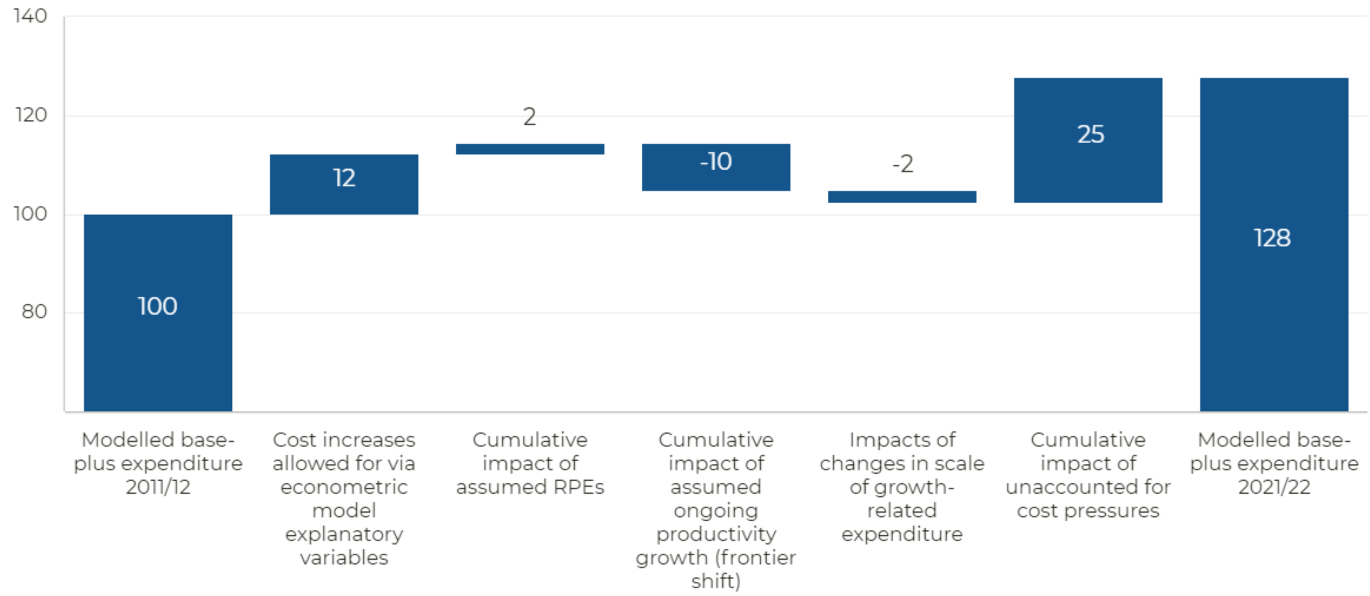
- In calculating averages across companies, we give each company an equal weight (so that the growth rates are not dominated by what is observed for the larger companies).
- In some cases we have grouped companies together over the period 2011/12 to 2021/22 to allow for like-for-like comparisons, in the context of the mergers that have taken place. For instance, for wastewater we follow the approach that Ofwat uses for its econometric models of base costs and use a notional combined company of SVH (comprising what is now Severn Trent England and Hafren Dyfrdwy).
- We calculate annual growth rates on a compound annual growth rate (CAGR) basis between 2011/12 and 2021/22.
- All growth rates in costs are for changes in costs relative to CPIH.
- The main data source we have used is the dataset on expenditure and cost driver variables published by Ofwat in April 2023 alongside its consultation models for base costs.

Before we present a build-up of our key calculations, we provide a more intuitive representation of our methodology by reference to the waterfall chart below, taking the case of wastewater network plus as an example. Our approach – and this chart – seeks to decomposes the overall industry-average growth in modelled base-plus expenditure between 2011/12 and 2021/22 into a number of components (with modelled base-plus expenditure set to 100 in 2011/12).[1]

[1] We have used the term modelled base-plus expenditure here to refer to costs falling within the scope of "modelled base costs" (i.e. excluding what Ofwat refers to as "unmodelled costs" and including the enhancement costs that feature in Ofwat's scope of modelled base costs). In this diagram we are concerned with changes over time in outturn costs and the term modelled base-plus expenditure in this context is not intended to refer to outputs from specific econometric models.

Please note that the figures in the waterfall diagram below are approximate and do not match exactly the formal calculations of annual growth rates that we set out below.[2]

Figure 1- Approximate decomposition of growth in wastewater network plus costs over time



We summarise the individual components of changes over time that are shown in the waterfall chart – and describe our approach to quantification of them – as follows:

- **Cost increases allowed for via econometric model explanatory variables**. Ofwat's econometric models provide for changes in modelled costs over time insofar as there are changes over time in the explanatory variables used in these models. For example, the coefficients on explanatory variables in Ofwat's models means that increases over time in the number of connected properties, the length or water mains, the length of sewers and sewage load act (all else equal) to increase modelled base costs. We have calculated the annual growth rate in modelled costs (averaged across companies) by comparing modelled costs in 2011/12 with modelled costs in 2021/22 using a consistent set of models over time.
- **Cumulative impacts of assumed RPEs**. In line with broader UK regulatory practice, Ofwat's price control methodology makes some allowance for the impact on water companies' costs over time from changes over time in wages rates and other input prices (to the extent that these differ from general inflation captured by CPIH). In practice, at PR19 both Ofwat and the CMA only made allowance for the impact of wage increases (relative to CPIH) on an assumed share of labour costs within totex. For our analysis in step 1, we have taken the methodology determined by Ofwat and the CMA at PR19 for the RPE true-up mechanism and used historical ASHE wage rate data from the ONS back to 2011/12 to estimate the cumulative impact of RPEs on water company costs between 2011/12 and 2021/22.
- **Cumulative impact of assumed ongoing productivity growth (frontier shift)**. In line with broader UK regulatory practice, Ofwat's price control methodology involves assumptions on the impact on the costs of an efficient water company making ongoing productivity improvements over time. For our analysis in step

[2] This is due to (a) rounding; and (b) the waterfall chart using a simpler way to calculate the cumulative impact of individual factors on base-plus expenditure in 2021/22 than that used more formally below.

1, we used an assumption of 1% which is taken from the CMA's determination in the PR19 water price control references. We calculated the cumulative impact on base expenditure, between 2011/12 and 2021/22, of this assumed rate or productivity improvement. This figure is slightly lower than assumed by Ofwat at PR19 (1.1%).

- **Impacts of changes in the scale of growth-related expenditure**. Our analysis considers changes over time in base-plus expenditure, which is aligned with Ofwat's scope of modelled base costs from its April 2023 econometric models. This includes not only pure base expenditure (as defined in RAG 4.11) but also some elements of what Ofwat has previously called "growth-related expenditure" which includes network reinforcement expenditure and some enhancements expenditure (e.g. enhancement expenditure to reduce sewer flooding risk).[3] It is possible that part of the observed increase over time in base-plus expenditure is due to changes between 2011/12 and 2021/22 in such growth-related expenditure (e.g. due to changes in rates of housebuilding and new connections or changes in enhancement spend in those categories falling within scope of base-plus expenditure). It is also possible that the increase over time in base-plus expenditure have been suppressed, to some degree, by such changes. For our analysis in step 1, we compared the average growth across companies in outturn base-plus expenditure between 2011/12 and 2021/22 against the average growth across companies in outturn base expenditure, as a means to strip out the impact of changes in the scale of growth-related expenditure.
- **Cumulative impact of unaccounted for cost pressures**. We use the term "unaccounted for cost pressures" to refer to factors that have put upward pressure on costs and which are not accounted for by the factors listed above and by Ofwat's current methodology for base cost assessment (at least in the absence of allowances for a cost adjustment claim such as this). We calculate the cumulative impact of unaccounted for cost pressures as a residual, which is effectively the cumulative increase (decrease) in base-plus expenditure which is needed to close the gap between (a) the cumulative impacts of the other factors above and (b) the average across companies in the observed growth, between 2011-12 and 2021/22 in base-plus expenditure.

In the chart above, we show cumulative impacts over the period 2011/12 to 2021/22 as this makes the chart clearer for purposes of exposition. For the main analysis under step 1 we have focused on average annual growth rates (on CAGR basis) rather than cumulative impacts. In the next section we present our more formal calculations of the average annual impact of unaccounted for cost pressures.

Estimates of average annual impact of unaccounted for cost pressures

This claim concerns the water network plus and wastewater network plus price controls.

A key part of our analysis is the increases (or decreases) in costs that are allowed for under Ofwat's econometric models of base costs. In line with its approach at PR19, Ofwat's April 2023 model suite does not allow for separate analysis of water resources and water network plus (models are either at the level of wholesale water, treated water distribution or water resources plus). So, we focus in step 1 analysis on wholesale water, for which water network plus is the main component, assuming that the cost trends and impacts of contributing factors are the same across water resources and water network plus. When we calculate cost adjustments in £m under step 3, we apply growth rates (in %) to water network costs only to focus the claim on water network plus. For wastewater, Ofwat's consultation models do allow us to take wastewater network plus separately from bioresources within step 1.

[3] We expect Ofwat to build on the approach from its PR19 final determinations and the CMA determinations to apply off-model adjustments to all companies for differences over time, and between companies, in growth-related expenditure in AMP8 and we have omitted this factor from this claim.

On this basis we present our calculations of the average annual impact of unaccounted for cost pressures below for each of wholesale water and wastewater network plus.

Table 2 - Estimation of average annua impacts of unaccounted for cost pressures: 2011/12 to 2021/22

	Wholesale water	Wastewater network plus
A. Average annual growth in modelled base-plus expenditure observed across companies	1.18%	2.38%
B. Average annual cost increases allowed for via econometric model explanatory variables	0.88%	1.15%
C. Average annual impacts of assumed RPEs	0.21%	0.21%
D. Assumed ongoing annual productivity growth	-1.00%	-1.00%
E. Average annual net impact of econometric model explanatory variables, RPEs and productivity on modelled base-plus expenditure Where E = [(1+B) * (1+C) * (1+D)] - 1	0.08%	0.34%
F. Estimated impact of changes over time in expenditure on growth-related enhancements	-0.01%	-0.24%
G. Estimated annual average impact of unaccounted for cost pressures on modelled base-plus expenditure Where G = [(1+A) / ((1+E)*(1+F))] -1	**1.11%**	**2.28%**

We use the figures calculated in row G for subsequent steps in our methodology.

Some points to keep in mind about the analysis above are as follows:

- The calculation of annual growth rates in base-plus expenditure in row (A), and the adjustment for the estimated impact of changes over time in expenditure on growth-related enhancements (F), are likely to be sensitive to the time period over which the growth rate is calculated.
- The analysis is based on triangulation of modelled costs across the set of models from Ofwat's April 2023 consultation, giving equal weight to different models (as advised by Ofwat). The figures in row (B) may differ if refinements are made to model specifications, as additional years of data are included in the econometric analysis, and if the selection and weighting of models varies from what we have assumed.
- As discussed further under step 2, the calculations are subject to the assumptions we have made on RPE and ongoing productivity growth.

In the remainder of the PR24 process, there may be opportunity to update the analysis from the table above for cost data up to 2022/23. If so, to reduce the impact on the figures of the profile of the uneven spending within each price control period, it may be appropriate to take the average of (a) CAGR in base-plus expenditure between 2011/12 and 2021/22 and (b) CAGR in base-plus expenditure between 2012/13 and 2022/23. This would enable updated data to be used while still calculating CAGR from corresponding points in each price control period. However, as explained earlier in this document, we have not extended the analysis beyond data to 2021/22. If an update to 2022/23 was to be made, we consider that the RPE assumptions used may also need to be revised to capture the impacts of rising energy costs.

Further evidence on unaccounted for cost increases: (1) Ofwat's findings

The evidence we have presented above of an upward trend in base expenditure over time is something that Ofwat has recognised and which has been observed over a much longer time period than that covered by Ofwat's base-plus econometric models and our quantitative analysis above. The chart below is a reproduction of a chart from Ofwat slides to one of the PR24 cost assessment working groups.[4]

Of particular note, Ofwat stated that "base expenditure has steadily increased over the period 2000-01 to 2019-20".

Figure 2 - Ofwat analysis of changes over time in base expenditure

Further evidence on unaccounted for cost increases: (2) time trend econometric models

In addition to the primary analysis on step 1 set out above, we carried out further analysis concerning evidence of changes over time in base-plus expenditure which are not captured by Ofwat's April 2023 econometric models. For this we took each of Ofwat's econometric models, across wholesale water and wastewater network plus, and estimated a variant of the Ofwat model which included a time trend. The main finding from this analysis was follows:

[4] Ofwat (2021) *PR24 Cost Assessment Working Group Forward looking capital maintenance*, page 11.

- For the TWD models, the time trend in each model was significant at at least the 5% level of significance with a coefficient implying an increase in modelled base-plus expenditure for treated water distribution of around 1% per year.
- For the WRP models, the time trend was not significant at the 10% level and the coefficients implied an increase in modelled base-plus expenditure of over 1% per year.
- For the WW models, the time trend coefficient was significant at either the 5% or 10% levels, and implied increases in modelled base-plus expenditure for wholesale water of around 1% per year.
- For the sewage collection models the coefficients on the time trend were not significant at the 10% level (with very high p-values) and did not imply any material trend in these costs.
- For the sewage treatment models the time trend was significant at the 10% level an implied an increase in modelled base-plus expenditure for sewage treatment of around 1.2 % per year.
- For the wastewater network plus models, the coefficients on the time trend were not significant at 10% level but implied an annual increase in these costs of around 0.3% to 0.4%.

We consider that this provides further evidence on the existence of significant unaccounted for cost pressures since 2011/12 across water and wastewater activities.

We have not used these model variants directly as part of the quantification of this cost adjustment claim. There is a separate case for at least some of the base cost models including time trends, as we set out in our response to Ofwat's April 2023 consultation on the PR24 base cost models. But the purpose of this cost adjustment claim is to provide for an adjustment against Ofwat's April 2023 models – on the working assumption that these would be used as the basis for base cost allowances at PR24 – rather than to propose alternative model specifications.

Step 2: Assessment of drivers of unaccounted for cost pressures

Under step 1 we presented evidence that, over the period 2011/12 to 2021/22 there have been significant upward pressures on base costs within the industry which are not captured by the outputs from Ofwat's base-plus econometric models when adjusted for the impacts of RPEs, ongoing productivity growth and growth-related enhancements.

In this step, we examine possible explanations for these unaccounted for upward pressures on base costs. We consider two main types of explanation that could apply in principle (potentially in combination):

- First, it is possible that there are some "unaccounted for dynamic factors" which put upward pressure on base costs within the industry which are not captured by the explanatory variables in Ofwat's base-plus econometric models and which are not related to RPEs and ongoing productivity growth.
- Second, it is possible that the assumptions about productivity and RPEs used in the calculations in step 1 above are not reflective of what has been experienced in practice in the historical period.

We summarise key points from our assessment related to the first potential explanation above in the subsection below. We discuss the second potential explanation in the subsequent subsection.

Summary of assessment of unaccounted for dynamic factors

We summarise our assessment of potential unaccounted for dynamic factors in the table below. We provide further evidence and analysis relating to some of these factors in the appendix.

Table 3 - Summary of possible unaccounted for dynamic factors

Possible factor	Key points from our assessment
Increases in the number of customers connected to water and wastewater systems and the demands they place on these systems	Increases in the number of customers, and the demands they place on water and wastewater systems, will be an important factor in explaining the overall increases over time in modelled base-plus expenditure (i.e. row A in the table under step 1 above). However, Ofwat's econometric models include explanatory variables that are intended to take account of these factors (e.g. number of properties, length of mains and sewers, sewage load) and we have already adjusted for growth in these variables in our calculations in step 1. And we have stripped out the effects of changes over time in the level of growth-related expenditure. While there may be some residual impact that is not captured by Ofwat's models this does not seem likely to be a key source of unaccounted for cost pressures.
The costs of observed performance improvements	This factor concerns the additional costs arising over time from continuing improvements over time in key areas of customer service and environmental performance. We interpret performance improvements broadly, to include efforts to maintain service levels in the context of worsening external conditions (e.g. climate change impacts on flooding risk). Ofwat's base cost models do not include explanatory variables relating to changes over time in customer service and environmental performance (with the sole exception of ammonia removal). Some of the financial incentives that Ofwat has applied to PCs in the past (e.g. based on estimates of WTP and marginal benefits) are designed to encourage companies to incur additional costs to improve performance to customers (insofar as the benefits from these improvements outweigh the costs). There is clear evidence that water companies have improved performance significantly over time in the areas covered by PCs. For instance, at PR19 Ofwat highlighted that the sector had achieved a performance improvement of 40% in water supply interruptions between 2012-13 and 2016-17, a 26% improvement in internal sewer flooding incidents between 2015-16 and 2018-19, and a 30% improvement in pollution incidents between 2013 and 2018. There have been further improvements in performance since PR19 review. A key area is leakage, where we have made substantial improvements as a direct result of initiatives for which the cost is reported as base expenditure.
The ongoing costs arising from past enhancements	At each past price review, Ofwat has chosen to approve customer funding under the price controls for large amounts of enhancement expenditure. In all or most cases, enhancement improvements are maintained in successive AMPs. So the enhancement schemes / outputs / outcomes that

Possible factor	Key points from our assessment
	Ofwat has funded involve ongoing operating costs and, in time, capital maintenance expenditure, both of which fall under base expenditure. As a matter of logic, a process of a further tranche of enhancement schemes, additional outputs and improved outcomes being approved in each successive AMP will tend to put upward pressure on base expenditure.
Increasing regulatory requirements:	This factor concerns increases to base costs arising from increases over time in the extent of regulatory requirements that water companies operate under (beyond those captured above relating past enhancements). For example, there may be base expenditure increases as a consequence of changes in requirements from the EA, DWI, ICO, and HSE.
Cost allocation between wholesale price controls	In principle, an observed increase in reported costs over time in one part of the value chain might reflect changes in cost allocation, rather the underlying cost drivers. We considered whether it was possible that the level of unaccounted for costs might be due to some reallocation of costs over time between different price controls. In relation to our claim for water network plus, our analysis in step 1 above is based on wholesale water expenditure (rather than expenditure for water network plus only) given the way that Ofwat's econometric models of base costs are specified. So any reallocation of costs between water network plus and water resources that has happened would not affect the figures we calculate for water network plus. For wastewater network plus, our analysis in step 1 could be affected in principle by a reallocation of costs from bioresources to wastewater network plus. However, this seems highly unlikely to explain the unaccounted for cost increases observed for wastewater network plus. This is for two mains reasons. First, although there seems to be an unaccounted for *reduction* in base costs for bioresources (using the same methodology as applied to wastewater network plus) this is smaller as a percentage than the increase we saw for wastewater and, moreover, implies a far smaller amount in £m due to bioresources base costs being much smaller than wastewater network plus base costs. Second, the reduction observed for bioresources seems likely to be heavily influenced by increases over time in renewable energy generation as part of bioresources activities (which will act to reduce opex and provide income treated as negative expenditure).
Peaks and troughs in investment	It is possible that, when comparing a company's base expenditure at two points in time, the calculated growth rate in expenditure is affected by peaks and troughs in investment requirements. Our approach to the analysis in step 1 is designed to mitigate the risk that the calculation of unaccounted for cost increases are impacted by peaks and troughs in investment cycles. First, by taking the average across all

Possible factor	Key points from our assessment
	companies in the industry, we would expect considerably less influence of any peaks and troughs in investment cycles. Second, by calculating the CAGR between year 2 of AMP5 and year 2 of AMP7 we mitigate impacts from investment variations between different points in the price control cycle. While there could be some residual impact, we do not see peaks and troughs as a credible explanation for the bulk of unaccounted for cost increased we have identified.
Impacts of Covid-19	While Covid-19 will have had some effects on water company costs, it does not seem a credible explanation for the unaccounted for cost increases identified under step 1. As can be seen in figure 2, which is Ofwat's own analysis of base expenditure over time, it is not the case that base expenditure was constant relative to CPIH and then shot up around the time of the Covid-19 pandemic. Instead, as Ofwat identified, "base expenditure has steadily increased over the period 2000-01 to 2019-20".

We provide further information, evidence and analysis that supports our claim in the appendix. This includes:

- Evidence on improvements in performance over time.
- Submissions on performance improvements from base expenditure versus enhancement expenditure.
- Evidence on cost increases from leakage improvements.
- Evidence on increased regulatory requirements
- Simulation analysis concerning the under-funding of capital maintenance from past enhancements.
- Wessex Water historical RCV growth.
- Wessex Water capital maintenance over time.

Potential differences between productivity and RPE assumptions and experience

As highlighted above, it is possible that the assumptions about productivity and RPEs used for step 1 above are not reflective of what has been experienced in practice in the historical period, and this could explain part of unaccounted for cost pressures calculated under step 1. We discuss these issues below, starting with the productivity assumption.

Under the calculation approach from step 1, the higher is the assumption on the ongoing productivity growth for a notional efficient company, the higher is the scale of unaccounted for cost pressures.

It is possible that the industry-wide productivity growth rate has been less than the figure assumed by the CMA at PR19 (1% per year) which we used as an assumption for the analysis in step 1. If so, this could explain some of the unaccounted for cost pressures that we have estimated.

Estimation of the rate of productivity growth actually achieved by water companies in the period since 2011/12 is a challenging exercise especially given major changes over time to water companies' environmental performance and customer service.

In the past Ofwat has referred to a Water UK report suggesting 0% productivity growth has been achieved by water companies between 2011 to 2017. However, the estimates of productivity growth from that report do not seem to provide a reliable guide to the productivity growth actually achieved by water companies. For example, there have been major improvements in customer service and environmental performance in the water industry, but it is very challenging to take these properly into account in productivity estimation, and this was not resolved in the report for Water UK that Ofwat referred to. Ofwat has recognised that the figure of 0% does not fully account for changes in quality.[5] This is an understatement: the methodology applied in that report was very limited in terms of its recognition of quality improvements, with a tendency to under-estimate productivity growth by counting growth in measures of inputs without recognising the benefits from those inputs in terms of quality and outcomes.

For the purposes of our business plan for AMP8, we have assumed frontier shift (ongoing productivity growth) of 0.5% per year for wholesale price controls. This assumption has drawn on a recent report by Economic Insight,[6] which is based primarily on updated evidence on other sectors of the economy rather than on water company data. If Ofwat were to adopt the view that historical water industry productivity growth was around 0.5% per year, this would reduce the scale of unaccounted for cost pressures identified above but these would still be significant.

It is also possible that the assumptions we have used for historical RPEs are not entirely reflective of the RPEs faced by efficient water companies.

Our assumptions are based on the RPE true-up adjustment methods used by Ofwat and CMA at PR19, applied to historical data. This approach led to a historical RPE which averages 0.21% per year. Our impression is that this might be an underestimate for the historical period.

For instance, one phenomenon that we have experienced in the business is that of asset lives getting shorter (in terms of what is available for companies to procure), without a corresponding reduction in upfront cost in many cases. This can be seen as a form of real price effect, such that the whole-life costs of assets with similar functionality tends to increase faster than CPI.

Energy price increases may also be a factor for actual RPEs being greater than implied by the PR19 methodology. However, much of the effect of recent increases in energy price will fall outside of the time period covered by the analysis in step 1 above.

Step 3: Judgement on the implications for efficient costs in AMP8

Our view, at this stage in the PR24 process, is that 100% of the unaccounted for base cost increases observed historically across the industry should be extrapolated for the purposes of setting allowances *for Wessex Water's base expenditure in AMP8*. We did not identify a good basis to scale down this percentage. This is for the following reasons.

First, both theoretically and in light of the evidence under step 2 above, we consider that most, or a large part, of the unaccounted for upward pressures on base costs observed historically is likely to be due to (a) increases in base-plus costs over time to support improvements in performance captured by PCs and subject to financial incentives via ODIs; (b) increases in base-plus costs over time as a result of the ongoing operational and capital maintenance associated with past enhancement expenditure; and (c) increases in base-plus costs over time from broader sets of increasing regulatory requirements. We expect these factors to be just as relevant into AMP8 as they have been over AMP5, AMP6 and AMP7. There is no basis for taking the view that their effects will suddenly cease in AMP8.

[5] Ofwat (2022) *Creating tomorrow, together: Our final methodology for PR24 Appendix 9 – Setting expenditure allowances*, page 35.
[6] WSX08 – Annex A13 – Economic Insight (April 2023) – Productivity and Frontier Shift at PR24.

Second, we recognise that the analysis unaccounted for base cost increases uses industry wide data and is not focused on the data for Wessex Water over this period. However, it is much more appropriate on price control incentive grounds to use industry-wide data for an uplift to modelled costs in AMP8 rather than to use data specific to Wessex Water. If a cost adjustment for Wessex Water for AMP8 was based on Wessex Water's own historical increase in costs, this could act against Ofwat's use of benchmarking base costs.

Third, it is also quite possible that some element of the estimated unaccounted for cost pressures is due to (a) RPE growth being somewhat higher than implied by the methodologies of Ofwat and the CMA and/or (b) productivity growth being somewhat lower than implied by the assumptions of Ofwat and /the CMA. Nonetheless, the cost adjustment claims presented in this document are claims for adjustments to be applied in the context of Ofwat's own models and methodology for base cost assessment. While Ofwat's position on productivity and RPEs for PR24 remains to be determined, our central expectation at this stage is that Ofwat will adopt a similar methodology for RPEs, and to make similar assumptions for productivity, at PR24 as at PR19. Therefore, for the purposes of this claim, we consider it appropriate to use the methodology and assumptions on productivity and RPEs that are most consistent with Ofwat's models and methodology.

Fourth, we consider that there are two reasons why the scale of unaccounted for cost pressures identified in step 1 and considered in step 2 may be *underestimated* because of other factors acting in the opposite direction. In particular, there might be other factors which have acted to offset the effects on base expenditure of cost increases from performance improvement, past enhancements, and increased regulatory requirements. These are:

- **Implications of totex incentives for the profile of expenditure**. Where companies have responded to the new totex incentives introduced at PR14 by moving to asset management approaches and performance strategies that involve a greater use of operating expenditure rather than capital expenditure, in relation to those activities covered by base expenditure, then this would tend to lead to reduction in *expenditure* in the short term, with offsetting increases in expenditure further down the line. Leaving aside any benefits from productivity improvements and efficiency gains, a switch in the balance of expenditure away from capital expenditure and towards operating expenditure will tend to reduce total expenditure in the short term. All else equal, the introduction of the totex and outcomes approach at PR14 should have led to significant reductions in base expenditure across the industry.
- **Capital maintenance deferral**. Companies may have taken opportunities to defer capital maintenance expenditure requirements to future price control periods, without immediate adverse effects (e.g. via managing near-term needs using opex-based solutions or investment in shorter-life and lower-cost assets).

In relation to the second of these points, the information we present in our separate cost adjustment claim on mains renewal shows that there have been significant reductions in the levels of water mains renewal over the period 2011/12 to 2021/22.

Importantly, while these two factors may have offset other cost pressures (i.e. those from outcomes improvements and past enhancements) in recent years, their ability to offset cost pressures in the future is likely to reduce over time. The first factor above concerns a transitory effect of a process of adopting more opex-based solutions within base expenditure. The opportunities to offset cost pressures by deferring capital expenditure will tend to decrease over time.

In this context, there is a reasonable argument for the annual rate of unaccounted for cost increases being greater in AMP8 than estimated historically.

Overall, there is considerable uncertainty about both the relative scale of factors influencing the cost increases observed in the past and about cost increases into the future. Nonetheless, given the various considerations discussed above, using a figure of 100% of the historical average annual increases in unaccounted for costs for extrapolation into AMP8 seems a reasonable approximation at this stage.

Step 4: Calculation of adjustment to apply to modelled costs

Our calculation of the adjustment to apply for Wessex Water has four steps:

- Step 4A: Estimation of modelled costs for Wessex Water for 2025-30.
- Step 4B: Application of catch-up efficiency adjustments.
- Step 4C: Derivation of adjustment factors for unaccounted for costs increases.
- Step 4D: Calculation of net value of the cost adjustment claim.

We describe each of the steps below.

In addition we briefly describe how we calculated the implicit allowance for the purposes of Ofwat's data tables. Given the way that the calculations work logically, the implicit allowance is not an explicit part of the calculation of the net value of the claim under step 4. This is because we have, in effect, already stripped out the increases over time in modelled base-plus expenditure that are allowed for via Ofwat's econometric models as part of step 1. But the implicit allowance corresponding to our methodology can be calculated using the information produced as part of the process to calculate the net value of the claim.

Step 4A: Estimation of modelled costs for Wessex Water for 2025-30

Our approach to estimation of the modelled costs for Wessex Water for 2025-30 is as follows.

The modelled costs for Wessex Water are calculated using the suite of econometric models that Ofwat consulted on in April 2023 (excluding the separate models of sewage treatment with the coastal population variable). We have triangulated across models in a way that gives: (a) equal weight to models in the same part of the value chain; (b) equal weight to disaggregated models (water resources plus, treated water distribution, sewage collection, sewage treatment) compared to aggregated models (wholesale water, wastewater network plus.

For the purposes of the early cost adjustment claim that we submitted to Ofwat in June 2023, we estimated modelled costs for AMP8 by extrapolating the historical rate of change in modelled costs for Wessex Water. More specially, we calculated the CAGR between 2011/12 and 2021/22 in modelled costs for Wessex Water and then used this growth rate to form projections of modelled costs for the 2025-30 period.[7] We have retained this approach for our business plan submission. We found, as part of our sensitivity analyses, that there was no material impact on the net value of our claim from updating the estimates of AMP8 modelled costs for our business plan forecast explanatory variables and, in any event, these figures may need to be revisited in light of the suite of models that Ofwat chooses to use for PR24.

We needed to make an allocation of modelled costs for wholesale water between the water resources price control and the water network plus price control and within the latter, between the individual cost areas needed for the business plan data tables completed as part of this cost adjustment claim (i.e. between raw water transport, raw water storage, raw water treatment, and treated water distribution). We did so by making a proportionate allocation based on the relative share of Wessex Water's base expenditure in 2021-22 APR.[8] We also conducted some

[7] The figures for modelled costs derived from Ofwat's April 2023 models are in 2017/18 prices. We used CPIH figures on a financial year average basis to convert modelled costs to a 2022/23 price base. For our June 2023 submission we used a provisional figure for financial year average for CPIH for 2022/23 for this calculation. We also carried out sensitivity analysis using the CPIH figures for 2022/23 from our business plan submission, which showed that this did not have a material impact on the net claim. In line with our broader approach for this claim, we have retained the CPIH figures from the June 2023 submission.

[8] We used total base expenditure (excluding third party costs and gross of grants and contributions) from table 4D line 4 and line 11.

sensitivity analysis using AMP8 forecasts for the split of base expenditure between water resources and water network plus, which did not indicate a material difference compared to the original approach of using 2021/2022 APR data for the allocation.

Table 4 - Modelled costs 2025-30

	Water network plus	Wastewater network plus
Estimate of aggregate modelled costs for Wessex Water 2025-30	£488m	£979m

Step 4B: Application of catch-up efficiency adjustments

We applied assumptions for catch-up efficiency adjustments to the modelled costs from step 4A.

We do not know what catch-up adjustments Ofwat will use for PR24. The scale of catch-up efficiency adjustment applied depends on the results of the specific suite of models used, and their weights in the triangulation, and on decisions on how to define a notional efficient company for the purposes of the adjustment (e.g. upper quartile or some other position).

For the purposes of our cost adjustment submission at the business plan stage, we used information from PR19 to make working assumptions on the scale of adjustment that might apply at PR24. We took the average of the catch-up assumptions determined by Ofwat and the CMA at PR19, for wholesale water and wholesale wastewater. The relevant figures are presented in the table below.

The figures we used are working assumptions about what Ofwat might do at PR24. They do not in any way represent Wessex Water's own views on how Ofwat should set catch-up efficiency adjustments or what levels might be reasonable for PR24.

Table 5 - Assumptions on catch-up efficiency adjustments to be applied to modelled costs

	Water network plus	Wastewater network plus
Ofwat PR19	4.60%	8.70%
CMA PR19	1.40%	2.20%
Assumed catch-up efficiency challenge for this claim	3.00%	5.45%

Step 4C: Derivation of adjustment factors for unaccounted for cost increases

In step 1 we estimated that the following rates of average annual increases in modelled base-plus expenditure (between 2011/12 and 2021/22) were unaccounted for under Ofwat's models, methodology and assumptions:

- An increase of 1.11% per year for water network plus.
- An increase of 2.28% per year for wastewater network plus.

Based on the evidence and assessment from step 2, we decided in step 3 to apply 100% of these historical rates in projecting forward to the 2025-30 period.

On this basis, we derived adjustment factors for unaccounted for cost increases for each year in the 2025-30 period as follows, separately for water network plus and wastewater network plus:

- We created a series which starts at one in 2011/12 and then increased each year in line with the assumed annual increases in unaccounted for costs (1.11% for water network plus; 2.28% for wastewater network plus).
- For each year in the 2025-30 period, we calculated an adjustment factor for unaccounted for costs as the value for this series in that year divided by the average value of the series over the five-year period 2017/18 to 2021/22. This calculation reflects Ofwat's approach at PR19 of calculating the catch-up efficiency adjustments using efficiency scores (actual costs relative to modelled costs) calculated over the last five years of data. If Ofwat changes its approach to the period over which efficiency scores are calculated, then the corresponding adjustment factor would differ accordingly.

We set out below the adjustment factors for unaccounted for costs that we derived.

Table 6 - Summary of uplift factors for unaccounted for costs

	Water network plus	Wastewater network plus
2025/26	1.07	1.14
2026/27	1.08	1.17
2027/28	1.09	1.20
2028/29	1.10	1.22
2029/30	1.12	1.25

Step 4D: Calculation of net value of the cost adjustment claim

We calculate the net value of the adjustment for Wessex Water separately for each year in the 2025-30 period. We do this by:

- taking the modelled costs for that year from step 4A;
- applying the catch-up adjustment from step 4B; and
- multiplying by: the uplift factor for unaccounted for costs for that year from step 4C minus 1.

We provide annual figures for the 2025-30 period in the data tables corresponding to this claim.

We summarise aggregate amounts for 2025-30 period (i.e. AMP8) in the table below.

Table 7 - Provisional quantification of the net value of the claim

	Water network plus	Wastewater network plus
Estimate of aggregate modelled costs for Wessex Water 2025-30	£488m	£979m
Estimate of aggregate modelled costs for Wessex Water 2025-30 after application of catch-up efficiency adjustment	£473m	£925m
Provisional quantification of the net value of the claim: aggregate for 2025-30	**£44m**	**£184m**

The figure is larger for the wastewater network plus price control because of the following:

- Modelled base costs are higher for Wessex Water's wastewater network plus price control compared to its water network plus price control.
- The historical scale of unaccounted for cost pressures identified under step 1 are greater for Wessex Water's wastewater network plus price control compared to its water network plus price control.

Our quantification of the net value of the claim is a provisional estimate based on current information on the models, methodologies and assumptions that Ofwat will use in its base cost assessment for PR24. These are subject to uncertainty and the precise calculation could benefit from updates, as the PR24 process progresses, in the light of clarification on relevant aspects of Ofwat's models, methodologies and assumptions.

For instance, there are interactions between our calculation of the adjustment in step 1 above and the assumptions that Ofwat makes for productivity and RPEs in respect of base-plus costs when setting allowances for PR24. If Ofwat were to set a productivity assumption for AMP8 that is lower than 1% – due to an interpretation that that the levels of productivity growth achieved in practice by efficient water companies over the 2011/12 to 2021/22 period was less than previously assumed (e.g. an assumption of around 0.5% per year rather than 1% per year) – then the scale of adjustment calculated under step 4 above might be smaller. If Ofwat were to adopt an alternative or refined methodology for RPEs, this could also affect the calculations, at least insofar as the change of methodology has implications for the estimation of historical RPEs as well as future RPEs in AMP8.

Derivation of implicit allowances

As highlighted earlier, the implicit allowance is not an explicit part of the calculation of the net value of the claim under step 4. This is because we have, in effect, already stripped out the increases over time in modelled base-plus expenditure that are allowed for via Ofwat's econometric models as part of step 1.

Nonetheless, we can calculate an implicit allowance corresponding to our methodology.

Conceptually, we have defined the implicit allowance corresponding to our methodology as the allowance for increases over time in modelled base-plus expenditure that is allowed for via Ofwat's April 2023 econometric models. These models do not have time trends or time dummy variables, but for wholesale water and wastewater network plus they tend to produce increases in modelled costs over time. This is because some of the cost driver explanatory variables tend to increase over time.

For the purposes of this claim, and consistent with the calculations used to quantify the net claim above, we have calculated the implicit allowance by taking (a) the modelled costs we calculated for Wessex Water for the 2025-30 period in step 4A above and deducting (b) the modelled costs we calculated for Wessex Water for the last five years of outturn data (i.e. 2017/18 to 2021/22). We used the five-year period as the reference point as Ofwat considers modelled costs over the last five years of data when calculating efficiency scores, and because it seemed relevant to compare the five-year period of AMP8 with a five-year period of historical data.

There may be other ways to define the implicit allowance in the context of this claim. But given that this amount is not actually used in the calculation of the net value of the claim, and our proposed adjustment to modelled costs, this did not seem a priority issue to examine further.

Need for adjustment

To a large extent, the analysis and evidence on the need for an adjustment is provided in the previous section of this document (supplemented by the appendix). In this section we provide a response organised by each of Ofwat's questions, but this should be read in conjunction with the previous section and the appendix.

Unique circumstances

Ofwat's PR24 final methodology is clearly designed to enable companies to use the cost adjustment process to submit claims relating to the view that efficient levels of base costs will be higher in the future than in the past. For example:

- Ofwat said that it will allow companies to submit cost adjustment claims for factors outside of company control that cause material differences in costs over time and are not captured in its benchmarking analysis.
- Ofwat said that it was open to considering company evidence on additional exogenous factors / cost drivers that require a step change in efficient maintenance expenditure through the cost adjustment claim process.

In this context, we do not consider it necessary or appropriate to demonstrate that Wessex Water operates in "unique circumstances" for this claim. Indeed, the fact that significant real terms cost increases have been experienced on average and across the industry is evidence that the cost pressures faced by Wessex Water are not due to inefficiency or poor cost control on Wessex Water's part.

Ofwat recognised in its PR24 final methodology that different criteria will be applicable for different types of claims.

For these reasons we have not responded to the following questions from Ofwat's assessment criteria as these do not seem relevant to this claim:

- *Is there compelling evidence that the company has unique circumstances that warrant a separate cost adjustment?*
- *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)?*
- *Is there compelling evidence of alternative options being considered, where relevant?*

Management control

Ofwat's assessment criteria raise the following questions on management control:

- *Is the investment driven by factors outside of management control?*

- *Have steps been taken to control costs and have potential cost savings (eg spend to save) been accounted for?*

We provide comments on management control in the table below, against what we see as the three key drivers of the increases in base costs which are covered by this claim. These relate primarily to the first question above.

Table 8 - Summary response to Ofwat questions on management control

Factor	Comments on management control
The costs of observed performance improvements	We recognise that it may be possible in theory to limit the extent of increases over time in modelled base-plus expenditure by reducing (or not increasing) various aspects of observed customer service and environmental performance. However, we consider that this would not be in the interests of customers to do so. We interpret Ofwat's ODI financial incentives (at least where it has used WTP data or marginal benefits to set incentive rates) as intended to encourage companies to improve performance where the costs of this are less than the perceived customer benefits. Furthermore, if we did seek to avoid cost increases by constraining performance levels we would expect to experience ODI penalties and this approach would not be consistent with the decisions of an efficient and well-run company. Such an approach could also raise financeability problems for a notional efficient company as it would imply an expectation of systematic ODI penalties in a context where Ofwat's PCLs tend to become more challenging at each review.
The ongoing costs arising from past enhancements	Where enhancements have been carried out under WINEP, we have legal obligations to continue to operate the agreed schemes/outputs. For other enhancements we consider that under Ofwat's regulatory model there is an expectation to maintain the customer/environmental benefits of those enhancements over time unless there is evidence that it would provide bet benefits customers to terminate those enhancements. We do not consider that management has the discretion to stop operating past enhancement schemes simply to constrain base expenditure to historical levels. Nor would this be in the interests of customers
Increasing regulatory requirements	Regulatory requirements are determined by third parties and are not under management control.

Furthermore, in relation to both the first and second questions above, the quantification of the claim presented in the section above headed "Methodology and key results" concerns observed industry-wide cost pressures and this effectively means that the cost adjusted sought is based on cross-company benchmarks. Using a benchmarking approach such as this helps to mitigate the risk that the costs experienced or observed by any one company reflect a failure by management to properly control costs, rather than other factors.

Materiality

Based on our business plan totex for AMP8 we found that:

- Our claim exceeds, by a considerable margin, Ofwat's materiality thresholds in respect of the water network plus and wastewater network plus price controls.
- The claim does not come close to meeting Ofwat's materiality thresholds for the water resources and bioresources price controls.

Ofwat's assessment criteria for cost adjustment claims pose two specific questions on materiality which we respond to in the table below.

Table 9 - Summary response to Ofwat questions on materiality

Ofwat question	Summary response
Is there compelling evidence that the factor is a material driver of expenditure with a clear engineering / economic rationale?	We have set out in the section headed "Methodology and key results", and appendix 1, the economic and engineering rationale for the following factors being a material driver of expenditure: • observed performance improvements • the ongoing costs arising from past enhancements • increasing regulatory requirements
Is there compelling quantitative evidence of how the factor impacts the company's expenditure	In the section headed "Methodology and key results" we have described and applied a methodology which shows that he significant increases in water company costs over time are likely to be attributable (in full or in large part) to the three factors in the row above. There is further evidence in appendix 1, including an example of the large increases in a part of water network plus base expenditure which is driven by improved leakage performance.

Adjustment to allowances

In this section we respond to Ofwat's cost assessment criteria and questions in relation to the "adjustment to allowances". We summarise in the table below response against Ofwat questions under "adjustment to allowances".

Note that the analysis and evidence in the section headed "Methodology and key results" and Appendix A1 is directly relevant to Ofwat's questions on adjustment to allowances and forms part of our overall response to these questions.

Table 10 - Summary response to Ofwat questions on adjsutment to allowances

Ofwat question	Summary response
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?	Yes The analysis set out in the section headed “Methodology and key results” shows that the cost claim is not included in Ofwat’s modelled baseline (given latest information on these models). By design, these models cannot capture the full impact of the increases in efficient costs associated with improved outcomes due to extremely limited coverage of performance and outcomes in the explanatory variables (e.g. limited to ammonia). The model specifications used by Ofwat (which have a constant term and no time trend or time dummies) *prevent* the models from capturing and revealing any industry-wide increases in costs over time other than increases associated with changes over time in the data used for explanatory variables. Furthermore, the cost increases over time that are reasonably attributable to improved outcomes and enhanced regulatory requirements exceed the cost increases allowed for in the models (as the analysis presented in the section headed “Methodology and key results” shows).
Is the claim material after deduction of an implicit allowance? Has the company considered a range of estimates for the implicit allowance?	Yes, the claim is highly material on current evidence for water network plus and wastewater network plus – see quantification above for further information on the scale of the claim. For this claim, we adopted an approach to the calculation of the implicit allowances (for changes over time in base-plus expenditure) that is reasonably straightforward and intuitive. There may be other ways to conceive of, and calculate, the implicit allowance. But, given the methodology we use to derive the net claim, the calculation of the implicit allowances does not actually affect the net value of the claim.
Has the company accounted for cost savings and/or benefits from offsetting circumstances, where relevant?	Our claim is a broad one across base-plus expenditure rather than for specific projects or initiatives. We propose – and anticipate – that the claim would be applied by Ofwat to figures for modelled cost derived from the econometric models that Ofwat has adjusted for (a) an assumption on catch-up efficiency improvements and (ii) an assumption on ongoing productivity growth.

Ofwat question	Summary response
	For the purposes of the claim, we have not identified and described any specific additional cost savings or offsetting circumstances that will apply in AMP8 to reduce the value of the claim. Where there have been cost savings and benefits from offsetting circumstances in the period 2011/12 to 2021/22, across the industry, these will act to reduce the scale of unaccounted for cost pressures that we estimated in step 1 of our methodology and this, in turn, will tend to reduce the calculation of the net value of the claim.
Is it clear the cost allowances would, in the round, be insufficient to accommodate the factor without a claim?	Yes. Particularly given the size of the claim and the factors underlying it, we do not see how it could be funded "in the round" from other aspects of the cost allowances to be set by Ofwat for Wessex Water.
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 claim does not concern peaks and troughs in base expenditure which might even out over time. Our claim essentially concerns the existence of factors that lead to an upward trajectory in base costs (relative to CPIH) and Ofwat's econometric models – and its current approach to setting allowances – do not allow for this either in the short term or long term.
If an alternative explanatory variable is used to calculate the cost adjustment, why is it superior to the explanatory variables in our cost models?	This question is not applicable. The approach we have taken to calculate the cost adjustment is not based on adding an alternative explanatory variable to Ofwat's econometric models.

Cost efficiency

This section addresses the parts of Ofwat's cost adjustment claim assessment criteria that relate to cost efficiency.

Table 111 - Summary response to Ofwat questions on cost efficiency

Ofwat question	Summary response
a) Is there compelling evidence that the cost estimates are efficient (for example similar scheme outturn data, industry	The primary form of analysis we have used for the assessment and quantification of the cost adjustment claim is industry-wide data

and/or external cost benchmarking, testing a range of cost models)?	rather than data specific to Wessex Water. In effect, we have looked at changes over time in cost benchmarks. This aspect of our approach helps to avoids the risk that any cost increases in costs experienced by, or anticipated by, Wessex Water might be – or might be perceived as – due to inefficiency on the part of Wessex Water. Furthermore, we found no evidence that the above-CPIH cost increases observed across the industry in the period 2011/12 to 2021/22 (which form the basis for our assessment) are limited to companies who appear to be relatively inefficient on the basis of Ofwat's April 2023 base cost models.
b) Does the company clearly explain how it arrived at the cost estimate? Is there supporting evidence for any key statements or assumptions?	The cost estimates relevant to this claim are calculated as part of our approach to the calculation of the adjustment to allowances. Rather than calculating gross costs and deducting an implicit allowance, our approach to this claim starts with the historical implicit allowance from Ofwat's models for changes over time in base costs and then assesses the incremental costs which are not funded under Ofwat's models and wider approach. As such, the primary cost estimates forming part of our claim are covered under the assessment methodology set out in the section headed "Methodology and key results". We have set out clearly how we have arrived at these costings in that section.
c) Does the company provide third party assurance for the robustness of the cost estimates?	We do not consider that this question is directly relevant to this claim, because it does not rely on any specific "cost estimates" (e.g. costings for specific projects or initiatives or services). The value of the claim is derived from industry wide data on outturn costs, combined with a transparent methodology and set of assumptions.

Need for investment

Ofwat's criteria for cost assessment claims include a category for "need for investment". But as highlighted above, Ofwat recognised in its PR24 final methodology that different criteria will be applicable for different types of claims.[9]

[9] Ofwat (2022) Creating tomorrow/w, together: Our final methodology for PR24 Appendix 9 – Setting expenditure allowances, page 156.

We consider that the “Need for investment” criterion is most relevant when the cost adjustment claim concerns a specific investment proposal or initiative for which the needs case can be set out and assessed. It is much less relevant to the current claim, which:

- Is not limited to investment expenditure as it also includes ongoing operational costs.
- Is not focused on a single identifiable project/scheme (or programme of projects/schemes) but concerns the cumulative impacts of improvements and past enhancements in a range of areas.

For this specific claim, the “need for investment” is an inherent part of the “need for adjustment” which we have addressed in detail in the previous sections of this document.

In this context we have not responded directly to the following questions from Ofwat’s cost adjustment claim assessment criteria:

- *Is there compelling evidence that investment is required?*
- *Is the scale and timing of the investment fully justified?*
- *Does the need and/or proposed investment overlap with activities already funded at previous price reviews?*
- *Is there compelling evidence that customers support the need for investment (both scale and timing)?*

Best option for customers

Ofwat’s criteria for cost assessment claims include a category for “best option for customers”. But as highlighted above, Ofwat recognised in its PR24 final methodology that different criteria will be applicable for different types of claims.

We consider that the “Best option for customers” criterion is most relevant when the cost adjustment claim concerns a specific investment proposal or initiative which reflects a selected single option (or set of options) for addressing an identified need or providing specified customer benefits. It is much less relevant to the current claim, which:

- Is not limited to a specific investment proposal or initiative.
- Is not focused on a single identifiable project/scheme (or programme of projects/schemes) but concerns the cumulative impacts of improvements and past enhancements in a range of areas.

Nonetheless, we have sought to respond briefly to a subset of the Ofwat assessment criteria questions relating to best option for customers.

Table 12: Summary responses to Ofwat questions on best option for customers

Ofwat question	Summary response
a) Did the company consider an appropriate range of options to meet the need?	N/A
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	N/A

in the long term? Is third-party technical assurance of the analysis provided?	
c) Has the impact of the investment on performance commitments been quantified?	Given the broad coverage of this claim, it does not have a direct quantifiable impact on specific performance commitments in the same way that a single investment project or programme might. Our claim is consistent with PCLs being set at more demanding levels in AMP8 than historically, which is the approach we expect Ofwat to take for PR24 in the light of its approach at PR19 and its PR24 final methodology.
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
e) Has the company secured appropriate third-party funding (proportionate to the third party benefits) to deliver the project?	N/A
f) Has the company appropriately presented the scheme to be delivered as Direct Procurement for Customers (DPC) where applicable	N/A
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?	This claim does not relate to any specific proposed solutions and we do not consider this question relevant to this claim. In effect, the claim relates in large part to the costs of (a) performance improvements encouraged under Ofwat's ODI incentive regime; (b) continuation of benefits from past enhancements that have been approved by Ofwat and/or the EA; and (c) performance improvements due to UK legal requirements.

Customer protection

Our claim is essentially that it is appropriate for Ofwat to apply an uplift to the allowances for base-plus expenditure that it derives for Wessex Water from its cross-company benchmarking models, due to ongoing cost pressures experienced across the industry historically which are likely to continue into AMP8.

Ofwat's established approach for the price control treatment of base-plus expenditure is largely an outcomes-focused one where:

- Allowances for efficient levels of modelled base costs are determined via cross-company benchmarking (subject to various adjustments).
- Allowances for efficient levels of modelled base costs are not hypothecated.
- Companies face PCs with financial ODIs, as well as PCDs, to protect customers in relation to outcomes.
- Companies face other obligations to deliver and maintain enhancements and improved outcomes (e.g. WINEP obligations).

Within the context of this approach, our view is that the allowances determined by Ofwat for modelled base costs for Wessex Water should represent a reasonable central estimate of the level of base-plus expenditure that would be incurred by a notional efficient company operating in the exogenous conditions faced by Wessex Water (e.g. in terms of customer numbers, density and raw water quality) and which faces the various performance commitments and regulatory/legal obligations that Wessex Water.

Our view – as we have evidenced in this claim and on the basis of Ofwat's April econometric 2023 models – is that it will be necessary for Ofwat to apply a cost adjustment claim of the nature proposed in this document in order that its allowances represent a reasonable central estimate of the level of base-plus expenditure that would be incurred by a notional efficient company.

In this context, we do not see a need for additional customer protection beyond that which is already incorporated in the price control framework. To clarify, the claim is not for the additional costs of discretionary investment (which Wessex Water might conceivably defer or cancel). It is for the efficient costs of operating within the regulatory framework – and wider legal requirements – that we expect to apply within AMP8.

We respond to Ofwat's specific cost adjustment criteria questions in the table below.

Table 13 - Summary response to Ofwat questions on customer protection

Ofwat question	Summary response
a) Are customers protected (via a price control deliverable or performance commitment) if the investment is cancelled, delayed or reduced in scope?	This claim does not relate to any single investment that might be cancelled, delayed or reduced in scope. The claim relates to changes over time in the efficient costs of what Wessex Water is already required and incentivise to do. See discussion earlier in this section.
b) Does the protection cover all the benefits proposed to be delivered and funded (eg primary and wider benefits)?	As for question (a) above
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

A1 Supporting information

This appendix provides supporting information in relation to step 2 and step 3 of the methodology we have described in this document. It supports our contention that a large part of the unaccounted for upward pressures on base costs identified under step 1 is likely to be due to (a) increases in base-plus costs over time to support improvements in performance captured by PCs and subject to financial incentives via ODIs; (b) increases in base-plus costs over time as a result of the ongoing operational and capital maintenance associated with past enhancement expenditure; and (c) increases in base-plus costs over time from broader sets of increasing regulatory requirements.

This section is organised as follows:

- Evidence on improvements in performance over time.
- Submissions on performance improvements from base expenditure versus enhancement expenditure.
- Evidence on cost increases from leakage improvements.
- Evidence on increased regulatory requirements
- Simulation analysis concerning the under-funding of capital maintenance from past enhancements.
- Wessex Water historical RCV growth.
- Wessex Water capital maintenance over time.

A1-1.1. Evidence on improvements in performance over time

There have been substantial improvements in performance over time across the industry for some of the performance commitments that Ofwat set at PR19. We consider that this is a key factor which helps to explain increases in base costs over time.

In its PR19 final determinations, Ofwat presented evidence on the scale of historical improvements achieved across companies in three key areas, findings as follows:[10]

- The sector had achieved a performance improvement of 40% in water supply interruptions between 2012-13 and 2016-17.
- The sector had achieved a 26% improvement in internal sewer flooding incidents between 2015-16 and 2018-19.
- The sector had achieved a 30% improvement in pollution incidents between 2013 and 2018.

We now look at more recent data, and more broadly across different PCs (using PCs that Ofwat plans for PR24). We present some charts below, based on the data that Ofwat published in April 2023.[11] In each case, we show the industry-average performance (simple average across companies) and Wessex Water's performance. As reflected in the charts, the time period of available data varies across different performance commitments. We take the following PCs in turn, using the abbreviations used in the Ofwat dataset in the charts below:

- Water quality contracts (WQC)
- Leakage (LEA)

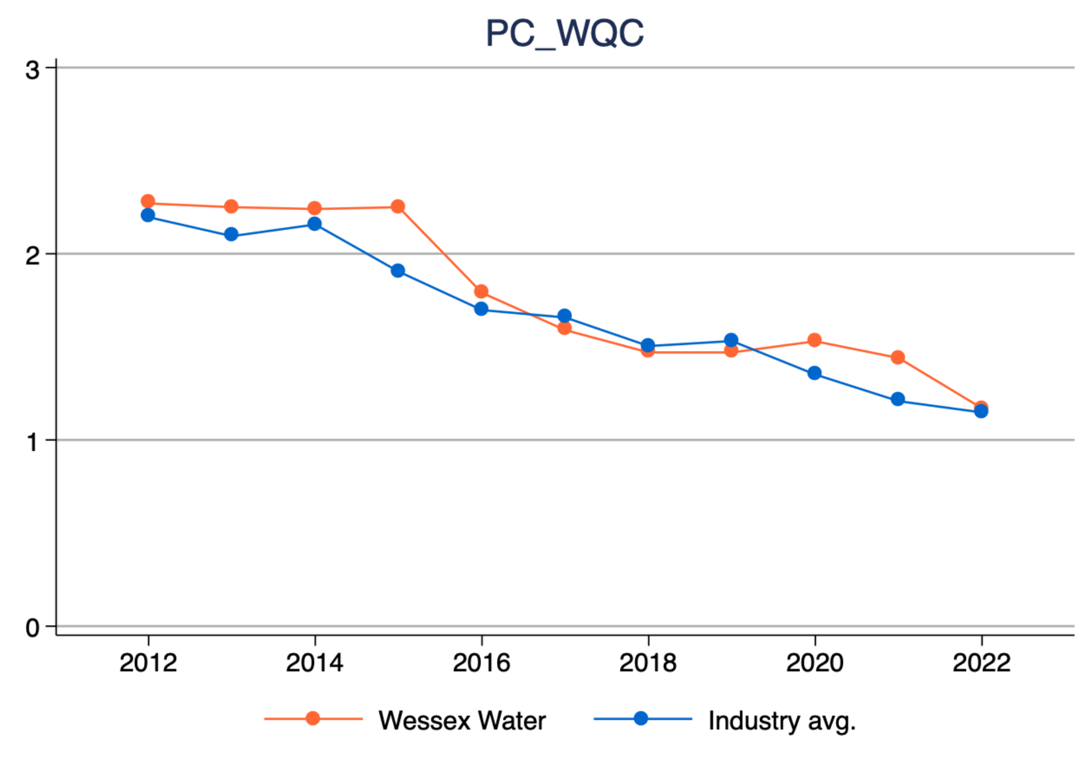
[10] Ofwat (2019) *Overall stretch on costs, outcomes and cost of capital policy appendix*, pages

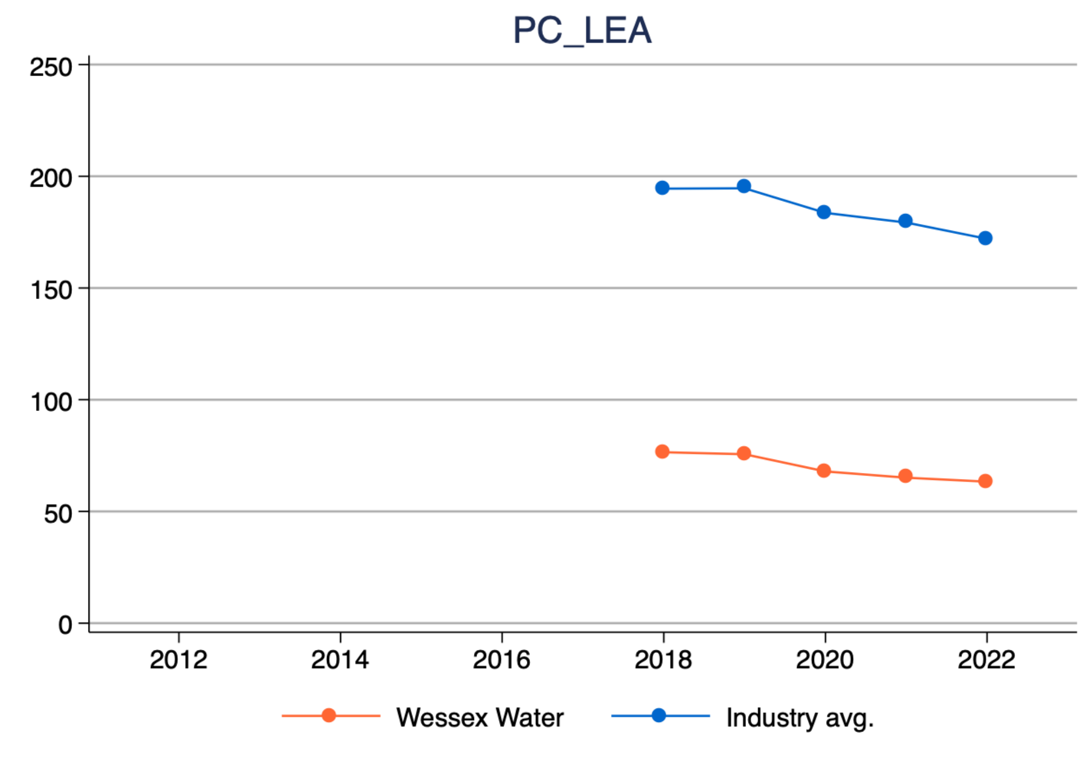
[11] Analysis based on "Historical performance trends for PR24 V1.0" published by Ofwat in April 2023.

- Water supply interruptions (WSI)
- Pollution incidents (POL)
- Internal sewer flooding (ISF)
- External sewer flooding (ESF)
- Discharge compliance (DIS)

Across the PCs shown we see a number of areas where performance across the industry has shown further improvements beyond the improvements identified by Ofwat at PR19.

While we show Wessex Water's historical performance for reference, we consider that the more relevant evidence for this claim concerns the industry-average performance, given that Wessex Water's allowances for base expenditure are derived primarily from Ofwat's cross-company benchmarking models.

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250
200
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50
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2012
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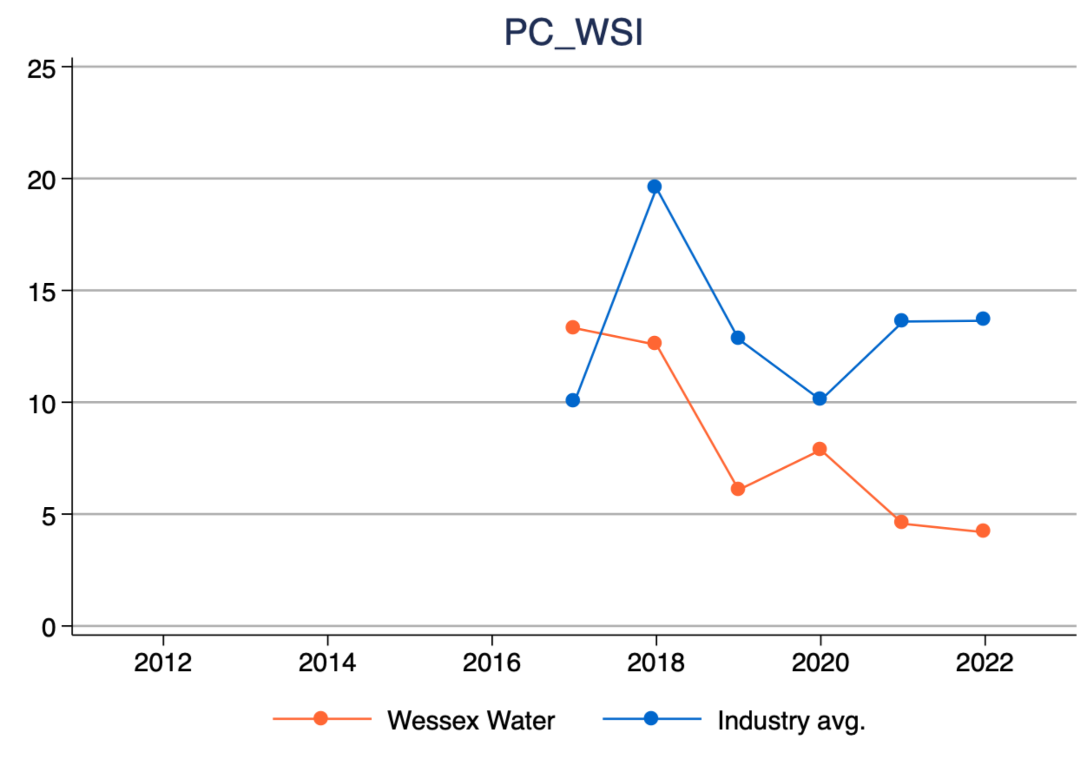
2022
Wessex Water
Industry avg.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2012
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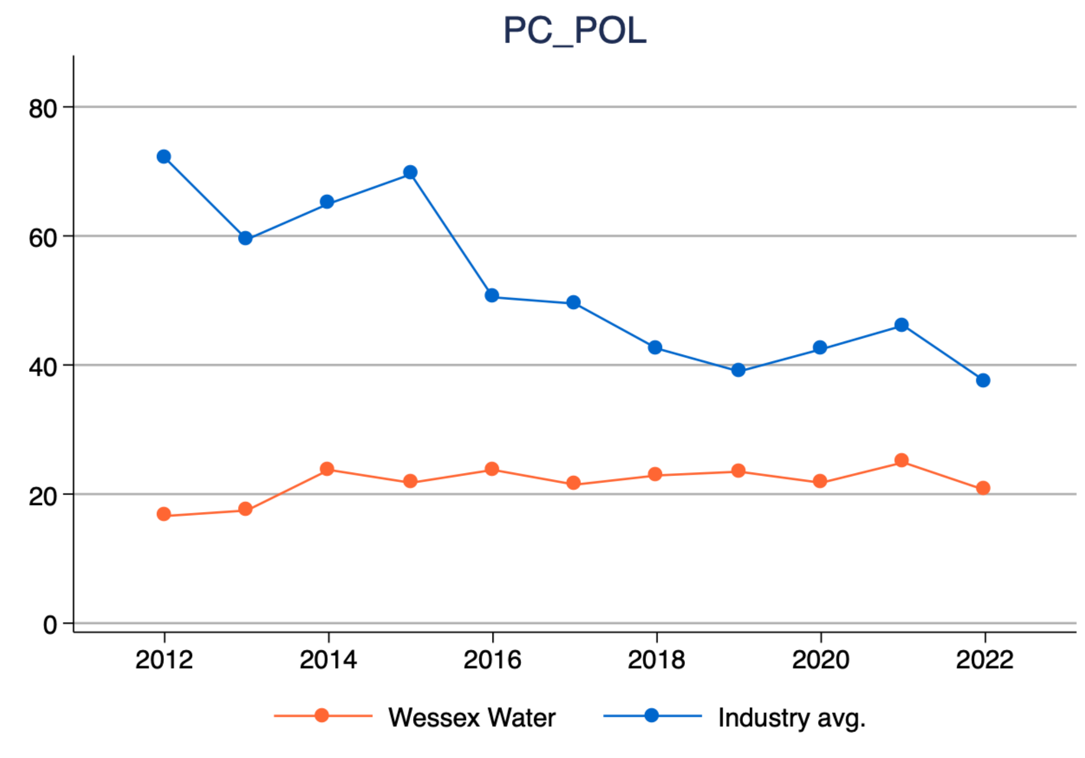
Wessex Water
Industry avg.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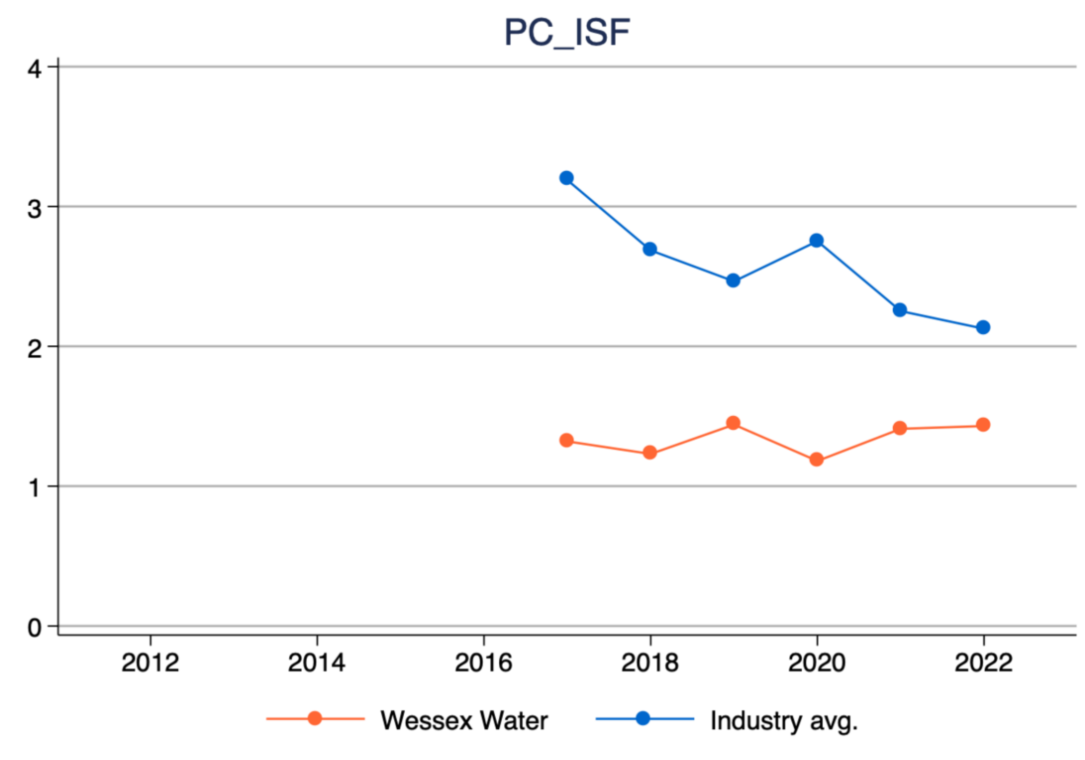
Wessex Water
Industry avg.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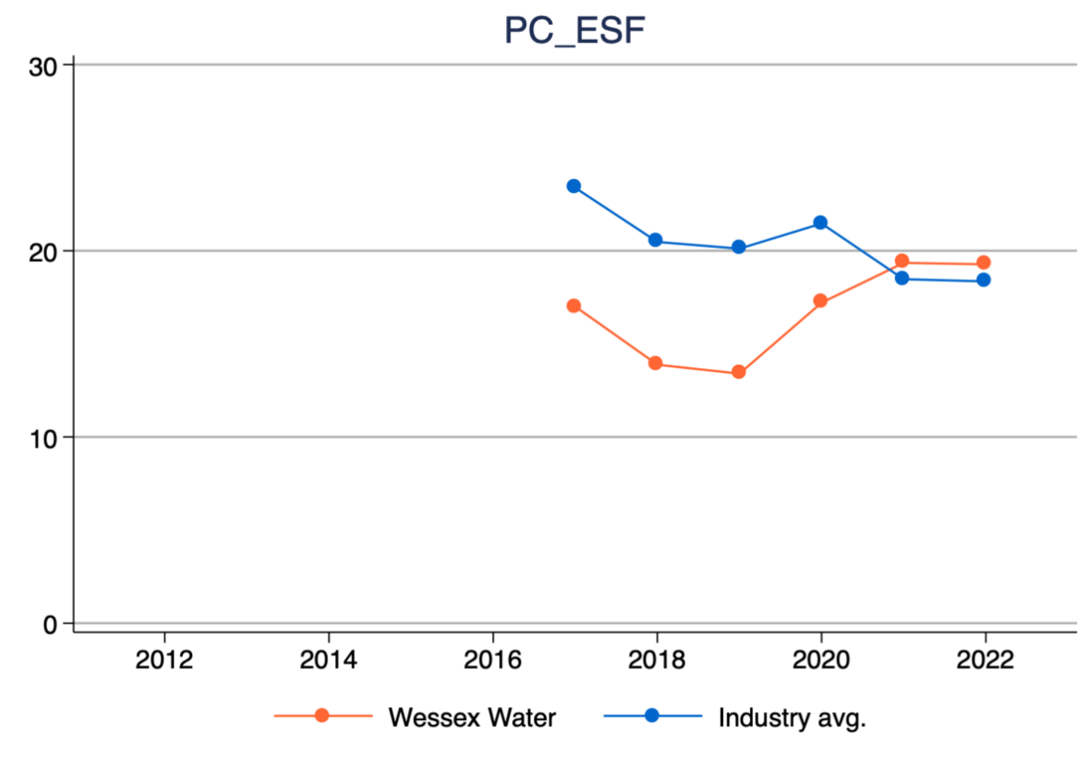
Industry avg.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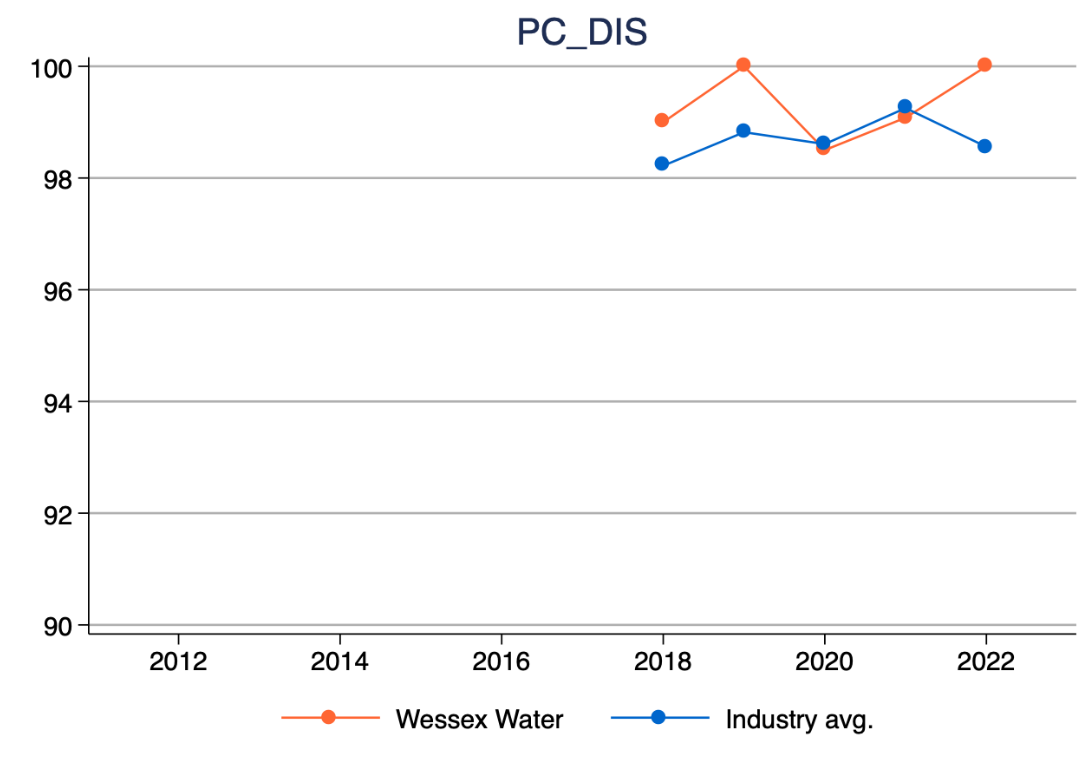
PC_DIS
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92
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2022
Wessex Water
Industry avg.

A1-1.2. Submissions on performance improvements from base expenditure versus enhancement expenditure

In January 2023 Wessex Water provided a response to Ofwat in relation to its data request on "performance improvements from base, enhancement and ODIs". We said that we had adopted a high-level and proportionate approach to this submission, in the context of a number of significant challenges in providing the full set of information Ofwat had requested. Nonetheless, our submission provided some relevant information and perspectives on this cost adjustment claim.

In the cover to our submission, we said the following: "*In practice, we see both base expenditure and performance of the sector increasing, which suggests that performance improvement from base cannot be sustained over the long run. We consider this points to a combination of the following: (1) Service improvements delivered by productivity gains; (2) Service improvements delivered by enhancement, but allocated to base (in the absence of enhancement funding being allowed) – i.e. 'hidden enhancement'".*

On this point of hidden enhancement expenditure, our position is that expenditure carried out to improve performance is technically enhancement expenditure under the long-standing distinction between base expenditure and enhancement expenditure under Ofwat's RAGs. However, in practice we consider that the expenditure covered by Ofwat's base cost models includes a substantial amount of hidden or embedded enhancement expenditure. [12]

We summarise in the table below some key pieces of information and evidence from our response. This shows that for most areas of performance, we consider that we achieved performance improvements entirely or primarily from expenditure *reported as* base expenditure. It also provides examples of specific interventions we have carried out to improve performance, which have contributed to increases in base expenditure over time.

Table 14: Evidence on use of base expenditure to improve perfomance from Wessex Water January 2023 submission to Ofwat

Performance area	Indicative estimate of % of improvement since 2011 achieved from reported base expenditure	High-level summary of interventions made to deliver performance improvements from base expenditure
Water supply interruptions	100%	Reducing planned interruptions through the use of line stopping and other under pressure techniques to undertake almost all planned works without an interruption over 3 hours. This approach has increased the cost of planned interruptions. Network Response Coordinators Tanker infusion Calm Network Strategy

[12] See sections 2.2 and 2.3 of Reckon (2022) *The opportunities for a more coherent regulatory approach for Ofwat's funding of base expenditure and enhancements*.

Performance area	Indicative estimate of % of improvement since 2011 achieved from reported base expenditure	High-level summary of interventions made to deliver performance improvements from base expenditure
Leakage	100%	Detect leaks and fix them (repairs) Maintaining and enhancing non-revenue metering
Customer contacts about water quality	95%	Root cause analysis of hotspot areas Mains replacement Proactive customer awareness to inform customers when they may experience discoloured water.
Compliance Risk Index	76%	Catchment management Operation & maintenance of all supply assets Mains replacement Water fittings programme
PCC	43%	Home visits Water efficiency devices Information campaigns Community engagement Research and 3rd party influencing Monitoring and response of behaviours (some retail)
Mains repairs	100%	Mains repairs
Unplanned outage	100%	Operation and maintenance of water treatment works including assets that improve resilience e.g. power backup generators
Serious pollution incidents	100%	Rising main burst detection programme Localised sewer repair Sewer lining Reduced response time to incidents and sampling protocols

Performance area	Indicative estimate of % of improvement since 2011 achieved from reported base expenditure	High-level summary of interventions made to deliver performance improvements from base expenditure
		Operation and maintenance of all waste assets Mis-use campaign (e.g. letters)
Internal sewer flooding	74%	Installing NRV's Routine maintenance (including CCTV inspections and jetting) Localised sewer repair Sewer lining Mis-use campaign (e.g. letters)
Sewer collapses	100%	CCTV inspection Localised sewer repair Sewer lining Investigation of sewerage incidents to detect collapses
Discharge permit compliance	68%	Operation and maintenance of all water recycling centres
Operational GHG emissions - Water	100%	Energy usage reduction EV vehicles Energy efficient equipment Lower emission vehicles
Biodiversity	63%	Survey, manage and improve biodiversity of WWSL landholding including Sites of Special Scientific Interest
Operational GHG emissions - Wastewater	100%	Energy usage reduction EV vehicles Energy efficient equipment Lower emission vehicles

Performance area	Indicative estimate of % of improvement since 2011 achieved from reported base expenditure	High-level summary of interventions made to deliver performance improvements from base expenditure
Storm overflows	0%	N/A
Bathing water quality	85%	Operation and maintenance of water recycling centres (WRCs) discharging into bathing waters
River water quality	0%	N/A

The evidence above concerns Wessex Water. We expect that it is not just Wessex Water that considers that it has achieved performance improvements from expenditure falling within the scope of Ofwat's modelled base costs. Ofwat has access to the full set of company responses, and we would expect Ofwat to be carrying out its own review of the implications of these submissions. We note that Ofwat has said that, based on its review of the full set of company responses, "for most performance commitments, companies stated that historical performance was not significantly influenced by enhancement expenditure" and Ofwat has recognised the role of base expenditure in supporting the improvements in performance over time.[13]

A1-1.3. Evidence on cost increases from leakage improvements

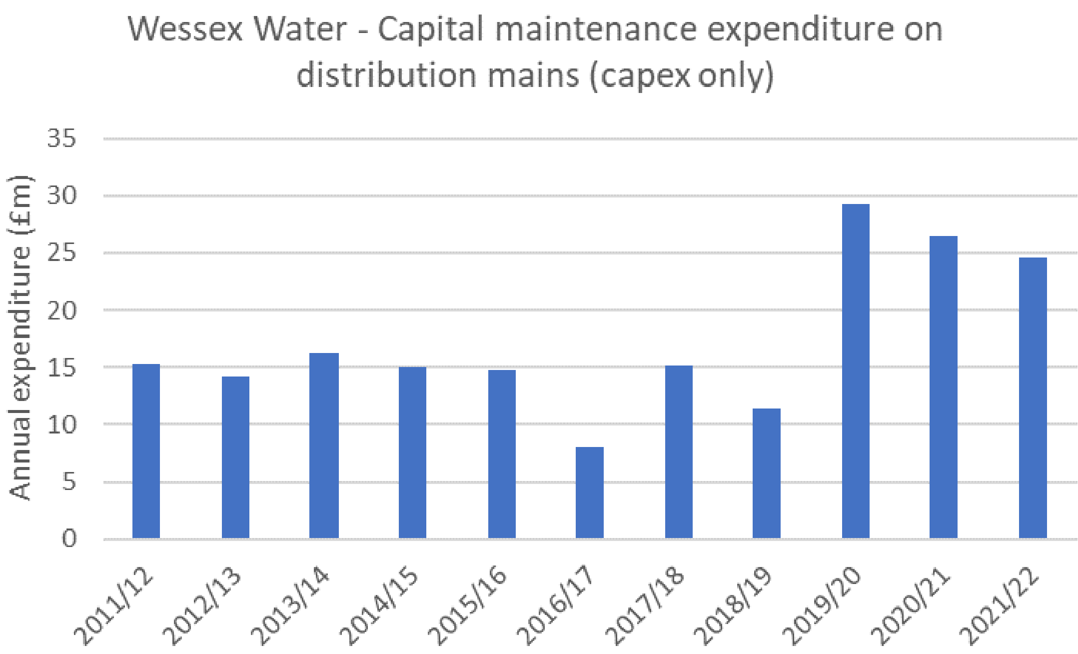
We identified above that we estimated that 100% of leakage improvements since 2011 have been achieved via *reported* base expenditure rather than *reported* enhancement expenditure.

We identified in the table above that the interventions to improve leakage performance included action to detect leaks and fix them (repairs) as well as maintaining and enhancing non-revenue metering.

A better understanding of the impact that performance improvements can have on reported base expenditure can be achieved by considering expenditure on capital maintenance activities relating to distribution mains. This shows that we have spent considerably more in this area since 2019/20 compared to the period from 2011/12. This increase is primarily due to strategic decisions to improve leakage performance in response to the outcome of the PR19 review which set very demanding short-term leakage improvement targets (as well as our longer-term aspirations to reduce leakage). As seen in the charts in the previous subsection, we have made significant increases in leakage performance over the same period.

[13] Ofwat (2023) *Information Notice 23/07 Assessing the influence of enhancement expenditure on historical performance trends for PR24*.

Figure 3 Wessex Water's capital maintenance expenditure on distribution mains (capex only)



A1-1.4. Evidence on increased regulatory requirements

In the table below we provide below some examples where increased regulatory requirements will act to increase costs into AMP8, in the case of the wastewater network plus price control.

The main point we wish to convey is the range of different regulatory drivers. The indicative figures are intended to provide some further context but are not firm cost estimates of individual elements – these indicative figures are from our early cost adjustment claim in June 2023 and in the interests of proportionality and prioritisation we have not sought to update them for our business plan (in the event of any discrepancies with figures elsewhere in our plan, the latter take preference).

Table 15: Indicative examples of cost pressures from increased regulatory requirements

Summary of increased regulatory requirement / expectation	Regulator	Year introduced?	Time period impacted	Indicative costing of AMP8 impact £m
Increased number of phosphorus removal requirements at WRCs (P permits). All listed in WINEP, but increased operational and compliance related costs. Eg: increased data reporting.	EA	ongoing	Ongoing but doubled recently	0.25

Summary of increased regulatory requirement / expectation	Regulator	Year introduced?	Time period impacted	Indicative costing of AMP8 impact £m
EDM monitoring (UMON3 storm tank monitors) - increased operational, maintenance and compliance reporting related costs.	EA	2020	2020 to date	0.75
EA strategic review of charging - annual subsistence fees	EA	2018	2018 to date	5
EA strategic review of charging - permit application fees	EA	2018	2018 to date	0.3
EA strategic review of charges - charging for WINEP permit variations	EA	2018	2018 to date	1.0
EA strategic review of charging - charging for pre-application advice	EA	2018	2018 to date	0.05
EA - Digital waste tracking	EA	TBC (2024?)	2024 onwards	0.5
Flow - flow4 at pumping stations	EA	2015	2015	0.25
Flow - regulatory flow measurement requirements on sludge volume flow meters	OFWAT	2025?	2025?	0.5
Pollution - expectation that we need ammonia samples for pollution incident reclassification – response is the utilisation of OHES to support this	EA	2019	2019 onwards	0.5
Flow - AMP8 new drivers for MCERTS on SPSs / SPS EOs	EA	2025	2025 onwards	2.645
Flow monitoring - FPF accreditation for flow (previously only TDV was accredited prior to AMP7)	EA	2020	2020	0.4
EDM monitoring (UMON1 discharge to environment) - increased operational, maintenance and compliance reporting related costs	EA	2010	2010 (for ~90 BW sites), 2015 for remaining ~1200 sites	0.25

Summary of increased regulatory requirement / expectation	Regulator	Year introduced?	Time period impacted	Indicative costing of AMP8 impact £m
Enforcement of third parties (e.g. trade effluent) - not including legal costs	-	2020 internal policy created	2020	0.25
EDM UMON1 annual report	EA	2015	2015	0.25
Flow analyst for annual regulatory report	EA	2020	2020	0.25
EIR requests - requirement for a full time position	ICO	ongoing	ongoing but more since ~2018	0.25

A1-1.5. Simulation analysis concerning the under-funding of capital maintenance from past enhancements

Along with Anglian Water and United Utilities, we commissioned project from Reckon in 2022 which considered a number of issues relating to the interactions between base expenditure and enhancements in the context of Ofwat's approach to cost assessment.

One issue that the project considered was what Reckon described as the "Industry-wide risks of under-funding capital maintenance from past enhancements" and explained as follows:[14]

> *"The PR19 approach to cost assessment seems to lack a proper funding channel for the capital maintenance that arises from past enhancements. […] This issue arises from a number of features of the current arrangements acting together:*
>
> *It is not the intention, or effect, of Ofwat's explicit allowances for enhancement expenditure to cover the expenditure associated with enhancements that arises in later price control periods. These allowances are only meant to cover expenditure within the forthcoming price control period.*
>
> *There is no direct allowance, at the price review, for the capital maintenance expenditure that will be needed in the forthcoming price control period as a consequence of past enhancements.*
>
> *In some cases, the base-plus allowances might provide an implicit allowance for the capital maintenance expenditure for past enhancements through the explanatory variables used for base-plus models. For instance, this may be the case for enhancements relating directly to customer growth, given the use of explanatory variables capturing the scale of water companies' systems in the base-plus models (e.g. the number of connected properties or length of water mains or sewers). But this is very much a special case and whether the allowance is adequate would depend on the details of each case. Most aspects of companies' enhancement activities to improve customer service quality and environmental performance do not get recognised in the explanatory variables in the base-plus models.*

[14] Reckon (2022) *The opportunities for a more coherent regulatory approach for Ofwat's funding of base expenditure and enhancements*, pages 46-48.

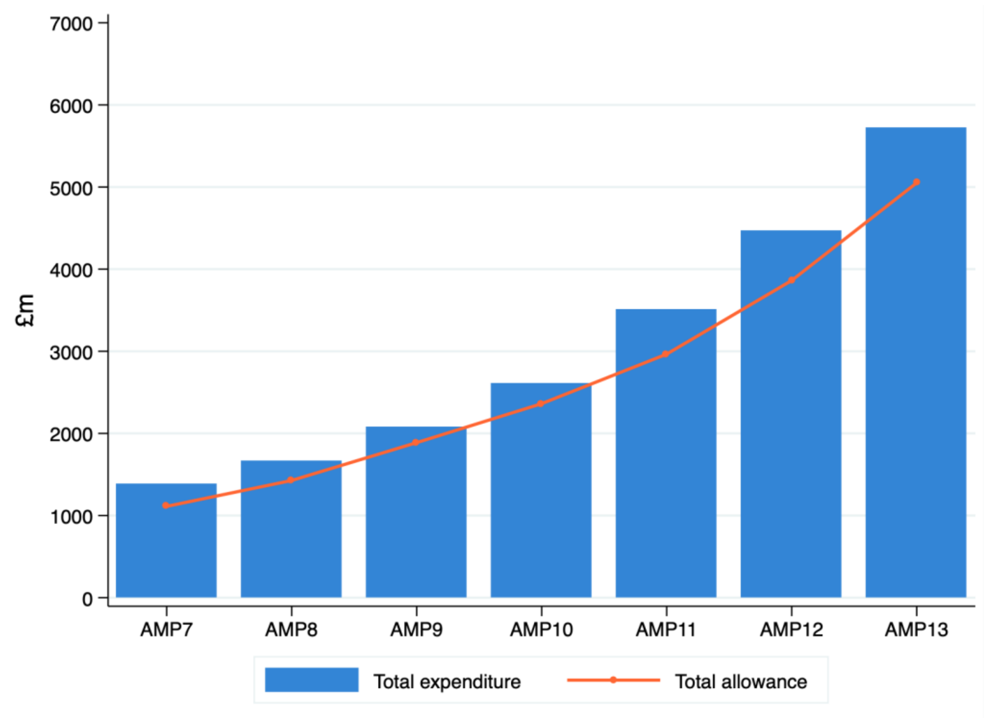
> *The capital maintenance expenditure incurred to maintain past enhancements across the industry will, over time, form part of the expenditure data feeding into the base-plus models. However, the allowances derived from base-plus models are estimated using historical data. There is a significant time lag before capital maintenance incurred in a given year feeds through to the allowances from the base-plus models. The allowances for one price control period tend to reflect the capital maintenance expenditure incurred historically (adjusted for any explanatory variables in the base-plus models: see point above) which, in terms of capital maintenance from enhancements, would tend to be less than the capital maintenance requirements faced today."*

In its analysis, Reckon assumed that Ofwat's PR24 econometric models of base costs do not have time trend explanatory variables (the PR19 models did not have time trend variables). The situation would be different if the models had well-estimated time trend variables, but this was not a feature of Ofwat's recent consultation on base cost models from April 2023.

Reckon's report included some simulation analysis intended to help illustrate - and develop a better understanding of - a number of the issues covered by the project. In relation to the capital maintenance arising from past enhancements, Reckon applied its simulation analysis to a simplified scenario in which companies have been doing capex-based enhancements with a 20-year asset life since AMP4 and in which Ofwat's base cost models cover the most recent five-year window of historical expenditure data.[15]

We reproduce a chart from the report below, which shows that under the simulation scenario, from AMP5 onwards, the total expenditure allowance derived from econometric models applied to historical base expenditure would not be sufficient to fund the efficient levels of a company's capital maintenance expenditure.[16]

Figure 4: Example of Reckon simulation analysis for a scenario of ongoing performance improvements achieved via capex-based enhancements in every AMP



[15] For a more detailed explanation of the simulation analysis see Appendix 1 (and in particular scenario S4) from Reckon (2022) *The opportunities for a more coherent regulatory approach for Ofwat's funding of base expenditure and enhancements*.

[16] Note that part of the shortfall is also due to the under-funding of operating expenditure, which is a separate issue in the Reckon report but also applicable to Ofwat's cost assessment approach.

A1-1.6. Wessex Water historical RCV growth

As highlighted above, a key aspect of this cost adjustment claim concerns the impact that past enhancement expenditure has on ongoing operating expenditure and capital maintenance expenditure.

With each successive phase of enhancement activity in each AMP, the capital asset base of the business grows and there are ongoing costs arising from these assets which form part of base expenditure in subsequent AMPs.

While the RCV is not a perfect measure of the capital asset base or growth it is nonetheless relevant to recognise that there has been significant real terms growth in the RCV over time.

We take Wessex Water as an example of a wider phenomenon. We present figures below for Wessex Water's real-term RCV growth over time. We show separate figures for wholesale water and wastewater since the start of AMP6 and figures for then total RCV since 2011/12.

We draw the following high-level points from this analysis:

- These figures are consistent with the view that the asset base of Wessex Water has grown in real terms over time.
- These figures show higher RCV growth for wastewater, which (if reflective of longer-term trends) is consistent with the finding from step 1 of the analysis in the section headed "Methodology and key results" that there have been larger increases over time in *base-plus expenditure* in wholesale wastewater rather than wholesale water.

Note that RCV is not a perfect measure of the value of capital assets (or changes over time in the physical asset base) for a number of reasons. For instance, the RCV not a pure measure of capital stock and may be affected by regulatory assumptions on RCV run-off and financeability considerations. For these reasons, we do not seek to use the figures from the table below as a direct measure of capital stock growth, but more as a secondary indicator.

Table 16: Calculations of approximate Wessex Water RCV growth over time on a CPIH-real basis

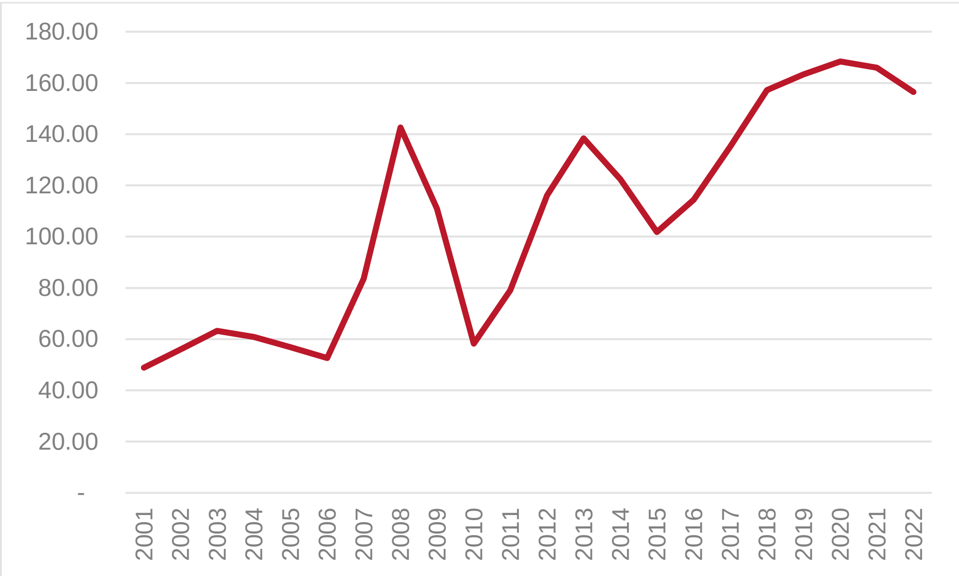
Area	Time period	Approximate annual growth in Wessex Water RCV (CAGR at constant CPIH price base)
Wholesale water	2015/16 to 2021/22	1.4%
Wholesale wastewater	2015/16 to 2021/22	1.8%
Total	2011/12 to 2021/22	1.7%

For these calculations, we took the average of the opening and closing RCV values for each financial year (on a financial year end price base) and then converted to a 2022/23 price base using figures for the financial year average CPIH in the corresponding year relative to the financial year average for CPIH for 2022/23.[17]

A1-1.7. Wessex Water capital maintenance over time

In this final section we show long-term profile over time in Wessex Water's capital maintenance expenditure (2022/23 prices) since financial year ending 2001/02. To allow for a long-term perspective, these are aggregate figures for Wessex Water, rather than broken down between wholesale and retail price controls or individual wholesale controls. We have excluded expenditure attributed to unregulated activities.

Figure 5: Wessex Water capital maintenance expenditure (excluding unregulated activities)



The chart shows significant increases over time, including in the period since 2011/12 which is the focus of analysis in the section headed "Methodology and key results". There are some ups and downs from year to year which reflect decisions on the profile of spend within price control periods.

[17] For our June 2023 submission we used a provisional figure for financial year average for CPIH for 2022/23. We also carried out sensitivity analysis using the CPIH figures from our business plan submission, which showed that this did not have a material impact on the net claim. In line with our broader approach for this claim, we have retained the figures from the June 2023 submission.

A2 CAC2 – Mains replacement costs

WSX09 - Annexes - Base cost adjustment claims

Business plan 2025-2030

Wessex Water
YTL GROUP

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CAC2 – Mains replacement costs

CONTENTS

A1 Mains replacement costs

A1-1. Introduction to the claim

A1-1.1. Overview of the claim

This cost adjustment claim submission relates to the additional costs that we expect to incur in AMP8 to deliver efficient increases in the level of potable water mains replacement activity, over and above the levels that we consider are implicitly funded through Ofwat's draft econometric models published in April 2023.

This document is to be read alongside the completed cost adjustment claim template. This document provides supporting information in line with Ofwat's assessment criteria for cost adjustment claims as set out in Appendix 9 of the PR24 final methodology. This section is structured in line with Ofwat's assessment criteria for cost adjustment claims.

A1-1.2. Scope of costs covered by this claim

This claim covers the costs associated with potable water mains replacement activity. These costs are reported within base expenditure and form part of modelled base costs.

A1-1.3. Summary of claim value

The gross and net values of the claim are summarised in the table below.

Table 1 Summary of the claim value

	2025/26	2026/27	2027/28	2028/29	2029/30	Total
Gross value of the claim (£m)	£11.701	£13.971	£16.682	£19.918	£23.782	£86.054
Implicit allowance (£m)	£10.168	£10.193	£10.218	£10.243	£10.268	£51.088
Net value of the claim (£m)	£1.533	£3.778	£6.464	£9.675	£13.514	£34.966

A1-1.4. We are not proposing a symmetrical cost adjustment

We are not proposing that Ofwat make a symmetrical cost adjustment across the industry as part of this claim. This claim is about a step change in Wessex Water's level of mains replacement activity in AMP8 relative to the levels undertaken in previous years and the levels implicitly funded by Ofwat's April 2023 models.

A1-2. The need for a cost adjustment

This section sets out our response to Ofwat's "need for a cost adjustment" criterion. We first set out some contextual information on the need for a cost adjustment. We then address each question that Ofwat has listed under this criterion.

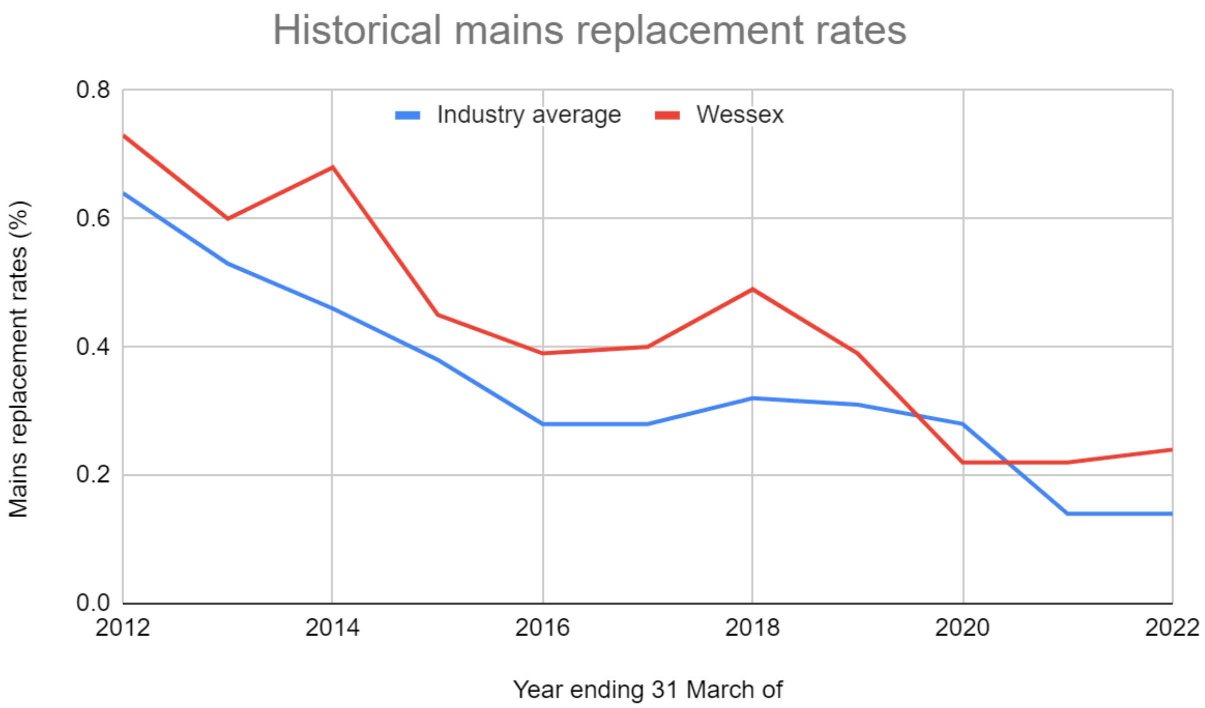
A1-2.1. Context for the cost adjustment claim

This section sets out some background information on historical mains replacement activity, the need for a step change in activity levels, and why a cost adjustment outside Ofwat's econometric models is needed.

A1-2.1.1. Historical mains replacement activity

As Ofwat has noted in Appendix 9 of the PR24 final methodology, the rate at which potable water mains have been replaced has fallen in recent years compared to levels seen earlier across the industry. The chart below shows industry average mains replacement rates since 2011/12 and compares this to Wessex Water's own replacement rates over that period.

Figure 1 Historical mains replacement rates across the industry



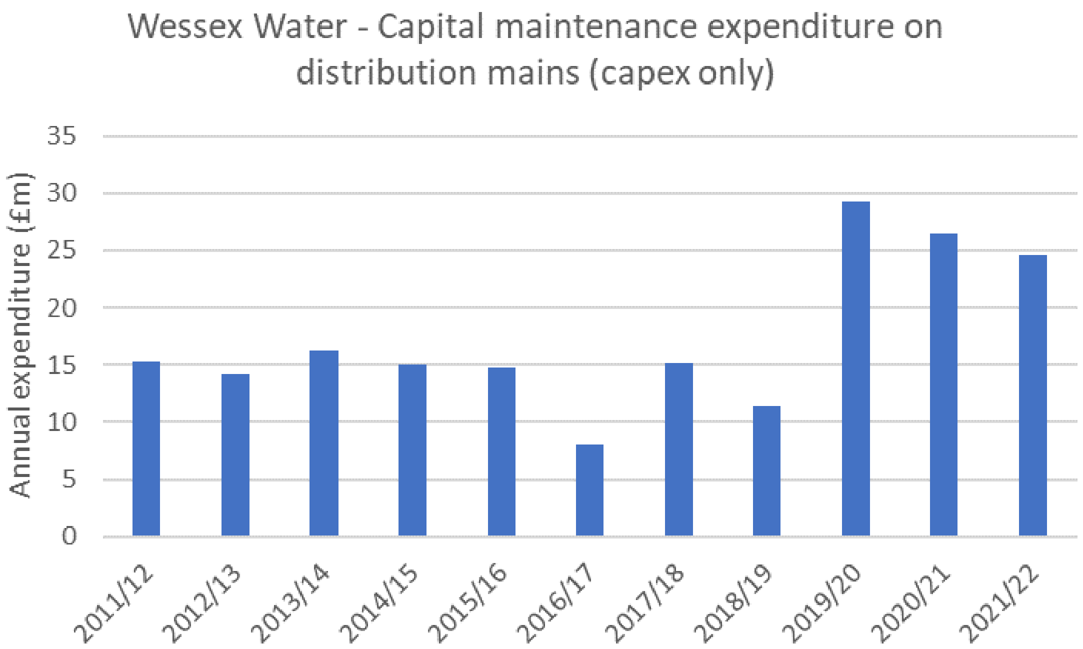
As shown in the chart above, our mains replacement rates have been reducing in recent years, although they have been above industry average levels in all but one of those years.

The timing of proactive mains replacement activity is, to an extent, within our control, particularly in the short term. In recent years, like the rest of the industry, we have targeted our capital maintenance expenditure on activities other than mains replacement, with a greater focus on areas such as proactive leakage detection and repairs on distribution mains to keep up with the challenging leakage reduction targets that Ofwat has set for us.

This has been necessary as our proposed enhanced performance investment in PR19 was allocated by Ofwat into base and as a result there was more pressure on base, and we had no choice but to reallocate within water network + and even with this we have considerably overspent the allowance.

As the chart below shows, we have significantly increased our expenditure in recent years on capital maintenance activities relating to distribution mains.

Figure 2 Wessex Water's capital maintenance expenditure on distribution mains (capex only)



Furthermore, across the water network plus price control as a whole, we have overspent our AMP7 ex ante totex allowances to the end of 2021/22 by 33% (Actual totex of £238m against ex ante allowances of £180m).[1]

A1-2.1.2. Efficient mains replacement rates going forward

We believe that the current low mains replacement rates are neither sustainable nor in the long-term interests of customers. This view is supported by industry-wide studies that considered this matter.

A study undertaken for UKWIR in 2017 found that if the industry-wide mains replacement activity were to continue at the levels seen in 2016/17, there would be significant negative outcomes for customers and the environment by 2050.[2] Specifically, the report concludes that by 2050:

- the number of water main bursts will increase by 20%
- the number of interruptions to water supplies will increase by 25%
- leakage will increase by 40% unless other leakage control measures are significantly increased.

[1] As reported in the 2021/22 APR data table 4C. Figures are net of business rates, abstraction licence fees, grants and contributions and other items not subject to cost sharing.
[2] Long term investment in infrastructure, UKWIR (2017)

In this context, it should be recognised that day-to-day operational performance (e.g. on leakage or interruptions) is not a reliable guide to changes over time in the risks posed to outcomes in the future.

Another study undertaken for Water UK found that across the industry:[3]

[As] of 2021, mains are (on average) 57 years old. Furthermore, there is a ‘long tail’ of assets that are older than this, with:

– 24.7% of assets being over 80 years old; and

– 13.2% of assets being over 100 years old.

The same study also found that average mains replacement rate in England and Wales in 2020/21 (0.1%) was significantly below the reported average replacement rates in Europe (1.0%).

We acknowledge that it may be possible to continue with the current low replacement rates in the near term, and focus on delivering outcomes that Ofwat has prioritised through its performance commitment framework (e.g. leakage and supply interruptions) through less capital intensive measures. However, we do not think that this is the long-term efficient approach for our customers.

Continuing with the current mains replacement activity with a view to increasing it in future AMPs would likely require much steeper increases in replacement rates to avoid the negative outcomes identified in the UKWIR report by 2050. This could lead to higher unit costs and deliverability issues as companies across England and Wales seek to do the same. It is far from clear that the risks to outcomes identified in the UKWIR report can actually be mitigated through remedial action when problems start to emerge. There are risks of adverse impacts on customer and environmental outcomes in the future, including risks of harm to customer trust in the industry and regulatory framework.

We believe that a more efficient approach, which is in the long-term interests of customers, would be to start to increase mains replacement rates in AMP8 and maintain higher rates going forward.

As part of the development of our PR24 Business Plan, we have assessed the efficient level of mains replacement activity for AMP8 in the context of our longer-term strategy. Following this assessment, we have concluded that it would be appropriate for us to target an average level of 0.4% over AMP8. We believe targeting this level in AMP8 strikes the best balance between the need for a step change, the deliverability of the replacement programme and the impact on customer bills.

A1-2.1.3. The need for a cost adjustment

In its final methodology decision, Ofwat said that it expects “*companies to manage cycles of maintenance across large, diverse asset bases within their long-term average cost allowance, and companies have a duty to maintain an efficient and economical system of water supply, including maintaining water mains*”.[4] We agree that we have this duty, but we believe that totex allowances will need to be set at levels that are sufficient to allow us to undertake increased levels of mains replacement activity, taking account of all the outcomes and performance commitments that Ofwat will set for us as part of the price controls. We do not believe that the modelled base costs that would result from the application of Ofwat’s April 2023 econometric models are sufficient to do this.

[3] Options for a sustainable approach to asset maintenance and replacement (2022), Economic Insight for Water UK
[4] PR24 Final Methodology Appendix 9 (Ofwat)

As set out in the previous section, we have had to significantly increase the level of capital maintenance expenditure in recent years, focusing on solutions such as reactive and targeted repairs rather than mains replacement, to deliver increasingly challenging leakage reduction targets that Ofwat has set for us. This has led to a decrease in the amount of mains replacement activity that we are able to undertake. We do not envisage a change in these cost pressures going forward.

Industry-wide levels of mains replacement activity over the period covered by Ofwat's April 2023 econometric models, and therefore the levels that are *implicitly* funded by those models, are significantly lower than the levels that we consider to be efficient – and in customers' interests - in the long term. See section [A1-2.5.3] for further details on our estimates of the levels that are implicitly funded.

In its PR24 final methodology decision, Ofwat states that companies can "*submit cost adjustment claims where they can evidence that a step change in capital maintenance/renewals is required to maintain asset health*". We will be reporting on the condition of our water mains through the additional business plan tables that Ofwat has introduced for PR24. We will also support Ofwat's efforts to make forward-looking assessments of asset health and the level of expenditure needed to keep these at sustainable levels. However, we believe that the work undertaken to-date on behalf of UKWIR and Water UK provide evidence that a step change in mains replacement activity is required. We will provide further evidence specific to Wessex Water as part of our Business Plan.

Ofwat also states that, in assessing any cost adjustment claims for mains replacement activity, "*we will take account of renewals companies have previously been funded to deliver when assessing claims to ensure that customers do not pay twice for mains renewals previously funded*". We agree that customers should not pay twice for the same thing.

However, under Ofwat's totex framework, price control allowances are not hypothecated to particular activities (unless these are covered by ODIs or PCDs), and companies have the flexibility to set their own expenditure priorities to meet outcomes and performance commitments that Ofwat has set. We have not sought to unduly benefit by reducing the level of mains replacement activity in recent years. Instead, we have prioritised our allowances on those activities that contribute to meeting outcome expectations and performance targets that Ofwat has set for us. In addition, we have overspent against our overall water network plus totex allowances in this AMP to-date by 33%.

We consider that it is relevant for Ofwat to look at past levels of over-spend or under-spend against totex allowances in the context of claims for customer funding for increases in proactive asset replacement. But we do not consider that it is appropriate – or consistent with Ofwat's totex framework – for Ofwat to adopt the possible view that that there is an explicit or implicit requirement on us to carry out a specified amount or rate of mains replacement in AMP7 or AMP6 (unless covered by and ODI or PCD)

A1-2.2. Unique circumstances

Ofwat lists the following questions in relation to this area:

a) *Is there compelling evidence that the company has unique circumstances that warrant a separate cost 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)?*
c) *Is there compelling evidence of alternative options being considered, where relevant?*

This claim for a cost adjustment is *not* based on a view that Wessex Water has unique circumstances that warrant an adjustment to allowances based on Ofwat's April 2023 econometric models, or that it faces higher efficient costs in the round than its peers. Indeed, the circumstances that justify this claim potentially applies more widely across the industry.

In its PR24 final methodology, Ofwat said that companies "*can submit cost adjustment claims where they can evidence that a step change in capital maintenance/renewals is required to maintain asset health*". This claim is based on our view that a step change in needed in the rate at which we replace potable water mains across our network, and that this necessary step change is not adequately funded through allowances derived from Ofwat's April 2023 econometric models.

We have considered alternative options that involve continuing the current rates of mains replacement into the next AMP. However, as set out in the previous section, we do not believe that those options would be efficient in the long term.

As such, we do not believe that the "unique circumstances" criterion is relevant to this claim.

A1-2.3. Management control

In relation to the "management control" area, Ofwat lists the following questions:

- d) *Is the investment driven by factors outside of management control?*
- e) *Have steps been taken to control costs and have potential cost savings (eg spend to save) been accounted for?*

Our claim is based on our view that a step change is needed in the rate of mains replacement to deliver long term efficient outcomes for our customers and the environment. As set out in the previous section, the timing of proactive mains replacement activity is, to an extent, within our control. However, this control only provides flexibility in the short term. Over a longer period, we cannot indefinitely maintain the current low levels of mains replacement activity without negative consequences in terms of asset failures, leading to higher levels of leakage and customer supply interruptions. In addition, the flexibility to defer mains replacement activity in the short term potentially comes at a cost in terms of lower efficiencies and higher unit costs in the future.

Our approach to achieving cost efficiencies and savings will be set out in our business plan submission later in 2023.

A1-2.4. Materiality

Based on totex forecasts set out in our business plan, our claim exceeds, by a considerable margin, Ofwat's materiality thresholds in respect of the water network plus price control.

As set out in section [A1-2.5.2], the gross value of our claim is £86m based on an increase in the annual average mains replacement rate over AMP8 to 0.4%. Taken in conjunction with our estimate of the implicit allowance of £51m, the net value of the claim is £35m over AMP8.

A1-2.5. Adjustment to allowances (including implicit allowance)

In relation to the adjustment to allowances, Ofwat lists the following questions:

- f) *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?*
- g) *Is the claim material after deduction of an implicit allowance? Has the company considered a range of estimates for the implicit allowance?*
- h) *Has the company accounted for cost savings and/or benefits from offsetting circumstances, where relevant?*
- i) *Is it clear the cost allowances would, in the round, be insufficient to accommodate the factor without a claim?*

j) *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?*
k) *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 now set out the rationale for our proposed adjustment to allowances, which also addresses Ofwat's questions.

A1-2.5.1. The treatment of mains replacement costs within Ofwat's April 2023 models

Ofwat's April 2023 consultation on econometric models for base costs includes 6 water resources plus models, 6 treated water distribution (TWD) models and 12 wholesale water (WW) models. The costs that are the subject of this claim, i.e. costs relating to the replacement of potable water mains, are included within the TWD and WW models.

As set out in the table below, we do not believe that the explanatory variables in any of Ofwat's proposed econometric models capture inter-company variations, or variations over time, in mains replacement rates (and costs).

Table 2 Explanatory variables (cost drivers) included in Ofwat's April 2023 econometric models

Level of cost aggregation	Proposed cost drivers in Ofwat's April 2023 econometric models	Are variations in mains replacement costs captured by the cost driver?
Treated water distribution	Scale • Length of potable water mains (included in all 6 models)	No. The scale variable does not capture differences between companies in mains replacement rates.
	Network topography • Booster pumping stations per length of mains (included in 3 models) • TWD – Average pumping head (included in 3 models)	No. Neither variable relating to network topography captures differences between companies in mains replacement rates.
	Population density • Weighted average density – LAD from MSOA (included in 2 models) • Weighted average density – MSOA (included in 2 models) • Properties per length of mains (included in 2 models)	No. None of the variables relating to population density captures differences between companies in mains replacement rates.
Wholesale water	Scale • Number of properties (included in 12 models)	No. The scale variable does not capture differences between companies in mains replacement rates.
	Treatment complexity • Proportion of water treated at complexity levels from 3 to 6 (included in 6 models) • Weighted average treatment complexity (included in 6 models)	No. Neither variable relating to treatment complexity captures differences between companies in mains replacement rates.

	Network topography • Booster pumping stations per length of mains (included in 6 models) • TWD – Average pumping head (included in 6 models)	No. Neither variable relating to network topography captures differences between companies in mains replacement rates.
	Population density • Weighted average density – LAD from MSOA (included in 2 models) • Weighted average density – MSOA (included in 2 models) Properties per length of mains (included in 2 models)	No. None of the variables relating to population density captures differences between companies in mains replacement rates.

Ofwat's consultation notes that it did consider using the proportion of mains renewed or relined as a cost driver explanatory variable relating to or capital maintenance requirements but decided against including this in the proposed models as Ofwat considered that it is under company control and could lead to perverse incentives.

A1-2.5.2. The gross value of the claim

The gross value of the claim is our forecast of the efficient cost of undertaking the planned level of mains replacement activity over the AMP8 period.

We have planned to deliver a mains replacement rate within AMP8 of 0.4% per year on average over AMP8. This rate represents the average replacement rate forecast to be achieved over the AMP. We have assumed that the replacement rate ramps up each year from our forecast level of mains replacement at the end of AMP7.

We have estimated the cost of undertaking the planned level of mains replacement activity by multiplying the length of mains replaced in that year by our estimated efficient unit cost of mains replacement (i.e. £350 per metre).

The table below summarises the calculation of the gross value of the claim.

Table 3 Summary of the gross value of the claim (provisional)

	2025/26	2026/27	2027/28	2028/29	2029/30	Total
Forecast length of potable water mains for Wessex Water (km)	12,206	12,236	12,266	12,296	12,326	
Forecast mains replacement rate (%)	0.27%	0.33%	0.39%	0.46%	0.55%	
Forecast length of mains replaced	33.4	39.9	47.7	56.9	67.9	245.9
Gross value of the claim Cost of mains replacement at the estimated unit cost of £350/m (£m)	£11.701	£13.971	£16.682	£19.918	£23.782	£86.054

A1-2.5.3. Estimated implicit allowance for mains replacement

Under Ofwat's price control framework, totex allowances are not typically attached to (or ring-fenced for) particular activities. In this context, the 'implicit' allowance for an activity is a notional concept, rather than one that is explicitly set out in a price control decision. As part of its assessment criteria for cost adjustment claims, Ofwat has specifically asked for claims to include estimates of the implicit allowance associated with the activities that are the subject of the claim.

Ofwat's April 2023 models cover the period from 2011/12 to 2021/22 and includes actual expenditure by companies on mains replacement activity, even if these costs are not separately identified. This means that estimates of modelled costs for PR24 derived from these models will include some implicit allowances for mains replacement activity.

Appendix 9 of Ofwat's PR24 methodology decision sets out guidance for companies on the estimation of implicit allowances and provides three illustrative and non-exhaustive examples for how implicit allowances could be calculated:

- removal of relevant expenditure from the cost models;
- removal of an explanatory variable from the models; and
- assessment of unit costs related to the claim.

We do not think that the first two approaches can be applied to this claim using information that is currently available to us. We do not have industry-wide data on expenditure on mains replacement activity over the relevant time period, and Ofwat's proposed models do not include an explanatory factor that could explain (or could proxy) variations between companies in mains replacement rates.

For the purposes of our claim, we have developed an approach that is broadly consistent with the third approach, i.e. assessment of unit costs related to the claim, tailored to work within the constraints of the data available to us. This approach is summarised below.

- Use industry-wide data to estimate the historical annual mains replacement rate for each company and year during the period covered by Ofwat's April 2023 models, i.e. from 2011/12 to 2021/22.
- Estimate the annual mains replacement rate (in % of mains length) that is implicitly funded by Ofwat's April 2023 models for notional company in the model. See below for further details on this aspect of our approach.
- Estimate the implied annual length of mains replacement (in km) for Wessex Water funded by the models by multiplying the mains replacement rate implicitly funded by the models by Wessex Water's forecast length of potable water mains.
- Estimate the implicit allowance for Wessex Water (in £m per year) by multiplying the annual length of mains replacement implicitly funded by the model by the forecast unit cost of mains replacement.

A key step in this approach is the estimation of the annual mains replacement rate that is implicitly funded by Ofwat's models. We explain our approach to this calculation below.

Ofwat's April 2023 models include expenditure on mains replacement for the period from 2011/12 to 2021/22. As set out in the previous section, none of the models include explanatory variables that could explain (or are correlated with) differences between companies in mains replacement rates (or replacement expenditure per km of main) over that period. This means that the modelled base costs derived from these models are likely to reflect the industry average level of mains replacement expenditure per km of main.

We do not have data on unit costs for mains replacement (£/km) for other companies. For the purposes of this early claim submission, we have assumed that mains replacement unit costs are broadly similar across the industry.

Under this assumption, the industry average level of mains replacement expenditure per km of main funds an industry average mains replacement rate (in % of mains length).

Ofwat's approach to setting the catch-up efficiency challenge, as set out in its April 2023 econometric modelling consultation, is to estimate efficiency scores as the ratio between actual costs and modelled costs in the last five years for which it has data (i.e. 2017/18 to 2021/22). This approach gives relatively little weight to actual expenditure by companies in earlier years (i.e. 2011/12 to 2016/17) of the period, including on mains replacement.

We do not know if Ofwat plans to retain this approach for the draft and final determinations. However, for the purposes of this early claim submission, we have assumed that Ofwat's catch-up challenge would be calculated using a comparison of companies' efficiency scores calculated over the last five years of historical data. This is the approach that Ofwat and the CMA took at PR19 for wholesale cost and is consistent with the calculation of efficiency scores presented in the spreadsheet published as part of Ofwat's April 2023 consultation.

We have industry-wide data on the average annual mains replacement rate (in % of mains length) over the period from 2011/12 to 2021/22. However, as set out above, Ofwat's use of a catch-up efficiency challenge calculated using data from the last five years means that the allowances derived from its models gives greater weight to the last five years included within the model.[5] In line with this approach, our estimate of the implicitly funded rate (after the application of the catch-up challenge) is the industry average level of mains replacement over the period from 2017/18 to 2021/22.

The implicit allowance for mains replacement is then estimated by multiplying the implicitly funded replacement rate by Wessex Water's forecast length of potable water mains and by the forecast unit cost of mains replacement (in £/km). The table below presents our estimates of the implicit allowance.

Table 4 Summary of the estimated implicit allowances for mains replacement based on Ofwat's April 2023 models

	2025/26	2026/27	2027/28	2028/29	2029/30	Total
Mains replacement rate implicitly funded by Ofwat's April 2023 models	0.24%	0.24%	0.24%	0.24%	0.24%	
Forecast length of potable water mains (km)	12,206	12,236	12,266	12,296	12,326	
Implicit allowance (£m) based on unit cost of £350/km	£10.168	£10.193	£10.218	£10.243	£10.268	£51.088

[5] To illustrate, consider a simple example where the models are estimated using 10 years of data, and where all companies are equally efficient (and spend the same amount as each other in proportionate terms relative to model explanatory variables) and where mains replacement across companies was 0.5% in the first five years and 0.25% in the last five years of data. In this context, we would expect the catch-up adjustment calculated over the last five years of data to pick up the lower expenditure in this period, relative to the full dataset, due to lower replacement rates in the last five years. While the catch-up efficiency challenge is typically presented as an adjustment for efficiency differences *between companies*, the adjustment also has the feature of adjusting for differences *over time* in spend and activities (insofar as not picked up via explanatory variables). On this basis, it seems more reasonable and internally consistent in this case to look at mains replacement rates over the historical period covered by the catch-up efficiency challenge than over the full data period.

The implicit allowance associated with this claim is sensitive to modelling choices that Ofwat makes as part of its draft and final determinations. As such, this estimate would need to be updated to take account of those choices, including in relation to the time period of data used for the purposes of estimating the catch-up efficiency factors.

A1-2.5.4. The net value of the claim

The net value of the cost adjustment claim is estimated by subtracting the implicit allowance from the gross value of the claim. This figure takes account of the catch-up efficiency challenge as set out in the section above. The net values based on our figures for the gross claim value are set out in the table below.

Table 5 Summary of the net value of the claim

	2025/26	2026/27	2027/28	2028/29	2029/30	Total
Gross value of the claim (£m)	£11.701	£13.971	£16.682	£19.918	£23.782	£86.054
Implicit allowance (£m)	£10.168	£10.193	£10.218	£10.243	£10.268	£51.088
Net value of the claim (£m)	£1.533	£3.778	£6.464	£9.675	£13.514	£34.966

A1-3. Cost efficiency

In relation to cost efficiency, Ofwat lists the following questions in its guidance:

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)?*
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?*
c) *Does the company provide third party assurance for the robustness of the cost estimates?*

The previous section explains how we have estimated the gross and net values of the cost adjustment claim for mains replacement. These estimates draw on our forecast of the efficient unit cost of mains replacement activity (in £/km) over AMP8.

For our mains replacement activity, we have used an average unit rate of £350/m which has been developed based on the actual cost of schemes delivered under this programme over the last three years using our internal delivery team. We have a dedicated internal delivery team focused on our business as usual mains replacement programme for all mains up to 320mm diameter. The internal delivery team has a mature and proven track record for delivering efficiently and innovatively and constantly challenges itself to use new construction methods to deliver safely, to time, cost and quality requirements.

Cost efficiency is supported by our supply chain frameworks and supplier/hub arrangements with over 70% of the overall project cost being competitively tendered.

To help provide independent validation, we have used the cost consultant ChandlerKBS to benchmark our mains replacement construction costs. They did this by applying their water sector cost models to a defined scope of work for a selection of recently completed schemes and this showed our internal delivery team was c23% more efficient.

A1-4. Need for investment

In relation to the need for investment, Ofwat lists the following questions:

a) *Is there compelling evidence that investment is required?*
b) *Is the scale and timing of the investment fully justified?*
c) *Does the need and/or proposed investment overlap with activities already funded at previous price reviews?*
d) *Is there compelling evidence that customers support the need for investment (both scale and timing)?*

[Section A1-2.1.2] of this document explains the rationale for our view that a step change in the mains replacement rate is needed in AMP8.

As set out in [Section A1-2.1.3], the proposed mains replacement activity in AMP8 does not overlap with activities that have been funded at previous price reviews.

A1-5. Best option for customers

We have proposed an annual average mains replacement rate (as a % of total potable mains length) of 0.4%. [Section A1-2.1.2] explains the rationale for our view that a step change in the mains replacement rate is needed in AMP8.

A1-6. Customer protection

a) Are customers protected (via a price control deliverable or performance commitment) if the investment is cancelled, delayed or reduced in scope?
b) Does the protection cover all the benefits proposed to be delivered and funded (eg primary and wider benefits)?
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?

We recognise that it is important to protect customers if the investment is cancelled, delayed or reduced in scope. In this case, the mains repairs asset health PC is not an appropriate measure of the investment delivered due to the lag effect on performance and its volatility due to weather conditions and leakage activities. We therefore would propose a PCD, subject to the final guidance on PCD's being appropriate for this purpose.

A3 CAC3 Growth at Water Recycling Centres (WRCs)

WSX09 - Annexes - Base cost adjustment claims

Business plan
2025-2030

Wessex Water
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CAC3 – Growth at Water Recycling Centres (WRCs)

CONTENTS

A1-1. Introduction and background

It is not clear how Ofwat will assess growth at Water Recycling Centres (WRCs) and, in particular, Dry Weather Flow (DWF) related costs, and therefore this high-level introductory claim has been prepared in the context of this uncertainty. The claim should be read alongside the appropriate data table entries, with costs as below:

Table 1: Growth at Water Recycling Centres - net value of claim

	2025/26	2026/27	2027/28	2028/29	2029/30	Total
CAC3 – Growth at Water Recycling Centres (WRCs)	£42.357m	£12.863m	£8.600m	£11.911m	£50.650m	£126.382m

Of the above proposed expenditure, c60% of this (£76m totex) is related to sites where the increased capacity is driven by DWF and pro-rata tightening.

In Ofwat's consultation on their proposed Econometric base cost models for PR24, they state:

> *"The main differences from PR19 are the exclusion of the following growth related costs from the base cost models at PR24.*
>
> - *Site-specific developer services costs – …*
> - *Growth at sewage treatment works costs – Arup concluded that a standalone econometric model may be a viable option for assessing these costs. We will continue to assess this. If a robust standalone cost model is not feasible, we may* revert to including growth at sewage treatment works costs in the base cost models. "[1]

Prior to AMP6, expenditure to increase capacity at WRCs driven by DWF and pro-rata tightening was funded under the Environment Agency's National Environment Programme (NEP) and allowances set against quality drivers. The growth models for PR19 and currently proposed for PR24 did/do not take into account this additional DWF quality expenditure in the historic data.

At time of submission of this claim there remains significant uncertainty regarding both the scope and scale of the Water Industry National Environmental Programme (WINEP) for AMP8. A number of sites we have identified for capacity provision have also been identified as requiring enhancements under the WINEP, particularly regarding nutrient requirements at our WRCs. Many of the currently developed options and proposed improvements to WRC discharges have been superseded through the emergence of new legislation and/or changes to regulatory guidance. Costs will be purpose split as appropriate and in line with Ofwats' regulatory reporting guidelines.

Given the uncertainty regarding how Ofwat will assess growth at WRCs, as well as the WINEP still being in development, we reserve the right to amend/re-submit this claim. We plan to provide further supporting evidence to Ofwat's cost adjustment claim assessment criteria as part of our business plan submission for any partially or not addressed through this early submission.

[1] Ofwat (April 2023). Econometric_base_cost_models_for_PR24_final.pdf (ofwat.gov.uk)

A1-2. Need for adjustment

For each permitted site, the Environment Agency (EA) sets numeric discharge permit limits for the daily Dry Weather Flow (DWF) of treated sewage or other effluent that operators may discharge. The effluent quality limits are determined on the basis of the permitted DWF.

The underlying need for investment in capacity enhancement is population and trade effluent growth in specific catchments. If growth within a WRC catchment leads to the measured DWF exceeding this permitted DWF limit, then we are required to investigate the reasons for the exceedance and provide a report to the EA. Measured DWF flows do tend to vary from year to year due to e.g. weather conditions or groundwater levels, although a higher DWF limit must be applied for if, following investigation, the cause of the exceedance is due to:

- Growth of connected pop, or
- Long-term increase in existing trade effluent discharges, or
- New trade effluent discharge, or
- Connection of other drainage systems.

To prevent deterioration of the receiving watercourse, a higher DWF permit limit will necessitate an associated tightening of quality permit limits, such as for sanitary or nutrient parameters. If the tighter quality limits cannot be achieved at the respective WRC through the operation of existing assets, then investment is required for provision of advanced treatment even if the WRC otherwise has capacity to meet existing sanitary and nutrient permit conditions.

Prior to PR14, quality enhancement due to a growth-related DWF exceedance was funded under the National Environment Programme (NEP) as a ‘prevent deterioration’ driver. As with PR14 and PR19, under the Water Industry NEP (WINEP) for PR24, the EA no longer allows for prevent-deterioration funding for sites with a DWF exceedance (i.e. growth beyond the permit headroom).

The following statement outlines the EA’s view on funding principles for DWF exceedance schemes:

> *“Investment required to ‘prevent deterioration’ to current permitted Dry Weather Flows (DWF) should be included in the WINEP under the prevent deterioration driver.*
>
> *Investment to accommodate growth beyond the permit headroom should not be included in the WINEP under the prevent deterioration driver, but should be included in water company business plans, as a supply demand scheme.”*[2]

The WRC growth model for PR19 model and the proposed PR24 model use load as the key variable, however the load / population equivalent (PE) increase used includes the additional PE provided by the DWF quality driver (but not the expenditure against the quality driver), making historic growth allowances look more efficient on a £ per PE added basis than in reality.

[2] Environment Agency (September 2022). PR24 WINEP Driver Guidance – Prevent Deterioration

A1-2.1. Materiality

Our business plan totex for AMP8 is still under development, so we do not have figures to apply Ofwat's materiality thresholds. Nonetheless, on current evidence:

- Our claim of £126m exceeds, by a considerable margin, Ofwat's materiality thresholds in respect of the wastewater network plus price control.

A1-2.2. Adjustment to allowances (including implicit allowance)

As set out in the introduction section it is not clear how Ofwat will assess growth at Water Recycling Centres (WRCs) and, in particular, Dry Weather Flow (DWF) related costs. Given the proposed exclusion of growth-related costs from the PR24 models, we would expect the corresponding implicit allowance funded by the models to be zero.

A1-2.3. We are not proposing a symmetrical cost adjustment

We are not proposing that Ofwat make a symmetrical cost adjustment across the industry as part of this claim at this stage, as it is unclear if Ofwat will assessment this costs within the base econometric models.

A1-3. Cost efficiency

Capex estimates have been derived from a high level capex costing tool, informed/calibrated through representative bottom-up estimates, alongside estimates developed for PR24. These bottom-up estimates are produced by our in-house estimating team, who have extensive experience both with Wessex Water and as commercial estimators for contracting companies. In addition to their core estimating skills the team also have substantial technical and design skillsets which contribute to making sure that the scope of works is complete and buildable. Additional estimating support was provided by our procurement team, who have day to day responsibility for procuring goods and services.

Risk allowances are required to cover unforeseen scope development, ground conditions and other risks. Typical risks to project costs, in addition to scope development, that may not be known during early development include changes in:

- Planning permission and conditions
- Environmental protection and improvement measures
- Land purchase costs, loss of business claims and other 3rd party compensation
- Extensive service / utility issues
- Major operational constraints
- Ground conditions.

The change in site opex associated with the required enhancement is similarly derived from a high level opex costing tool, informed/calibrated through representative bottom-up estimates and actual site-based opex costs, alongside estimates developed for PR24 which includes engagement with suppliers for new process units.

We have employed ChandlerKBS – an independent specialist cost consultant – to produce estimates for a representative sample of the investment proposals. They have extensive experience in the water sector and have worked with a number of other water companies. We supplied them with project briefs, appraisal reports, scopes of works, M&E schedules and civil quantities where available. In all cases the cost consultants were asked to provide independent estimates without sight of our cost values.

A1-4. Need for investment

A1-4.1. Discharge permit compliance

Discharge permit compliance measures progress against the EA expectation to achieve 100 per cent compliance for all licences and permits, and reduced impact on the water environment. The detail behind the measure is given in the EA's Environmental Performance Assessment (EPA) Methodology.

Increases in flows to sewage works can result in tightened permit levels to prevent deterioration of the environment. WRC compliance is therefore an important indicator as to whether investment levels have been sufficient to meet the pressures of new development and urban creep.

The following table illustrates discharge permit compliance by English WaSC from 2011, with data sourced from the EA's annual EPA.

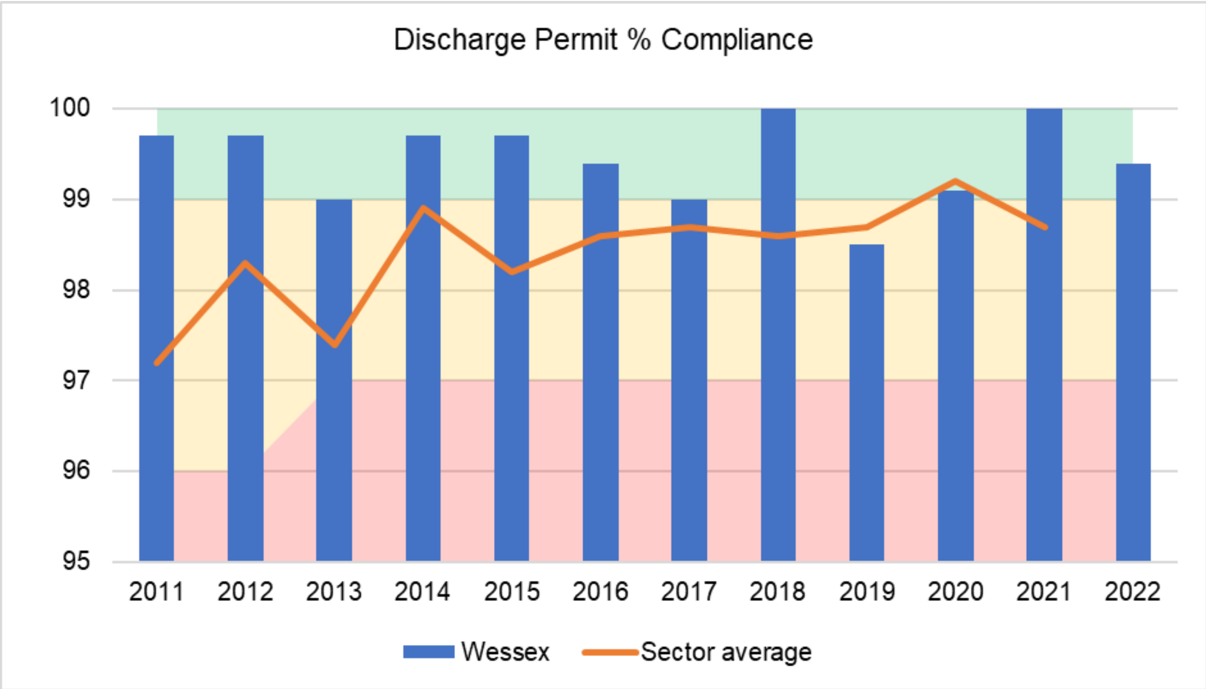
Table 2: Discharge permit % compliance – industry performance

WaSC	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Anglian	97.1	98.1	97.5	98.6	99.0	99.1	98.6	98.2	98.6	99.3	98.2	98.6
Northumbrian	99.4	100	98.1	99.4	99.4	97.8	96.0	99.4	96.6	99.4	98.3	98.9
Severn Trent	97.5	99.1	99.3	99.9	99.0	99.6	99.6	98.4	99.6	99.6	99.3	99.3
Southern	96.0	96.8	96.0	99.0	99.3	98.7	97.1	99.1	98.8	97.1	97.9	98.2
South West	90.1	97.1	92.5	96.1	95.8	98.1	98.2	98.7	98.7	99.0	97.5	99.4
Thames	99.7	99.1	95.7	98.9	99.1	97.9	99.5	99.0	99.7	99.7	99.0	99.5
United Utilities	98.6	99.2	98.6	98.3	97.2	97.4	98.8	98.7	98.5	99.7	99.0	98.5
Wessex	**99.7**	**99.7**	**99.0**	**99.7**	**99.7**	**99.4**	**99.0**	**100.0**	**98.5**	**99.1**	**100.0**	**99.4**
Yorkshire	97.3	93.2	98.0	99.3	99.3	97.2	98.6	97.5	97.5	99.0	99.0	99.7
Sector average	**97.2**	**98.3**	**97.4**	**98.9**	**98.2**	**98.6**	**98.7**	**98.6**	**98.7**	**99.2**	**98.7**	**99.0**
Wessex Rank	**1**	**2**	**2**	**2**	**1**	**2**	**3**	**1**	**6**	**6**	**1**	3

RAG scoring:	2011 - 2012	2013 - 2020	2021 to date
	≤96 red <99 amber ≥99 green	≤97 red <99 amber ≥99 green	≤98 red <99 amber ≥99 green

Wessex Water have historically consistently ranked 1st or 2nd for discharge permit % compliance and our permit compliance is consistently above the sector average. We have ensured our historical level of investment was appropriate in order to safeguard our ability to maintain this leading performance. As can be seen in the chart below, however, our discharge permit % compliance trend has been slightly downward whilst the sector average has improved. Indeed, in 2018 and 2019 we were below the sector average.

Figure 1: Discharge permit % compliance – Wessex Water performance



A1-4.2. DWF permit compliance

The EA sets limits on the quality and quantity of treated effluent from WRCs to ensure discharges from WRCs do not cause an unacceptable impact on the environment. The flow that may be discharged in dry weather is one of these limits. DWF is the average daily flow to a WRC during a period without rain, and the permitted DWF limit is set as the planned annual 80% exceed daily volume discharged. For compliance purposes an exceedance is recorded for a calendar year only when the limit at the end of that year is exceeded by 90% or more of the recorded total daily volumes in that year (excluding spurious/missing flow readings).

From 01/01/2026, the EA are changing their DWF compliance assessment. The DWF limits will have been complied with in an assessment calendar year unless the limit was exceeded in the compliance assessment year, and two or more exceedances have occurred in the preceding 4 years, summarised as ‘3-in-5 year’ compliance. Along with discharge permit compliance, the EA are considering adding flow compliance (including DWF) as a further EPA metric from 2027 (based on the 2026 calendar year).

As described in the following section, we have and continue to mitigate enhancement at WRCs linked with DWF compliance through maintenance activities in the sewerage network. This approach has, however, effectively led to a concertina effect where many sites are now at or imminently at risk of exceeding their DWF permit limits, and where infiltration reduction / sewer sealing is no longer sufficiently effective.

A DWF permit increase is associated with a pro-rata tightening of sanitary/nutrient permit limits under a ‘maintenance of load’ approach, alongside additional storm storage requirements (typically to meet 68l/hd, based on a residential population equivalent) as well as a potential increase to the flow passed forward (FPF) rate.

A1-4.3. Ofwat funding allowance

The table below summarises Wessex Water's request for WRC capacity provision through past business plan submissions and Ofwat's subsequent allowances.

Table 3: Prior business plan allowances for WRC capacity provision

	Business Plan Submission	Stated Capacity Provision	Ofwat (Implicit) Allowance	Actual Expenditure	Actual Capacity Provision
PR09/AMP5 2010-15	£52.9m*	77,095 p.e.	£60.4m	£57.7m	78,930 p.e.
PR14/AMP6 2015-20	£51.9m	72,358 p.e.	£29.5m	£60.4m	71,685 p.e.
PR19/AMP7 2020-25	£72.1m	138,714 p.e. *(see below)*	£49.5m	£23.9m *(to 2022/23)*	42,674 p.e. *(to 2022/23)*

All costs at 2022/23 price base.
* Excludes costs associated with DWF Exceedance, as prior to PR14 quality enhancement due to growth-related DWF exceedance was funded under the National Environment Programme (NEP) as a 'prevent deterioration' driver.

The stated capacity enhancement for PR19 included a significant proportion associated with AMP7 WINEP Flow to Full Treatment (FFT) Increase schemes, with PE stated here but c.95% of costs purpose split to 'Schemes to increase flow to full treatment'. This includes 30,729 PE at Avonmouth (Bristol) WRC and 19,937 PE at Saltford WRC.

For both PR14 and PR19 we submitted WRC growth cost adjustment claims for additional funding above the implicit allowance. On both occasions, however, our claims were rejected. We did not agree with Ofwat's allowance at either PR14 or PR19, but accepted the Final Determination in-the-round. To ensure we continue to appropriately invest in WRC growth to maintain compliance we invested greater than our allowance in AMP6, and are forecasting to do similar in AMP7, with a further £65m forecast by the end AMP7.

A1-5. Best option for customers

Our approach to ensuring DWF compliance is to:

1. Identify WRCs where the measured Q90 flow is approaching or exceeding the permitted DWF.
2. Assess the level of infiltration using population and consumption figures.
3. Survey sewerage catchments to locate areas of infiltration.
4. Prioritise the lengths of sewers identified for sealing.
5. Monitor flows post-sealing works.
6. Apply for a new permit where permit DWF compliance cannot be achieved.

Where WRCs have a measured Q90 flow within 15% of the permit DWF we calculate the theoretical DWF flow. If the calculation indicates that the measured Q90 flow reflects the predicted flow with little infiltration, then we assess development rates and likely timescales for permit exceedance and amendment.

The table on the following page indicates the progress that has been made since 2015. It identifies the investigations and sealing works completed and those planned. Whilst there have been a number of successful sealing works, in other catchments this success has only been partial. The table shows which catchment have been repeatedly visited for sewer sealing works at diminishing levels of success, and where a new DWF permit is now required at the WRC.

We regularly liaise with the EA regarding DWF compliance. For a number of the sites exceeding for extended periods we have engaged with the EA about aligning with PR24 WINEP requirements – such as phosphorus removal – to ensure we deliver holistic upgrades to the sites at lower overall costs. This does mean that we hold DWF compliance risk for longer. As noted earlier, with EA’s change in DWF compliance assessment and the likelihood of it becoming a metric in the EPA, we are no longer in a position to take this approach.

Table 4: DWF compliance and network mitigation measures

	Network Measures & Sewer Sealing Lengths (INV = Investigations, MF = Monitoring Flows, MHs = Manholes)									Flows										
Water Recycling Centres	**2015/16**	**2016/17**	**2017/18**	**2018/19**	**2019/20**	**2020/21**	**2021/22**	**2022/23**	**2023/24 (planned)**	**Permit DWF m^3/d**	**Q_{90} 2014 m^3/d**	**Q_{90} 2015 m^3/d**	**Q_{90} 2016 m^3/d**	**Q_{90} 2017 m^3/d**	**Q_{90} 2018 m^3/d**	**Q_{90} 2019 m^3/d**	**Q_{90} 2020 m^3/d**	**Q_{90} 2021 m^3/d**	**Q_{90} 2022 m^3/d**	**DWF 3 in 5 Year**
All Cannings	INV	445	MF	985 & MHs	MF	INV	734		245	**240**	279	259	288	259	236	265	392	332	167	Fail
Bishops Caundle					INV	664				**52**	42	48	60	43	41	50	51	50	44	Pass
Bradford on Tone	450	MHs & INV	14 & MHs			INV		263	INV	**280**	330	454	266	252	206	291	248	286	217	Pass
Buckland Newton	INV	MF	489		150	330	1,656	103	INV	**83**	101	80	165	122	130	165	197	162	127	Fail
Burton			INV				INV	244		**32**	35	33	36	27	29	25	37	38	31	Pass
Cannington		INV					INV			**510**	452	524	379	394	516	560	557	646	508	Fail
Cerne Abbas	330						INV			**159**	175	122	125	105	120	118	116	127	128	Pass
Ditcheat	INV	215								**144**	136	152	129	139	107	102	102	97	72	Pass
Fitzhead			INV							**55**	37	45	62	20	20	27	42	45	38	Pass
Great Somerford			INV							**177**	144	156	198	147	149	141	173	167	145	Pass
Great Wishford	INV	197	331	INV	235	INV	499	103	130	**791**	1,243	1,062	1,066	926	959	911	870	927	485	Fail
Halstock		INV								**95**	84	103	73	90	51	50	65	77	43	Pass
Hatch Beauchamp		INV							INV	**70**	67	70	81	90	82	74	72	78	78	Fail
Holt Pond Head							INV	211	INV	**75**	41	45	40	41	39	61	82	91	98	Fail
Hurdcott	INV	450	INV		898		INV		286	**2,034**	2,680	2,877	2,461	2,652	2,735	2,444	2,439	2,621	2,149	Fail
Lavington Woodbridge		INV	491 & MHs							**1,212**	1,393	1,241	1,157	1,132	992	1,023	1,208	1,119	1,030	Pass
Leyhill					INV	145		223		**300**	Adopted in 2016		289	275	305	308	298	285	244	Pass
Longburton	801	INV	MF	88 & MHs			601	230		**75**	84	81	149	102	81	96	82	92	71	Fail
Marden							INV	35		**190**	131	108	140	126	145	155	217	190	131	Pass
Marnhull Common				INV		215				**1,163**	1,159	1,068	1,119	1,238	1,091	1,100	1,136	1,089	1,043	Pass
Meare					INV			542		**227**	174	199	184	188	221	192	228	253	219	Pass
Merriott								879		**1,184**	865	686	689	675	625	497	1,179	1,290	1,162	Fail
Milborne Port	INV	92	MF	716		INV		1073		**900**	931	914	887	950	960	1,122	1,027	811	651	Fail
North Petherton		INV	267							**780**	803	804	727	667	642	721	715	725	654	Pass
Nunney		INV								**334**	427	335	205	212	246	233	255	226	173	Pass
Over Stratton	INV					263				**71**	131	92	69	90	70	81	89	93	83	Fail
Pewsey	INV	66	MF			56	308		INV	**1,596**	1,741	1,620	1,730	1,565	1,650	1,751	2,037	1,719	1,683	Fail
Puncknowle				INV						**435**	228	351	380	481	332	303	267	277	232	Pass
Ringwood				INV	INV	963		241	INV	**4,564**	5,277	3,868	3,791	4,681	4,912	4,753	4,624	4,984	4,205	Fail
South Perrott		INV	107							**160**	171	172	151	153	134	59	124	127	124	Pass
Stourton Caundle					INV					**100**	51	46	40	41	112	72	41	34	24	Pass
Sydling St Nicholas	374	MHs	MHs	MF		INV			450	**86**	118	113	110	71	53	63	69	69	53	Pass
Thornford	532	MF								**670**	676	630	518	591	493	541	441	425	359	Pass
Tisbury	INV	257	MF						INV	**925**	1,037	980	792	838	816	933	1,060	879	876	Pass
Wellington			INV	854						**3,750**	3,158	2,981	3,018	3,042	2,997	3,001	3,244	3,189	2,789	Pass
West Lavington			491							**1,212**	1,393	1,241	1,157	1,132	992	1,023	1,208	1,119	1,030	Pass
Wiveliscombe Styles				INV				INV		**318**	334	296	269	304	244	293	310	418	268	Pass
Wookey	INV	248	INV	572	MF	INV		743		**315**	434	439	427	507	308	372	387	455	404	Fail
Length Sealed (m)	**2,487**	**1,577**	**1,295**	**2,952**	**1,283**	**2,636**	**3,798**	**4,890**	**1,111**											

An example of sewer sealing improvement in permit DWF compliance is below.

Figure 2: Sewer sealing improvements prior to sealing (2013)

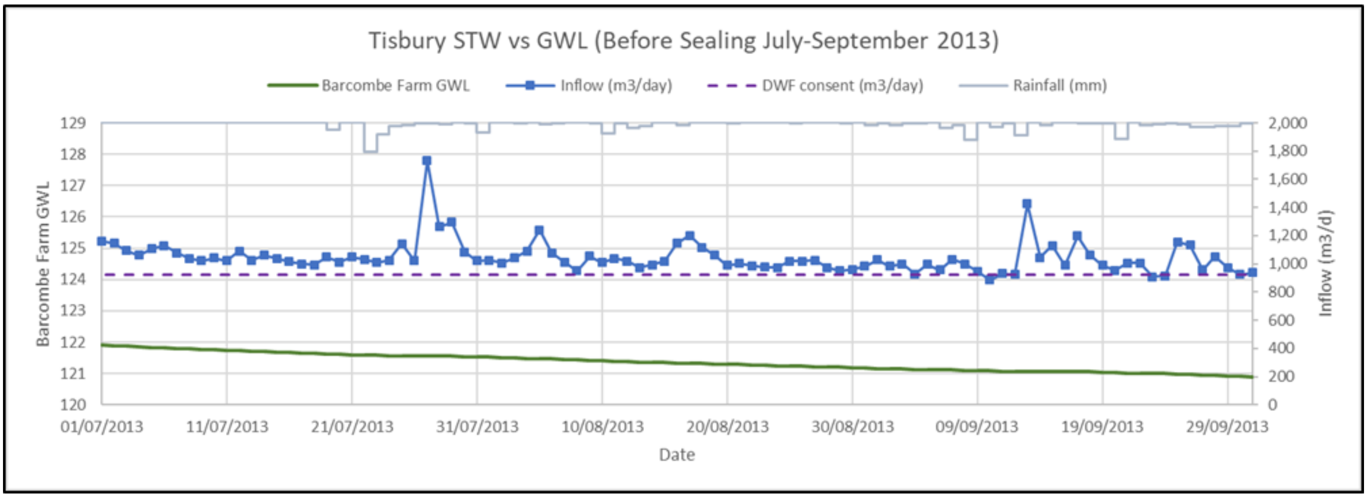
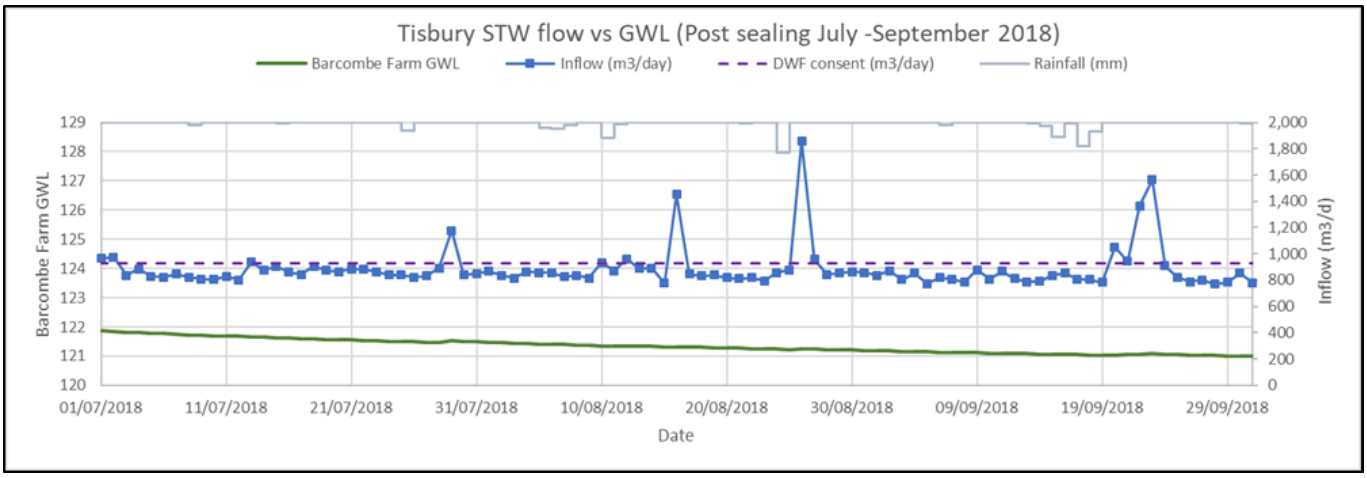


Figure 3: Sewer sealing improvements post sealing (2018)



For those catchments where sewer sealing does not show a demonstrable reduction in measured DWF and thus DWF compliance remains a risk, an increase in the DWF permit limit is required. For these WRCs we assess a number of different options, including many as described in our Drainage and Wastewater Management Plan and as summarised in the table below. We typically use a 20-yr planning horizon when forecasting new DWF permit limits, although in some cases adopt a shorter design horizon, for example to reduce the enhancement spend needed to achieve other permit limits (which could include tolerating a tightening of limits), or if there is uncertainty in the forecast growth, or to align with other expected future changes on site (either linked with a WINEP quality driver or capital maintenance needs promoting wholesale changes to a site's operation).

Table 5: Unconstrained options at WRCs

Option	Description
Modify consents/permits	Review/revise permits with the EA.
River catchment / dynamic permitting	Work with the EA to spread loading across the catchment, or seasonal/flexible permitting.
Tolerate	Site already achieving new permit requirements.
Optimise/operate	Increase the efficient use of the existing capacity with the existing assets.
Treat/pre-treat in network	Reduce load transferred to the WRC, e.g. network chemical dosing.
Rationalisation/centralisation	Close smaller treatment works and transfer flows to a larger one
De-centralisation	Remove flows from a treatment works and create localised treatment works
Catchment management initiatives	Source Control – Treating either diffuse or point-source non-domestic elements of wastewater before they enter the sewer system
	Catchment Nutrient Balancing – Treating and controlling the other contributors to the environment.
Discharge relocation	Relocate effluent discharge to remove/reduce the need for other enhancement.
Increase treatment capacity	Green – Nature-based solutions, such as integrated constructed wetlands.
	Grey – Invest in new assets to provide additional capacity.

We plan to provide further supporting evidence in this area as part of our business plan, including individual site/scheme based proposals.

A1-6. Customer protection

Ofwat are proposing a PR24 Performance Commitment on ‘Discharge permit compliance’, and state in their final methodology that they propose to use the EA’s discharge compliance metric definition, as described earlier. Our historical performance for permit compliance is outlined in the table below.

Table 6: Discharge permit % compliance - Wessex Water performance

WaSC	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Discharge permit % compliance	99.7	99.7	99.0	99.7	99.7	99.4	99.0	100.0	98.5	99.1	100.0	99.4

Our target of 100% discharge permit compliance is stretching and our investment in WRC capacity due to growth is critical to meeting treatment works compliance.

As this PC has an associated underperformance payment only, failure to invest and thus failure to meet the PC will ensure our customers are protected.

A4 CAC4 Catchment and nature-based solutions

WSX09 - Annexes - Base cost adjustment claims

Business plan
2025-2030

Wessex Water
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CAC4 – Catchment management and nature-based solutions

CONTENTS

A1 Catchment- and nature-based solutions

A1-1. Introduction to the claim

A1-1.1. Overview of the claim

This cost adjustment claim submission relates to funding for efficient operating expenditure relating to the continuation of pre-AMP8 catchment- and nature-based solutions (C&NBS).

- In relation to the water resources price control, the claim is for efficient operating expenditure for the continuation of pre-AMP8 C&NBS to improve raw water quality in a context where Ofwat's cost models are specified in a way that remunerates the costs of addressing raw water quality deterioration via increases to water treatment works complexity rather than solutions that apply before water reaches the treatment works.
- In relation to the wastewater network plus price control, it relates to the efficient operating expenditure for the continuation of AMP7 C&NBS to reduce nitrates and phosphorus in catchments.

This document is to be read alongside the completed data tables for this cost adjustment claim. This document provides supporting information in line with Ofwat's assessment criteria for cost adjustment claims as set out in Appendix 9 of the PR24 final methodology. This section is structured in line with Ofwat's assessment criteria for cost adjustment claims.

While we have included a cost adjustment claim for the ongoing operating expenditure of pre-AMP8 C&NBS, we do not consider that Ofwat's standard cost adjustment process is well-suited in this case and we would favour a separate remuneration process for these costs. Indeed, Ofwat has recently proposed an alternative funding arrangement for the ongoing operating expenditure for phosphorus removal (which is relevant to part of this claim), but this has yet to be confirmed. Our view is that Ofwat's standard cost adjustment process poses unnecessary risks of disincentivising C&NBS and innovative alternatives to conventional capex-intensive enhancement solutions because it does not provide the certainty that companies should be able to expect when choosing the most efficient solution. We have discussed this with Ofwat on several occasions and proposed alternative approaches to Ofwat that we do not repeat here for the sake of brevity.

A1-1.2. Scope of costs covered by this claim

This claim covers the efficient operating costs for the continuation of pre-AMP8 C&NBS.

- Costs associated with schemes that target raw water quality deterioration pertain to the water resources price control.
- Costs associated with schemes that address river water quality (phosphorus and nitrate removal through C&NBS) pertain to the wastewater network plus price control.

The set of catchment management schemes included within this claim relating to the water resources price control cover:

- Pre-AMP8 C&NBS that we expect to continue broadly unchanged into the AMP period.
- Pre-AMP8 C&NBS that we expect to continue into AMP8, but for which we plan to adopt a new and higher cost approach agreed with the Environment Agency in AMP8. These schemes will be used in catchments that face a particularly high risk from nitrates.

Tables 4 and 5 in section A1-2.51 set out a full list of these schemes. We have taken a decision on proportionality grounds to not include within this claim submission a relatively small amount of opex associated with schemes affecting other price control areas (i.e. bioresources).

A1-1.3. Summary of claim value

The gross and net values of the claim are summarised in the table below.

Table 1 Summary of the net value of the claim for water resources (2022/23 prices)

	2025/26	2026/27	2027/28	2028/29	2029/30	Total
Gross value of the claim (£m)	£2.336	£2.336	£2.336	£2.336	£2.336	£11.680
Implicit allowance (£m)	Zero	Zero	Zero	Zero	Zero	Zero
Net value of the claim (£m)	£2.336	£2.336	£2.336	£2.336	£2.336	£11.680

Table 2 Summary of the net value of the claim for wastewater network plus (2022/23 prices)

	2025/26	2026/27	2027/28	2028/29	2029/30	
Gross value of the claim (£m)	£4.672	£4.672	£4.672	£4.672	£4.672	£23.360
Implicit allowance (£m)	£0.012	£0.012	£0.012	£0.012	£0.012	£0.060
Net value of the claim (£m)	£4.660	£4.660	£4.660	£4.660	£4.660	£23.300

A1-1.4. We are not proposing a symmetrical cost adjustment

We are not proposing that Ofwat makes a symmetrical cost adjustment across the industry as part of this claim. This claim relates to Wessex Water's ongoing opex associated with current C&NBS. We did not identify a good basis for making material adjustments across the industry.

Instead, we propose that, if Ofwat accepts this claim, it might consider action to exclude, where possible, the historical operating expenditure attributable to the activities covered by this claim (at least for Wessex Water) from the scope of modelled costs *input data* feeding into its econometric models of base costs. This would be a proportionate step to tackle concerns of potential double counting across the industry. It may benefit from further information requests from companies.

This might be a similar approach to that which Ofwat would take under its proposals to provide a separate remuneration channel for the ongoing costs of phosphorous removal. While the details of that approach are not yet known, Ofwat may decide to exclude operating expenditure identified with phosphorous removal from its scope of modelled base costs.

A1-2. The need for a cost adjustment

This section sets out our response to Ofwat's "need for a cost adjustment" criterion. We first set out some contextual information on the need for a cost adjustment. We then address each question that Ofwat has listed under this criterion.

A1-2.1. Context for the cost adjustment claim

In Appendix 9 of its final methodology statement, Ofwat recognised the need to provide a level playing field between traditional and non-traditional solutions (i.e. nature-based and catchment solutions that primarily involve *ongoing* operating expenditure).

In relation to new enhancement schemes for AMP8, this would involve setting ten-year ongoing operating expenditure allowances (with the potential for companies to apply for further funding at the end of the ten-year period).

Ofwat also recognised that its base cost models may not provide funding for the continuation of schemes that were initiated in previous AMPs. Specifically, Ofwat said that companies may submit cost adjustment claims where they consider that the base cost models are "*unlikely to provide sufficient funding for catchment- and nature-based solutions allowed for in previous price reviews*". This cost adjustment claim sets out Wessex Water's request for a cost adjustment to fund such schemes.

Wessex Water began implementing C&NBS in 2005. These solutions involve working with local farmers and landowners within catchment areas to reduce nutrient levels in raw water sources and rivers. Our catchment management objective is to stabilise and then reduce the levels of contaminant at each source to reduce the complexity of treatment required at our water treatment works as well as to improve the quality of river water.

Through this cost adjustment claim submission, we are seeking funding for the continuation of catchment management schemes, for which funding is not reflected in the cost models, that we have categorised into two broad areas:

- Schemes that address raw water quality deterioration in our surface and ground raw water sources. The costs associated with these schemes are considered part of the water resources price control area.
- Schemes that aim to improve river water quality by reducing nutrient levels (particularly phosphates and nitrates) at source. The costs associated with these schemes are considered part of the wastewater network plus price control area.

We provide some background information relating to these schemes below, and more details including costs on the section on adjustment to allowances.

A1-2.1.1. Addressing raw water quality deterioration in surface and ground water sources through catchment management

Each of our surface and groundwater catchments have been designated as drinking water safeguard zones (SGZ) by the Environment Agency. Within these zones, specific substances must be managed carefully to prevent the pollution of raw water sources that are used to provide drinking water.

The water that flows into our surface water reservoirs comes from a number of sources over many miles, but it can become polluted by nutrients, pesticides and other chemicals on its way. The main water quality issue in our groundwater catchments is high and rising levels of nitrate, caused predominantly by intensive agricultural activities.

The more pollutants in our reservoirs and groundwater sources, the more complex our treatment processes need to be. The traditional methods to address raw water quality issues involve capital-intensive upgrades to our treatment works. Catchment management and nature-based solutions offer an alternative that is cost-effective and is better for the environment. These solutions involve partnering with local stakeholders, including local authorities, regulators and farmers in the catchment areas of public water supply boreholes and reservoirs.

We work with the farmers within the catchment areas to reduce the risk of pollution and support changes that will have a positive impact on water quality and the wider environment. This includes:

- raising awareness of surface water quality issues;
- sharing the results of water, soil, crop and manure testing that we have carried out for farmers;
- providing advice and information about ways of improving the efficiency of how their crops use key inputs, such as fertilisers and pesticides; and
- supporting farmers to adopt alternative practices to protect water, such as establishing buffer strips to prevent soil and pesticides from washing into watercourses.

The methods we use include sharing data, providing expertise and advice, and offering practical help and compensation, where applicable. As a result of this work, we've not had to install new treatment upgrades at any of the sites where we engage in catchment management.

Case study: Durleigh

Durleigh is a surface reservoir in the western area of our supply region which supplies water to Bridgwater and the surrounding area. The treatment works for the reservoir includes granular activated carbon (GAC) which is effective in removing most of the pesticides that enter the reservoir from the farmland in the catchment. However, the plant is not effective in removing metaldehyde, a widely used molluscicide which passes through GAC, so the source had to be shut down in 2008 when a large spike of metaldehyde entered the reservoir. It remained switched off for four months between September and December 2008 and the only way to remove the metaldehyde was to drain the reservoir and allow it to refill naturally with cleaner water from the catchment.

Treatment options were investigated but given the difficulty of removing metaldehyde we decided to tackle it using catchment management – active catchment management began at Durleigh in October 2008.

We sent a letter to all the catchment farmers explaining the situation and requesting their cooperation with our catchment adviser and followed this with joint visits to the catchment together with the Environment Agency (EA). Catchment water samples were taken and the results shown to the farmers. Their response was exemplary to the extent that one farmer, whose fields had been shown to be contributing significantly to the 2008 incident, voluntarily switched to a different, more expensive molluscicide.

In recognition of the goodwill and effectiveness of this action, we agreed to contribute financially to all catchment farmers who made the switch to non-metaldehyde based slug treatments. Catchment management continues at Durleigh through a mixture of catchment sampling, farm visits and a regular newsletter sent out jointly from the EA and ourselves. In addition to natural inflows from the catchment, we can also pump water into the reservoir, from *the River Tone via the Bridgwater and Taunton Canal, to top it up during autumn. The use of the canal at this time is a balance between the need to refill the reservoir and avoiding the transfer of any contaminant into it from the very large River Tone catchment where no catchment management takes place.*

Since the start of active catchment management there has been only one incident of metaldehyde exceedance in the reservoir and this occurred in October 2014 when significantly elevated metaldehyde levels occurred in the River Tone as the canal was being pumped. The volume of water pumped before sample analysis confirmed the metaldehyde contamination was enough to push the raw reservoir water over the limit. Fortunately, the success of catchment management in minimising metaldehyde within the natural reservoir catchment meant that once the canal pump was switched off, the natural catchment inflows were able to dilute the raw reservoir to the extent that there was no interruption to supply. Although unfortunate, this event provided further indication of the difference that our active catchment management makes.

Case study: Eagle Lodge

Eagle Lodge is a groundwater source supplying the Dorchester area. The water from the boreholes failed the nitrate standard several times between 1999 and 2001 and we are required by the Drinking Water Inspectorate (DWI) to ensure and maintain compliance with regard to nitrate. A nitrate removal plant was planned and designed for Eagle Lodge in 2004 but the high construction and running costs of such a plant, and the need for additional land to build it on, led us to look at a catchment management option for the source.

Our catchment management started in 2005 and followed a series of dry winters when nitrate peaks regionally had been lower than in previous years. The objective was to optimise nitrate inputs in the catchment to the extent that under high groundwater situations nitrate peaks remained below the nitrate standard.

Our catchment adviser made contact with the catchment farmers, explained the nitrate problem to them, obtained farm records, identified specific issues and developed a good working relationship. This allowed the adviser to suggest changes in farming practice including:

- *improved nutrient and manure management*
- *calibration of fertiliser spreaders*
- *altered drilling dates of autumn sown crops*
- *use of winter cover crops and the adoption of resource protection measures under environmental stewardship.*

Many farmers took up these options assisted, between 2005 and 2008, by a jointly funded European project, the Water Resources Management in Cooperation with Agriculture (WAgriCo). Since 2006, with a return of some wetter winters, there have been some nitrate peaks, but below the drinking water standard limit and well below the levels seen before catchment management began.

A1-2.1.2. Improving river water quality through catchment management

In addition to avoiding the need for complex water treatment at our treatment works, our catchment management activities have a significant beneficial impact on river water quality and the downstream environment. We are currently undertaking the following schemes in this area.

Phosphorus reduction at Rivers Stour, Tone, Parrett and Yeo

Wessex Water is working with farmers in sub-catchments of the Rivers Stour, Tone, Parrett and Yeo to reduce phosphorus (P) run-off from farmyards, tracks and fields. This P offsetting initiative forms part of a wider programme of water company investment where P removal is being installed at our water recycling centres (sewage treatment works) across the catchment.

- *This programme has already resulted in approximately six tonnes less P entering the River Stour each year and by 2025 around a further 190 tonnes will have been removed in this way.*
- *By 2020 this programme had already resulted in approximately 85 tonnes less P entering the Rivers Tone, Parrett and Yeo each year and by 2025 around a further 60 tonnes will have been removed in this way.*

In rural catchments such as these, wastewater treatment is only one source of P to the river, with agriculture being the other main contributor. By working with farmers to reduce P loadings from agriculture, the overall improvement in river water quality will be greater than if only P loadings from wastewater treatment are reduced.

Poole Harbour nitrogen offsetting schemes

Agriculture contributes to 66% of the nitrogen that enters Poole Harbour compared to the 12% that comes from our water recycling centres (WRCs). We are using catchment management since 2015/16 with the aim of reducing the amount of nitrogen entering Poole Harbour by 40 tonnes per year by 2020 through working with local farmers. We achieved this goal in 2016/17 preventing 60.4 tonnes of nitrogen from entering the harbour. For the five years that followed, we continued to surpass this target.

By working with farmers in the catchment, we have been able to invest in agricultural measures that reduce nitrate leaching and provide wider environmental benefits, such as biodiversity improvements. The alternative, installing nitrate removal plants at WRCs, only deals with nitrate and doesn't deliver wider environmental benefits. It would also be far more expensive, in addition to releasing significant quantities of carbon into the environment.

We work with the farmers in a targeted area of the Poole Harbour catchment to:

- *identify and raise awareness of water quality issues*
- *share the results of water, soil, crop and manure testing that we have carried out for them*
- *provide advice and information on ways to improve the efficient use of key inputs*
- *compensate farmers (where appropriate) for adopting alternative practices.*

A1-2.1.3. Ofwat's PR24 approach does not adequately fund pre-AMP8 enhancements that involve catchment management and nature-based solutions

Working with Anglian Water and United Utilities, we commissioned a report in 2022 from the consultancy Reckon, which gave particular attention to the regulatory treatment of nature-based solutions and operating expenditure associated with enhancement activities.[1] Reckon's report sets out how Ofwat's PR19 approach creates a bias in favour of enhancement initiatives that involve a relatively high proportion of capital expenditure rather than operating expenditure (see section 3.2 of the Reckon report).

Ofwat's final methodology for PR24 recognised these risks and proposed changes to its PR19 methodology for PR24. Ofwat's proposed changes are welcome and go some way towards addressing the bias against opex-heavy enhancements. However, these changes are not sufficient and, in any event, do not apply to enhancements that were undertaken before the start of AMP8.

In the rest of this section, we set out the reasons that Ofwat's PR24 approach does not adequately fund our pre-AMP8 catchment management and nature-based solutions. Taking each in turn, we consider the problems relating to the water resources price control and the wastewater network plus price control.

[1] The opportunities for a more coherent regulatory approach for Ofwat's funding of base expenditure and enhancements, Reckon LLP (sponsored by Anglian Water, United Utilities and Wessex Water)

Schemes costs reported within water resources

Opex relating to schemes that primarily address raw water quality deterioration in surface and ground water sources through catchment management and nature-based solutions are reported within the water resources price control.

As reported in the previous section, our approach of managing the deterioration of raw water quality through such non-traditional methods has meant that we were able to avoid capital-intensive upgrades to water treatment works across all catchment areas where we operate these schemes. This has led to significant cost savings for our customers compared to the cost of treatment works upgrades.[2] These catchment solutions also offer environment benefits that treatment upgrades cannot.

We recognise that we have achieved significant efficiencies in water treatment costs as a result of catchment management. However, Ofwat's proposed PR24 base cost models are specified in a way that explicitly penalises companies that prioritise catchment management and nature-based solutions over capital-intensive treatment upgrades.

Ofwat's April 2023 modelling consultation proposes to include within its wholesale water models explanatory variables relating to treatment complexity. Specifically:

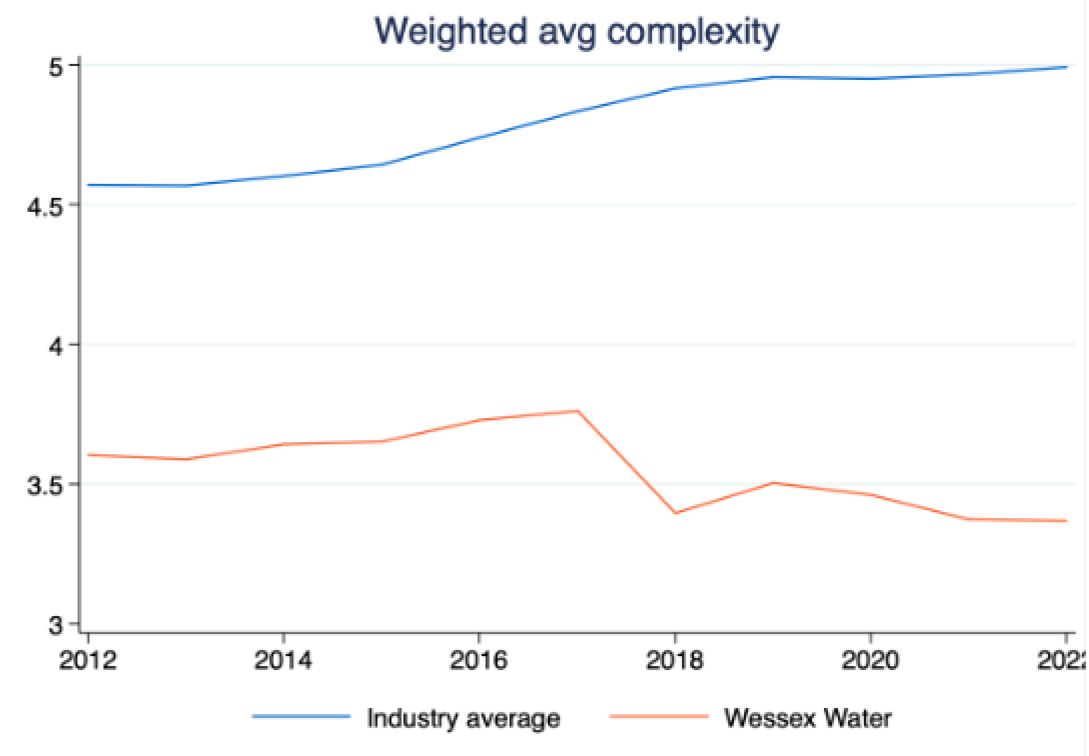
- The "*proportion of water treated at complexity levels from 3 to 6*" variable is used in three out of six water resource plus models and six out of twelve wholesale water models.
- The "*weighted average treatment complexity*" variable is used in the remaining water resource plus and wholesale water models.

While these variables capture do capture some differences between companies in the efficient cost of water treatment, these variables have the effect of remunerating treatment works upgrades but not catchment management solutions or other initiatives that improve the quality of water before it reaches the treatment works.

The chart below shows the evolution of the weighted average treatment complexity variable over the period covered by Ofwat's April 2023 models (i.e. 2011/12 to 2020/21), comparing the industry average to Wessex.

[2] Our estimates show that catchment management solutions costs, are on average across our catchments, only 12% of the costs of treatment works upgrades that deliver equivalent benefits (in NPV terms).

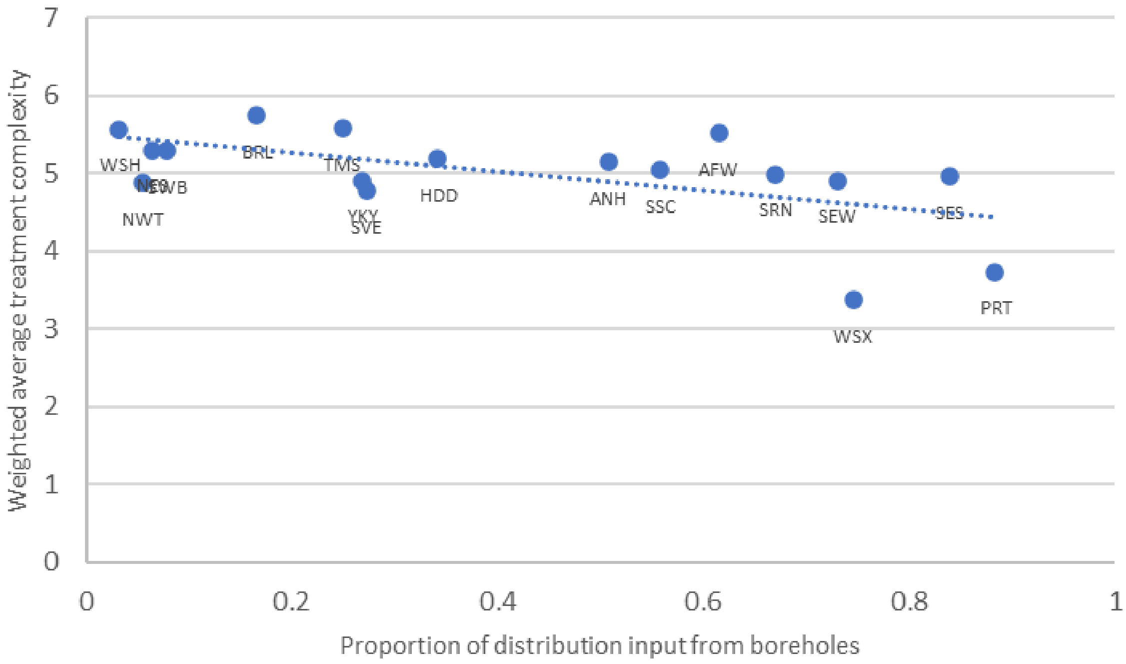
Figure 1 Evolution of the "weighted average treatment complexity" variable over time (Wessex vs Industry average)



The chart shows that there has been a material reduction and a downward trend in Wessex Water's weighted average treatment complexity variable, at the same time as a material upward trend in the same variable on average in the industry as a whole.

At the same time, we consider that this reduction in Wessex Water's weighted average treatment complexity has made it an outlier compared to the rest of the industry, even controlling for the fact that most of our raw water comes from groundwater sources (i.e. boreholes). The chart below shows the weighted average treatment complexity across the industry plotted against the proportion of that company's distribution input that comes from boreholes. Wessex is a clear outlier in terms of its low treatment complexity, and our investment in developing catchment management and nature-based solutions is the main driver for this.

Figure 2 Weighted average treatment complexity, controlling for proportion of distribution input from boreholes (all data from 2021/22)



Given that the coefficient on the treatment complexity term in Ofwat's models is positive (as expected), a reduction in the weighted average treatment complexity variable would lead to a reduction in the predicted base costs based on those models. This means that companies such as Wessex Water that seek to use catchment management over treatment works upgrades face the prospect of *lower* base cost allowances every time they implement such a scheme that successfully leads to improvements in raw water quality.

To illustrate this point, we have estimated what the values of the two treatment complexity variables for Wessex Water *would have been in the absence of our catchment management activities*, and used these alternative values to estimate what the predicted base costs for Wessex Water using Ofwat's models would have been under that scenario. Our estimates suggest that our modelled base costs would have been higher by £19m over AMP8 (and potentially in subsequent periods) if we had opted for treatment works upgrades over catchment management activities. This would have translated into higher bills for customers. A key feature of our claim therefore is not just that we have implemented catchment management solutions but that these have been successful in limiting the *upfront* and *ongoing* costs that customers pay.

We accept that some operating expenditure relating to catchment management and nature-based solutions may be included in Ofwat's modelling (to the extent that they are reported within base costs). We do not have data reported at a sufficiently granular level across the industry to be able to estimate the size of any implicit allowance arising from this inclusion. However, we consider that any implicit allowances are likely to be more than offset by the reduction in allowances through the treatment complexity variable (assuming that this variable appropriately captures the cost of upgrading treating works, and given our finding that the NPV of catchment management costs are just 12% of the cost of treatment works upgrades) compared to a counterfactual where we had implemented a treatment complexity solution. This feature of Ofwat's models acts as a material deterrent to non-traditional solutions to raw water quality deterioration in a way that is inconsistent with Ofwat and Government policy objectives. Furthermore, it would mean that Ofwat's approach to base cost assessment could fail to properly remunerate companies who have in the past adopted successful catchment management initiatives in the past.

We therefore believe that if Ofwat were to use its April 2023 models for draft and final determinations, a cost adjustment is required to ensure that Wessex Water is appropriately funded for its catchment management activities. Further details about our proposed adjustment are set out in [section A1-2.5].

Schemes costs reported within wastewater network plus

We now turn to consider C&NBS on the wastewater side of the business.

We include opex relating to schemes that primarily address river water quality through C&NBS within the sewage treatment and disposal activity area within the wastewater network plus price control.

Ofwat's April 2023 modelling consultation said that:

"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. We are exploring alternative options to ensure that our cost assessment approach funds efficient ongoing P removal costs, which we welcome company views on:

- *We will continue to consider models with a P-driver (eg percentage of load with a Ppermit <= 0.5mg/l) fixed at the 2024-25 level. This will have the impact of funding the additional base expenditure associated with phosphorus removal enhancement schemes funded at PR19 and completed by the end of AMP7.*
- *We are considering whether we can calculate an accurate post-modelling adjustment that funds efficient ongoing opex associated with P-removal using data provided by companies in annual performance reports (APRs).*
- *The cost adjustment claim process."*

At this stage of the process, we do not know which of these approaches will be adopted for draft and final determinations. In the event that Ofwat chooses to rely on the cost adjustment claim process, we consider that the costs included within this claim submission would qualify.

Wessex Water's phosphorus and nitrate removal catchment management schemes are at the forefront of industry efforts to address the quality of the natural environment downstream of wastewater treatment works. In a 2018 report, the House of Commons Environmental Audit Committee specifically referred to schemes operated by three water companies in England (including Wessex Water) in its discussion on the use of catchment management schemes to reduce nitrate concentrations in river water.[3]

"*Water companies told us that they were focusing on catchment management as contained within the RBMPs and engaging with the agricultural community, the Environment Agency, Natural England and independent agricultural advisers. This was because working in collaboration they could support initiatives which could tackle nitrate pollution at source rather than dealing with it downstream by way of expensive nitrate removal and water blending plants. Anglian Water told us that this approach delivers cleaner water but also other wider benefits such as biodiversity, amenity and habitat. Wessex Water, Yorkshire Water Services, and Anglian Water told us they have been helping farmers fund measures such as using cover crops during the winter to retain nitrogen and protect soils and had their own teams of advisers to help farmers ensure that where possible they could make decisions that reduced or mitigated nitrate and other forms of pollution.*"

In its April 2023 modelling consultation, Ofwat has proposed to include within its wastewater network plus models a subset of enhancement operating expenditure reported since the start of AMP7, including that relating to nitrogen

[3] UK progress on reducing nitrate pollution, Report of the House of Commons Environmental Audit Committee (2018)

and phosphorus removal. To the extent that companies report costs against these expenditure lines, Ofwat's models could be seen as providing some implicit allowances for the ongoing costs of these enhancements. However, catchment management and nature-based solutions are likely to be a subset of these costs. For Wessex Water, we estimate that 46% of the reported enhancement opex relates to catchment management schemes.

Separately, there may be pre-AMP7 schemes for which the operating costs are reported by companies within their base expenditure. To the extent that these costs are included, Ofwat's models could include some implicit allowances for the continuation of those schemes.

We have undertaken analysis of the enhancement opex reported by companies across the industry in the first two years of AMP7, and have produced indicative estimates of the implicit allowances associated with these reported costs. We set out these estimates in [section A1-2.5.3]. However, we do not have visibility of other schemes and associated costs across companies in England and Wales, and therefore are not in a position to estimate the size of any implicit allowances, if any, that may arise from any pre-AMP7 schemes.

Nevertheless, it is clear that our costs of continuing non-traditional schemes that were started in AMP7 and earlier are materially greater than any implicit allowances. A cost adjustment is therefore required to ensure that Wessex Water is appropriately funded for its catchment management activities. Further details about our proposed adjustment are set out in [section A1-2.5]

A1-2.2. Unique circumstances

Ofwat lists the following questions in relation to this area:

a) *Is there compelling evidence that the company has unique circumstances that warrant a separate cost 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)?*
c) *Is there compelling evidence of alternative options being considered, where relevant?*

As set out in the previous sections, Wessex Water is one of the leading water companies within England and Wales in its use of catchment management and nature-based solutions. This means that Wessex Water is in a relatively unique position in delivering water and environmental quality improvements through non-traditional solutions.

Furthermore, we do not consider that it is necessary for a company's situation to be completely unique for a cost adjustment to be warranted. What matters is how the company stands relative to others in the industry, given Ofwat's use of cross company benchmarking to set allowances for base costs. This point is considered in some detail in the Reckon (2022) report referred to above. Our position on this issue is consistent with that adopted by Ofwat for its PR19 adjustments for growth related expenditure, which took the historical industry average rate of growth in connections as the relevant reference point in considering need for adjustment.

A1-2.3. Management control

In relation to the "management control" area, Ofwat lists the following questions:

d) *Is the investment driven by factors outside of management control?*
e) *Have steps been taken to control costs and have potential cost savings (eg spend to save) been accounted for?*

We do not think this criterion applies directly to this claim.

The extent to which Wessex Water uses C&NBS to address raw water quality deterioration as opposed to traditional capex-based solutions is within our management control. Indeed, we have made a conscious decision to prioritise non-traditional solutions where possible and economically viable.

Our claim is based on our view that the Ofwat's price control approach fails to adequately remunerate companies that take this approach. Ofwat's final methodology for PR24 recognises this failure and proposed changes going forward. However, we do not think that these changes work for the continuation of pre-AMP8 schemes.

A1-2.4. Materiality

In relation to materiality, Ofwat list the following questions:

f) *Is there compelling evidence that the factor is a material driver of expenditure with a clear engineering / economic rationale?*
g) *Is there compelling quantitative evidence of how the factor impacts the company's expenditure?*

Ofwat's threshold for materiality is that the net value of the claim (i.e. the gross value less implicit allowances) should be greater than:

- For the water resources price control, 6% of forecast totex for AMP8.
- For the wastewater network plus price control, 1% of forecast totex for AMP8.

On current evidence, we do not expect the net value of our claim for non-traditional solutions would exceed the materiality threshold in either price control area.

However, we believe that these thresholds should not be applied to this specific claim. There are strong reasons for our position on this matter:

- There does not seem to be a good case for the application of a materiality threshold in a context where Ofwat has recognised that a funding gap exists for the continuation of non-traditional solutions that commenced in previous price control periods.
- The application of the same relatively high materiality threshold to claims relating to both AMP8 capex and AMP8 opex could in itself create a bias against opex-based solutions for equivalent benefits. Opex reflects the annual cost of the solution, whereas capex captures costs over the lifetime of the underlying asset so even if a capex-based approach was less efficient it would be more likely to exceed materiality thresholds.
- The application of a materiality threshold could be seen as a barrier to the continuation of catchment management and nature-based solutions, which would be inconsistent with stated Government and Ofwat policy in this area. The incentives that companies face in relation to nature-based solutions and other innovative initiatives are driven not only by the funding arrangements for new initiatives from AMP8 onwards but also by the approach that Ofwat takes to funding the ongoing costs of nature-based solutions that companies are already committed to.

We understood from Ofwat's PR24 final methodology that it was open to adopting a modified application of its standard cost adjustment process in relation to nature-based solutions. Specifically, Ofwat said that it proposed to change "*the burden of proof for cost adjustment claims which relate to catchment and nature-based solutions.*" The disapplication of the standard materiality threshold seems particularly relevant in this context.

A1-2.5. Adjustment to allowances (including implicit allowance)

In relation to the adjustment to allowances, Ofwat lists the following questions:

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?*
i) *Is the claim material after deduction of an implicit allowance? Has the company considered a range of estimates for the implicit allowance?*
j) *Has the company accounted for cost savings and/or benefits from offsetting circumstances, where relevant?*
k) *Is it clear the cost allowances would, in the round, be insufficient to accommodate the factor without a claim?*
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?*
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 now set out the rationale for our proposed adjustment to allowances, which also addresses Ofwat's questions.

A1-2.5.1. The gross value of the claim

The gross value of the claim is the forecast opex of continuing catchment management and nature-based solution schemes that had commenced in AMP7 and earlier. The tables below set out our current forecasts of costs split into the water resources and wastewater network plus price control areas.

Table 3 Water Resources: Gross value of the claim, £ thousands 2022/23 prices

Pre-AMP8 Scheme name	Approach to continuation into AMP8	2025/26	2026/27	2027/28	2028/29	2029/30
Belhuish SGZ enhanced CM	Continue using different approach	305	305	305	305	305
Cherhill SGZ enhanced CM	Continue using different approach	110	110	110	110	110
Deans Farm SGZ enhanced CM	Continue using different approach	386	386	386	386	386
Diversbridge SGZ enhanced CM	Continue using different approach	121	121	121	121	121
Fonthill Bishop SGZ enhanced CM	Continue using different approach	170	170	170	170	170
Friar Waddon SGZ enhanced CM	Continue using different approach	117	117	117	117	117
Milborne St Andrew SGZ enhanced CM	Continue using different approach	196	196	196	196	196

Sturminster MarshallSGZ enhanced CM	Continue using different approach	239.5	239.5	239.5	239.5	239.5
Shepherds Shore SGZ enhanced CM	Continue using different approach	115	115	115	115	115
Shapwick SGZ enhanced CM	Continue using different approach	239.5	239.5	239.5	239.5	239.5
Continuation Surface Water SGZ Catchment Delivery (Ashford catchment)	Continue unchanged	60	60	60	60	60
Continuation Surface Water SGZ Catchment Delivery (Durleigh Catchment)	Continue unchanged	60	60	60	60	60
Continuation Surface Water SGZ Catchment Delivery (Sutton Bingham)	Continue unchanged	30	30	30	30	30
Continuation Surface Water SGZ Catchment Delivery (River Tone to Durleigh catchment)	Continue unchanged	50	50	50	50	50
Continuation Groundwater SGZ nitrate CM (Alton Pancras)	Continue unchanged	2	2	2	2	2
Continuation Groundwater SGZ nitrate CM (Briantspuddle)	Continue unchanged	66	66	66	66	66
Continuation Groundwater SGZ nitrate CM (Bulbridge)	Continue unchanged	1	1	1	1	1
Continuation Groundwater SGZ nitrate CM (Eagle Lodge)	Continue unchanged	13	13	13	13	13
Continuation Groundwater SGZ nitrate CM (Empool)	Continue unchanged	23	23	23	23	23
Continuation Groundwater SGZ nitrate CM (Forston)	Continue unchanged	5	5	5	5	5
Continuation Groundwater SGZ nitrate CM (Hooke)	Continue unchanged	3	3	3	3	3
Continuation Groundwater SGZ nitrate CM (Litton Cheney)	Continue unchanged	4	4	4	4	4

Continuation Groundwater SGZ nitrate CM (Sutton Poyntz)	Continue unchanged	20	20	20	20	20
Total (Water resources)		2,336	2,336	2,336	2,336	2,336

Table 4 Sewage treatment and disposal (Wastewater network plus): Gross value of the claim, £ thousands 2022/23 prices

Pre-AMP8 Scheme name	2025/26	2026/27	2027/28	2028/29	2029/30
Poole Harbour Nitrate Offsetting Scheme	401	401	401	401	401
Poole Harbour Nitrate voluntary performance commitment	121	121	121	121	121
Phosphorus CNB (Stour, Parrett/Tone)	4,000	4,000	4,000	4,000	4,000
Nitrate Source Trend Modelling - Nmod20	50	50	50	50	50
Sustainable nutrient management to land investigation	100	100	100	100	100
Total (Wastewater network plus)	4,672	4,672	4,672	4,672	4,672

A1-2.5.2. Estimated implicit allowances for non-traditional solutions

Under Ofwat's price control framework, totex allowances are not typically attached to (or ring-fenced for) particular activities. In this context, the 'implicit' allowance for an activity is a notional concept, rather than one that is explicitly set out in a price control decision. As part of its assessment criteria for cost adjustment claims, Ofwat has specifically asked for claims to include estimates of the implicit allowance associated with the activities that are the subject of the claim.

Ofwat's April 2023 models cover the period from 2011/12 to 2021/22 and includes actual expenditure by companies on catchment management and nature-based solutions to the extent that these have been included within reported base expenditure even if these costs are not separately identified. Separately, Ofwat has said that it will include within its base cost models enhancement opex relating to phosphorus and nitrate removal relating to the years 2020/21 and 2021/22.

This means that estimates of modelled costs for PR24 derived from these models will include some implicit allowances for catchment management and nature-based solutions.

Appendix 9 of Ofwat's PR24 methodology decision sets out guidance for companies on the estimation of implicit allowances and provides three illustrative and non-exhaustive examples for how implicit allowances could be calculated:

- removal of relevant expenditure from the cost models;
- removal of an explanatory variable from the models; and
- assessment of unit costs related to the claim.

In relation to water resources costs, we do not have industry-wide data to be able to estimate the amount of relevant expenditure that are included within the models. Furthermore, Ofwat's proposed models do not include an explanatory factor that could explain (or could proxy) variations between companies in relation to these costs. As such, we are not able to estimate the size of any implicit allowances. However, as set out in the previous section, we believe that we are in a relatively unique position across the industry in the extent of our use of catchment management activities and nature-based solutions.

For the purposes of this claim, we have assumed that any implicit allowances arising from Ofwat's proposed water resources models are immaterial in the context of the claim.

In relation to sewage treatment and disposal, we have industry-wide data reported in APR submissions on enhancement opex associated with phosphorus and nitrate removals for the years 2020/21 and 2021/22. As set out in the previous section, non-traditional solutions are likely to be a subset of these costs. We do not have data on the extent to which any opex relating to pre-AMP8 schemes have been reported within base expenditure. For the purposes of this claim, we have assumed there are no costs reported within base expenditure.

We have developed an approach that is broadly consistent with the first approach, i.e. removal of reported enhancement opex. This approach is summarised below.

- We estimate annual average modelled costs for Wessex Water for sewage treatment and disposal over the period from 2017/18 to 2021/22 using Ofwat's models April 2023 models SWT1, SWT2 and SWT3, *including* the reported enhancement opex on phosphate and nitrate removal (i.e. Ofwat's original models).
- We then estimate the annual average modelled costs for Wessex Water for sewage treatment and disposal over the period from 2017/18 to 2021/22 using Ofwat's models SWT1, SWT2 and SWT3, *excluding* the reported enhancement opex on phosphate and nitrate removal for all companies.
- We calculate the difference between the two sets of modelled costs for Wessex Water. This is an estimate of the implicit annual allowance for Wessex Water for AMP7 enhancement opex on phosphate and nitrate removal.
- We then scale this implicit allowance down by an estimate of the proportion of Wessex Water's enhancement opex on phosphate and nitrate removal that is attributable to catchment management and nature-based solutions.
- This scaled-down figure is our estimate of the implicit allowance for phosphate and nitrate removal through nature-based solutions and catchment management arising from the inclusion of those enhancement opex lines within Ofwat's base models.

Using this approach, we estimate that the annual implicit allowance for nature-based and catchment solutions within Ofwat's sewage treatment models is £0.01m per year (in 2022/23 prices).

We focused on Ofwat's three sewage treatment models from April 2023 because these allowed the analysis to focus on sewage treatment costs, which is the focus of the claim.

These may be over- or under-estimates of the level of implicit allowances. However, due to data limitations, we are not currently in a position to improve upon these estimates. Ofwat may be able to request additional data from companies that would allow more robust estimates to be produced for its draft and final determinations.

A1-2.5.3. The net value of the claim

The net value of the cost adjustment claim is estimated by subtracting the estimated implicit allowance from the gross value of the claim. The net values are set out in the table below.

Table 5 Summary of the net value of the claim for water resources (2022/23 prices)

	2025/26	2026/27	2027/28	2028/29	2029/30	Total
Gross value of the claim (£m)	£2.336	£2.336	£2.336	£2.336	£2.336	£11.680
Implicit allowance (£m)	Zero	Zero	Zero	Zero	Zero	Zero
Net value of the claim (£m)	£2.336	£2.336	£2.336	£2.336	£2.336	£11.680

Table 6 Summary of the net value of the claim for wastewater network plus (2022/23 prices)

	2025/26	2026/27	2027/28	2028/29	2029/30	
Gross value of the claim (£m)	£4.672	£4.672	£4.672	£4.672	£4.672	£23.360
Implicit allowance (£m)	£0.012	£0.012	£0.012	£0.012	£0.012	£0.060
Net value of the claim (£m)	£4.660	£4.660	£4.660	£4.660	£4.660	£23.300

A1-3. Cost efficiency

In relation to cost efficiency, Ofwat lists the following questions in its guidance:

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)?*
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?*
c) *Does the company provide third party assurance for the robustness of the cost estimates?*

The previous section explains how we have estimated the gross and net values of the cost adjustment claim. These estimates draw on our current forecasts of the costs associated with catchment management and nature-based solutions over AMP8.

A1-4. Need for investment

In relation to the need for investment, Ofwat lists the following questions:

a) *Is there compelling evidence that investment is required?*
b) *Is the scale and timing of the investment fully justified?*
c) *Does the need and/or proposed investment overlap with activities already funded at previous price reviews?*
d) *Is there compelling evidence that customers support the need for investment (both scale and timing)?*

In this section, we provide a brief summary of the need for solutions that address deterioration in raw water quality and river water downstream from our treatment works. Although Ofwat's criterion mentions 'investment', these costs are primarily operating expenditure.

The costs covered by this claim relate to enhancements that Ofwat funded via previous price controls, but for which the funding provided does not extend into AMP8. This includes schemes that were enhancements in AMP7 and earlier schemes. As part of its enhancement allowances for raw water determination at PR19, Ofwat provided an allowance to Wessex Water for "the continuation of catchment management projects started in AMP6. Ofwat used its discretion in setting explicit enhancement allowances to provide funding for the ongoing operating expenditure of enhancements introduced in previous price control periods.

About 80% of the water we supply comes from groundwater sources in Wiltshire and Dorset. These natural underground reservoirs, known as aquifers, are formed when rainwater infiltrates rocks such as chalk, limestone and sandstone. Groundwater is usually free of the impurities found in other water sources like surface reservoirs or rivers so it needs less treatment. However, the level of treatment required to maintain and further improve water quality is affected by rising levels of nitrates and pesticides that the water has picked up from the soil.

The remaining 20% of the water we supply comes from surface reservoirs filled by rainfall and runoff from the surrounding catchment. Water quality in these reservoirs is directly affected by the activities taking place on this land. If routine operations such as pesticide and/or nutrient use are poorly timed or managed they can put additional pressure on treatment works or restrict use of the sources.

Fertilisers (nutrients) and pesticides are key components for agricultural production and land management. Nitrogen fertiliser increases crop yields and pesticides are used to control insects, molluscs, weeds and diseases. Excess nitrates that are not taken up by crops and pesticide residues that have not broken down are at risk of being washed into rivers and aquifers. These will pollute the environment and the water sources used for public water supply. Currently more than 20 of our water supply sources are affected by elevated nitrate concentrations.

The traditional approach to dealing with poor quality water has been to undertake capex-intensive treatment works upgrades. We have already built four treatment plants to remove nitrate and 11 sites now have carbon filters to remove pesticides. But these are expensive to build and operate, have a large carbon footprint and provide no benefit to the wider environment.

Building more treatment plants does not benefit the environment or our customers. Instead we have developed an approach that is more sustainable, lower in cost, has wider benefits for the environment and involves working with the local community.

A1-5. Best option for customers

[Section A1-2.1.] of this document explains the rationale for our view that catchment management and nature-based solutions can provide a cost-effective alternative to capex-intensive upgrades to treatment works.

A1-6. Customer protection

a) Are customers protected (via a price control deliverable or performance commitment) if the investment is cancelled, delayed or reduced in scope?
b) Does the protection cover all the benefits proposed to be delivered and funded (eg primary and wider benefits)?

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?

Given the legislation and regulatory incentives (including PCs) that exist around providing excellent quality drinking water and nutrient removal, we will be required to continue this work or propose an alternative, traditional treatment solution. This gives very significant customer protection against us discontinuing this spend and no further protection ought to be required. Specifically, Ofwat is clear that PCDs are to protect customers from under- or non-deliver of funded enhancements, and as this claim relates to the on-going maintenance of previous improvements, PCDs do not apply.

A5 CAC5 Industrial Emissions Directive (IED) and Environmental Permitting Regulations (EPR) costs

WSX09 - Annexes - Base cost adjustment claims

Business plan
2025-2030

Wessex Water
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CAC5 - Industrial Emissions Directive (IED) and Environmental Permitting Regulations (EPR) costs

CONTENTS

Background

Application of IED and EPR to bioresources

In February 2013, the EU Industrial Emissions Directive (IED) was transposed into UK law under the Environmental permitting Regulations (EPR). Under IED, pollutants from industrial emissions are regulated and industrial installations are therefore required to reduce their emissions to air, land and water. The Environment Agency (EA) have decided to enact IED across all industries in England and Wales, including bioresources. The application of IED in bioresources meant that all bioresources treatment sites undertaking the biological treatment of sewage sludge (i.e., anaerobic digestion) exceeding 100 tonnes per day are required to apply for IED environmental permits under EPR.

As sewage sludge has historically been exempted as a waste by way of the Urban Waste Water Treatment Directive, there was initial uncertainty surrounding the applicability of IED to sewage sludge treatment. A legal review was undertaken to resolve this and EA set out an interim position which delayed the need for water companies to apply for IED permits. In July 2019, water companies received an official letter from the EA confirming the requirement to apply for permits by August 2022. This has since been extended to December 2024 to account for permitting delays. This revised timescale means that design and delivery of improvement works for IED compliance will be undertaken in AMP8.

The move of sewage sludge into EPR regulation also means that all sludge treatment activities that currently operate under a T21 waste exemption, such as our lime treatment and mechanical sludge thickening sites, will need to operate under a waste operation permit in the future. This is because the EA are looking to change waste tonnage limits for the T21 to 100,000 wet tonnes imported per year to 100,000 wet tonnes indigenous plus imported volumes. There are no EPR standard rule sets for physico-chemical treatment, which lime treatment and mechanical sludge thickening are classed, and so these processes will require a bespoke waste operation permit.

The EA intended to publish their Sludge Strategy in 2023 to provide guidance on the permitting requirements for these T21 sites. However, they have indicated that this work is now delayed. Therefore, it remains unclear what the exact requirements would be for the T21 sites that will need to operate under bespoke waste operation permits, and the length of time allowed for transition changes. We anticipate that the permit requirement will likely be sometime in AMP8 and therefore, the design and delivery of improvement works required for EPR compliance will be undertaken in AMP8.

Implications on sludge treatment assets

All sludge treatment sites that require IED permits will need to comply with:

- The EU Waste Treatment Best Available Techniques (BAT) which are best economically and technically viable techniques in waste treatment to prevent, minimise and reduce emission to air, water and land.
- The EA's 'Biological Waste Treatment: Appropriate Measures for Permitted Facilities' guidance ('Appropriate Measures') which prescribes the measures that are required in the design, construction, operation, and maintenance of a waste operation facility.

BAT and Appropriate Measures (AM) are the key guiding principles underlying the EA's approach on IED compliance. The EA expect all sites to be risk-assessed to determine if they comply with BAT and AM. All non-compliant sites would need to be improved and upgraded to BAT and AM standards by December 2024. The EA have however indicated that as long as "best endeavours" are being made with IED site improvements, work can continue beyond the December 2024 deadline. This means that development of solutions and designs will be crucial to show the EA of our intentions to provide environmental protection.

Significant capital investment is required to bring the infrastructure at our five anaerobic digestion (AD) sites up to BAT and AM standards, so that they can comply with IED. The two areas that require significant CAPEX are the provision of impermeable surfaces and secondary containment to all digesters and sludge tanks, and the retrofit of all open sludge tanks with covers.

We also expect a significant increase in OPEX when the sites operate under IED permits, as additional operational and maintenance activities are required to maintain the performance of the AD process and condition of all sludge assets to the standard required by BAT. Examples of the additional responsibilities required under IED are the increased monitoring, sludge and liquor sampling, inspections for leaks (fugitive air emissions and potential liquid leaks to ground water) and odour, and maintenance of the new online monitoring equipment required under IED (such as flowmeters, pressure monitors and gas analysers).

The T21 sites that will be permitted under EPR will also need to comply with AM guidance. One uncertainty is there is no dedicated AM guidance for physio-chemical treatment, which would mean that the lime treatment process falls between the biological treatment AM and chemical waste AM. However, we expect all types of AM to be very similar, as they are based on BAT and the EA's necessary measures for waste operations. Therefore, we expect that the T21 sites will require significant improvements, like the IED sites, to meet AM standards.

Misalignment in PR19 timescales

The formal letter from the EA in July 2019 (Annex A9) requesting water companies to apply for IED permits came too late in the PR19 cycle, as business plans for AMP7 were already submitted. While the EA's position is that they have warned water companies about the future inclusion of sewage sludge into IED and EPR, this was challenged legally until 2019, which meant there was uncertainty around the applicability of IED on sewage sludge treatment throughout the PR19 planning process. Furthermore, at that time the EA were not clear on what they deemed as acceptable BAT as the AM guidance document was only consulted on in 2020 and published in 2022. Therefore, there has been a 'moving goalpost' leaving companies in a position where they have not been able to adequately estimate the level of investment required at the sludge treatment sites.

Therefore, in PR19, most companies did not include any costs associated with IED, as evidenced in Table 1 which shows the 'Allowance v. Submitted' costs in the PR19 Final Determination (based on the WWS5 table of each company's business plan data tables).

Yorkshire Water and Northumbrian Water subsequently included in their CMA submission that they will incur costs of complying with IED which were not considered at PR19. Both companies asked for an uncertainty mechanism that allowed for cost recovery through adjustments to the bioresources RCV in AMP7. CMA findings affirmed the uncertainty around the scope of IED and associated costs for compliance:

"There is a high level of uncertainty around the cost of IED compliance, arising from potential differences in needs, scope, and efficient costs for a large number of activities. This makes setting ex-ante allowances particularly problematic."

Table 1 - Allowance v. submitted cost table from PR19 FD[1]

Other costs, allowances for AMP7
Price base: £m Real, 2017/18 prices

Cost: **Industrial emissions directive**

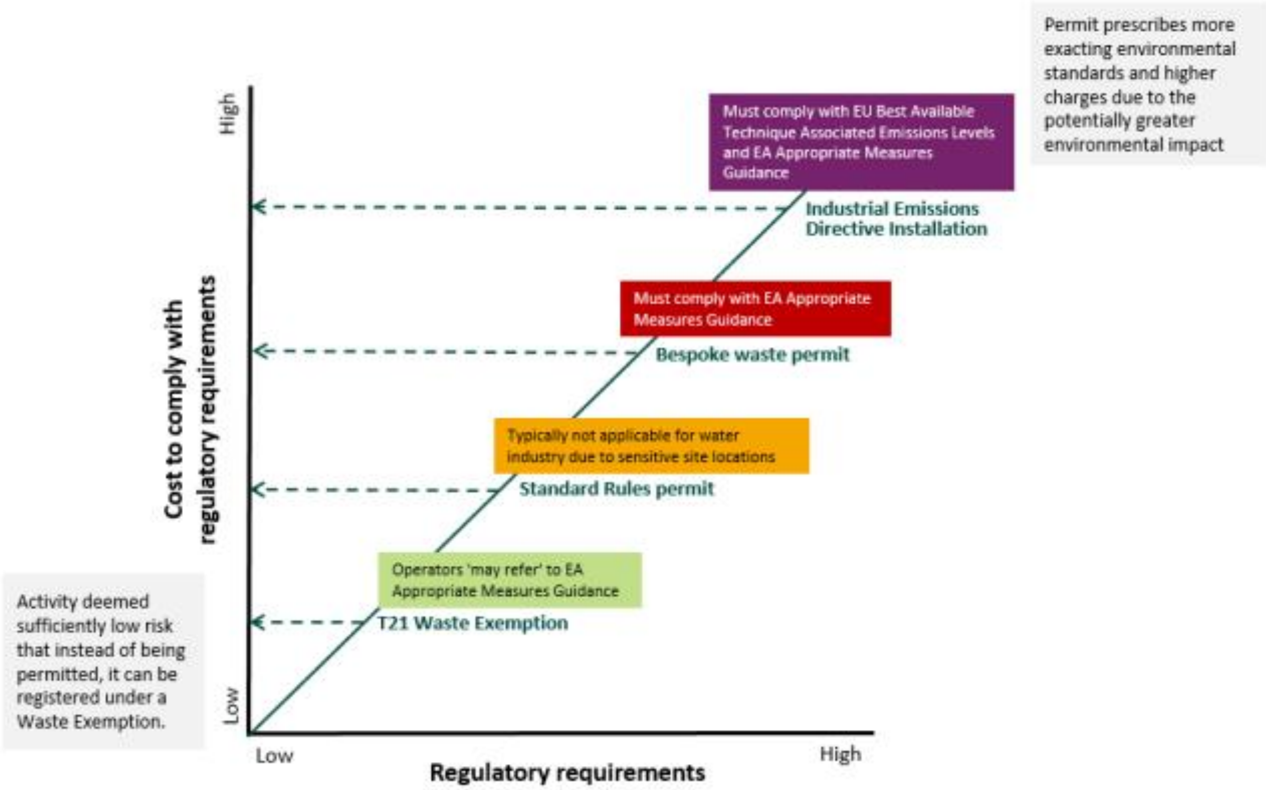
	Business plans		Ofwat allowance	
Company	Wastewater network plus	Bioresources	Wastewater network plus	Bioresources
ANH	0	0.0	0.0	0.0
HDD	0	0.0	0.0	0.0
NES	0	0.0	0.0	0.0
NWT	0.9	8.7	0.9	8.7
SRN	0	0.0	0.0	0.0
SVE	0	0.0	0.0	0.0
SWB	0	0.0	0.0	0.0
TMS	0	0.3	0.0	0.3
WSH	0	0.2	0.0	0.2
WSX	0	0.0	0.0	0.0
YKY	0	0.0	0.0	0.0
AFW				
BRL				
PRT				
SES				
SEW				
SSC				
Total	**0.9**	**9.2**	**0.9**	**9.2**

Further scope creep in PR24

The lack of guidance in PR19 on what the EA deemed as acceptable BAT resulted in uncertainties around the scope of site improvements required and therefore the level of investment required in AMP7. Additionally, the EA stated in a Waste and Recycling Network meeting in June 2019 that they consider the cost implications will relate to permit variation costs and limited asset improvements, as they assumed that there was not a significant step change in standards required under T21 Waste Exemptions (that companies had to comply with prior to IED) to those required under IED. However, this was not the case, as the “goalpost” for what was acceptable BAT solutions continued to move in the following years which resulted in the scope of IED improvements to grow larger than previously expected. This is also supported by Atkins in their independent technical review of IED in April 2023. A figure from their report which shows the significant step change in regulatory requirements and associated cost to comply is provided in Figure 1.

[1] Source: https://view.officeapps.live.com/op/view.aspx?src=https%3A%2F%2Fwww.ofwat.gov.uk%2Fwp-content%2Fuploads%2F2019%2F12%2FFM_UC_OtherCosts_FD.xlsx&wdOrigin=BROWSELINK

Figure 1 - Regulatory requirements and costs to comply[2]



The AM guidance, which the EA only formally published in September 2022 after the vast majority of permit applications were made, sets out blanket requirements for all assets in a prescriptive approach using terminology such as "you must", whereas BAT allows for a more risk-based approach. AM effectively raises the bar in environmental protection standards and the associated costs for compliance. AM requirements significantly exceed those of BAT in the areas of covering/storage and secondary containment, which are two areas that require the most significant investment to upgrade. We have seen an instance of the EA's strict adherence to AM requirements when they rejected our risk-assessed containment proposal of providing vehicle collision protection to a concrete tank at Poole, insisting that secondary containment is necessary for this tank despite its extremely low failure rate.

As of September 2023, the EA have provided more clarity to their "must" statements in the AM guidance document. They clarified that operators should risk-assess the requirements to determine if the prescribed appropriate measure should be applied or an alternative measure would be more applicable. However, any alternative measure must provide the same level of environmental protection.

The comparison between BAT and AM has been assessed by Atkins, and their summary is provided in Annex A1.

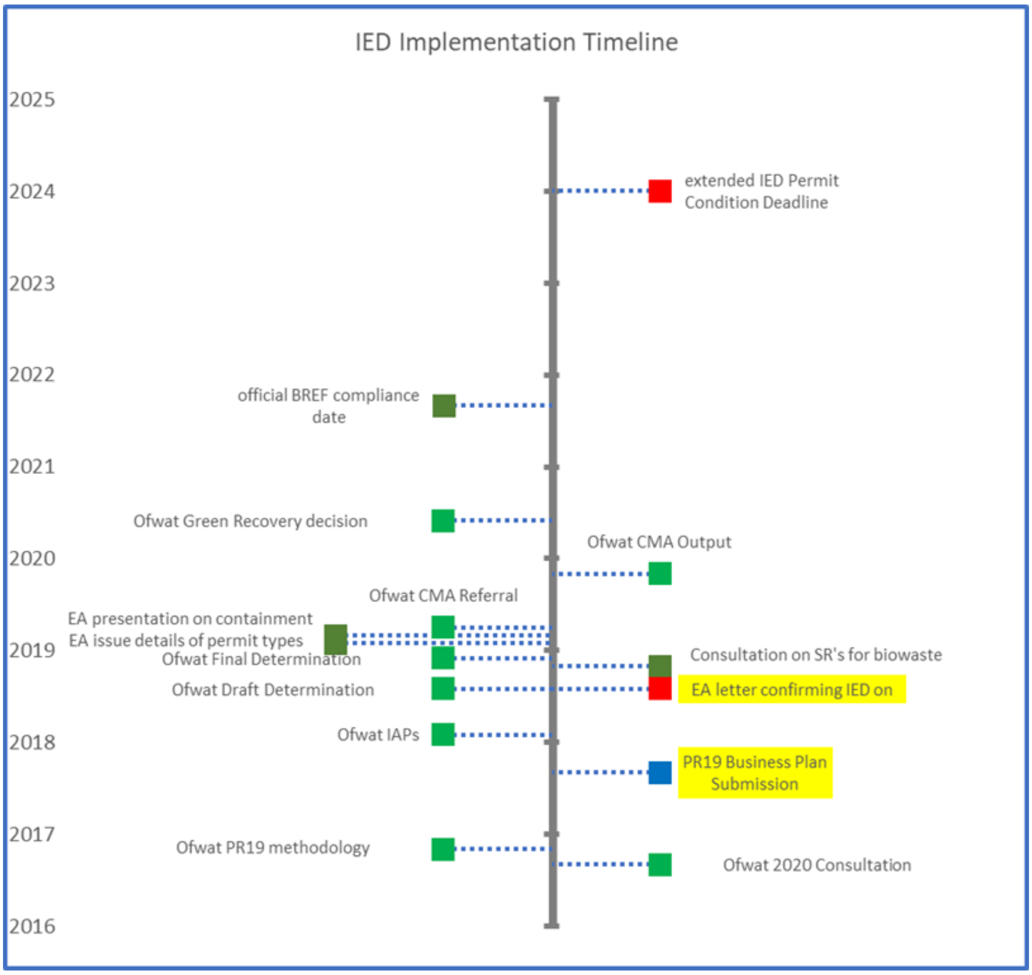
Timeline of events

Figure 2 (taken from a briefing note on IED to Water UK in May 2022) shows when significant events have taken place in the development of IED within the industry. As can be seen the industry did not have clear guidelines that

[2] Source: Atkins, "Industrial Emissions Directive Supporting Document for Water UK," 2023.

permitting would be required in AMP7 and so were unable to adequately estimate the investment required. Additionally, delays in the release of the AM guidance have put further pressure on being able to clearly articulate the costs of compliance.

Figure 2 - Timeline of IED related events[3]



United Utilities submitted IED investment proposals under the Green Recovery scheme in 2020, but were rejected by Ofwat because the deadline for IED compliance was 2024, so IED investment proposals would not needed to be brought into AMP8. Ofwat cited the EA's position that companies have been given sufficient time to have their sites BAT-assessed, draw up improvement plans and implement them before 2024. However, we now know that this would have not been the case, and the delivery of IED improvements were likely slip into AMP8 due to the scope creep caused by AM guidance in 2022 and the delays in the permitting process. However, Ofwat acknowledged in their Green Recovery final decision document that:

"…if any IED requirements did extend into the 2025-30 period, [they] would be open to considering an allowance under transition funding allowance for investment in 2024-25 as part of the 2024 price review. This process is available for all companies that did not appeal their PR19 final determinations to the Competition and Markets Authority."

[3] Source: Thames Water, "IED Background for Water UK," 2022

The industry considered including IED investment proposals in the PR24 Water Industry National Environment Programme (WINEP) as the IED obligations are viewed as PR24 sludge enhancement activities. However, Ofwat and EA both disagreed with this view (as evidenced in the Ofwat WINEP feedback letter in 2022 in Annex A5, and the EA-WaSCs WINEP evidence log in Annex A6). Therefore, we did not include any IED investment proposals in our PR24 WINEP programme.

Permit details

In Table 2, the expected permit dates detailed are the latest estimation produced by our EA permitting officer in early August 2023. The expected permit dates for the physico-chemical permits at the lime sites will depend on when the EA publish their Sludge Strategy and the length of time allowed for transition changes. We expect there could be similar permitting delays as experienced for the IED installation permitting process with the number of physio-chemical only permits needed in the water industry.

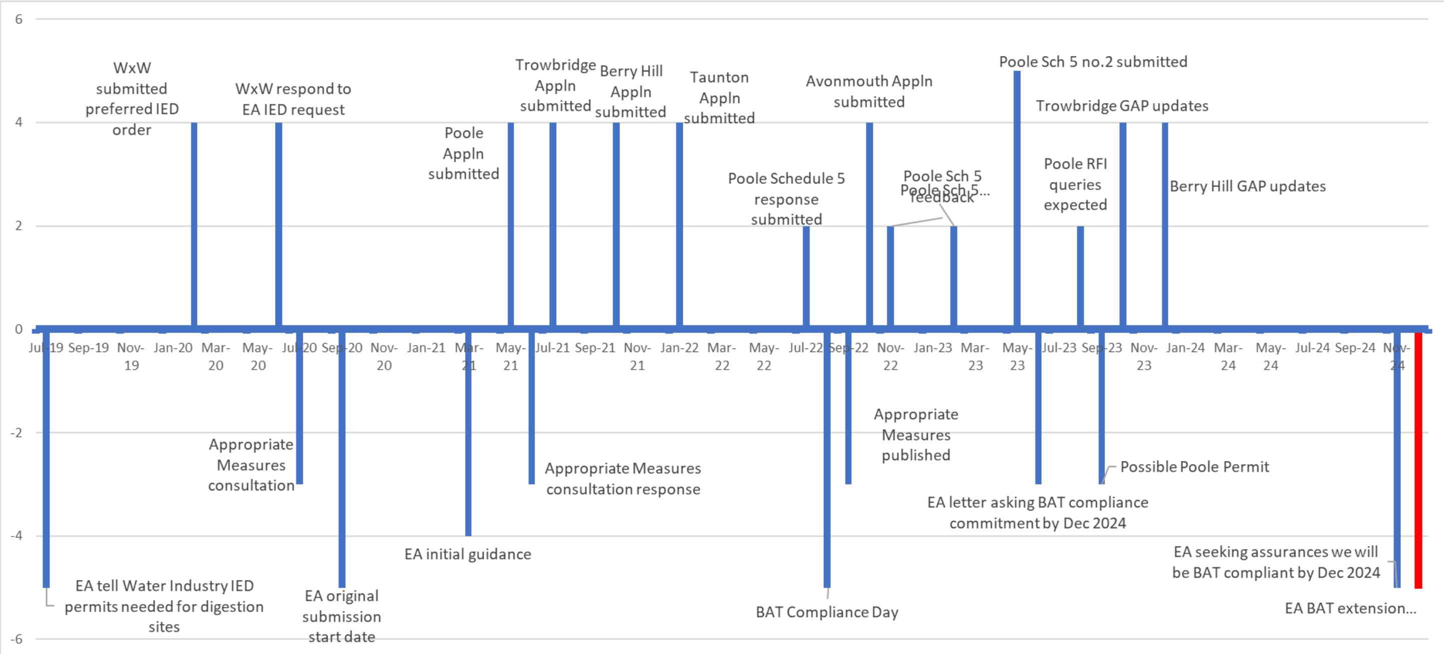
Please note: All Wessex Water sites will be bespoke IED installation permits because maximum acceptance will exceed 500,000 tonnes per year and the sites are close to sensitive receptors, which means no site meets the criteria stipulated by the EPR standard rules AD installation permit (SR2021 No.10).

Table 2 – Summary of Wessex Water sites that require IED and EPR permits.

Site name	Sludge treatment process	Existing permit type and process covered	Expected Permit issued date (also detailed in column BM)	Will the site have physico-chemical activity as well as AD (Yes/ No)
Poole	AD	Waste operation permit for tankered sludge imports	October / November 2023	No
Trowbridge	AD	Waste operation permit for tankered sludge imports	June 2024	No
Berry Hill	AD	Waste operation for tankered sludge imports	September / October 2024	No
Taunton	AD	Waste operation permit for sludge storage in Barns	Late 2024	No
Avonmouth	AD	Waste operation permit for tankered sludge imports	Spring 2025	Yes – Avonmouth only will have a physico-chemical activity added onto its IED installation permit
£	Lime	T21 exemption	AMP8	n/a
Ratfyn	Lime	T21 exemption	AMP8	n/a
Yeovil Vale Road	Lime	T21 exemption	AMP8	n/a
West Huntspill	Lime	T21 exemption	AMP8	n/a
Palmersford	Lime	T21 exemption	AMP8	n/a

IED permit timeline in Figure 3 shows key dates for Wessex Water above x-axis and EA key dates below x-axis; and used in conjunction with Table 3 shows the current permit application status of Wessex Water's sites.

Figure 3 - Permit timeline showing key Wessex Water and EA time points. (n.b. scale only used to allow entries to fit on)



Dates for Wessex Water permit applications are further detailed in Table 3; we have only received EA feedback on the Poole application via the Schedule 5 notification. The latest response we made to the EA was completed in May 2023 and are expecting some RFIs (Requests for Further Information) to finalise the information the EA holds about the site. This enables the EA to complete its determination phase. Following these replies to the RFIs, our EA permitting officer has indicated they will start to draft the Poole permit with an expected publication date later this year.

EA's requirements have become more certain over the Schedule 5 process, and we now are more aware of the standard required, so we are currently under taking an appraisal of gaps that are still remaining in information we've provided in the applications. Trowbridge and Berry Hill are being completed this autumn.

Table 3 - Current Wessex Water permit application status

Site	Submitted Date	Schedule 5 notification no. 1 submitted	Schedule 5 notification no. 2 submitted	Estimated end to end determination time (EA estimation)	Estimated Permit Issue Date
Poole	April 2021	July 2022	May 2023	Already in determination	October/November 2023
Trowbridge	July 2021			6 – 9 months	June 2024
Berry Hill	October 2021			6 – 9 months	September / October 2024
Taunton	January 2022			6 – 9 months	Late 2024

Avonmouth	September 2022			9 – 18 months (based on complexity)	Spring 2025

Estimated costs

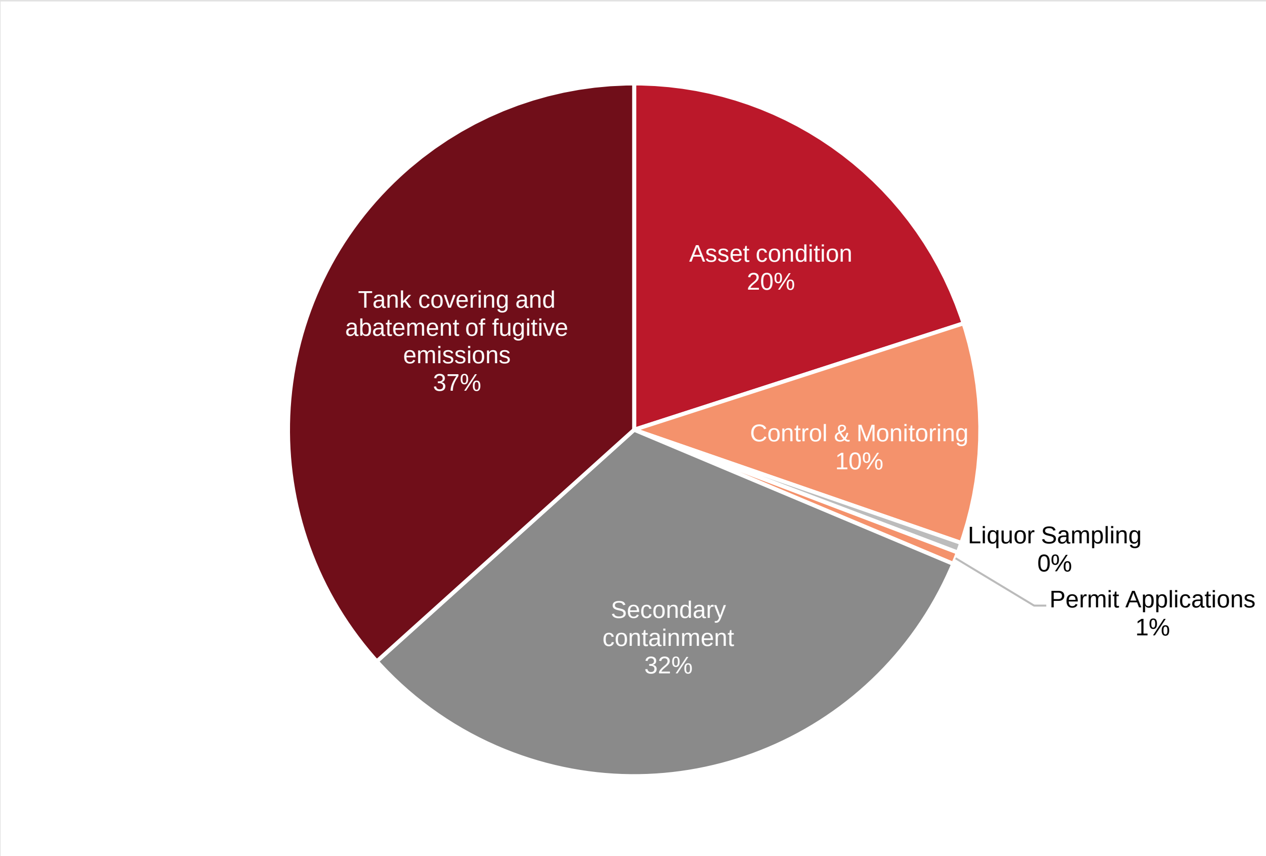
The areas of IED compliance expenditure for our 5 AD sites are summarised in Table 4.

Table 4 - Areas of IED compliance expenditure.

Area of expenditure	Funding	Description
Secondary containment	Enhancement	Providing secondary containment for all digesters and sludge holding tanks to the standard of CIRIA 736
Tank covering and abatement of fugitive emissions	Enhancement	Covering all open sludge tanks and extracting the headspace gas for either odour treatment (if methane levels are low) or recovery to the biogas system (if methane levels are high)
Control and monitoring	Enhancement	Providing additional online monitors (such as flowmeters, pressure monitors, gas analysers, etc.) to improve the control and monitoring of the AD process
Liquor sampling	Enhancement	Undertake a rigorous 12-month sampling programme to fully characterise the liquor streams that are discharged back to the sewage treatment process, followed by routine sampling to monitor the quality of the liquors
Permit application	Enhancement	The development of various management plans (such as odour, leaks, waste, raw materials, energy efficiency, etc.) and one-off surveys and risk assessments that need to be completed as part of the permit application process
Additional resources	Enhancement	Additional resources (such as plant operators, scientists, engineers, and technical specialists) would need to be recruited to undertake the additional operational and maintenance activities required by the AD sites when they operate under IED permits
Asset maintenance	Base	Additional maintenance will be required to improve the condition of a large number of bioresources assets up to BAT standard

The pie chart in Figure 4 illustrates the CAPEX profile of the expenditure for upgrading all our 5 AD sites to BAT and AM standards. The estimated total CAPEX is £158m. The two areas of most significant CAPEX expenditure are the implementation of secondary containment as per the CIRIA 736 standard, and the installation of covers on all open sludge tanks to reduce fugitive emissions.

*Figure 4 - CAPEX split by expenditure areas for upgrading all existing Wessex Water AD sites to comply with IED (**total CAPEX of £158m**).*



The CAPEX profile for upgrading all our T21 lime treatment sites to BAT and AM standards for EPR compliance is similar – with secondary containment and tank covering being the most significant areas of expenditure. The estimated total CAPEX for EPR compliance is £26m.

Table 5 shows the expenditure profile of both IED and EPR upgrades in AMP8, split by enhancement and base costs. AMP8 TOTEX is estimated to be £200.8m, with £33.4m allocated as base costs and £167.5m allocated as enhancement costs.

We have spent c. £0.7m in permit application costs from 2020/21 to 2022/23, which consist of permit application fees, and consultancy work on surveys, assessments, and plan development. Unfortunately, we have erroneously not reported these costs in the APR under Line 4K.13. We will continue to incur these permit application costs in 2023/24 and 2024/25, c£0.9m. These new costs are not included in this claim however the expenditure in 2023/24 and 2024/25 are included in our transitional investment tables. We will start reporting these costs in the 2023/24 APR under Line 4K.13.

We believe all our IED capital costs will be incurred in AMP8 as the design and delivery of IED upgrades can only be undertaken in AMP8 due to the delays in the permitting process. We also believe all EPR costs will be incurred in AMP8 as the EA will likely begin the EPR permitting process in AMP8.

Table 5 – Expenditure profile of IED and EPR upgrades split by base and enhancement costs.

Expenditure	2025-26	2026-27	2027-28	2028-29	2029-30	AMP8 total
IED Base CAPEX	£6.8	£12.8	£8.2	£2.6	£0.0	£30.4
IED Base OPEX	£0.4	£0.5	£0.5	£0.8	£0.8	£3.0
IED Enhancement CAPEX	£27.9	£51.4	£38.5	£9.5	£0.0	£127.4
IED Enhancement OPEX	£1.4	£1.8	£2.2	£3.3	£3.6	£12.4
EPR Base CAPEX	£0.0	£0.0	£0.0	£0.0	£0.0	£0.0
EPR Base OPEX	£0.0	£0.0	£0.0	£0.0	£0.0	£0.0
EPR Enhancement CAPEX	£9.2	£9.2	£0.0	£7.5	£0.0	£25.8
EPR Enhancement OPEX	£0.3	£0.3	£0.3	£0.5	£0.5	£1.9
						£200.8

Note the above TOTEX figures for IED are marginally higher (c£5m) than the IED data submission in August 2023 due to continued refinement of scope as our permit applications are progressed, and an adjustment to the allocation of operating costs between enhancement and base.

Basis of the claim

We believe there will be step-change increase in the maintenance requirements for bioresources assets when our AD sites operate under IED permits. This is because there are a number of bioresources assets on our sites that do not meet BAT due to their design or condition. Assets that are in poor condition and therefore not compliant, will therefore need to be repaired or replaced. As the assets are replaced on a like-for-like basis, we have allocated these costs as base costs. Where assets are replaced with enhanced versions (e.g., an open tank replaced with a closed tank with odour control), we have allocated the cost of the enhancement (which in this case is the tank cover and odour control) as an enhancement cost.

In most cases, the need to repair or replace these assets would be brought forward (i.e., accelerated maintenance) due to the need to maintain asset condition to BAT standards, which removes the flexibility of risk management that would be part of our maintenance strategy for bioresources prior to IED implementation. We are submitting this cost adjustment claim to argue that the step-change increase in maintenance requirements due to IED needs to be modelled in the base cost (as this was not the case in PR19).

As we believe there is still uncertainty in the funding mechanism for IED, we have decided to include both base and enhancement costs in our claim to ensure the total cost of the IED compliance programme is clearly captured for full transparency.

A detailed breakdown of all the IED costs (by base and enhancement, and CAPEX and OPEX) has been included in the IED Data Request and supporting commentary submitted in August 2023.

Due to the similar nature of the required site upgrades for EPR compliance, we have also included all EPR enhancement costs in our cost adjustment claim. We felt that it is important to highlight the need for EPR investments to be funded in PR24, as the EA have excluded EPR upgrades from the scope of the PR24 WINEP.

Need for adjustment

As with the rest of the industry, we do not expect to be able to fully comply with IED by December 2024 due to the delays in the permitting process and the large scale of capital works to upgrade all our sites to BAT and AM standards. We expect the EA to agree to relaxing the improvement condition programme into AMP8, so we are including our IED investment proposals in PR24. As explained in the previous section, there will be a step-change increase in maintenance requirements due to IED, which will need to be included in the econometric modelling of base costs. Therefore, we consider it prudent to include a cost adjustment claim on the basis of incurring increased maintenance costs for the first time in PR24. For the same reason, we also expect to incur a higher level of efficient costs in the round, compared to the historical period.

Unique circumstances

Like most other companies, we did not include any costs associated with IED compliance in PR19 because the formal letter from the EA requesting for companies to apply for IED permit came too late in the PR19 process. Prior to that there was a high level of uncertainty around the scope and applicability of IED on sewage sludge treatment. Furthermore, the late request to comply with IED also meant there was limited time to assess the implications of IED at a site level and therefore include any accurate cost estimates for IED in our PR19 plans. This is aligned with the 2020 CMA findings which state:

> *'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.'* [4]

Any cost estimations for IED in PR19 would now be inaccurate given the significant scope development of IED post-PR19 through the publication of the EA's AM guidance which raised the bar for compliance, and the various additional requirements included in the IED scope during the permitting process.

In PR24 we have since undertaken site-specific risk assessment of our AD sites to scope the site upgrades required for IED in more detail. Like the other companies, we have found that the scope of capital works and the associated investment required are significant. This is also largely due to the pressure from the EA to complete all site upgrades within an AMP, ignoring the fact that the industry normally phases asset replacement or refurbishment programmes over several AMPs.

Our risk assessments of our T21 lime treatment centres showed that these sites also require significant upgrades to meet BAT and AM standards for complying with future EPR permits.

The estimated capital investment for IED compliance is c. £152m, and for EPR compliance, c. £25m. These are significant capital investment costs that will drive up the level of efficient costs in bioresources in AMP8.

Throughout the permitting process, the EA have shown that they have a strict interpretation of the BAT and AM guidance. They have only accepted solutions that provide the highest level of risk mitigation, which is often not the most cost-efficient solution or the solution that provides the highest level of benefits overall. For example, the EA have indicated that all tanks, regardless of their risk of failure, will need to be provided secondary containment that

[4] Competition and Markets Authority (CMA), "Anglian Water Services Limited, Bristol Water plc, Northumbrian Water Limited and Yorkshire Water Services Limited price determinations," 2020

are CIRIA 736-compliant. They have rejected our proposal to provide vehicle collision protection to a liquor holding tank at Poole instead of full secondary containment, despite the extremely low probability of the tank catastrophically failing.

Given these unique circumstances, we believe a cost adjustment is warranted in this instance.

Management control

Our IED and EPR investment proposals for AMP8 are based on the EA's AM guidance and their interpretation of acceptable BAT measures. We have undertaken site-specific risk assessment of our AD and lime treatment sites to identify the areas that do not currently comply with the standards set out by BAT and AM. We have then scoped the necessary improvements works for upgrading these sites to BAT and AM standards, as interpreted by the EA. Therefore, we believe the scope of IED and EPR compliance is solely in the control of the EA, and we have limited influence in the factors that drive the required IED and EPR investments.

We have considered steps to control the costs associated with IED and EPR. We proposed alternative measures to meet BAT and AM standards that are more cost efficient and affordable. An example of this is our proposal of an alternative measure to secondary containment for the liquor holding tank at Poole, as explained in the previous section. Another example is initiative to start monitoring the methane emissions from our open sludge tanks to inform the appropriate solution for controlling fugitive emissions from these tanks – whether the headspace gas from these tanks when covered would need to be returned to the biogas system, or odour treated and vented.

We have also considered any opportunities for potential cost savings. For example, where there is a cluster of sludge tanks, we proposed a shared containment system to reduce the cost and carbon footprint of the containment solution.

However, all solutions that vary or deviate from what is prescribed in the AM guidance will need to be approved by the EA. We will need to demonstrate that all alternative solutions can provide the same level of risk mitigation or environmental protection as the solutions in the AM guidance.

Materiality

The EA have taken a very cautious approach in assessing the pollution risk associated with the operation of a biowaste treatment or handling facility. As such their AM guidance recommends very prescriptive measures or interventions for mitigating these pollution risks. We have reviewed the AM guidance and undertaken site-specific risk assessments for our AD and lime treatment sites to identify gaps in compliance with BAT and AM. We have then undertaken a bottom-up site-level scoping exercise to develop the engineering solutions required to upgrade each site and its assets to meet BAT and AM standards. The estimated costs for the capital works identified in the scoping exercise are significant (c. £158m for IED and £26m for EPR); we are therefore confident that IED and EPR compliance is a material driver for increased expenditure in AMP8.

In the technical review of IED by Atkins, they estimated a significant investment programme is required to bring sites across all companies to meet BAT and AM standards. They assessed the total estimated CAPEX and one-off OPEX expenditure for the industry to be c. £2.0b, based on IED investment costs reported from all companies. Secondary containment and covering of sludge tanks were identified as the two most significant areas of expenditure across the industry – which is consistent with our IED expenditure profile.

Based on our business plan totex for AMP8, our claim exceeds, by a considerable margin, Ofwat's materiality threshold in respect of the bioresources price control.

Adjustment to allowances (including implicit allowance)

In considering an adjustment to allowances, we have recognised several broad types of IED and EPR-related costs.

First, there are the costs which Ofwat refers to in its April 2023 base cost model consultation as “wastewater Industrial Emissions Directive (IED) operating costs” which Ofwat excluded from the scope of modelled costs.

Second, there are enhancement costs for the improvements needed for compliance with IED and EPR.

Third, as reflected in this claim, there is additional capital maintenance expenditure which is expenditure that would not be incurred in the absence of IED and EPR.

Our claim covers costs falling under all three types.

In relation to the first of these, our understanding is that Ofwat will exclude these from the scope of modelled base costs and, as a consequence, we would not expect an implicit allowance for these costs within the allowances from Ofwat’s base cost models.

In relation to the second type, these would most naturally be classified as enhancement expenditure and outside of the scope of modelled base costs (most of the expenditure we identify in this claim is enhancement expenditure). In its April 2023 base cost model consultation, Ofwat proposed to exclude capital enhancement expenditure from its bioresources models, other than growth-related enhancement expenditure which is separate from that arising from IED and EPR. For the purposes of our claim, we have sought to include capital enhancement expenditure which we expect to incur during AMP8 which, in the absence of IED and EPR compliance requirements, we would not incur in AMP8. We have not included capital enhancement expenditure which supports IED/EPR compliance but which we would need to do anyway due to requirements arising from growth. On this basis, we do not consider there to be overlap with the scope of costs in the base cost models and no need for an implicit allowance adjustment for these costs.

On the third category above, there will be an implicit allowance for capital maintenance within the allowances for modelled base costs derived from econometric models of historical bioresources base expenditure. However, we have sought to develop and quantify our claim in a way that avoids any duplication with costs that we would expect to be funded through Ofwat’s base cost models and hence to avoid the need for any implicit allowance adjustment.

In particular, the capital maintenance included in this claim is limited to expenditure which we expect to incur during AMP8 which, in the absence of IED and EPR compliance requirements, we would not incur in AMP8. We have not included expenditure which supports our compliance with IED and EPR but which would be likely to incur in any event in AMP8 as part of normal asset maintenance practices. Our claim is essentially for the incremental capital maintenance expenditure above that which would be incurred under asset management practices that existed before IED and EPR (as captured in Ofwat’s base cost models for bioresources).

Our understanding is that across the industry there is little of this type of expenditure already incurred in AMP7, due to the timing of the permitting processes and the low number of permits issued. The EA’s requirements have become more certain over the Schedule 5 process, however this has been formed as permit applications have progressed

On this basis, we have not made any implicit allowance deductions for the purposes of our claim.

However, if Ofwat has a richer source of information (e.g. based oncompany returns to the August 2023 information request) which indicates, to the contrary, that significant incremental capital maintenance expenditure has been incurred due to IED and EPR within in the historical period used for the econometric models for bioresources, then there is a risk of some element of double counting with our claim (albeit diluted by the time period before IED and EPR costs were incurred). We think that the best way to do this would be to strip out, from the input data feeding into the base cost models, any incremental capital maintenance that has only been incurred in AMP7 due to IED and EPR. This approach would also avoid the need for any implicit allowance adjustment and would be consistent with the way that Ofwat proposes to treat IED-related operating expenditure.

We do not consider this claim to be symmetrical. We are incurring costs related to IED, which is an industry-wide regulatory requirement.

Cost Efficiency

We are confident the cost estimates of our IED investment proposals are robust and efficient. As mentioned in previous sections, we have undertaken a risk-assessment at each of our AD and lime treatment sites to produce a site-level gap analysis of BAT and AM requirements. We then developed the scope of engineering works for each site and built our cost estimates based on this. We benchmarked the cost estimate of our scope using an independent body (ChandlerKBS) for assurance. As an example, the internal cost estimate for upgrading Trowbridge was found to be only 1% different from the benchmarked cost.

The results of the cost benchmarking exercise undertaken for the scope of upgrade works at Trowbridge are provided in Annex A2.

Need for investment

The EA have formally confirmed to us in 2019 that sewage sludge treatment facilities that process more than 100 tonnes of sewage sludge per day fall within the regulation of IED. This affects all 5 of our AD sites. We were given until August 2022 to apply IED permits for these sites, but this deadline was pushed back to December 2024.

All new and existing sites will need to comply with standards set out in the 2018 BAT reference documents (BREF) and AM guidance published in 2022. Our 5 existing AD sites will need to retrospectively made compliant by upgrading existing assets to BAT and AM standards. The EA expect all existing sites to be made compliant at the time of permit application before 2024, or at the very least demonstrate an improvement programme towards compliance.

Due to the significant scope creep and delays in the permitting process, there is a recognition within the industry that the deadline of December 2024 for IED compliance is not likely to be achievable in full. Capital enhancement improvements, such as secondary containment and covering of sludge tanks, will need to be relaxed into AMP8 through a phased delivery approach. The EA have been made aware of the issue but have yet to formally agree to slipping the compliance deadline into AMP8, or a phased improvement condition programme that is relaxed into AMP8.

The site-specific risk assessments and BAT gap analysis we have done for our 5 AD sites show significant areas that require improvement to BAT and AM standards (the list of site upgrade works required is provided in Annex B). The areas of secondary containment and covering of sludge tanks account for more than 50% of the £158m capital enhancement improvements required (which is similar to the rest of the industry, as reported by Atkins).

The lack of funding for IED in AMP7 would mean that this investment is then required in AMP8. Furthermore, from a capital delivery perspective, the delivery and implementation of improvements of such a scale will likely extend into AMP8 given that companies are only receiving 1st tranche permits in April 2023 (with the 2nd and 3rd Tranche permits likely to be issued later in 2023 and early 2024). Committing to large-scale improvements like these prior to permits being issued carries a high level of risk with no mitigation due to the precedence of scope creep and uncertainty in the EA's interpretation of guidance documents.

There is no overlap in the proposed IED investment with activities already funded at previous price reviews because the improvements required under IED are completely new, and have never been required under any existing environmental legislation.

In the case of EPR, we expect all our lime treatment sites (that currently operate under T21 waste exemptions) will need to apply for bespoke waste operation permits in AMP8 as the EA are revising the T21 tonnage limit on sludge processing capacity. The EA are expected to publish their Sludge Strategy which will set out the permitting requirements for these sites and the allowed timescale for transitioning to the new permits.

All our lime treatment sites will need to be upgraded to meet BAT and AM standards, like the IED sites. All EPR compliance costs will be enhancement costs as EPR compliance is likely to be an AMP8 obligation, However, the change in regulation has not yet occurred as this is dependent on the EA’s Sludge Strategy, which is delayed. Therefore, there was no driver for EPR site upgrades in the PR24 WINEP and our EPR compliance proposals were subsequently rejected in the WINEP. To avoid a repeat of the funding issue that occurred in PR19 with IED, we have decided to include the EPR costs as an enhancement case in our business plan, as well as in this claim to ensure the investment requirements for EPR compliance are funded.

Best option for customers

We have considered a range of options to meet the requirements for IED and EPR as explained in the previous sections. The EA’s strict interpretation of the BAT and AM guidance limits our ability to propose alternative solutions that may be more cost efficient or affordable. The solutions we have included in our IED and EPR proposals are the ones that the EA have accepted, or ones that we are confident they would accept, based on their interpretation of the BAT and AM guidance.

There is also uncertainty in the interpretation of compliance between the EA national permitting team and the local EA officers that enforce the permit. The EA’s approach on implementing IED in the water industry is for their national permitting team to review all permit applications and decide on the improvement conditions for each permit; and when the permits are issued, the responsibility of interpreting and enforcing the permits fall on the team of local EA officers. This approach will likely result in inconsistent interpretation of site requirements by each local EA officer and therefore a lack of standardisation of improvements by site. This would make comparison of costs across companies challenging when the assessment of risk is performed in isolation for each site. A standardised approach for risk assessment would be required, as highlighted in the Atkins report.

Customer protection

As IED is a regulatory requirement, each site with an IED permit, after issue, will be audited annually by the local EA officer to monitor compliance against the requirements of the permit, as well as the progress against improvement conditions set out when the permit is issued. All audit findings and non-conformances will be recorded in Compliance Audit Reports (CAR) issued to the operator/company. The EA are also proposing to include a new metric in the EPA related to compliance with IED/EPR permits. Any non-conformances logged under an IED permit can adversely affect this metric and the overall EPA score.

We believe the regulatory system for IED put in place by the EA would ensure our proposed investment for IED improvements are delivered and therefore provide sufficient customer protection.

We have not proposed a price control deliverable as customers would be protected from non-delivery in this area through our proposed uncertainty mechanism which will trigger if the requirements change. This is discussed in more detail in the Supporting Document WSX31 titled ‘Risk and Return’ in Section 3.

A1 Implications of BAT and AM (Atkins[5])

Transformation in the regulation of sewage sludge treatment and the need to comply with the IED is leading to an investment requirement across the water industry of c. £2.0bn.

The publication of the EA's Appropriate Measures guidance in 2022, introduced additional requirements with associated costs, and has further compounded this challenge for the WaSCs to comply with the IED.

The compliance approach taken by the EA appears more precautionary than the original intent of IED, and consequently the scale of change is resulting in a significant challenge to the industry in terms of feasibility, affordability and deliverability.

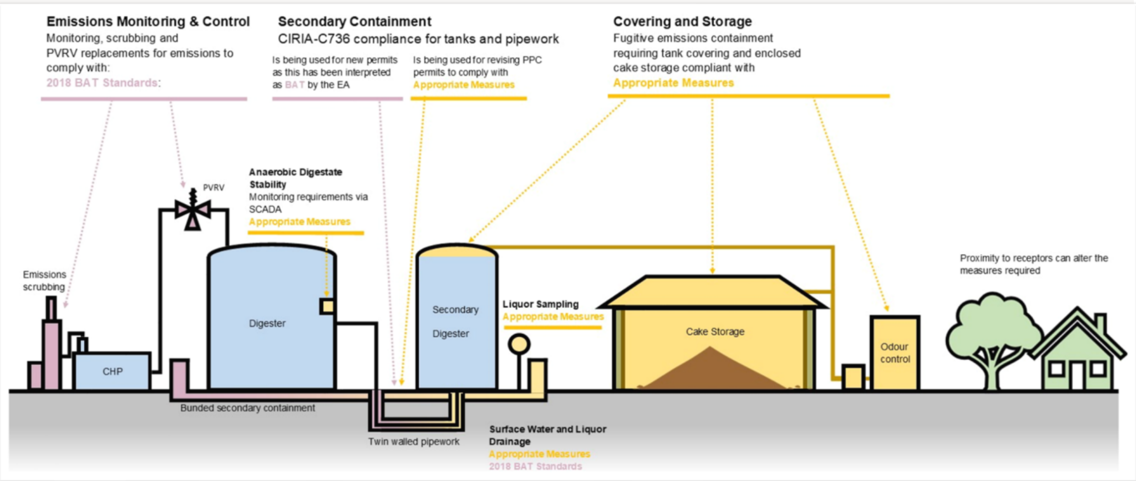


Figure 1 – Illustrated Impacts of Appropriate Measures and BAT 2018 Standards on a Notional Digestion Facility

[5] Source: Atkins, "Industrial Emissions Directive Supporting Document for Water UK," 2023.

Appropriate Measures vs. BAT Comparison Overview

Key
- BAT and Appropriate Measures are similar (green)
- Appropriate Measures requirements go slightly above those set out by BAT (yellow)
- Appropriate Measures requirements significantly exceed those of BAT (pink)

Focus Area	Sub-Area
Covering / Storage (pink)	Volume / residence time (green)
	Storage areas (pink)
	Covering (pink)
	Storage tank design (pink)
	Lagoons (yellow)
	Handling / transfer (yellow)
Containment / Failure Modelling (green)	Monitoring (green)
	Maintenance planning (green)
	Operational areas (yellow)
Secondary Containment (pink)	Minimising Risks (pink)
Emissions Control / Monitoring (yellow)	General (green)
	Bioaerosols (yellow)
	Point source emissions (yellow)
	Biofilters (green)
	Pre-treatment abatement scrubbers (yellow)
	Fugitive emissions (pink)
Liquor Sampling (yellow)	Sample analysis (yellow)
Surface Water / Liquor Drainage (green)	Infrastructure and inspection (green)
Anaerobic Digestate Stability (yellow)	Parameter monitoring / maintenance (yellow)

- **Retrofitting of storage area elements of CIRIA standard to existing facilities** is the key driver of cost here.
- Appropriate Measures applies blanket approach and requires **covering for all bulk storage tanks and transfer/management areas which 'may produce emissions'**.
- This includes **retrofitting to existing facilities**, driving costs higher than under BREF.

- Appropriate Measures **delivers a singular overall site classification** designed with higher levels of containment than may be required for individual areas.

- **Appropriate Measures is more prescriptive than BREF's risk-based approach** regarding drainage system requirements and documentation.
- BREF includes caveats surrounding existing plants on the segregation of water streams.

Overall Conclusion: Appropriate Measures guidance sets out prescriptive blanket requirements for all equipment and procedures whereas BREF implements a more flexible risk-based approach.

A2 Benchmarking of IED site upgrade costs

The scope of site upgrades for Trowbridge was used for external benchmarking by ChandlerKBS. The difference between the estimates was only 1%.

Table 1 – Internal estimated costs v. benchmarked costs for the scope of works at Trowbridge

Capex Breakdown	Internal Estimation (Capex £'000s)	ChandlerKBS Estimation (Capex £'000s)	% difference
Optioneering and Outline Design	325	325	0%
Overheads	283	285	1%
Detailed Design	651	651	0%
Supervision and Preliminaries	1,064	325	-69%
Civil Work Items	2,213	2,326	5%
M&E Work Items	378	1,036	174%
Risk Items	548	553	1%
Third Party Costs	195	195	0%
Total (excluding corporate overheads)	**5,658**	**5,697**	**1%**

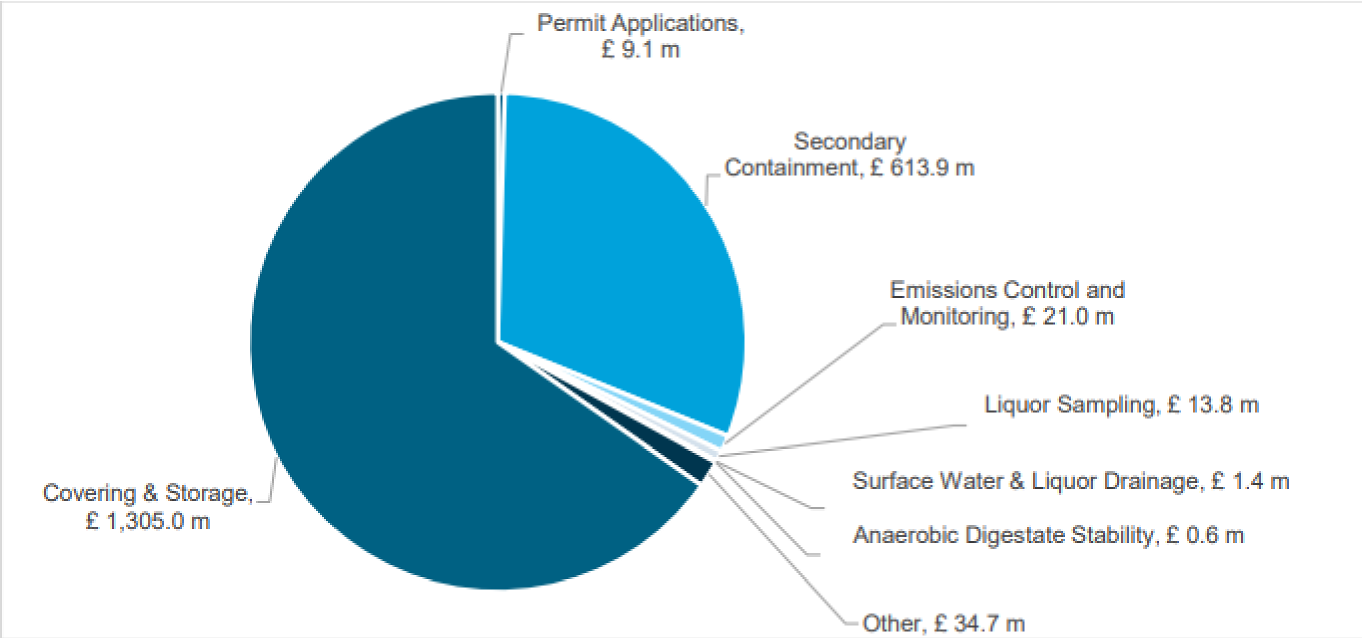
A3 National IED investment programmes (Atkins[6])

Atkins collated information on each company's proposed IED investment programme as part of their technical review on IED. They found that:

- The total national investment programme for IED amounted to c. £2.0b.
- The 2 significant areas of spend are secondary containment and covering / storage.
- Complying with AM requirements required additional spend above what is required to comply with BAT requirements
- There is no consistency in the spend per site by company because the assessment of risk (of not complying with BAT or AM) is performed in isolation for each site and there is therefore a lack of standardised approach in the risk assessment.

The figures below are taken from the Atkins report.

Figure 1 – Overall Split of capex and one-off spend by theme



[6] Source: Atkins, "Industrial Emissions Directive Supporting Document for Water UK," 2023.

Figure 2 – Aggregate one-off spend by company

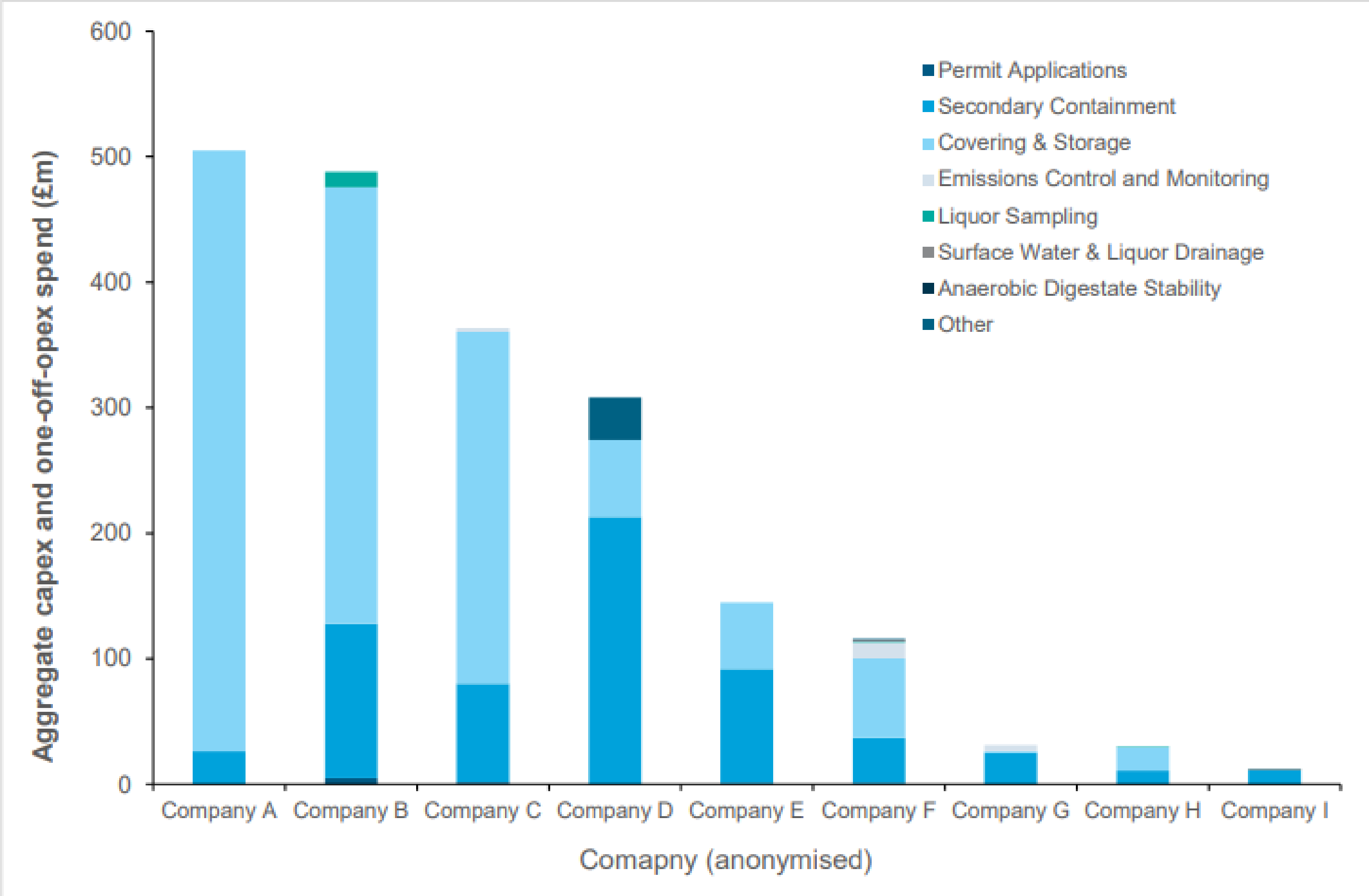


Figure 3 – Spend split between BAT 2018 and Appropriate Measures focus areas

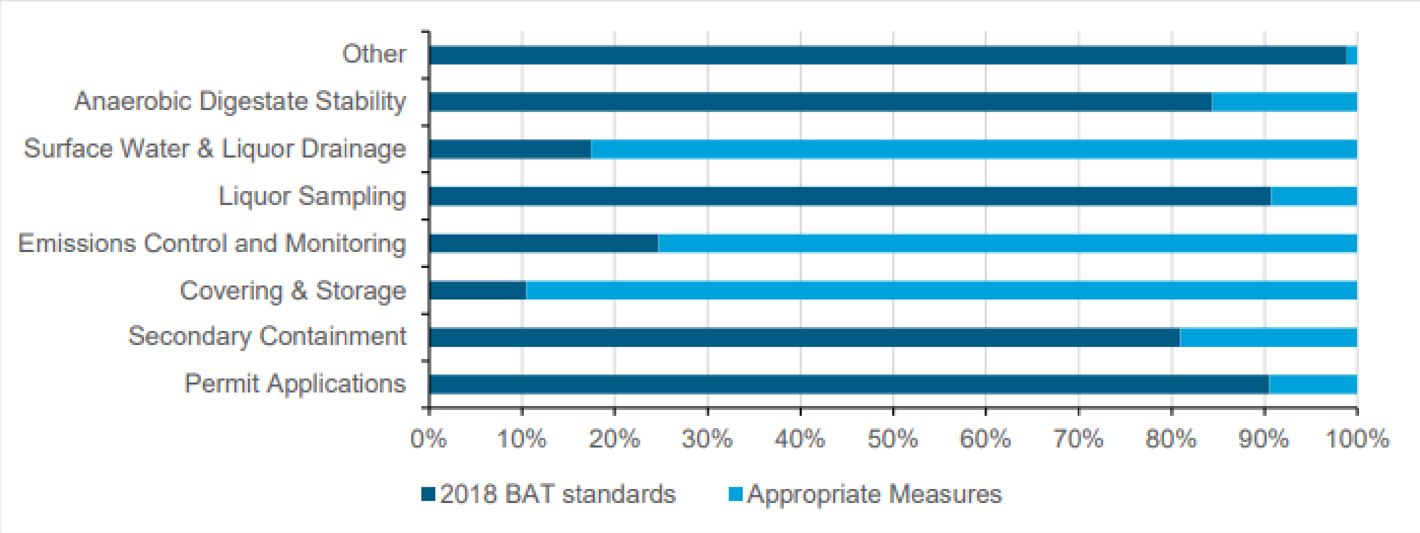
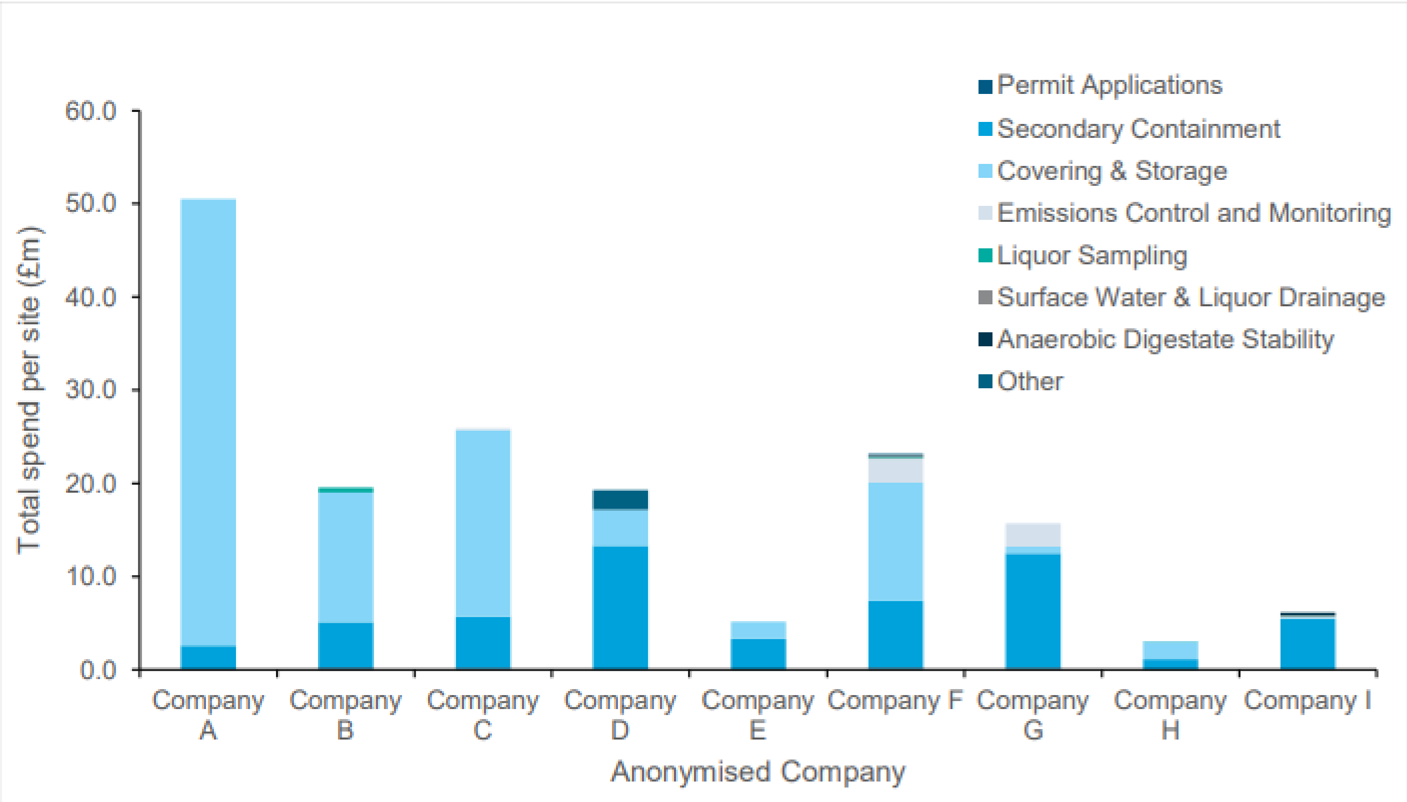


Figure 4 – Total one-off spend per site by company



A4 2019 EA Letter on IED

Matt Wheeldon
Director of Assets and Compliance
Wessex Water

Our ref: MSK/DM

Date: 9 July 2019

matt.wheeldon@wessexwater.co.uk

By email only

Dear Matt,

INDUSTRIAL EMISSIONS DIRECTIVE

At the last Strategic Steering Group meeting on 2 April 2019 we tabled a paper about implementation of the Industrial Emissions Directive (IED) for biological treatments of sewage sludge. The paper (enclosed) informed the group that the IED applies to the biological treatment of sewage sludge, and that we would be discussing the timetable and process for permit applications with the Water UK waste and recycling network. The meeting acknowledged the paper and its contents received some discussion.

The purpose of this letter is to inform you that we are now implementing this aspect of the IED. This means that permits will be required for the biological treatment of sewage sludge above the IED thresholds. We will arrange for engagement and further communications to take place, principally through the Water UK waste and recycling network, and will be inviting applications for permits in accordance with a timetable to be agreed.

In order to agree the timetable implementation and to initiate the permitting process we are asking each water and sewerage company to provide details of the following to Clive Humphreys via your waste and recycling network representative by 24th July:

- sites carrying out biological treatment of sludge
- sites carrying out biological treatment of other sewage related wastes such as screenings and grits
- sites operating biogas engines
- sites injecting biogas to the gas grid

Should you require any further information please contact Clive Humphreys at clive.humphreys@environment-agency.gov.uk.

Yours sincerely

Mark Sitton-Kent
Director of Operations – West and Central

Trentside Offices, Scarrington Road, West Bridgford, Nottingham, NG2 5FA.
Customer services line: 03708506506
Email: enquiries@environment-agency.gov.uk
www.gov.uk/government/organisation/environment-agency

Strategic Steering Group Meeting
Item No.SSG19.02.04-02

Subject: Implementation of the Industrial Emissions Directive for biological treatments of sewage sludge

SSG is asked to note that the Environment Agency:

1. has determined that the Industrial Emissions Directive applies to the biological treatment of sewage sludge
2. will be discussing the timetable and process for permit applications through the Water UK waste and recycling network

1.0 Background

1.1 Directive 2010/75/EU on industrial emissions (the IED) entered into force on 6 January 2011 and was transposed into UK law on 20 February 2013[1]. The IED recast the Directive on integrated pollution prevention and control (IPPC) and introduced a revised schedule of industrial activities falling within scope of its permitting requirements. The schedule of waste management activities includes the recovery of non-hazardous waste with a capacity exceeding 75 tonnes per day involving biological treatment, but excludes activities covered by the Urban Waste Water Treatment Directive[2] (UWWTD).

1.2 There was much discussion about whether the biological treatment of sewage sludge is an activity covered by the UWWTD. In July 2014 we deferred the need to submit permit applications for sewage sludge digestion at sewage treatment works to allow further consideration of the question. All of the UK environmental regulators have now concluded that the biological treatment of sewage sludge is not an activity covered by the UWWTD and is therefore within the scope of the IED. This unanimously held view has been communicated to the UK and devolved governments with a view to commencing implementation.

2.0 Implementation

2.1. The IED seeks to achieve a high level of protection for the environment taken as a whole from the harmful effects of industrial activities. It does so by requiring each of the industrial installations to be operated under a permit from the competent authority with conditions based around the use of best available techniques (BAT). In this instance the Environment Agency is the competent authority.

2.2. The IED set a deadline of 7 January 2014 for existing installations to obtain an environmental permit. We have therefore delayed implementation of this aspect of the IED for over five years. We now

[1] Environmental Permitting (England and Wales)(Amendment) Regulations 2013
[2] Directive 91/271/EEC concerning urban waste water treatment

1

need to address this by ensuring all installations involving the biological treatment of sewage sludge obtain and operate under an environmental permit in as short a timescale as can reasonably be achieved.

2.3. We recognise that many sludge treatment facilities were constructed prior to the current permitting requirements and their design may not be compatible with the best available techniques as described in the EU BAT reference documents. Where this is the case risk assessments can be used to demonstrate that an equivalent level of environmental protection is being or can be achieved. Where additional measures are required we will use improvement conditions within permits to allow time to achieve the BAT standard.

3.0 Next Steps

3.1. The Environment Agency is developing a sludge strategy in order to plan and deliver clear and consistent regulation of sewage sludge treatment and use activities. It will be finalised by the end of 2019. The permitting of sewage sludge biological treatment activities is one element of the strategy. It will be delivered in parallel with the development of the strategy.

3.2. We will use the Water UK waste and recycling network (WaRN) as the main forum to discuss IED and permitting arrangements. We therefore propose that the representatives who attend WaRN act as the main point of contact. We will also ensure that our water company account managers are kept fully informed of progress.

3.3. On a practical level all internal resourcing and training needs are being addressed in preparation to support pre-application discussions and the receipt of permit applications later this year. Through WaRN we be asking each company to provide a definitive list of all sites used to carry out biological treatment of sludge, and to provide a best estimate of the number of permit applications they anticipate making.

Clive Humphreys, Environment and Business, Environment Agency

A5 Ofwat PR24 WINEP feedback on IED (Oct 2022)

WINEP meetings, feedback October 2022

Annex 1: Wessex Water specific feedback

In this annex we outline further feedback points that are specific for Wessex Water. These are the main points:

- You stated that spend under Storm Overflows drivers is one of the most significant spend areas of your WINEP. We recognise this but would also encourage you to consider profiling within this area. Storm overflows are one area where profiling across multiple AMPs is possible, profiling based on environmental benefit priorities would help balance the spend and delivery profile, and potentially reduce the bill impact.
- We are supportive of outcomes-based submissions where applicable but emphasise all statutory requirements must be met by your WINEP and any A-WINEP submissions.
- Within your slides and WINEP estimated costs you have included for expenditure to achieve compliance with the Industrial Emissions Directive (IED). The price controls for the 2025-30 period will not include any allowance in relation to the costs of meeting statutory and regulatory obligations (to include IED compliance) that need to be delivered in the 2020-25 period.
- We recognise the majority of the WINEP is Statutory (S), but where this is not the case it is essential you include details of customer support in your November submission.
- We welcome your approach to consider nature based (NBS) and catchment solutions where possible. We recognise developing legislation for the Environment Act targets and Nutrient Neutrality may make utilising NBS and catchment solutions more challenging, but we would still encourage combined solutions incorporating NBS where they can be part of a best value solution.
- We continue to work with government, other regulators, and companies on areas you highlighted, specifically continuous water quality monitoring, storm overflows and nutrient neutrality.

A6 EA PR24 WINEP feedback on IED (2022)

Aim: collaboratively agree what is the issue and evidence for the issue.

Line Ref	WINEP Driver	Generic Risk	Risk / Issue	Referenced in WINEP Driver Guidance?	Commentary (EA driver guidance text in *italics*)	Water Industry Assumptions	Supporting Evidence	In / Out of Scope	Are Requirements Clear?	EA Action / Agreement	Further Work Needed (Atkins	Inform Long term Strategy
3	WINEP_IMP	Statutory Obligation	IED (Biological Treatment of Waste)	No	New assets to be delivered to IED standard. Retrospective compliance assumed AMP7 driver and no link to WINEP	Risk that new UK BAT standards may be developed in AMP8. Assumed that any updates to EU BAT standards will not apply to UK. Any updates to BAT are outside WINEP scope (&AMP8 investment) as no known plans. Investment to meet 2018 BREF assumed AMP7, rather than AMP8 driver. Companies may have site specific invesment which rolls into AMP8, to be agreed on a permit by permit basis.		Out of Scope	n/a	AGREED		
4	WINEP_IMP	Statutory Obligation	IED (Phys/chem)	No	Linked to need for disposal outlet for resilience	Potential AMP8 driver if company strategy is to move to disposal outlets, rather than biosolids recycling, as upstream Phys/chem sites will fall within IED regulations. Risk of reinterpretation of legislation to apply to sites with a Recovery code, as well as Disposal code. No known plans, so out of scope for AMP8. Risk that new UK BAT standards may be developed in AMP8: Outside WINEP scope as no known plans. Individual companies to assess if sites will require compliance with IED standards in AMP8 resulting from a move to a disposal outlets for biosolids.		Out of Scope	n/a	AGREED		

A6 CAC6 Energy costs

WSX09 - Annexes - Base cost adjustment claims

Business plan 2025-2030

Wessex Water
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CAC6 – Energy costs

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A1 Energy costs

A1-1. Introduction to the claim

A1-1.1. Overview of the claim

This cost adjustment claim submission relates to the additional costs that we expect to incur in AMP8 in order to deliver our services given the increase in energy costs over and above the levels that we consider will be implicitly funded through Ofwat's PR24 econometric models.

Ofwat's base cost allowances are set based on its benchmarking models. These models use historical data to predict costs for AMP8. Using this starting point for allowances will significantly under-provide efficiently allowances for energy because there is a disconnect between the energy price to CPIH wedge, across the historical modelling time period and the forecast period (AMP8). That is, energy prices will be materially higher relative to CPIH at AMP8, compared to the PR24 modelling period. Absent a variable to capture this wedge in Ofwat's benchmarking models, predicted costs at AMP8 will not reflect the higher energy prices. Therefore, we propose that Ofwat applies an off-model adjustment to correct allowances accordingly.

Within the consulted on PR24 regulatory framework we consider this take the form of a cost adjustment claim to 're-set' what is considered to be a baseline level of efficient expenditure for PR24; and given energy price forecasts suggest no return to the pre-2021/22 prices (see graph in Figure 1), that this be in conjunction to an ex-ante energy RPE allowance (see Annex WSX08). We recognise there may be more appropriate methods within the developing and yet-to-developed aspects of the PR24 cost assessment framework and acknowledge the letter and additional data request to companies, since early submission of cost adjustment claims with this regard.

We add, that whilst our claim method is only material in the water network and wastewater network price controls, energy is a fundamental input across all price controls and we consider that an adjustment is needed across all areas of our business, with disregard to materiality thresholds, as fundamentally we procure a single wholesale price for energy regardless of whether it abstracts water resources, pumps waste from customer homes or keeps the lights on at our billing company. Consistent with this, our Energy RPE is applicable to all areas of our business.

Finally, we also note that this issue is not peculiar to PR24 or to a particular input cost. That is, in future price controls, Ofwat should establish a methodology to take into account the possibility of future real input price inflation mismatches between the modelling period, and the forecast period. We focus on energy prices as it is the most material at PR24.This document is to be read alongside the business plan data tables CW18 and CWW18. This document provides supporting information in line with Ofwat's assessment criteria for cost adjustment claims as set out in Appendix 9 of the PR24 final methodology. This section is structured in line with Ofwat's assessment criteria for cost adjustment claims.

This claim has been updated since early submission to reflect an update of energy price forecasts and PR24 energy consumption forecasts, assessment of claim materiality and synergies with the wider plan and regulatory framework (e.g. Ofwat energy data request, Sept 2023).

A1-1.2. Scope of costs covered by this claim

This claim covers the costs of energy prices from 2022/23, where these are above the historical average of energy costs reported within base expenditure that form part of modelled base costs.

A1-1.3. Summary of claim value (provisional)

The net value of the claim is summarised in the table below.

Table 1 - Summary of the claim value

Water Network +

	2025/26	2026/27	2027/28	2028/29	2029/30
Gross value of the claim (£m)	£18.1	£17.6	£16.2	£15.4	£18.9
Implicit allowance (£m)	£6.2	£5.7	£4.2	£3.5	£6.9
Net value of the claim (£m)	£11.9	£11.9	£11.9	£11.9	£11.9

Wastewater Network +

	2025/26	2026/27	2027/28	2028/29	2029/30
Gross value of the claim (£m)	£44.9	£43.7	£40.0	£38.2	£46.7
Implicit allowance (£m)	£15.4	£14.1	£10.5	£8.7	£17.2
Net value of the claim (£m)	£29.5	£29.5	£29.5	£29.5	£29.5

A1-1.4. We are not proposing a symmetrical cost adjustment

We are not proposing that Ofwat make a symmetrical cost adjustment across the industry as part of this claim. This is an industry-wide issue, given the step change in energy costs relative to the levels implicitly funded by Ofwat's April 2023 models.

A1-2. The need for a cost adjustment

This section sets out our response to Ofwat's "need for a cost adjustment" criterion. We first set out some contextual information on the need for a cost adjustment. We then address each question that Ofwat has listed under this criterion.

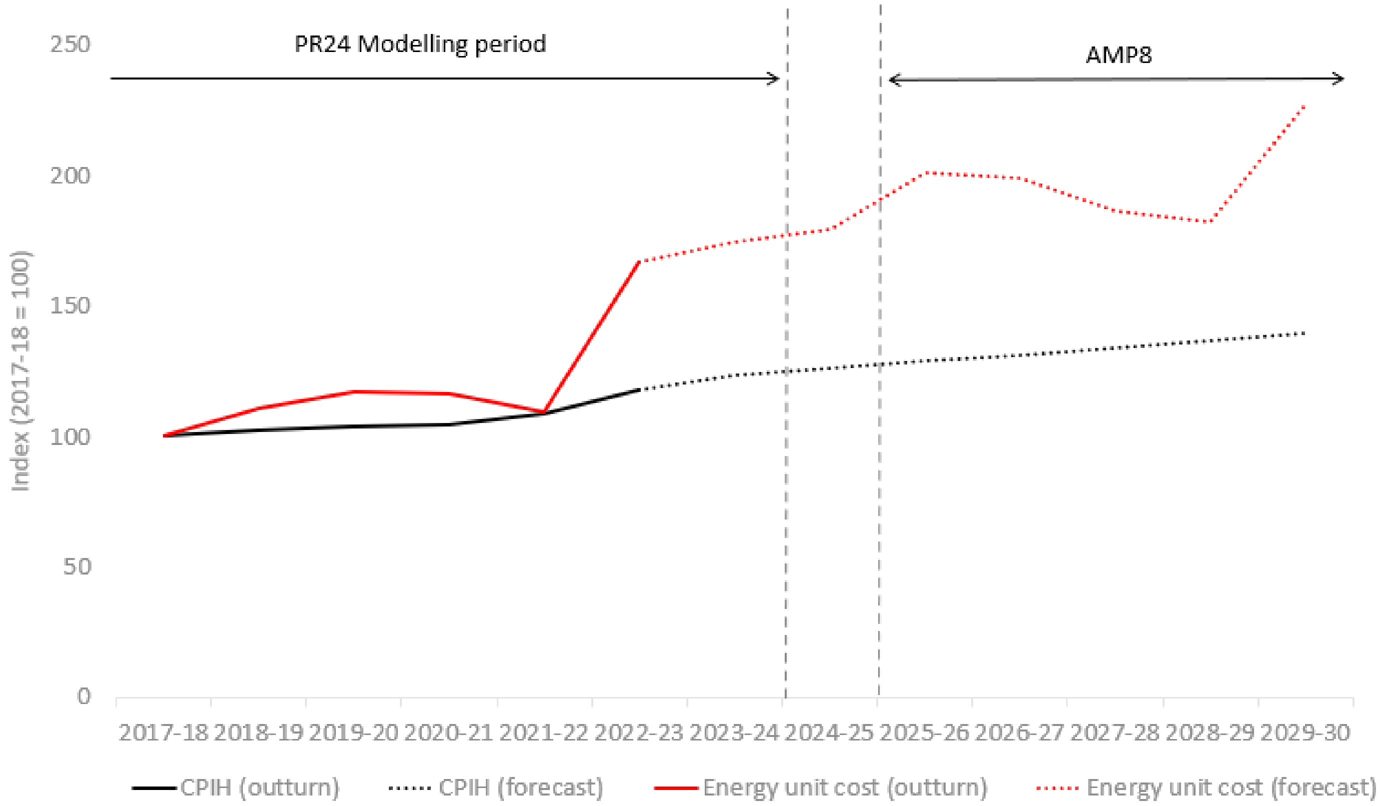
A1-2.1. Context for the cost adjustment claim

This section sets out some background information on the step change in energy costs and why a cost adjustment outside Ofwat's econometric models is needed.

A1-2.1.1. Historical energy prices

The unit price of energy in 2022/23 incurred is a marked step change compared to the historical average as shown in the chart below.

Figure 1 - Comparison of energy unit costs and CPIH over time



A1-2.1.2. The need for a cost adjustment

Ofwat's base econometric models implicitly fund power at an average unit cost observed over time period of modelling. Most important to the time period of modelling is the time period over which the efficiency score is modelled (i.e. last five years). If models were to be run today, the corresponding cost assessment dataset available would be 2017-18 to 2021-22 for calculation of allowances. The below table summarises on a unit cost basis the shortfall in efficient allowances with reference to historical unit costs we have incurred.

Table 2 – Comparison of 22/23 energy prices to historical energy prices

	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23
Historical p/kWh (inc. Fixed), 22/23 prices	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Historical average p/kWh (prior to energy price hike)	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
22/23 p/kWh above historical average	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

The above illustrates that the efficient allowance for energy costs needs to be higher than the level of modelled costs implied by the base expenditure econometric models. We consider a cost adjustment claim to all price controls is appropriate to upward adjust the efficient level of modelled costs to align what the model would allow as efficient expenditure for energy with what that allowance could actually buy today in the energy market. An RPE in PR24 can then be used to capture increases or decreases in energy prices relative to CPIH.

A1-2.2. Unique circumstances

Ofwat lists the following questions in relation to this area:

a) *Is there compelling evidence that the company has unique circumstances that warrant a separate cost 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)?*
c) *Is there compelling evidence of alternative options being considered, where relevant?*

This claim for a cost adjustment is *not* based on a view that Wessex Water has unique circumstances that warrant an adjustment to allowances based on Ofwat's April 2023 econometric models, or that it faces higher efficient costs in the round than its peers. Indeed, the circumstances that justify this claim applies more widely across the industry.

Energy is a business-critical input that cannot readily be substituted.

As such, we do not believe that the "unique circumstances" criterion is relevant to this claim.

A1-2.3. Management control

In relation to the "management control" area, Ofwat lists the following questions:

d) *Is the investment driven by factors outside of management control?*
e) *Have steps been taken to control costs and have potential cost savings (eg spend to save) been accounted for?*

In the short term we can and do hedge energy prices to secure the future unit cost of energy. The primary purpose of this is to provide price stability, not necessarily to out-perform the market.

In the current climate of energy price hikes, market hedging cannot provide indefinite protection to the sharp rise in prices. Whilst we have used hedging to secure a relatively good unit price for 22/23, this cannot be sustained and we are expected to experience the full impact and exposure in achieved prices in 23/24 and PR24 based on current information.

A1-2.4. Materiality

Based on our business plan totex for AMP8:

- Our claim exceeds, by a considerable margin, Ofwat's materiality thresholds in respect of the water network plus and wastewater network plus price controls; and
- The claim does not meet Ofwat's materiality thresholds for the water resources and bioresources price controls.

However as set earlier in this document, we add, that whilst our claim method is only material in the water network and wastewater network price controls, energy is a fundamental input across all price controls and we consider that an adjustment is needed across all areas of our business, with disregard to materiality thresholds, as fundamentally we procure a single wholesale price for energy regardless of whether it abstracts water resources, pumps waste from customer homes or keeps the lights on at our billing company. Consistent with this, our Energy RPE is applicable to all areas of our business.

Finally, we also note that this issue is not peculiar to PR24 or to a particular input cost. That is, in future price controls, Ofwat should establish a methodology to take into account the possibility of future real input price inflation mismatches between the modelling period, and the forecast period. We focus on energy prices as it is the most material at PR24.

A1-2.5. Adjustment to allowances (including implicit allowance)

In relation to the adjustment to allowances, Ofwat lists the following questions:

- *f) 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?*
- *g) Is the claim material after deduction of an implicit allowance? Has the company considered a range of estimates for the implicit allowance?*
- *h) Has the company accounted for cost savings and/or benefits from offsetting circumstances, where relevant?*
- *i) Is it clear the cost allowances would, in the round, be insufficient to accommodate the factor without a claim?*
- *j) 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?*
- *k) 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 now set out the rationale for our proposed adjustment to allowances, which also addresses Ofwat's questions.

A1-2.5.1. The treatment of energy costs within Ofwat's April 2023 models

Ofwat's models use outturn costs incurred by incumbents, expressed in real terms (for PR24 this will be in 22/23 prices). These outturn costs have embedded in them the impact of input price costs and efficiencies.

Models run on current historical data will not capture the impact of step change in energy prices seen since 22/23 as set out above.

We have taken a proportionate approach to recognise the above principle in this cost adjustment claim, noting we consider this issue more endemic to cost assessment than the above materiality considerations might otherwise suggest. We recognise that there may be alternative ways to consider the required adjustment and acknowledge Ofwat's PR24 energy data request issued between early and final submission of cost adjustment claims to this effect.

A1-2.5.2. The gross value of the claim

We have calculated the gross value of the claim to be the product of:

- Forecast energy prices for PR24. Forecast energy prices have been informed by a WaterUK industry study with Cornwall Insight (June 2023) and Wessex specific management costs. The table below provides a summary of the p/kWh forecasts, including forecasts for the last two years of the current AMP.

Table 3 – Forecast energy prices

	2023-24	2024-25	2025-26	2026-27	2027-28	2028-29	2029-30
Forecast p/kWh (inc. Fixed), 22/23 prices	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

- Forecast energy consumption for PR24. Energy consumption is forecast as per those reported in our PR24 business plan data tables for the respective controls

The gross value of the claim is summarised in the table below.

Table 4 – Gross valuation of claim, £m 22/23 prices

Gross valuation of claim, £m 22/23 prices	2025/26	2026/27	2027/28	2028/29	2029/30
Water network +	£18.1	£17.6	£16.2	£15.4	£18.9
Wastewater network +	£44.9	£43.7	£40.0	£38.2	£46.7

A1-2.5.3. Estimated implicit allowance

Ofwat's base econometric models implicitly fund power at average unit cost observed over the time period of the modelling. Most important to the time period of modelling is the time period over which the efficiency score is modelled (i.e. last five years).

We have estimated the delta between the current achieved price (22/23) to last five years of modelling data (17/18 to 21/22). We summarise the implicit allowance in the table below.

Table 5 – Implicit allowance of claim, £m 22/23 prices

Implicit allowance, £m 22/23 prices	2025/26	2026/27	2027/28	2028/29	2029/30
Water network +	£6.2	£5.7	£4.2	£3.5	£6.9
Wastewater network +	£15.4	£14.1	£10.5	£8.7	£17.2

A1-2.5.4. The net value of the claim

The net value of the cost adjustment claim is estimated by subtracting the implicit allowance from the gross value of the claim. The table below summarises the net value of the claim.

Table 6 – Net valuation of claim, £m 22/23 prices

Net valuation of claim, £m 22/23 prices	2025/26	2026/27	2027/28	2028/29	2029/30
Water network +	£11.9	£11.9	£11.9	£11.9	£11.9
Wastewater network +	£29.5	£29.5	£29.5	£29.5	£29.5

A1-3. Cost efficiency

In relation to cost efficiency, Ofwat lists the following questions in its guidance:

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)?*
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?*
c) *Does the company provide third party assurance for the robustness of the cost estimates?*

The previous section explains how we have estimated the gross and net values of the cost adjustment claim for energy costs. Claim estimates are based on achieved prices paid by Wessex Water, and forecast prices, using a methodology easily replicable.

We have a dedicated team at Wessex Water who look to secure the best energy prices given market conditions, whilst balancing cost efficiency with price stability over applicable time horizons.

Energy prices have been informed by a Water UK industry study with Cornwall Insight (June 2023), as a reputable third party expert.

A1-4. Need for investment

We have not considered this test applicable to this claim.

A1-5. Best option for customers

We have not considered this test applicable to this claim.

A1-6. Customer protection

Customers are protected against variance in expenditure through the existing totex reconciliation and can further be protected by the appropriate use of forward looking RPEs. This strikes the correct balance of risk, still giving customers protection against price changes that are different to those expected whilst still retaining incentives for companies to manage their consumption and power purchase strategies efficiently.

A7 Increases to efficient costs over time (separate document)

This document is a supporting file to CAC1, and has been submitted separately to Ofwat.

A8 Energy costs supporting file for CAC6 and Energy RPE (separate document)

This annex has been submitted separately to Ofwat.

A9 Cornwall Insight (June 2023) Water UK Delivered Electricity Cost forecasts

This document has been submitted separately to Ofwat.

A10 Cornwall Insight (June 2023) Water UK Delivered Electricity Cost forecasts (separate document)

This annex has been submitted separately to Ofwat.

A11 Economic Insight (August 2023) – Chemical RPEs at PR24

Economic Insight

09 August 2023

Economic Insight Ltd

CHEMICAL RPES AT PR24

A report for Wessex Water

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As part of the development of its PR24 business plan, Wessex Water has asked us to estimate the real price effects (RPEs) for its chemical costs at PR24. In order to do this, we have used an econometric approach which estimates that Wessex faces annual RPEs of 1.63% - 1.77% in each year of PR24 (with an average annual RPE of 1.7%). These results are robust to tested sensitivities around different econometric models and analytical approaches.

1 Introduction and summary

Wessex Water has asked us to quantify the RPEs relating to chemical input costs at PR24. Ofwat has said that wholesale costs at PR24 will be indexed to inflation (specifically CPIH)[1] – hence companies will be able to recover any increased chemical costs that equate to inflation. RPEs represent input price pressure (IPP) – i.e. changes in the cost of inputs – that is not captured in inflation.

In this chapter, we: (i) set out our approach to quantifying RPEs for chemicals at PR24, including our preferred approach out of the three that are available; (ii) provide a summary of our results for chemical RPEs at PR24; and (iii) set out the structure of the report.

1A. Approaches to measure RPEs for chemicals at PR24

In this report, we seek to estimate RPEs for chemicals at PR24, on a financial year basis (i.e. April – March). In order to do this, we do the following:[2]

(i) Firstly, we estimate IPP in each financial year of the PR24 price control period, using the analytical approach detailed in the remainder of this section.

(ii) Secondly, we subtract forecasted CPIH from IPP in each financial year to arrive at an estimate of chemical RPEs at PR24.

1 *'Creating tomorrow, together: Our final methodology for PR24 Appendix 9 Setting expenditure allowances.' Ofwat (December 2022); p. 38.*

2 *We also do this for 2023-24 and 2024-25, as these are requested by Ofwat in SUP11.*

There are three main approaches available to us to quantify IPP:

- **Extrapolation approach**. This approach uses historical chemical IPP data, and assumes that the historical trends will persist into the future – i.e. into the PR24 period. The benefit of this approach is that it is simplistic and transparent. On the other hand, it expects historical trends to continue into the future and therefore does not account for any changes in trend. In the current climate this may be inaccurate – for instance, due to the war in Ukraine. As Russia is a major producer of oil, there was a major impact on oil prices due to the significant disruption to global supply chains. Given that oil is a major input to the production of many chemicals, and closely correlated with energy costs – a key input to many other chemicals (as we detail below in section 2C) this led to the extraordinary increase in global chemical prices in 2022, that is not expected to normalise in the future.

- **Independent third-party forecasts.** This approach involves using forecasts of data that are generated by the World Bank (i.e. an independent third-party). In theory, these provide a relatively robust forward-looking measure of chemical IPP based on independent sources, and therefore provide the IPP faced by an efficient firm. However, the only available forecasts that extend into the PR24 period were generated in October 2021, which was before the war in Ukraine (with the effect of this on chemical prices provided in the paragraph above). As such, the reliability of these estimates may be limited. This is further exacerbated by the fact that the applicability of the chemicals, for which there are forecasts, to the water industry is unclear – with more details given in section 2B. We note that Ofwat also placed limited weight on these forecasts at PR19.[3]

- **Econometric approach**. The third approach involves: (i) firstly examining the relationships between historical changes in chemical prices (chemical IPPs) and drivers of chemical IPP by way of an econometric analysis; and (ii) secondly forecasting forward likely IPP over PR24.[4] Therefore, it accounts for changes in the drivers of chemical IPP, rather than merely assuming that trends in chemical IPP will continue into the future. In addition, it utilises the most up-to-date data available.

On balance, based on the above, we consider the econometric approach to be the most preferable.

In order to set up our econometric approach, we have used economic theory and econometric literature and identified the following as the key drivers of chemical IPP: (i) GDP growth; (ii) crude oil price changes; and (iii) changes in the production output of the construction industry. In addition, we control for exogenous shocks that occur during our analytical period, specifically 2008 for the Global Financial Crisis and 2022 for the start of the war in Ukraine.[5] This is on the basis that these events affected chemical IPP so dramatically that our drivers set out above (the drivers in the model) cannot explain the full extent of these changes in chemical IPP.

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[3] *'PR19 final determinations - Securing cost efficiency technical appendix.' Ofwat (December 2019); p. 207.*
[4] *Further details on step (ii) are provided in section 3A.*
[5] *Although the war has continued, we note that 2022 is the last year for which data is available across chemical prices and all our chosen drivers.*

We note that, while we consider that the econometric approach results in robust and reliable estimates of chemical RPEs at PR24, there is inherent uncertainty with any approach to forecasting input price pressure. For instance, there is limited data available on both chemical IPP and drivers. This is on both a historical basis (for the variables in our main model, data is available for at most 35 years), and on a forward-looking basis (with none of the drivers in our main model containing data covering the whole of the PR24 period). This increases the risk that any result is (at least in part) driven by anomalous years of data.

1B. Chemical RPEs at PR24

In the table below, we show estimated RPEs in each year between 2025-26 and 2029-30 for: (i) our main model; and (ii) the three sensitivities assessed as part of our econometric analysis, in which we tweak elements of the main model to test its robustness.

For these models, we also show the average RPE across the PR24 period (i.e. across 2025-26 to 2029-30). We recommend that the figures in the first row of the table (i.e. our main model) are used to complete the PR24 years of the SUP11 table.[6]

Table 1: Summary of chemical RPE estimates at PR24[7]

Analytical details		**2025-26**	**2026-27**	**2027-28**	**2028-29**	**2029-30**	**PR24 average**
Main model[8]		1.77%	1.67%	1.65%	1.63%	1.63%	**1.67%**
Sensitivity analysis	Minimum[9]	1.56%	1.52%	1.54%	1.52%	1.53%	**1.53%**
	Midpoint[10]	0.38%	1.37%	1.98%	2.37%	2.62%	**1.74%**
	Maximum[11]	2.12%	1.99%	1.96%	1.93%	1.93%	**1.98%**

Source: Economic Insight analysis

We also note that the SUP11 table does not contain RPE splits across different price control areas, unlike its predecessor – the App24 table at PR19. As such, this report focuses on an aggregated RPE across Wessex's entire chemical cost base. However, we have also calculated RPEs separately for the price control areas for which Wessex

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6 *The RPE estimates for the remaining two years (2023-24 and 2024-25) of the SUP11 table can be found in chapter 4.*
7 *In this table, we note that "Minimum", "Midpoint" and "Maximum" are defined by the PR24 average RPE (shown in the final column).*
8 *We regress chemical IPP on GDP growth; current crude oil price changes; lagged crude oil price changes; construction output growth; and a dummy variable for 2008 and 2022. The temporal scope is 2001-2022.*
9 *We regress chemical IPP on GDP growth; lagged GDP growth; current crude oil price changes; lagged crude oil price changes; construction output growth; and a dummy variable for 2008 and 2022. The temporal scope is 2001-2022.*
10 *We regress the chemical price level on the lagged chemical price level; the GDP level; the crude oil price level; the lagged crude oil price level; the construction output level; and a dummy variable for 2008 and 2022. The temporal scope is 2001-2022.*
11 *We regress chemical IPP on GDP growth; current crude oil price changes; lagged crude oil price changes; and construction output growth. The temporal scope is 2001-2022.*

primarily uses chemicals, namely: (i) water network plus; (ii) wastewater network plus; and (iii) bioresources. We have these estimates in chapter 4.

1C. Structure of the report

The remainder of this report is structured as follows:

- Chapter 2 describes the data that we rely on, and provides detail on our choice of variables for the analysis – which are based on economic theory and economic literature. Specifically, we set out data on the following, in turn: (i) the breakdown of Wessex's chemical costs; (ii) chemical prices (from which we calculate chemical IPP); (iii) drivers; (iv) exchange rates; and (v) inflation forecasts. In addition, we provide detail on any assumptions we have made to fill gaps in the data.
- Chapter 3 explains our methodology, including: (i) key analytical decisions and assumptions that need to be made in relation to our econometric analysis (both in terms of the drivers and other elements of the model); (ii) the extrapolation approach; and (iii) a summary of our different specifications.
- Chapter 4 presents the full RPE estimates across our main model and sensitivity analysis.
- Annex 1 presents the full set of econometric results.

2 Data and choice of variables

In order to estimate RPEs at PR24, we need data on different metrics, specifically:

(i) The set of chemicals used by Wessex in its day-to-day operations, and in what proportion they are used.

(ii) Data on chemical prices (both historical and, to the extent available, forecasts) – which we use to calculate chemical IPP.

(iii) Historical and forecast data on the drivers of chemical IPP.

(iv) Data on exchange rates.

(v) Forecasts of CPIH.

In the remainder of this chapter, we provide information on the sources of each of the abovementioned pieces of data, in addition to the rationale for our use of the variables in the analysis. In addition, where appropriate, we set out any assumptions that we have had to make to fill gaps in the data.

2A. Wessex's set of chemicals

In order to ensure that the chemical price data set out in section 2B is sufficiently representative of the chemicals used by Wessex (and thus corresponds most closely to the chemical IPP experienced by Wessex), we have sought to calculate a "Wessex-specific" chemical price index.

Wessex has provided us with its cost breakdown of different chemicals back to 2012, which we have used to derive weightings to attach to different chemical price indices. Wessex's data also contains price control splits for its chemical purchases, such that we can also derive price control-specific weightings for the estimates of RPE.

We have chosen to base these weights on Wessex's data for 2021-22 for the following reasons:

- The table below shows that the cost breakdown of different chemicals is relatively stable across time, particularly for those chemicals that make up a significant proportion of Wessex's chemical cost base. As such, the choice of 2021-22 is unlikely to make a material difference to our analysis.

- Furthermore, as the mix of chemicals used by Wessex is likely to be outside of management control (a conclusion reached by Ofwat at PR19),[12] it is likely the case that recent data is most representative of Wessex's current mix of chemicals. Given that 2022-23 data is only available for April – December 2022 (i.e. data is unavailable for 25% of the year), 2021-22 is the last full year for which data is available.

Table 2: Breakdown of Wessex's chemical cost base over time

Chemical	2018-19	2019-20	2020-21	2021-22	2022-23
Reagents	2.97%	4.01%	3.37%	3.08%	3.26%
Nutriox (Calcium Nitrate)	2.36%	2.69%	2.90%	3.14%	3.36%
Sundry Chemicals & Gases	13.54%	14.95%	17.92%	13.07%	12.96%
Oxygen	1.87%	1.65%	1.50%	1.94%	1.61%
Coagulant- Irons	16.71%	19.86%	19.23%	18.05%	19.21%
Coagulants- Alum	6.36%	6.25%	6.25%	5.26%	5.42%
Chloros	2.76%	1.52%	2.12%	1.90%	1.45%
Polyelectrolite	25.52%	25.97%	25.41%	26.40%	21.48%
Fly Dosing	0.93%	0.95%	0.49%	1.34%	0.65%
Alkali	12.33%	10.91%	6.01%	11.46%	12.99%
Methanol	4.88%	4.16%	4.51%	4.73%	4.12%
Activated Carbon	3.06%	0.42%	3.05%	2.20%	2.82%
Dechlorination Agents	0.00%	0.22%	0.35%	0.81%	0.67%
Chlorine	3.46%	3.22%	3.15%	2.70%	2.65%
Phosphoric Acid	2.12%	2.38%	2.84%	2.75%	6.03%
Sulphuric Acid	1.13%	0.85%	0.91%	1.17%	1.30%

Source: Economic Insight analysis of data provided by Wessex Water

[12] *'PR19 final determinations - Securing cost efficiency technical appendix.' Ofwat (December 2019); table A3.7.*

2B. Chemical prices

In order to estimate future chemical IPP, it is necessary to collect data on:

- Historical chemical prices for both the econometric and extrapolation methods described in section 1A.
- Forecast chemical prices for the independent third-party forecast method described in section 1A.

Historical chemical prices

In this section, we: (i) firstly, describe the data that we have relied on for chemical prices, and explain our choice of data source; and (ii) secondly, set out the approach that we have adopted to fill in gaps in the data.

Data source used

Historical chemical prices have been sourced from US Producer Price Index (PPI) data, which *"measures the average change over time in the selling prices received by domestic producers for their output."*[13] This data contains a nominal index that shows how prices for different chemicals change over time. At time of writing this report, actual monthly historical data was available from 1987[14] until May 2023 (although only five months of data are available in 2023). We average this data across months in order to obtain a price index for that year.

We note that a sufficiently granular UK-based time series of chemical prices over time does not exist – with the ONS PPI data only breaking down chemicals into a small number of relatively high-level categories.[15] We also note that the metric relied on by Ofwat at PR19 ("Chemicals & Chemical products") appears to have been discontinued.[16]

As such we have chosen to use US chemical prices because: (i) commodities (such as chemicals) are traded globally, meaning that US chemical prices are likely to be highly informative of global prices; and (ii) the data contains a granular breakdown across a range of chemicals that allows us to match across to Wessex's mix of chemicals, and thus derive "Wessex-specific" chemical IPP.

We have collected US PPI data for a range of chemicals, which we use to match across to Wessex's chemical cost data. The table below shows the equivalent chemical in the US PPI data for each of the chemicals in Wessex's 2021-22 cost base. In addition, we calculate the relative weightings of each chemical, corresponding to the cost incurred on that chemical in 2021-22 divided by the total cost of chemicals in 2021-22. As such, the table below also includes: (i) the weighting in Wessex's costs base; and (ii) the

13 Please see: https://www.bls.gov/ppi/.

14 This is the first year that data is available for all the chemicals in Wessex's cost data in 2021-22. Prior to 1987, data is available for some (but not all) chemicals. However, using incomplete data would lead to a bias in the price index as we would not be accounting for all chemicals purchased by Wessex.

15 Please see: https://www.ons.gov.uk/economy/inflationandpriceindices/bulletins/producerpriceinflation/june2023includingservicesapriltomarch2023/pdf (Table 5).

16 Please see: https://www.ons.gov.uk/economy/inflationandpriceindices/timeseries/k37z/ppi.

corresponding weighting of the matching chemical in the US PPI data (which is equal to the sum across (i) of the matching chemicals in Wessex's cost data).

Table 3: Matching of Wessex's mix of chemicals to US data on chemical prices

Chemical (Wessex data)	Weighting (Wessex data)	US PPI equivalent	Weighting (US PPI)
Alkali	11.46%	Alkalies and chlorine, including natural sodium carbonate and sulfate	17.30%
Chlorine	2.70%		
Nutriox (Calcium nitrate)	3.14%		
Coagulant- Irons	18.05%	Basic inorganic chemicals	24.13%
Coagulants- Alum	5.26%		
Dechlorination agents	0.81%		
Activated Carbon	2.20%	Carbon black	2.20%
Methanol	4.73%	Industrial gases	17.81%
Sundry Chemicals & Gases	13.07%		
Reagents	3.08%	Inorganic chemicals, other than alkalies and chlorine	3.08%
Oxygen	1.94%	Oxygen	1.94%
Phosphoric Acid	2.75%	Phosphates	2.75%
Sulphuric Acid	1.17%	Sulfuric acid	1.17%
Polyelectrolite	26.40%	Unsupported plastic film, sheet and other shapes	26.40%
Chloros	1.90%	Water-treating compounds	3.25%
Fly Dosing	1.34%		

Source: Economic Insight analysis of data provided by Wessex Water and US PPI data on chemical prices

Filling in gaps in the data

To forecast forward chemical prices beyond 2023 (required for one of our sensitivity models, we use the forecasted price index from the previous year. For instance, for 2026, we:

- Calculate the predicted chemical price in 2024, and assign this to be the lagged price level in 2025.
- Calculate the predicted price level in 2025 (incorporating the forecasted 2025 lagged value), and then assign this forecasted price level to be the 2026 lagged price level.
- Calculate the predicted price level in 2026 (incorporating the forecasted 2026 lagged value).

Independent third-party forecasts

In addition, we have also collected data on independent third-party forecasts from the World Bank on a set of five chemicals.[17] In theory, we could use these to estimate RPEs at PR24 – given that they are forward-looking and generated by an independent body. However, we do not consider these forecasts appropriate to use in our analysis, and thus do not include estimates from these forecasts in our assessment of RPEs. This is for the following reasons:

- **Timing of the forecast**s. Since 2018, the World Bank has published two sets of forecasts each year.[18] The most recently available (April 2023) does not contain forecasts for any year after 2024 (i.e. it does not cover any of the PR24 period). As was detailed in section 1A, the most recently available iteration that contains forecasts into the PR24 period was made in October 2021, which was before the war in Ukraine. Given the significant impact that this event had on chemical IPP (as was discussed in section 1A), we do not consider that these forecasts are sufficiently reliable to be included.

[17] *Please see: https://www.worldbank.org/en/research/commodity-markets#3.*
[18] *We note that forecasts between 2014 and 2017 are unavailable on the World Bank's website.*

- **Applicability of the chemicals.** As was mentioned above, we have forecasts on five separate chemicals: DAP (Diammonium Phosphate); Phosphate Rock; Potassium Chloride; TSP (Trisodium Phosphate); and Urea. Out of these, our research suggests that only Phosphate Rock is applicable to the water industry.[19,20,21,22] Although it appears to be mainly used in the manufacturing of fertilisers, it also provides a source of phosphorous and phosphoric acid for water softeners[23] – with phosphoric acid a chemical that is purchased by Wessex.

- **Underestimation of the forecasts**. For the one chemical that appears to be applicable to the water industry (Phosphate Rock), evidence suggests that the World Bank forecast has underestimated its price in recent years. The figure below shows the percentage difference between the actual price index (with the forecast year on the x axis) and the World Bank forecast price index (with the year in which the forecast was made corresponding to the colour of the bar in the legend). As can be seen, in 2019 and 2020, there is some evidence to suggest that the forecasts were overestimated, but in recent years they have been underestimated consistently.

[19] *DAP is used solely as a fertiliser. Please see: https://www.phosagro.com/production/fertilizer/azotno-fosfornye-udobreniya/7088/.*

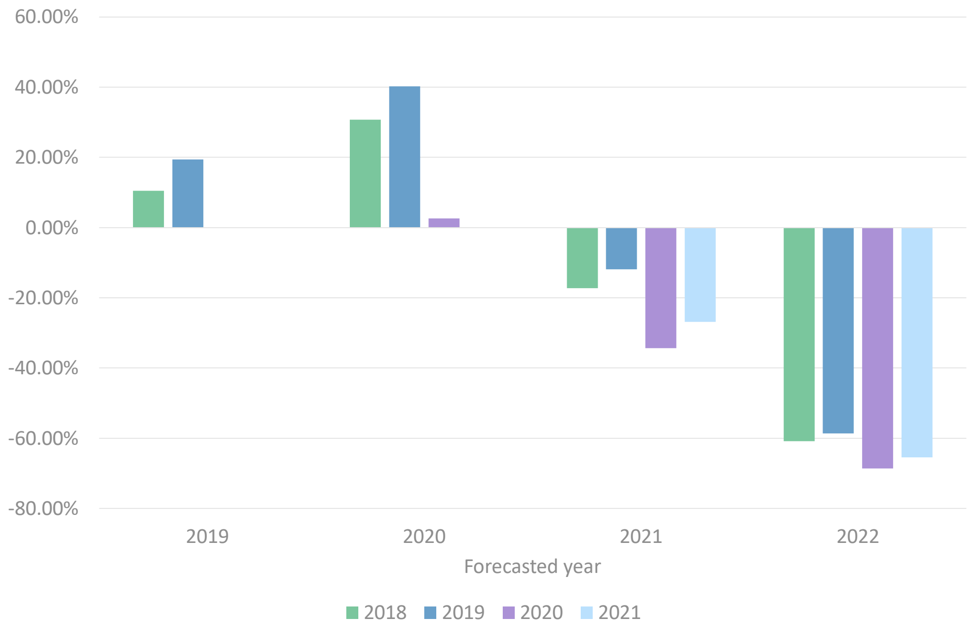
[20] *Potassium Chloride is used as a medicine to prevent / treat low potassium levels in the body. Please see: https://www.everydayhealth.com/drugs/potassium-chloride#:~:text=Potassium%20chloride%20is%20a%20medicine,remove%20potassium%20from%20the%20body.*

[21] *TSP is used mostly used as a cleaning agent, with no other purpose applicable to the water industry. Please see: https://www.sunnysidecorp.com/product.php?p=c&b=s&n=64216#:~:text=TSP%20or%20Trisodium%20Phosphate%20is,from%20walls%2C%20woodwork%20and%20floors.*

[22] *Urea is used in fertilisers as a source of nitrogen. Please see: https://www.spglobal.com/commodityinsights/en/ci/products/fertilizers-urea.html.*

[23] *Please see: https://earthresources.vic.gov.au/geology-exploration/minerals/industrial-minerals/phosphate-rock#:~:text=The%20major%20use%20of%20phosphate,%2C%20soaps%2C%20detergents%20and%20insecticides.*

Figure 1: Percentage difference between actual and forecasted "Phosphate Rock" price index



Source: Economic Insight analysis of World Bank data
Notes: Forecasts shown above are all taken from the second iteration in each year – i.e. in October. Colour-coded bars correspond to forecasts that were made at the same time, whilst a set of bars corresponding to one label on the x-axis corresponds to the forecasted year. For instance, the green bar above the "2021" label on the x-axis refers to the difference between the actual in 2021 and the forecast made for 2021 in October 2018.

2C. Drivers

In addition to data on chemical IPP, it is necessary for us to obtain data on drivers of chemical prices for the econometric method described in section 1A. Historical data on these drivers is included in our econometric analysis, and forecast data is used to predict future chemical IPP.

Below, we set out further details on each of the following drivers: (i) GDP growth; (ii) crude oil price changes; and (iii) construction output growth. Specifically we present, in turn, the rational for the inclusion of the variable in our model; and the availability of data for the variable.

GDP

Rationale for inclusion

Economic theory suggests that GDP growth will have a positive impact on the price of chemicals and other commodities. As high GDP growth corresponds to increasingly high demand in the economy (and, thus, high demand for products), this puts pressure on inputs to these products – with chemicals a key input to many products. As such, if the supply of chemicals is unable to respond quickly enough to the increased demand, then this leads to scarcity in the supply of chemicals and thus puts upward pressure on chemical IPP. We note that this effect may not be immediate – i.e. it is possible that GDP growth is reflected in future (as opposed to current) chemical IPP, depending on how long it takes for demand shocks to impact commodity prices.

Furthermore, there is a broad range of literature detailing this positive relationship between economic growth and other commodities, including food.[24] For instance, an academic paper by Fama and French (1988) looked into business cycles and the price of metals and found that the latter reflected "*near-term supply responses that are insufficient to absorb positive demand shocks around business cycle-peaks*".[25] Although the abovementioned literature implies that economic activity drives the price of chemicals, the reverse has also been documented within the literature. For example, Deaton (1999)[26] found that a "*12 percentage point swing in commodity price growth will eventually lead to a change of 1.8 percentage points in the growth rate*". Taken together, this literature demonstrates a clear correlation between GDP growth and commodity prices.

Data availability

We have used data on historical and forecast GDP growth from the IMF,[27] which contains US GDP index data on a current (i.e. nominal) price basis, consistent with the data that we have obtained on chemical prices. We have collected: (i) actual historical data from 1987 until 2022; and (ii) forecast data for 2023 until 2028. In order to forecast forward to 2030, we have assumed GDP growth in 2029 and 2030 to be the same as in 2028 (the last year that forecasted data is available).

Crude oil price changes

Rationale for inclusion

Crude oil is a major input to the production of many chemicals, and is closely correlated with energy costs – which are a major input to the production of other chemicals. As such, crude oil is either a key input cost for producers of chemicals, or closely proxy energy costs (a different key input). As such, changes in the price of crude oil are likely to be reflected in changes in the price of chemicals, e.g. with crude oil price increases (or energy price increases proxied by crude oil price increases) passed on to customers of chemicals, resulting in higher chemical IPP. However, as with GDP growth, this effect may not be immediate – i.e. it is possible that changes in the price of crude oil (or energy) are reflected in future (as opposed to current) chemical IPP, depending on how long it takes input costs to be reflected in chemical IPP. This is something that we account for in our modelling decisions – detailed in section 3A below.

There are various academic papers detailing this relationship, one of which (Babula and Somwaru (1992))[28] examined the dynamic effects on agricultural chemical (and fertiliser) prices of a crude oil price shock. Through the use of a vector autoregression

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24 *'Global agricultural supply and demand: factors contributing to the recent increase in food commodity prices.' R. Trostle, United States Department of Agriculture (May 2008).*
25 *'Business cycles and the behaviour of metals prices.' French, K,. and Fama, E, Journal of Finance (December 1988).*
26 *'Commodity prices and growth in Africa.' A. Deaton, Journal of Economic Perspectives, Vol. 13 No. 3 (1999).*
27 *Please see: https://www.imf.org/external/datamapper/NGDPD@WEO/USA.*
28 *'Dynamic Impacts of a Shock in Crude Oil Price on Agricultural Chemical and Fertilizer Prices.' R. A. Babula and A. Somwaru, Agribusiness, Vol. 8 No. 3, 243-252 (1992).*

analysis (VAR) model of crude oil, industrial chemicals and fertiliser prices, the authors found that a quarter of an increase in crude oil prices would be passed on to chemical IPP. Whilst their work implied that this effect does not feedback immediately, an article by McKinsey suggested the reverse: *"In addition, some chemicals, such as chlorine, are produced through highly energy-intensive manufacturing routes and have a strong link to oil prices. Changes in oil prices have an immediate and significant impact on the cost structures of these chemicals."*[29]

Data availability

Data on the crude oil price index is taken from the World Bank, and is measured in USD per barrel.[30,31] We have collected: (i) actual historical data from 1987 until 2022; and (ii) forecast data for 2023 and 2024.[32] As such, consistent with GDP, we have taken crude oil price changes in each year between 2025 and 2030 to be the same as in 2024 (the last year that data is available).

Construction output growth

Rationale for inclusion

In addition, we include the growth in construction output as an driver in our model on the basis that construction is one of the key industries that uses chemicals. If there are changes in the demand for the products of the construction industry (captured via changes in output), this means that the demand for the inputs to the construction industry (such as chemicals) will change. As such, if suppliers of chemicals are unable to respond immediately to construction changes, then this will result in upward price pressure on chemicals – due to the increased demand.

Data availability

We use data from the OECD on industrial production, which *"refers to the output of industrial establishments and covers sectors such as mining, manufacturing, electricity, gas and steam and air-conditioning. This indicator is measured in an index based on a reference period that expresses change in the volume of production output."*[33] We have collected this for the US construction industry.

We have collected historical data from 1987 until 2022. To generate forecasted construction output growth over PR24, we have taken construction output growth in each year between 2023 and 2030 to be the same as in 2022 (the last year that data was available).

29 'Oil-price shocks and the chemical industry: Preparing for a volatile environment'. S, Hong et al., McKinsey & Company (May 2015).

30 Please see 'Annual prices' under '"Pink Sheet" Data': https://www.worldbank.org/en/research/commodity-markets.

31 Due to a lack of availability of forecast data on the average price of crude oil, we use data on the price of Brent crude oil (crude oil that is extracted from the North Sea). The average price of crude oil is simply the average prices of Brent crude oil, Dubai crude oil and WTI crude oil – which are all relatively similar over time.

32 We note that forecasts are available for 2023, 2024, 2025 and 2030; but these were made in 2020. Given that this was before the Ukraine war, these forecasts may be inaccurate.

33 Please see: https://data.oecd.org/industry/industrial-production.htm.

2D. Exchange rates

As has been discussed above, our estimates of chemical IPP at PR24 are based on US prices. Therefore, it is necessary to convert these estimates from USD to GBP – meaning that it is necessary to incorporate exchange rates into our analysis.

In this section, we: (i) firstly set out more detail on the rationale for including exchange rates in our analysis; and (ii) secondly set out data availability for exchange rates on both a historical and forward-looking basis.

Rationale for consideration

In addition to the above drivers, a relationship between exchange rates and commodity prices has been widely acknowledged within economic literature. The direction of this correlation, however, appears to be that commodity prices *drive* exchange rates,[34] rather than exchange rates being a driver of commodity prices. For example, Kohlscheen et al (2016) show that "*there is a distinct commodity-related driver of exchange rate movements*"[35] and that this link is economically and statistically significant, even at high-frequency. Relatedly, Baumgärtner and Klose (2018) found that commodity prices had considerable forecasting power of exchange rates and that this feature held *irrespective* of whether a country was a net exporter or importer of commodities.[36] As such, we have chosen not to include exchange rates as an driver in our analysis, as the literature suggests that they are not a driver of commodities, and therefore chemical IPPs.

Nonetheless, exchange rates can affect the purchasing power of a foreign currency – in this case GBP. The mechanism is such that, if the GBP were to appreciate significantly relative to the USD, UK businesses would have much greater purchasing power in the US – given that imports would now be relatively cheaper. The effect of this strengthening of the GBP against the USD would result in Wessex paying a lower price for US chemicals, all else equal.[37] However, where US chemical IPPs are particularly high in a given year, and the USD is also relatively weak, the effect of the increased purchasing power parity for UK businesses (arising from a weak USD) would be somewhat dampened by the high US chemical IPPs. A foreign producer's purchasing power parity would therefore be dependent upon which of the two effects is stronger, i.e. price or exchange rate.

This assumption that the USD is negatively correlated with chemical, and thus commodity, prices is shown in the literature. For instance, Rees (2023) discusses the USD-commodity prices relation and highlights the negative correlation that has existed from "*at least the mid-1980s until the eve of the Covid pandemic*"[38] due largely to the US being a net oil importer.

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34 This is particularly the case for commodity-exporting countries.
35 Please see: https://www.bis.org/publ/work551.pdf
36 Please see: https://www.econstor.eu/bitstream/10419/200668/1/12-2018_baumgaertner.pdf
37 This means that the exchange rate (USD/GBP) has not decreased as a result of an increase in the price of chemicals.
38 Please see: https://www.bis.org/publ/work1083.pdf

As such, we need to account for the exchange rate in a particular year when considering the applicability of prices in the US to the UK. We have done this in our analysis through an ex-post adjustment to predicted IPP, with more details provided in section 3A. We note that, in practice, this adjustment makes little difference due to the lack of availability of forecasts of exchange rates (detailed in the next paragraph) – as such, for the PR24 period we assume the exchange rate to be constant, and thus it has no impact on RPE estimates since purchasing power is assumed to remain constant as a result.

Data availability

We have sourced data on historical daily GBP-USD exchange rates from 1986 until June 2024 from the Bank of England,[39] averaging on a financial year basis from 1986-87 up until 2023-24. Forecast rates are sourced from BNP Paribas,[40] and are only available up until the end of 2024-25. We have calculated forecast rates for 2023-24 and 2024-25 by averaging across the forecasts for Q3 and Q4 2023; and Q2 and Q4 2024 respectively. For the years in PR24 (i.e. 2024-25 up to 2029-30), we have assumed that the exchange rate in each financial year between 2025-26 and 2029-30 is equal to that in 2024-25.

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[39] *Please see: https://www.bankofengland.co.uk/boeapps/database/Rates.asp?TD=30&TM=Dec&TY=2022&into=GBP&rateview=D.*

[40] *Please see: https://www.exchangerates.org.uk/news/38461/2023-06-16-bnp-paribas-2024-exchange-rate-forecasts-for-us-dollar-vs-pound-euro-yen-and-g10-currencies.html.*

2E. Inflation forecasts

As was discussed in section 1A, we use forecasts of CPIH in order to calculate RPEs, by subtracting forecasted inflation from estimated IPP. In order to do this, we use data provided to us by Wessex on forecasted CPIH – which represents the company's long-term view of CPIH inflation, which is generated in line with the Bank of England target CPIH inflation rate of 2%. The table below includes: (i) the assumed CPIH index averaged across all months in the financial year; and (ii) the implied CPIH inflation rate between each financial year. These are subtracted from the IPP estimates we derive in order to obtain RPE estimates for chemicals.

Table 4: Wessex CPIH assumptions at PR24

	2023-24	2024-25	2025-26	2026-27	2027-28	2028-29	2029-30
CPIH index	130.06	133.41	136.08	138.80	141.57	144.40	147.29
CPIH inflation (%)	5.70%	2.57%	2.00%	2.00%	2.00%	2.00%	2.00%

Source: Wessex Water

3 Methodology

In this chapter, we present further details on our methodology. Firstly, we provide information on our econometric analysis, specifically: (i) the specification of the drivers used in our analysis; (ii) methodological choices in relation to the choice of temporal scope, and whether to use rates or levels; and (iii) the approach taken to converting econometric results into IPP to estimate RPEs for the SUP11 table. Secondly, we set out our extrapolation approach in more detail – we use this approach in our sensitivity analysis, comparing it to the econometric results.

3A. Econometric approach

Drivers

GDP growth

As has been discussed in section 2C, economic theory and literature suggest that GDP growth has an impact on chemical IPP. As such, we include GDP growth as a driver in our analysis, in order to test its effect on historical chemical IPP and help predict future chemical IPP.

We consider it plausible that crude oil prices (or energy prices proxied for by crude oil prices) may have had either (or, both) an immediate and a delayed impact on chemical IPP – depending on the time it takes for changes in input costs to feed through to chemical IPP (and, to what extent).

We note that there is neither a clear-cut method, nor a consensus in the literature, that can be used to determine whether using current GDP growth or lagged GDP growth is most appropriate (and, relatedly, how many years GDP growth should be lagged). As such, this choice is a matter of judgment. We have sought to empirically inform the choice of including current compared to one-year lagged GDP growth, by examining the extent of correlation between the variables and the model fit.

The correlation between current GDP and chemical IPP is **0.48** between 2001 and 2022 (while it was **0.21** between 2001 and 2017, which is the last year that both sets of data were available during the corresponding PR19 analysis). This indicates that current GDP growth is more closely related to chemical IPP than considered previously. The figure below shows the relationship between chemical IPP and GDP growth for the temporal scope of our model – i.e. from 2001 until 2022.[41] As can be seen in the figure,

[41] *We note that each of the figures shown in this section are shown on a calendar year basis, whereas our RPE estimates are shown on a financial year basis. This is because our econometric analysis is conducted in calendar years, since this is how the raw data is measured, with an ex-post adjustment to convert the resulting predicted values to a financial year basis – further details are provided at the end of this section.*

movements in chemical IPP more closely match movements in GDP growth during later years of the temporal scope.

Figure 2: Chemical IPP and GDP growth (2001-2022)

Source: Economic Insight analysis

The model fit is captured by the adjusted R^2 statistic, and this measures how much of the variation in historical chemical IPP is explained by the drivers, relative to how much of it is unexplained. The model that uses current (rather than one-year lagged) GDP growth gives (marginally) the best model fit – which is why we have chosen current GDP growth in our main model. At PR19, we chose lagged GDP growth on the basis of a better model fit – as such, although the tow specifications differ, our approach to choosing the specifications is consistent.

Nonetheless, we also test the robustness of our main model results by including lagged GDP as an driver. Our analysis shows that the model fit falls marginally as a result, but that the results obtained remain robust – as is shown in chapter 4.

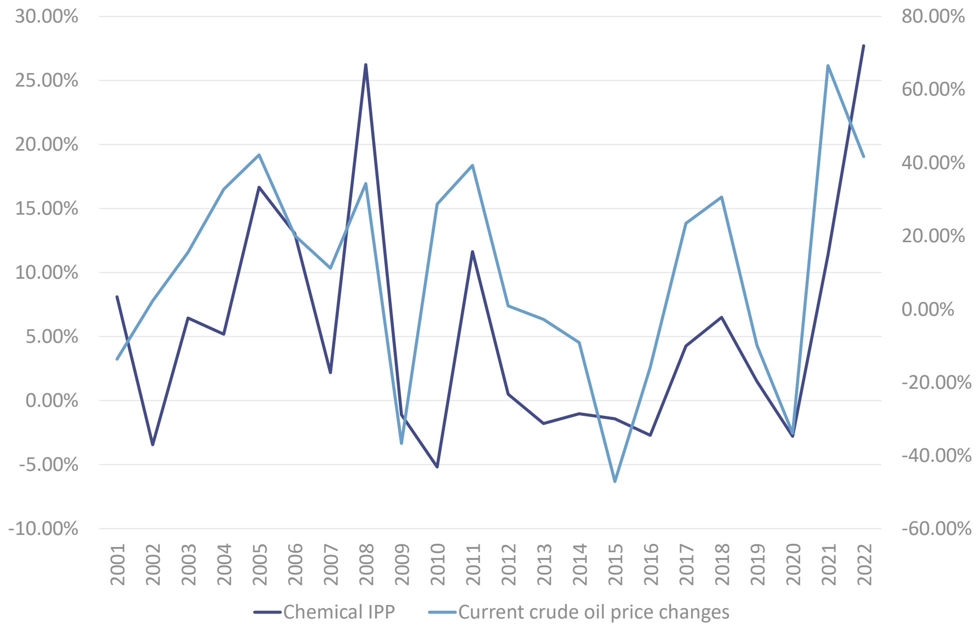
Crude oil price changes

As has been discussed in section 2C, we include crude oil prices changes in our econometric analysis, given that oil is a key input to the production of many chemicals (and is closely correlated with energy costs – a key input for other chemicals) – and is, thus, a key cost driver (or proxy for a key cost driver).

We consider it plausible that crude oil prices changes (or energy price changes) may have had either (or, both) an immediate and a delayed impact on chemical IPP – depending on the time it takes for changes in input costs to feed through to chemical IPP (and, to what extent). As such, consistent with our approach to GDP growth, we have chosen the model that provides the best fit – this includes both current crude oil price changes and lagged crude oil price changes.

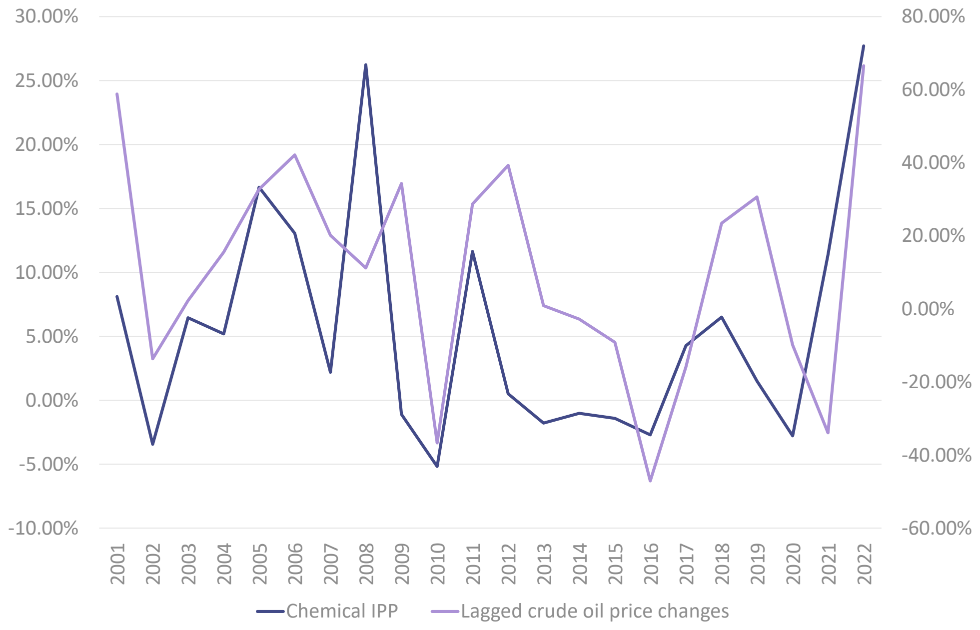
Empirically, we find that both are highly correlated with chemical IPP – specifically **0.64** and **0.51**, respectively, between 2001 and 2022.[42] Furthermore, as can be seen in the figures below, both *generally* move in line with chemical IPP over time.

Figure 3: Chemical IPP and current crude oil price changes (2001-2022)



Source: Economic Insight analysis

Figure 4: Chemical IPP and lagged crude oil price changes (2001-2022)



Source: Economic Insight analysis

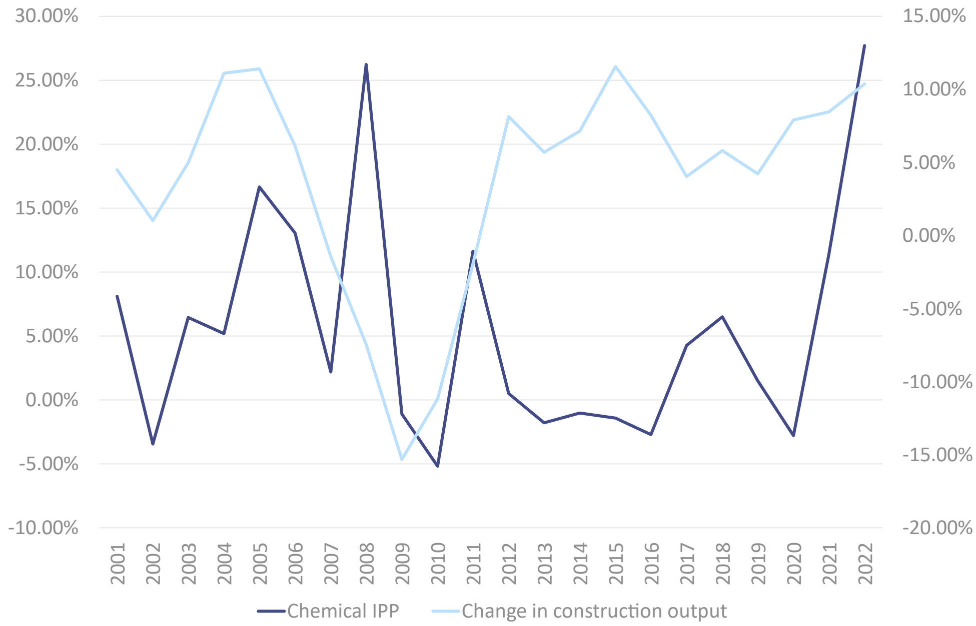
[42] *We note that both current crude oil price changes and lagged crude oil price changes were included in our preferred specification at PR19. This is consistent with the correlations between 2001 and 2017 –* ***0.59*** *and* ***0.55****, respectively.*

Change in construction output

As was also discussed in section 2C we include the growth in construction output as a driver in our model on the basis that construction is one of the key industries that uses chemicals.

We note that the correlation between the two metrics has gone up over time. Between 2001 and 2016 (the last year that both sets of data were available whilst the corresponding analysis was undertaken at PR19), the correlation was **0.00** whilst, between 2001 and 2022, it is **0.11.** This demonstrates an increasingly strong relationship between the two over time. This, alongside the fit of the model, points towards construction output growth being a relevant driver.

Figure 5: Chemical IPP and construction output growth (2001-2022)



Source: Economic Insight analysis

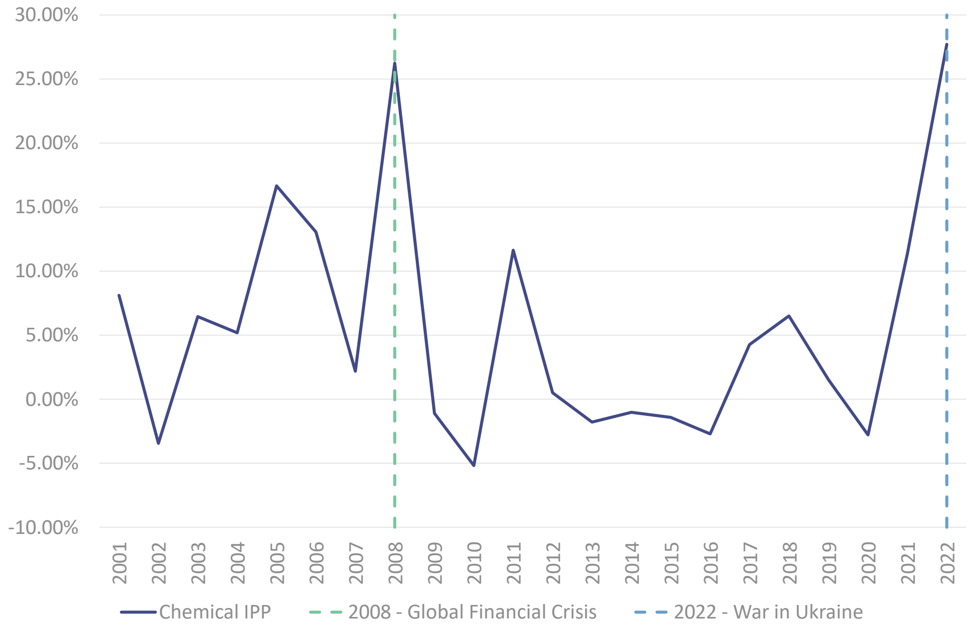
Dummy variables for exogenous shocks

In our analysis, it is feasible that there are large movements in our dependent variable (chemical IPP) that have occurred at the time of exogenous shocks, with these shocks not expected to continue (at least to the same extent) into the PR24 period.

The figure below shows two such shocks in: (i) 2008, corresponding to the Global Financial Crisis; and (ii) in 2022, corresponding to the War in Ukraine. During both these years, there was extraordinarily high chemical IPP – in fact it exceeded 25.00% in both these years (and was not greater than 20.00% in any other year).

Not accounting for these shocks in some way may cause our estimates of forecast chemical IPP to be inaccurate, as the econometric analysis would potentially become biased. Furthermore, the explanatory power of the model would reduce significantly – this is reflected in the adjusted R^2 values presented in chapter 4. As such, we control for each of these years using a dummy variable, which is equal to "1" in each of these years, and "0" otherwise. This effectively treats these years as separate to the other years in the model, with the extraordinary impact on chemical IPP in these years accounted for by the dummy variable.

Figure 6: Chemical IPP and exogenous shocks (2001-2022)



Source: Economic Insight analysis

Methodological choices

Temporal scope

US chemical price data is consistently available[43] for all chemicals used by Wessex (in 2021-22) from 1988 onwards.[44] As such, a key analytical decision to be made is the year in which to start the econometric analysis. When making this decision, there is a key trade-off to be balanced between the sample size and the explanatory power of the model, specifically:

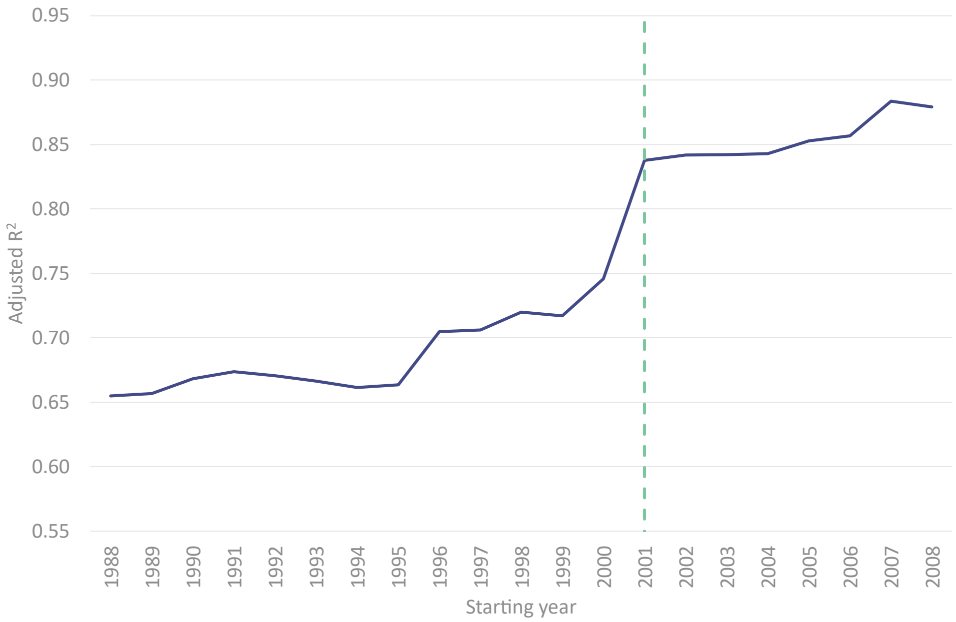
- **Sample size.** Ideally, one would want to make the most of all of the data available – i.e. start the econometric analysis from 1988 – thus improving the sample size (captured by the number of observations). This is because this typically improves the precision of the estimates, as it limits the risk of anomalous years of data influencing the results.

43 This is defined at the first point at which data is available for all chemicals used by Wessex in 2021-22.
44 The index is available from 1987, which means that the rate of growth (i.e. the price increase) is only available from the following year.

- **Explanatory power.** In practice, the drivers used may explain less of the variation in chemical IPP at certain points in time. This would be the case if (for instance): (i) there were large shifts in chemical IPP that did not correlate with equivalent movements in the drivers; or (ii) there were methodological changes relating to the recording of the variables in the analysis that meant this was not consistent over time.[45] We capture this via the adjusted R^2 value, which captures the variance in chemical IPP that can be explained by variation in the drivers.

For our main model, we have run econometric analysis for each starting year from 1988 until 2008 in order to examine the explanatory power (noting that the sample size increases on a linear basis the earlier the starting year is). The figure below shows the adjusted R^2 values for each of these econometric analyses.

Figure 7: Adjusted R^2 values varying the starting year of the main model



Source: Economic Insight analysis

As can be seen by the dashed vertical line, there is a clear flattening out of the lines in 2001. This suggests that the trade-off between sample size and explanatory power is likely to be optimised at this point, given that the drivers are much less able to explain the variation in chemical IPP prior to 2001. Therefore, historical econometric models that use this year as the starting year are likely to lead to more accurate forecasts of RPEs at PR24 – meaning we choose 2001 to be the starting year for our main model.

We use 2022 as the cut-off year of our analysis since this is the final year that historical data is available on each of the variables included in our model, and as such is the final year for which we do not need to forecast any data.

Choice of rates or levels

45 *The information on whether this applies to the variables in our analysis does not appear to be publicly available.*

A second key analytical decision is whether to undertake the econometric analysis in rates or in levels. For instance, in 2005 this would be the choice between:

- The percentage change in chemical prices between 2004 and 2005 – i.e. the chemical IPP.
- The chemical price index in 2005.

We have chosen to undertake our main econometric analysis in *rates* rather than levels. This is for the following reasons:

- **Stationarity**. The variables that we use in our analysis naturally tend upwards over time when measured as a level, e.g. the nominal level of GDP will (all else equal) tend upwards over time both due to general economy-wide inflation and because economies tend to grow over time. This means that the expected value of these variables change over time (i.e. they are non-stationary). As such, regressing these variables on one another may result in findings of spurious relationships, i.e. since they both trend upwards over time, the estimate of the relationship between the two could merely capture this general upward trend over time. In order to mitigate this, one can: (i) convert the metric to a stationary series (e.g. rates of change); or (ii) include lags of the dependent variable in the econometric analysis.
- **Comparability**. As was set out in the previous bullet, it is necessary to include lags of the dependent variable in any econometric analysis that is done in levels, in order to mitigate the impacts of non-stationary time series. As such, this significantly increases the explanatory power of the model, since much of the variation in the lagged value of the dependent variable often explains a lot of the variation in the current value of the variable. This means that models conducted in levels (as opposed to rates) lead to higher adjusted R^2 values by design, meaning that the model fits across the two different types of econometric analysis are not directly comparable – and thus comparing explanatory power between models becomes more challenging. Therefore, adopting option (i) from the previous bullet improves comparability between models.

Estimation of RPEs for the SUP11 table from econometric models

In order to obtain predicted chemical IPP in GBP for a given financial year across each econometric analysis (to be consistent with SUP11), it is necessary to convert the predicted values estimated in USD for a calendar year. We do this in the following way:

- Firstly, we predict the chemical IPP in USD (given that the chemical price data we use is from the US). This involves: (i) for each driver in each year of PR24, multiplying the relationship derived from the econometric analysis, with the forecast value of the driver, in order to predict the effect of the driver on chemical IPP in that year; and (ii) summing these predicted effects together (across all drivers), and adding the constant derived from the analysis, to generate predicted chemical IPP in that year.

- Secondly, we convert the predicted chemical IPP from a calendar year basis to a financial year basis, by calculating a weighted average of the two respective calendar years – e.g. to estimate 2005-06 we would multiply the 2005 estimate by 0.75 and the 2006 value by 0.25.

- Thirdly, (for econometric analysis in rates), we convert the predicted value of chemical IPP into an index that increases over time by the chemical IPP.

- Fourthly, we multiply the index (either converted in the bullet above for rates econometric analysis, or the predicted value for levels econometric analysis) in each financial year by the average of the daily USD/GBP exchange rates in that financial year.

- Finally, we convert the index into a rate in order to estimate chemical IPP – we do this both for econometric analysis in rates and in levels.

3B. Extrapolation approach

An alternative approach to calculate RPEs is to use the extrapolation approach. As was discussed in section 1A, this involves assuming the trend of chemical IPP over a particular period of time remains constant into the future, i.e. into the PR24 period.

We select two periods over time over which to extrapolate:

- From 2001-02 until 2022-23, with this *broadly* consistent with the econometric approach described above.
- From 1988-89 until 2022-23, as chemical IPP data is first available in 1988.

For each of these two time periods, we initially convert growth rates in USD to GBP by calculating an index and multiplying this by the exchange rate in that financial year, before then calculating average chemical IPP across the financial years of the period.

3C. Summary of specifications

Table 5: Details of specifications used in our analysis

Model details		Type of analysis	Form of variables	Temporal scope	Lagged chemical price	GDP	Lagged GDP	Current crude oil price	Lagged crude oil price	Construction	Dummy for 2008 and 2022
Main results	Main model	Econometric	Rates	2001-2022	✗	✓	✗	✓	✓	✓	✓
Sensitivity analysis	Minimum	Econometric	Rates	2001-2022	✗	✓	✓	✓	✓	✓	✓
	Midpoint	Econometric	Levels	2001-2022	✓	✓	✗	✓	✓	✓	✓
	Maximum	Econometric	Rates	2001-2022	✗	✓	✗	✓	✓	✓	✗
	Consistent with econometrics	Extrapolation	Rates	2001-2023[46]	✗	✗	✗	✗	✗	✗	✗
	Full period	Extrapolation	Rates	1988-2023[47]	✗	✗	✗	✗	✗	✗	✗

Source: Economic Insight analysis

46 *We note that this is on a financial year basis, i.e. 2001-02 until 2022-23.*
47 *We note that this is on a financial year basis, i.e. 1988-89 until 2022-23.*

4 Results

In this chapter, we present the RPE estimates and (for the econometric analysis) the model fit of our main model and sensitivity models. For the main model, we show these estimates both for the entirety of Wessex's chemical cost base, and split by price control area.

We note that, in Annex 1, we show the results of our econometric analysis, specifically the: (i) coefficient on each driver; (ii) standard error on each driver; and (iii) number of observations.

In the tables below, we show the results of our econometric analysis (with the specifications of each model shown in Table 5), in addition to our extrapolation analysis. This suggests that the results of our main model are relatively robust. This is because we have tweaked three separate elements of our main model in our sensitivity analysis, and the results remain consistent with what is shown in our main model.

The results of our econometric analysis demonstrate the following for the regressions based on total costs (i.e. not the price control splits):

(i) Annual RPE estimates over the PR24 period across each of the four models are between 1.37% and 1.98% (with the exception of one model in one year).

(ii) PR24 average RPE estimates of 1.53% - 1.98% - we note that the main model average (1.67%) is below both the mean (1.73%) and median (1.71%) across the four models.

(iii) Adjusted R^2 values ranging from 0.56-0.98, with the main model the greatest of the three models conducted in <u>rates</u> – we note that (as was discussed in section 3A), models conducted in <u>levels</u> lead to higher adjusted R^2 values by design, meaning that the model fits across the two different types of econometric analysis are not directly comparable.

(iv) The results of the extrapolation analysis show significantly higher RPEs than what was shown in the econometric analysis, based on each of the different approaches. For the reasons detailed in section 1A, we consider the econometric approach to be preferable. However, these results demonstrate the possibility of higher RPEs than those indicated by the econometric analysis – for instance in the case of exogenous shocks for which the drivers do not fully capture the effect on chemical IPP.

In relation to the regressions split by price control area: (i) the annual RPE estimates are between 0.88% and 3.36%; and (ii) the averages across PR24 are between 0.95% and 1.37%. Furthermore, the adjusted R^2 values are all at least 0.78.

For each model, we note that the 2023-24 and 2024-25 RPE estimates are negative. This is because, during these two years, the forecasted values of some of our drivers are negative. This is the result of the return towards steady state levels following the major exogenous shock of the war in Ukraine (the effects of which have been detailed in section 1A and 3A. As a result, this reduces the value of the drivers in both the 2023-24 and 2024-25 financial years – which then causes the predicted value of chemical IPP in these years to be lower.

However, as was detailed in section 1A, the extraordinary effects of the war are not expected to entirely normalise in the future – such that the values of our drivers would be expected return to pre-war levels over PR24. As such, this implies that positive predicted chemical IPP over the course of PR24 (as the tables below suggest) is reasonable.

Table 6: Model fit and RPEs – main model

	Main model
Dependent variable	Chemical IPP
Drivers	US GDP growth Current crude oil price changes Lagged crude oil price changes US construction output growth Dummy for 2008 and 2022
Temporal scope	2001 – 2022
Adjusted R^2	0.84
2023-24	-6.97%
2024-25	-5.01%
2025-26	1.77%
2026-27	1.67%
2027-28	1.65%
2028-29	1.63%
2029-30	1.63%
PR24 average	**1.67%**

Source: Economic Insight analysis

Table 7: Model fit and RPEs – minimum sensitivity analysis (econometrics)

	Minimum
Dependent variable	Chemical IPP
Drivers	Current US GDP growth Lagged US GDP growth Current crude oil price changes Lagged crude oil price changes US construction output growth Dummy for 2008 and 2022
Temporal scope	2001 – 2022
Adjusted R^2	0.83
2023-24	-6.63%
2024-25	-4.88%
2025-26	1.56%
2026-27	1.52%
2027-28	1.54%
2028-29	1.52%
2029-30	1.53%
PR24 average	**1.53%**

Source: Economic Insight analysis

Table 8: Model fit and RPEs – midpoint sensitivity analysis (econometrics)

	Midpoint
Dependent variable	Chemical price level
Drivers	Lagged chemical price level Current US GDP level Current crude oil price level Lagged crude oil price level US construction output level Dummy for 2008 and 2022
Temporal scope	2001 – 2022
Adjusted R^2	0.98
2023-24	-7.23%
2024-25	-3.55%
2025-26	0.38%
2026-27	1.37%
2027-28	1.98%
2028-29	2.37%
2029-30	2.62%
PR24 average	**1.74%**

Source: Economic Insight analysis

Table 9: Model fit and RPEs - maximum sensitivity analysis (econometrics)

	Maximum
Dependent variable	Chemical IPP
Drivers	Current US GDP growth Current crude oil price changes Lagged crude oil price changes US construction output growth
Temporal scope	2001 – 2022
Adjusted R^2	0.56
2023-24	-6.54%
2024-25	-5.22%
2025-26	2.12%
2026-27	1.99%
2027-28	1.96%
2028-29	1.93%
2029-30	1.93%
PR24 average	**1.98%**

Source: Economic Insight analysis

Table 10: RPEs – sensitivity analysis (extrapolation)

	Mean	**Median**
Full data available	5.16%	2.93%
Consistent with econometrics	7.31%	3.88%

Source: Economic Insight analysis

Table 11: Model fit and RPEs – main model (PC split)

	Water Network Plus	**Wastewater Network Plus**	**Wastewater Bioresources**
Dependent variable	Chemical IPP		
Drivers	US GDP growth Current crude oil price changes Lagged crude oil price changes US construction output growth Dummy for 2008 and 2022		
Temporal scope	2001 – 2022		
Adjusted R^2	0.83	0.78	0.79
2023-24	-6.23%	-7.49%	-6.97%
2024-25	-3.92%	-5.80%	-5.09%
2025-26	3.36%	1.10%	1.36%
2026-27	3.18%	0.95%	1.37%
2027-28	3.15%	0.92%	1.37%
2028-29	3.10%	0.88%	1.37%
2029-30	3.10%	0.88%	1.37%
PR24 average	**3.18%**	**0.95%**	**1.37%**

Source: Economic Insight analysis

5 Annex 1: Full set of results

Table 12: Full econometric results - main model

Variable	Statistic	Main model
US GDP growth	Coefficient	-0.494
	Standard error	(0.612)
Current crude oil price changes	Coefficient	0.173***
	Standard error	(0.0515)
Lagged crude oil price changes	Coefficient	0.0987***
	Standard error	(0.0280)
US construction growth	Coefficient	0.250
	Standard error	(0.159)
Dummy (2008 and 2022)	Coefficient	0.166***
	Standard error	(0.0305)
Constant	Coefficient	0.0239
	Standard error	(0.0200)
Adjusted R^2		0.838
Number of observations		22

Source: Economic Insight analysis

*Notes: The asterisks alongside the coefficient values correspond to the statistical significance of the estimate, specifically; (i) * means the coefficient is significant at the 10% level; (ii) ** at the 5% level; and (iii) *** at the 1% level. The significance level denotes the probability that the coefficient has a value of zero. If this probability is less than 5%, then we say that we are 95% confident that the coefficient does not have a value of zero. Our 'best guess' of the value of a coefficient if we believe that it is not zero, is given by the coefficient estimated by the model.*

Table 13: Full econometric results – sensitivity analysis (minimum)

Variable	Statistic	Minimum
US GDP growth	Coefficient	-0.469
	Standard error	(0.642)
US GDP growth lagged	Coefficient	0.156
	Standard error	(0.717)
Current crude oil price changes	Coefficient	0.175***
	Standard error	(0.0534)
Lagged crude oil price changes	Coefficient	0.0902*
	Standard error	(0.0484)
US construction growth	Coefficient	0.222
	Standard error	(0.210)
Dummy (2008 and 2022)	Coefficient	0.161***
	Standard error	(0.0392)
Constant	Coefficient	0.0187
	Standard error	(0.0315)
Adjusted R^2		0.827
Number of observations		22

Source: Economic Insight analysis

*Notes: The asterisks alongside the coefficient values correspond to the statistical significance of the estimate, specifically; (i) * means the coefficient is significant at the 10% level; (ii) ** at the 5% level; and (iii) *** at the 1% level. The significance level denotes the probability that the coefficient has a value of zero. If this probability is less than 5%, then we say that we are 95% confident that the coefficient does not have a value of zero. Our 'best guess' of the value of a coefficient if we believe that it is not zero, is given by the coefficient estimated by the model.*

Table 14: Full econometric results – sensitivity analysis (midpoint)

Variable	Statistic	Midpoint
Lagged chemical price level	Coefficient	0.595***
	Standard error	(0.184)
US GDP level	Coefficient	0.00436
	Standard error	(0.00297)
Current crude oil price level	Coefficient	0.405***
	Standard error	(0.120)
Lagged crude oil price level	Coefficient	-0.0923
	Standard error	(0.161)
US construction level	Coefficient	0.0997
	Standard error	(0.264)
Dummy (2008 and 2022)	Coefficient	37.80***
	Standard error	(8.227)
Constant	Coefficient	-8.723
	Standard error	(12.70)
Adjusted R^2		0.979
Number of observations		22

Source: Economic Insight analysis

*Notes: The asterisks alongside the coefficient values correspond to the statistical significance of the estimate, specifically; (i) * means the coefficient is significant at the 10% level; (ii) ** at the 5% level; and (iii) *** at the 1% level. The significance level denotes the probability that the coefficient has a value of zero. If this probability is less than 5%, then we say that we are 95% confident that the coefficient does not have a value of zero. Our 'best guess' of the value of a coefficient if we believe that it is not zero, is given by the coefficient estimated by the model.*

Table 15: Full econometric results – sensitivity analysis (maximum)

Variable	Statistic	Maximum
US GDP growth	Coefficient	-0.681
	Standard error	(1.001)
Current crude oil price changes	Coefficient	0.236**
	Standard error	(0.0821)
Lagged crude oil price changes	Coefficient	0.146***
	Standard error	(0.0436)
US construction growth	Coefficient	0.194
	Standard error	(0.259)
Constant	Coefficient	0.0376
	Standard error	(0.0325)
Adjusted R^2		0.564
Number of observations		22

Source: Economic Insight analysis

*Notes: The asterisks alongside the coefficient values correspond to the statistical significance of the estimate, specifically; (i) * means the coefficient is significant at the 10% level; (ii) ** at the 5% level; and (iii) *** at the 1% level. The significance level denotes the probability that the coefficient has a value of zero. If this probability is less than 5%, then we say that we are 95% confident that the coefficient does not have a value of zero. Our 'best guess' of the value of a coefficient if we believe that it is not zero, is given by the coefficient estimated by the model.*

Table 16: Full econometric results – Water Network Plus

Variable	Statistic	Water Network Plus
US GDP growth	Coefficient	-0.890
	Standard error	(0.948)
Current crude oil price changes	Coefficient	0.278***
	Standard error	(0.0797)
Lagged crude oil price changes	Coefficient	0.141***
	Standard error	(0.0434)
US construction growth	Coefficient	0.466*
	Standard error	(0.246)
Dummy (2008 and 2022)	Coefficient	0.255***
	Standard error	(0.0472)
Constant	Coefficient	0.0287
	Standard error	(0.0310)
Adjusted R^2		0.835
Number of observations		22

Source: Economic Insight analysis

*Notes: The asterisks alongside the coefficient values correspond to the statistical significance of the estimate, specifically; (i) * means the coefficient is significant at the 10% level; (ii) ** at the 5% level; and (iii) *** at the 1% level. The significance level denotes the probability that the coefficient has a value of zero. If this probability is less than 5%, then we say that we are 95% confident that the coefficient does not have a value of zero. Our 'best guess' of the value of a coefficient if we believe that it is not zero, is given by the coefficient estimated by the model.*

Table 17: Full econometric results – Wastewater Network Plus

Variable	Statistic	Wastewater Network Plus
US GDP growth	Coefficient	-0.763
	Standard error	(0.750)
Current crude oil price changes	Coefficient	0.177**
	Standard error	(0.0631)
Lagged crude oil price changes	Coefficient	0.118***
	Standard error	(0.0343)
US construction growth	Coefficient	0.153
	Standard error	(0.194)
Dummy (2008 and 2022)	Coefficient	0.170***
	Standard error	(0.0373)
Constant	Coefficient	0.0368
	Standard error	(0.0245)
Adjusted R^2		0.776
Number of observations		22

Source: Economic Insight analysis

*Notes: The asterisks alongside the coefficient values correspond to the statistical significance of the estimate, specifically; (i) * means the coefficient is significant at the 10% level; (ii) ** at the 5% level; and (iii) *** at the 1% level. The significance level denotes the probability that the coefficient has a value of zero. If this probability is less than 5%, then we say that we are 95% confident that the coefficient does not have a value of zero. Our 'best guess' of the value of a coefficient if we believe that it is not zero, is given by the coefficient estimated by the model.*

Table 18: Full econometric results – Wastewater Bioresources

Variable	Statistic	Wastewater Bioresources
US GDP growth	Coefficient	0.0290
	Standard error	(0.503)
Current crude oil price changes	Coefficient	0.120**
	Standard error	(0.0423)
Lagged crude oil price changes	Coefficient	0.0612**
	Standard error	(0.0230)
US construction growth	Coefficient	0.181
	Standard error	(0.130)
Dummy (2008 and 2022)	Coefficient	0.0997***
	Standard error	(0.0250)
Constant	Coefficient	0.00951
	Standard error	(0.0164)
Adjusted R^2		0.792
Number of observations		22

Source: Economic Insight analysis

*Notes: The asterisks alongside the coefficient values correspond to the statistical significance of the estimate, specifically; (i) * means the coefficient is significant at the 10% level; (ii) ** at the 5% level; and (iii) *** at the 1% level. The significance level denotes the probability that the coefficient has a value of zero. If this probability is less than 5%, then we say that we are 95% confident that the coefficient does not have a value of zero. Our 'best guess' of the value of a coefficient if we believe that it is not zero, is given by the coefficient estimated by the model.*

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A12 ChandlerKBS (September 2023) – Inflation Review

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Wessex Water PR24 Business Planning Support

Inflation Review

12 September 2023

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Contents

Appendices

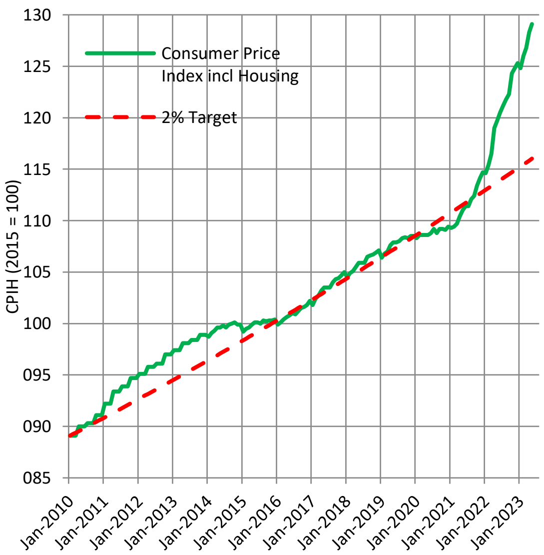
Version		Prepared by	Checked by	Issue date
1.0	Draft for comment	W. Heap	M. Thomas G. Maidment	19.07.2023
2.0	Revised Draft	W. Heap	J. Gavigan	03.08.2023
3.0	No Changes - Final Version	W. Heap	J. Gavigan	12.09.2023

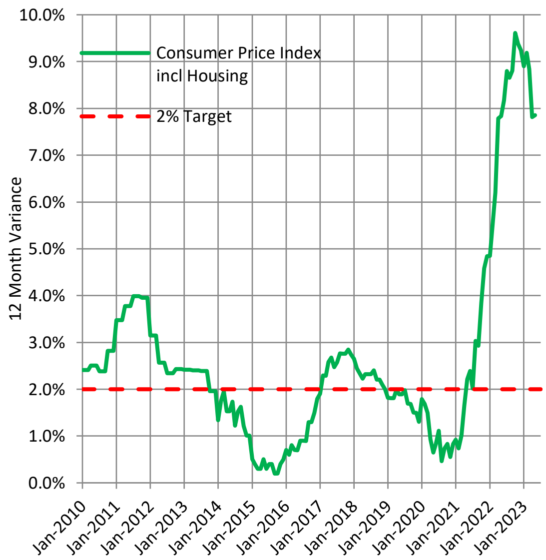
Executive Summary

ChandlerKBS was commissioned by Wessex Water to undertake a review of the historic performance of the Consumer Price Index including owner occupiers' housing costs (CPIH) and provide forecasts of inflation.

CPIH measure of consumer price inflation historical trend and volatility

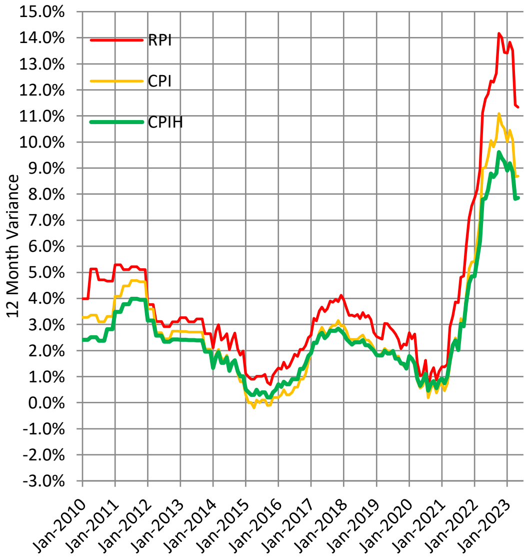
In the period from 2010 to 2021, the CPIH short-term 12-month moving trend varied between 0.4% and 3.8%. From mid-2021, the short-term trend rose above the 2% Bank of England target, increasing to 9.6% in October 2022.

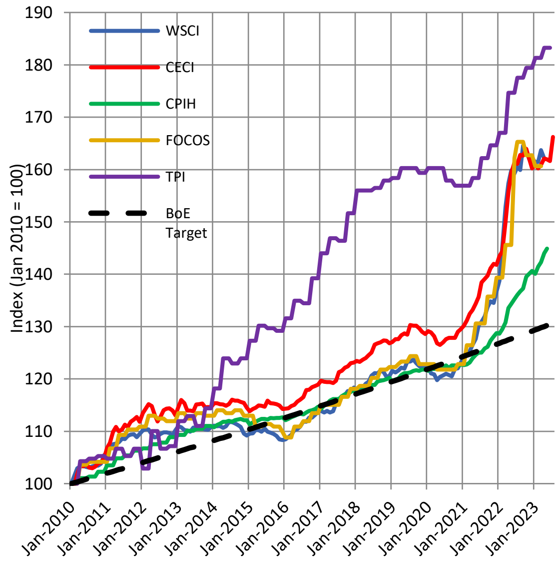




Other suitable construction indices and comparison of equivalent past performance with CPIH

CPIH, CPI and RPI utilise similar consumer input costs so it is predictable that the trends look similar. However, RPI has shown consistently higher inflation than CPIH and CPI so the RPI trend is steeper resulting in a divergence of the trends over time.





CPIH has no construction cost inputs and analysis of the trends showed that CPIH diverges from construction costs in both the short and long term, demonstrating that using CPIH to adjust construction costs is not a robust methodology.

Changes in labour, plant and key materials for construction and trends

BCIS indices for labour report a significant increase in cost for all construction roles compared to CPIH inflation since 2011. Labour indices forecast more increases at a higher rate than CPIH over the period to December 2027.

Plant indices generally follow the CPIH trend but present a slightly lower cost increase over the period 2010 to 2023. The input costs to some plant supply indices do not appear to be influenced by the same inputs to consumer or construction indices used in this report.

Multiple material indices from BCIS and BEIS present similar trends for the period 2015 to 2023, showing high volatility and divergence from CPIH at a much higher rate from 2021. Material cost increases have been responsible for the majority of construction index variance to CPIH. Material forecasts predict further increases of the index delta already established. The following chart demonstrates inflation and forecasts from January 2020.

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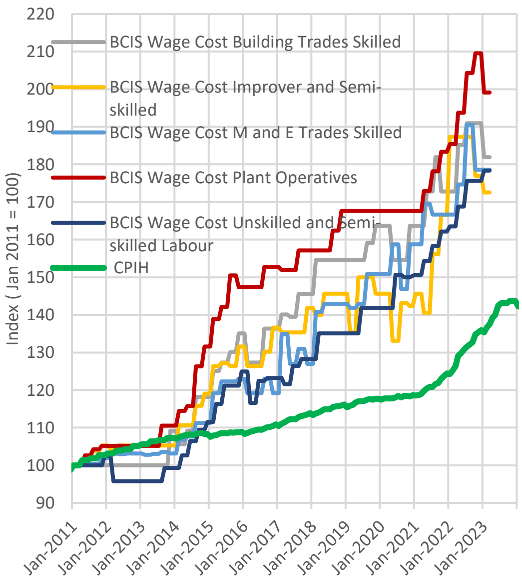
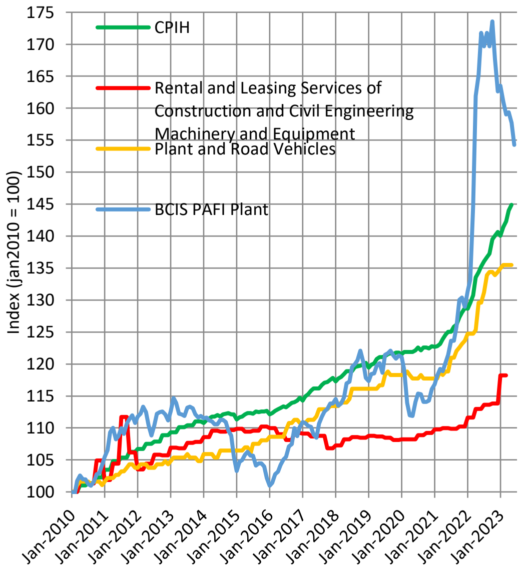
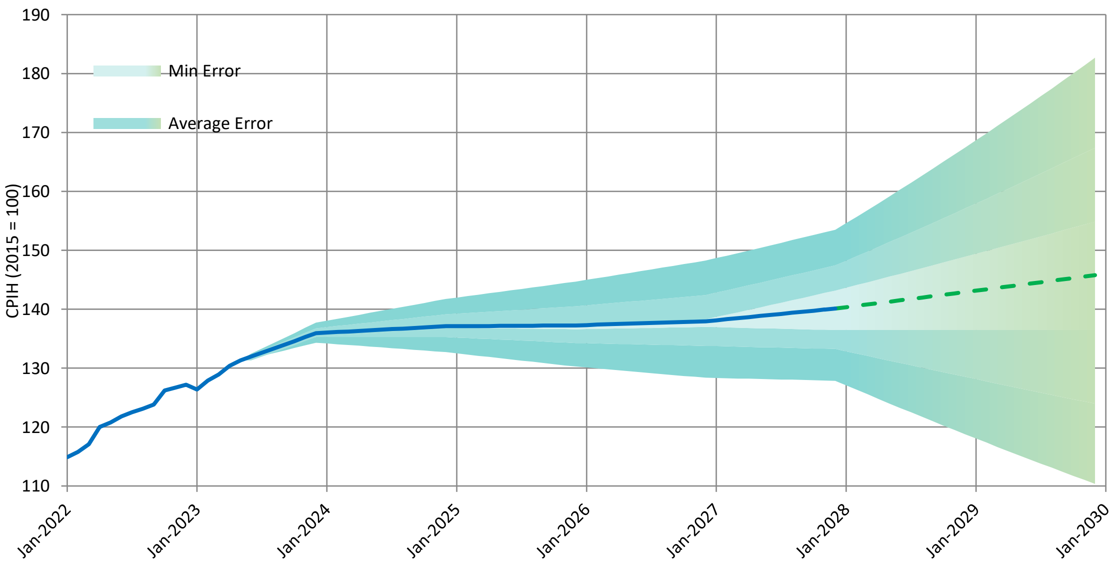




CPIH forecasts for 2023 – 2030

The latest OBR forecast for the period 2022 to 2027 reports inflation dropping from 6.1% to 1.6%. Inflation beyond the OBR forecast period is assumed to be at the BoE target of 2% per year. The extrapolated forecast has a wider error band that includes the risk of inflation at the same rate as experienced in 2022 of 9.1%.



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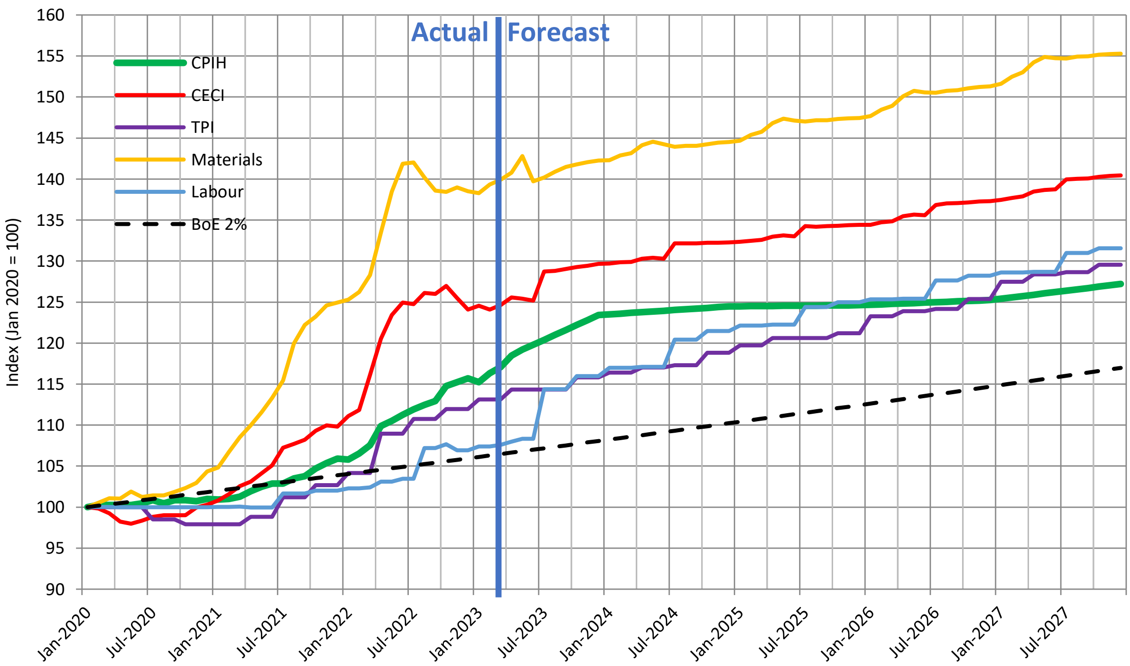
Forecasts for other indices to 2030

The analysis of key index trends and forecasts demonstrates the industry's price volatilities compared to CPIH. BCIS Materials index presents a significant variance to the to CPIH trend from 2020.

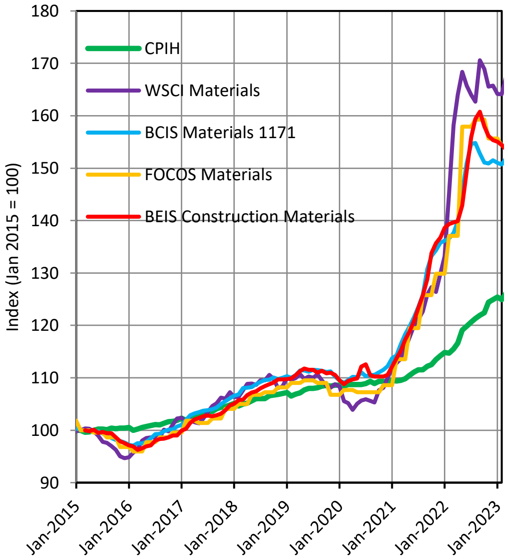


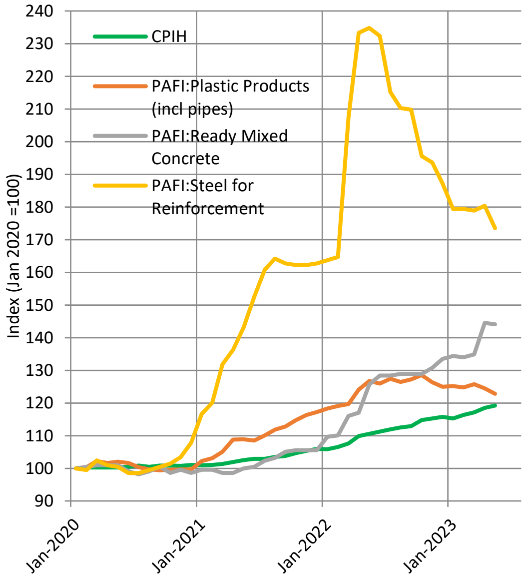
Impact of other major investment programmes and projects on the South West Region

CITB are forecasting a decline in the South West of infrastructure growth over the next 5 years of -3.1% against an overall increase of just 0.6% in the same period. Overall growth in the South West region is predicted to be driven by a number of very large scale and long term developments such as Hinckley Point C, Panattoni logistics development, University of Bristol's new Temple Quarter Enterprise Campus and the Galleries shopping centre.

Table: CITB Growth Forecast 2023 to 2027

	2023	2024	2025	2026	2027	2023 to 2027 Annual Average
Infrastructure	-9.3%	-5.5%	-0.3%	0.1%	0.1%	-3.1%
Total Work	-2.0%	0.4%	1.4%	1.7%	1.8%	0.6%





Summary of energy prices impact on material cost inflation

Energy costs are known to impact the cost of producing key construction materials such as steel and cement. The rise in material costs coincided with the steep cost increases of gas and electricity during 2021 and 2022. In 2023, the energy prices started to retract along with prices of some key construction materials. However, the decreasing energy prices have not reversed the general construction material cost index increases during this period.

Summary of cost inflation specific to the South West region

The trends of the MCF and New Orders indices indicate that construction output has been in decline since 2018. The CITB infrastructure output forecast of the South West region predicts a continued declining trend to 2027. Usually, this would indicate a negative impact to contractor's margins. However, due the significance of other influences on today's market prices, the declining output forecast is not a robust signal that construction prices and margins are also reducing.

Real Price Effects – OFWAT table SUP11

The methodology for calculating RPE used appropriate construction cost indices with published forecasts to provide the input price inflation variances to CPIH. The following table presents the RPE percentages to align with the *PR24 business plan table SUP11 – real price effects and frontier shift.*

	YT Mar 2024	YT Mar 2025	YT Mar 2026	YT Mar 2027	YT Mar 2028	YT Mar 2029	YT Mar 2030
SUP11.1 CPIH (%)	5.36	0.67	0.21	0.77	1.68	2.00	2.00
SUP11.3 Labour (%)	3.19	3.73	2.38	1.83	0.90	0.52	0.52
SUP11.5 Materials, Plant & Equipment (%)	-1.07	1.40	1.50	1.45	0.54	0.23	0.27

Recommendations

The PR19 to PR24 (2017 to 2022) period presented unprecedented cost control challenges to the water sector. The PR19 forecasters could not have predicted the world events that impacted construction costs in the period to 2023. Likewise, the latest forecasts to December 2027 only include currently known influences. This is a prime example of why a robust cost control methodology should be implemented to continuously monitor and manage the risks of changes in construction costs.

It was noted that the PR19 forecast reports by AECOM and Mott MacDonald recommended that CPIH should not be used to adjust construction costs. This report also recommends that consumer price indices are not suitable measures of construction cost adjustments for similar reasons.

This report has outlined categories of information that can help to implement a robust cost control methodology. Our recommendation is that construction cost inflation is monitored regularly to provide the latest information to make informed business decisions.

1. Introduction

Wessex Water commissioned ChandlerKBS to produce an independent review of inflation performance and forecast for the period 2010 to 2028.

For the 2019 price review (PR19), Ofwat changed the method of inflation from the Retail Price Index (RPI) to the Consumer Price Index including owner occupiers' housing costs (CPIH). Prior to PR19, the water sector experienced an unchallenging period of inflationary growth that was well represented by RPI inflation measure. This enabled water companies to deliver programmed works within the allowed revenues as indexed by Ofwat, even where company inefficiencies existed. There is no indication that Ofwat will change the method of inflation from CPIH for the 2024 price review (PR24).

The AMP 7 delivery period (2020 to 2025) has already experienced a significant rise in inflation as recorded by consumer and construction cost indices alike. This is an issue that water companies have not had to contend with since AMP 4 (2005-2010) where double-digit percentage increases in inflation were experienced.

This report presents the review of CPIH for adjusting water industry construction costs historically, and for forecasting future price movements compared with other cost indices.

The scope for this report was agreed by Wessex Water on 28 June 2023 and is covered as follows:

i. Provide a summary of CPIH measure of consumer price inflation and identify and comment on its historical trend and volatility – **Section 3**.
ii. Provide a summary of other suitable construction indices including RPI and BCIS, and compare equivalent past performance with CPIH – **Section 4, 5 and 6**.
iii. Consider changes in labour, plant and key materials for construction and trends over the past 5 years [including a summary of energy prices impact on material cost inflation*] – **Section 7, 8, 9, 10 and 11**.
iv. Identify CPIH forecasts for 2023 to 2030 -– **Section 12**.
v. Identify forecasts for the indices identified in item 2 (where feasible) for 2023 to 2030 – **Section 13**.
vi. Produce the inflation report that will allow WSX to update the capex elements of the SUP11 form for Real change in input price for labour, materials, plant and equipment – **Section 14**.

vii. Consider the impact other major investment programmes and projects may have on the South West Region [including a summary of cost inflation specific to the South West region*] – **Section 15.**

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*addition to the original scope.

2. Approach

This section details the approach taken by ChandlerKBS to provide analysis of movements recorded in cost indices used in the construction industry, and more specifically, the water sector.

The approach is summarised by the following categories:

- Data sources
- Indices in this report
- Comparison methodology
- Forecasting methodology

2.1. Data Sources

ChandlerKBS monitors and analyses cost and location indices from multiple sources. The sources of information used in this report are as follows:

- Office for National Statistics
- Building Cost Information Services
- Department for Business, Energy & Industrial Strategy
- Office for Budget Responsibility
- Construction Industry Training Board
- The Office of Gas and Electricity Markets

2.1.1. Office for National Statistics

The Office for National Statistics (ONS) is the UK's largest independent producer of official statistics and its recognised national statistical institute. The ONS is responsible for collecting and publishing statistics related to the economy, population and society at national, regional and local levels.

Data sourced from ONS was obtained from the website
www.ons.gov.uk

2.1.2. Building Cost Information Services

The BCIS is the Building Cost Information Service of the Royal Institution of Chartered Surveyors (RICS). It is described by RICS as 'the leading provider of cost and price information to the construction industry and anyone else who needs comprehensive, accurate and independent data. The BCIS online database contains elemental cost analyses for over 17,500 projects across the UK.

Data sourced from BCIS was obtained using the ChandlerKBS accounts for the BCIS Online website.

2.1.3. Department for Business, Energy & Industrial Strategy

The Department for Business, Innovation and Skills (BIS) and the Department of Energy and Climate Change (DECC) merged in July 2016 to form the Department for Business, Energy and Industrial Strategy (BEIS).

BEIS existed until February 2023 when it was split to form the Department for Business and Trade (DBT), the Department for Energy Security and Net Zero (DESNZ) and the Department for Science, Innovation and Technology (DSIT). Responsibility for national security and investment policy has transferred to the Cabinet Office.

Data sourced from BEIS was downloaded from the government website www.gov.uk/government/statistics

2.1.4. Office for Budget Responsibility

The Office for Budget Responsibility (OBR) was created in 2010 to provide independent and authoritative analysis of the UK's public finances. It is one of a growing number of official independent fiscal watchdogs around the world.

The OBR has five main roles:

1. Economic and fiscal forecasting
2. Evaluating performance against targets
3. Sustainability and balance sheet analysis
4. Evaluation of fiscal risks
5. Scrutinising tax and welfare policy costing

Data sourced from OBR was downloaded from obr.uk/data

2.1.5. Construction Industry Training Board

Construction Industry Training Board (CITB) is the industry training board for the construction sector in England, Scotland and Wales. CITB produce Construction Industry Research Reports, including reports on Construction Skills Network Labour Market Information (LMI) to help plan and meet future employment and skills requirements.

Data sourced from CITB was downloaded from citb.co.uk

2.1.6. The Office of Gas and Electricity Markets

The Office of Gas and Electricity Markets (Ofgem) regulates the monopoly companies which run the gas and electricity networks. It takes decisions on price controls and enforcement, acting in the interests of consumers and helping the industries to achieve environmental improvements.

Data sourced from Ofgem was downloaded from www.ofgem.gov.uk

2.2. Indices in this report

This section lists the indices used in this report and the date that the indices were published. Where appropriate, the indices' series data have been presented from January 2010 to May 2023. May 2023 is the latest index for most of the index series.

It should be noted that inflation figures for 2023 will only include inflation information for January 2023 to the latest index date.

2.2.1. Table: Indices Used in this Report

Index Source	Index	Reference	Published Date
ONS	Consumer Price Index	D7BT	21 June 2023
ONS	Consumer Prices Index including owner occupiers' housing costs	L522	21 June 2023
ONS	Retail Price Index	CHAW	21 June 2023
ONS	Construction Output Price Index		13 July 2023
ONS	New Orders - All New Work		
BCIS	Civil Engineering Cost Index	1191	28 June 2023
BCIS	Tender Price Index	101	28 June 2023
BCIS	Materials	1171	28 June 2023
BCIS	Labour	1161	28 June 2023
BCIS	Plant	1181	28 June 2023
BCIS	FOCOS Resource Cost Index Combined	7415	12 June 2023
BCIS	FOCOS Resource Cost Index Materials	7417	12 June 2023
BCIS	Building Market Conditions	191	28 June 2023
BCIS	Tender Price Studies Location (using 2000 boundaries data)		9 June 2023
BCIS	Price Adjustment Formulae Indices (PAFI)		28 June 2023
BEIS	Construction Materials All Work		12 July 2023
Ofgem	Gas Prices Day Ahead Contracts		12 July 2023
Ofgem	Electricity Prices Day Ahead Contracts		12 July 2023

2.3. Comparison Methodology

Time-related cost indices are measures of cost changes from a reference date. The index series will have a convenient value set at 100 for the reference base date or an average value of 100 for the reference base date range. Each index has a reference date with a syntax similar to 2015 = 100 indicating that the index series for 2015 has an average value of 100.

To make changes in indices comparable, each index in the comparison must be normalised to a common reference date. The common reference date will have the value 100 and all other values in the index series will be referenced to the common date. This is achieved by dividing all the indices in the series by the value at the reference date, then multiply by 100.

2.4. Forecasting Methodology

The indices are calculated from multiple inputs of cost information, survey responses and economists. The aggregation of information to create the indices is complex and other parties are not able to create a robust forecast based on the available input information. Therefore, ChandlerKBS relies on forecasts published by the index owner to inform us of potential future price movements in their index.

Not all indices have a future price movement forecast. ONS do not generally publish forecasts so indices in this report sourced from ONS do not have forecast data.

OBR publish forecasts of several UK economy monitoring indices such as CPI and RPI. OBR do not publish a forecast for CPIH but due to its similarity to CPI, it is often used as a good approximation.

BCIS regularly publish forecasts for some of their indices such as General Civil Engineering Cost Index which is used in this report. However, not all of the BCIS input indices have a published forecast, such as the Price Adjustment Formula Indices and the Water and Sewage Cost Index.

The forecasts use the same reference date as the index they are published for. Therefore, the normalising methodology for aligning with other indices is the same as for the base index series.

2.4.1. Table: Cost Indices Forecasts Used in this Report

Index Source	Index	Reference	Forecast to Date
BCIS	General Civil Engineering Cost Index	1191	December 2027
BCIS	Tender Price Index	101	December 2027
BCIS	Materials	1171	December 2027
BCIS	Labour	1161	June 2028
OBR	Historical Official Forecast		2027

3. CPIH Review

3.1. Background

Consumer price indices are important indicators of how the UK economy is performing. The indices are used in many ways by the government, businesses, and society in general. They can affect interest rates, tax allowances, wages, state benefits, pensions, maintenance, contracts and many other payments. They also show the impact of inflation on family budgets and affect the value of the pound.

As of 21 March 2017, the Consumer Prices Index including owner occupiers' housing costs (CPIH) became the lead measure of inflation. Although otherwise identical to CPI, it is the most comprehensive measure as it includes costs associated with owning, maintaining and living in your own home (known as owner occupiers' housing costs, or OOH), along with Council Tax.

The CPIH and CPI are consumer inflation or pure price indices defined as an average measure of change in the prices of goods and services bought within the domestic territory for consumption by households in the UK and foreign visitors to the UK.

There are several important points to note in this definition:

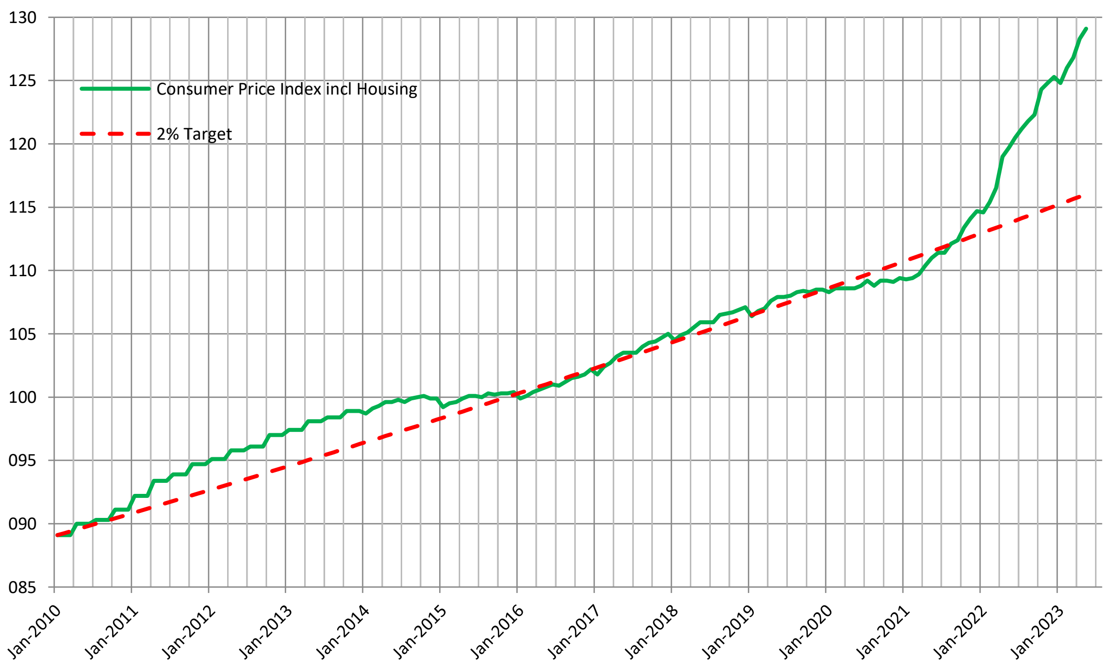
- average measure: a single figure that combines, or averages, all the price changes covered.
- change: its purpose is to measure how prices change over time rather than the absolute level of prices at a point in time.
- goods and services: it does not just measure price changes for necessities such as food, heating and clothing, but a wide variety of purchases made by most households, including leisure goods and services.
- consumption: the CPIH and CPI do not cover investment spending. For example, in the CPIH, owner occupiers' housing costs are included but the cost of the house, an investment, is excluded. Likewise, because they are not consumed, savings and direct taxes are also excluded.
- households: it measures price changes affecting private households, but it excludes price changes that affect business or the government.
- in the UK: coverage extends to the whole of the UK.
- foreign visitors: the expenditure of foreign visitors to the UK is included in the reference population.

The UK government uses CPI as the measure of inflation in the UK. It has set the Bank of England (BoE) a 2% CPI annual inflation target. CPI and CPIH are closely related so the annual inflation target of 2% for CPIH is also applicable.

3.2. CPIH Trend

The CPIH trend has been analysed by ChandlerKBS by investigating the index changes over the period January 2010 to May 2023. The CPIH index is presented below with the BoE target of 2% per year identified from January 2010.

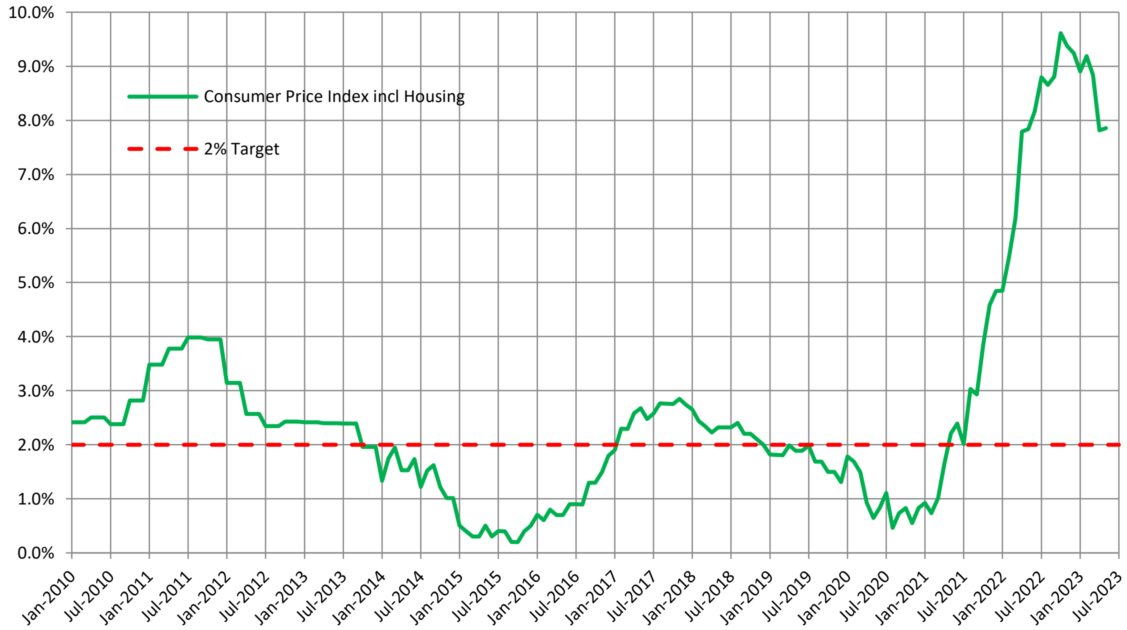
3.2.1. Chart: CPIH January 2010 to May 2023 Trend (2015 = 100)



3.2.2. Table: CPIH Trend Average Annual Values

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
CPIH	90.1	93.6	96.0	98.2	99.6	100.0	101.0	103.6	106.0	107.8	108.9	111.6	120.5	127.0

3.2.3. Chart: CPIH 12 Month Moving Percentage Changes 2010 to 2023



3.2.4. Table: CPIH 12 Month Moving Percentage Changes January 2010 to May 2023

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
CPIH	2.5%	3.8%	2.6%	2.3%	1.5%	0.4%	1.0%	2.6%	2.3%	1.7%	1.0%	2.5%	7.9%	5.4%

3.3. CPIH Basket of Goods

CPIH is calculated from a weighted list of goods and services. This list forms the basket of goods. The table below presents the categories of input prices to the calculation of CPIH and their weightings.

3.3.1. Table: Allocation of items to CPIH in 2023

	CPIH weight, February 2023 (per cent)
Food & non-alcoholic beverages	9.6
Alcohol & tobacco	3.5
Clothing & footwear	4.8
Housing & household services	30.3
Furniture & household goods	5.6
Health	1.8
Transport	11.1
Communication	1.9
Recreation & culture	11.2
Education	2.3
Restaurants & hotels	11.2
Miscellaneous goods & services	6.7

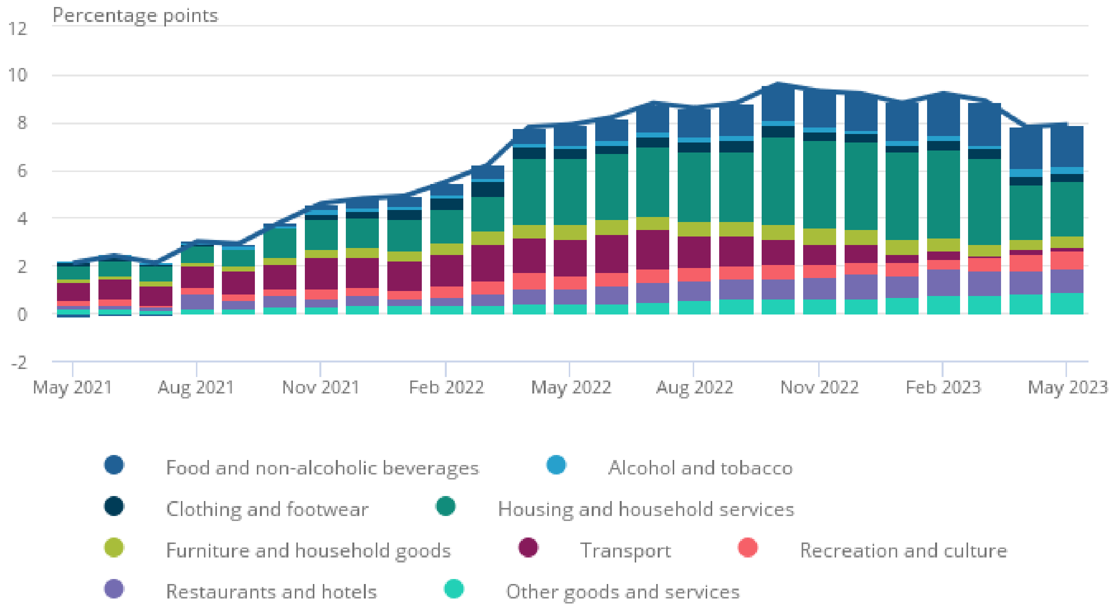
3.4. CPIH Trend Summary

In the period from 2010 to 2021, the CPIH short-term 12-month moving trend varied between 0.4% and 3.8%. The aggregated effects of the short-term trends resulted in the long-term trend from 2010 to August 2021 being the same as the Bank of England's 2% annual increase target.

From mid-2021, the short-term trend rose above the 2% target, increasing to 9.6% in October 2022. The short-term trend has since reduced to 7.9% in May 2023. The recent increase in CPIH trend has meant that since September 2021, the CPIH has been trending above the long term target. ONS reported the May 2023 CPIH as 129.1 which is 13 points above the Bank of England's annual target of 2%.

The contributing factors to CPIH inflation over the period May 2021 to May 2023, published by ONS in June 2023 is presented below. The chart shows increases in all factors with significant increases in prices for food and household services.

3.4.1. ONS Chart: Contributions to the Annual CPIH Inflation Rate May 2021 to May 2023



4. CPIH, CPI and RPI Comparison

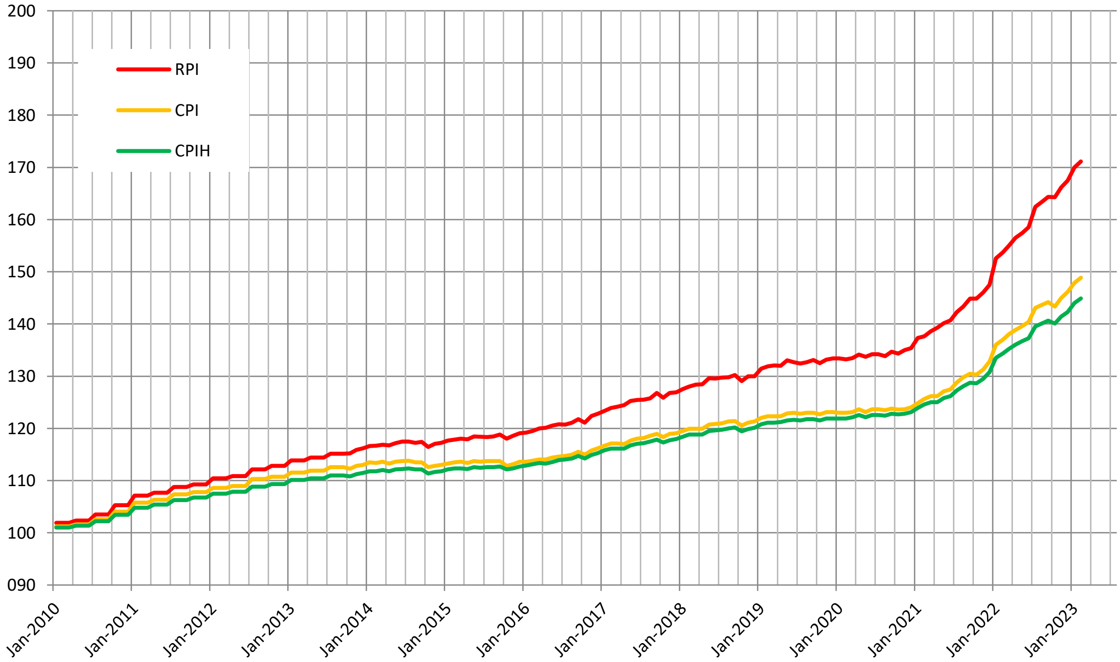
4.1. Background

The CPIH, CPI and RPI all measure the average change from month to month in the prices of consumer goods and services purchased in the UK, although there are differences in coverage and methodology. The most significant differences in coverage relate to the treatment of housing costs, particularly owner-occupier costs, which are included in CPIH and RPI but excluded from the CPI. There are also differences in the population covered, RPI covers only private households but excludes the top 4% of households by income and pensioner households who receive at least three-quarters of their income from benefits. The CPIH and CPI, by contrast, cover the expenditure of all private households, institutional households and visitors to the UK.

The RPI was initially developed as a compensation index, derived from an index designed as an aid to protect ordinary workers from price increases associated with the First World War. The Retail Prices Index (RPI) and its derivatives have been assessed against the Code of Practice for Official Statistics and found not to meet the required standard for designation as National Statistics.

The following charts and tables present the comparison of CPIH to CPI and RPI trends over the period January 2010 to May 2023.

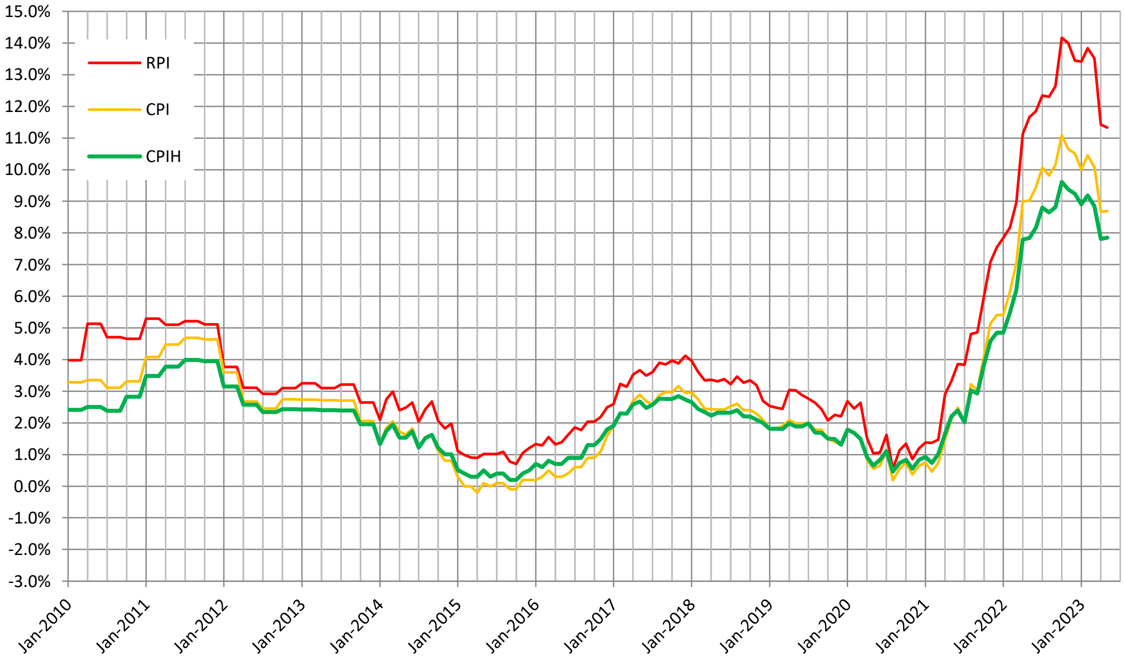
4.1.1. Chart: CPIH, CPI and RPI Trend Comparison (Jan 2010 = 100)



4.1.2. Table: CPIH, CPI and RPI Annual Values (Jan 2010 = 100)

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
CPIH	101.2	105.0	107.7	110.2	111.8	112.2	113.4	116.3	118.9	121.0	122.2	125.3	135.2	142.5
CPI	101.4	105.9	108.9	111.7	113.3	113.4	114.1	117.2	120.1	122.2	123.3	126.5	137.9	146.2
RPI	101.9	107.2	110.7	114.1	116.8	117.9	119.9	124.2	128.4	131.7	133.7	139.1	155.2	167.8

4.1.3. Chart: CPIH, CPI and RPI Annual % Change



4.1.4. Table: CPIH, CPI and RPI Annual % Changes

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
CPIH	2.5	3.8	2.6	2.3	1.5	0.4	1.0	2.6	2.3	1.7	1.0	2.5	7.9	8.5
CPI	3.3	4.5	2.9	2.6	1.5	0.1	0.6	2.7	2.5	1.8	0.9	2.6	9.0	9.6
RPI	4.6	5.2	3.2	3.1	2.4	1.0	1.7	3.6	3.3	2.6	1.5	4.0	11.5	12.7

4.2. Summary of CPIH, CPI and RPI Comparison

The CPIH, CPI and RPI utilise similar consumer input costs so it expected that the trends look similar. However, RPI has shown consistently higher inflation than CPIH and CPI so the RPI trend is steeper resulting in a divergence of the trends over time.

5. CPIH and Construction Indices Comparison

This section provides insight as to how CPIH has performed relative to the following construction cost indices:

- BCIS Civil Engineering Cost Indices
- BCIS Tender Price Index (TPI)
- BCIS Resource Cost Index (FOCOS)
- ONS Construction Output Prices Index (COPI)

5.1. BCIS Civil Engineering Cost Indices

The BCIS Civil Engineering input cost indices are produced and published by the Building Cost Information Service (BCIS) and consist of the following:

- BCIS General Civil Engineering Cost Index (CECI)
- BCIS Rail Cost Index
- BCIS Water and Sewerage Cost Index (WSCI)
- BCIS Road Cost Index

The BCIS Civil Engineering input cost indices measure changes in costs of labour, materials and plant, i.e. input cost to contractor. The indices are based on cost models produced by BCIS which represent typical expenditure profiles for the sectors. The resultant series are therefore base weighted indices.

The inputs to the indices are, in the main, selected Work Category Indices from the Price Adjustment Formulae Indices (PAFI) Civil Engineering 1990 series. Other inputs include ONS Producer Price Indices and earnings statistics. The indices allow for changes in the costs of nationally agreed labour rates, factory gate material prices and plant costs, they do not necessarily reflect changes in contractors' actual site costs.

5.2. BCIS General Civil Engineering Cost index

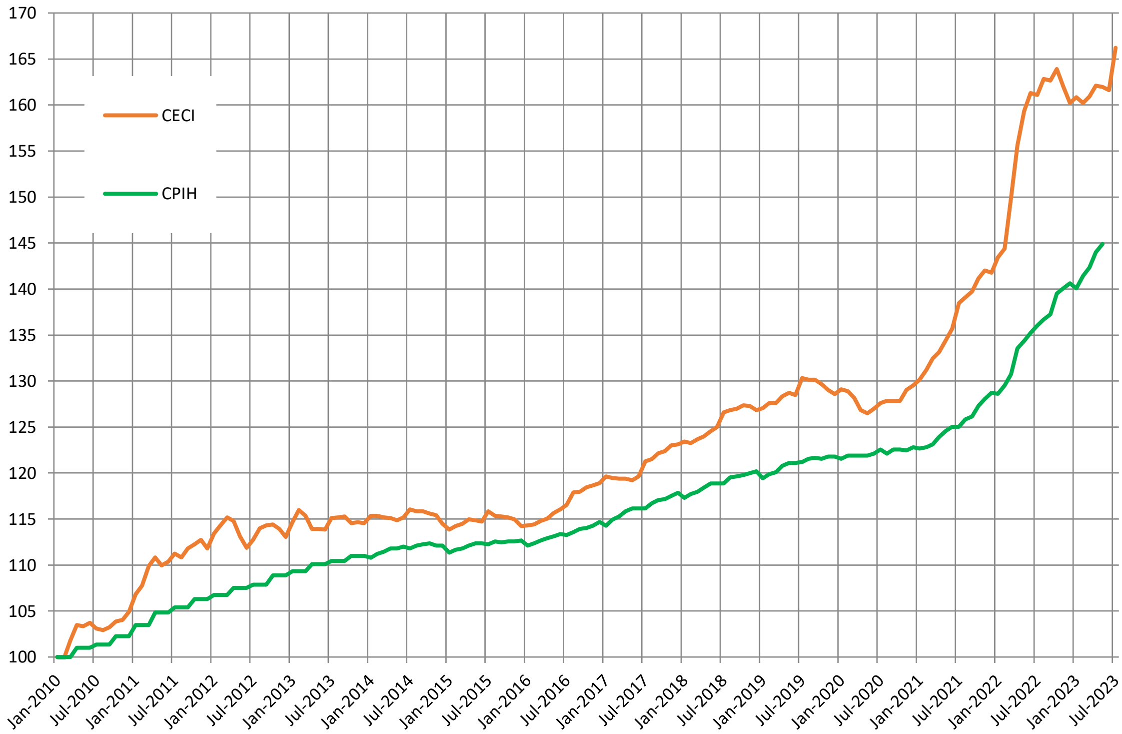
The BCIS General Civil Engineering Cost Index (CECI) was first published in December 2008 and the model was revised in November 2013. The model is based on an analysis of sub-sector infrastructure output and is compiled from the sub-sector Civil Engineering input cost indices.

The following table shows the input indices and weights of this index and the trend comparison to CPIH from January 2010 to May 2023.

5.2.1. CECI Input Indices Weightings

Index	2005 Weights	January 2014 Weights
BCIS Rail Cost Index	49.2%	46.2%
BCIS Water and Sewerage Cost Index	34.5%	34.9%
BCIS Road Cost Index	16.3%	18.9%

5.2.2. Chart: CPIH and CECI Comparison (Jan 2010 = 100)



5.3. BCIS Water and Sewerage Cost Index

The index model for water and sewerage is based on an analysis of water industry projects, the expertise of a specialist practitioner, and the input cost indices selected to measure the movements of the resources.

The models used to calculate the Water and Sewerage input cost indices have been compiled by BCIS from a variety of sources. The inputs are, in the main, Price Adjustment Formulae Indices (PAFI). The monthly indices are calculated from the equivalent month of the PAFI. Labour resource is the average price ruling of the month to which the index refers. Materials and plant resource is the price ruling in the month to which the index refers. Other inputs to the Water and Sewerage input cost indices include ONS Producer Price Indices and earnings statistics.

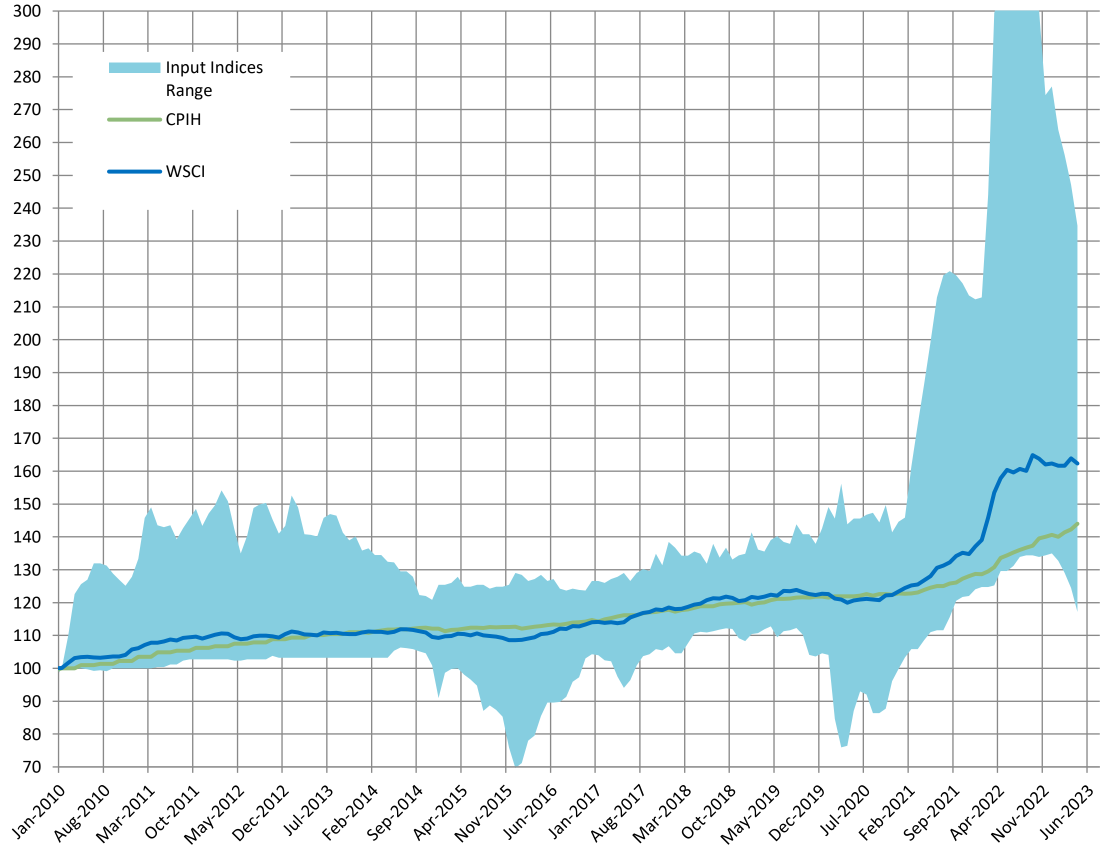
Input and weightings are given below for all the cost indices included in the Water and Sewerage index. The 2005 average weightings were used to compile the index at the base date and the weights from the more recent date reflect the differential movement in the cost of the inputs, not a reassessment of the model.

5.3.1. Table: WSCI Input Indices

Reference	Index	2005	Jan-14	Sep-17	Sep-22
90/1	Labour and Supervision	29%	27%	29%	24%
90/2	Plant and road vehicles	18%	17%	17%	15%
90/3	Aggregates	4%	4%	4%	5%
90/4	Bricks and clay products	7%	7%	7%	8%
90/6	Ready mixed concrete	8%	8%	8%	8%
90/7	Cast and spun iron products	5%	5%	6%	5%
90/9	Coated macadam and bituminous products	3%	4%	4%	4%
90/10	DERV fuel	4%	4%	3%	4%
90/11	Gas oil fuel	4%	6%	4%	9%
90/12	Timber	1%	1%	1%	1%
90/13	Reinforcing steel	3%	4%	4%	5%
90/14	Metal sections	1%	1%	1%	2%
90/15	Steel sheet piling	1%	1%	1%	1%
PPI	Plastic tanks	3%	3%	3%	3%
PPI	PCC pipes and sections	3%	3%	3%	3%
PPI	Plastic pipes	6%	5%	5%	4%

5.3.2. Chart: WSCI Input Indices Range (Jan 2010 = 100)

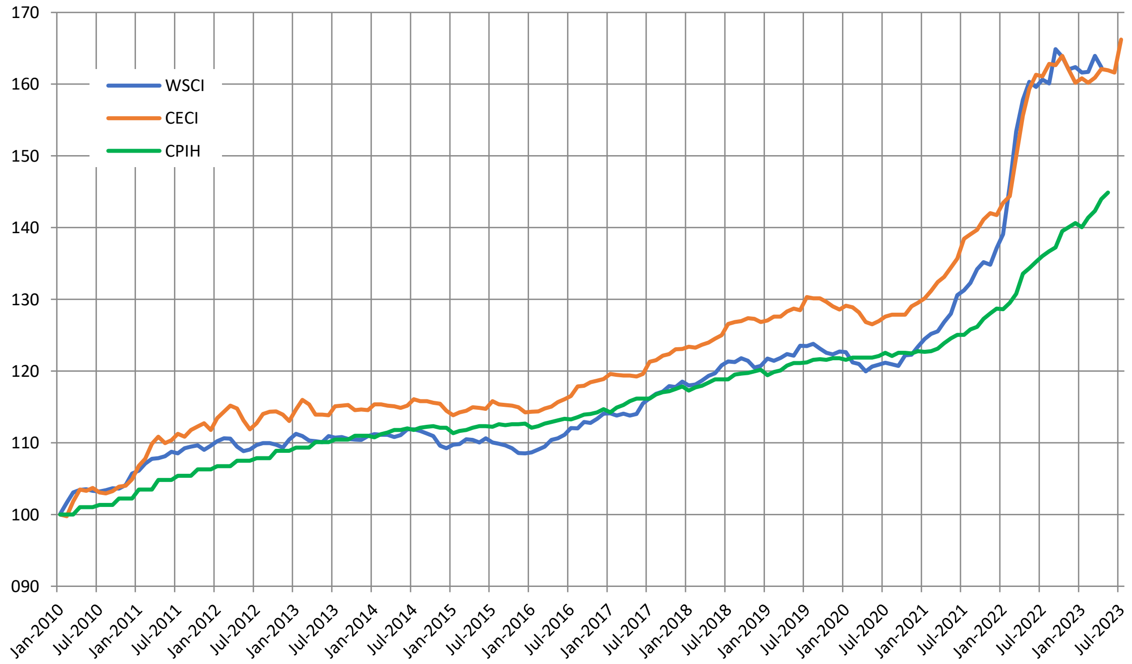
Due to the number of WSCI input indices they are shown as a shaded area that demonstrates the minimum to maximum range of values.



5.4. CPIH Comparison to CECI and WSCI

The chart and table below presents the CECI and WSCI trends compared to the CPIH trend for the period January 2010 to May 2023.

5.4.1. Chart: CPIH, CECI and WSCI Comparison (Jan 2010 = 100)



5.4.2. Table: CPIH, CECI and WSCI Annual % Change

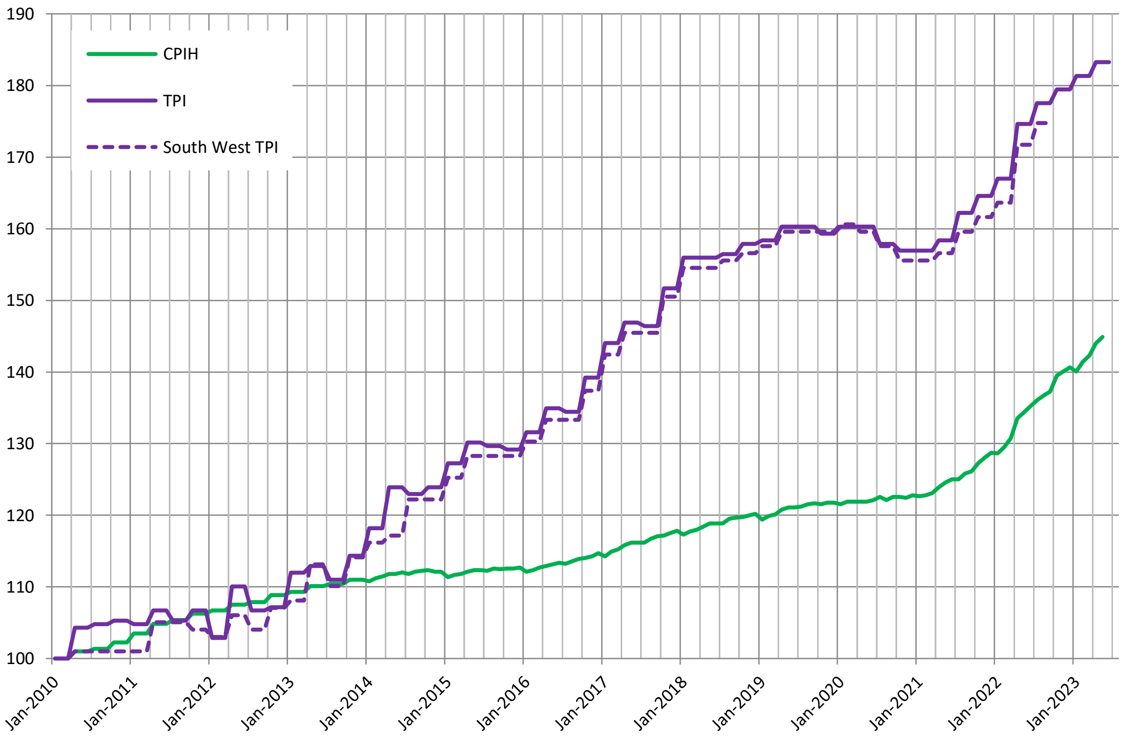
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
CPIH	2.5	3.8	2.6	2.3	1.5	0.4	1.0	2.6	2.3	1.7	1.0	2.5	7.9	5.4
CECI	5.3	7.5	2.9	0.9	0.5	-0.5	1.5	3.7	3.8	2.7	-0.6	6.7	15.1	4.3
WSCI	3.3	5.0	1.3	0.7	0.3	-1.1	1.5	4.0	3.7	2.0	-1.0	7.4	20.7	3.1

5.5. BCIS Tender Price Index

BCIS Tender Price Indices (TPIs) measure the trend of contractors' pricing levels in accepted tenders, i.e. cost to client, for schemes let on a lump sum basis, built up from rates and quantities, usually a Bill of Quantities, at commit to build stage.

Since the BCIS TPIs are constructed using projects based on traditional procurement routes, projects based on contractor-led procurement methods, such as design and build and partnering, are only included when the required pricing documents are available.

5.5.1. CPIH Comparison to TPI January 2010 to May 2023 (Jan 2010 = 100)



5.5.2. Table: CPIH, TPI and South West TPI Annual % Change

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022*	2023*
CPIH	2.5	3.8	2.6	2.3	1.5	0.4	1.0	2.6	2.3	1.7	1.0	2.5	7.9	5.4
TPI	-0.1	2.2	0.8	5.5	8.6	5.6	4.6	9.0	6.3	1.9	-0.4	1.1	8.8	4.4
SW TPI	0.5	3.0	1.2	6.0	7.3	6.8	4.8	9.3	6.4	2.4	-0.5	0.0	7.4	n/a

*Inflation figures for CPIH and TPI are only available for part of 2023. Inflation figures for SW TPI are only available up to September 2022.

5.5.3. South West TPI Summary

The index trend for the South West TPI is similar to the general TPI. The general TPI is published more frequently and the South West TPI series stops in September 2022. Therefore, for the purposes of comparisons this report the general TPI will be used.

5.6. BCIS FOCOS

The Department for Business and Trade (DBT) Construction Material Price Indices (CMPIs) give a measure of the notional trend of input costs to a contractor in terms of changes in the cost of building materials, i.e. factory gate prices charged by materials manufacturers.

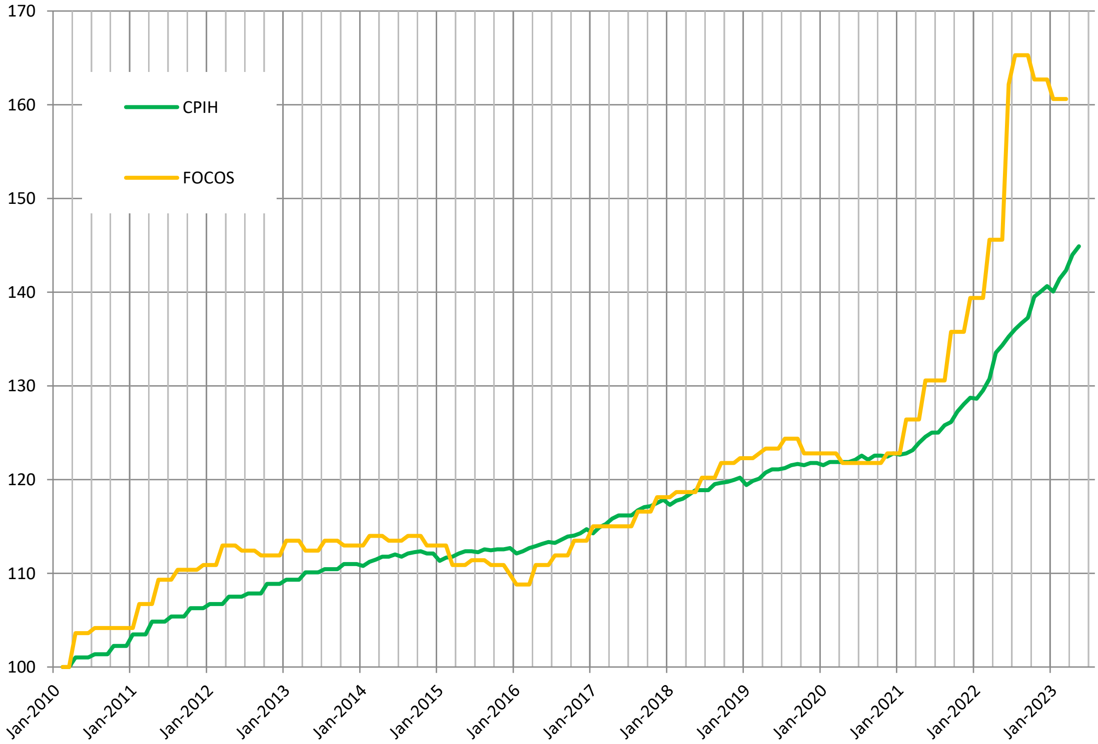
The indices do not take into account current market conditions experienced by a contractor on a particular project purchasing from sub-contractors, merchants or other factors (e.g. materials discounts or premiums paid for material resources in short supply). The compilation of the indices involves a number of different ONS Producer Price Indices (PPI) to produce the Price Adjustment Formulae Indices (PAFI), published by BCIS.

The CMPIs are compiled by weighting together the materials-only content of Resource Cost Indices (RCI). The CMPI for ‘Other New Work’ contains the RCI for infrastructure, including repair and maintenance, known as FOCOS. The table and chart below identify the input indices to the FOCOS index and its trend from January 2010 to May 2023.

5.6.1. Table: FOCOS Input Indices and Weights

Code	Name	FOCOS
90/1	Labour and Supervision	20.7%
90/2	Plant and Road Vehicles	15.7%
90/3	Aggregates	4.7%
90/4	Bricks and Clay Products	3.3%
90/5	Cements	2.7%
90/6	Ready Mixed Concrete	4.7%
90/7	Cast and Spun Iron Products	1.3%
90/8	Plastics Products	1.3%
90/9	Coated Macadam and Bituminous Products	17.3%
90/10	DERV Fuel	3.0%
90/11	Gas Oil Fuel	1.0%
90/12	Timber	2.0%
90/13	Steel for Reinforcement	4.7%
90/14	Metal Sections	3.0%
90/15	Sheet Steel Piling	1.3%
3/S1	Structural Steelwork - Labour	2.3%
3/S3	Structural Steelwork - Materials: Civil Engineering Work	4.3%
3/L1	Lift – Mechanical Engineering Labour	1.5%
3/L2	Lift - Mechanical Engineering Materials	2.2%
3/L3	Lift - Electrical Engineering Materials	1.8%
3/L4	Lift - Electrical Engineering Labour	1.2%

5.6.2. Chart: CPIH and FOCOS Comparison January 2010 to May 2023 (Jan 2010 = 100)



5.7. ONS Construction Output Price Index

The ONS Construction Output Price Indices (OPIs) provide a best estimate of inflation within the UK construction industry. The OPIs are compiled using existing ONS data sources. The ONS approach involves input costs, which are materials, labour and plant hire, weighted together for a selection of types of construction projects, with a mark-up being applied to account for profit by the construction firm. The result is considered a proxy for output prices known as COPI.

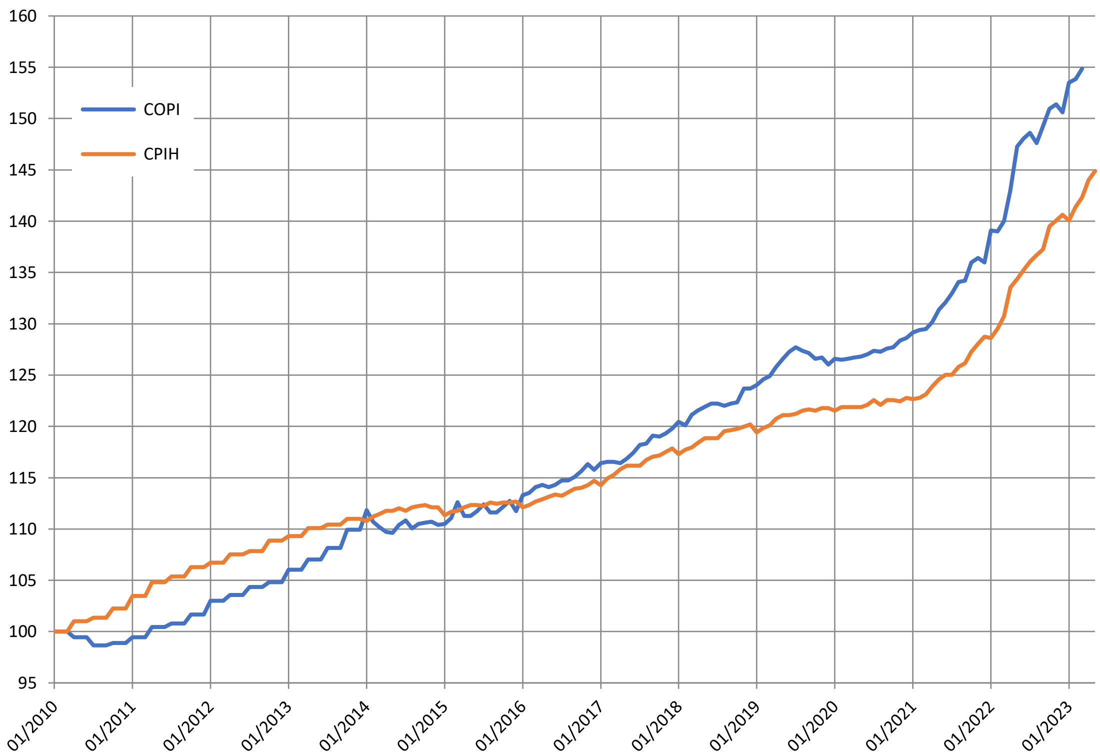
The main strengths of COPI include:

- the index is comprehensive, covering a wide variety of products or services
- the data provides users with valuable insight into the changing inflation within the UK construction industry

The main limitations of COPI include:

- inconsistency with the timelines of input data; plant, labour and material costs are updated monthly, however, the mark-up profit margin is only available two years after the respective reference period

5.7.1. Chart: CPIH and COPI Comparison January 2010 to May 2023 (Jan 2010 = 100)



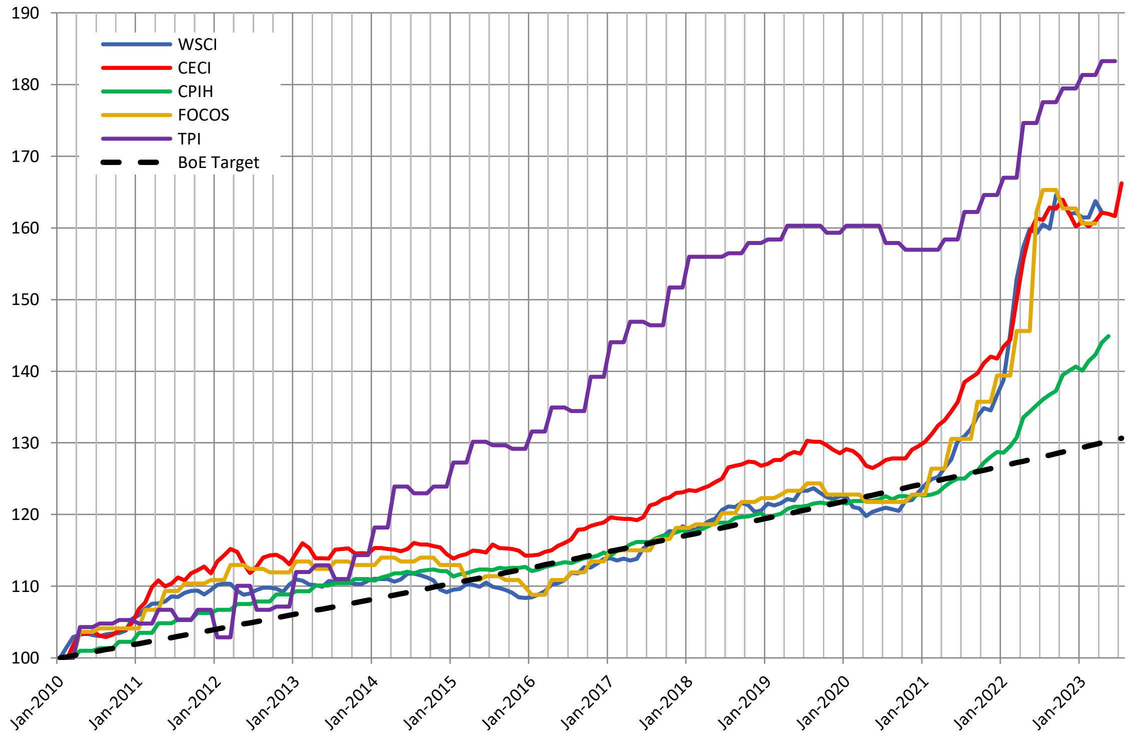
5.7.2. Table: CPIH and COPI Annual % Change

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
CPIH	2.5	3.8	2.6	2.3	1.5	0.4	1.0	2.6	2.3	1.7	1.0	2.5	7.9
COPI	-3.8	1.4	3.3	3.7	2.5	1.1	2.6	2.8	3.5	3.5	0.8	4.2	10.3

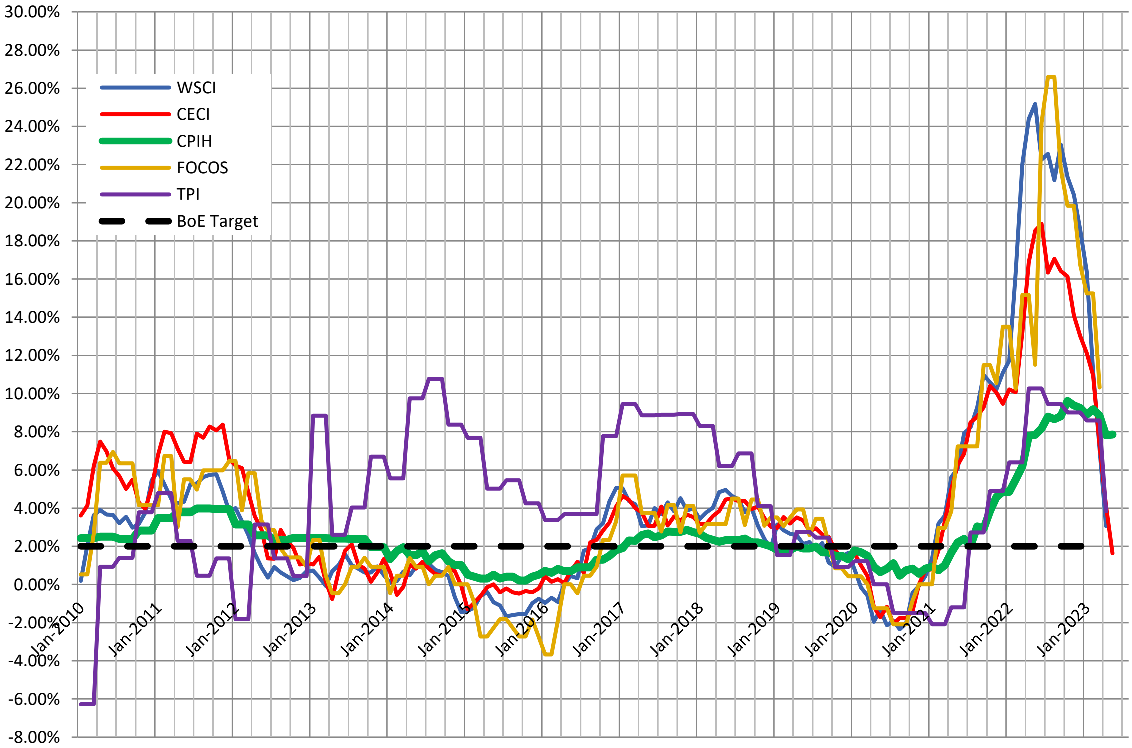
5.8. CPIH and Construction Indices Comparison Summary

The BCIS indices are presented together and compared with CPIH in the following charts.

5.8.1. Chart: CPIH and Construction Indices 2010 to 2023 (Jan 2010 = 100)



5.8.2. Chart: CPIH and Construction Indices Annual % Changes January 2010 to May 2023



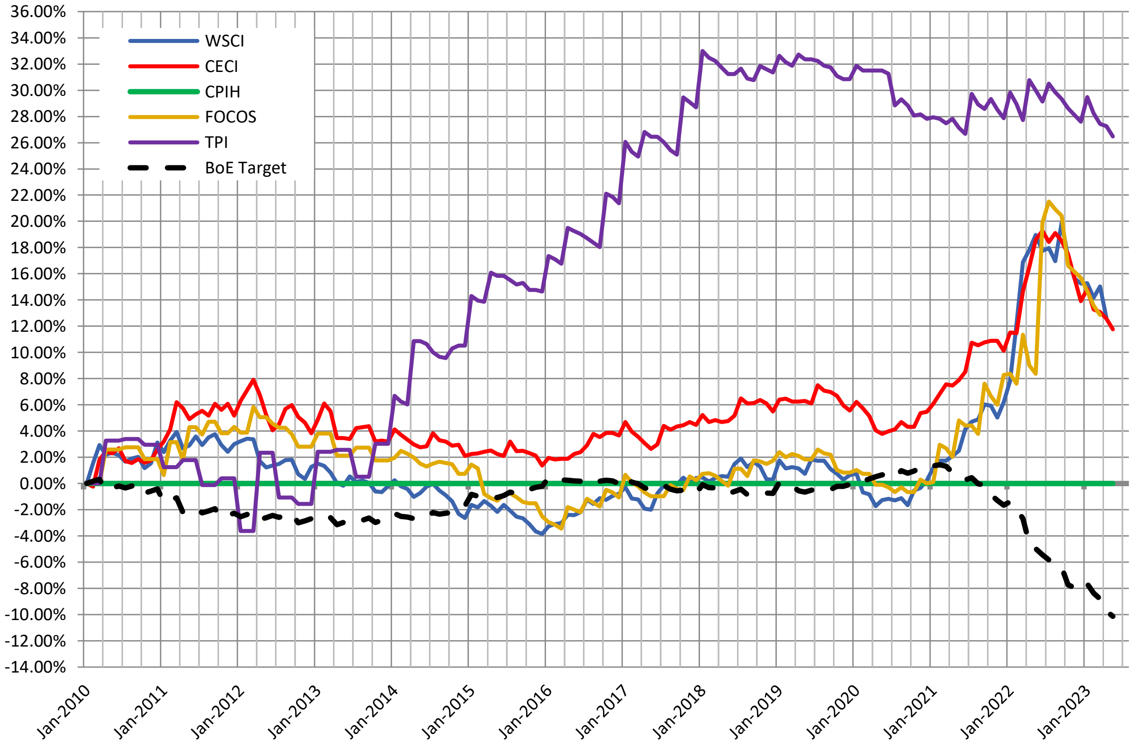
5.8.3. Table: CPIH and Construction Indices Annual % Changes January 2010 to May 2023

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
CPIH	2.5	3.8	2.6	2.3	1.5	0.4	1.0	2.6	2.3	1.7	1.0	2.5	7.9	5.4
CECI	5.3	7.5	2.9	0.9	0.5	-0.5	1.5	3.7	3.8	2.7	-0.6	6.7	15.1	4.3
WSCI	3.3	5.0	1.3	0.7	0.3	-1.2	1.4	4.0	3.8	2.1	-1.0	7.3	20.8	3.2
FOCOS	4.6	5.6	3.1	0.8	0.5	-2.1	-0.0	4.2	3.6	2.6	-0.8	7.1	18.5	3.5
TPI	-0.1	2.2	0.8	5.5	8.6	5.6	4.6	9.0	6.3	1.9	-0.4	1.1	8.8	3.8

5.9. BCIS Indices Variance to CPIH

The following chart presents the BCIS indices variance to CPIH.

5.9.1. Chart: BCIS Indices Variance to CPIH 2010 to 2023 (Jan 2010 = 100)



5.9.2. CPIH and BCIS Trend Summary

The BCIS trends stay within 8% variance to CPIH from January 2010 to mid-2021 with exception of TPI which has trended at a higher inflation rate than CPIH.

The CPIH trend aligns with the BoE inflation target of 2% per year from January 2010 until mid-2021. Since mid-2021, CPIH trended above the BoE target, resulting in an average annual increase of 2.7% per year, totalling 44.9% for the period January 2010 to May 2023.

The TPI trend appears to be independent of the other indices and trends above the BoE's 2% target for the majority of the period. The TPI trend increase from January 2010 is equivalent to a 4.4% rise per year, totalling 83.3% to May 2023. The TPI reports that tender prices have risen 26.5% compared to CPIH in the period.
The CECI trend is consistently higher than CPIH and BoE target for the whole period. The CECI reports that civil engineering prices have risen 12.6% compared to CPIH in the period.

The WSCI and FOCOS trends are similar to CPIH from January 2017 to 2020, staying within 2% variance of CPIH increases. The WSCI and FOCOS also report that civil engineering prices have risen circa 12.6% compared to CPIH in the period January 2010 to May 2023.

The CECI, WSCI and FOCOS trends from January 2010 are equivalent to a 3.5% rise per year, totalling 62.0% to May 2023.

Consumer Price Indices such as CPIH, CPI and RPI measure consumer price changes and have no input costs from the construction sector. Therefore, the consumer indices are not designed to represent price movements in the construction sector.

There have been periods where the CPIH trend was coincidentally similar to trends in some construction costs. However, Section 6 of this Report demonstrates that any comparable trend is short-term only and cannot be reliably extrapolated to the long-term.

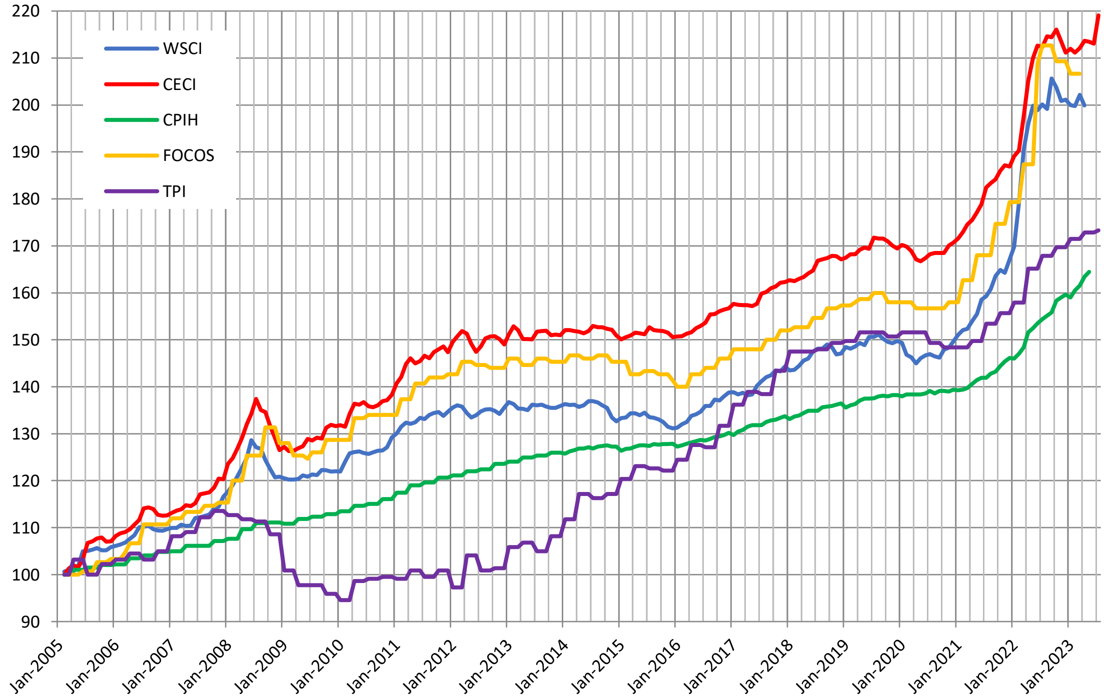
6. Short and Long Term Trends

To demonstrate the effect on the trend analysis of changing the indices' base dates, the long term and short term comparisons of CPIH and BCIS construction indices are shown in this section.

6.1. Long Term Index Comparison

The long-term comparison, from January 2005 to May 2023, is presented below for the CPIH and BCIS indices.

6.1.1. Chart: CPIH and Construction Indices Comparison 2005 to 2023 (Jan 2005 = 100)



6.1.2. Table: CPIH and BCIS Indices' % Increase From 2005 to 2025

	2005 to 2010	2005 to 2015	2005 to 2020	2005 to May 2023	2005 to 2025 (Forecast)
CPIH	16.1	27.9	39.4	61.5	67.8
CECI	38.3	50.6	70.1	112.1	128.8

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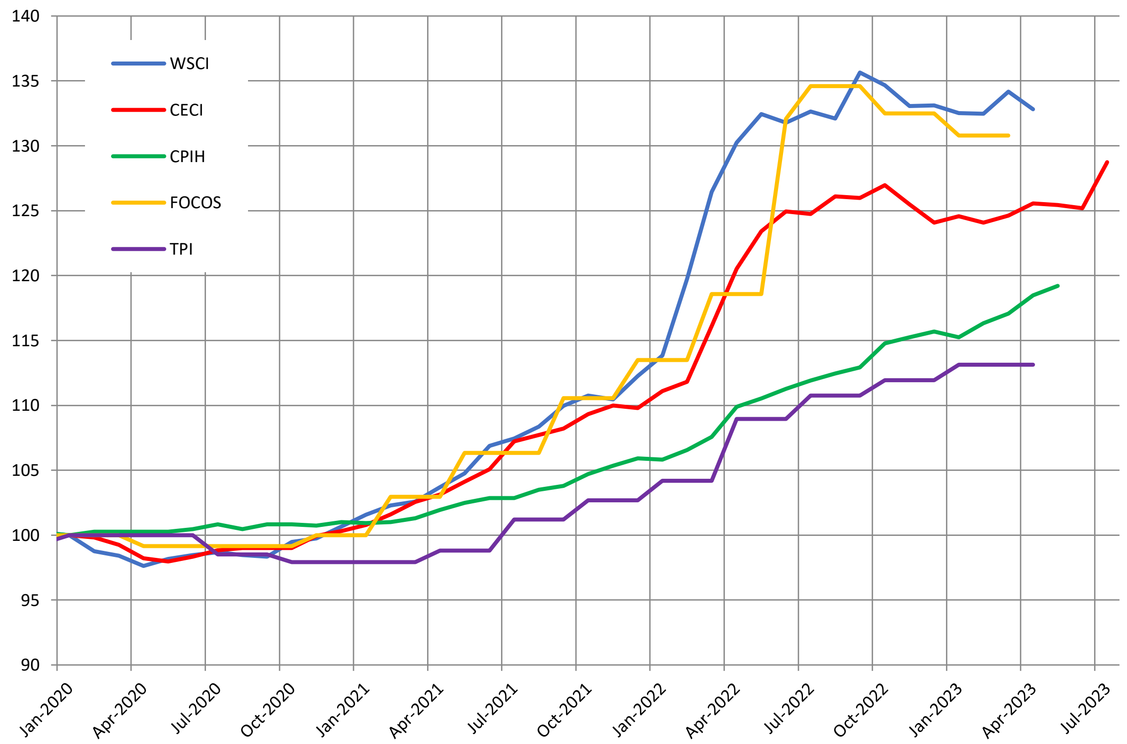
6.2. Short-Term Index Comparison

The short-term comparison, from January 2020 to May 2023, is presented below for the CPIH and BCIS indices.

6.2.1. Chart: CPIH and Construction Indices Comparison 2020 to 2023 (Jan 2020 = 100)



6.2.2. Short and Long Term Trend Summary

Rebasing the CPIH and BCIS indices to 2005 demonstrates that the WSCI percentage increase at the end of each 5 year period is approximately 2 times the CPIH increase in the same period.

Rebasing the CPIH and BCIS indices to 2020 demonstrates that over the period to May 2023, WSCI has increased by 33% compared to the CPIH increase of 18%.

There have been periods where the CPIH trend was coincidentally similar to trends in some construction costs. However, the analysis above demonstrates that any comparable trend is short-term only and cannot be reliably extrapolated to the long-term.

7. Labour Cost Indices

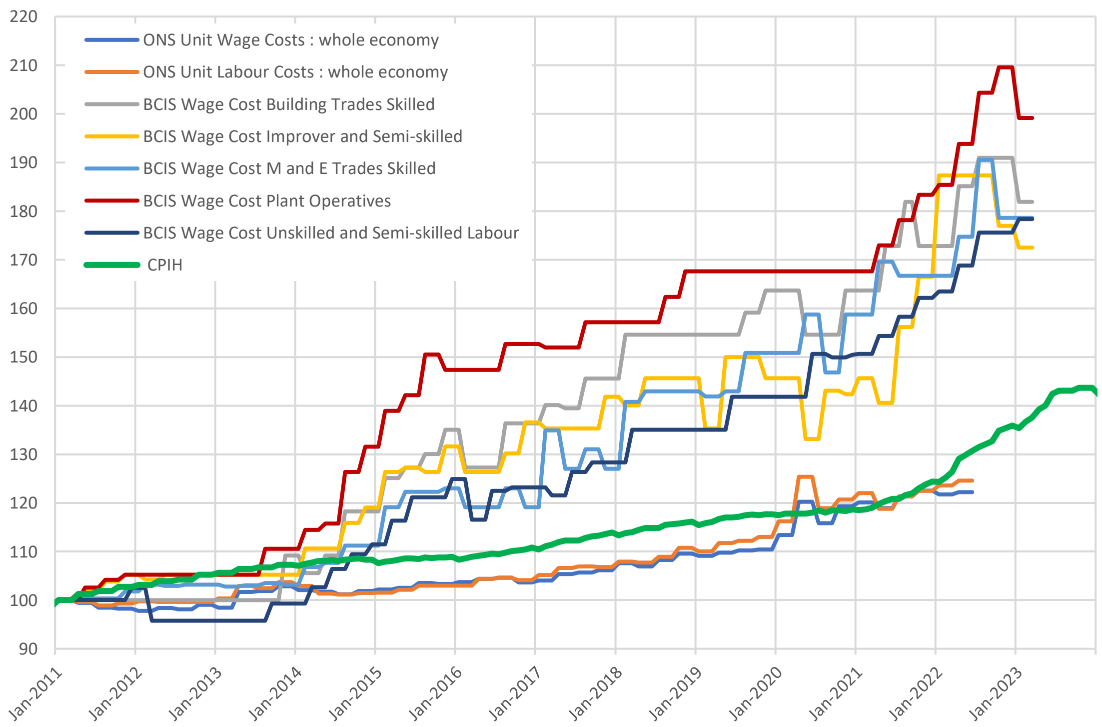
In this section of the report the labour cost indices are presented compared to CPIH.

7.1. Labour Indices

ChandlerKBS sourced the following indices to present the change in labour costs from January 2011 to January 2023:

- ONS Unit Wage Costs: Whole Economy
- ONS Unit Labour Costs: Whole Economy
- BCIS Wage Cost Building Trades Skilled
- BCIS Wage Cost Improver and Semi-Skilled
- BCIS Wage Cost M and E Trades Skilled
- BCIS Wage Cost Plant Operatives
- BCIS Wage Cost Unskilled and Semi-Skilled Labour

7.1.1. Chart: CPIH and Labour Indices Comparison (Jan 2011 = 100)



7.2. Labour Indices Summary

BCIS construction labour indices present a different trend to ONS general labour indices. BCIS indices have increased between 72% and 99% in the period January 2011 to March 2023 compared to the CPIH increase of 38% in the same period. ONS general labour indices have increased between 22% and 25% in the period January 2011 to June 2022.

8. Plant Cost Indices

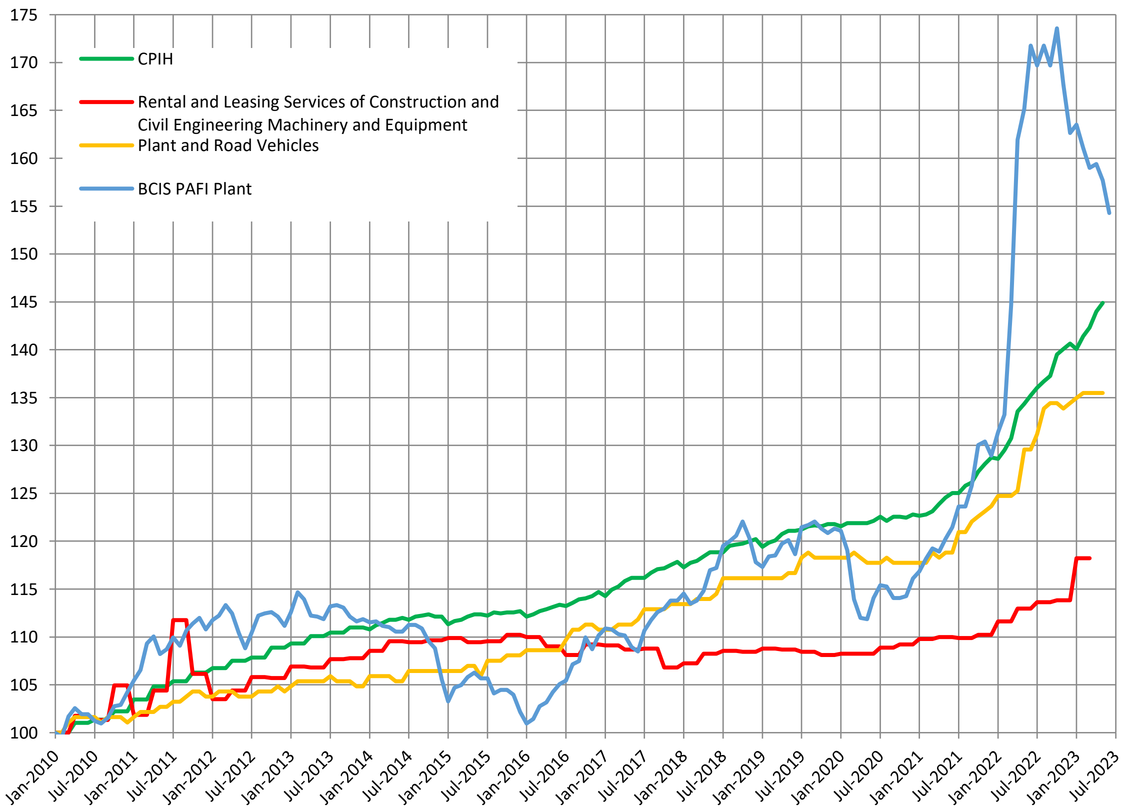
In this section of the report the plant cost indices are presented compared to CPIH.

8.1. Plant Cost Indices

ChandlerKBS sourced the following indices to present the change in plant costs from January 2020 to May 2023 compared to CPIH:

- BCIS WSCI PAFI input indices for Plant and Road Vehicles excluding fuel.
- BCIS Plant Index.
- ONS Rental and Leasing Services of Construction and Civil Engineering Machinery and Equipment.

8.1.1. Chart: CPIH and Plant Cost Indices (2010 = 100)



8.2. Plant Cost Indices Summary

The BCIS Plant Index has increased at a rate similar to CPIH from January 2010 to January 2022. By mid-2022, the BCIS Plant Index had risen significantly higher than CPIH whilst 2023 movements have presented a downward trend but is still above the CPIH trend.

The trend for the WSCI input index for plant costs is similar to the CPIH but is consistently lower than CPIH.

The ONS plant rental index trend does not follow the CPIH trend or the BCIS trends and has increased at less than half the rate of CPIH.

The plant indices present a collective trend that is lower than CPIH over the period January 2010 to May 2023. However, the three indices used in the comparison present three different trends and do not provide a conclusive relationship

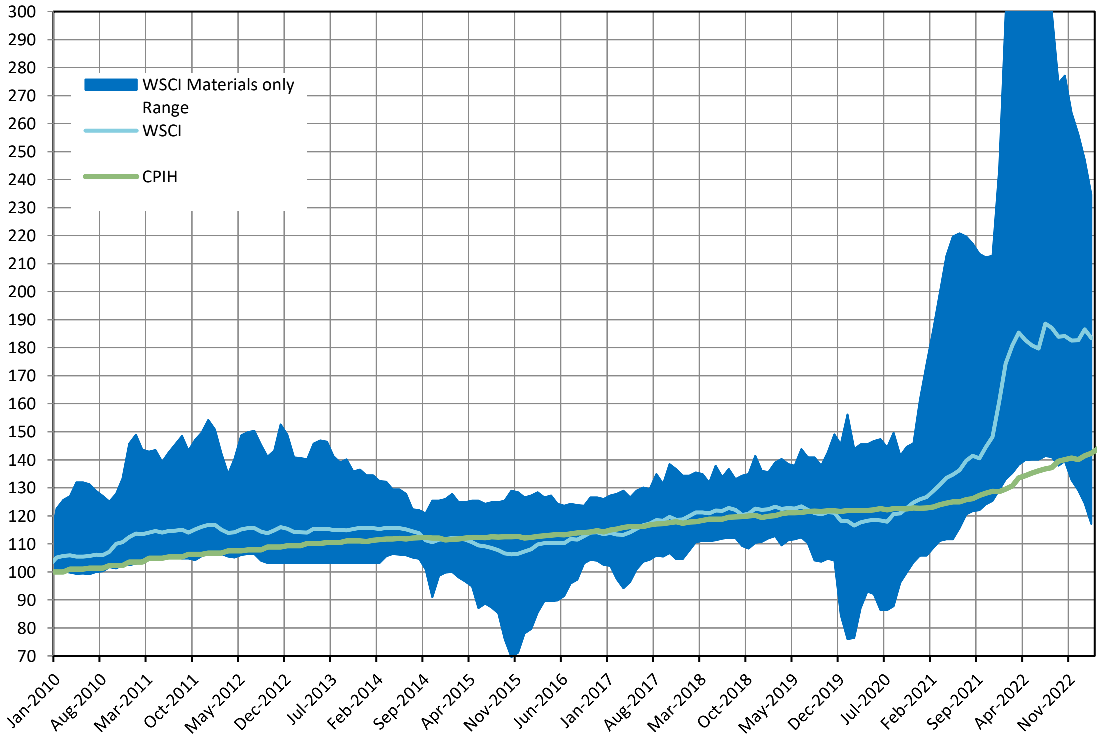
9. Materials

In this section of the report we focus on the changes to the key construction material costs for the water sector.

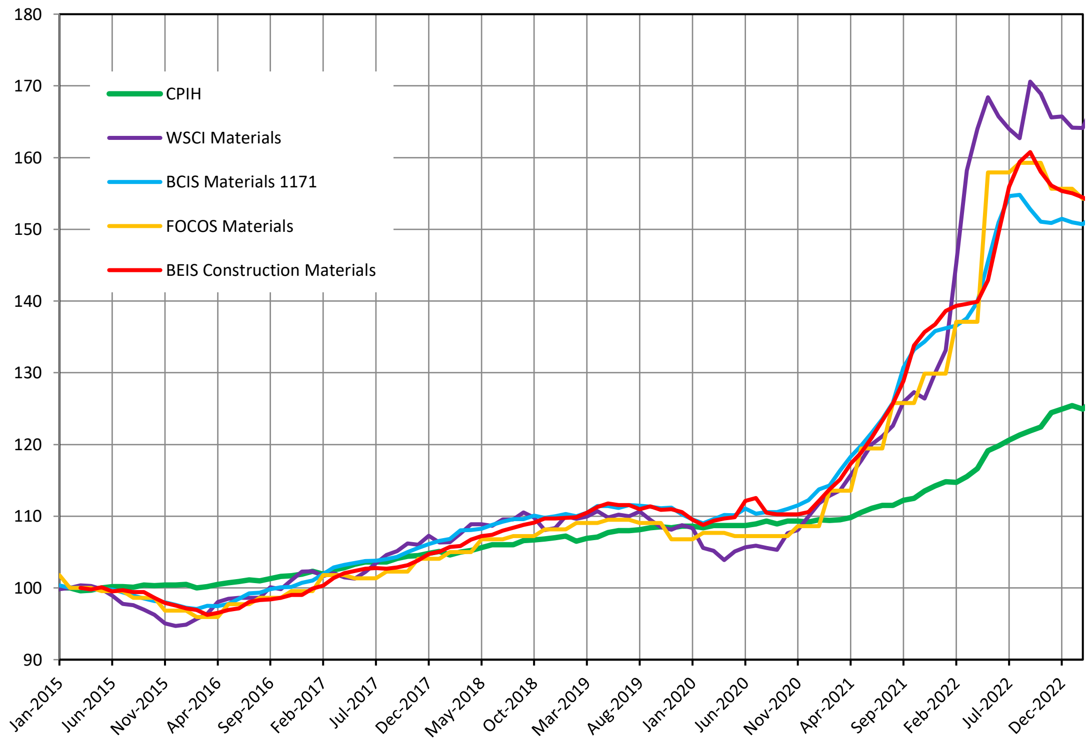
9.1. Material Indices

The WSCI input indices include a list of the key materials specific to the water sector. The charts below presents the range of material input indices to WSCI, compared with the standard WSCI, BCIS Materials cost index ref 1171, BEIS Construction Materials and CPIH.

9.1.1. Chart: CPIH and WSCI Materials Comparison (2010 = 100)



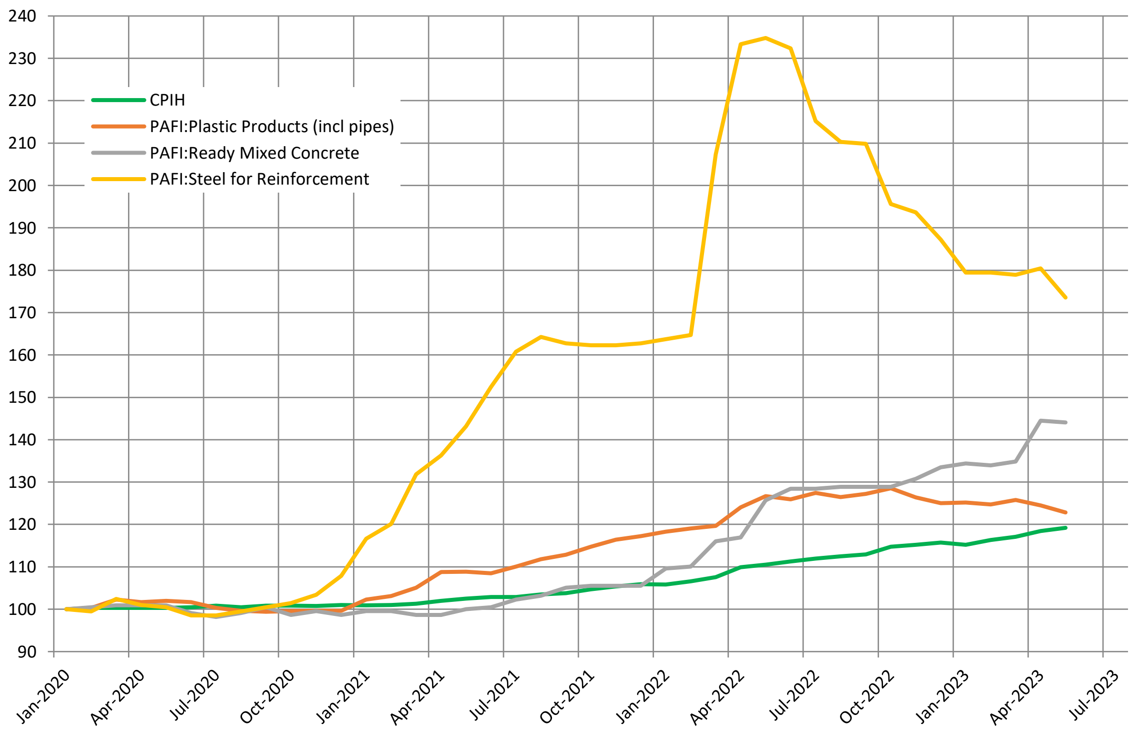
9.1.2. Chart: CPIH and WSCI Materials, BCIS Materials, FOCOS and BEIS Construction Materials (2015 = 100)



9.2. Material Price Volatility

The prices of construction materials started to rise sharply during 2020 and continue to be volatile. Key construction materials such as concrete, steel and plastic pipes have seen significant variations to the CPIH trend as presented below.

9.2.1. CPIH and WSCI Key Materials (January 2020 = 100)



9.3. Materials Summary

The range of WSCI input material cost index trends intersect with the CPIH trend until 2022 when CPIH trend was lower than all material cost trends.

The key construction materials such as steel have seen significant price volatilities with monthly price fluctuations often greater than pre-2020 annual price fluctuations.

2Q2023 has seen some material prices start to retract but supply chain prices remain volatile.

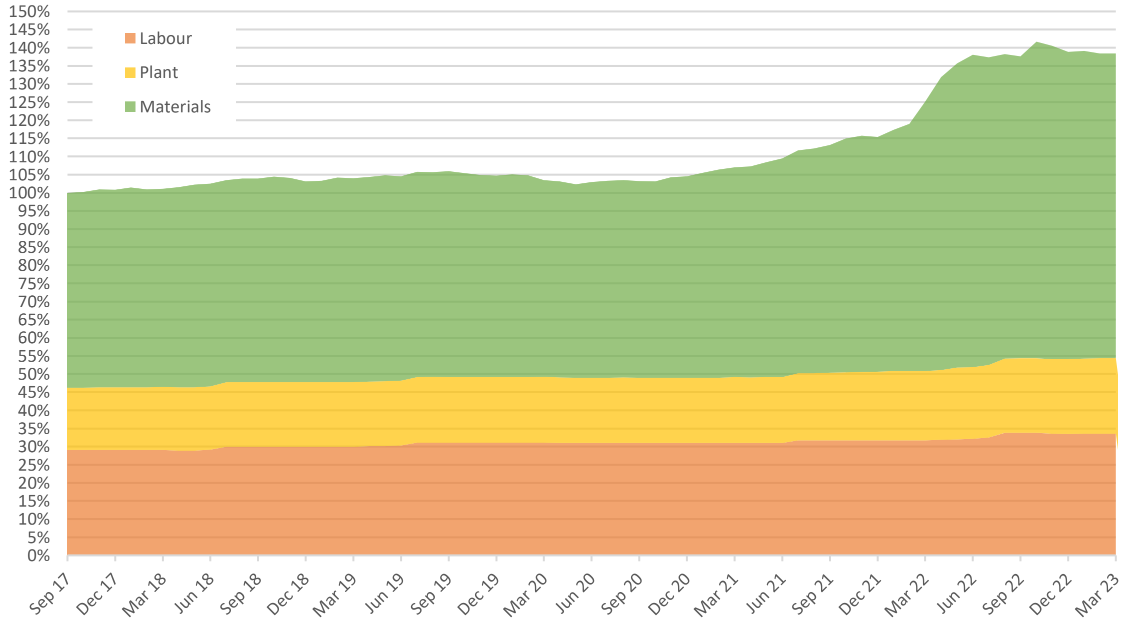
10. Labour, Plant and Material Proportions

In this section of the report we present the comparison of the labour, plant and material proportions.

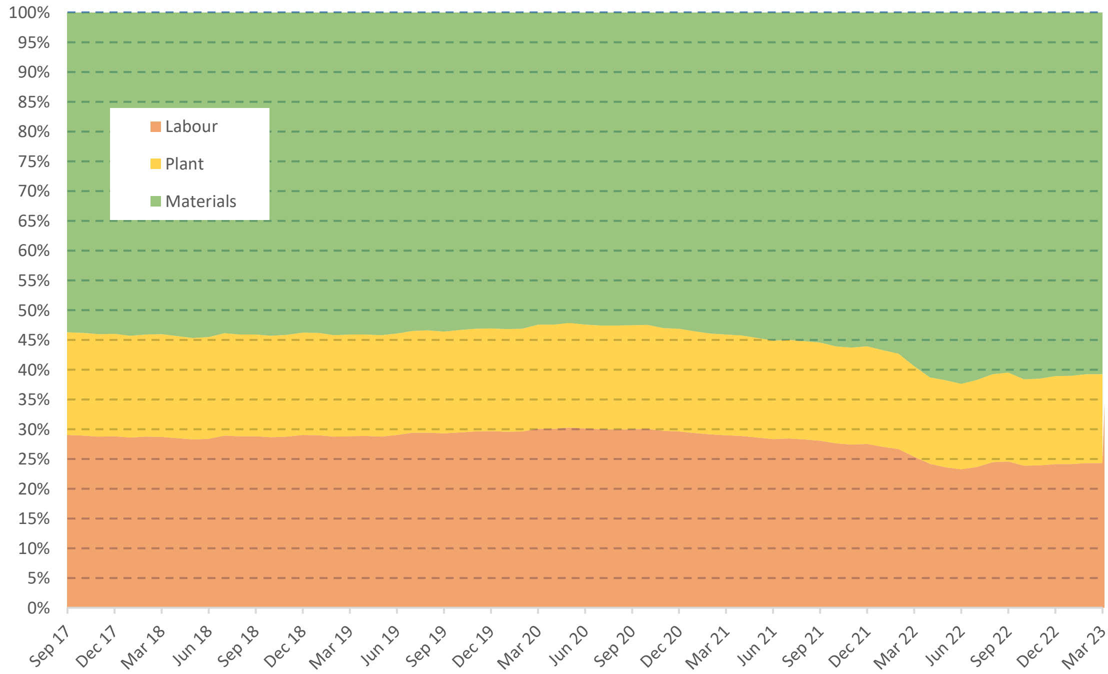
10.1. WSCI Input Indices

Utilising the input indices for the WSCI, we can determine the changes in proportions of labour, plant and materials over time. The following charts present the changes from September 2017 to March 2023.

10.1.1. Chart: WSCI Labour, Plant and Material Aggregated Input Indices September 2017 to March 2023



10.1.2. Chart: WSCI Labour, Plant and Material Input Indices Proportions September 2017 to March 2023



10.1.3. Table: Labour, Plant and Material % Proportions

	2017	2018	2019	2020	2021	2022	2023*
Labour	29	29	29	30	28	24	24
Plant	17	17	17	17	17	15	15
Material	54	54	54	53	55	61	61

*Data available up to May 2023

10.2. Summary

Due to the increases in construction material costs, the proportions of labour and plant costs in the WSCI have dropped to 24% and 15% respectively of estimated construction costs.

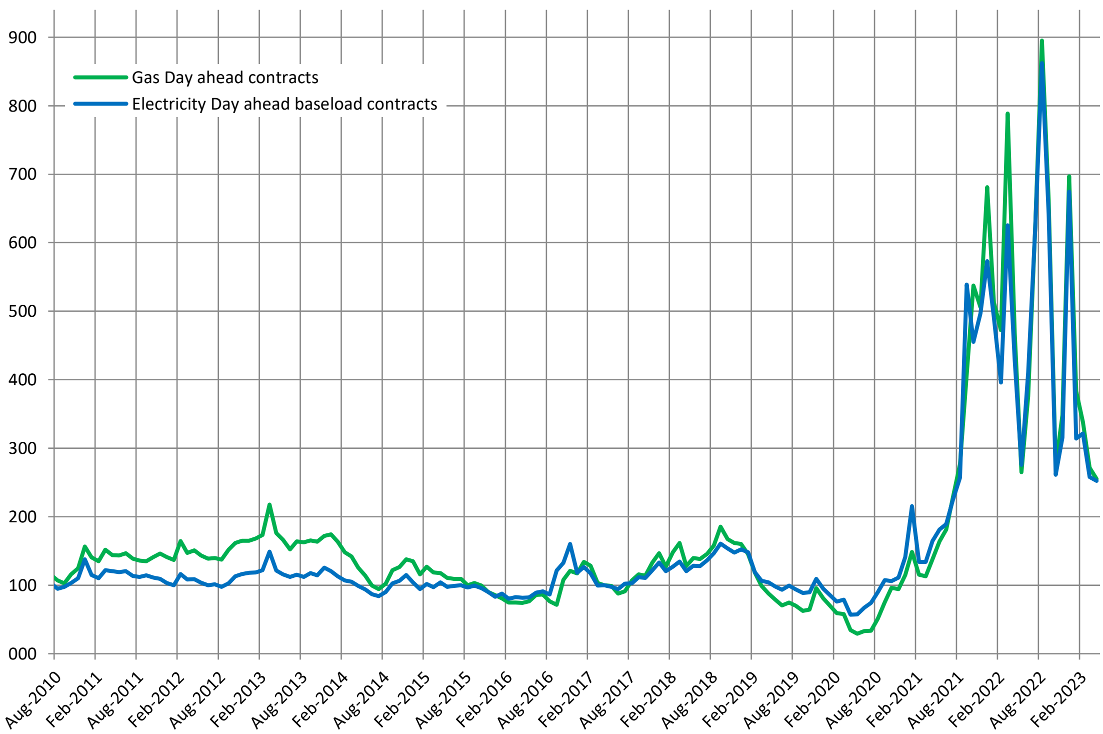
11. Energy

Energy prices for gas and electricity impact costs in the construction industry's supply chain. Production of some of the key construction materials such as cement and steel are highly energy intensive and have increased in line with the rise of energy costs.

11.1. Energy Indices

Energy cost indices for gas and electricity, sourced from Ofgem's "Day Ahead" contract values, are presented in the chart below.

11.1.1. Chart: CPIH, Gas and Electricity Comparison (Jan 2010 = 100)



12. CPIH Forecast

There were no forecasts available specifically for CPIH from any of our information sources. The OBR have published a forecast for the CPI. Due to its close relationship with CPIH, the CPI forecast has been used as a surrogate to represent the forecast of CPIH.

12.1. OBR Historical Forecast Performance

ChandlerKBS carried out an assessment on the OBR forecasts for CPI to determine their accuracy against the outturn CPI values. The table below presents the error % points for each forecast year.

12.1.1. Table: OBR Forecast Error % Points Analysis Results

	1 Year	2 Years	3 Years	4 Years	5 Years
Minimum	0.04	0.21	0.31	0.21	1.96
Average	0.86	0.87	0.86	0.87	1.96
Median	0.79	0.77	0.59	0.64	1.96
Maximum	1.96	2.06	1.96	1.96	1.96

12.2. OBR Forecast Application

The forecast performance results have been applied to the OBR forecasts to determine the upside and downside of the forecast as shown below.

12.2.1. Table: OBR Forecast with Average Forecast Error Limits

Year	OBR Forecast	Upside	Downside
2023-24	6.1%	7.0%	5.3%
2024-25	0.9%	1.7%	0.0%
2025-26	0.1%	1.0%	-0.7%
2026-27	0.5%	1.4%	-0.4%
2027-28	1.6%	3.5%	-0.4%

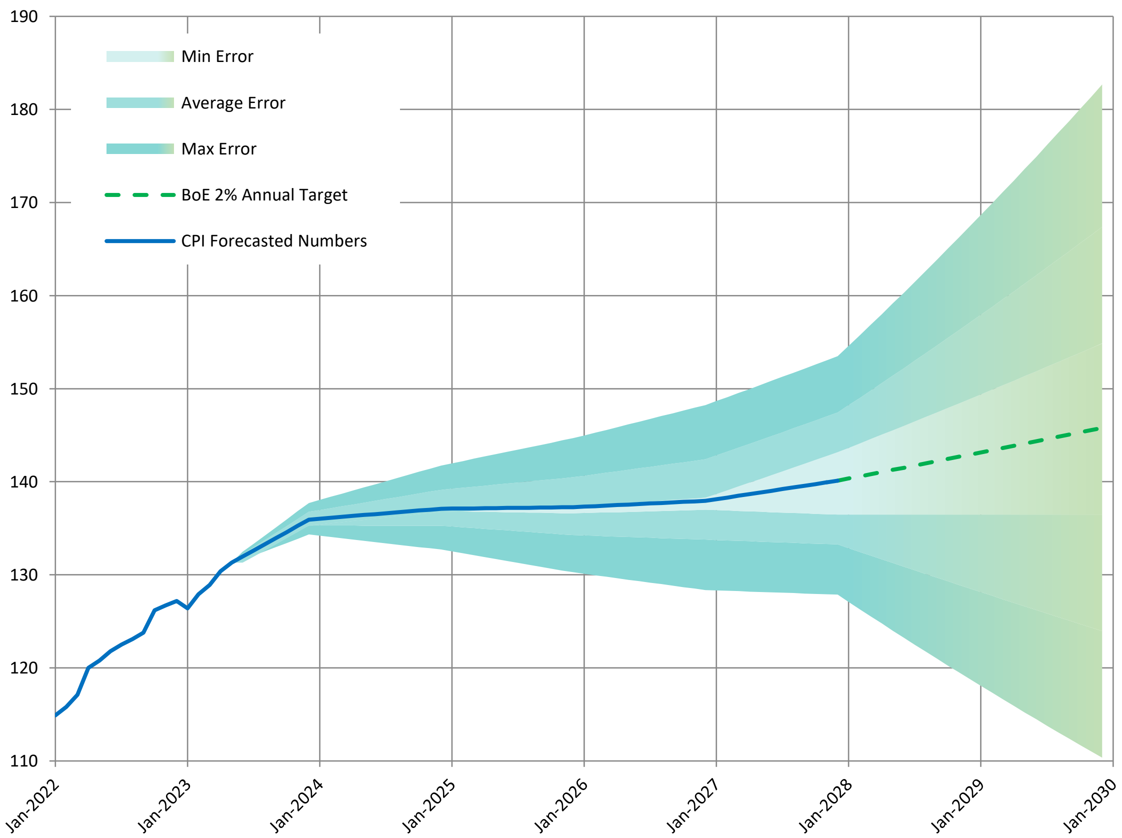
12.3. CPIH Forecast 2028 to 2030

The latest OBR forecast for the period 2022 to 2027 reports inflation dropping from 6.1% to 1.6%. Previous OBR forecasts have predicted a return to the BoE target of 2% inflation per year over the 5 year forecast period.

The CPIH forecast for 2027 to 2030 is not available from the OBR forecast for CPI. For the purposes of this report, inflation in this extended forecast period is assumed to be at the BoE target of 2% per year. The extrapolated forecast has a wider error band that includes the risk of inflation at the same rate as experienced in 2022 of 9.1%.

The chart below presents the CPIH with adjustments of the OBR forecast from June 2023 to December 2027 and BoE target inflation from January 2028 to December 2029.

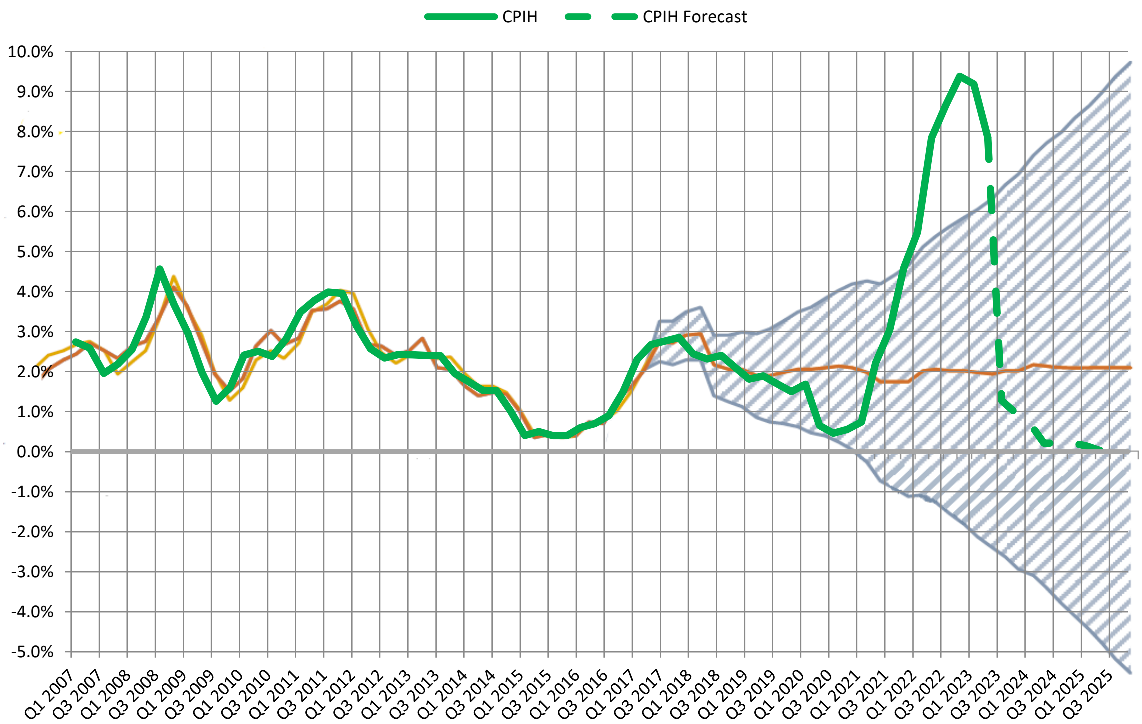
12.3.1. Chart: CPIH With OBR CPI Forecast and Errors (2015 = 100)



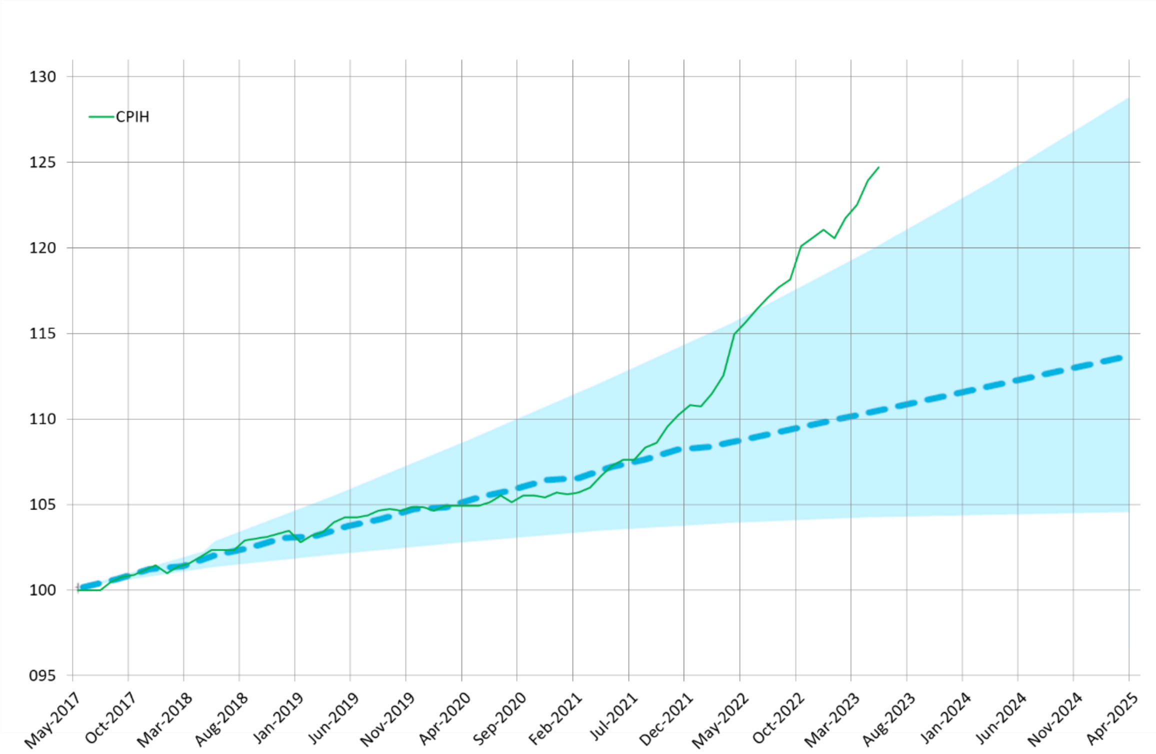
12.4. 2017 Forecast Comparisons

The inflation reports produced by AECOM and Mott MacDonald in 2017 for Wessex Water forecast the CPIH yearly percentage changes to 2025. The forecasts have been reproduced and compared to actual CPIH values.

12.4.1. Chart: Mott MacDonald CPIH % Annual Change Forecast 2017 to 2025



12.4.2. Chart: CPIH and 2017 AECOM CPIH Forecast (May 2017 = 100)



12.4.3. PR19 Forecast Performance

The 2017 inflation forecasts for the period 2017 to 2025 by Mott MacDonald and AECOM showed no anticipated volatility in CPIH.

CPIH trended outside the upper limits for both forecasts in 2022.

The performance of the 2017 forecasts was not able to predict or account for the causes of inflation due to unforeseen events such as the Covid 19 pandemic and the conflict in Ukraine.

13. Construction Cost Indices Forecasts

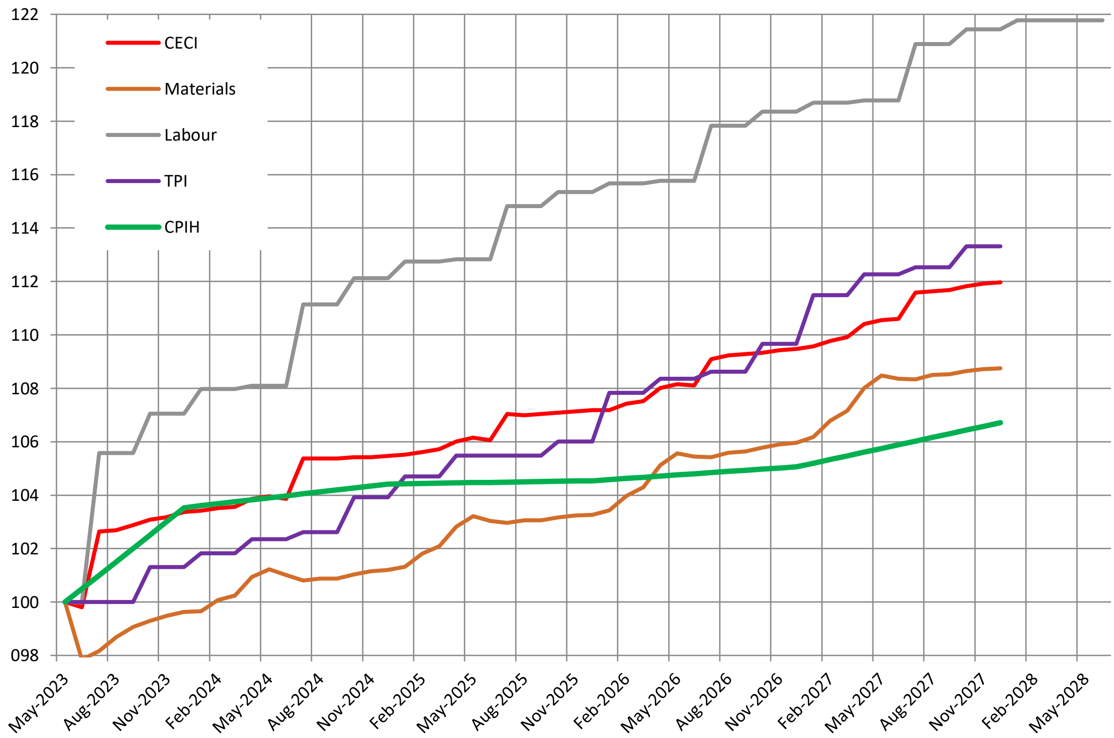
13.1. BCIS Forecasts

BCIS regularly update the forecasts for a select number of construction cost indices. A summary of the available forecasts is presented in the chart below for the following:

- Civil Engineering Cost Index
- Materials
- Labour
- Tender Price Index

The OBR CPI forecast for CPIH has also been included for comparison. It should be noted that these forecasts are from May 2023 and do not consider any delta in prices already in effect at this date.

13.1.1. Chart: BCIS Construction Indices Forecast (May 2023 = 100)



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13.1.2. Table: BCIS Construction Indices Forecast of Annual % Increases

	2022 to 2023	2023 to 2024	2024 to 2025	2025 to 2026	2026 to 2027	2022 To 2027
CPIH	7.7	3.5	0.5	0.3	1.0	13.6
CECI	4.3	3.2	1.8	1.9	2.2	14.3
TPI	5.0	2.6	2.7	3.0	3.5	17.9
Materials	3.6	2.2	2.0	2.4	2.7	13.5
Labour	6.5	6.7	3.7	2.6	2.6	24.1

13.2. Published Construction Forecast Summary

CPIH is forecast to increase 13.6% from 2022 to 2027. This is a similar forecast increase to the BCIS Civil Engineering Cost forecast and BCIS Materials forecast. TPI has a slightly higher increase of 17.9% predicted over the same period. Labour costs are expected to rise more sharply until 2024 and continue to diverge from the CPIH trend to 24.1% by 2027.

13.3. BCIS Forecasts 2020 to 2030

The key indices' forecasts have been analysed from a base date of 2020 and extrapolated using their long-term forecast trends. The charts below present the forecasts to December 2029 against the extrapolated CPIH forecast and the BoE 2% target trend.

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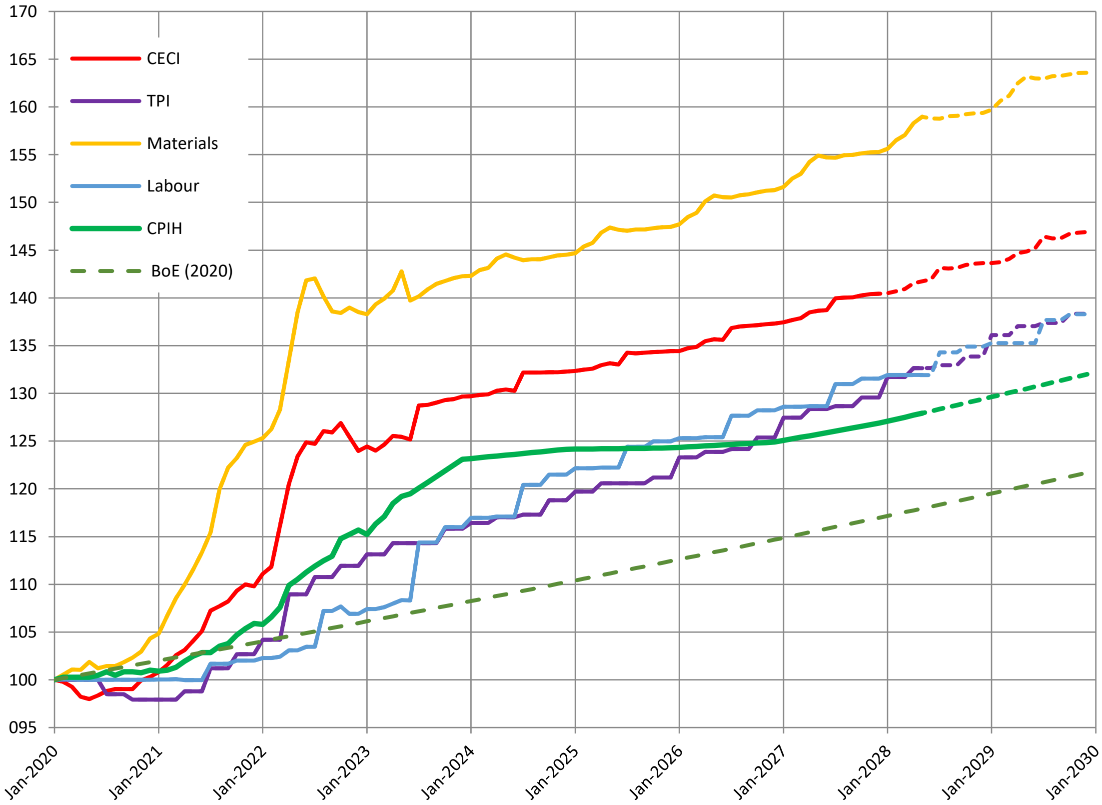
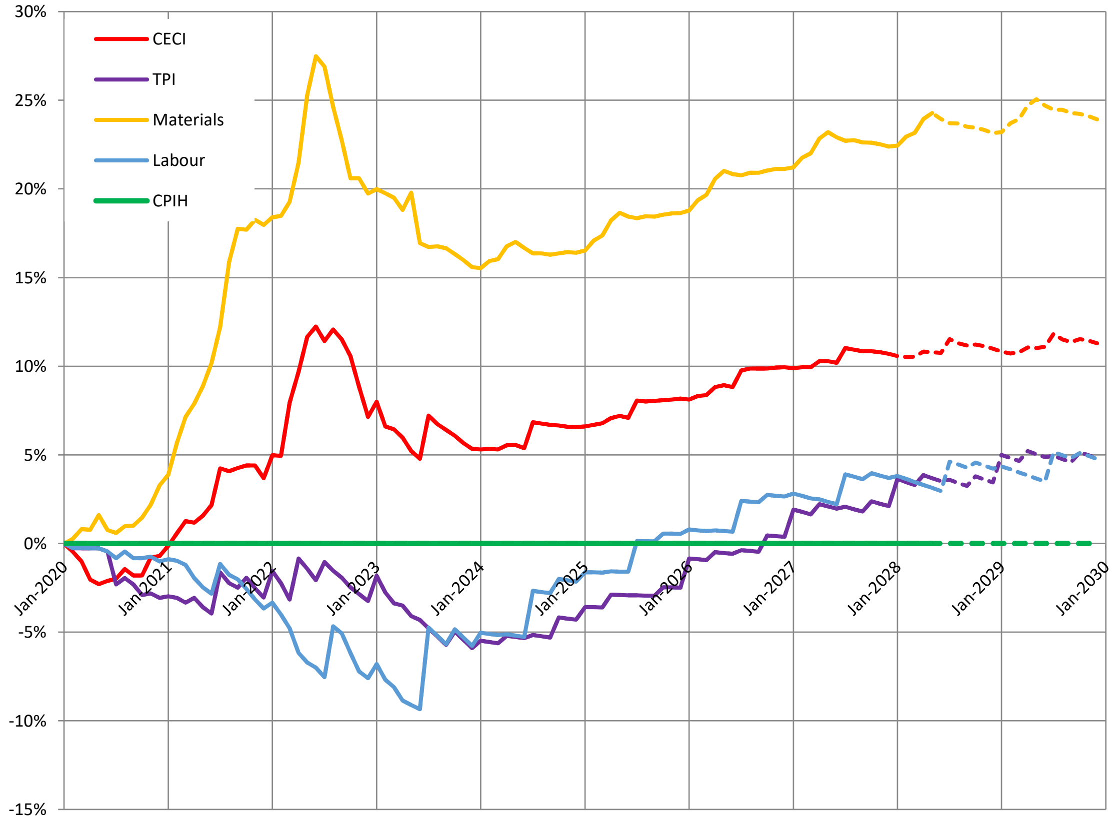
13.3.1. Chart: Key Forecasts January 2020 to December 2029 (January 2020 = 100)



13.3.2. Chart: Key Forecasts % Comparison to CPIH January 2020 to December 2029 (January 2020 = 100)



13.3.3. Forecast Analysis

The analysis of key index trends and forecasts demonstrates the industry's price volatilities compared to CPIH. BCIS Materials index presents a significant variance to the to CPIH trend from 2020.

The selected base date is critical in this analysis. As demonstrated in the long-term analysis from 2005 to 2025, the CECI rate increased by approximately 100% more than the CPIH rate. The forecast analysis presented to 2030 shows that CECI will increase by 50% more than CPIH.

CPIH is forecasted to increase by 13.6% from January 2022 to December 2027. This is a similar forecast increase to the CECI forecast and BCIS Materials forecast. TPI has a slightly higher increase of 17.9% predicted over the same period. Labour costs are expected to rise more sharply until 2024 and continue to diverge from the CPIH trend to 24.1% by December 2027.

The charts above demonstrate the increasing delta between CPIH and construction costs. The forecasts suggest that this gap will not close and will continue to widen.

The use of consumer indices for adjusting construction prices adds unnecessary risk to construction contracts that could be mitigated and managed more effectively by applying a more appropriate adjustment mechanism.

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14. Real Price Effect

The Real Price Effect (RPE) relates to input prices increasing or decreasing in real terms relative to CPIH.

14.1. Assessing RPE

ChandlerKBS recommends using the BCIS indices to assess the RPE for several reasons presented in this report and summarised below:

- The BCIS input indices are specifically construction items.
- A key input to the CECI is the WSCI which has price inputs selected by water sector experts.
- The BCIS indices are updated and published monthly.
- The BCIS indices forecasts are published monthly.

14.2. RPE Methodology

ChandlerKBS was requested to provide forecast RPE for the *PR24 business plan table SUP11 – real price effects and frontier shift* for the following categories.

- SUP11.1 CPIH: Financial year average indices year on year %
- SUP11.2 Real change in input price – Labour
- SUP11.5 Real change in input price – Materials, plant and equipment

The methodology for calculating RPE used appropriate construction indices with published forecasts to provide the input price inflation for comparison to CPIH. The Input Price Inflation series used for each RPE category are as follows

	SUP11 Category	Forecast Index
SUP11.1	CPIH: Financial year indices year on year %	OBR CPI Forecast to 2027 BoE target 2028 to 2030
SUP11.2	Real change in input price - Labour	BCIS Labour Index 1161
SUP11.5	Real change in input price – Materials, plant and equipment	BCIS Civil Engineering Cost Index 1191

The RPE percentage has been calculated using the following equation.

RPE (%) = (1 + Input Price Inflation (%)) / (1 + CPIH (%)) - 1

The table below presents the RPE adjustments forecast to 2030. The RPE adjustments are relative to the CPIH adjustment presented in the table. Therefore, the RPE adjustments can only be used in conjunction with the CPIH adjustments in the table.

14.2.1. Table: Year on Year to March RPE % Adjustments 2020 to 2030

	YT Mar 2020	YT Mar 2021	YT Mar 2022	YT Mar 2023	YT Mar 2024	YT Mar 2025	YT Mar 2026	YT Mar 2027	YT Mar 2028	YT Mar 2029	YT Mar 2030
SUP11.1 CPIH	1.50	1.01	6.20	8.84	5.36	0.67	0.21	0.77	1.68	2.00	2.00
Labour Cost Index	3.45	0.04	2.36	5.05	8.72	4.42	2.59	2.61	2.60	2.53	2.53
SUP11.3 Labour	1.92	-0.96	-3.62	-3.48	3.19	3.73	2.38	1.83	0.90	0.52	0.52
Civil Engineering Cost Index	0.43	3.33	13.20	7.34	4.23	2.08	1.71	2.23	2.23	2.23	2.28
SUP11.5 Materials, Plant & Equipment	-1.05	2.30	6.59	-1.38	-1.07	1.40	1.50	1.45	0.54	0.23	0.27

14.2.2. RPE Summary

The Labour RPE adjustments relative to the CPIH show negative adjustments for 2021, 2022 and 2023. The following years; 2024, 2025 and 2026, show positive RPE adjustments.

The Materials, Plant and Machinery RPE adjustments relative to the forecast CPIH show a negative adjustment for 2023 and 2024 following the positive RPE for 2021 and 2022.

The periods of consistently higher and lower RPE demonstrates that the forecast RPE adjustments can only be applied if the prices already include for previous volatilities and are representative of current market prices.

We recommend that the variance between the business plan forecast and actual price adjustment is reviewed to maintain an informed view of potential changes to trends throughout the business plan delivery period.

The monthly published indices will record short term and seasonal price volatilities. The annual adjustments will include the volatilities with a relatively smoothed-out trend. Therefore, we recommend that the RPE is reviewed on an annual basis to ensure it is providing a continuously robust result.

15. South West Region Tender Prices

This section of the report presents the analysis of tender prices in the South West region.

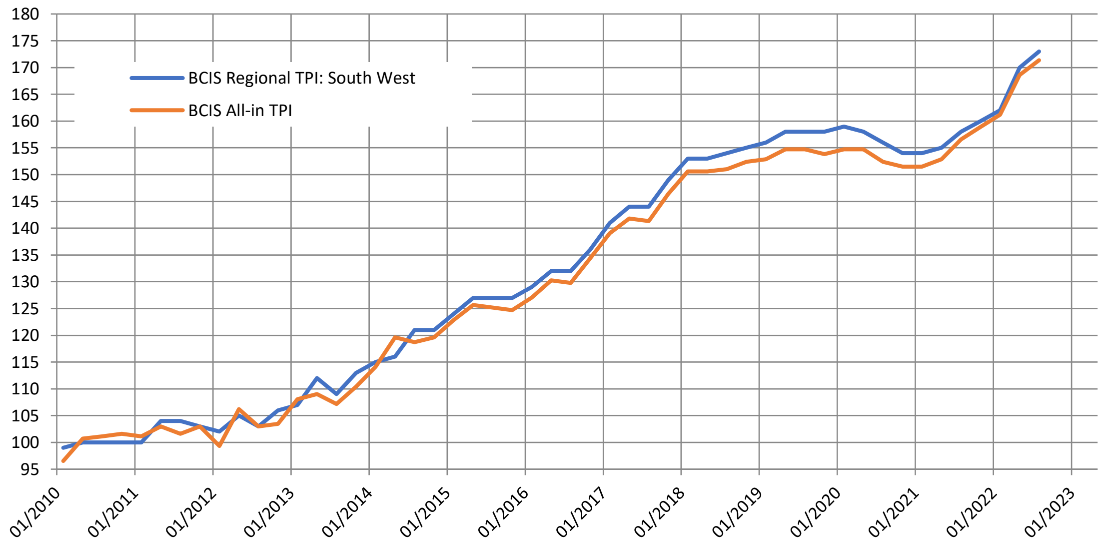
15.1. BCIS Regional Indices

BCIS publish the regional indices for the UK with regions and sub-region divisions. The index has a UK average of 100. In the latest publication, the South West region has an index of 102, meaning it experiences tender prices 2% above the UK average. The sub-regions are presented in the table below. The historic performance of the South West tender prices against the UK average is presented in the chart below.

15.1.1. Table: BCIS South West Regional Adjustments 2023

Location	Index	90% confidence interval	Standard deviation	Range	Sample
South West	102	101 - 102	12	71 - 228	881
Cornwall	103	101 - 105	17	78 - 228	133
Devon	100	99 - 101	11	73 - 140	211
Dorset	103	101 - 105	13	82 - 156	122
Gloucestershire	102	100 - 104	13	71 - 143	93
North Somerset	101	100 - 103	11	74 - 128	125
Somerset	99	98 - 101	10	76 - 129	85
Wiltshire	102	100 - 103	11	80 - 145	112

15.1.2. Chart: BCIS Regional TPI for South West and All In TPI Comparison



15.2. CITB Forecast

The CITB Construction Skills Network Forecast for the South West predicts a fall in infrastructure construction output of -3.1% over the period 2023 to 2027 compared to a regional average growth of 0.6% in the same period.

15.2.1. Table: CITB Growth Forecast 2023 to 2027

	2023	2024	2025	2026	2027	2023 to 2027 Annual Average
Infrastructure	-9.3%	-5.5%	-0.3%	0.1%	0.1%	-3.1%
Total Work	-2.0%	0.4%	1.4%	1.7%	1.8%	0.6%

Growth in the South West region is predicted to be driven by a number of very large scale and long term developments:

- Hinckley Point C continues to be the main project under construction and is providing a significant proportion of infrastructure work which is contributing to the high output value seen for the sector.
- Goram Homes project was given the green light by Bristol City Council in March 2021. It plans to deliver 1,435 new homes over the next 5 years.
- University of Bristol's new Temple Quarter Enterprise Campus worth £500m, commenced in May 2023.
- Panattoni, the largest logistics real estate developer in Europe, is planning a speculative logistics development worth £250m and will include the UK's largest ever speculative logistics building in Avonmouth, Bristol.
- Construction for the new £550m Galleries shopping centre is due to start Autumn 2024 and be completed by 2027.
- A30 development in Cornwall £330m upgrade is underway and expected to be open to traffic at the end of 2023.

15.3. Market Conditions

BCIS produce the Market Conditions Factor (MCF) using the difference between costs and tender prices. MCF is presented in the chart below, compared with the ONS index for New Orders and 6 periods of construction growth and decline.

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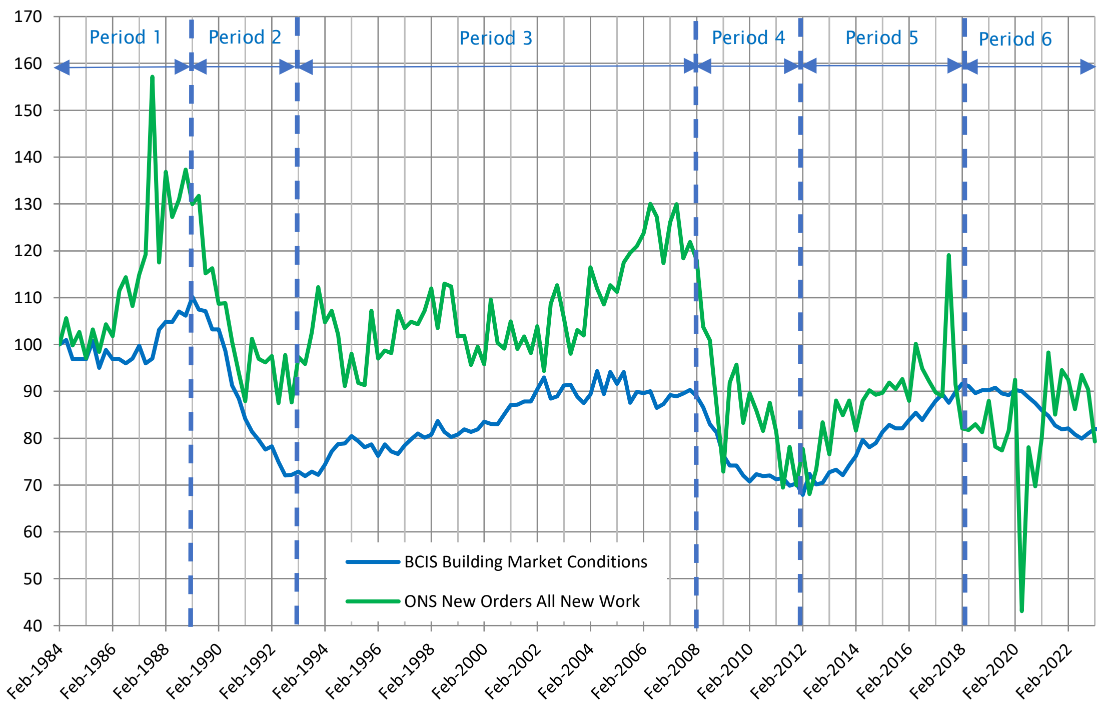
15.3.1. Chart: Market Conditions Factor and Construction New Orders 1984 to 2023



15.3.2. Table: Market Conditions Factors and Construction New Orders

Period	Dates	BCIS Market Conditions Factor Change	ONS New Orders All New Work Change
1	February 1984 – February 1989	10.2%	29.9%
2	February 1889 – May 1992	-32.0%	-32.7%
3	May 1992 – November 2007	20.5%	39.3%
4	November 2007 – May 2011	-20.8%	-43.0%
5	May 2011 – February 2018	28.2%	18.3%
6	February 2018 – July 2023	-10.6%	-3.5%

15.4. Summary

The trends of the MCF and New Orders indices indicate that construction output has been in decline since 2018. The CITB infrastructure output forecast of the South West region predicts a continued declining trend to 2027. Usually, this would indicate a negative impact to contractor’s margins. However, due the significance of other influences on today's market prices, the declining output forecast is not a robust signal that construction prices and margins are reducing.

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Appendix A

Cost Indices Used in this Report

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DATE	CPI	CPIH	RPI	COPI	New Orders - All New Work	CECI	TPI	Materials	Labour	Plant	FOCOS Combined	FOCOS Materials	Building Market Conditions	Construction Materials All Work	Gas	Electricity
Jan-05	77.3	78.5	189.7	80.0	136.8	95.4	221.0	193.5	291.2	238.4	148.0	145.0	0.9			
Feb-05	77.3	78.5	189.7	80.0	136.8	95.9	221.0	195.5	291.6	239.2	150.0	145.0	0.9			
Mar-05	77.3	78.5	189.7	80.0	136.8	97.2	221.0	195.9	291.9	243.7	150.0	145.0	0.9			
Apr-05	78.0	79.3	191.9	81.9	144.5	97.8	228.0	196.3	291.9	245.2	150.0	146.0	1.0			
May-05	78.0	79.3	191.9	81.9	144.5	97.4	228.0	197.0	292.0	243.0	150.0	146.0	1.0			
Jun-05	78.0	79.3	191.9	81.9	144.5	99.1	228.0	197.1	292.2	247.5	151.0	146.0	1.0			
Jul-05	78.4	79.7	192.6	83.5	147.1	102.4	221.0	197.2	309.6	262.0	151.0	143.0	0.9			
Aug-05	78.4	79.7	192.6	83.5	147.1	102.7	221.0	196.3	309.7	264.2	151.0	143.0	0.9			
Sep-05	78.4	79.7	192.6	83.5	147.1	103.3	221.0	195.7	310.0	266.9	154.0	143.0	0.9			
Oct-05	78.8	80.1	193.7	84.8	148.8	103.5	226.0	195.4	311.5	267.3	154.0	144.0	0.9			
Nov-05	78.8	80.1	193.7	84.8	148.8	102.6	226.0	195.8	311.4	263.1	154.0	144.0	0.9			
Dec-05	78.8	80.1	193.7	84.8	148.8	102.7	226.0	196.6	311.3	263.1	155.0	144.0	0.9			
Jan-06	78.7	80.2	194.2	86.1	152.2	103.8	228.0	197.3	313.0	263.9	155.0	148.0	0.9			
Feb-06	78.7	80.2	194.2	86.1	152.2	104.3	228.0	199.7	313.2	264.2	155.0	148.0	0.9			
Mar-06	78.7	80.2	194.2	86.1	152.2	104.6	228.0	201.4	313.6	265.8	157.0	148.0	0.9			
Apr-06	79.8	81.2	197.6	86.7	159.9	105.2	231.0	202.3	313.8	266.9	160.0	152.0	0.9			
May-06	79.8	81.2	197.6	86.7	159.9	106.1	231.0	204.6	313.9	267.3	160.0	152.0	0.9			
Jun-06	79.8	81.2	197.6	86.7	159.9	107.1	231.0	207.3	314.0	270.3	160.0	152.0	0.9			
Jul-06	80.3	81.7	199.3	87.3	156.6	109.4	228.0	208.4	321.5	276.4	166.0	160.0	0.9			
Aug-06	80.3	81.7	199.3	87.3	156.6	109.6	228.0	210.4	321.7	276.0	166.0	160.0	0.9			
Sep-06	80.3	81.7	199.3	87.3	156.6	109.3	228.0	211.0	321.7	273.8	166.0	160.0	0.9			
Oct-06	80.9	82.3	201.4	87.9	144.4	108.1	232.0	212.0	322.0	269.2	166.0	162.0	0.9			
Nov-06	80.9	82.3	201.4	87.9	144.4	107.9	232.0	212.8	322.9	268.0	166.0	162.0	0.9			
Dec-06	80.9	82.3	201.4	87.9	144.4	108.0	232.0	213.3	323.1	269.2	166.0	162.0	0.9			
Jan-07	81.0	82.4	203.0	88.9	155.1	108.5	239.0	212.5	324.8	266.5	168.0	166.0	0.9			
Feb-07	81.0	82.4	203.0	88.9	155.1	109.0	239.0	215.8	325.2	267.7	168.0	166.0	0.9			
Mar-07	81.0	82.4	203.0	88.9	155.1	109.2	239.0	217.2	325.6	269.6	168.0	166.0	0.9			
Apr-07	81.8	83.3	206.3	89.9	159.8	110.1	241.0	216.7	325.7	272.2	170.0	167.0	0.9			
May-07	81.8	83.3	206.3	89.9	159.8	109.9	241.0	219.0	325.8	272.6	170.0	167.0	0.9			
Jun-07	81.8	83.3	206.3	89.9	159.8	110.5	241.0	219.6	325.7	274.5	170.0	167.0	0.9			
Jul-07	81.7	83.3	207.1	91.8	145.6	112.3	248.0	220.0	335.4	281.0	170.0	167.0	0.9			

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Aug-07	81.7	83.3	207.1	91.8	145.6	112.5	248.0	221.3	335.5	281.7	172.0	167.0	0.9			
Sep-07	81.7	83.3	207.1	91.8	145.6	112.7	248.0	221.9	336.2	281.4	172.0	167.0	0.9			
Oct-07	82.6	84.1	209.8	92.6	149.9	113.7	251.0	221.6	336.4	287.8	172.0	166.0	0.9			
Nov-07	82.6	84.1	209.8	92.6	149.9	115.5	251.0	220.9	336.4	294.3	173.0	166.0	0.9			
Dec-07	82.6	84.1	209.8	92.6	149.9	115.4	251.0	220.6	336.5	293.9	173.0	166.0	0.9			
Jan-08	82.9	84.5	211.1	93.4	145.1	118.5	249.0	220.3	338.4	296.9	173.0	176.0	0.9			
Feb-08	82.9	84.5	211.1	93.4	145.1	119.7	249.0	223.7	338.7	300.0	180.0	176.0	0.9			
Mar-08	82.9	84.5	211.1	93.4	145.1	121.7	249.0	225.5	339.0	305.7	180.0	176.0	0.9			
Apr-08	84.6	86.1	215.3	94.1	127.6	123.8	247.0	227.3	338.8	310.6	180.0	187.0	0.9			
May-08	84.6	86.1	215.3	94.1	127.6	126.6	247.0	229.6	339.0	320.9	188.0	187.0	0.9			
Jun-08	84.6	86.1	215.3	94.1	127.6	128.7	247.0	231.6	339.0	324.3	188.0	187.0	0.9			
Jul-08	85.7	87.1	217.4	94.3	124.1	131.8	246.0	234.9	352.8	333.1	188.0	199.0	0.8			
Aug-08	85.7	87.1	217.4	94.3	124.1	129.5	246.0	236.7	352.8	324.3	188.0	199.0	0.8			
Sep-08	85.7	87.1	217.4	94.3	124.1	129.1	246.0	238.3	352.8	322.4	197.0	199.0	0.8			
Oct-08	85.8	87.2	215.5	94.3	106.9	126.2	240.0	239.6	354.3	311.8	197.0	195.0	0.8			
Nov-08	85.8	87.2	215.5	94.3	106.9	123.8	240.0	238.2	354.3	304.9	197.0	195.0	0.8			
Dec-08	85.8	87.2	215.5	94.3	106.9	121.3	240.0	235.5	354.3	297.3	192.0	195.0	0.8			
Jan-09	85.4	87.0	210.9	93.8	89.6	122.0	223.0	232.2	356.1	299.2	192.0	189.0	0.8			
Feb-09	85.4	87.0	210.9	93.8	89.6	121.1	223.0	232.1	356.0	295.8	192.0	189.0	0.8			
Mar-09	85.4	87.0	210.9	93.8	89.6	121.2	223.0	232.0	356.0	296.2	188.0	189.0	0.8			
Apr-09	86.4	87.8	212.6	92.7	113.0	121.7	216.0	230.7	355.8	298.8	188.0	186.0	0.8			
May-09	86.4	87.8	212.6	92.7	113.0	122.1	216.0	229.8	356.2	300.4	188.0	186.0	0.8			
Jun-09	86.4	87.8	212.6	92.7	113.0	123.6	216.0	229.3	356.3	304.5	187.0	186.0	0.8			
Jul-09	86.9	88.2	214.4	92.0	117.7	123.3	216.0	229.3	356.4	303.0	189.0	186.0	0.8			
Aug-09	86.9	88.2	214.4	92.0	117.7	123.9	216.0	230.9	356.4	306.8	189.0	186.0	0.8			
Sep-09	86.9	88.2	214.4	92.0	117.7	123.7	216.0	232.0	356.5	305.7	189.0	186.0	0.8			
Oct-09	87.6	88.6	216.9	90.8	102.4	125.9	212.0	232.9	356.9	309.5	193.0	193.0	0.7		25.2	
Nov-09	87.6	88.6	216.9	90.8	102.4	126.5	212.0	234.8	357.1	310.6	193.0	193.0	0.7		27.0	
Dec-09	87.6	88.6	216.9	90.8	102.4	126.2	212.0	234.5	357.3	309.9	193.0	193.0	0.7		31.4	
Jan-10	88.2	89.1	219.3	89.5	110.2	126.4	209.0	235.0	359.0	313.7	193.0	192.0	0.7		39.8	
Feb-10	88.2	89.1	219.3	89.5	110.2	126.1	209.0	235.4	359.3	312.2	193.0	192.0	0.7		35.8	
Mar-10	88.2	89.1	219.3	89.5	110.2	128.7	209.0	236.9	359.5	319.0	193.0	192.0	0.7		32.1	
Apr-10	89.3	90.0	223.5	89.0	105.7	130.8	218.0	241.2	359.8	321.7	200.0	203.0	0.7		32.8	
May-10	89.3	90.0	223.5	89.0	105.7	130.6	218.0	245.8	360.1	319.8	200.0	203.0	0.7		39.5	
Jun-10	89.3	90.0	223.5	89.0	105.7	131.1	218.0	248.1	360.3	319.8	200.0	203.0	0.7		42.2	42.2

Jul-10	89.6	90.3	224.5	88.3	100.3	130.3	219.0	249.4	360.5	317.5	201.0	204.0	0.7		45.9	43.5
Aug-10	89.6	90.3	224.5	88.3	100.3	130.1	219.0	249.8	360.8	316.7	201.0	204.0	0.7		42.6	40.0
Sep-10	89.6	90.3	224.5	88.3	100.3	130.5	219.0	250.4	360.9	318.6	201.0	204.0	0.7		40.8	41.1
Oct-10	90.5	91.1	227.0	88.5	107.7	131.3	220.0	250.0	362.0	322.4	201.0	204.0	0.7		46.0	43.5
Nov-10	90.5	91.1	227.0	88.5	107.7	131.5	220.0	250.3	362.0	322.8	201.0	204.0	0.7		49.7	46.4
Dec-10	90.5	91.1	227.0	88.5	107.7	132.6	220.0	250.3	362.0	327.0	201.0	204.0	0.7		62.3	58.0
Jan-11	91.8	92.2	230.9	89.0	100.1	135.0	219.0	251.6	362.6	330.8	201.0	211.0	0.7		56.0	48.4
Feb-11	91.8	92.2	230.9	89.0	100.1	136.2	219.0	254.2	362.5	334.2	206.0	211.0	0.7		53.7	46.5
Mar-11	91.8	92.2	230.9	89.0	100.1	138.9	219.0	255.8	362.4	342.9	206.0	211.0	0.7		60.4	51.4
Apr-11	93.3	93.4	234.9	89.9	85.4	140.1	223.0	257.4	362.4	345.2	206.0	218.0	0.7		57.2	50.9
May-11	93.3	93.4	234.9	89.9	85.4	139.0	223.0	259.4	363.3	339.5	211.0	218.0	0.7		57.0	50.3
Jun-11	93.3	93.4	234.9	89.9	85.4	139.5	223.0	260.6	363.4	341.0	211.0	218.0	0.7		58.3	50.8
Jul-11	93.8	93.9	236.2	90.2	96.1	140.6	220.0	260.6	366.2	344.9	211.0	221.0	0.7		55.1	48.0
Aug-11	93.8	93.9	236.2	90.2	96.1	140.1	220.0	261.2	366.5	342.2	213.0	221.0	0.7		54.1	47.4
Sep-11	93.8	93.9	236.2	90.2	96.1	141.3	220.0	260.8	370.0	347.1	213.0	221.0	0.7		53.6	48.3
Oct-11	94.7	94.7	238.6	91.0	86.0	141.9	223.0	260.4	370.1	349.4	213.0	220.0	0.7		56.1	46.8
Nov-11	94.7	94.7	238.6	91.0	86.0	142.5	223.0	259.8	370.1	351.3	213.0	220.0	0.7		58.2	46.2
Dec-11	94.7	94.7	238.6	91.0	86.0	141.3	223.0	259.4	370.1	347.5	214.0	220.0	0.7		56.0	43.5
Jan-12	95.1	95.1	239.6	92.2	95.6	143.4	215.0	258.3	371.2	350.6	214.0	226.0	0.7		54.4	42.2
Feb-12	95.1	95.1	239.6	92.2	95.6	144.5	215.0	260.1	371.1	352.1	214.0	226.0	0.7		65.4	49.1
Mar-12	95.1	95.1	239.6	92.2	95.6	145.6	215.0	261.6	371.1	355.5	218.0	226.0	0.7		58.4	45.6
Apr-12	95.8	95.8	242.2	92.7	83.7	145.1	230.0	262.4	370.4	352.8	218.0	227.0	0.7		59.9	45.9
May-12	95.8	95.8	242.2	92.7	83.7	143.0	230.0	262.7	369.5	346.4	218.0	227.0	0.7		57.0	43.8
Jun-12	95.8	95.8	242.2	92.7	83.7	141.4	230.0	261.5	370.8	341.4	217.0	227.0	0.7		55.2	42.2
Jul-12	96.1	96.1	243.1	93.4	90.2	142.5	223.0	260.9	371.5	346.4	217.0	224.0	0.7		55.6	42.7
Aug-12	96.1	96.1	243.1	93.4	90.2	144.1	223.0	260.2	371.5	352.1	217.0	224.0	0.7		54.5	41.2
Sep-12	96.1	96.1	243.1	93.4	90.2	144.5	223.0	260.3	371.7	352.8	216.0	224.0	0.7		60.5	43.4
Oct-12	97.3	97.0	246.0	93.8	102.6	144.6	224.0	260.0	371.8	353.2	216.0	223.0	0.7		64.4	47.6
Nov-12	97.3	97.0	246.0	93.8	102.6	144.0	224.0	259.7	375.3	351.7	216.0	223.0	0.7		65.6	49.0
Dec-12	97.3	97.0	246.0	93.8	102.6	142.9	224.0	259.1	375.3	348.7	216.0	223.0	0.7		65.5	49.8
Jan-13	97.7	97.4	247.4	94.9	94.2	144.9	234.0	259.4	380.9	353.2	219.0	225.0	0.7		66.8	50.0
Feb-13	97.7	97.4	247.4	94.9	94.2	146.6	234.0	260.5	381.1	359.7	219.0	225.0	0.7		68.9	51.4
Mar-13	97.7	97.4	247.4	94.9	94.2	145.8	234.0	261.0	381.1	357.4	219.0	225.0	0.7		86.6	62.9
Apr-13	98.4	98.1	249.7	95.8	108.3	144.0	236.0	261.8	381.3	352.1	217.0	224.0	0.7		70.0	51.3
May-13	98.4	98.1	249.7	95.8	108.3	144.0	236.0	261.9	381.3	351.7	217.0	224.0	0.7		66.1	48.9

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Jun-13	98.4	98.1	249.7	95.8	108.3	143.9	236.0	261.6	380.1	350.9	217.0	224.0	0.7		60.5	47.3
Jul-13	98.7	98.4	250.9	96.8	104.4	145.5	232.0	260.8	380.2	355.1	219.0	226.0	0.7		65.2	48.7
Aug-13	98.7	98.4	250.9	96.8	104.4	145.6	232.0	260.4	380.2	355.5	219.0	226.0	0.7		64.7	47.3
Sep-13	98.7	98.4	250.9	96.8	104.4	145.7	232.0	260.1	380.4	354.7	219.0	226.0	0.7		65.7	49.6
Oct-13	99.3	98.9	252.5	98.4	108.3	144.8	239.0	260.5	380.8	351.7	218.0	225.0	0.8		65.1	48.2
Nov-13	99.3	98.9	252.5	98.4	108.3	144.9	239.0	260.7	380.9	350.2	218.0	225.0	0.8		68.3	53.1
Dec-13	99.3	98.9	252.5	98.4	108.3	144.8	239.0	260.9	381.0	350.9	218.0	225.0	0.8		69.4	50.8
Jan-14	99.0	98.7	252.6	100.1	100.4	145.8	247.0	261.2	383.4	349.8	218.0	228.0	0.8		65.1	47.7
Feb-14	99.5	99.1	254.2	99.1	100.4	145.8	247.0	262.5	383.5	350.2	220.0	228.0	0.8		58.9	45.2
Mar-14	99.7	99.3	254.8	98.6	100.4	145.6	247.0	263.4	383.7	348.7	220.0	228.0	0.8		56.5	44.4
Apr-14	100.1	99.6	255.7	98.2	108.2	145.5	259.0	263.1	383.7	348.3	220.0	228.0	0.8		49.9	41.8
May-14	100.0	99.6	255.9	98.1	108.2	145.2	259.0	263.4	383.8	346.8	219.0	228.0	0.8		45.3	39.6
Jun-14	100.2	99.8	256.3	98.8	108.2	145.6	259.0	263.6	384.0	346.8	219.0	228.0	0.8		39.5	36.7
Jul-14	99.9	99.6	256.0	99.2	111.0	146.7	257.0	263.6	390.6	349.0	219.0	226.0	0.8		37.5	35.5
Aug-14	100.2	99.9	257.0	98.5	111.0	146.4	257.0	263.6	390.7	349.0	220.0	226.0	0.8		40.6	38.0
Sep-14	100.3	100.0	257.6	98.9	111.0	146.4	257.0	263.8	390.7	347.9	220.0	226.0	0.8		48.4	43.3
Oct-14	100.4	100.1	257.7	99.0	109.8	146.1	259.0	263.5	391.6	343.7	220.0	225.0	0.8		50.4	44.8
Nov-14	100.1	99.9	257.1	99.1	109.8	145.9	259.0	263.6	391.5	341.4	218.0	225.0	0.8		54.8	48.4
Dec-14	100.1	99.9	257.5	98.8	109.8	144.7	259.0	263.2	391.6	331.2	218.0	225.0	0.8		53.6	44.0
Jan-15	99.3	99.2	255.4	98.9	110.3	143.9	266.0	262.2	392.6	323.9	218.0	221.0	0.8	101.2	46.1	39.9
Feb-15	99.5	99.5	256.7	99.4	110.3	144.4	266.0	262.2	392.8	328.5	218.0	221.0	0.8	101.0	50.5	42.9
Mar-15	99.7	99.6	257.1	100.8	110.3	144.7	266.0	261.6	392.9	329.3	214.0	221.0	0.8	101.3	47.2	40.9
Apr-15	99.9	99.9	258.0	99.6	113.0	145.3	272.0	261.6	395.6	331.9	214.0	220.0	0.8	100.7	46.9	44.0
May-15	100.1	100.1	258.5	99.6	113.0	145.2	272.0	261.6	395.7	333.4	214.0	220.0	0.8	100.9	44.1	41.2
Jun-15	100.2	100.1	258.9	100.0	113.0	145.0	272.0	260.6	396.0	331.5	215.0	220.0	0.8	100.6	43.4	41.7
Jul-15	100.0	100.0	258.6	100.6	111.3	146.4	271.0	259.4	403.8	331.5	215.0	218.0	0.8	100.6	43.5	42.2
Aug-15	100.3	100.3	259.8	99.9	111.3	145.8	271.0	258.3	404.0	326.6	215.0	218.0	0.8	99.8	39.7	40.9
Sep-15	100.2	100.2	259.6	99.9	111.3	145.7	271.0	257.4	404.2	327.7	214.0	218.0	0.8	99.1	41.0	42.0
Oct-15	100.3	100.3	259.5	100.4	113.9	145.6	270.0	256.9	405.0	327.7	214.0	214.0	0.8	98.7	39.6	40.3
Nov-15	100.3	100.3	259.8	100.9	113.9	145.3	270.0	256.0	404.9	326.2	214.0	214.0	0.8	98.3	35.9	38.0
Dec-15	100.3	100.4	260.6	100.0	113.9	144.4	270.0	255.0	404.8	320.5	212.0	214.0	0.8	98.1	34.0	35.1
Jan-16	99.5	99.9	258.8	101.4	108.2	144.5	275.0	254.5	406.0	316.7	210.0	212.0	0.9	97.4	32.1	37.0
Feb-16	99.8	100.1	260.0	101.6	108.2	144.6	275.0	255.7	406.1	318.2	210.0	212.0	0.9	97.7	29.7	33.9
Mar-16	100.2	100.4	261.1	102.1	108.2	145.1	275.0	255.5	406.2	322.4	210.0	212.0	0.9	98.1	29.6	34.8
Apr-16	100.2	100.6	261.4	102.3	123.2	145.4	282.0	256.4	406.6	323.6	214.0	216.0	0.9	98.3	29.4	34.4

May-16	100.4	100.8	262.1	102.1	123.2	146.2	282.0	258.2	406.7	327.0	214.0	216.0	0.9	99.2	30.4	34.6
Jun-16	100.6	101.0	263.1	102.3	123.2	146.7	282.0	260.2	406.7	329.6	214.0	216.0	0.9	99.5	34.2	37.5
Jul-16	100.6	100.9	263.4	102.7	116.7	147.3	281.0	260.4	406.7	330.8	216.0	218.0	0.9	99.6	34.3	38.4
Aug-16	100.9	101.2	264.4	102.7	116.7	149.0	281.0	261.7	414.2	336.1	216.0	218.0	0.9	99.8	30.4	36.5
Sep-16	101.1	101.5	264.9	103.0	116.7	149.1	281.0	262.5	414.3	337.2	216.0	218.0	0.9	100.2	28.4	51.1
Oct-16	101.2	101.6	264.8	103.5	113.4	149.7	291.0	262.6	415.8	344.9	219.0	220.0	0.9	100.2	42.8	56.0
Nov-16	101.4	101.8	265.5	104.1	113.4	150.0	291.0	264.1	415.8	341.0	219.0	220.0	0.9	101.1	48.1	67.5
Dec-16	101.9	102.2	267.1	103.6	113.4	150.3	291.0	264.9	415.8	345.6	219.0	220.0	0.9	101.5	46.5	49.9
Jan-17	101.4	101.8	265.5	104.2	110.4	151.2	301.0	267.2	417.6	347.9	222.0	225.0	0.9	102.6	53.4	53.4
Feb-17	102.1	102.4	268.4	104.3	110.4	151.0	301.0	269.7	417.6	347.5	222.0	225.0	0.9	103.3	51.0	49.5
Mar-17	102.5	102.7	269.3	104.3	110.4	150.9	301.0	270.6	417.6	346.0	222.0	225.0	0.9	103.6	41.0	42.0
Apr-17	102.9	103.2	270.6	104.2	109.5	150.9	307.0	271.3	417.6	345.6	222.0	224.0	0.9	103.9	39.7	42.1
May-17	103.3	103.5	271.7	104.6	109.5	150.7	307.0	272.0	417.6	341.8	222.0	224.0	0.9	104.0	39.3	41.2
Jun-17	103.3	103.5	272.3	105.1	109.5	151.2	307.0	272.2	417.6	340.3	222.0	224.0	0.9	103.9	34.8	39.7
Jul-17	103.2	103.5	272.9	105.8	146.5	153.3	306.0	272.7	425.8	347.1	222.0	226.0	0.9	104.1	36.2	43.1
Aug-17	103.8	104.0	274.7	105.9	146.5	153.6	306.0	273.6	425.8	350.6	225.0	226.0	0.9	104.4	42.6	43.3
Sep-17	104.1	104.3	275.1	106.6	146.5	154.4	306.0	275.3	425.8	353.2	225.0	226.0	0.9	105.1	46.0	47.2
Oct-17	104.2	104.4	275.3	106.5	112.5	154.7	317.0	276.8	427.5	354.4	225.0	230.0	0.9	106.0	45.4	46.7
Nov-17	104.6	104.7	275.8	106.8	112.5	155.5	317.0	278.2	427.5	357.0	228.0	230.0	0.9	106.3	53.0	51.5
Dec-17	104.9	105.0	278.1	107.2	112.5	155.6	317.0	279.4	427.5	357.0	228.0	230.0	0.9	107.0	58.3	56.2
Jan-18	104.4	104.5	276.0	107.8	101.0	156.0	326.0	280.1	429.1	359.3	228.0	232.0	0.9	107.1	50.4	50.8
Feb-18	104.9	104.9	278.1	107.5	101.0	155.8	326.0	283.3	429.1	355.9	229.0	232.0	0.9	108.0	59.0	53.7
Mar-18	105.0	105.1	278.3	108.4	101.0	156.3	326.0	283.4	429.1	357.0	229.0	232.0	0.9	108.5	64.3	56.8
Apr-18	105.4	105.5	279.7	108.8	100.6	156.7	326.0	283.8	428.5	360.1	229.0	236.0	0.9	108.7	50.9	50.7
May-18	105.8	105.9	280.7	109.1	100.6	157.4	326.0	285.3	428.5	366.9	229.0	236.0	0.9	109.3	55.6	54.3
Jun-18	105.8	105.9	281.5	109.4	100.6	158.0	326.0	286.4	428.5	367.7	232.0	236.0	0.9	109.7	55.0	54.0
Jul-18	105.8	105.9	281.7	109.4	102.1	160.0	327.0	287.3	439.2	374.9	232.0	237.0	0.9	110.1	57.9	57.6
Aug-18	106.5	106.5	284.2	109.2	102.1	160.3	327.0	287.4	439.2	376.4	232.0	237.0	0.9	110.4	62.8	61.9
Sep-18	106.6	106.6	284.1	109.4	102.1	160.5	327.0	288.6	439.2	378.3	235.0	237.0	0.9	111.0	73.7	67.7
Oct-18	106.7	106.7	284.5	109.5	100.0	161.0	330.0	287.8	441.0	382.9	235.0	239.0	0.9	111.0	66.5	64.8
Nov-18	107.0	106.9	284.6	110.7	100.0	160.9	330.0	288.4	441.0	377.5	235.0	239.0	0.9	111.1	64.4	62.2
Dec-18	107.1	107.1	285.6	110.7	100.0	160.3	330.0	289.2	441.0	369.6	236.0	239.0	0.9	111.2	63.7	64.3
Jan-19	106.3	106.4	283.0	111.0	108.2	160.6	331.0	288.4	443.0	368.0	236.0	241.0	0.9	111.8	57.7	62.6
Feb-19	106.8	106.8	285.0	111.5	108.2	161.3	331.0	289.7	443.0	371.5	236.0	241.0	0.9	112.6	47.1	50.3
Mar-19	107.0	107.0	285.1	111.8	108.2	161.3	331.0	292.1	443.0	371.8	237.0	241.0	0.9	113.1	39.3	45.0

Apr-19	107.6	107.6	288.2	112.6	96.2	162.2	335.0	292.1	445.3	375.6	238.0	242.0	0.9	112.9	35.0	43.9
May-19	107.9	107.9	289.2	113.3	96.2	162.7	335.0	291.4	445.3	376.8	238.0	242.0	0.9	112.9	31.4	41.4
Jun-19	107.9	107.9	289.6	113.9	96.2	162.4	335.0	292.5	445.3	372.2	238.0	242.0	0.9	112.3	28.0	39.4
Jul-19	107.9	108.0	289.5	114.3	95.2	164.7	335.0	292.3	454.2	381.0	240.0	241.0	0.9	112.7	29.6	41.9
Aug-19	108.4	108.3	291.7	114.0	95.2	164.5	335.0	291.9	454.3	381.7	240.0	241.0	0.9	112.2	27.8	39.6
Sep-19	108.5	108.4	291.0	113.8	95.2	164.5	335.0	291.3	454.3	382.9	240.0	241.0	0.9	112.3	24.9	37.3
Oct-19	108.3	108.3	290.4	113.3	100.4	163.9	333.0	291.6	456.4	380.6	237.0	236.0	0.9	111.9	25.7	37.7
Nov-19	108.5	108.5	291.0	113.4	100.4	163.1	333.0	289.1	456.4	379.1	237.0	236.0	0.9	110.8	38.0	46.0
Dec-19	108.5	108.5	291.9	112.8	100.4	162.5	333.0	287.2	456.4	380.6	237.0	236.0	0.9	110.1	32.1	39.9
Jan-20	108.2	108.3	290.6	113.3	113.8	163.2	335.0	285.8	458.2	379.8	237.0	238.0	0.9	110.7	27.9	35.9
Feb-20	108.6	108.6	292.0	113.2	113.8	162.9	335.0	287.3	458.3	373.4	237.0	238.0	0.9	111.0	23.5	32.0
Mar-20	108.6	108.6	292.6	113.3	113.8	162.0	335.0	288.9	458.3	357.4	237.0	238.0	0.9	111.2	22.9	33.2
Apr-20	108.5	108.6	292.6	113.4	53.0	160.3	335.0	288.8	458.2	351.3	235.0	237.0	0.9	113.5	13.8	24.0
May-20	108.5	108.6	292.2	113.5	53.0	159.9	335.0	291.2	458.2	350.9	235.0	237.0	0.9	113.9	11.6	24.1
Jun-20	108.6	108.8	292.7	113.7	53.0	160.5	335.0	289.3	458.2	357.8	235.0	237.0	0.9	111.8	13.2	28.4
Jul-20	109.1	109.2	294.2	114.0	96.0	161.3	330.0	289.9	458.2	362.0	235.0	237.0	0.9	111.6	13.2	31.3
Aug-20	108.6	108.8	293.3	113.9	96.0	161.6	330.0	289.9	458.2	361.6	235.0	237.0	0.9	111.6	20.2	37.9
Sep-20	109.1	109.2	294.3	114.2	96.0	161.6	330.0	291.1	458.2	357.8	235.0	237.0	0.9	111.6	29.9	45.3
Oct-20	109.1	109.2	294.3	114.3	85.8	161.6	328.0	292.4	458.2	357.8	235.0	240.0	0.9	111.9	38.2	44.7
Nov-20	108.9	109.1	293.5	114.9	85.8	163.1	328.0	294.2	458.2	358.5	237.0	240.0	0.9	113.5	37.6	46.8
Dec-20	109.2	109.4	295.4	115.1	85.8	163.7	328.0	298.2	458.2	364.2	237.0	240.0	0.9	115.1	45.7	59.6
Jan-21	109.0	109.3	294.6	115.6	98.3	164.5	328.0	299.6	458.3	366.5	237.0	251.0	0.9	116.5	59.0	90.9
Feb-21	109.1	109.4	296.0	115.8	98.3	165.8	328.0	305.1	458.3	370.7	244.0	251.0	0.9	118.7	45.9	56.5
Mar-21	109.4	109.7	296.9	115.9	98.3	167.4	328.0	310.2	458.5	374.1	244.0	251.0	0.9	120.3	45.0	56.5
Apr-21	110.1	110.4	301.1	116.5	120.9	168.3	331.0	314.3	458.0	373.0	244.0	264.0	0.9	122.4	54.8	69.4
May-21	110.8	111.0	301.9	117.6	120.9	169.9	331.0	318.9	458.0	377.2	252.0	264.0	0.9	124.8	65.2	76.4
Jun-21	111.3	111.4	304.0	118.2	120.9	171.5	331.0	323.9	458.0	381.0	252.0	264.0	0.9	127.2	72.0	79.8
Jul-21	111.3	111.4	305.5	119.0	104.6	175.0	339.0	329.9	465.9	387.8	252.0	278.0	0.8	130.4	90.9	94.7
Aug-21	112.1	112.1	307.4	120.0	104.6	175.8	339.0	342.8	465.9	387.8	252.0	278.0	0.8	135.4	110.0	108.3
Sep-21	112.4	112.4	308.6	120.1	104.6	176.6	339.0	349.3	465.9	394.7	262.0	278.0	0.8	137.3	162.1	227.3
Oct-21	113.6	113.4	312.0	121.7	116.3	178.4	344.0	352.2	467.5	408.0	262.0	287.0	0.8	138.4	213.8	192.0
Nov-21	114.5	114.1	314.3	122.1	116.3	179.5	344.0	356.1	467.5	409.1	262.0	287.0	0.8	140.3	201.1	209.6
Dec-21	115.1	114.7	317.7	121.7	116.3	179.2	344.0	357.1	467.5	404.5	269.0	287.0	0.8	141.0	271.0	241.8
Jan-22	114.9	114.6	317.7	124.5	113.8	181.3	349.0	358.1	468.7	412.1	269.0	303.0	0.8	141.3	203.8	206.9
Feb-22	115.8	115.4	320.2	124.4	113.8	182.5	349.0	360.8	468.7	417.9	269.0	303.0	0.8	141.6	187.7	166.9

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Mar-22	117.1	116.5	323.5	125.3	113.8	189.5	349.0	366.7	469.3	454.0	281.0	303.0	0.8	144.6	313.6	263.8
Apr-22	120.0	119.0	334.6	128.0	106.0	196.7	365.0	381.5	472.4	508.0	281.0	349.0	0.8	151.3	186.1	180.6
May-22	120.8	119.7	337.1	131.8	106.0	201.4	365.0	395.8	472.4	518.2	281.0	349.0	0.8	157.8	105.3	116.4
Jun-22	121.8	120.5	340.0	132.5	106.0	203.9	365.0	405.4	474.1	538.8	313.0	349.0	0.8	161.3	149.5	173.1
Jul-22	122.5	121.2	343.2	133.0	115.0	203.6	371.0	405.9	474.1	532.3	319.0	352.0	0.8	162.7	247.7	261.9
Aug-22	123.1	121.8	345.2	132.1	115.0	205.8	371.0	400.6	491.2	538.8	319.0	352.0	0.8	159.9	356.0	363.7
Sep-22	123.8	122.3	347.6	133.6	115.0	205.6	371.0	396.1	491.2	532.3	319.0	352.0	0.8	158.0	263.4	270.7
Oct-22	126.2	124.3	356.2	135.1	111.2	207.2	375.0	395.6	493.4	544.5	314.0	344.0	0.8	157.2	109.3	110.1
Nov-22	126.7	124.8	358.3	135.5	111.2	204.8	375.0	397.2	489.9	526.2	314.0	344.0	0.8	156.9	138.4	133.1
Dec-22	127.2	125.3	360.4	134.8	111.2	202.5	375.0	395.9	489.9	510.2	314.0	344.0	0.8	156.3	277.1	284.6
Jan-23	126.4	124.8	360.3	137.4	97.5	203.3	379.0	395.2	492.1	512.9	310.0	341.0	0.8	155.4	152.5	132.4
Feb-23	127.9	126.0	364.5	137.7	97.5	202.5	379.0	398.2	492.1	505.3	310.0	341.0	0.8	156.1	134.5	135.6
Mar-23	128.9	126.8	367.2	138.6	97.5	203.4	379.0	399.7	493.0	498.8	310.0	341.0	0.8	157.2	108.0	108.8
Apr-23	130.4	128.3	372.8			204.9	383.0	402.3	494.7	500.0			0.8	158.4	101.5	106.4
May-23	131.3	129.1	375.3			204.7	383.0	408.1	496.4	494.7			0.8	160.1	73.5	82.3

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Appendix B

Cost Index Forecasts Used in this Report

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Index Date	CPI	CPIH	TPI	Materials	Labour	CECI
01/05/2023	131.3	129.1	383	408.1	496.4	204.7
01/06/2023	132.0	132.0	383	399.3	496.3	204.3
01/07/2023	132.6	132.6	383	400.6	524.1	210.1
01/08/2023	133.3	133.3	383	402.7	524.1	210.2
01/09/2023	133.9	133.9	383	404.3	524.1	210.6
01/10/2023	134.6	134.6	388	405.2	531.4	211
01/11/2023	135.3	135.3	388	406	531.4	211.2
01/12/2023	135.9	135.9	388	406.6	531.4	211.6
01/01/2024	136.0	136.0	390	406.7	536	211.7
01/02/2024	136.1	136.1	390	408.4	536	211.9
01/03/2024	136.2	136.2	390	409.1	536	212
01/04/2024	136.3	136.3	392	411.9	536.6	212.6
01/05/2024	136.4	136.4	392	413.1	536.6	212.8
01/06/2024	136.5	136.5	392	412.2	536.6	212.6
01/07/2024	136.6	136.6	393	411.4	551.7	215.7
01/08/2024	136.7	136.7	393	411.7	551.7	215.7
01/09/2024	136.8	136.8	393	411.7	551.7	215.7
01/10/2024	136.9	136.9	398	412.3	556.6	215.8
01/11/2024	137.0	137.0	398	412.8	556.6	215.8
01/12/2024	137.1	137.1	398	413	556.6	215.9
01/01/2025	137.1	137.1	401	413.5	559.7	216
01/02/2025	137.1	137.1	401	415.5	559.7	216.2
01/03/2025	137.1	137.1	401	416.6	559.7	216.4
01/04/2025	137.2	137.2	404	419.6	560.1	217
01/05/2025	137.2	137.2	404	421.2	560.1	217.3
01/06/2025	137.2	137.2	404	420.5	560.1	217.1
01/07/2025	137.2	137.2	404	420.2	570	219.1
01/08/2025	137.2	137.2	404	420.6	570	219
01/09/2025	137.2	137.2	404	420.6	570	219.1
01/10/2025	137.2	137.2	406	421	572.6	219.2
01/11/2025	137.2	137.2	406	421.3	572.6	219.3
01/12/2025	137.3	137.3	406	421.4	572.6	219.4
01/01/2026	137.3	137.3	413	422.1	574.2	219.4
01/02/2026	137.4	137.4	413	424.3	574.2	219.9
01/03/2026	137.4	137.4	413	425.6	574.2	220.1
01/04/2026	137.5	137.5	415	429	574.7	221.1
01/05/2026	137.5	137.5	415	430.8	574.7	221.4
01/06/2026	137.6	137.6	415	430.3	574.7	221.3
01/07/2026	137.7	137.7	416	430.2	584.9	223.3

01/08/2026	137.7	137.7	416	430.9	584.9	223.6
01/09/2026	137.8	137.8	416	431.1	584.9	223.7
01/10/2026	137.8	137.8	420	431.7	587.5	223.8
01/11/2026	137.9	137.9	420	432.2	587.5	224
01/12/2026	137.9	137.9	420	432.4	587.5	224.1
01/01/2027	138.1	138.1	427	433.3	589.2	224.3
01/02/2027	138.3	138.3	427	435.8	589.2	224.7
01/03/2027	138.5	138.5	427	437.3	589.2	225
01/04/2027	138.7	138.7	430	440.8	589.6	226
01/05/2027	138.8	138.8	430	442.7	589.6	226.3
01/06/2027	139.0	139.0	430	442.2	589.6	226.4
01/07/2027	139.2	139.2	431	442.1	600.1	228.4
01/08/2027	139.4	139.4	431	442.8	600.1	228.5
01/09/2027	139.6	139.6	431	442.9	600.1	228.6
01/10/2027	139.8	139.8	434	443.4	602.8	228.9
01/11/2027	139.9	139.9	434	443.7	602.8	229.1
01/12/2027	140.1	140.1	434	443.8	602.8	229.2
01/01/2028					604.5	
01/02/2028					604.5	
01/03/2028					604.5	
01/04/2028					604.5	
01/05/2028					604.5	
01/06/2028					604.5	

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A13 Economic Insight (April 2023) – Productivity and Frontier Shift at PR24

Economic Insight

28 April 2023

Economic Insight Ltd

PRODUCTIVITY AND FRONTIER SHIFT AT PR24

A report on behalf of a consortium of water companies

CONTENTS

1 Introduction and executive summary

In this report, we undertake a comparator analysis using total factor productivity (TFP) data to arrive at estimates for an appropriate frontier shift challenge for water companies at PR24. We summarise our results (for the total water value chain) with respect to three estimated ranges: (i) our *'plausible range'* is **0.3%-0.8%** (we think it is implausible, but not impossible, for frontier shift to lie outside of this range); (ii) our *'PR24 focused range'* is **0.3%-0.7%** (we think it is likely frontier shift will be within this range at PR24); and (iii) our *'sensitivity analysis range'* is **0.1%-1.1%** (this shows what frontier shift *could* be, under alternative sets of comparators and time periods to those we recommend). In addition, for water retail specifically, we derive a *'plausible range'* of **0.3%-0.6%**.

1A. Introduction

Aims of our study

A consortium of water companies[1] commissioned Economic Insight to provide a report on the scope for frontier shift at PR24. The primary aim of this study is to reach our own independent and robust view on the appropriate range for frontier shift at PR24. In order to do this, we:

- review data on economic conditions, so as to determine the appropriate time period for our analysis; and
- provide a set of criteria that we apply in order to reach a view on an appropriate set of comparable sectors to the water industry.

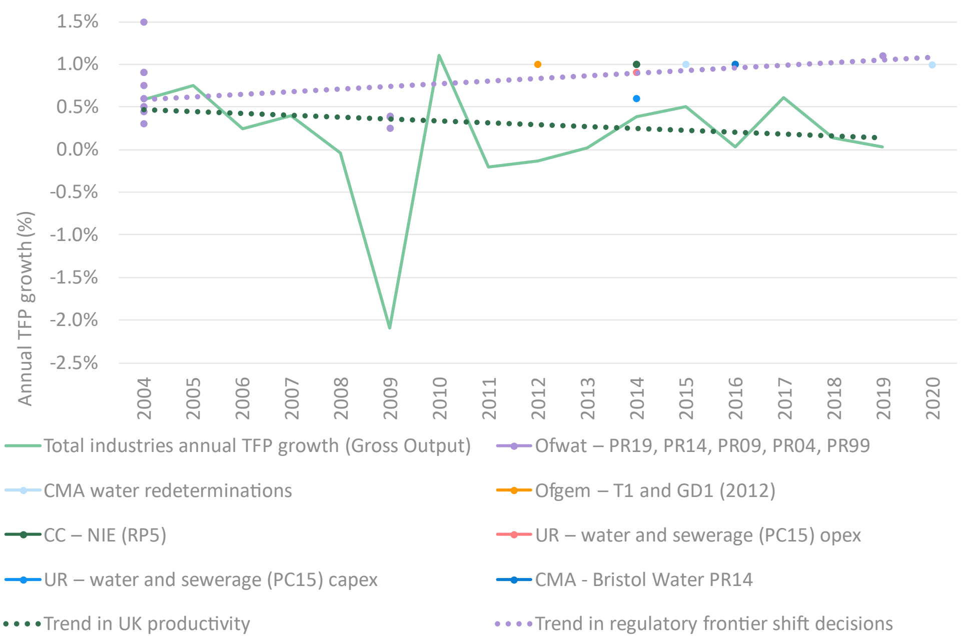
[1] *Affinity Water; Anglian Water; Bristol Water; Northumbrian Water; Severn Trent Water; South East Water; South Staffordshire Water; South West Water; Southern Water; Thames Water; United Utilities; Welsh Water; Wessex Water; and Yorkshire Water.*

In addition to the above primary aims, our work seeks to provide clarity as to the relevant economics theory and analytical considerations that should inform the appropriate approach to frontier shift at PR24. Accordingly, this report sets out our findings and recommendations.

Context

Following the 2008 financial crisis, the UK has now experienced 15 years of falling, and low, productivity performance (as measured by total factor productivity - TFP); a pattern that is consistently seen across the majority of UK industries (i.e. it is not unique to the water industry). However, as shown in Figure 1, at the same time sectoral regulators have been setting increasingly challenging frontier shift targets. This appears counterintuitive.

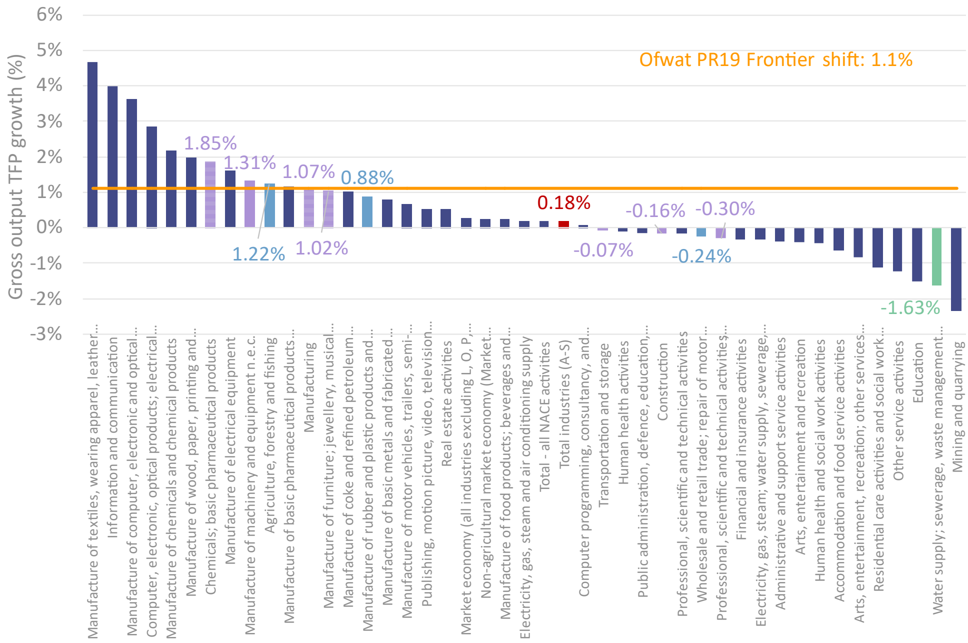
Figure 1: Falling UK productivity; increasing regulatory frontier shift decisions



Source: Economic Insight analysis

Further to the above, when one examines regulatory decisions from a cross-sectional (across industry) perspective, they imply regulated industries are (on regulators' assessments) 'outliers', with unusually high expected productivity. For example, in relation to Ofwat's PR19 frontier shift challenge (1.1%), Ofwat's position suggests that the water industry should have productivity growth above the majority of other industries in the UK. Indeed, Figure 2 shows that, between 1995 and 2019, only 12 out of 46 sectors in the UK had TFP growth of 1.1% or above (and many of these, as one would expect, relate to high-tech industries, such as telecoms; chemicals; and computing). Furthermore, Figure 2 shows (in red) that average annual TFP growth for "Total industries" between 1995 and 2019 was 0.18% (which is significantly lower than Ofwat's PR19 challenge of 1.1%).

Figure 2: Sector level gross output TFP growth (1995 to 2019)



Source: Economic Insight analysis of EU KLEMS data

Notes: We have not included "Telecommunications" in this chart in order to improve readability, as its average TFP growth is 12.9%.

Put simply, the persistence and consistency of low productivity in the UK over time, and across industries, calls into question the trajectory of regulatory determined frontier shift, as we look ahead to PR24. In this context, it should also be recalled that in the water industry, prior to PR14, frontier shift was typically set well below 1.0% by Ofwat.

The above data means that it is important to consider the approach to frontier shift at PR24 with care. In particular, there are a number of analytical complexities regarding the inference of frontier shift from TFP data that require attention. Similarly, the choice of comparator sectors, and time periods, over which TFP is assessed must be duly weighed.

1B. Executive summary

Analytical considerations

Estimates for frontier shift are typically derived from TFP data. Indeed, this is the approach we have taken in this report, drawing primarily on the EU KLEMS database, which is split into: NACE I (1970-2007); and NACE II (1995-2019).[2] However, TFP itself is *not* a direct measure of frontier shift. Rather, being a measure of productivity, it merely measures a change in outputs for a given change in inputs. Here, the key issues are as follows:

- TFP will include catch-up, as well as frontier shift related, efficiency gains. Raw TFP data will therefore always *overestimate* frontier shift to some degree for this reason. This holds under our analysis (although we seek to mitigate this, by taking the competitiveness of industries into account when selecting comparator sectors).

- TFP will include efficiencies from economies of scale. In principle, this could lead to frontier shift being either over, or under, stated (depending on whether the comparators have similar scope for economies of scale to that in the water industry).[3] We seek to control for this in comparator selection in our analysis. However, as regards the comparators we ultimately include, in practice there may be some *understatement* of frontier shift relating to economies of scale (although the magnitude of this understatement is logically *smaller* than the equivalent overstatement for catch-up efficiency).

- The question of whether an adjustment is needed for embodied technological change is complex, with no clear cut or easy answer. We find both on intuition and the evidence that TFP data includes *some* element of embodied technological change; it is a matter of degree (as confirmed to us by the ONS). Furthermore, the extent to which TFP data includes / excludes embodied technological change will vary by industry. Based on our recommended comparators, we consider *some* uplift for excluded embodied technological change may be appropriate (but we cannot preclude the possibility that a downwards adjustment is, in fact, appropriate). Box 1 below summarises our views on the theory and evidence on the embodied change issue.

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2 *We note that an updated version of the EU KLEMS NACE II database was released in February 2023. This database includes an extra year of data but, in addition, compared to the previous iteration of this database, much of the data has changed for the same years and the same comparators. We have raised a query with EU KLEMS as to exactly what has driven this change.*

3 *That is to say, it is not (strictly) necessary to 'strip out' all scale related gains from the TFP data of comparators. This is because, if the productivity (TFP) gains that comparators could achieve were similar to those the water industry could achieve, the fact that economies of scale are included is not problematic. Rather, what matters is whether the 'scope' for TFP gains from economies of scale are materially different for the comparators than for water. This contrasts to catch-up efficiency, whereby Ofwat's approach already identifies and applies a catch-up challenge to water companies, meaning that any catch-up efficiencies in the TFP data of comparators results in an overstatement of frontier shift.*

Box 1: Our views on the embodied change issue

Ongoing efficiency (frontier shift) consists of productivity gains from both: (i) embodied change (gains made from higher quality inputs / new technology); and (ii) disembodied change (gains made from existing inputs / existing technology). The consensus is that TFP estimates do not fully account for embodied change. However, this, in and of itself, does not mean that frontier shift for the water industry (as inferred from the TFP of comparator industries) should be adjusted upwards to account for omitted embodied change. Rather, this depends on two considerations.

1. The amount of embodied change that is included in / excluded from TFP

We recognise the challenges in quantifying an exact amount of excluded embodied change. Nonetheless, we consider that there is a greater degree of embodied change captured within TFP, than regulators have recognised to date, since:

- Firstly, TFP growth is shown to be highly volatile, with regular peaks and troughs. If TFP growth corresponded only to disembodied change, the volatility would imply the effectiveness with which companies can use their existing assets and resources is highly variable (i.e. making 'gains' in one year, only to 'lose' those gains the next). This seems doubtful.
- Secondly, TFP and economic growth are shown to be highly correlated; as are levels of investment and economic growth. As investment in new technologies leads to embodied (rather than disembodied) change, one would not expect such a strong relationship between TFP and economic growth, were embodied change fully (or even mostly) excluded from TFP estimates.
- Thirdly, there is neither a consensus in the academic literature, nor between the ONS and EU KLEMS, on the degree of excluded embodied change.

We also consider that the amount of embodied change that is included in TFP varies significantly by industry – with more embodied change captured in those industries that use relatively more capital and intermediate inputs.

2. The applicability of embodied change from comparator sectors to water

We consider that the water sector likely contains low rates of technological progress, relative to many industries. As such, given that embodied change results from investment in new technologies, the water industry is unlikely to be able to achieve high productivity due to embodied change. Indeed, if the comparators used to infer frontier shift have higher scope to achieve gains from embodied change than the water industry then, even if some of that embodied change is excluded from their TFP data, the proportion that is included within TFP may in fact result in an overstatement of frontier shift for water. The key point, therefore, is simply that the relative scope of the water industry to benefit from new technology, relative to the comparators, is also important.

Source: Economic Insight

Beyond the above analytical considerations that arise due to the use of TFP to estimate frontier shift, there are two further important issues pertinent to setting frontier shift at PR24:

- CPIH (which is used to index the RCV under the regulatory framework) must logically capture productivity gains. CPIH is a broad measure of consumer inflation faced in the UK, and efficiency savings made by firms producing goods and services are a key driver of general movements in consumer prices. At PR19, Ofwat compensated companies for input cost changes (real price effects) where these differed from CPIH – which is inconsistent with the approach taken for frontier shift. Specifically, we consider that, at PR24, Ofwat should adopt an internally consistent approach. By this, we mean that the frontier shift challenge should be set to the extent that the 'industry specific' frontier shift differs from the productivity gains already implicitly captured within CPIH (consistent with real price effects).

- It is important to highlight that in setting performance commitments that companies must achieve from base funding, Ofwat is setting said companies an efficiency challenge that is *in addition* to both the frontier shift and catch-up % challenges applied to costs. Put another way, the total efficiency challenge for any firm can be considered as being four parts of a pie. Within both catch-up and frontier shift, efficiency gains can be realised through any combination of cost reductions and / or quality improvements (output increase). The point being, however, that the total efficiency can never be more than the sum of its parts. Consequently, setting aside the fact that TFP does not strictly accord to frontier shift (i.e. it includes some degree of other efficiencies, as above) the frontier shift itself captures productivity gains made by comparator firms via cost reductions and quality improvements. Thus, when applying any estimate of frontier shift derived from a comparator approach, the figures should be allocated between cost reductions and quality improvements, in order to avoid a double-count. In practice in the water industry, the starting point should be to measure the efficiency challenge implicit in the performance commitments.

Choice of time period

TFP varies considerably, depending on the time period over which it is assessed. In this report, we have therefore weighed four considerations in determining the appropriate period for determining frontier shift at PR24.

- **Internal consistency**, such that the time period used to assess frontier shift is consistent with the time period (and assumed economic context) used to inform other key components of the price control (e.g. equity returns, given their correlation with productivity and growth).

- The **structural break** arising from the financial crisis, which has marked a 15-year period of falling and persistently low productivity.

- The inclusion of **full business cycles**, as productivity is shown to be pro-cyclical.
- The **utilisation of the data** available, to reduce the impact of outliers.

Applying the above four considerations, in our *'plausible range'* we assess frontier shift over the following time periods (noting that the availability of data also constrains the start and end of these periods): (i) 2010-2019; (ii) 1995-2019; and (iii) 1970-2007. In our *'PR24 focused range'*, we use: (i) 2010-2019; and (ii) a weighted average of 1995-2019 and 1970-2007.[4] In addition, in our *'sensitivity analysis range'*, we include the period: 1992-2007.

Choice of comparators

The choice of comparator industries is important - primarily in order to mitigate the impact of economic efficiencies that are captured in TFP, but that do not correspond to frontier shift. We select comparators based on three criteria.

- **Criterion 1:** the activities undertaken in the comparator sector should be similar to those in water.
- **Criterion 2:** the comparator sector should be competitive (to mitigate the impact of catch-up efficiencies).
- **Criterion 3:** the extent of fixed costs and growth rates over time should be similar between comparators and the water industry (to mitigate the impact of scale effects).

We have applied a three-colour grading to each of the criteria detailed above, ranking possible comparator industries as: "Red"; "Amber"; or "Green". Following this, we have arrived at a *'preferred set'* of comparators, that takes into account the ranking across each of these criteria. In addition, we have included "Total industries", as we consider it is beneficial to include a metric that captures productivity changes across the entire UK 'on average' (given the inherent subjectivity in comparator choice).[5] In our *'plausible range'* and *'PR24 focused range',* we use our *'preferred set'* of comparators.

We have also set out several sensitivities that test the robustness of our choice of comparators, by widening[6] / narrowing the set of comparators, based on the three criteria above. These correspond to our *'sensitivity analysis'* range. We also recognise that the mix of activities undertaken by water companies (and therefore appropriate selection of comparators) can vary somewhat over time. For example, if a water company expected to undertake significantly more asset construction or maintenance

[4] *Please see Chapter 7 for details of how this weighted average has been calculated.*

[5] *Our 'preferred set' of comparators is therefore as follows: (i) Total industries; (ii) Agriculture, forestry and fishing; (iii) Manufacturing; (iv) Chemicals; basic pharmaceutical products; (v) Manufacture of rubber and plastic products and other non-metallic mineral products; (vi) Manufacture of furniture; jewellery, musical instruments, toys; repair and installation of machinery and equipment; (vii) Wholesale and retail trade; repair of motor vehicles and motorcycles; and (vii) Transportation and storage. Please see Table 12 for the NACE I equivalents of each of these.*

[6] *This widened set of comparators corresponds to the 'preferred set' plus (in separate sensitivities): (i) "Mining and quarrying"; and (ii) "Construction".*

at PR24 than in the past, it may be appropriate to give that due consideration when assessing frontier shift under its Business Plan.

Results

Table 1 shows the lower and upper ends of each of our three ranges of estimates, as described above (and also sets out the time period and set of comparators that correspond to that particular estimate).

Table 1: Summary of estimates (total water value chain)

	Plausible range		PR24 focused range		Sensitivity analysis range	
	Low	High	Low	High	Low	High
Frontier shift estimate	0.3%	0.8%	0.3%	0.7%	0.1%	1.1%
Time period	2010-2019	1970-2007	2010-2019	Weighted average of: 1970-2007; and 1995-2019	2010-2019	1970-2007
Comparators	Preferred set	Preferred set	Preferred set	Preferred set	**Sensitivity 1**[7]	**Sensitivity 3**[8]

Source: Economic Insight analysis of EU KLEMS data

Retail

We have also assessed the scope for frontier shift specifically in relation to water retail, using the same broad approach (and the same time periods) as summarised above for the total water value chain. Again, we derive three ranges of estimates. Our analysis for retail suggests: (i) a *'plausible range'* of 0.3%-0.6%; (ii) a *'PR24 focused range'* of 0.4%-0.6%; and (iii) a *'sensitivity analysis range'* of -0.2%-1.2%. Overall, these ranges are highly similar to those for the total water value chain; but note that the upper ends of our *'plausible range'* and *'PR24 focused range'* are slightly lower for water retail. This is consistent with intuition, whereby we would characterise retail activities as being somewhat more 'vanilla'; with lower value add; lower capital intensity; and (therefore likely) lower scope for technological change that could, in turn, drive improved productivity.

[7] *This corresponds to our 'preferred set' plus "Mining and quarrying". Further details are provided in Section 5C.*

[8] *This corresponds to our 'preferred set' but with: (i) Criterion 3 strengthened; and (ii) highly aggregated sectors excluded. Further details are provided in Section 5C.*

1C. Recommendations

Recommendations to companies

In terms of how we recommend companies utilise our estimates in developing their PR24 business plans, this is as follows:

- The estimation of frontier shift is inherently uncertain. As such, companies have some discretion as to what evidence / approaches they place most weight on when determining what frontier shift to assume in their business plans for PR24. Our own analysis suggests frontier shift for the total water value chain could plausibly lie between 0.3% and 0.8% pa (0.3% and 0.6% for water retail); and so companies could select any figure within this range and it would be supportable, on the evidence. In determining 'where' in that range to select, companies should consider (and explain in their plans) the specific evidence / rationale in our report (or from elsewhere) they rely on.

- That said, with a focus specifically on the PR24 time period, it seems *likely* (both on the evidence and intuition, given the persistence of low productivity) that frontier shift will sit within a narrower range (which we find to be 0.3% to 0.7% for the total water value chain; and 0.4% to 0.6% for water retail). Companies should therefore consider with care the case for selecting figures outside of these narrower ranges (noting that, prior to PR14, frontier shift in the water industry was typically set around these levels by Ofwat).

- The fact that embodied technological change is only partially captured in our estimates may provide some basis for choosing numbers towards the higher end of our ranges. On the other hand, the fact that our raw estimates implicitly include efficiencies other than frontier shift means they are overstated, providing some basis for choosing numbers towards the lower end of our ranges.[9] Our recommendation is therefore that companies should: (i) generally adopt numbers at the mid-points of our ranges; or (ii) could deviate from that (i.e. selecting higher or lower numbers within our ranges) if that decision was informed by additional evidence relating to:
  - an assessment of the rate of technological change in the water industry, relative to the comparator sectors; and / or
  - additional evidence as to the scope for other efficiencies (e.g. economies of scale) in the water industry, relative to the comparator sectors.[10]

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[9] *Noting that the overstatement of frontier shift due to catch-up is likely greater in magnitude than a potential understatement due to scale effects.*

[10] *Relatedly, and as noted previously in this executive summary, companies could further consider whether the comparator set itself might change, if (for example) the expected mix of activities they will undertake at PR24 is sufficiently different from the past.*

- We consider that (in principle) frontier shift gains should be applied to the totality of company costs (i.e. both base and enhancement), other than costs which are deemed outside of management control. In relation to enhancement costs, in order to avoid either omitting (or double-counting) a frontier shift challenge, companies should provide clear evidence as to how the frontier shift has been applied. If companies consider a frontier shift challenge has been implicitly included, they should explain why and provide evidence to support that. Where the challenge has been explicitly applied, they should state so and demonstrate this.

- Companies may want to consider whether, and to what extent, the possible use of Ofwat's innovation fund may affect the scope for frontier shift on a forward-looking basis. However, we note that the size of the fund (£200m)[11] relative to total industry totex set by Ofwat in its PR19 FD (£49.6bn)[12] is sufficiently small that it seems doubtful that this can materially affect productivity and thus, we do not recommend making an adjustment for this.

Wider recommendations for PR24

Below we set out recommendations for Ofwat and companies for PR24, in order to ensure that the most appropriate estimate of frontier shift is selected:

- Ensure that any choice of time period is based on a transparent assessment against the considerations captured within our criteria (specifically: internal consistency; use of complete business cycles; utilisation of data; and reflecting the structural break in productivity in the UK, post 2008). The UK's economic outlook should be reviewed as plans are finalised / regulatory determinations are made, to help ensure this is the case.

- In selecting comparators, undertake analysis to apply the evaluation criteria outlined in this report; critically assessing each comparator industry to objectively determine its applicability. This will also help inform how (or whether) to reflect any efficiencies other than frontier shift captured in the raw TFP data.

- Any updated productivity data (in particular, the EU KLEMS or ONS datasets) that is published between now and the determinations should, ideally, be utilised and frontier shift estimates updated prior to the determinations.

- Any further information / evidence relating the relative competitiveness of comparator sectors (published prior to the determinations) should be reviewed and taken into consideration.

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[11] *'Creating tomorrow, together: Our final methodology for PR24 Appendix 9 Setting expenditure allowances.' Ofwat (December 2022); page 38.*

[12] *'PR19 slow track draft determinations: Securing cost efficiency technical appendix.' Ofwat (December 2019); page 8.*

- Frontier shift estimates should be based on gross output TFP productivity, with little or no weight given to value added estimates.
- If frontier shift is estimated over a very long time period, the use of a geometric mean should be considered.
- In relation to embodied technological change, this matter could be further informed by the following:
  - (i) Analyse historical TFP growth in the industry; and track the extent to which periods of higher technological change correlate with increased TFP growth. Then one could 'map forward' any anticipated technological change over PR24, to determine whether it is likely to be a relatively 'high', or 'low', period of technological change.
  - (ii) Undertake a literature review regarding empirical estimates of embodied technological change. From our existing research, we have identified academic articles that estimate between 20%[13] and 60%[14] of TFP growth may represent embodied change. However, these estimates should be taken with certain caveats. Firstly, both studies rely upon data that is 40 years old (i.e. when productivity growth was much higher than it is now). Secondly, they take data from the US, whose economy has been consistently subject to higher levels of investment and greater productivity growth than the UK. Therefore, although these academic sources are informative in providing a starting point for quantifying the degree to which TFP may underestimate achievable frontier shift, their calculations should not be taken as a 'rule' for any adjustments required (further noting our finding that, in any event, TFP already includes *some* embodied technological change).
  - (iii) For each chosen comparator, undertake a two-stage process to determine the importance of potentially excluded embodied technological change. Firstly, develop evidence as to the amount of embodied change that is likely reflected in the TFP data of the comparators. Secondly, examine the rate of technological change in the comparators, and compare this to the rate of technological change in the water industry. Where the rates are similar, the more appropriate it is to adjust for excluded embodied technological change. Conversely, where the rate of technological change is materially different in the water industry, relative to the comparators, adjustments for embodied change are more likely to result in an over or understatement of frontier shift. For example, where technological change in the water industry is slower than

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13 'Growth Accounting When Technical Change is Embodied in Capital.' Hulten, C. (January 1992).

14 'Embodied and disembodied technical change and the constant elasticity of substitution production function.' Uri, N. (December 1983).

that for the comparators, an adjustment would likely result in an overstatement of frontier shift (and vice-versa).

- As a matter of urgency, the industry needs some way to scale the size of the efficiency challenge being set under the performance commitments at PR24. Without this, the totality of the efficiency challenge (both catch-up and frontier shift) cannot be determined; and a 'double-count' will likely occur. This is a material limitation under the current regulatory framework.

- Ofwat should adopt an internally consistent approach between that which is currently taken for real price effects, and what should be taken for frontier shift. Specifically, any frontier shift challenge should only account for ongoing efficiency gains specific to the water industry, that are not already implicitly captured within CPIH.

2 Context and aims

In this chapter we set out the context to, and aims of, our work. In turn we: (i) define frontier shift and explain how this relates to an overall measure of efficiency; (ii) illustrate how frontier shift challenges set at recent regulatory decisions have changed, relative to trends in productivity over time; (iii) review the approaches to frontier shift taken by Ofwat and the CMA at PR19; (iv) consider whether to adjust frontier shift for the innovation fund; and then (v) set out the aims of our study.

2A. Overview of frontier shift

In this report, when we refer to frontier shift, we are referring to the ongoing efficiency challenge that Ofwat applies to company costs. This challenge is designed to encourage companies to continue to make productivity improvements. It is applied in addition to the catch-up efficiency challenge, which is designed to encourage companies to 'catch-up' with the frontier efficient firm. The economic rationale for these two types of efficiency is explained further as follows:

- **Catch-up efficiency.** This is the efficiency improvement required for less efficient firms (i.e. those who are behind the efficiency frontier) to reach said efficiency frontier. For companies, catch-up is theoretically (primarily) achieved by management implementing the best operational practices. These often relate to appropriate responses to: (i) changes in technical efficiency (meaning how quickly companies are able to respond to material changes in input factors);[15] or (ii) changes in allocative efficiency (meaning the extent to which companies are able to vary their mix of inputs, in order to increase output).[16]

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15 *'The Luenberger productivity indicator in the water industry: An empirical analysis for England and Wales.' Molinos, M; Maziotis, A; Sala-Garrido, R; (September 2014).*

16 *'Productive efficiency and allocative efficiency: why better water management may not solve the problem.' Allan, T; (March 1999).*

- **Frontier shift.** This relates to the change in the productivity frontier of an industry over time.[17] Frontier shift thus represents the efficiency savings that even the most efficient firms in an industry can make. By setting firms a frontier shift, Ofwat hopes to reflect the challenge firms face in non-regulated markets, where they are constantly required to make efficiency savings on an ongoing basis. The frontier is typically pushed out by strategic oversight; and capital investment, allowing more efficient new technology to be deployed and accumulated.[18]
  - Frontier shift is thus closely related to rates of technological change within industries, which is typically closely associated with rates of capital investment. Accordingly, one would intuitively expect frontier shift (and productivity more broadly) to vary significantly across industries, as is reflected in the data in practice.
  - The above link (between investment; leading to new technology; leading to productivity gains) also means that changes in frontier shift within an industry arising from increased spending (investment) are not instantaneous. For example, academic literature finds that there is usually a lag (approximately five years) following investment for productivity gains to be fully realised in the manufacturing industry. This reflects the time it takes for companies to make capital investments; deploy the related technology; and then learn the most effective way of using it.[19] The relevance of this to PR24 is that, to the extent that companies increase their capital investment (relative to the past), care must be taken not to assume this translates to immediately higher frontier shift. Moreover (and far more materially in this context), it remains problematic that, historically, the regulatory determined frontier shift challenge in the water industry has increased so significantly over time in a context of low investment (as highlighted in the recent House of Lords report).[20]

In principle, both catch-up and frontier shift efficiency can be delivered through either cost savings, or improvements in quality (or, indeed, any balance between / combination of the two). Accordingly, Figure 3 shows how one can think of efficiency (productivity) as a ‘pie’ with four constituent parts. As no market is perfectly competitive, all firms (in any industry) can likely make efficiency gains through some combination of both ‘catch-up’ and ‘frontier shift’. For each of these, a firm can then choose[21] whether to achieve said gains through cost reductions or quality improvements (again, or any balance between the two). However, the whole pie can never be more than the sum of its constituent parts.

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[17] *‘Energy efficiency in Spanish wastewater treatment plants: A non-radial DEA approach.’ Hernández-Sancho, F; Molinos-Senante, M; Sala-Garrido, R; (June 2011).*

[18] *‘U.S. Economic Growth at the Industry Level.’ Jorgenson, D; Stiroh, K; (May 2000).*

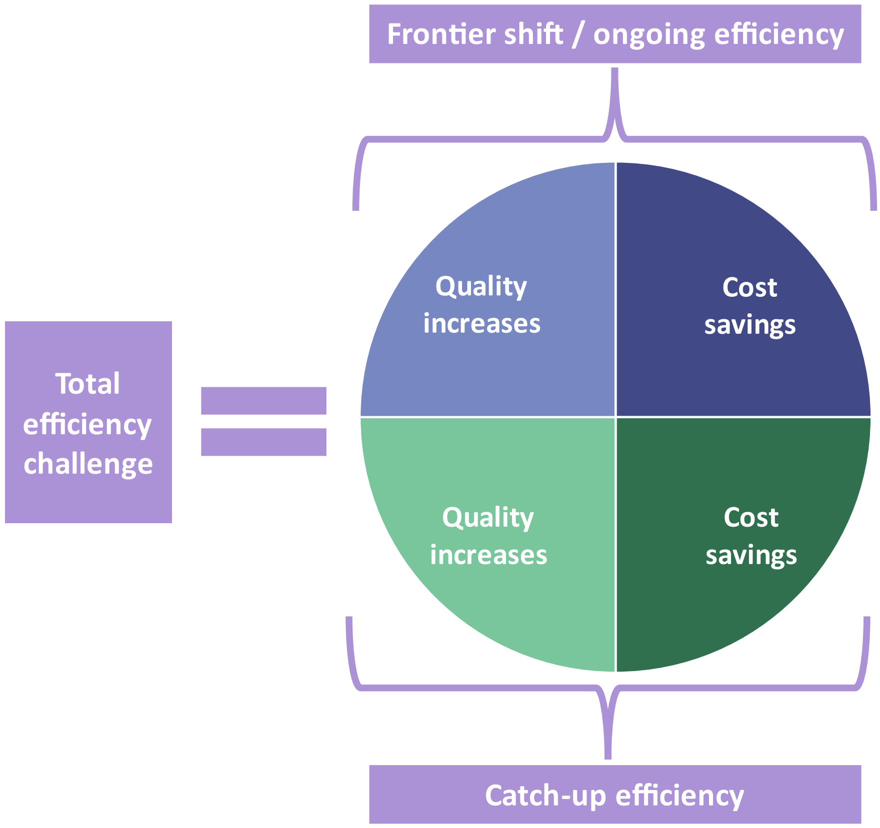
[19] *‘Linking investment spikes and productivity growth.’ Geylani, P; Stefanour, S; (April 2012).*

[20] *‘The affluent and the effluent: cleaning up failures in water and sewage regulation.’ House of Lords (March 2023).*

[21] *In practice, competitive conditions in each market would determine the allocation of gains between cost and quality.*

The above discussion is pertinent to the setting of frontier shift in the water industry at PR24 (which is the focus of this report). Specifically, the key issue is that the *total* efficiency challenge companies are set (catch-up and frontier shift) also includes the efficiency gains they must make when tasked with delivering quality improvements (as per the performance commitments) out of base funding. We discuss this more fully in Section 3E.

Figure 3: Illustration of four components of efficiency gains



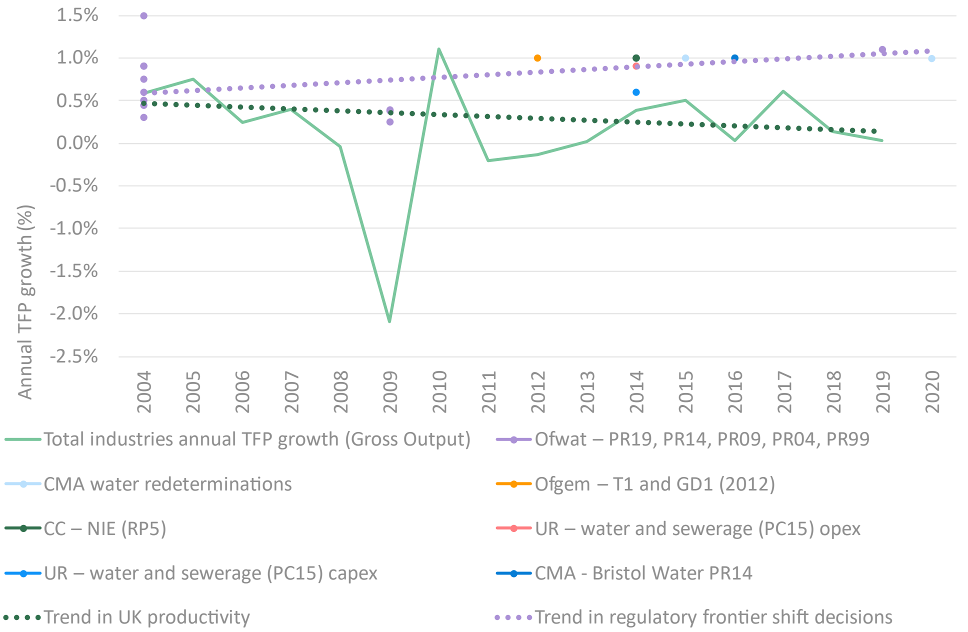
Source: Economic Insight

2B. Frontier shift and observed productivity

Whilst productivity in the UK has fallen over time, the frontier shift challenges set at more recent regulatory decisions in energy and water have risen. Figure 4 shows a *downward* trend in TFP growth for the UK, contrasting with an *upward* trend in the frontier shift challenge set by regulators, in both the water and energy sectors. Furthermore, regulatory decisions to set a 'higher' frontier shift actually coincide with a structural break (and marked decline) in UK productivity performance, following the 2008 financial crisis.

Over the last 20 years, frontier shift challenges have been as low as 0.25% (PR09 base opex), with the challenge only moving to around the 1% level at the time that the PR14; ED1; and PC15 decisions were made. It is also notable that older regulatory determinations are consistent with sectoral regulators taking the view that regulated industries are likely 'less productive' than the 'average' firm (as reflected in the UK's overall TFP performance); whereas more recent determinations suggest regulators now consider these same industries are likely 'more productive' than the average firm. There is no intuitive explanation for this apparent change in expected relative performance.

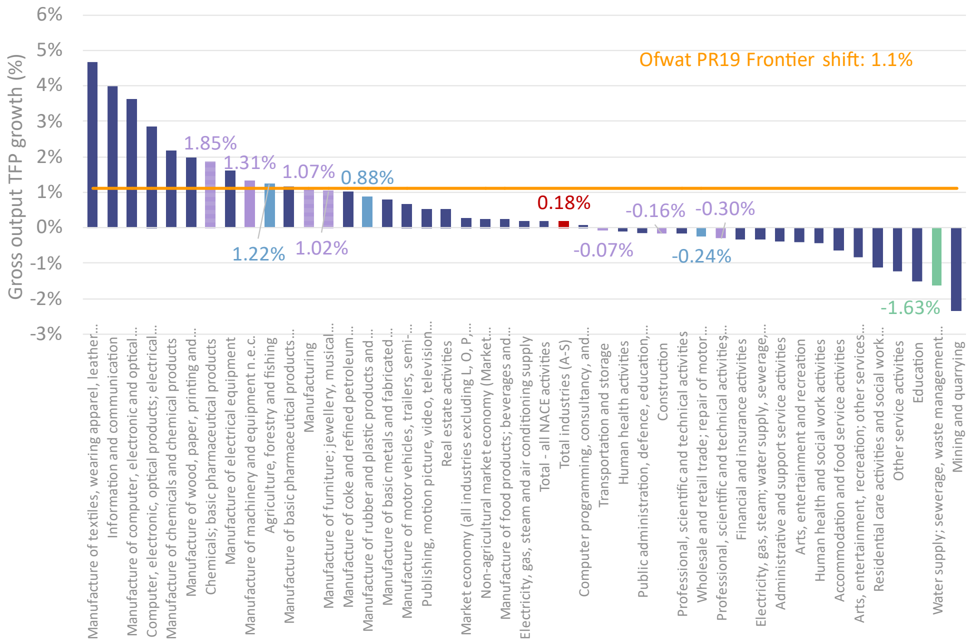
Figure 4: Falling UK productivity; increasing regulatory frontier shift decisions



Source: Economic Insight analysis

Specifically in relation to Ofwat's PR19 frontier shift challenge (1.1%), Figure 5 shows how this assumed frontier shift sits, relative to observed TFP growth of other sectors between 1995 and 2019. As can be seen, only 12 of 46 sectors experienced TFP growth of at least 1.1% (and many of these, as one would expect, relate to high-tech industries, such as telecoms; chemicals; and computing). Furthermore, Figure 5 shows (in red) that average annual TFP growth for "Total industries" between 1995 and 2019 was 0.18% (which is significantly lower than Ofwat's PR19 challenge of 1.1%). We provide further examples in Annex 1. Annex 1 also provides additional details of the colour coding in Figure 5, which is used to identify our comparator choices, as explained in Chapter 5.

Figure 5: Sector level gross output TFP growth (1995 to 2019)



Source: Economic Insight analysis of EU KLEMS data
Notes: We have not included "Telecommunications" in this chart in order to improve readability, as its average TFP growth is 12.9%.

Put another way, Ofwat's position suggests that the water industry should have productivity growth well above most other industries in the UK. One must therefore consider how plausible that implied relative performance is.

Specifically, one might expect industries with very high TFP to have certain characteristics. For example, 'tech industries' tend to have high productivity (i.e. because, by definition, they have high rates of technological change / and / or high utilisation of technology, which drives greater productivity growth than the UK industry average). Consistent with this, some of the industries that outperform most in the data are: computing; communications; and electrical equipment sectors (again, as shown in Figure 5). It is intuitively questionable as to whether the water industry could be similarly characterised.

In the above context, we note that in its PR24 Draft and Final Methodologies, Ofwat specified that it plans to set a *"stretching"* frontier shift challenge at PR24.[22]

2C. Treatment of frontier shift at PR19

In the following two sections, we consider the approaches taken by Ofwat and the CMA at PR19 in arriving at decisions on: (i) an overall level of frontier shift; and (ii) the scope of frontier shift, i.e. the costs to which it should be applied.

[22] *'Creating tomorrow, together: Our final methodology for PR24 Appendix 9 Setting expenditure allowances.' Ofwat (December 2022); page 35.*

Level of frontier shift

At PR19, Ofwat and the CMA set the following frontier shift challenges:

- Ofwat Final Determinations: 1.1% (down from 1.5% in its Draft Determinations).
- CMA Redeterminations: 1.0%.

In its FD, Ofwat described its choice of a 1.1% frontier shift as being a *"stretching but achievable challenge for water companies."*[23] The CMA similarly characterised its choice of a 1.0% frontier shift, stating that it wanted to "*to ensure our estimate remained achievable but stretching."*[24] In selecting these values, both Ofwat and the CMA chose estimates from the top of their derived ranges (0.6%-1.2% and 0.3%-1.2%, respectively).

In setting their respective challenges, Ofwat and the CMA considered the following:

- **Embodied change**. Both Ofwat and the CMA considered that, since evidence suggests that TFP estimates do not fully capture embodied technological change, frontier shift estimates based on TFP would be understated. We discuss the embodied change issue in Sections 3C and 6B.
- **Totex framework.** Ofwat commissioned a report by KPMG, which claimed that the recent addition of a totex approach to water regulation could unlock additional ongoing productivity gains of 0.2% to 1.2% pa (i.e. *'over and above'* the above-mentioned range).[25]
- **Relative productivity in water**. The CMA suggested that, despite low levels of UK productivity growth since the financial crisis, the water sector may be less affected by this than other sectors – we consider this argument in Section 4E.

Scope of frontier shift

In addition to determining the level of frontier shift, regulators must determine the 'scope' of costs to which it is applied. At PR19, Ofwat and the CMA applied a frontier shift challenge to cost categories as follows:

- **Modelled wholesale costs.** Frontier shift was applied to all of these costs.

23 *'PR19 slow track draft determinations: Securing cost efficiency technical appendix.' Ofwat (December 2019); page 177.*

24 *'PR19 slow track draft determinations: Securing cost efficiency technical appendix.' Ofwat (December 2019); page 177.*

25 *'Innovation and efficiency gains from the totex and outcomes framework.' KPMG (June 2018).*

- **Unmodelled wholesale costs**. In its FD, Ofwat also applied frontier shift to all of these costs. In contrast, the CMA did not apply frontier shift to unmodelled wholesale costs that it consider to be mostly outside of management control (e.g. business rates and abstraction charges).[26]

- **Enhancement costs**. Ofwat applied frontier shift to a selection of these costs, specifically those that corresponded to larger and more common work programmes across companies. This was on the basis that these had greater potential for ongoing efficiency gains than smaller, less homogenous, programmes. The CMA adjusted this approach and applied frontier shift to all enhancement costs, as it considered that the frontier shift challenge was derived using TFP estimates from comparator sectors; and these included productivity gains made from all inputs, including enhancement expenditure. The CMA also undertook a review of companies' business plans to determine the extent to which ongoing efficiency gains had already been accounted for within enhancement. This was in order to prevent the risk of a double-count. The CMA considered that evidence in business plans was often inconsistent and unclear, noting that *"in the future, there may be a benefit in clarifying the basis for the reporting of these figures more explicitly, in order to avoid factual disputes of this nature (such as double-counting)."*[27]

- **Retail**. In its FD, Ofwat also considered applying frontier shift to retail costs, but chose not to (since these were partly based on forward-looking costs that *"reflect significant efficiency improvements on historical expenditure")*.[28]

2D. Whether to adjust for innovation funding

The question of whether to adjust frontier shift estimates for innovation funding has been raised by Ofwat in its PR24 Draft and Final Methodologies. Specifically, Ofwat has said that it will consider *"efficiency improvements driven by the £200 million innovation fund"*[29] when setting a frontier shift estimate at PR24.

At RIIO-GD2, Ofgem's application of an innovation uplift to its frontier shift challenge innovation fund was a key part of the appeals to the CMA. GEMA initially applied an upwards adjustment of 0.2% to *"reflect the extra innovation funding companies received from consumers."*[30] However, the CMA subsequently removed this uplift at appeal.

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26 *'Anglian Water Services Limited, Bristol Water plc, Northumbrian Water Limited and Yorkshire Water Services Limited price determinations Final report.' CMA (March 2021); paragraphs 4.628-4.629.*

27 *'Anglian Water Services Limited, Bristol Water plc, Northumbrian Water Limited and Yorkshire Water Services Limited price determinations Final report.' CMA (March 2021); paragraph 5.742.*

28 *'PR19 slow track draft determinations: Securing cost efficiency technical appendix.' Ofwat (December 2019); page 177.*

29 *'Creating tomorrow, together: Our final methodology for PR24 Appendix 9 Setting expenditure allowances.' Ofwat (December 2022); page 38.*

30 *'Cadent Gas Limited, National Grid Electricity Transmission plc, National Grid Gas plc, Northern Gas Networks Limited, Scottish Hydro Electric Transmission plc, Southern Gas Networks plc and Scotland Gas Networks plc, SP Transmission plc, Wales & West Utilities Limited vs the Gas and Electricity Markets Authority Final determination Volume 2B: Joined Grounds B, C and D.' CMA (October 2021); paragraph 7.4.*

In our view, the key issues pertinent to this are as follows:

- **Materiality.** If the overall size of innovation funding is small, relative to overall industry costs, its scope to affect productivity will be limited (and vice-versa).
- **The proportion of innovation funding that is intended to deliver efficiencies for companies (as opposed to supporting positive externalities).** At RIIO-GD2, companies submitted evidence to show that *"fewer than 50% of projects were primarily focused on cost reduction,"*[31] with much of the funding focused on achieving positive externalities (e.g. environmental benefits). Put simply, if the funding is not actually focused on delivering company efficiency savings, it is irrelevant to frontier shift.
- **Existing R&D rates in the water industry relative to comparator sectors.** If existing rates of R&D in water (absent the innovation fund) are significantly lower than in comparator sectors, then TFP estimates from comparator sectors would display higher productivity gains than those that are achievable for water. As such, if the total innovation funding only increases the rate of innovation in the water industry, up to a level that is equivalent to comparator industries, then this would suggest that all of the potential ongoing efficiency gains resulting from the innovation funding are already captured in TFP estimates – therefore pointing away from any innovation uplift. This occurred at RIIO-GD2, with GEMA assuming that the innovation funding was entirely incremental to R&D in other sectors (i.e. that existing R&D rates in the energy sector were equivalent to those in comparator sectors). However, evidence presented to the CMA showed that existing R&D rates were in fact lower in energy than in comparator sectors.
- **The extent to which business plans already account for efficiency benefits from innovation funding.** In order to prevent a double-count of ongoing efficiency gains, an adjustment for innovation funding should only be applied if companies' business plans do not already include these gains. We note that, at RIIO-GD2, the CMA considered that GEMA had double-counted these benefits.

We now briefly consider the above in relation to the water industry at PR24. Taken together, these points suggest that an adjustment to frontier shift for the innovation fund would be inappropriate.

- The total size of the innovation fund (£200m)[32] relative to total industry totex set by Ofwat in its PR19 FD (£49.6bn)[33] is approximately 0.4%. As such, it is doubtful that the fund can materially affect productivity.

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31 *'Cadent Gas Limited, National Grid Electricity Transmission plc, National Grid Gas plc, Northern Gas Networks Limited, Scottish Hydro Electric Transmission plc, Southern Gas Networks plc and Scotland Gas Networks plc, SP Transmission plc, Wales & West Utilities Limited vs the Gas and Electricity Markets Authority Final determination Volume 2B: Joined Grounds B, C and D.' CMA (October 2021); paragraph 7.805.*

32 *'Creating tomorrow, together: Our final methodology for PR24 Appendix 9 Setting expenditure allowances.' Ofwat (December 2022); page 38.*

33 *'PR19 slow track draft determinations: Securing cost efficiency technical appendix.' Ofwat (December 2019); page 8.*

- Ofwat has stated that the: *"overarching objective of the Fund is that the sector can better meet the needs of, and create long-term value for, customers, society and the environment through innovation."*[34] As such, the proportion of innovation funding provided to water economies that is intended for efficiency gains, relative to positive externalities, is unclear.

- We have reviewed competitions run as part of the innovation fund, and the extent to which they directly address company cost reductions (rather than externalities, e.g. environmental benefits) is unclear.[35]

2E. Aims of our study

In the above context, a consortium of water companies[36] commissioned Economic Insight to provide an independent report on the scope for frontier shift at PR24. The primary aim of this study is to reach our own independent and robust view on the appropriate range for frontier shift at PR24. In order to do this, we:

- review data on recent economic conditions, so as to determine the appropriate time period for our analysis; and

- provide a set of criteria that we apply in order to reach a view on an appropriate set of comparable sectors to the water industry.

We then build on the analysis of Ofwat and the CMA, by using more recent versions of the EU KLEMS and ONS productivity datasets to arrive at our frontier shift estimates.

Further to our overarching objective, our work also aims to:

- Provide clarity as to the economics theory relevant to measuring frontier shift; relatedly, 'what' the existing productivity datasets measure; and hence, 'how' they should be interpreted.

- Identify the key conceptual considerations in determining appropriate methods for estimating frontier shift in practice.

- Set out clear criteria to inform the 'in practice' choices that must be made when applying said methodology.

- Provide clarity as to 'what' the total efficiency challenge is under the regulatory model for the water industry (and 'how' this is set). Here, the key issue is how one takes into account the efficiency challenge associated with improving outcomes out of base funding.

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34 *Please see: https://waterinnovation.challenges.org/ofwat-innovation-fund/about-the-fund/.*

35 *For instance the "Innovation in Water Challenge"; "Water Breakthrough Challenge"; and "Water Breakthrough Challenge 2". Please see: https://waterinnovation.challenges.org/past-competitions/.*

36 *Affinity Water; Anglian Water; Bristol Water; Northumbrian Water; Severn Trent Water; South East Water; South Staffordshire Water; South West Water; Southern Water; Thames Water; United Utilities; Welsh Water; Wessex Water; and Yorkshire Water.*

3 Total factor productivity

In this chapter we: (i) provide an overview of total factor productivity (the metric used at PR19 to determine the frontier shift); (ii) set out how it is measured; (iii) explain the difference between TFP and frontier shift (and the key issues in inferring the latter from the former); and (iv) explain how the performance commitments set in the water industry also form part of the overall efficiency challenge, and the implications of this for frontier shift.

3A. Overview

Productivity gains made from ongoing efficiency (frontier shift) are most frequently assessed through TFP analysis. TFP is a measure that '*captures changes in performance attributable to increased physical production of outputs relative to inputs*'.[37] Put simply, TFP growth measures the change in outputs that cannot be explained by changes in the quantity of inputs used. It is chosen over other measures, such as labour productivity, because it captures all the measurable factors of production that it is possible to include. Inputs are measured as capital and labour, whilst output is usually a measure of aggregate economic output. TFP thus represents the change in output that cannot be explained by changes in the quantity of capital and labour.[38] In the PR19 FD and CMA redeterminations, the EU KLEMS dataset (which provides a measure of TFP) was used to arrive at estimates for frontier shift.

In addition to TFP data, multifactor productivity (MFP) data is available from the ONS, which differs slightly to TFP – we discuss this in more detail in Section 3B and Annex 2. In this report, our frontier shift ranges are based on EU KLEMS TFP data,[39] and so we do not use ONS MFP estimates to inform any of our frontier shift estimates. Therefore, throughout the remainder of this report, whenever we refer to TFP we are also referring to MFP.

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[37] *'Regulatory Price Performance, Excess Cost Indexes and Profitability: How Effective is Price Cap Regulation in the Water Industry?' Maziotis, A; Saal, D; Thanassoulis, E (September 2009) page 5.*

[38] *And so, TFP growth is considered to comprise of intangible factors, such as technological change; R&D; and synergies.*

[39] *This comprises TFP data from both the NACE II (1995-2019) and NACE I databases (1970-2007). We note that an updated version of the EU KLEMS NACE II database was released in February 2023. This database includes an extra year of data but, in addition, compared to the previous iteration of this database, much of the data has changed for the same years and the same comparators. We have raised a query with EU KLEMS as to exactly what has driven this change.*

3B. Measuring TFP in practice

TFP can be assessed using two different methodologies: (i) value added (often labelled as 'VA'); and (ii) gross output (often labelled as 'GO').[40] These methodologies produce different productivity values. Therefore, when selecting which to use, one must assess the advantages and disadvantages of each, relative to the objectives at hand. Below, we provide an overview of each of these metrics.

- **Value added TFP**. The value added approach excludes intermediate outputs (materials, energy and services used up in the process of production), meaning that value added productivity measures the rate of change of real value added, compared to the rate of change of primary inputs (i.e. labour and capital). In practice, this is the difference between prices and costs.
  - Advantages: Most academic literature expresses the view that TFP is easier to calculate accurately using this method.[41] The rationale is that a value added approach (when compared to a gross output methodology) avoids the risk of double-counting intermediate outputs, which may vary greatly by industry and can be difficult to quantify.[42] A value added method can also account for differences in the quality of inputs, through its inclusion of prices.[43]
  - Disadvantages: This method can provide a distorted view of the impact of technology, as it removes the effect of changes in the prices of raw materials. In general, TFP estimates are 'higher' when a value added methodology is used. This is because the exclusion of intermediate goods and services can create an upward bias. Research has found that the value added methodology amplifies the size of TFP by between two and three times for most industries.[44] Whilst, in the short-term, this magnification factor can be approximated by the share of primary inputs within total inputs, this does not work over the longer term, where the share of primary inputs can vary.[45]
- **Gross output TFP**. The gross output approach includes intermediate outputs (materials; energy; and services, used up in the process of production). It measures the difference between the rate of change in the volume of outputs and the weighted average rate of growth of all combined inputs.

[40] *In this report, these labels may be used in equations and graphs, but not in the main body text.*
[41] *'Productivity measurements in Indian manufacturing: A comparison of alternative methods.' Kathuria.V; (2011).*
[42] *'The quadratic approximation lemma and decompositions of superlative indexes.' Diewert, W E; (December 2002).*
[43] *'Sources of output growth in Bangladesh food processing industries: a decomposition analysis.' Salim, R A; Kalirajan, K P. (September 1999).*
[44] *'On the Relationship between Gross Output-based TFP Growth and Value Added-based TFP Growth: An Illustration Using Data from Australian Industries.' Calver, M; (2015).*
[45] *'On the Relationship between Gross Output-based TFP Growth and Value Added-based TFP Growth: An Illustration Using Data from Australian Industries.' Calver, M; (2015).*

- Advantages: The advantage of this method is that it can separate primary inputs from intermediate inputs.[46] As above, primary inputs are defined as capital and labour, whilst intermediate inputs are energy; materials; and services. In practice, this allows the model to separate components like fuel and raw materials, from labour and capital. According to Norsworthy and Jang (1992), this offers an advantage over the value added methodology, particularly when there is rapid change in intermediate input prices, such as during the 1970s energy crisis.[47]

- Disadvantages: It is more complicated to calculate than the value added approach; and the data required to calculate gross output accurately is harder to collect.

In practice, TFP data is more frequently presented using the value added methodology, given that is easier to calculate. Specifically, both the EU KLEMS and ONS datasets use a value added methodology.

The EU KLEMS dataset also presents gross output figures (which, in the case of the UK, are based on the value added measures produced by the ONS, which are then adjusted to gross output). The use of gross output is aligned with Ofwat's position at PR19, where Europe Economics stated that gross output is a more accurate measure of frontier shift than value added, since *"Ofwat intend to apply the frontier shift estimates to totex or botex, both of which include expenditure on intermediate input"* and *"[a] gross output measure of TFP is also less sensitive to changes in the degree of outsourcing over time. Therefore, for sectors in which outsourcing is important, the gross output TFP measure is typically preferable."*[48] We also note that, in the EU KLEMS database, the water industry exhibits an average ratio of 0.46 between intermediate inputs and gross output (between 2015 and 2019),[49] relative to a median across all sectors of 0.48 – implying that intermediate inputs are important for the water sector.

In light of the above, we consider that **the gross output approach more appropriately reflects the scope for achievable frontier shift in the water industry**, than the value added approach.

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[46] *'Productivity measurements in Indian manufacturing: A comparison of alternative methods.' Kathuria.V; (2011).*

[47] *'Productivity measurements in Indian manufacturing: A comparison of alternative methods.' Kathuria.V; (2011).*

[48] *'Real Price Effects and Frontier Shift – Final Assessment and Response to Company Representations.' Europe Economics (December 2019); page 76.*

[49] *Data on the intermediate inputs was from the tab "II_CP", and gross output from the tab "GO_CP", both available from the file "National Accounts" for the UK here: https://euklems-intanprod-llee.luiss.it/download/.*

3C. Total factor productivity vs Frontier shift

Whilst it is established practice for TFP metrics to be used to derive estimates of ongoing efficiency (i.e. the frontier shift challenge), it is important to note the differences between the two measures. Whilst frontier shift represents the efficiency improvements that it is possible for even the most efficient firms to make over a period of time, (as above) TFP merely measures the change in the quantity of outputs relative to a change in the quantity of inputs (i.e. the change in outputs that cannot be explained by a change in inputs). Due to TFP's broader definition, there is debate over what is captured within the metric; and the most appropriate way to interpret and apply it, for regulatory price control setting purposes.

The main issues are: (i) TFP captures other efficiency savings that can be achieved, beyond just frontier shift; (ii) the potential understatement of frontier shift due to embodied change; (iii) the fact that the overall TFP estimate is highly sensitive to the choice of time period over which comparators are assessed. We discuss (i) and (ii) in more detail below; and we address issue (iii) in Chapter 4.

TFP captures multiple efficiency savings

As set out in the proceeding section, TFP growth measures the change in the ratio of outputs to inputs. This means that it is a measure of *all* efficiency improvements that have been made. Although ongoing efficiency (which is what the frontier shift challenge is intended to represent) is one way that a firm could achieve TFP growth, it is also possible to achieve growth through other efficiency improvements. We set out these efficiencies below.

- **Catch-up efficiency.** Specifically, TFP estimates also include catch-up gains, which are distinct from frontier shift gains, as explained in Section 2A. Specifically, if a firm, or firms, within an industry are not already operating at the efficiency frontier, TFP growth can be achieved via a firm 'catching-up' to the frontier. Catch-up efficiency will be present for <u>all</u> industries to some extent, as none are *perfectly* efficient (and no market is perfectly competitive), meaning that there will always be some firms that are operating behind the frontier.

- **Economies of scale.** These occur in scenarios where unit costs rise or fall, depending on whether a firm's output volume is increasing or decreasing. If an industry benefits from economies of scale, then an increase in inputs would lead to a more than proportionate increase in outputs, as the unit costs of producing the output would fall. This would show an improvement in TFP growth. However, it would not be caused by an outward shift in the production frontier (i.e. it would not be equivalent to frontier shift).

Following from the above, when using TFP estimates to determine the appropriate frontier shift challenge, it is important to consider these issues; and how they can be mitigated (e.g. through careful comparator selection). In Table 2, we summarise the implications for inferring frontier shift from TFP, arising from the above, and the potential mitigation options.

Table 2: Impact of efficiencies included in TFP estimates and available mitigations

Efficiency	Impact	Rationale	Potential mitigation
Catch-up	TFP will overstate frontier shift	This is because no sectors are perfectly competitive. This means that in any industry (used as a comparator) there are always some firms that operate behind the efficient frontier, so their TFP figures will contain a degree of catch-up.	To mitigate this as best as possible, comparators can be selected that operate in as 'competitive' markets as possible, such that fewer firms are a long way from the efficiency frontier.
Economies of scale	Symmetrical	Economies of scale will either over or understate frontier shift, depending on whether comparators benefit from greater, or smaller, scale effects (relative to the water industry), respectively.	To best control for this, comparators can be chosen which have similar: (i) proportions of fixed costs to the water industry (as there is generally a relationship between the proportion of fixed costs and achievable scale effects); and (ii) output growth rates (as scale effects may vary over time).

Source: Economic Insight analysis

The potential understatement of frontier shift due to embodied change

When measuring potential frontier shift, it is important that both embodied and disembodied technological change are included, in order that the full scope for productivity gains is captured:

- **Embodied** technological change relates to productivity gains generated by improvements in the design and quality of new capital equipment, and intermediate products, compared to using older iterations of the same equipment (i.e. embodied change captures the use of *new* technology and assets).

- **Disembodied** technological change relates to gains made without improvements arising from the use of new equipment (i.e. disembodied change captures gains from the use of *existing* technology and assets).

TFP estimates by definition *include* disembodied change, meaning that the key considerations here relate to embodied change. There are two main questions when considering embodied change in relation to a frontier shift challenge for the water industry, as derived from TFP data. Namely:

  - what is the amount of embodied change that is included in / excluded from TFP?; and

– what is the scope for the water industry to make TFP gains from embodied technological change, relative to any comparators used to inform the frontier shift challenge?

Below, we discuss each in turn.

The amount of embodied change that is included in / excluded from TFP

A TFP measure that *excludes* embodied change in effect has an input measure that includes quality adjustments that reflect the benefit of new technologies, but which are not reflected in the change in outputs. As a result, the *'true'* productivity gains for that sector would be understated. The amount of embodied change that is *include*d in TFP is, however, unclear (and is the subject of considerable debate in the academic literature). It is *generally* considered that TFP does not *fully* capture embodied technological change; but, as it is difficult to entirely account for quality changes in the inputs, it is likely that *some* embodied change will still be included within TFP. It is also likely that the relative share of embodied change that is captured in TFP varies considerably by sector. Figure 6 shows how gross output TFP growth in the EU KLEMS database (both NACE I and NACE II) has changed over time for the UK as a whole. As can be seen, productivity growth is highly volatile, with frequent peaks and troughs. If TFP included *only* disembodied change, then the entirety of these movements would be due to shifts in the way that companies use *existing* infrastructure / assets. Therefore, the processes used by companies when producing outputs based on their current inputs would need to improve and then worsen substantially (often within the space of just a few years).

Figure 6: TFP growth data - EU KLEMS NACE I and NACE II databases

Source: Economic Insight analysis of EU KLEMS data

We consider the above is unlikely to be the case, given that this would require companies to: acquire knowledge / establish best practices / make technological progress, relating to their use of *existing inputs,* and then suddenly *'go backwards'.* We consider it more plausible that the large observable movements in TFP at the UK level are consistent with the data reflecting embodied technological change (at least to some degree). Indeed, this point has also recently been made by the Bundesbank, when analysing productivity across the EU:

> *"The long-term development of TFP is sometimes also seen as an indicator of disembodied technological progress. In the short term, though, it is difficult to make such an interpretation. Even in the case of severe economic downturns, decreases in technological progress* [from existing technology / assets] *can, if at all, only be regarded to a very limited extent as a plausible explanation for calculated TFP declines. Furthermore, due to its residual character, the contribution of TFP can also pick up other influences on labour productivity. Against this background, there is good reason to interpret TFP more broadly and to view it as a metric of production efficiency"*[50] [emphasis added].

Specifically, the Bundesbank is proposing that technological progress / decline from the utilisation of *existing* assets (i.e. disembodied change) can only explain a small part of the extreme changes in TFP across Europe. As a result, technological progress / decline from the utilisation of *new* assets (i.e. embodied change) must explain the majority of these changes.

The academic literature also makes the above point, and highlights the complexity in determining precisely 'what' TFP measures. Hulten (2000) provides the following helpful characterisation:

Firstly, on the intuition for why one might *not* think TFP fully captures embodied technological change, the author refers to the Solow Paradox. This refers to the 'new economy' critique of TFP statistics, which relates to various arguments made that the slowdown in productivity seen in the USA in the late 1960s and early 1970s was at odds with perceived benefits from technological change that occurred at that time (e.g. the computing revolution). In relation to this, Robert Solow in 1987 famously argued that: *"[y]ou can see the computer age everywhere but in the productivity statistics."*[51] In his paper, Hulten summarises the point more broadly as: *"one might well say that we see new technology everywhere but in the productivity statistics."*[52]

Secondly, and on the other hand, Hulten explains the counterpoint: *"However, there is another 'new economy' paradox that has been largely overlooked: if the missed quality change* [arising from new technology] *is of the magnitude suggested above* [an upward bias of 0.6 percentage points in CPI per year to account for quality improvements]*, the quality of the goods in past centuries – and the implied standard of living – must have been much lower than implied by official (and allegedly quality-based) statistics. Indeed, taken to its logical conclusion… quality adjusted average income in 1774…* [would be] *dubiously*

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[50] *'The slowdown in euro area productivity growth.' Deutsche Bundesbank Monthly Report (January 2021); page 20.*
[51] *'Total factor productivity: a short biography.' Hulten, C; NBER (January 2000); page 2.*
[52] *'Total factor productivity: a short biography.' Hulten, C; NBER (January 2000); page 3.*

small."[53] Put simply, Hulten suggests that growth in average income has been so significant over time that, if this somehow completely excludes embodied change, the starting point (for average income) seems implausible.

He then summarises the above-mentioned two points as follows: *"In other words, conventional estimates of productivity growth are either much too large or much too small, depending on one's view of the matter. The truth undoubtably lies somewhere between the two extremes."*[54]

Further, as was detailed in Section 4B, economic growth and TFP are shown to be highly correlated. This is further consistent with embodied technological change being captured (to some degree) in the TFP data. The intuition for this is as follows. Firstly, embodied technological change (by definition) requires investment in new technology (i.e. investing in new assets). Secondly, therefore, its impact on productivity is likely time variant; and will be higher in periods of greater investment and lower when the opposite is true. Consequently, if TFP *fully* excluded embodied technological change, one would arguably not expect such a close correlation between TFP and GDP % growth (i.e. because an important 'time varying' driver was being omitted, which would give rise to a poorer fit between the variables). We recognise that this is a matter of degree.

Consistent with the above discussion, an overview of the EU KLEMS dataset sets out the following, *"[u]nder strict neo-classical assumptions, TFP growth measures disembodied technological change. In practice, TFP is derived as a residual and includes a host of effects such as improvements in allocative and technical efficiency, changes in returns to scale and mark-ups and technological change proper. All these effects can be broadly summarised as "improvements in efficiency", as they improve the productivity with which inputs are being used in the production process. In addition, being a residual measure, TFP growth also includes measurement errors and the effects from unmeasured output and inputs"*[55] [emphasis added]. In effect, the description implies that EU KLEMS TFP (and ONS MFP) estimates *mainly* (but not *exclusively*) reflect disembodied technological change.

Recognising the importance, but complexity, of this issue, we sought views from the ONS as to the appropriate interpretation of the data (noting that EU KLEMS draws on the ONS' data). In response, the ONS told us that: *"whilst multifactor productivity should measure just the disembodied change, we do think that there is likely some embodied change in the measure."*

In recent decisions, Ofwat, Ofgem and the CMA have all stated that, in their view, TFP largely excludes embodied change. The CMA took the view that the EU KLEMS TFP data "*did not seek to measure productivity growth resulting from changes in embodied technical change*".[56]

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53 'Total factor productivity: a short biography.' Hulten, C; NBER (January 2000); page 3.
54 'Total factor productivity: a short biography.' Hulten, C; NBER (January 2000); page 4.
55 'An overview of the EU KLEMS Growth and Productivity Accounts.' European Commission (October 2007).
56 'Anglian Water Services Limited, Bristol Water plc, Northumbrian Water Limited and Yorkshire Water Services Limited price determinations Final report.' CMA (March 2021); paragraph 4.553.

From the above discussion, we summarise that the question of the extent to which embodied technological change is included in the TFP data has no clear cut or easy answer. However, for the purpose of determining the appropriate approach to inferring frontier shift from TFP data, some progress can, nonetheless, be made.

Recall that (as was discussed in Section 2B) gross output TFP estimates draw on inputs from labour, capital and intermediate outputs (with value added measures using just labour and capital). Quality adjustments are then applied to capital assets and intermediate inputs, in order to try to remove the effect of quality changes over time from these inputs (i.e. implying TFP would measure disembodied change).[57] However, there is likely a margin of error in this approach, such that not all of the 'quality' is removed (i.e. some embodied technological driven change remains). From this, we consider that TFP data for comparator sectors that use relatively more capital (and intermediate inputs), is likely to include a greater amount of embodied change.

Following from the above, rather than assume a 'blanket' adjustment for embodied change should be applied to any frontier shift derived from TFP data, we consider it more appropriate to consider the *specific comparator industries* being used. In Section 6B, we have therefore undertaken an initial assessment of the comparator sectors proposed under our analysis, in order to provide some indication of the extent to which embodied change may be included in their TFP data (relative to industries 'on average' in the UK).

This type of analysis provides a useful first step in determining 'how appropriate' an adjustment may be. However, it is objectively extremely challenging to determine precisely 'how much' of any comparator industries' embodied technological related productivity gains are captured in the TFP data.

The applicability of embodied change from comparator sectors to the water industry

Notwithstanding the inherent challenge under the first question above of identifying 'how much' of an industry's TFP is embodied technological change related, there is a second question as to the *relevance* of that to determining frontier shift for the water industry. This turns on one's view on the scope for embodied change in the water industry (and whether that is higher, or lower, than the comparator sectors of relevance). We explain this further in the following.

Setting aside the measurement challenge above, suppose one came to the view that a comparator industry could achieve embodied technological change related productivity gains of 0.3% pa, but only 0.1% of that was included in its TFP data (and suppose its annual average TFP was 0.5%). At face value, this would imply that, in

57 *This adjustment is not applied to labour in the same way. Specifically, the labour input measure in the ONS MFP dataset is called the "Quality-adjusted labour input" (with further details provided in Annex 2). However, we note that the quality adjustment is different in this situation as it is intended to adjust the number of hours worked by employees, based on the factors listed above (i.e. their "quality"). Therefore, for this "quality" to increase over time, it would be necessary to adjust the mix of employees. In contrast to this, embodied change relates to changes in the quality of the* <u>*same*</u> *inputs over time, i.e. without changing the mix of inputs used.*

inferring a frontier shift challenge for the water industry from the comparator TFP data, one would need to make an upwards adjustment of 0.2% for (excluded) embodied technological change (i.e. 0.3% of embodied change related gains, less the 0.1% of that included in the TFP data = 0.2%). However, this is not necessarily correct. For example:

- If, in fact, the water industry could achieve *higher* embodied technological change related gains than the comparator of (say) 0.4% pa, the above adjustment would be too small.
- If, alternatively, the water industry could achieve *lower* embodied related technological change related gains than the comparator of (say) 0.1%, the above adjustment would be too large.

Thus, having come to a view on the 'extent' of embodied change captured in the comparator TFP data in the first place, one must secondly also consider the scope for the water industry to make embodied technological related gains on a forward-looking basis (relative to said comparators).

In Section 6B, we therefore undertake an initial assessment of the likely extent to which comparator sectors are similar to the water industry, in terms of their technological progress. We then use this to arrive at a high-level view of the extent to which any excluded embodied change, from the TFP estimates of our chosen comparators, is applicable to the water industry.

As per the first question, there is no straightforward way of 'quantifying' the forward-looking scope for embodied technological change in the water industry, relative to the comparators used when inferring frontier shift. However, as a general observation, we note that the water industry is characterised by high value capital assets that last for a long time, which are then replaced at the end of their lifecycle by (broadly) similar infrastructure assets. In other words, it is not, at first blush, an industry in which one would expect rapid technological change (i.e. one would not expect high embodied technological related gains, relative to other industries).

Summary of our views

We find that it is appropriate to consider applying an adjustment to frontier shift, to reflect the fact that embodied technological related change may not be *fully* captured in the TFP data. However, in light of the evidence, we caution against any 'broad brush' mechanistic upwards adjustment. Rather, an appropriate approach would be as follows:

- Firstly, with respect to the specific comparators used to infer frontier shift, consider the scope for embodied change to be excluded from the TFP data. More embodied change is likely captured in TFP for industries with higher capital intensity and more intermediate inputs.
- Secondly, come to a view on the likely scope for technological change in the water industry, relative to any comparators used above.

- Thirdly, take the findings from the above two steps into account when determining 'where' in the range of frontier shift estimate to select (rather than making any formal adjustment).

3D. CPIH will capture productivity gains to some degree

A further important consideration is that CPIH itself (which is used to index the RCV under the regulatory framework) must logically capture productivity gains. That is to say, CPIH is a broad measure of consumer inflation faced in the UK. The main drivers of general movements in consumer prices will be: (i) changes in underlying costs incurred in producing goods and services; (ii) changes in the demand and supply of said goods and services; and (iii) efficiency savings achieved by firms producing those goods and services.

The above is problematic to the extent that it may contradict Ofwat's approach to compensating companies for inflation at PR24. That is to say, at PR19, Ofwat's position was that CPIH likely compensated companies for input costs changes; and so the regulator only provided separate allowances for movements in input costs (real price effects) to the extent that those differed from CPIH. Under that logic, however, the same lens should be applied to frontier shift. That is to say, Ofwat should only set a challenge relating to frontier shift to the extent that the 'industry specific' frontier shift differs from the productivity gains already implicitly captured within CPIH.

It is therefore important that, at PR24, Ofwat applies an internally consistent approach between compensating companies for input cost inflation and the setting of a productivity (frontier shift) challenge. Absent this, there is scope to apply an inappropriately high frontier shift for companies, as productivity gains are effectively double-counted. We have not, within the scope of this report, sought to estimate the frontier shift challenge implicit in CPIH.

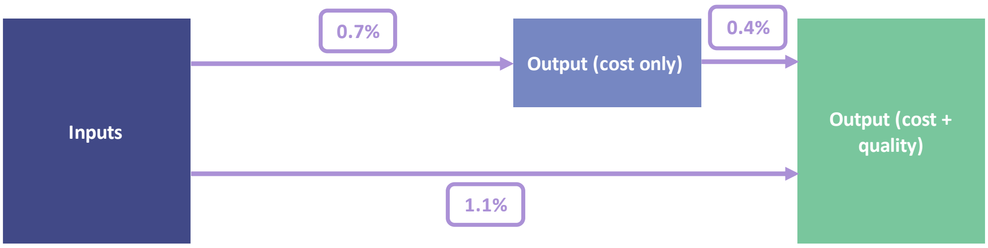
3E. Ofwat's performance commitments represent efficiency improvements

We note that the above consideration of quality-adjusted output is separable from the central, and more material, issue here: which is that the total of any efficiency estimates must be allocated between cost reductions and quality improvements, in order to avoid a double-count.

Ofwat sets companies performance targets to encourage firms to improve the quality of their output over time. As set out in the preceding chapter (see Section 2A), efficiency savings (both ongoing, and catch-up) can be achieved through a combination of both cost savings, and/or quality improvements. Therefore, Ofwat's performance commitments (quality improvement targets) represent an efficiency challenge, *in addition* to the efficiency challenge (both ongoing, and catch-up) as applied to costs. Put another way, as Ofwat is asking companies to achieve quality improvements out of base funding, the regulator is, by definition, requiring them to be achieved through efficiency. Thus, the performance targets themselves represent a mix of catch-up and ongoing efficiency for most companies (but for the 'frontier' company, implicitly only represent an ongoing / frontier shift challenge).

The consequence of this is that we need to calculate a 'cost-quality measure' of frontier shift, in order to avoid an overstatement of the appropriate level of frontier shift to apply to costs at PR24. That is, once the scope of total frontier shift water companies can make over the period has been determined (using TFP estimated from comparators), one needs to then determine what share of this will be delivered through quality improvements; and apply only the residual/remainder (should there be any) to cost reductions. Below, we present an illustrative example to help further explain the issue.

Figure 7: Illustrative example of cost-quality measure of frontier shift



Source: Economic Insight

With reference to Figure 7, suppose that Ofwat determined (as per PR19) that the total frontier shift challenge should be 1.1%. As explained previously, under the comparator method used to derive this, the 1.1% represents total gains that said comparator firms realised through various combinations of cost reductions and quality / output increases. Therefore, in order to avoid a double-count, it would be necessary to:

- Determine the total efficiency challenge implicit in the performance commitments set at PR24 (i.e. the improvements companies are being asked to make out of base costs).
- Determine what proportion of the above is frontier shift, as opposed to catch-up.
- And then only apply the residual / remaining amount of frontier shift to company base costs (and likewise, only apply the residual amount of catch-up to company base costs).

In the above example, suppose that the performance commitments translated to a frontier shift efficiency requirement of 0.4%; this would leave 0.7% of frontier shift to be allocated to reducing base costs (assuming 1.1% was the appropriate overall target for frontier shift). In this example, clearly the application of the entirety of the 1.1% frontier shift challenge to costs would be a double-count, as companies would (in addition) be required to make a further frontier shift saving of 0.4% under their performance commitments.

There are two methodological steps required in order to address this issue:

- the overall % efficiency challenge implicit in performance commitments must be estimated; and
- this must then be split between catch-up and frontier shift.

In principle, an appropriate way to measure the former would be as follows:

$$QE = \frac{(PCL - PL) * MCe}{Base\ totex}$$

Where:

- QE is the total % efficiency challenge a company is implicitly set under a performance commitment;
- (PCL – PL) is the difference between the target performance commitment level and a company's current actual outcomes performance; and
- MCe is an estimate of the efficient marginal cost of making the improvement.

Whilst, in principle, the above approach is straightforward, in practice in the water industry (under the current regulatory framework) it may be challenging. The main challenge relates to the estimation of marginal costs, which may be inherently difficult for so long as performance commitments are relatively 'narrow' (i.e. multiple, specific metrics) in a network industry, with a high degree of joint and common costs.

Notwithstanding the above practical considerations, the materiality of the issue should not be ignored at PR24. Indeed, it is plausible that the scale of efficiency savings implicit in the targeted quality improvements (performance commitments) are so large that there is no residual left over for cost efficiencies.

The allocation of any efficiency gains that companies are required to make under their performance commitments (once estimated as above) between catch-up and frontier shift is more straightforward, in that several practical methods likely exist. For example, one could simply take the 'benchmark firm' (or firms) as under Ofwat's base cost assessment, and then say that the totality of their required outcomes performance improvement (under their performance commitments) is the frontier shift element.

4 Time periods for analysis

In this chapter, we set out our choice of time periods for our analysis and rationale for selecting them. Specifically, we present: (i) the key considerations that need to be taken into account when determining time periods; (ii) recent evidence regarding the UK's economic performance; (iii) our resultant choice of time periods; (iv) a comparison with Ofwat's approach at PR19; and (v) a discussion of the relevance of lower recent productivity to the water industry.

4A. Key considerations

As economic performance and productivity are highly correlated, estimates of frontier shift are sensitive to the time period over which any comparator industry's TFP is assessed. When considering which time period(s) to use, there are several considerations that need to be taken into account. These are as follows:

- **Internal consistency**. It is important that the time period used to determine frontier shift is consistent with the time period (and assumed economic context) used to inform other key components of the price control (e.g. equity returns, given their correlation with productivity and growth). Therefore, this should be something that Ofwat considers when choosing the period for the purpose of deriving frontier shift estimates at PR24. In its Draft Methodology, Ofwat states "*while the water sector showed relatively strong productivity post privatisation with growth of 3 to 4% per year between 1994 and 2000, it appears to have stagnated since 2011 with weak growth since then*".[58] One interpretation of this is that Ofwat will favour pre-crisis time periods for its frontier shift analysis. If Ofwat does take this approach, however, it raises questions as to why (for the purpose of determining the cost of equity, for example) it would also not need to place similar weight on said time period.

[58] *'Creating tomorrow, together Consulting on our methodology for PR24.' Ofwat (July 2022); page 68.*

- **The structural break arising from the financial crisis**. The 2008 financial crisis coincides with a structural break in UK productivity (and consequently GDP growth) performance, worsening it substantially. Section 4B demonstrates that post financial crisis growth has not returned to pre-crisis levels. Until recently, data has not been available to assess a full business cycle affected by the financial crisis. However, following the publication of additional data, trough-to-trough analysis (using annual GDP growth data from the ONS and World Bank) now indicates a business cycle from 2010 until 2020 (shown in Figure 11 and Figure 12 below). When determining frontier shift on a forward-looking basis, it seems appropriate to place increasing weight on more recent time periods, given the clear persistence of depressed productivity performance in the UK (i.e. this is not a water industry specific issue). That we now have a full business cycle's worth of data post-crisis makes this more practical than previously.

- **The inclusion of full business cycles**. Because productivity is shown to be pro-cyclical, ideally the high and low periods of business cycles should be included within any time period used to estimate frontier shift. We have used estimates by the Economic Cycle Research Institute (ECRI) to determine the UK business cycles, in addition to the above-mentioned trough-to-trough analysis.

- **The utilisation of the data available**. Maximising the number of observations used in estimating frontier shift reduces the risk of outliers affecting the results.

The above points require (to some degree) trade-offs to be made when determining the estimation time period. Therefore, to understand which factors to prioritise, one must be clear on the question one is seeking to answer. In this case: *'what is the scope for frontier shift specifically over PR24?'*. As productivity and economic performance are well correlated, it is important to begin addressing this question by understanding the UK's likely economic outlook over the PR24 period, which we turn to below.

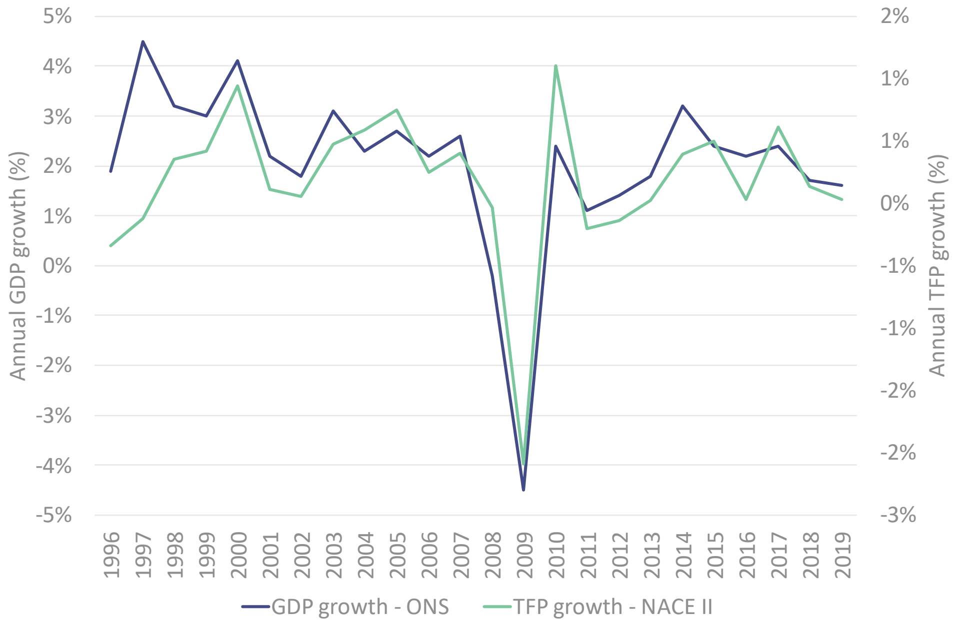
4B. Recent evidence of the UK economic situation

When choosing a historical period over which to estimate the frontier shift challenge using comparator data, it is important that this period shares similar characteristics with those forecast for PR24. Here, and as we show further below, a key point is the strong correlation between growth and productivity (as expected under economics theory and shown in previous empirical studies) in the UK. Consequently, if economic forecasts for the UK over the PR24 period are generally consistent with a continuation of low growth and productivity; then it would be appropriate to use an estimation period for TFP (frontier shift) that shares those characteristics. Put another way, it would seem 'odd' to use a period where growth and productivity were much higher.

Correlation between productivity and growth

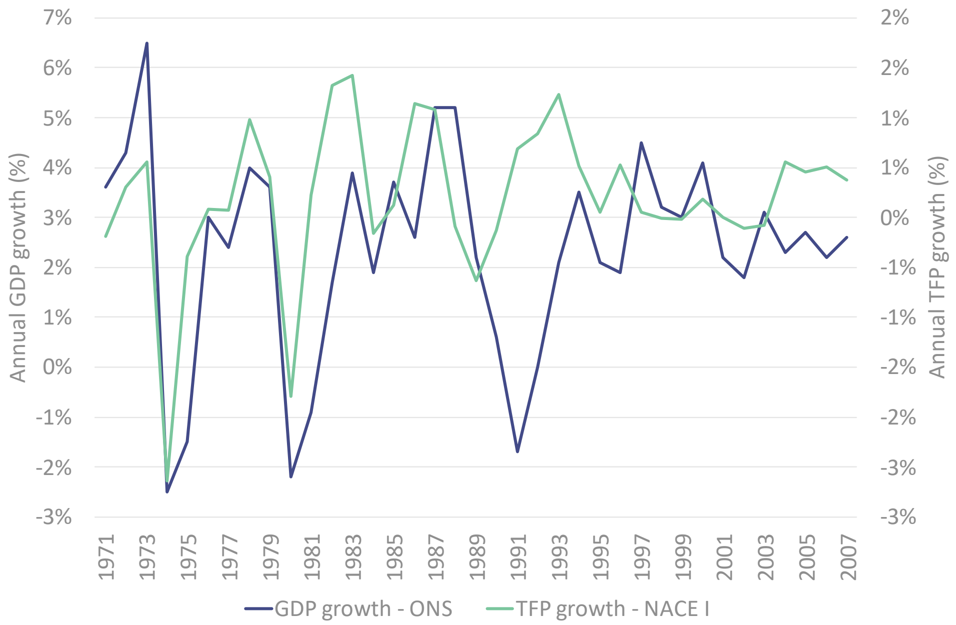
Figure 8, Figure 9 and Figure 10 show economic growth and productivity are strongly correlated with one another. This is the case whether using the TFP gross output growth data from EU KLEMS (NACE I and NACE II), or value added MFP growth data from the ONS.

Figure 8: Relationship between economic growth and productivity - NACE II TFP growth



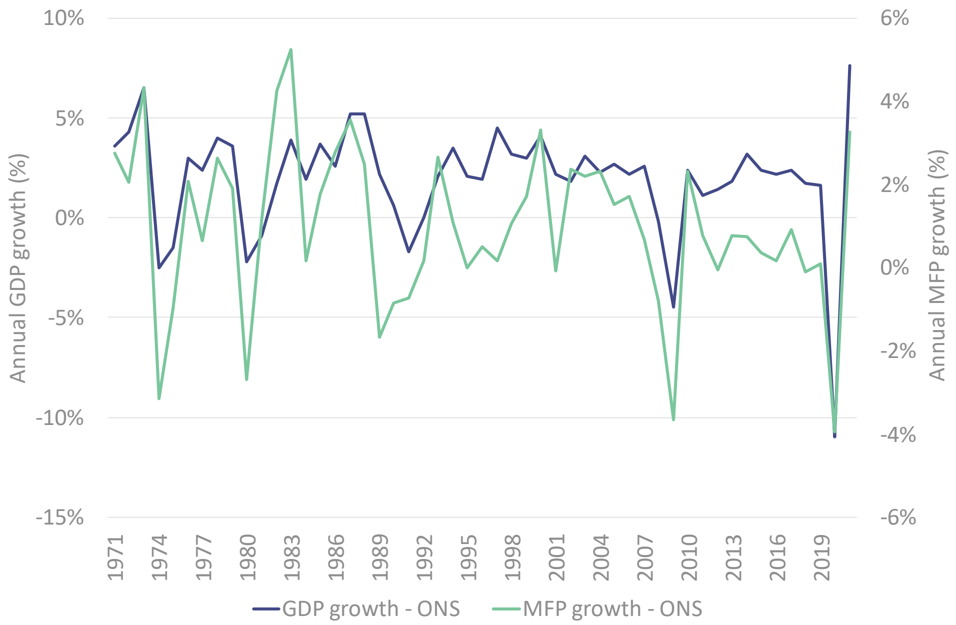
Source: Economic Insight analysis of ONS and EU KLEMS data

Figure 9: Relationship between economic growth and productivity - NACE I TFP growth



Source: Economic Insight analysis of ONS and EU KLEMS data

Figure 10: Relationship between economic growth and productivity – ONS MFP growth



Source: Economic Insight analysis of ONS and ONS MFP data

UK economic outlook

The UK economic outlook is fragile and uncertain, both over the immediate term and PR24. The economy is currently characterised by: significant levels of public debt;[59] high inflation;[60] rising interest rates;[61] low rates of business investment;[62] low to falling GDP growth;[63] relatively high levels of taxation (by historical standards);[64] and high rates of business closures.[65]

In Table 3, we have summarised published forecasts for UK real GDP growth over time from credible sources. However, limited inferences can be drawn from this as regards

[59] *The ONS states that: (i) "Public sector net debt excluding public sector banks (PSND ex) was £2,503.6 billion at the end of December 2022, which was an increase of £132.7 billion compared with December last year"; and (ii) "The extra funding required by government over the course of the coronavirus (COVID-19) pandemic, combined with reduced cash receipts and a fall in gross domestic product (GDP), have all helped to push public sector net debt at the end of December 2022 to 99.5% of GDP." Please see: https://www.ons.gov.uk/economy/governmentpublicsectorandtaxes/publicsectorfinance/bulletins/publicsectorfinances/december2022#debt.*

[60] *Please see: https://www.ons.gov.uk/economy/inflationandpriceindices/bulletins/consumerpriceinflation/december2022#consumer-price-inflation-rates; Figure 1.*

[61] *Please see: https://www.bankofengland.co.uk/boeapps/database/Bank-Rate.asp.*

[62] *The ONS has found that: "Business investment in Quarter 3 (July to Sept) 2022 remains below pre-coronavirus (COVID-19) levels at negative 8.1%". Please see: https://www.ons.gov.uk/economy/grossdomesticproductgdp/bulletins/businessinvestment/julytoseptember2022revisedresults#business-investment-growth-revised-down-as-levels-increase.*

[63] *Please see Table 3.*

[64] *The upper band of the 2022-23 basic income tax rate is 9% greater than in 2007-2009; and 35% greater than in 1999-2000. Please see: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1086426/Table-a2.ods.*

[65] *The ONS has found that: "The number of closures in Quarter 4 2022 is the second highest Quarter 4 figure since the start of the series in 2017, with only Quarter 4 2021 at a higher level. It is also the sixth quarter in a row where there have been more closures than creations." Please see: https://www.ons.gov.uk/businessindustryandtrade/business/activitysizeandlocation/bulletins/businessdemographyquarterlyexperimentalstatisticsuk/octobertodecember2022#business-closures.*

PR24, as only the OBR and Bank of England have published forecasts for 2025 or later. We also note that the OBR has a materially more optimistic forecast then the Bank; which again, indicates that caution should be exercised in interpretating these projections.

Table 3: Annual real GDP growth forecasts

Agency	Date of forecast	2023	2024	2025	2026	2027
HM Treasury	January 2023	-0.9%				
IMF	January 2023	-0.6%	0.9%			
OECD	November 2022	-0.4%	0.2%			
OBR	November 2022	-0.6%	1.2%	2.5%	2.6%	2.2%
Bank of England	November 2022	-1.5% (1.0%)	-1.0% (1.5%)	0.5% (2.0%)		
Average		**-0.8%**	**0.3%**	**1.5%**	**2.6%**	**2.2%**

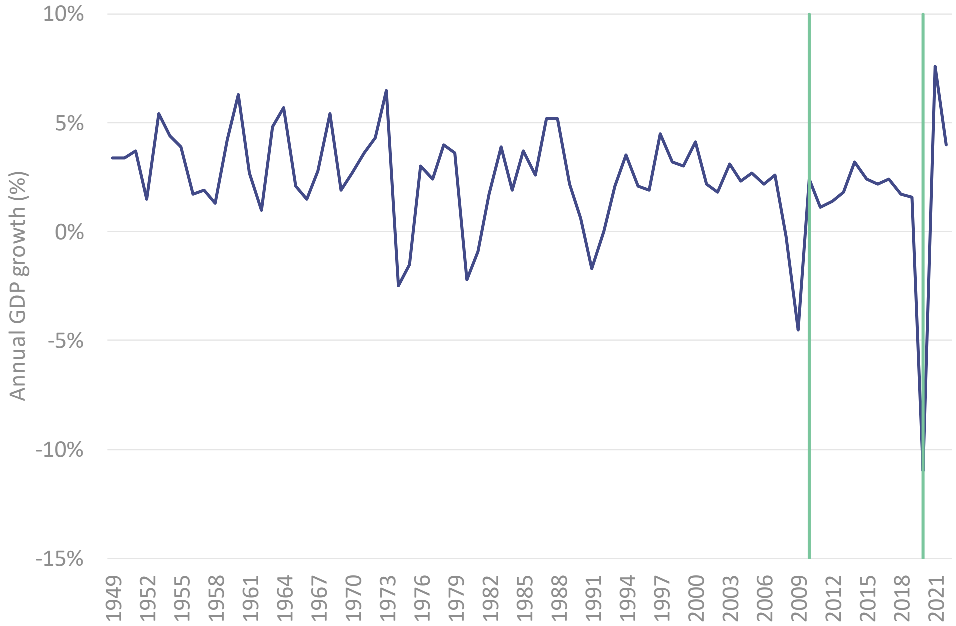
Source: (i) 'Forecasts for the UK economy: a comparison of independent forecasts.' HM Treasury (January 2023); (ii) 'WORLD ECONOMIC OUTLOOK UPDATE.' IMF (January 2023); (iii) 'Economic Outlook.' OECD (November 2022); (vi) 'Economic and fiscal outlook.' OBR (November 2022), Table A.3; and (v) 'Monetary Policy Report.' Bank of England (November 2022), Table 1.D.
Notes: (i) Figures for the OBR are provided on a financial year basis, which we have converted to calendar year by calculating a weighted average of the two calendar years based on the number of months in each; and (ii) world GDP figures are shown in brackets for the Bank of England forecasts.

As more forecast data becomes available, it will be helpful to see if a clearer view of economic performance for the UK emerges. At this point, we would merely highlight the long persistence of low productivity performance (15-years), which is common across the majority of UK sectors.

The most recent business cycle

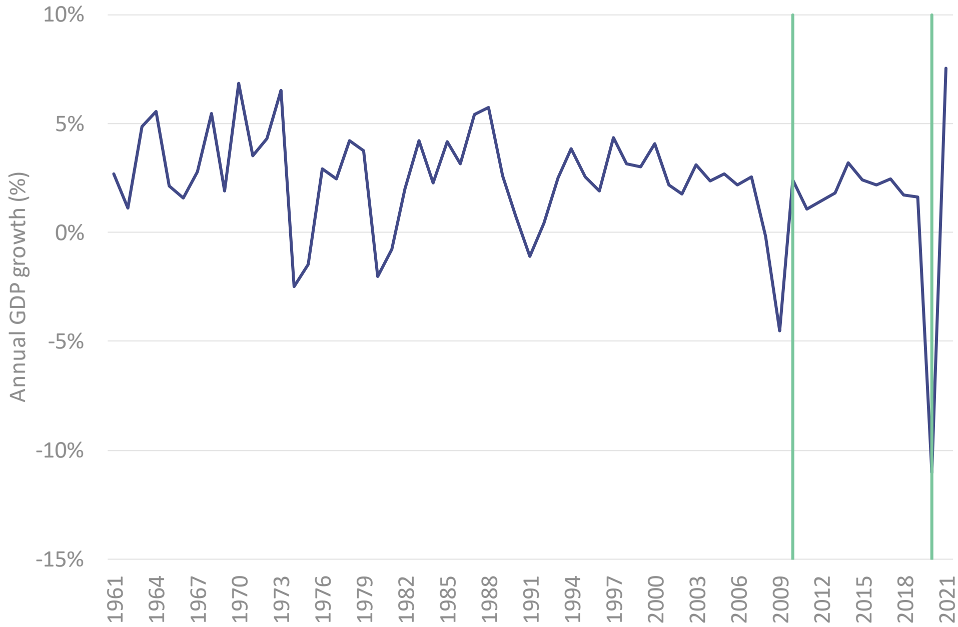
When Ofwat determined its frontier shift estimates for PR19, the UK economy was in the middle of a business cycle. Therefore, the regulator did not have a full view of TFP estimates for the most recent business cycle. However, we consider that this is no longer the case. Figure 11 and Figure 12 show UK annual GDP growth, based on data published by the ONS and World Bank, respectively. These cover the periods 1949-2022, and 1961-2021, respectively. Using trough-to-trough analysis, these figures both suggest that the most recent economic cycle is now 2010-2020 (with 2010 corresponding to the year after the end of the previous business cycle in 2009), meaning that this is now an important time period to consider for estimating frontier shift at PR24.

Figure 11: Recent business cycle based upon ONS annual GDP growth



Source: Economic Insight analysis of ONS data

Figure 12: Recent business cycles based upon World Bank annual GDP growth



Source: Economic Insight analysis of World Bank data

Further to the above, the ECRI has published the peak and trough dates for business cycles across 21 different countries, including the UK, since the 1970s. These dates are broadly consistent with the trough-to-trough analysis from Figure 11 and Figure 12, indicating that the most recent business cycle now corresponds to 2010-2020. These are reported in Table 4.

Table 4: ECRI UK business cycle peak and trough dates, 1974 - 2020

Business Cycle	Peak / Trough	Dates
1974-1975	Peak	September 1974
	Trough	August 1975
1975-1981	Peak	June 1979
	Trough	May 1981
1981-1992	Peak	May 1990
	Trough	March 1992
1992-2010	Peak	August 2008
	Trough	January 2010
2010-2020	**Peak**	**October 2019**
	Trough	**April 2020**

Source: Economic Insight analysis of 'Business Cycle Peak and Trough Dates, 22 Countries, 1948-2020.' (ECRI) (last accessed 9 February 2023).

4C. Our choice of time periods

Based on the evidence presented in this chapter, we consider that the frontier shift challenge at PR24 should be set mindful of: (i) the latest official UK economy forecasts, which are that economic conditions are likely to remain poor; and (ii) the now more than decade long persistence of low productivity. Both of these imply that one should take care not to attach undue weight to earlier time periods in which growth and productivity were (substantially) higher, given the aim to determine frontier shift over PR24. Nonetheless, we also consider that it is helpful to include data from periods that allow us to show what frontier shift *could* be, if the structural break in productivity from the financial crisis unwinds (to some degree) over the course of PR24, i.e. that incorporate data from before the financial crisis.

As such, we consider that the following represent 'plausible' time periods for our analysis:

- **Time Period 1: 2010-2019 (EU KLEMS NACE II)**. This covers the majority of the most recent business cycle (which we consider to be 2010-2020), noting that data on TFP estimates is unavailable in 2020 within the NACE II database. As a result, we consider that our frontier shift estimates using this period may, in fact, be biased upwards, given that the final year of poor economic performance in the UK is not captured in this period.

- **Time period 2: 1995-2019 (EU KLEMS NACE II).** This covers the whole period for which data is available in the NACE II database, in addition to the majority of the two most recent business cycles (which we consider to be 1992-2009; and 2010-2020); noting, as above, that data is unavailable in 2020, or before 1995, in the NACE II database.

- **Time period 3: 1970-2007 (EU KLEMS NACE I).** This covers the whole period for which data is available in the NACE I database, in addition to the vast majority of the four business cycles before the financial crisis (which we consider to be 1970-1974; 1975-1980; 1981-1991; and 1992-2009); noting that data is unavailable beyond 2007 in the NACE I database.

In Chapter 7, we set out the headline results of our analysis (with full results in Annex 3), in which we define three different ranges for our frontier shift estimates:

- **Plausible range.** This includes the following time periods: (i) **Time Period 1: 2010-2019 (EU KLEMS NACE II)**; (ii) **Time Period 2: 1995-2019 (EU KLEMS NACE II)**; and (iii) **Time period 3: 1970-2007 (EU KLEMS NACE I)**.

- **PR24 focused range.** This includes the time periods: (i) **Time Period 1: 2010-2019 (EU KLEMS NACE II)**; and (ii) a weighted average of **Time Period 2: 1995-2019 (EU KLEMS NACE II)** and **Time period 3: 1970-2007 (EU KLEMS NACE I)**.

- **Sensitivity analysis range**. This includes the three time periods listed in the *'plausible range'* above, but also the **1992-2007 (EU KLEMS NACE I)** time period.

4D. Comparison with Ofwat

Our choice of time periods for the EU KLEMS analysis are *relatively* similar to those adopted by Ofwat at PR19, as summarised in Table 5.

Table 5: Comparison of time periods between Ofwat's and our approach

Ofwat's time periods (used at PR19)	Our closest comparable period	Reason for Ofwat choice
1971-2007 (NACE I)	1970-2007 (NACE I)	To use the entire period for which NACE I data is available.[66]
1990-2007 (NACE I)	1992-2007 (NACE I)	To use data from the entirety of the previous business cycle before the financial crisis.[67]
1980-1989 (NACE I)	N/A	To use data from the whole of a business cycle.
1980-2007 (NACE I)	N/A	To use data from the entirety of the previous two business cycles before the financial crisis.
1999-2014 (NACE II)	1995-2019 (NACE II)	To use data for the entire period for which NACE II was available.[68]
1999-2007 (NACE II)	N/A	To use all NACE II data from the pre-crisis period.
2010-2014 (NACE II)	2010-2019 (NACE II)	To use all data from the post-crisis period.[69]

Source: 'Real Price Effects and Frontier Shift – Final Assessment and Response to Company Representations.' Europe Economics (2019); page 75.

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66 *We note that the 1971-2007 (NACE I) and 1970-2007 (NACE I) periods used by Ofwat and us (respectively) are identical. The difference arises as Ofwat has recorded 1971 as the start of the range as this is the first year for which a growth rate is used in the TFP estimates over the range, whereas we have recorded 1970 as the start as this is the first year of data that is used in the TFP estimates over this range (with 1970 data forming part of the calculation for the 1971 growth rate).*

67 *We note that this differs slightly from the approach taken by Ofwat, in which 1990 was taken as the start of the business cycle. This is because we consider the evidence presented above suggests 1992 as the appropriate starting year to use. Nonetheless, we note that this has a minimal impact on our results.*

68 *We note that Ofwat's approach only used data from 1999 as TFP data from 1995-1998 was not available in the 2017 version of the EU KLEMS NACE II dataset used by Ofwat.*

69 *We note that Ofwat's approach only used data until 2014 as this was the latest year that TFP data was available in the 2017 version of the EU KLEMS NACE II dataset used by Ofwat.*

The main differences between our choice of time periods and Ofwat's are:

- **The exclusion of pre-crisis data**. Ofwat chose to use "1999-2007 (NACE II)" as one of its periods of analysis, on the basis that this captured (only) the pre-crisis period. However, we disagree with this approach, as we do not think it appropriate to 'remove' over a decade's worth of the most recent data (which is available in the NACE II database). This is especially because the more recent data likely provides a better indication of productivity potential over PR24, given the economic outlook detailed in Section 4B. We therefore do not think that weight should be attached to a time period that is *entirely* 'pre-crisis' (particularly now that more recent data exists, which also captures an entire business cycle), at the expense of periods that include 'post-crisis' data.

- **The use of historic data**. Ofwat also chose to use "1980-1989" as one of its periods of analysis, on the basis that this corresponded to a whole business cycle, prior to the one that ended in 2009. However, we consider that data from so long ago is increasingly unlikely to be representative of PR24. Again, given the increased availability of more recent data, we do not think that weight should be given to this time period *at the exclusion* of said recent data.

4E. Relevance of lower recent productivity

As we have discussed above, in its PR19 redeterminations, the CMA considered that the water industry may be less affected by the low levels of UK-wide productivity since the financial crisis. Specifically, the CMA noted that the range over the period it considered (1990 to 2007), produced higher results than more recent figures (e.g. 2008 to 2014), and that *"[t]here is substantial uncertainty as to whether the UK's productivity growth will rebound"*. However, it also felt that *"the water sector will be less affected by many of the factors which led more recent UK-wide productivity growth to be lower than the long-term average"*.[70] The CMA used this as part of its rationale for setting a frontier shift challenge towards the upper end of its range (i.e. implicitly attaching less weight to more recent data, during which productivity was depressed).

From an 'in principle' perspective, the points raised by Ofwat and the CMA do not seem unreasonable. That is to say, we can see that 'in principle' there could be factors that explain reduced productivity observed for some industries, following the financial crisis, that are less applicable to the water industry. However, in practice, the data and evidence is not, in fact, supportive of the position taken by Ofwat and the CMA.

The question of 'how relevant' post financial crisis data is to water can be considered in the context of examining productivity across UK industries pre and post-crisis. As such,

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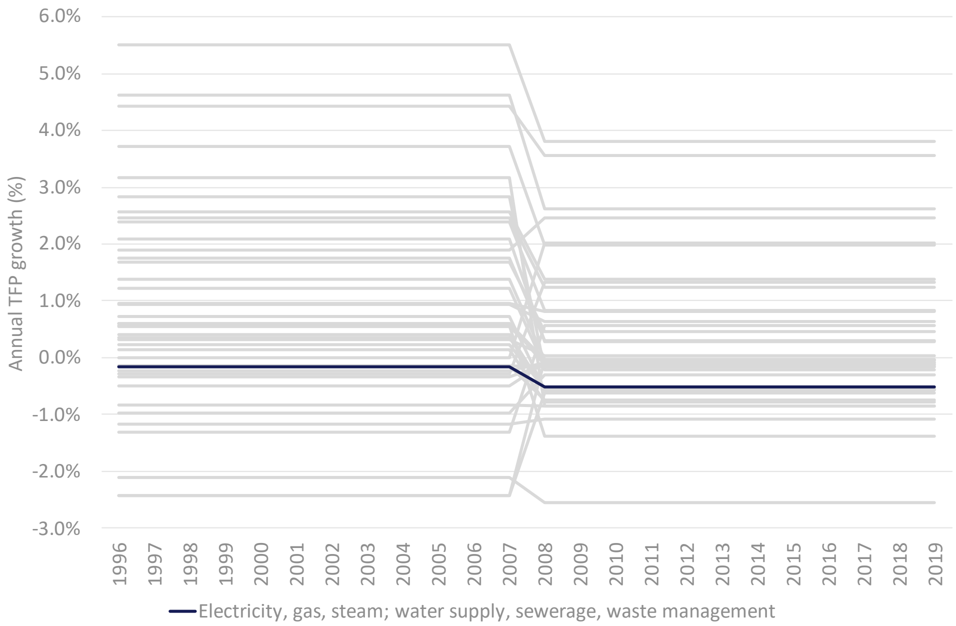
70 *'Anglian Water Services Limited, Bristol Water plc, Northumbrian Water Limited and Yorkshire Water Services Limited price determinations Final report.' CMA (March 2021); paragraphs 4.616.*

Figure 13 shows average annual TFP growth for industries in the EU KLEMS NACE II database[71] for the years up to 2007 (inclusive), and from 2008 (inclusive).

Figure 13: Average pre-and post-crisis TFP growth in UK industries



Source: Economic Insight analysis of EU KLEMS data

Following from the above, as regards the arguments put by Ofwat and the CMA, we would note:

- Firstly, the consistency of the reduction in productivity across multiple industries in the UK calls into question the plausibility of 'water being different'. That is to say, whilst (in principle) the characteristics of industries can vary, such that some might have been more / less affected by the factors that led to a downturn in productivity post-2008, in practice, we consistently observe a clear reduction in productivity across industries following the crisis. Thus, the Ofwat / CMA position would seem to require that 'water alone' was unaffected (or less affected).

- Secondly, in practice the data does, in fact, show a reduction in productivity in the water industry post financial crisis (see blue line in the above figure). Therefore, in practice, for the Ofwat / CMA position to hold, one would further need to believe that the reasons for this occurring in water were 'different' (i.e. unrelated to the wider UK productivity downturn) to those in other industries, and occurred at the same time, 'only by coincidence'. This is questionable.

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[71] *This is with the exception of: (i) Mining and quarrying; and (ii) Telecommunications. Average productivity in each of these sectors are significantly lower and greater, respectively, than the vast majority of other sectors. Therefore, they have been excluded to improve readability.*

- Thirdly, suppose the first two points above held (i.e. water alone was unaffected by the downturn; and the observed downturn in water was thus coincidental). Even if that were the case, for one to still take the view that lower productivity in water would not persist at PR24, it would also be necessary to believe that the 'reasons' for that low productivity in water (i.e. reasons other than those explaining the wider downturn in productivity in the UK, which are coincidental) would themselves not persist going forward. As this has not been established, the fact that water productivity has, in fact, been low, remains entirely relevant to an assessment of frontier shift at PR24 and means it is important to include data over a time horizon that accurately reflects that.

5 Comparator selection

In this chapter we provide an assessment of the comparators we consider relevant to informing the scope for TFP growth (and therefore frontier shift) in the water industry. In turn, we: (i) set out precedent from recent water industry decisions on comparator choice; (ii) detail a set of criteria that we use when considering comparator choice; (iii) present our choice of comparators; and (iv) discuss Ofwat's previous choice of comparators relative to our own.

5A. Precedent on comparator choice

During PR19 and the subsequent redeterminations Ofwat and the CMA broadly agreed on the industries that represent appropriate comparators to the water industry, for the purpose of assessing frontier shift. The industries considered were:[72]

- total manufacturing;
- construction;
- chemicals and chemical products;
- other manufacturing; repair and installation of machinery and equipment;
- transport and storage; and
- machinery and equipment n.e.c; and
- professional, scientific, technical, administrative and support service activities.[73]

Alongside the above comparators, Ofwat also reviewed a wider set of industries that included those assessed by various economics consultancies on behalf of water companies, which we have therefore also considered below.[74] Furthermore, in its Draft

[72] *We note that the names of these comparators have changed between the previous iteration of the EU KLEMS NACE II database, and the most up-to-date version. Please see Table 6 for the updated names of the comparators used by Ofwat.*

[73] *(i) 'Real Price Effects and Frontier Shift – Final Assessment and Response to Company Representations.' Europe Economics (December 2019); Table 3.9; page 71.; and (ii) 'Anglian Water Services Limited, Bristol Water plc, Northumbrian Water Limited and Yorkshire Water Services Limited price determinations: Final Report.' CMA (March 2021); Table 4-16; page 243.*

[74] *'Real Price Effects and Frontier Shift – Final Assessment and Response to Company Representations.' Europe Economics (December 2019); Table 3.8, page 71.*

Determination for the 2021-27 price control, UREGNI considered: "Manufacturing"; "Electricity, gas, steam and air conditioning supply"; "Transportation and storage"; "Financial and insurance activities"; and "Professional, scientific and technical activities; and administrative and support service activities".[75]

5B. Criteria

When exploring which comparators to consider for our analysis, our selection process has been consistent with best practice. This states that comparators should conform to three key criteria.

- **<u>Criterion 1:</u> Similarity of activities being undertaken.** To ensure that the parallels drawn between the comparators and the water industry are reasonable, it is important both undertake common (similar) activities. When activities are common between firms, one would expect productivity gains to be similar. Similar activities we have considered include: extraction and processing of a resource; operation and maintenance of a complex network; and the construction of major infrastructure.

- **<u>Criterion 2:</u> Competitiveness of industry.** Using comparators that operate in competitive industries means that TFP growth is more likely to have been primarily driven by frontier shift; and will be less driven by catch-up efficiency. Thus, by focusing on industries that are 'more competitive', this should allow us to somewhat mitigate (but not remove entirely) the overstatement of frontier shift that arises from 'catch-up' efficiency being included in any TFP figures.

- **<u>Criterion 3:</u> Extent of scale effects.** Because TFP also includes productivity gains achieved through economies of scale, it is important that comparators have a similar scope for scale-related gains to the water industry. This is to ensure that TFP estimates more accurately reflect achievable frontier shift. As was detailed above in Table 2, there are two ways in which the comparator choice can be used to mitigate against this:

  - We would expect there to be a high correlation between the extent of fixed costs in an industry and the extent of scale effects. Hence, having a similar proportion of fixed costs to the water industry is an important consideration when selecting comparators. Selecting industries with very different proportions of fixed costs to the water industry could either over, or understate the scope for frontier shift.

[75] *'Water & Sewerage Services Price Control 2021-27. Draft determination - Annex K Opex and Capex Frontier Shift.' UREGNI (September 2020); Table 3.1; page 20.*

- Efficiencies arising from scale effects vary over time, in part because they vary with growth rates. For example, for a given level of fixed cost, a faster growing firm benefits more from economies of scale than a slower growing firm. Hence, comparators that exhibit similar growth rates over time to the water industry further allow us to ensure that scale-related gains are likely to be similar over the relevant time period.

We have sought to apply our evaluation criteria transparently, so as to arrive at an objective view as to the appropriate comparators. In the following passages, we set out how we have applied these in practice. Note, before assessing any comparators against our set of criteria, we first filtered all the industries (in both the EU KLEMS and ONS databases) down to a set that contained just: (i) those previously considered by Ofwat and the CMA or by UREGNI;[76] and (ii) any further industries that we consider could share similar characteristics to the water industry.[77] We note that the application of this criteria applies to the NACE II industries, with the NACE I equivalents available in Table 12.

Criterion 1: Similarity of activities being undertaken

For Criterion 1, we undertook a qualitative assessment of the extent to which we considered the industry to share similar activities to those of water companies. For those comparators we assessed, our ranking system was as follows:

- **Green**. These correspond to industries that we consider to be either identical (or almost) to the water industry. This includes: (i) the water sector itself, "Water supply; sewerage, waste management and remediation activities"; (ii) the energy sector, "Electricity, gas, steam and air conditioning supply"; and (iii) the combination of these two sectors, "Electricity, gas, steam; water supply, sewerage, waste management".

- **Amber**. These correspond to the vast majority of industries assessed, as we consider most of these industries to share some activities with water, but only to a degree. For instance, "Mining and quarrying" includes activities related to the extraction and processing of a natural resource (as would be done for water, and also the treatment of wastewater), in addition to the operation and maintenance of a complex network of mines / quarries (i.e. it has network elements, like the water industry). However, it does not involve the delivery or transport of the product to end customers in a downstream market (i.e. the retail element of the water industry).

[76] *'Real Price Effects and Frontier Shift – Final Assessment and Response to Company Representations.' Europe Economics (December 2019); Table 3.8, page 71.*

[77] *We also note that we have only included industries for which TFP data is available in the NACE II database, e.g. we have not assessed "Wholesale and retail trade and repair of motor vehicles and motorcycles".*

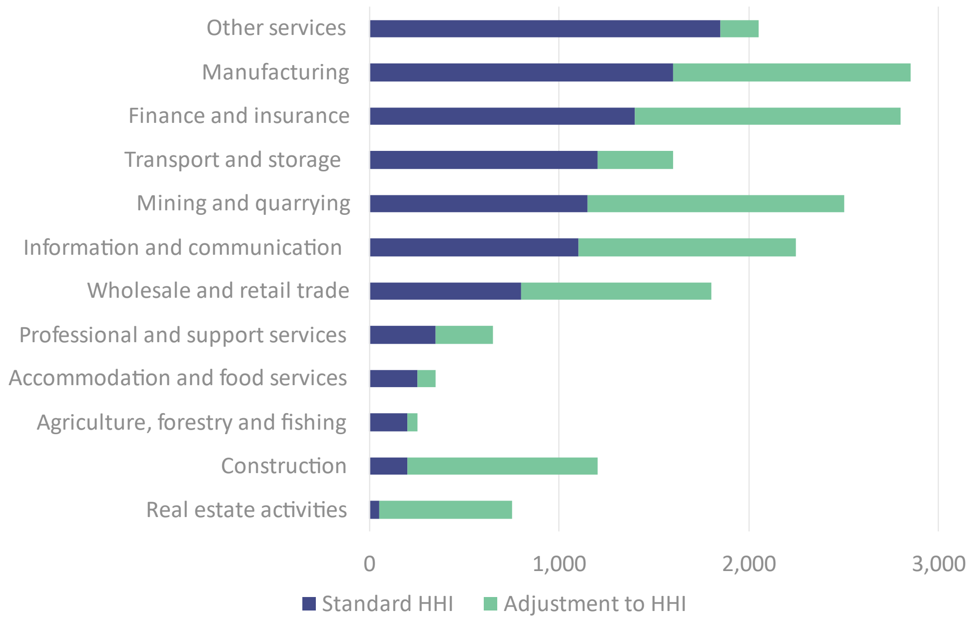
- **Red.** These are sectors that we consider to be very different to the water industry. For instance, we consider neither "Financial and insurance activities" nor "Real estate activities" to share similar activities to the water industry as a whole (i.e. the total water value chain).[78] These are only included in our assessment because they were considered by Ofwat at PR19.

Criterion 2: Competitiveness of industry

For Criterion 2, we assigned any regulated or public sector industry as "Red". This is because they can be assumed to not operate in competitive markets, and so any TFP estimates may include a significant catch-up element, in addition to frontier shift.

To inform the relative competitiveness of other industries, we used the Herfindahl-Hirschman Index (HHI) metric of market concentration, as published by the CMA in its State of Competition report from April 2022.[79] Figure 14 shows this. The adjusted figures also reported in the chart account for the effect of common ownership and international trade, which the CMA considers affect competition, but are not included in the standard HHI measure.[80]

Figure 14: Standard and adjusted HHI across UK SIC sectors



Source: 'The State of UK Competition.' CMA (29 April 2022).
Notes: The sector names in the chart differ slightly to those used in the EU KLEMS database, e.g. (i). "Transport and storage" in the above is equivalent to "Transportation and storage" in EU KLEMS NACE II; (ii) "Manufacturing" is equivalent to "Total Manufacturing" in EU KLEMS NACE I; and (ii) "Professional and support services" corresponds to "Professional, scientific and technical activities; administrative and support service activities" in the EU KLEMS database.

[78] *We note, however, that we consider "Financial and insurance activities" nor "Real estate activities" to share similar activities to water retail, which we discuss in more detail in Chapter 8.*
[79] *'The State of UK Competition.' CMA (April 2022); Figure 3.5; page 73.*
[80] *'The State of UK Competition.' CMA (April 2022); paragraph 3.1.*

We assigned "Green" and "Amber" in the following way: (i) "Green" where the adjusted HHI is less than 1,000; and (ii) "Amber" where the adjusted HHI is greater than 1,000. We note the CMA states that *"[p]roduct markets with HHIs of more than 1,000 are generally considered to be concentrated, and those with HHIs of more than 2,000 to be highly concentrated"*.[81] Consistent with the CMA's 'highly concentrated' distinction (and as detailed later in this chapter), we also include a sensitivity in which we remove all comparators that have an adjusted HHI that is greater than 2,000. As is shown in Annex 3, the impact of this change is limited.

We note that Figure 14 is based on the industries listed in the ONS dataset, rather than in the EU KLEMS dataset. In some cases the ONS industries are more aggregated than those in the EU KLEMS dataset. For example, "Transport and Storage" is broken down into further sectors in the EU KLEMS database, such as: (i) "Land transport and transport via pipelines"; and (ii) "Water transport". Given the EU KLEMS data structure, we apply the Criterion 2 rating (as applied to the aggregated sector from the ONS data) to all of its constituent disaggregated sectors in the EU KLEMS dataset. For example, both "Land transport and transport via pipelines" and "Water transport" would be rated as "Amber" as "Transport and storage" is rated as "Amber".

Criterion 3: Extent of scale effects

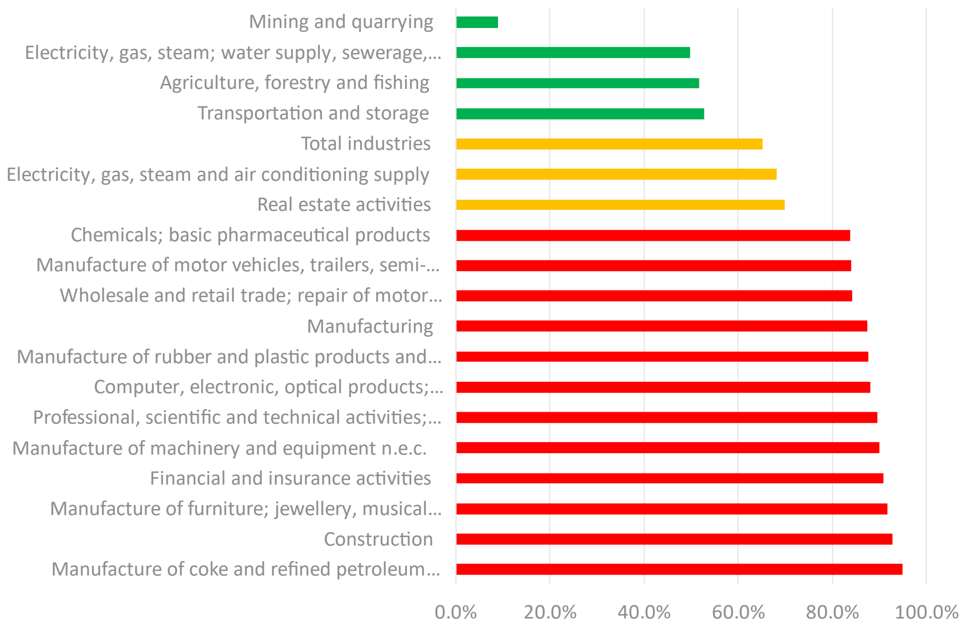
For Criterion 3, we calculated scale-related metrics across industries using EU KLEMS data, in order to determine which are most similar to water, splitting the criterion into three sub-criteria:[82]

- **For Criterion 3a,** we calculated the average capital stock / gross output ratio between 2015 and 2019, and compared this to the average for "Water supply; sewerage, waste management and remediation activities". We include this criterion on the basis that, where the average ratios are similar, this suggests that the comparator sector is similar to the water industry in terms of its capital intensity, and hence proportion of costs that are fixed. We then assigned the three-colour scale in the following way: (i) "Green" where the absolute divergence between the averages is less than 60.0%; (ii) "Amber" where the absolute divergence is between 60.0% and 80.0%; and (iii) "Red" where the absolute divergence is greater than 80.0%. Figure 15 shows the absolute divergence from the water sector.

[81] *'The State of UK Competition.' CMA (April 2022); paragraph 2.10.*

[82] *Data on the capital stock was taken from the tab "K_GFCF", available from the file "Capital" for the UK here: https://euklems-intanprod-llee.luiss.it/download/. Data on gross output was taken from the tab "GO_CP", available from the file "National Accounts" for the UK here: https://euklems-intanprod-llee.luiss.it/download/.*

Figure 15: Absolute divergence in average capital stock-gross output ratio (2015-2019)

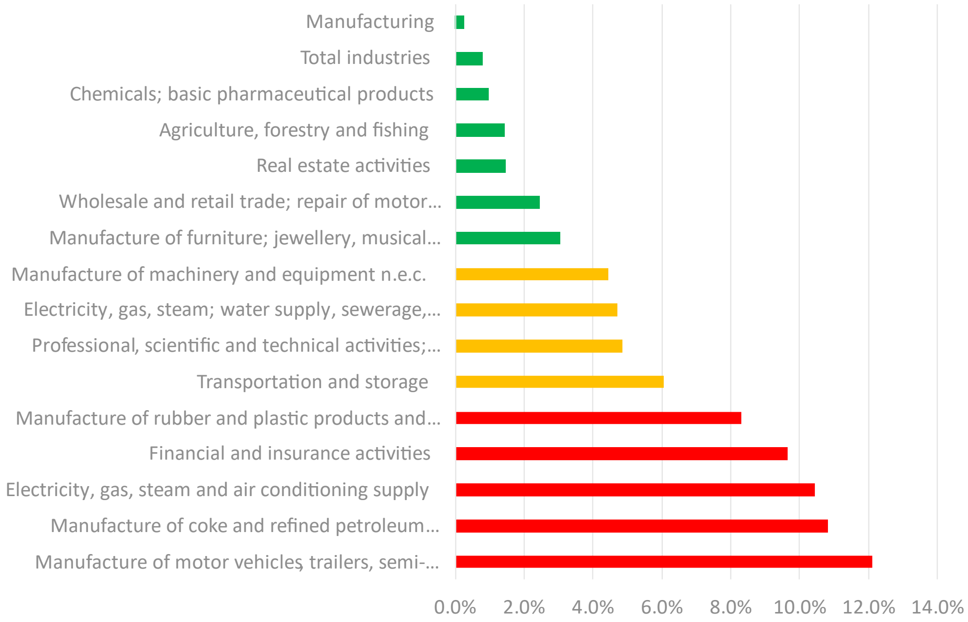


Source: Economic Insight analysis of EU KLEMS data

- **For Criterion 3b,** we calculated the growth rate of capital stock between 2015 and 2020.[83] We then compared this to the capital stock growth rate for "Water supply; sewerage, waste management and remediation activities". We include this criterion on the basis that, where the growth rates are similar, this suggests that the comparator sector is similar to the water industry in terms of its capex accumulation, and hence fixed cost accumulation over time. Following this, we then assigned the three-colour scale in the following way: (i) "Green" where the absolute average divergence is less than 4.0%; (ii) "Amber" where the absolute average divergence is between 4.0% and 8.0%; and (iii) "Red" where the absolute average divergence is greater than 8.0%. Figure 16 shows the absolute divergence from the water sector.

[83] *We note that we used 2020 for Criterion 3b, but 2019 for Criteria 3a and 3c, as capital stock data was available in 2020, whilst gross output data was only available until 2019.*

Figure 16: Average absolute divergence in capital stock growth rate (2015-2020)[84]

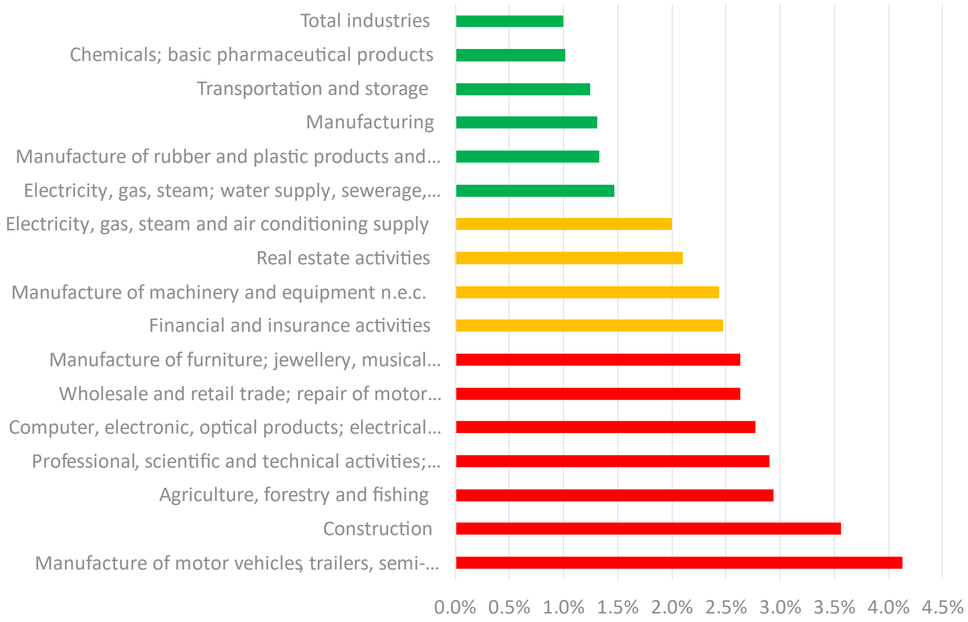


Source: Economic Insight analysis of EU KLEMS data
Notes: We do not include "Computer, electronic, optical products; electrical equipment", "Mining and quarrying" or "Construction" in this chart in order to improve comparability across sectors, as the absolute average divergences for these three sectors are 14.9%, 16.3% and 16.4%, respectively.

- **For Criterion 3c,** we calculated the growth rate of gross output in each year (the output growth rate) between 2015 and 2019, then took the absolute difference between this rate and the rate for "Water supply; sewerage, waste management and remediation activities". We include this criterion on the basis that, where the average divergence between growth rates is small, this suggests that scale effects are similar over time. We then assigned the three-colour scale as follows: (i) "Green" where the absolute average divergence is less than 1.5%; (ii) "Amber" where the absolute average divergence is between 1.5% and 2.5%; and (iii) "Red" where the absolute average divergence is greater than 2.5%. Figure 17 shows the absolute divergence from the water sector.

[84] *For "Total industries", we have taken the 2020 capital stock value from the corresponding entry in "Total - all NACE activities" as there is no data available in 2020 for "Total industries", but the entries in every year between 1995 and 2019 are identical for "Total industries" and "Total - all NACE activities".*

Figure 17: Absolute average divergence in gross output growth rate (2015-2019)



Source: Economic Insight analysis of EU KLEMS data

Notes: We do not include "Mining and quarrying" or "Manufacture of coke and refined petroleum products" in this chart in order to improve comparability across sectors, as the absolute average divergences for these two sectors are 13.0% and 15.7%, respectively.

5C. Our choice of comparators

Both the EU KLEMS and ONS datasets contain TFP information for a number of sectors (a full list of these is available in Annex 2). We note that, primarily due to limitations in available data (and because the extent to which any one data / analysis can 'precisely' inform the economic theory / evaluation criteria in question is limited), no choice of comparators will ever be perfect. Therefore, although we have applied the above set of three criteria, we recognise the inherent subjectivity in choosing comparators.

We define our *'preferred set'* of comparators as those that fulfil the following conditions.[85]

– Defined as "Green" or "Amber" in Criterion 1, such that the activities being undertaken by firms working in the comparator industry are similar (at least in part) to the water industry.

– Defined as being "Green" or "Amber" in Criterion 2, such that the industry is at least somewhat competitive.

[85] We note that, although "Mining and quarrying" fulfils the below conditions, we have chosen not to include it in our 'preferred' set of comparators. We provide details below as to why this is the case.

- Defined as "Green" in at least one of Criteria 3a, 3b and 3c, such that the magnitude and/or timing of scale effects are at least somewhat similar to the water industry.

In addition to this, we also included "Total industries" in our *'preferred set'* of comparators (and the sensitivities detailed below, unless specified otherwise). This reflects the inherent subjectivity in comparator choices, which means we think it beneficial to include a metric that captures productivity changes across the entire UK 'on average' (i.e. not assuming that the water industry would be either a 'low', or 'high', productivity industry).

We have also chosen to adopt five further sets of comparators, corresponding to several separate sensitivity analyses:

- **Sensitivity 1**, which includes all the same comparators as selected under our criteria, plus "Mining and quarrying". We have not included "Mining and quarrying" in our main analysis, despite it fulfilling the necessary conditions for inclusion. This is because the TFP estimates for this sector are significantly lower than for the other comparator sectors, implying it may be an outlier. However, we consider it beneficial to report it under a sensitivity analysis, in order to test the robustness of our *'preferred set'* of comparators to its inclusion.

- **Sensitivity 2**, where the assessment under Criterion 3 is strengthened. Specifically, this only includes comparators for which at least <u>two</u> of Criteria 3a, 3b and 3c are ranked as "Green" (and thus places more weight on the similarity of sectors as regards economies of scale).

- **Sensitivity 3**, in which: (i) the assessment under Criterion 3 is strengthened (in the same was as with **Sensitivity 2**); and (ii) highly aggregated sectors are excluded.[86] We implement condition (ii) in order to test whether the implicit inclusion of some activities that are less similar to water is affecting our results.

- **Sensitivity 4**, in which Criterion 2 is strengthened. We strengthen Criterion 2 in order to test the effect of including comparators that <u>may</u> be considered *'highly concentrated'* by the CMA (as detailed in our description of Criterion 2 in Section 5B) in our *'preferred set'* of comparators. Specifically, only comparators for which the adjusted HHI in Figure 14 is less than 2,000 are included.

[86] *This refers to "Total industries" and "Manufacturing".*

- **Sensitivity 5**, which includes all the same comparators as selected under our *'preferred set'*, plus "Construction". Although "Construction" does not fulfil our conditions (in relation to our three Criteria) to be included in either our *'preferred set',* or our above-mentioned sensitivities, we consider that there are some activities undertaken by water companies that may be consistent with those of construction companies. For instance, the creation and development of large-scale complex infrastructure. Therefore, although (under our criteria) construction is not sufficiently similar to the total water value chain 'as a whole' to be included, we consider it informative to have a sensitivity analysis that incorporates it. This may be more relevant if companies expect their mix of activities for PR24 to be 'more similar' to construction than in the past, for example.

Following from the above, there are some reasons to suppose that it may be beneficial to estimate frontier shift separately for the different elements of water companies' activities. For example: (i) by price control area; and / or (ii) split by opex and capex. This is because, for example, a good comparator for one price control area (as regards to the similarity of activities; or extent of scale effects, say) may be a less good comparator for another price control area. Indeed, we note that Ofwat's approach at PR19 was to set out separate estimates for totex and botex. Furthermore, in its PR24 Final Methodology, Ofwat stated that it may *"explore setting a specific frontier shift for bioresources that is separate from other wholesale activities"*,[87] but did not commit to this. Ofwat's Final Methodology for PR24 contained no further details as to its approach in this regard.

Table 6 presents the results of our assessment of comparators against the criteria detailed above. Table 6 also identifies: (i) which industries we have included in our *'preferred set'* of comparators (and those industries we have included in our five sensitivity analyses); and (ii) the industries selected by Ofwat as comparators under its PR19 approach.

As we have discussed above, we have sought to apply our three Criteria transparently; and have derived several sets of comparators that we use to derive our frontier shift estimates (both for our *'preferred set',* and the five sensitivity analyses detailed above). However, as previously noted, we would stress that the selection of comparators is inherently subjective. As such, we recognise that it is reasonable that some companies may consider alternative comparators to those we recommend (based on their specific circumstances). This forms part of our rationale for **Sensitivity 5,** whereby construction is included to allow for the possibility that some companies may intend to undertake a greater mix of large infrastructure project construction at PR24.

Where we set out our final frontier shift results in this report, we do so in relation to three defined 'ranges'.

87 *'Creating tomorrow, together: Our final methodology for PR24: Appendix 4 Bioresources control.' Ofwat (December 2022); page 20.*

- **Plausible range.** This includes our *'preferred set'* of comparators.
- **PR24 focused range.** This also only includes our *'preferred set'* of comparators.
- **Sensitivity analysis range.** This includes our *'preferred set'* of comparators, in addition to those as tested under our sensitivity analyses (**Sensitivity 1**; **Sensitivity 2**; **Sensitivity 3**; **Sensitivity 4**; and **Sensitivity 5**).

In the following table we identify which comparators are included for each of the above three ranges.

Table 6: Assessment of industries against Criteria (**total water value chain**)

Industry	Criteria					Preferred set	Sensitivity					Used by Ofwat
	1	2	3a	3b	3c		1	2	3	4	5	
Total industries	Grey	Grey	Amber	Green	Green	✓	✓	✓	✗	✓	✓	✗
Agriculture, forestry and fishing	Amber	Green	Green	Green	Red	✓	✓	✓	✓	✓	✓	✗
Mining and quarrying	Amber	Amber	Green	Red	Red	✗	✓	✗	✗	✗	✗	✗
Manufacturing	Amber	Amber	Red	Green	Green	✓	✓	✓	✗	✗	✓	✓
Manufacture of coke and refined petroleum products	Amber	Amber	Red	Red	Red	✗	✗	✗	✗	✗	✗	✗
Chemicals; basic pharmaceutical products	Amber	Amber	Red	Green	Green	✓	✓	✓	✓	✗	✓	✓
Manufacture of rubber and plastic products and other non-metallic mineral products	Amber	Amber	Red	Red	Green	✓	✓	✗	✗	✗	✓	✗
Computer, electronic, optical products; electrical equipment	Amber	Amber	Red	Red	Red	✗	✗	✗	✗	✗	✗	✗
Manufacture of machinery and equipment n.e.c.	Amber	Amber	Red	Amber	Amber	✗	✗	✗	✗	✗	✗	✓
Manufacture of motor vehicles, trailers, semi-trailers and of other transport equipment	Amber	Amber	Red	Red	Red	✗	✗	✗	✗	✗	✗	✗
Manufacture of furniture; jewellery, musical instruments, toys; repair and installation of machinery and equipment	Amber	Amber	Red	Green	Red	✓	✓	✗	✗	✗	✓	✓
Electricity, gas, steam and air conditioning supply	Green	Red	Amber	Red	Amber	✗	✗	✗	✗	✗	✗	✗
Electricity, gas, steam; water supply, sewerage, waste management	Green	Red	Green	Amber	Green	✗	✗	✗	✗	✗	✗	✗

Industry	Criteria					Preferred set	Sensitivity					Used by Ofwat
	1	2	3a	3b	3c		1	2	3	4	5	
Water supply; sewerage, waste management and remediation activities						✗	✗	✗	✗	✗	✗	✗
Construction						✗	✗	✗	✗	✗	✓	✓
Wholesale and retail trade; repair of motor vehicles and motorcycles						✓	✓	✗	✗	✓	✓	✗
Transportation and storage						✓	✓	✓	✓	✓	✓	✓
Financial and insurance activities						✗	✗	✗	✗	✗	✗	✗
Real estate activities						✗	✗	✗	✗	✗	✗	✗
Professional, scientific and technical activities; administrative and support service activities						✗	✗	✗	✗	✗	✗	✓

Source: Economic Insight

5D. Comparison to Ofwat

As shown above in Table 6, our *'preferred set'* of comparators shares four comparators with Ofwat's PR19 approach. Our *'preferred set'* of comparators contains four further comparators not chosen by Ofwat, whilst its approach contains three comparators not in our *'preferred set'*.

We consider there to be two key reasons for these differences:

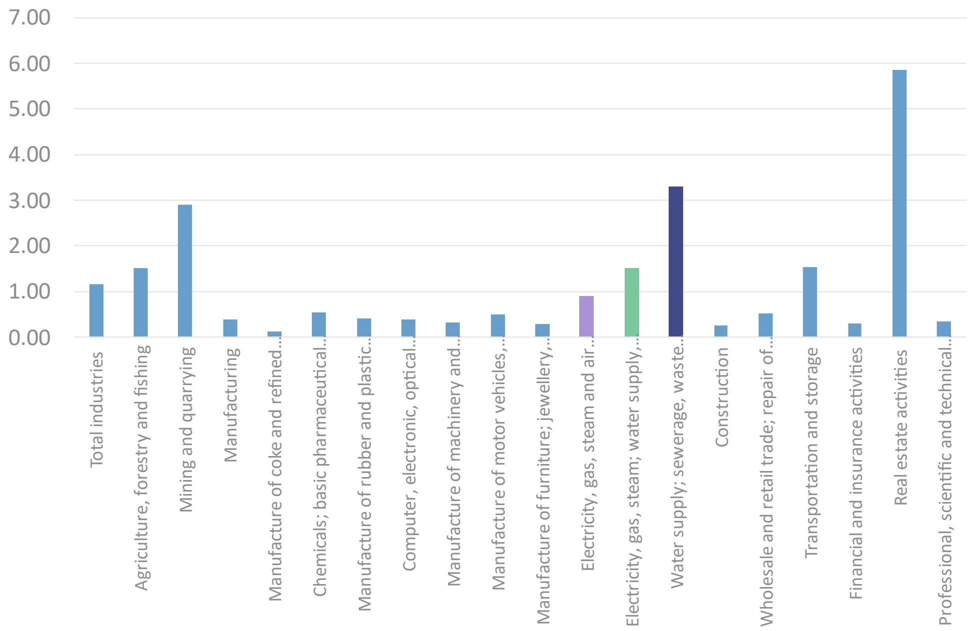
- **Relative importance of the three criteria.** Ofwat *"considered data on the capital intensity of each sector and how comparable that is to the water sector, although this was not treated as an over-riding consideration where there were other reasons for including a comparator."*[88] In relation to the criteria detailed in Section 5B, Ofwat therefore chose to place more weight on Criterion 1 (the activities of the comparators being similar to those of the water sector), than on Criterion 3 (the proportion of fixed costs between comparators and the water sector being relatively similar). On the other hand, we consider both these criteria to be important, with Criterion 3 highly important, to avoid wrongly attributing efficiency gains from economies of scale to frontier shift. We consider that there is an inherent subjectivity involved in Criterion 1, due to its inherently qualitative nature; and the fact that there are many industries that share some, but not all, of the activities with water (which can be seen in the Europe Economics report).[89] As a result of its approach, Ofwat has not systematically taken into account how differences in cost structure (and hence scale economies) can translate to differences in productivity growth across industries (even though theory and evidence shows this to be important).

88 *'Real Price Effects and Frontier Shift – Final Assessment and Response to Company Representations.' Europe Economics (December 2019); page. 69.*

89 *We note that Ofwat conducted a separate scale effects analysis but only on the comparators chosen for its analysis, and concluded that no adjustment was required. Please see:'Real Price Effects and Frontier Shift – Final Assessment and Response to Company Representations.' Europe Economics (December 2019); Appendix 2.*

- **Availability of data.** Ofwat's analysis for PR19 in relation to capital intensity involved a comparison of the energy and water sectors combined, as data on just the water industry was unavailable in the 2017 release of the EU KLEMS data. As we have noted, Ofwat's measure of capital intensity (capital stock-gross output ratio) is consistent with ours. However, Ofwat undertook this analysis only for 2014 (as this was the most recently available data at the time of the analysis). Figure 18 shows the capital stock-gross output ratio in this year, including: (i) the energy sector only (the purple bar); (ii) the water and energy sectors combined (the green bar); and (iii) the water sector only (the dark blue bar). The figure shows that the capital intensities are very different between the green and dark blue bars, which could lead to very different conclusions about appropriate comparators. Put simply, Ofwat was comparing industries against a benchmark that did not, in fact, reflect the capital intensity of the water industry. In any event, we again note that, in practice, Ofwat did not fully utilise this analysis, given its reliance on the more subjective criteria of 'similar activities' in its selection of comparators.

Figure 18: Capital stock-gross output ratios in 2014



Source: Economic Insight analysis of EU KLEMS data

6 Adjustments

Following from our comparator choice, in this chapter we consider whether, in light of the analytical issues discussed in Chapter 3, adjustments might be appropriate when inferring a frontier shift challenge for PR24 from TFP data.

6A. Multiple efficiency savings

As discussed in Section 3C, there are multiple efficiency savings captured within TFP, beyond just frontier shift. By basing frontier shift estimates solely on unadjusted TFP, there is therefore the risk that the extent of frontier shift would be incorrectly estimated (where whether the net impact results in an overall under or overstatement of frontier shift depends on the effect of each of the individual efficiencies).

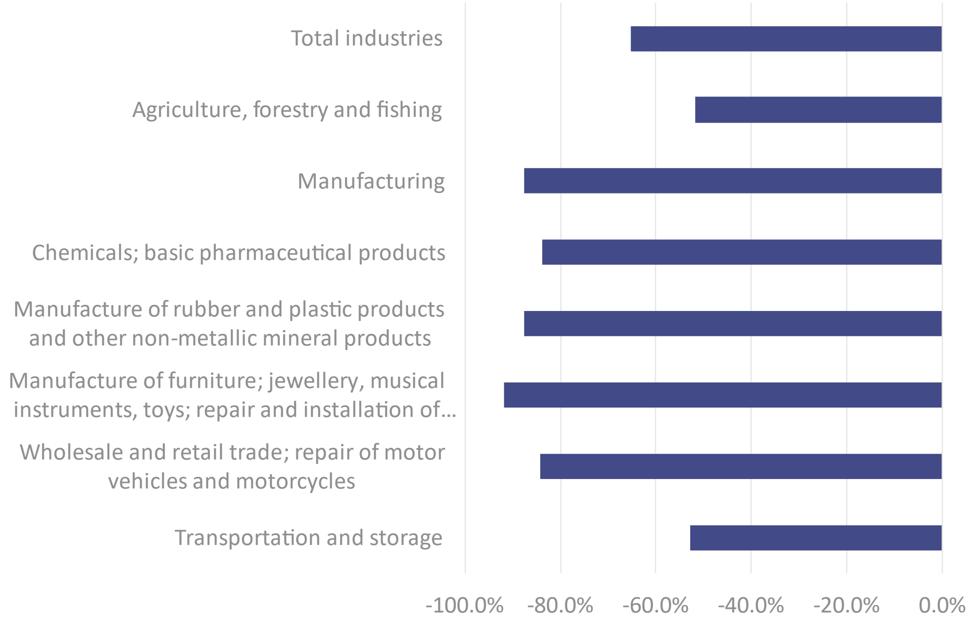
We present below how we have determined the likely direction of each the efficiencies on TFP estimates:

- **Catch-up efficiency**. This is based on Criterion 2, i.e. the competitiveness of the industry.

- **Scale effects**. In Figure 19, Figure 20 and Figure 21, we have determined the actual difference between our scale-related metrics for each comparator industry in our *'preferred set'*, and water.[90] Where the net divergence across the three appears to be conclusively negative (positive), we have concluded that there is an understatement (overstatement) of frontier shift as implied from TFP, due to efficiencies arising from scale effects also being captured. Where the overall divergence is ambiguous, we consider the direction of the effect to be unknown.

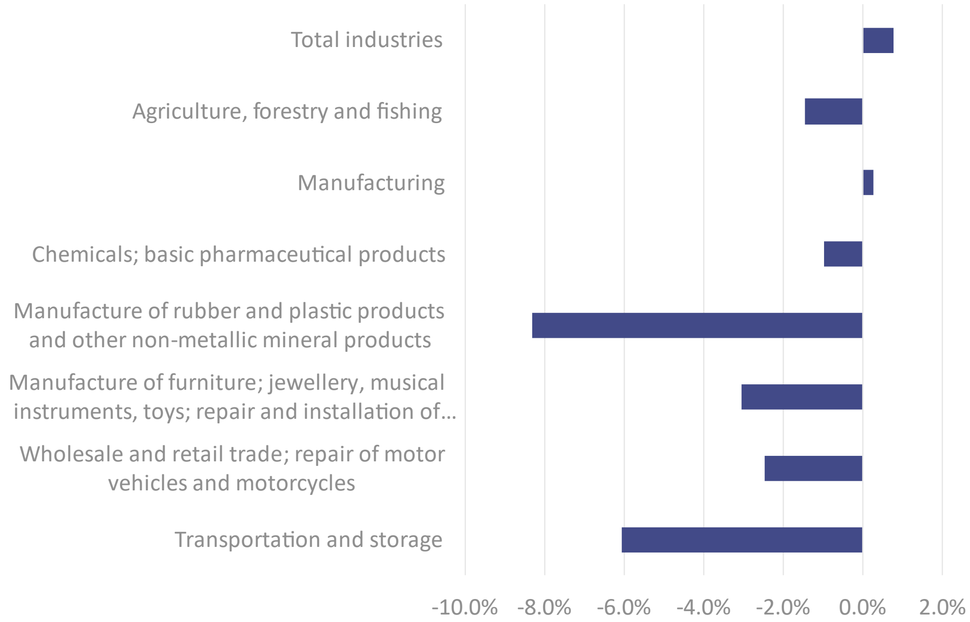
[90] *We note that when we undertook our assessment of Criteria 3 above, we used the absolute divergence between these metrics and water. However, it is necessary for us to include the sign of these differences in order to arrive at a conclusion of the likely direction of the bias resulting from scale effects.*

Figure 19: Actual divergence between average capital stock-gross output ratio of comparator industries and the water industry (2015-2019)



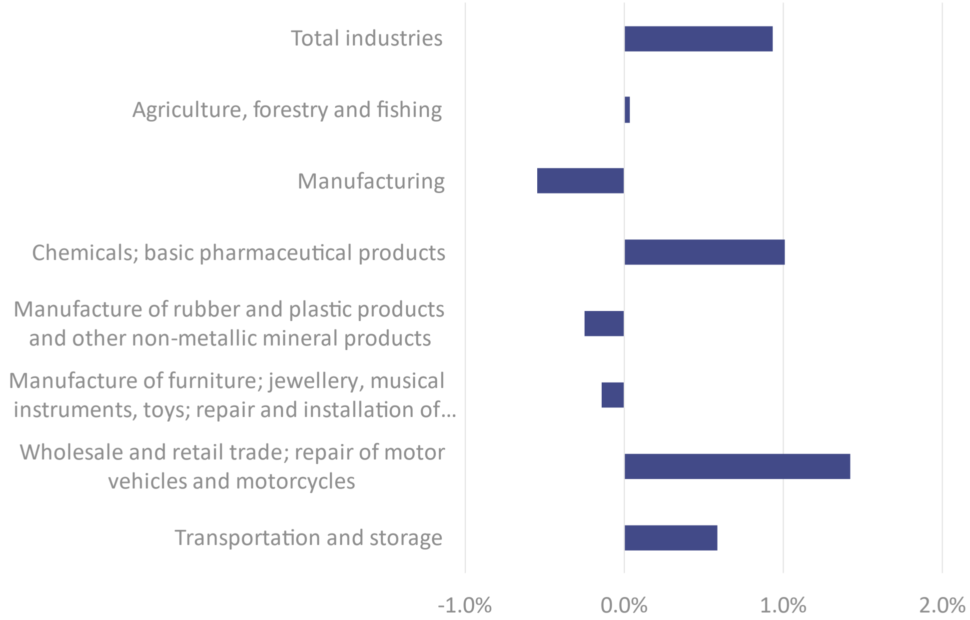
Source: Economic Insight of EU KLEMS data

Figure 20: Actual divergence between capital stock growth rates of comparator industries and the water industry (2015-2020)



Source: Economic Insight of EU KLEMS data

Figure 21: Actual divergence between gross output growth rates of comparator industries and the water industry (2015-2019)



Source: Economic Insight of EU KLEMS data

Table 7 presents our high-level expectation of the possible direction of each of these efficiencies on our TFP estimates for each of the comparator industries we identify. Entries reported as "Positive" in Table 7 mean that there is an upward bias to frontier shift (were one to infer this from TFP), which would thus warrant a downward adjustment to the TFP estimate (and vice-versa for "Negative").

Table 7: Likely direction of bias for each comparator in our analysis

Industry	Catch-up efficiency	Scale effects
Total industries	Positive[91]	Unclear
Agriculture, forestry and fishing	Slightly positive	Negative
Manufacturing	Positive	Negative
Chemicals; basic pharmaceutical products	Positive	Unclear
Manufacture of rubber and plastic products and other non-metallic mineral products	Positive	Negative
Manufacture of furniture; jewellery, musical instruments, toys; repair and installation of machinery and equipment	Positive	Negative
Wholesale and retail trade; repair of motor vehicles and motorcycles	Positive	Unclear
Transportation and storage	Positive	Unclear

Source: Economic Insight analysis

Overall, Table 7 is therefore consistent with:

- Frontier shift being *overstated* due to the exclusion of catch-up efficiency for all comparator industries (thus implying a downward adjustment to frontier shift).
- Frontier shift being *understated* due to the potential for efficiencies arising from economies of scale being smaller for some of the comparator industries, relative to water (thus implying a *small* upwards adjustment to frontier shift).[92]

[91] *Although a Criterion 2 ranking is not provided for "Total industries" in Table 6, we consider that there are likely to be some catch-up efficiencies within TFP estimates for this comparator, given that this is an aggregation across all sectors, some of which are uncompetitive.*

[92] *Because, for 'all' of our comparators, the data implies a downwards adjustment is required to account for catch-up; but in relation to scale economies, only some of the comparators are consistent with an upwards adjustment being appropriate.*

6B. Embodied change

As discussed in Section 3C, it is likely that TFP includes at least some, but not all of, the productivity gains made from embodied technological change. However, the discussion in Section 3C also highlighted that there is no easy / clear cut answer to the question of *'how much'* is included in (excluded from) the TFP data. Furthermore, we noted that (notwithstanding this first challenge) there is a second important step of determining the *relevance* of any excluded embodied technological change from a comparator industry's TFP to determining frontier shift for the water industry.

Following from the above, therefore, our position is that it is appropriate in principle to *consider* whether and how frontier shift should be adjusted to account for any excluded embodied technological change. However, in practice, this should be informed by an assessment of:

- the extent to which the TFP *for the comparators being used* includes / excludes embodied technological change; and
- the scope for the water industry to make productivity gains from embodied technological change, relative to the comparators being used (i.e. the relative scope for technological change across industries).

We discuss each of these in turn below, in the context of our comparator choice detailed in Section 5C.

The extent of embodied change that is included in / excluded from TFP

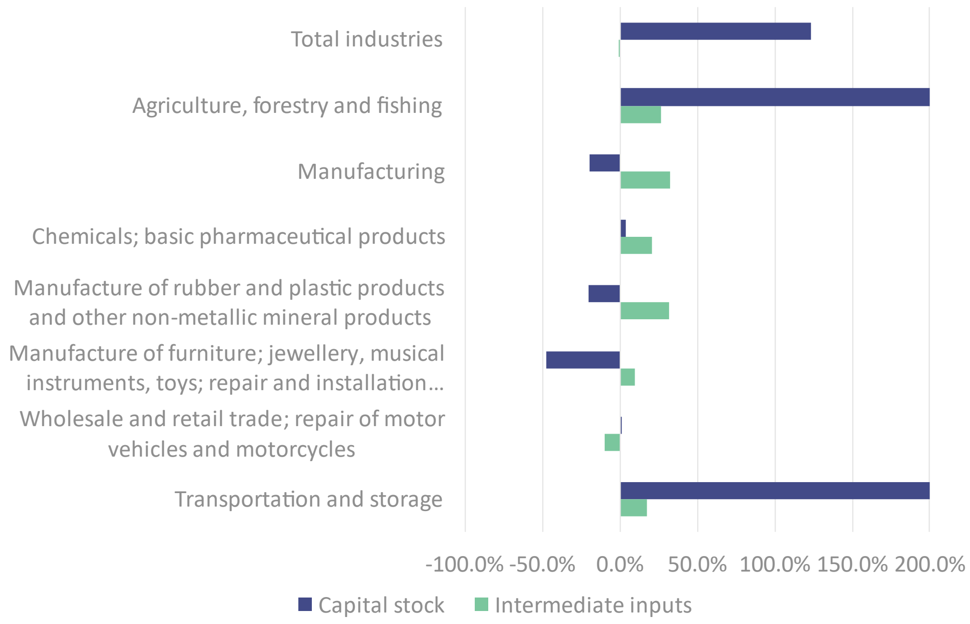
The extent of any embodied change that is captured in TFP likely varies by sector. Industries that: (i) are more capital intensive; and (ii) use *relatively* more intermediate inputs are likely to have a higher amount of gains from embodied technological change included within their TFP data (as was discussed in Section 3C). However, we reiterate that it is challenging to determine the exact amount of embodied change that is included in / excluded from TFP estimates with precision.

In order to inform this, we have calculated the following metrics for every industry in the NACE II database: (i) capital stock-gross output ratio;[93] and (ii) intermediate inputs-gross output ratio.[94] We then calculated the 'all industry' median for these metrics across 2015-19 (noting that the mean is more affected by extreme outliers). To then get a sense of whether our comparators might include 'more' or 'less' gains from embodied technological change in their TFP data than 'the average' for the UK, we calculated the difference between them on the above two metrics, relative to the all industry median. Figure 22 shows these divergences, for both capital intensity and the intermediate inputs-gross output ratio.

[93] We note that this is the same way that Ofwat measured capital intensity in its PR19 assessment. Please see: 'Real Price Effects and Frontier Shift – Final Assessment and Response to Company Representations.' Europe Economics (December 2019); footnote 67, page 69.

[94] Data on the intermediate inputs was from the tab "II_CP", available from the file "National Accounts" for the UK here: https://euklems-intanprod-llee.luiss.it/download/.

Figure 22: Difference between average capital stock-gross output ratio, and intermediate inputs-gross output ratio, and the median across all industries (2015-2019)



Source: Economic Insight analysis of EU KLEMS data

In terms of capital intensity, our analysis suggests:

– For three of the comparators in our *'preferred set'*, the average capital stock-gross output ratio is significantly greater than the median across all industries. This suggests, for these comparators, the amount of *included* (relative to *excluded*) embodied change, may be *greater* than for the average industry.

– For the other five comparators, the average capital stock-gross output ratio is either slightly lower than the median, or relatively similar. This suggests, for these comparators, the amount of *included* (relative to *excluded*) embodied change, may be *similar* to the average industry.

In terms of intermediate inputs, the analysis shows that, on average, the comparators in our *'preferred set' generally* contain more intermediate inputs than the median industry, but the difference is much less pronounced than for capital intensity. We note that the range of intermediate input-gross output ratios is significantly narrower than for capital stock-gross output ratios. Overall, this suggests that, for these comparators, the amount of *included* (relative to *excluded*) embodied change, may be *slightly greater* than for the average industry.

Taken together, the evidence presented in this section suggests that, across our comparators overall, the amount of *included* (vs *excluded*) embodied change *may* be greater than the UK industry average.

The applicability of embodied change from comparator sectors to the water industry

Having established a high-level view on the relative amount of *included* embodied change across our comparators, we now turn to the question of the applicability of embodied change in our comparator sectors to the water industry. As was discussed in Section 3C, this turns on one's view on the scope for embodied change in the water industry (and whether that is higher, or lower, than the comparator sectors in question).

As we previously discussed, the above largely turns on an assessment of the extent of likely technological change in the water industry, relative to those comparators, on a forward-looking basis. We also noted that the water industry is unlikely to be one where one would expect rapid technological progress (i.e. one would not expect high embodied technological related gains, relative to other industries). This is because it is characterised by high value capital assets that last for a long time, which are then replaced at the end of their lifecycle by (broadly) similar infrastructure assets.

For the purpose of this report, we have undertaken a high-level qualitative assessment of the expected rate of technological progress across our comparators. This is summarised in Table 8, using a three-colour scale (i.e. "Red", "Amber" and "Green"). We note that we would consider the water sector to be "Red", meaning that comparators rated "Amber" or "Green" would be expected to be able to make higher productivity gains from embodied technological change, relative to the water industry.

Table 8: High-level assessment of the rate of technological progress in comparator sectors

Comparator	Rate of technological progress
Total industries	
Agriculture, forestry and fishing	
Manufacturing	
Chemicals; basic pharmaceutical products	
Manufacture of rubber and plastic products and other non-metallic mineral products	
Manufacture of furniture; jewellery, musical instruments, toys; repair and installation of machinery and equipment	
Wholesale and retail trade; repair of motor vehicles and motorcycles	
Transportation and storage	

Source: Economic Insight analysis

Based on our initial assessment, we consider that three of the comparators in our *'preferred set'* likely exhibit low rates of technological progress over time. Therefore, we consider that embodied change in these three industries is likely relatively *similar* to water. However, importantly, by "similar", we are actually highlighting their common *limited capacity* to make gains from embodied technological change in the first place. Therefore, with reference to these, it would (in principle) be appropriate to make an upwards adjustment to frontier shift for the water industry to reflect any embodied technological change not captured in their TFP data, but in practice the absolute size of that embodied change must logically be limited (therefore, the upwards adjustment would also be relatively small).

The remaining five comparators (the majority) likely have *greater scope* for making productivity gains from embodied technological change, relative to the water industry. Therefore, (and the corollary of the above) is that whilst the absolute size of their gains from embodied change going forward may be larger, a much smaller proportion of those gains would be relevant to a forward-looking assessment of frontier shift in the water industry. Hence, again, in principle an upwards adjustment to frontier shift may be appropriate. However, it is likely to be small, *and could conceivably be negative* (if, for example, the scope for technological change related gains in water was sufficiently lower relative to these industries).

6C. Overall adjustment

To conclude, the evidence presented in Sections 6A and 6B suggests the following when inferring frontier shift for the water industry at PR24 from TFP data:

- A downward adjustment due to catch-up efficiencies that are captured in the TFP estimates for our choice of comparator industries.
- An upwards adjustment due to an understatement of scale effects in the TFP estimates for our choice of comparator industries (although the magnitude of this understatement would likely be *smaller* than the equivalent overstatement for catch-up efficiency).
- A likely upwards adjustment due to the excluded embodied change from comparator industries' TFP estimates that is applicable to the water industry. We reiterate that the likely magnitude of this adjustment would be small, and note that we cannot preclude the possibility of the appropriate adjustment in fact being a downwards one (i.e. if the scope for technologically driven embodied change in water was sufficiently smaller than for the comparators).

Following from the above, it is not possible to specify a precise net adjustment to frontier shift, based on the currently available evidence (or even determine whether that net adjustment would be positive or negative). Rather, at this time, we suggest the above is largely considered in terms of 'where' in our recommended ranges companies elect to set their proposed frontier shift at PR24. Given that we cannot say whether, in net terms, the above considerations over, or understate frontier shift, our recommendation is therefore that companies should: (i) generally adopt numbers at the mid-points of our ranges; or (ii) could deviate from that (i.e. selecting higher or lower numbers within our ranges) if that decision was informed by additional evidence relating to:

- the assessment of the rate of technological change in the water industry, relative to the comparator sectors; and / or
- the scope for other efficiencies (e.g. economies of scale) in the water industry, relative to the comparator sectors.[95]

[95] *Relatedly, and as noted previously in this executive summary, companies could further consider whether the comparator set itself might change, if (for example) the expected mix of activities they will undertake at PR24 is sufficiently different from the past.*

7 Results – total water value chain

In this chapter we summarise the results of our analysis, where we report three frontier shift ranges for the total water value chain: (i) our *'plausible range'* (**0.3%-0.8%**); (ii) our *'PR24 focused range'* (**0.3%-0.7%**); and (iii) our *'sensitivity analysis range'* (**0.1%-1.1%**). For the upper and lower ends of each of these ranges, we provide details of the specific time period and comparator set it relates to.

Following our choice of time periods and comparators, detailed previously in Chapter 4 and Chapter 5 respectively, we arrive at our proposed frontier shift estimates for PR24. We have grouped these into three distinct ranges, which are as follows:

- **Plausible range (0.3%-0.8%)**. This is the range that we consider frontier shift could *plausibly* sit within, over PR24 (i.e. numbers outside of this range are *implausible*, but not *impossible*, in our view). This range is based on our *'preferred set'* of comparators (shown in Table 6). It is further based on the following time periods:
  - **2010-2019 (NACE II)**. This period includes: (i) the most recently available data following the structural break coinciding with the 2008 financial crisis; and (ii) all of the data available from the most recent business cycle (noting that 2019 is the last year that data is available). This period leads to a frontier shift estimate of **0.3%.** This gives the lower end of our *'plausible range'*; the rationale being that the prevailing low productivity performance (as seen for the UK as a whole) persists over PR24.
  - **1995-2019 (NACE II)**. This period includes: (i) all of the available data following the financial crisis (as with 2010-2019); and (ii) all of the data available from the previous two business cycles. This period leads to a frontier shift estimate of **0.7%**. The rationale for this is that by balancing pre, and post, financial crisis time periods, we allow for a reversion (increase) in productivity, back to levels that were observed pre-crisis.
  - **1970-2007 (NACE I)**. This period allows us to show what frontier shift *could* be, if the structural break in productivity from the financial crisis fully unwinds over the course of PR24 towards its long-term average. This period leads to a frontier shift estimate of **0.8%.** The rationale being that this 'unwinding' represents (in our view) the maximum plausible productivity performance over PR24.

- **PR24 focused range (0.3%-0.7%)**. This represents the range we think frontier shift is *most likely* to lie within over PR24. This is also based on our preferred comparator sectors. However, relative to our *'plausible range'*, here we place greater weight on time periods that we consider to be most reflective of PR24 (given the trends in productivity over time and the economic outlook detailed in Section 4B). The time periods on which our focused range is based are as follows.
  - **2010-2019 (NACE II)**. As per the rationale for inclusion in our *'plausible range'*, this period contains all the data that is available from the most recent business cycle (which we consider most likely corresponds to the PR24 period), and leads to a frontier shift estimate of **0.3%** (i.e. the lower end of our *'PR24 focused range'*). This is on the basis that we think it is *unlikely* that productivity will deteriorate further; and so a persistence of the recent past also provides a likely lower bound.
  - **Weighted average of 1995-2019 (NACE II) and 1970-2007 (NACE I)**. In addition to the most recent business cycle, we have included an estimate that aims to capture data from the entire period for which we have data. We are unable to combine the NACE I and NACE II databases, because the data is recorded differently in overlapping years. We have therefore combined estimates from the two databases by calculating a weighted average.[96] This estimate effectively provides a long-term view, which balances the low productivity seen post financial crisis against higher productivity performance in the more distant past. As such, it implicitly allows for 'some' (but not full) unwinding of the productivity structural break over PR24. This leads to a frontier shift estimate of **0.7%,** which provides the upper end of our *'PR24 focused range'*. As this still amounts to (slightly more than) a 'doubling' of productivity, relative to prevailing levels, we consider it unlikely that performance in the water industry will be above this level over PR24.
- **Sensitivity analysis range (0.1%-1.1%)**. We have tested a number of sensitivities around our *'plausible'* and *'PR24 focused'* ranges, as regards to both alternative time periods and comparators (as detailed in Sections 4C and 5C respectively). Whilst this widens our estimates beyond the *'plausible range'*, the impact is relatively small, indicating our main estimates are reasonably robust. Further, the sensitivities we have run should not be interpreted as representing us endorsing selecting frontier shift estimates at the extreme ends of the scale. That is to say, our view is that frontier shift *below* 0.3% or *above* 0.8% is 'implausible'; and that the likely (focused) range over PR24 is narrower still.

[96] *We have calculated this average by weighting (for each comparator and also for the average across all comparators): (i) the average estimate derived from the 1995-2019 period (0.7%) to correspond to each year between 1995 and 2019, inclusive; and (ii) the average estimate derived from the 1970-2007 period (0.8%) to correspond to each year between 1970 and 1994, inclusive.*

Table 9 summarises our results for each of the three ranges and recaps the comparators and time periods used. We present our full set of results in Annex 3.

Table 9: Summary table of minimum and maximum results across our three ranges[97]

Comparator	Plausible range		PR24 focused range		Sensitivity analysis range	
	Low	High	Low	High	Low[98]	High[99]
Total industries	0.2%	0.2%	0.2%	0.2%	0.2%	
Agriculture, forestry and fishing[100]	1.1%	1.0%	1.1%	1.1%	1.1%	1.0%
Mining and quarrying					-1.7%	
Manufacturing	0.4%	0.7%	0.4%	0.9%	0.4%	
Chemicals; basic pharmaceutical products	1.2%	1.3%	1.2%	1.6%	1.2%	1.3%
Manufacture of rubber and plastic products and other non-metallic mineral products	1.0%	0.9%	1.0%	0.9%	1.0%	
Manufacture of furniture; jewellery, musical instruments, toys; repair & install of machinery & equip.	-0.4%		-0.4%	1.0%	-0.4%	
Wholesale and retail trade; repair of motor vehicles and motorcycles	-0.1%	0.1%	-0.1%	-0.1%	-0.1%	
Transportation and storage	-0.6%	1.1%	-0.6%	0.5%	-0.6%	1.1%
Final results (average)	**0.3%**	**0.8%**	**0.3%**	**0.7%**	**0.1%**	**1.1%**

Source: Economic Insight analysis of EU KLEMS data

97 *We note that, for some comparators in NACE II, there is no NACE I equivalent (e.g. "Manufacture of furniture; jewellery, musical instruments, toys; repair and installation of machinery and equipment"), hence there is no TFP estimate for this comparator at the 'High' end of our 'plausible range', but there is at the 'Low' end. For these comparators, the TFP estimate at the 'Low' end of our 'PR24 focused range' (1970-2019) is equal to the 1995-2019 average. As such, the average across comparators in 1970-2019 may not equate to the average of the individual comparator TFP estimates, as it is calculated using a weighted average of the total averages across comparators in 1995-2019 and 1970-2007.*

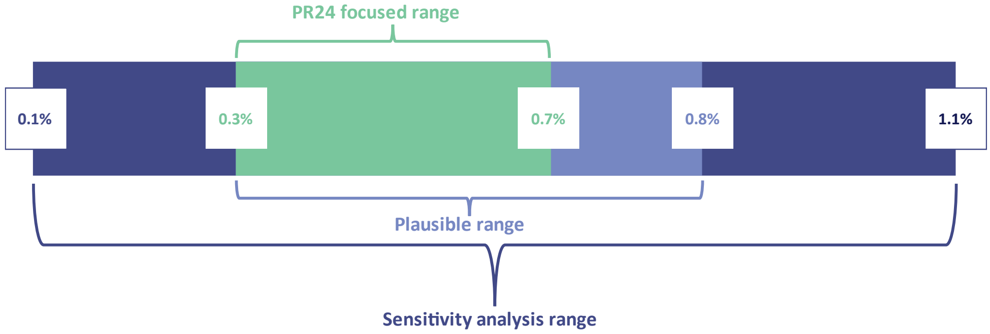
98 *This corresponds to: (i) the 'preferred set' of comparators plus "Mining and quarrying" (i.e.* ***Sensitivity 1****); and (ii) the 2010-2019 period.*

99 *This corresponds to: (i) comparators that are (a) not highly aggregated and (b) rated as "Green" in at least two of Criteria 3a, 3b or 3c (****Sensitivity 3****); and (ii) the 1970-2007 period.*

100 *We note that TFP data is unavailable in the 2023 release of the NACE II database for "Agriculture, forestry and fishing" in 2019. Therefore, for any specified range that includes 2019, for "Agriculture, forestry and fishing" the average TFP growth estimate is based on growth rates up to 2018.*

Figure 23 provides a visual summary of our ranges.

Figure 23: Illustration of our three ranges (total water value chain)



Source: Economic Insight

We note two further details regarding the above results.

- These results are based on a gross output, rather than value added, measure of TFP. In our view, gross output more accurately represents the actual scope for frontier shift at PR24 (for further details, see Section 3B). TFP estimates based on a value added approach can be found in Annex 3.

- The results are based on an arithmetic mean approach, rather than a geometric mean. We consider that a geometric approach may be more appropriate over longer time periods, for the reasons detailed in Annex 5 (where we also report our estimates using a geometric mean; which, in practice, fractionally *reduces* our estimates, relative to those reported above).

We also note that we have extended Ofwat's choice of comparators at PR19 to the three time periods included in our *'plausible range'*. This gives a range of **0.0%-0.8%**, with 2010-2019 forming the lower end of this range, and 1970-2007 the higher end. We present these results in full in Annex 3.

8 Water retail frontier shift estimates

In this chapter we set out our estimates of frontier shift relating to the retail part of the value chain. Our method is consistent with that set out for the total water value chain. We similarly frame our retail results in terms of three ranges: (i) our *'plausible range'* (**0.3%-0.6%**); (ii) our *'PR24 focused range'* (**0.4%-0.6%**); and (iii) our *'sensitivity analysis range'* (-**0.2%-1.2%**). As can be seen, our estimates for retail do not materially differ from those for the total value chain (with the upper end of our *'plausible range'* and *'PR24 focused range'* being fractionally lower for retail).

8A. Methodology

Our overall approach to arriving at retail-specific frontier shift estimates is consistent with that for the total water value chain. Specifically, we have adopted the same framework in considering the three criteria detailed previously in Section 5B:

- **Criterion 1**: similarity of activities being undertaken.
- **Criterion 2**: competitiveness of industry.
- **Criterion 3:** extent of scale effects.

In a broadly similar way to the total water value chain, we first filtered all the industries (in both the EU KLEMS and ONS databases) down to a set that contained just those that: (i) we considered could share similar characteristics to the water industry (i.e. not ranked as "Red" according to Criterion 1); and (ii) are neither in regulated nor public sector industries (i.e. not ranked as "Red" according to Criterion 2).

Following this initial filtering process, we applied Criterion 3 to the remaining industries. Given that a split between retail and wholesale activities (for the water industry) is unavailable in the EU KLEMS database, we used proxies for gross output and capital stock, noting that our choice of proxies was constrained by data availability. To proxy for each metric we used (respectively): (i) gross profit; and (ii) tangible fixed assets. We used two data sources to derive the data on each of these two metrics.

- For water retail, we used APR data for each year between 2015-16 and 2020-21. Specifically:[101]
  - We used Table 2F for gross profit, taking the sum (across all companies) of total revenue minus wholesale charges (i.e. "Retail revenue"). We note that this data is only available for residential retail, and not non-household retail.
  - We used Table 2D for tangible fixed assets, summing the value of the assets at the end of the financial year end across all companies. For consistency with gross profit, we did not include the value of non-household tangible fixed assets.
- For comparator industries, we used the FAME database between 2015-16 and 2020-21,[102] which contains data from companies' accounts. For each of tangible fixed assets and gross output, we used the annual average (for each industry) of that metric across the companies for which data was recorded in that year.[103]

Following the above steps, we then applied Criteria 3a-3c in a similar way as per our approach for the total water value chain (as is detailed in Section 5B). Our findings can be seen below:

- **For Criterion 3a**, we assigned our three-colour scale in the following way: (i) "Green" where the absolute divergence between the averages is less than 40.0%; (ii) "Amber" where the absolute divergence is between 40.0% and 80.0%; and (iii) "Red" where the absolute divergence is greater than 80.0%. Figure 24 shows the absolute divergence from water retail.

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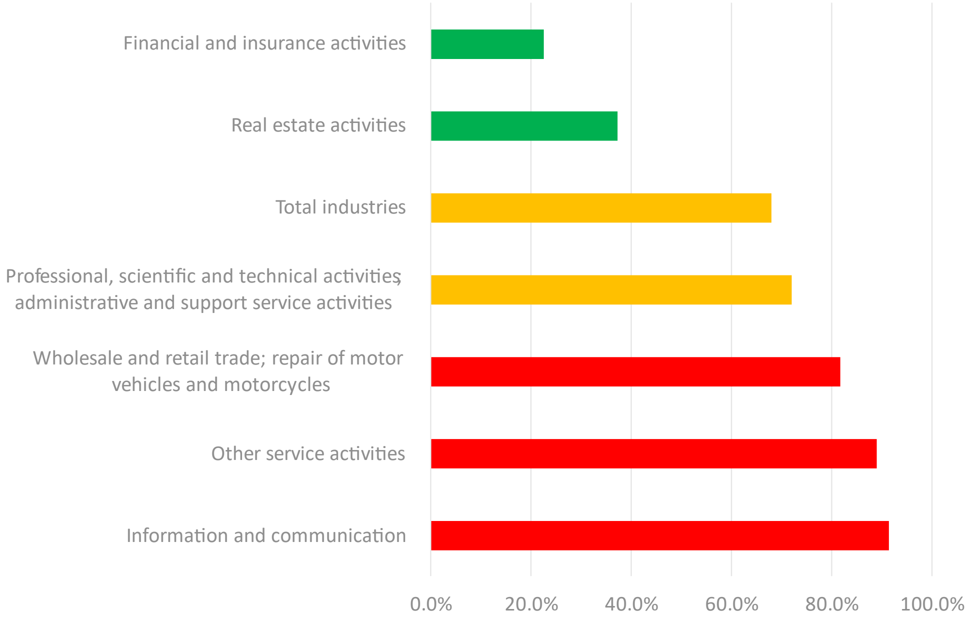
101 We adjusted data taken from both these sources to be in 2020-21 prices using quarterly CPIH index data. Specifically, we averaged the index for a given financial year over the four quarters in that year. Please see: https://www.ons.gov.uk/generator?format=xls&uri=/economy/inflationandpriceindices/timeseries/l522/mm23.

102 Please see: https://fame4.bvdinfo.com/ (last accessed 27 March 2023).

103 As the FAME database contains data from individual company accounts, there can be significant differences in the number of companies that have submitted data on each metric. As such, comparing sums across gross profit and tangible fixed assets could lead to inconsistencies; thus we chose to use the average across companies

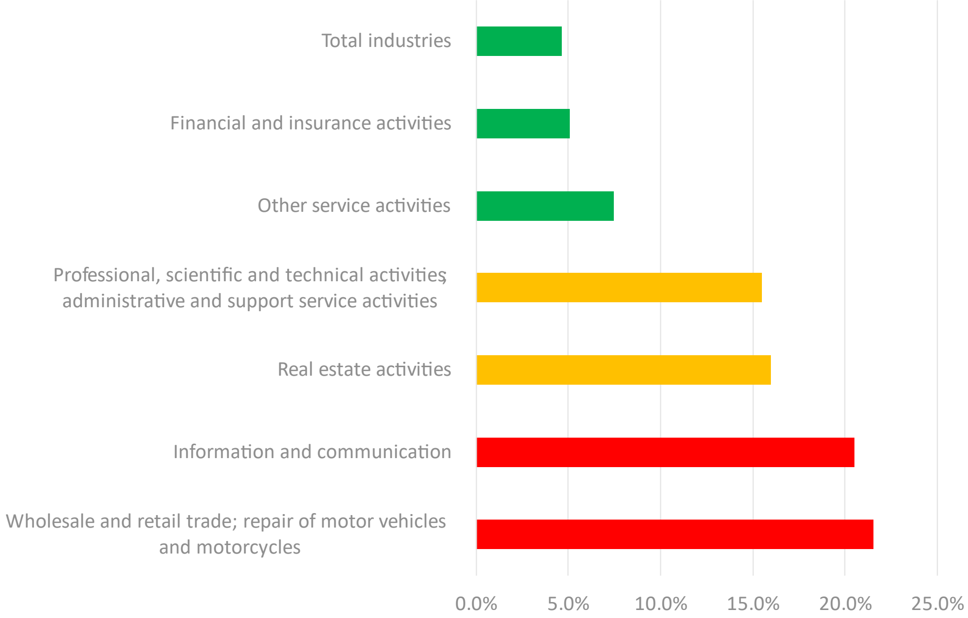
Figure 24: Absolute divergence in average tangible fixed asset-gross profit ratio (2015-16 to 2020-21)



Source: Economic Insight analysis of APR and FAME data

- **For Criterion 3b**, we assigned the three-colour scale in the following way: (i) "Green" where the absolute divergence between the averages is less than 10.0%; (ii) "Amber" where the absolute divergence is between 10.0% and 20.0%; and (iii) "Red" where the absolute divergence is greater than 20.0%. Figure 25 shows the absolute divergence from water retail.

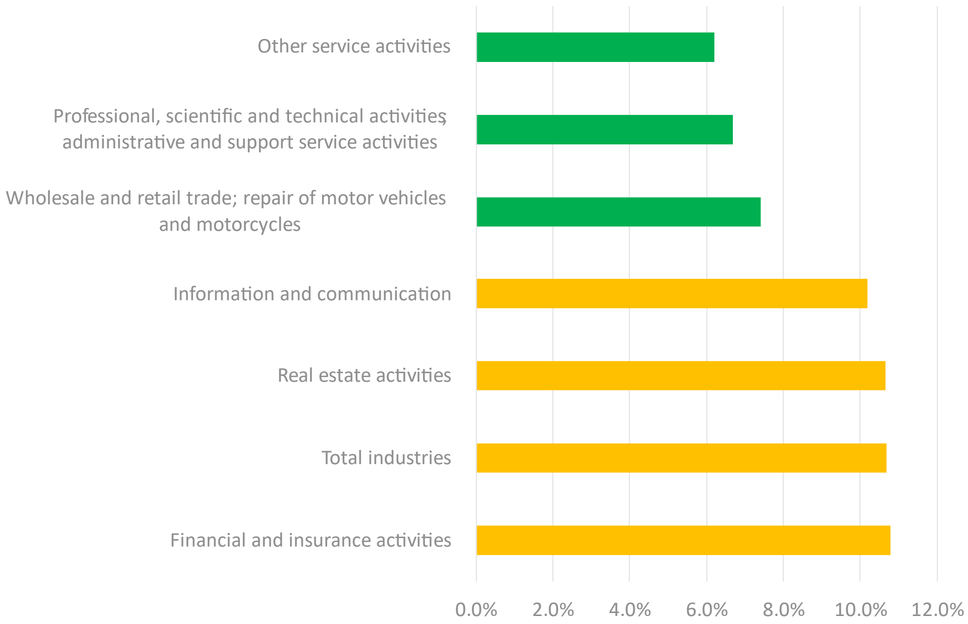
Figure 25: Absolute divergence in tangible fixed asset growth rate (2015-16 to 2020-21)



Source: Economic Insight analysis of APR and FAME data

- **For Criterion 3c**, we assigned the three-colour scale in the following way: (i) "Green" where the absolute divergence between the comparator and the water industry is between 6.0% and 8.0%; and (ii) "Amber" where the absolute divergence is greater than 8.0%. Figure 26 shows the absolute divergence from water retail.

Figure 26: Absolute divergence in gross profit growth rate (2015-16 to 2020-21)



Source: Economic Insight analysis of APR and FAME data

In the same way as per the total water value chain, we have defined a *'preferred set'* of comparators for our retail-specific analysis. In doing so, we have applied somewhat less stringent thresholds in order for a comparator industry to be included. Specifically, we have included any industry that is defined as "Green" in at least one of Criteria 1, 2, 3a, 3b and 3c.[104] In doing so, we are therefore attaching more weight to Criterion 1 (similarity of activities) and somewhat less weight to Criterion 3 (economies of scale) under our retail analysis, relative to our analysis for the total water value chain.

- We consider that more weight can be placed on Criterion 1 for water retail (relative to the total water value chain). This is because we are considering the activities of water retail specifically (as opposed to the totality of activities of a water company) meaning that choosing comparators with similar activities is easier.

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[104] *We note that, although "Total industries" fulfils this condition, we have chosen not to include it in our 'preferred set' of comparators. As we discuss below, we consider that more weight can be placed on Criterion 1 for water retail, relative to the total water value chain. As such, we consider that our 'preferred set' comprises industries that are more similar to water retail, than the equivalent set for the total water value chain. Therefore, we do not consider it necessary to include a metric that captures productivity changes across the entire UK 'on average' in our 'preferred set'.*

- We consider that less weight can be placed on Criterion 3 for water retail (relative to the total water value chain), due to the need to: (i) proxy for capital stock and gross output; and (ii) combine data from two separate data sources (APR and FAME), which might reduce comparability.

In addition to our recommended comparators, we have examined how varying the comparator set impacts our results by running four sensitivity analyses, as follows:

  – **Sensitivity 1**. In addition to our *'preferred set'* of comparators, this also includes "Total industries". This tests whether the inclusion of a metric that captures productivity changes across the entire UK 'on average' affects our results.

  – **Sensitivity 2**. Whereby the assessment under Criterion 1 is strengthened. Specifically, this only includes comparators for which Criterion 1 is defined as "Green" (and thus places more weight on the similarity of sectors).

  – **Sensitivity 3**. Here, the assessment under Criterion 2 is strengthened. Specifically, only comparators for which the adjusted HHI in Figure 14 is less than 2,000 are included.

  – **Sensitivity 4**. Finally, under this sensitivity, the assessment under Criterion 3 is strengthened. Specifically, this only includes comparators for which at least one of Criteria 3a-3c is defined as "Green" (and thus places more weight on the similarity of sectors as regards economies of scale).[105]

Table 10 presents the results of our assessment of comparators against the criteria detailed above. As with the total water value chain, we report our results in relation to three defined 'ranges'; and so below we detail which comparators we include under each. We also note that the time periods corresponding to each of the below ranges are consistent with those used for the total water value chain (as detailed in Section 4C).

- **Plausible range**. This includes our *'preferred set'* of comparators for water retail.
- **PR24 focused range**. This also only includes our *'preferred set'* of comparators for water retail.
- **Sensitivity analysis range.** This includes our *'preferred set'* of comparators for water retail, in addition to those as tested under our sensitivity analyses (**Sensitivity 1**; **Sensitivity 2**; **Sensitivity 3**; and **Sensitivity 4**).

[105] This also includes "Total industries".

Table 10: Assessment of industries against Criteria (**water retail**)

Industry	Criteria					Preferred set	Sensitivity			
	1	2	3a	3b	3c		1	2	3	4
Total industries						✗	✓	✗	✗	✓
Wholesale and retail trade; repair of motor vehicles and motorcycles						✓	✓	✓	✓	✓
Information and communication						✓	✓	✓	✗	✗
Financial and insurance activities						✓	✓	✓	✗	✓
Real estate activities						✓	✓	✗	✓	✓
Professional, scientific and technical activities; administrative and support service activities						✓	✓	✓	✓	✓
Other service activities						✓	✓	✗	✗	✓

Source: Economic Insight analysis

8B. Results

Following our methodology for arriving at frontier shift estimates for water retail across the three above-mentioned ranges, we arrive at the following frontier shift estimates for PR24. These ranges are as follows:

- **Plausible range (0.3%-0.6%).** The lower end of this range corresponds to 1970-2007 (NACE I), and the upper end to 1995-2019 (NACE II).
- **PR24 focused range (0.4%-0.6%).** The lower end corresponds to Weighted average of 1995-2019 (NACE II) and 1970-2007 (NACE I), and the upper end to 2010-2019 (NACE II).
- **Sensitivity analysis range (-0.2%-1.2%).** Details of the comparators and time periods for both the upper and lower ends of this range are given in Table 11.

Table 11 summarises our results for each of the three ranges and recaps the comparators used. We present our full set of results in Annex 4.

Table 11: Summary table of minimum and maximum results across our three ranges[106]

Comparator	Plausible range		PR24 focused range		Sensitivity analysis range	
	Low	High	Low	High	Low[107]	High[108]
Total industries					0.2%	
Wholesale and retail trade; repair of motor vehicles and motorcycles	0.1%	-0.1%	-0.1%	-0.1%	-0.2%	0.7%
Information and communication	1.8%	3.7%	2.9%	3.7%		3.2%
Financial and insurance activities	-0.2%	-0.6%	-0.3%	-0.6%	-0.3%	0.9%
Real estate activities	-0.5%	1.3%	0.0%	1.3%	0.5%	-0.1%
Professional, scientific and technical activities; administrative and support service activities		-0.1%	-0.3%	-0.1%	-0.3%	
Other service activities		-0.3%	-1.2%	-0.3%	-1.2%	
Final results (average)	**0.3%**	**0.6%**	**0.4%**	**0.6%**	**-0.2%**	**1.2%**

Source: Economic Insight analysis of EU KLEMS data

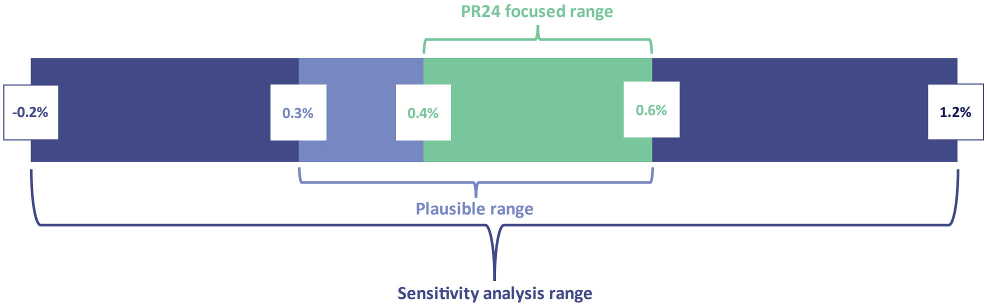
[106] *We note that, for some comparators in NACE II, there is no NACE I equivalent (e.g. "Other service activities"), hence there is no TFP estimate for this comparator at the 'Low' end of our 'plausible range', but there is at the 'High' end. For these comparators, the TFP estimate at the 'Low' end of our 'PR24 focused range' (1970-2019) is equal to the 1995-2019 average. As such, the average across comparators in 1970-2019 may not equate to the average of the individual comparator TFP estimates, as it is calculated using a weighted average of the total averages across comparators in 1995-2019 and 1970-2007.*

[107] *This corresponds to: (i) comparators that are defined as "Green" in at least one of Criteria 3a, 3b or 3c (**Sensitivity 4**); and (ii) the 1995-2019 period.*

[108] *This corresponds to: (i) comparators that are included in our 'preferred set'; and (ii) the 1992-2007 period.*

Figure 27 provides a visual summary of our ranges.

Figure 27: Illustration of our three ranges (water retail)



Source: Economic Insight

As with the total water value chain, our retail-specific estimates are based on: (i) a gross output approach; and (ii) an arithmetic mean.

In this report, we do not provide separate wholesale-specific frontier shift estimates, although we note that these would be very similar to those provided for the total water value chain, due to the fact that the vast majority of totex is wholesale-based. However, if companies wish to derive a wholesale-specific estimate, then the following formula can be used:

$$Frontier\ shift_W = \frac{Frontier\ shift_T \times Totex_T - Frontier\ shift_R \times Totex_R}{Totex_W}$$

In the above equation: "T" refers to total water; "W" to wholesale; and "R" to retail; and $Totex_T = Totex_W + Totex_R$.

9 Recommendations

Having presented our range of frontier shift estimates for both the total water value chain and water retail specifically, we now present a series of recommendations in light of these estimates. Firstly, we set out recommendations for companies, going into the development of their PR24 business plans. Secondly, we present a set of recommendations for both companies and Ofwat regarding the approach to frontier shift at PR24.

9A. Recommendations to companies

In terms of how we recommend companies utilise our estimates in developing their PR24 business plans, this is as follows:

- The estimation of frontier shift is inherently uncertain. As such, companies have some discretion as to what evidence / approaches they place most weight on when determining what frontier shift to assume in their business plans for PR24. Our own analysis suggests frontier shift for the total water value chain could plausibly lie between 0.3% and 0.8% pa (0.3% and 0.6% for water retail); and so companies could select any figure within this range and it would be supportable, on the evidence. In determining 'where' in that range to select, companies should consider (and explain in their plans) the specific evidence / rationale in our report (or from elsewhere) they rely on.

- That said, with a focus specifically on the PR24 time period, it seems *likely* (both on the evidence and intuition, given the persistence of low productivity) that frontier shift will sit within a narrower range (which we find to be 0.3% to 0.7% for the total water value chain; and 0.4% to 0.6% for water retail). Companies should therefore consider with care the case for selecting figures outside of these narrower ranges (noting that, prior to PR14, frontier shift in the water industry was typically set around these levels by Ofwat).

- The fact that embodied technological change is only partially captured in our estimates may provide some basis for choosing numbers towards the higher end of our ranges. On the other hand, the fact that our raw estimates implicitly include efficiencies other than frontier shift means they are overstated, providing some basis for choosing numbers towards the lower end of our ranges.[109] Our recommendation is therefore that companies should: (i) generally adopt numbers at the mid-points of our ranges; or (ii) could deviate from that (i.e. selecting higher or lower numbers within our ranges) if that decision was informed by additional evidence relating to:

  - an assessment of the rate of technological change in the water industry, relative to the comparator sectors; and / or
  - additional evidence as to the scope for other efficiencies (e.g. economies of scale) in the water industry, relative to the comparator sectors.[110]

- We consider that (in principle) frontier shift gains should be applied to the totality of company costs (i.e. both base and enhancement), other than costs which are deemed outside of management control. In relation to enhancement costs, in order to avoid either omitting (or double-counting) a frontier shift challenge, companies should provide clear evidence as to how the frontier shift has been applied. If companies consider a frontier shift challenge has been implicitly included, they should explain why and provide evidence to support that. Where the challenge has been explicitly applied, they should state so and demonstrate this.

- Companies may want to consider whether, and to what extent, the possible use of Ofwat's innovation fund may affect the scope for frontier shift on a forward-looking basis. However, we note that the size of the fund (£200m)[111] relative to total industry totex set by Ofwat in its PR19 FD (£49.6bn)[112] is sufficiently small that it seems doubtful that this can materially affect productivity and thus, we do not recommend making an adjustment for this.

9B. Wider recommendations for PR24

Below we set out recommendations for Ofwat and companies for PR24, in order to ensure that the most appropriate estimate of frontier shift is selected:

- Ensure that any choice of time period is based on a transparent assessment against the considerations captured within our criteria (specifically: internal consistency; use of complete business cycles; utilisation of data; and reflecting the structural break in productivity in the UK, post 2008). The UK's economic outlook should be reviewed as plans are finalised / regulatory determinations are made, to help ensure this is the case.

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[109] *Noting that the overstatement of frontier shift due to catch-up is likely greater in magnitude than a potential understatement due to scale effects.*

[110] *Relatedly, and as noted previously in this executive summary, companies could further consider whether the comparator set itself might change, if (for example) the expected mix of activities they will undertake at PR24 is sufficiently different from the past.*

[111] *'Creating tomorrow, together: Our final methodology for PR24 Appendix 9 Setting expenditure allowances.' Ofwat (December 2022); page 38.*

[112] *'PR19 slow track draft determinations: Securing cost efficiency technical appendix.' Ofwat (December 2019); page 8.*

- In selecting comparators, undertake analysis to apply the evaluation criteria outlined in this report; critically assessing each comparator industry to objectively determine its applicability. This will also help inform how (or whether) to reflect any efficiencies other than frontier shift captured in the raw TFP data.

- Any updated productivity data (in particular, the EU KLEMS or ONS datasets) that is published between now and the determinations should, ideally, be utilised and frontier shift estimates updated prior to the determinations.

- Any further information / evidence relating the relative competitiveness of comparator sectors (published prior to the determinations) should be reviewed and taken into consideration.

- Frontier shift estimates should be based on gross output TFP productivity, with little or no weight given to value added estimates.

- If frontier shift is estimated over a very long time period, the use of a geometric mean should be considered.

- In relation to embodied technological change, this matter could be further informed by the following:

  (ii) Analyse historical TFP growth in the industry; and track the extent to which periods of higher technological change correlate with increased TFP growth. Then one could 'map forward' any anticipated technological change over PR24, to determine whether it is likely to be a relatively 'high', or 'low', period of technological change.

  (iii) Undertake a literature review regarding empirical estimates of embodied technological change. From our existing research, we have identified academic articles that estimate between 20%[113] and 60%[114] of TFP growth may represent embodied change. However, these estimates should be taken with certain caveats. Firstly, both studies rely upon data that is 40 years old (i.e. when productivity growth was much higher than it is now). Secondly, they take data from the US, whose economy has been consistently subject to higher levels of investment and greater productivity growth than the UK. Therefore, although these academic sources are informative in providing a starting point for quantifying the degree to which TFP may underestimate achievable frontier shift, their calculations should not be taken as a 'rule' for any adjustments required (further noting our finding that, in any event, TFP already includes *some* embodied technological change).

  (iv) For each chosen comparator, undertake a two-stage process to determine the importance of potentially excluded embodied technological change. Firstly, develop evidence as to the amount of embodied change that is likely reflected in the TFP data of the comparators. Secondly, examine the rate of technological change in the comparators, and compare this to the rate of

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113 *'Growth Accounting When Technical Change is Embodied in Capital.' Hulten, C. (January 1992).*
114 *'Embodied and disembodied technical change and the constant elasticity of substitution production function.' Uri, N. (December 1983).*

technological change in the water industry. Where the rates are similar, the more appropriate it is to adjust for excluded embodied technological change. Conversely, where the rate of technological change is materially different in the water industry, relative to the comparators, adjustments for embodied change are more likely to result in an over or understatement of frontier shift. For example, where technological change in the water industry is slower than that for the comparators, an adjustment would likely result in an overstatement of frontier shift (and vice-versa).

- As a matter of urgency, the industry needs some way to scale the size of the efficiency challenge being set under the performance commitments at PR24. Without this, the totality of the efficiency challenge (both catch-up and frontier shift) cannot be determined; and a 'double-count' will likely occur. This is a material limitation under the current regulatory framework.

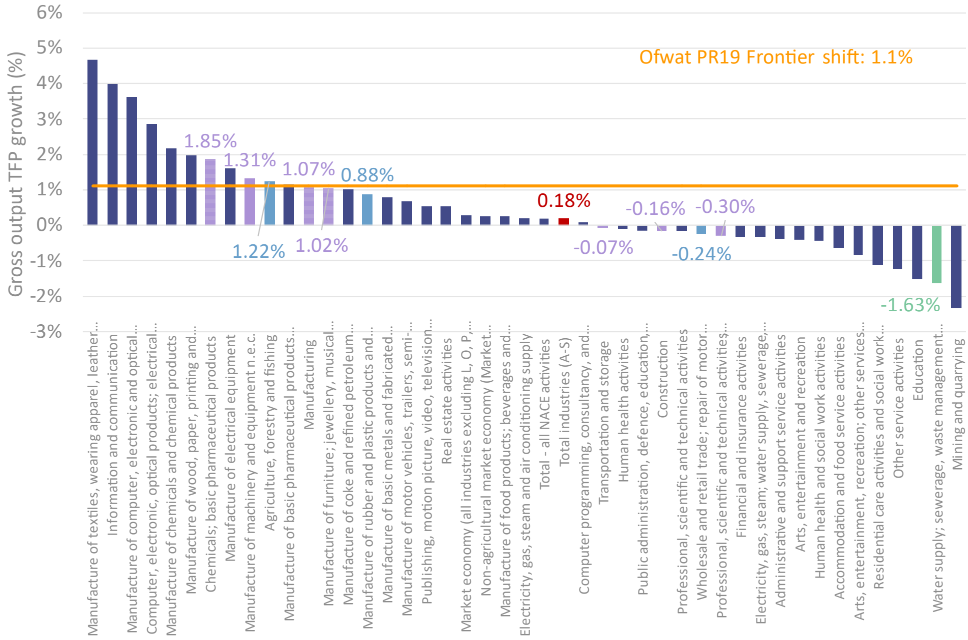
- Ofwat should adopt an internally consistent approach between that which is currently taken for real price effects, and what should be taken for frontier shift. Specifically, any frontier shift challenge should only account for ongoing efficiency gains specific to the water industry, that are not already implicitly captured within CPIH.

10 Annex 1: Ofwat’s PR19 target compared to UK industry-wide productivity performance

Below, we present Ofwat’s assumed frontier shift (1.1% pa) at PR19 against the distribution of TFP growth across industries using EU KLEMS data. We show this firstly against the three periods included in our *‘plausible range’*: (i) 1995-2019 (the majority of the last two business cycles, and the entirety of the period for which NACE II data is available); (ii) 2010-2019 (the majority of the most recent business cycle); and (iii) 1970-2007 (the majority of the four business cycles prior to the financial crisis, and the entirety of the period for which NACE I data is available). Secondly, we show this against the additional period included in our *‘sensitivity range’*: 1992-2007 (the majority of the business cycle before the financial crisis). In each of these figures in this annex (in addition to Figure 2 and Figure 5 in the main body of the report), the colour and style of the bars correspond to the following:

- Solid green bar: water sector only in NACE II (“Water supply; sewerage, waste management and remediation activities”); electricity and water sectors combined in NACE I (“Electricity, gas, steam; water supply, sewerage, waste management”).
- Red bar: “Total industries”, which is also a comparator included in our *‘preferred set’* but not used by Ofwat.
- Dashed purple bar: comparators used by Ofwat and also included in our *‘preferred set’*.
- Solid purple bar: comparators chosen by Ofwat but not included in our *‘preferred set’*.
- Solid light blue bar: comparators included in our *‘preferred set’* but not chosen by Ofwat (excluding “Total industries”).
- Dark blue bar: all other comparators.

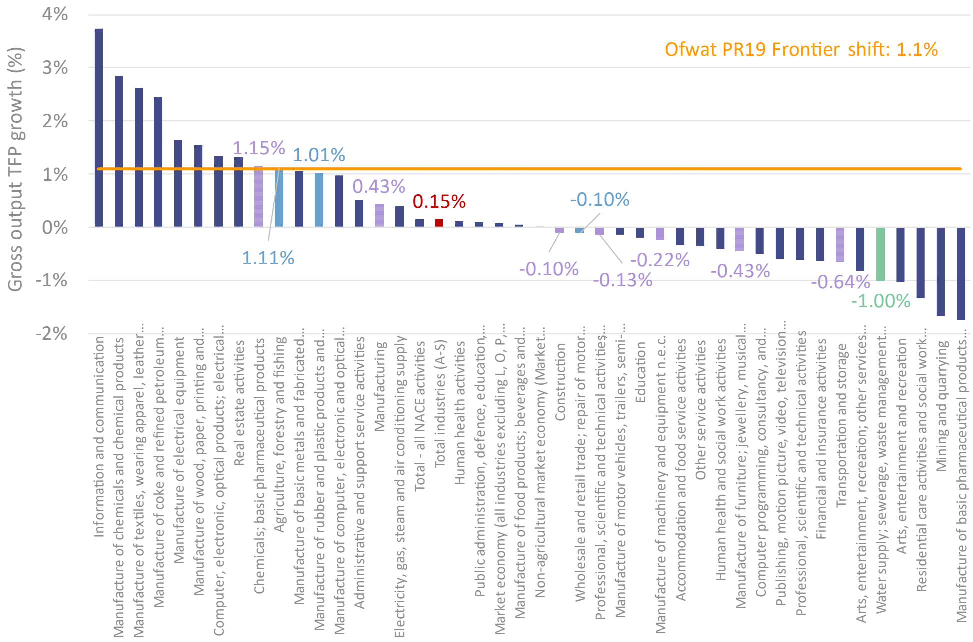
Figure 28: Sector level gross output TFP growth – EU KLEMS (1995 to 2019)



Source: Economic Insight analysis of EU KLEMS data

Notes: We have not included "Telecommunications" in this chart in order to improve readability, as its average TFP growth is 12.9%.

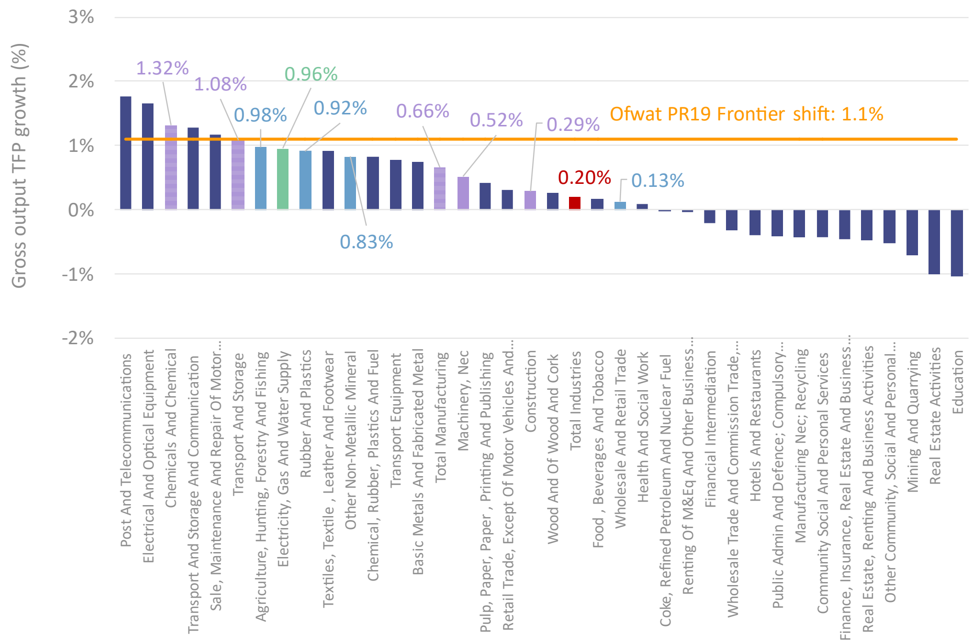
Figure 29: Sector level gross output TFP growth – EU KLEMS (2010 to 2019)



Source: Economic Insight analysis of EU KLEMS data

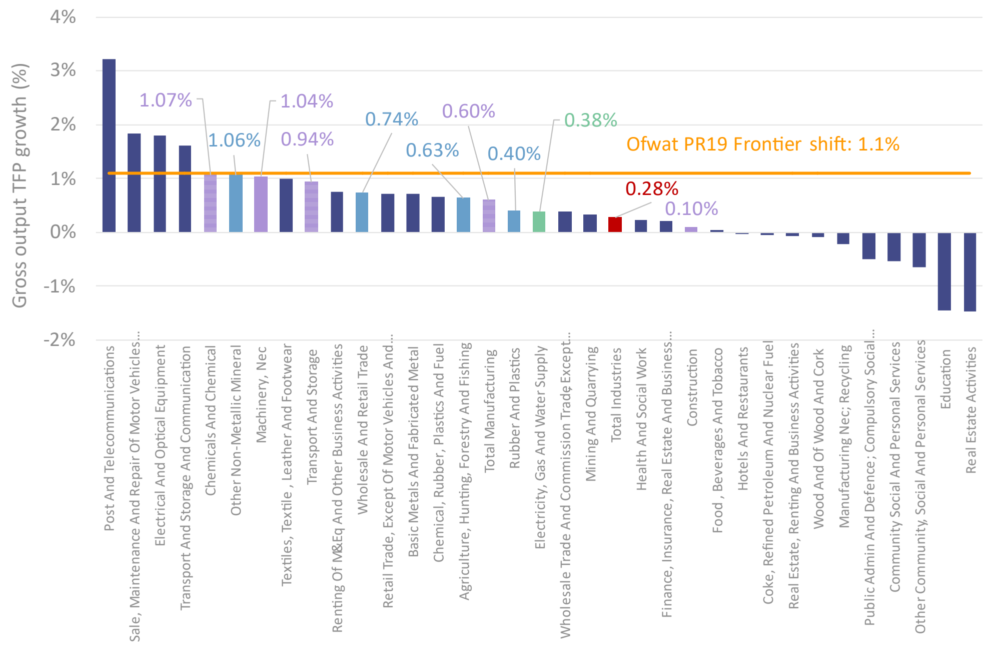
Notes: We have not included "Telecommunications" in this chart in order to improve readability, as its average TFP growth is 15.4%.

Figure 30: Sector level gross output TFP growth – EU KLEMS (1970 to 2007)



Source: Economic Insight analysis of EU KLEMS data

Figure 31: Sector level gross output TFP growth – EU KLEMS (1992 to 2007)



Source: Economic Insight analysis of EU KLEMS data

These figures show that, under any of these four time periods, Ofwat's PR19 frontier shift challenge (1.1%) is driving a frontier shift position that is an *'outlier'* (although clearly this is a matter of degree). Specifically, the average TFP productivity growth for "Total industries" is consistently below 1.1%. Furthermore, this is borne out by the number of sectors that would meet Ofwat's frontier shift challenge over the various time periods (noting that these often, as one would expect, relate to high-tech industries, such as telecoms; chemicals; and computing):

- Between 1995 and 2019, 12 sectors would achieve Ofwat's challenge out of the 46 considered in the dataset (as shown in Figure 28).
- Between 2010 and 2019, 11 sectors would achieve Ofwat's challenge out of the 46 considered in the dataset (as shown in Figure 29).
- Between 1970 and 2007, 5 sectors would achieve Ofwat's challenge out of the 38 considered in the dataset (as shown in Figure 30).
- Between 1992 and 2007, 4 sectors would achieve Ofwat's challenge out of the 38 considered in the dataset (as shown Figure 31).

Below, we compare whether productivity measures differ markedly when using ONS MFP as a proxy instead of EU KLEMS TFP. The time periods correspond to those detailed in Section 4C that are included in our sensitivity range: (i) 2010-2019 (the last full business cycle, excluding 2020 which was affected by COVID-19); (ii); 2010-2021 (the last full business cycle, applying an alternative definition for its end); and (iii) 1970-2021 (entire full period for which data is available, and applying an alternative definition for the end of the most recent business cycle).

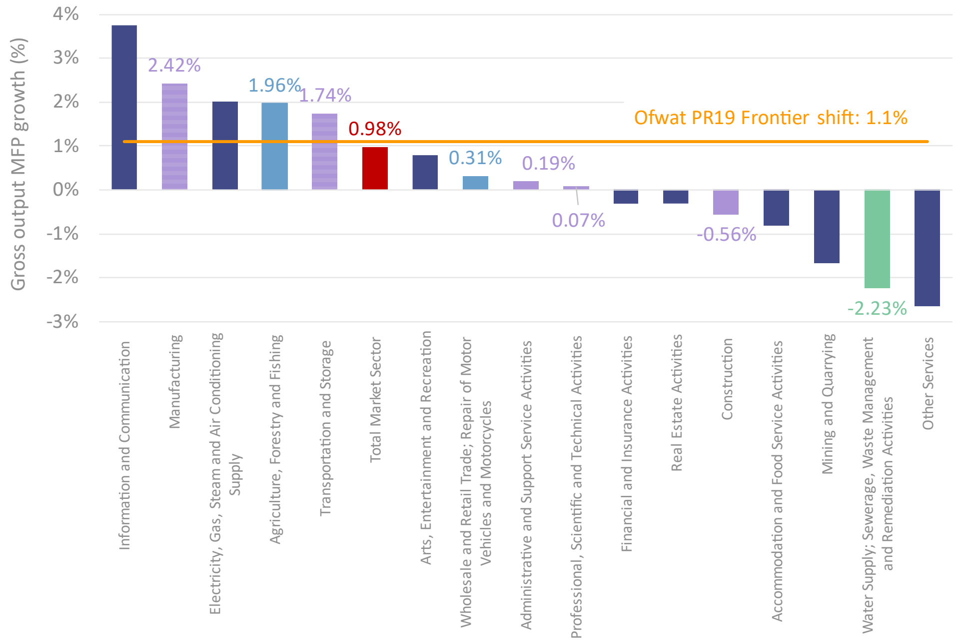
We note the following differences between the EU KLEMS and ONS measures.

- Firstly, the ONS dataset assesses how MFP varies over the time period, whilst EU KLEMS analyses how TFP varies over the time period. Whilst these measures are substantively the same, there are some slight differences. We explain these in Annex 2.
- Secondly, whilst 2019 is the last year captured in the EU KLEMS TFP data available, ONS MFP captures data up to and including 2021. To make maximum use of the available data, we therefore extend the end date of the period under consideration for two of the time periods in the figures below. Not only does this allow us to more fully assess the most recent complete business cycle, but it also means estimates include (part of) the effect of the COVID-19 period. As the effects of COVID-19 are likely to linger over PR24, it is important to have an in-depth understanding of them.
- Thirdly, when considering the results of these graphs, it is important to bear in mind that they present a value added estimate. This means that, ceteris paribus, we would expect their results to be higher than the EU KLEMS figures, which represent a gross output estimate. The economic theory underlying this rationale is explained in Section 3B.

- Lastly, the ONS and EU KLEMS data estimate productivity over slightly different sectors. As a generalisation, ONS only considers sectors at a high-level of aggregation, whilst EU KLEMS also breaks sectors down to a more granular level. This is made obvious when analysing the number of sectors each dataset considers – EU KLEMS considers up to 46 sectors in its NACE II dataset, whilst ONS only considers 17 sectors.

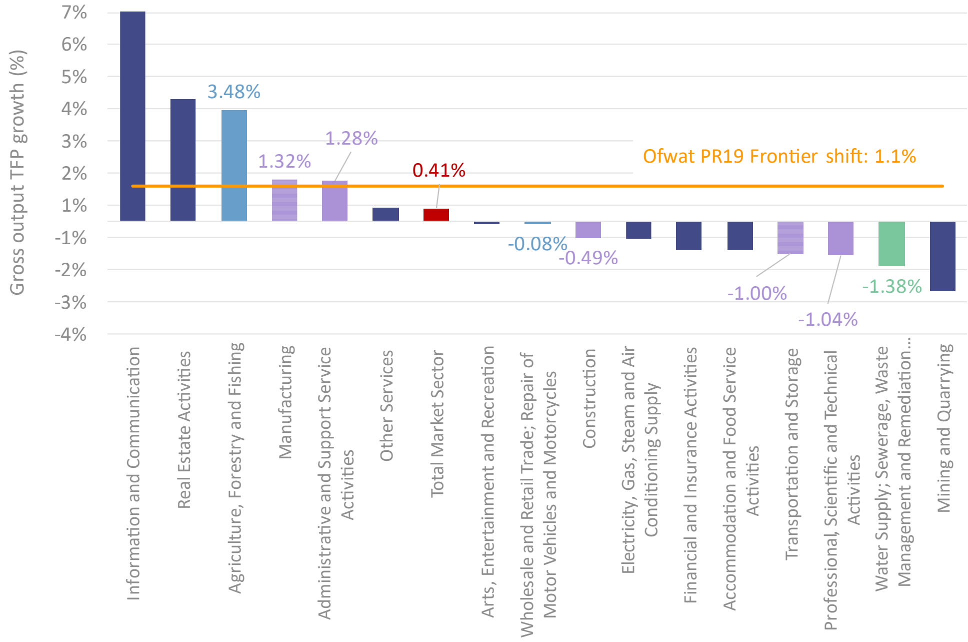
In the below figures, the colour coding used is the same as for the EU KLEMS figures, but we note that Ofwat did not use the ONS dataset in its analysis so the purple (both dashed and solid) bars correspond to the bars that would have been chosen by Ofwat had it used the ONS database, based on its choice of EU KLEMS comparators.

Figure 32: Sector level productivity growth – ONS (1970 to 2021)



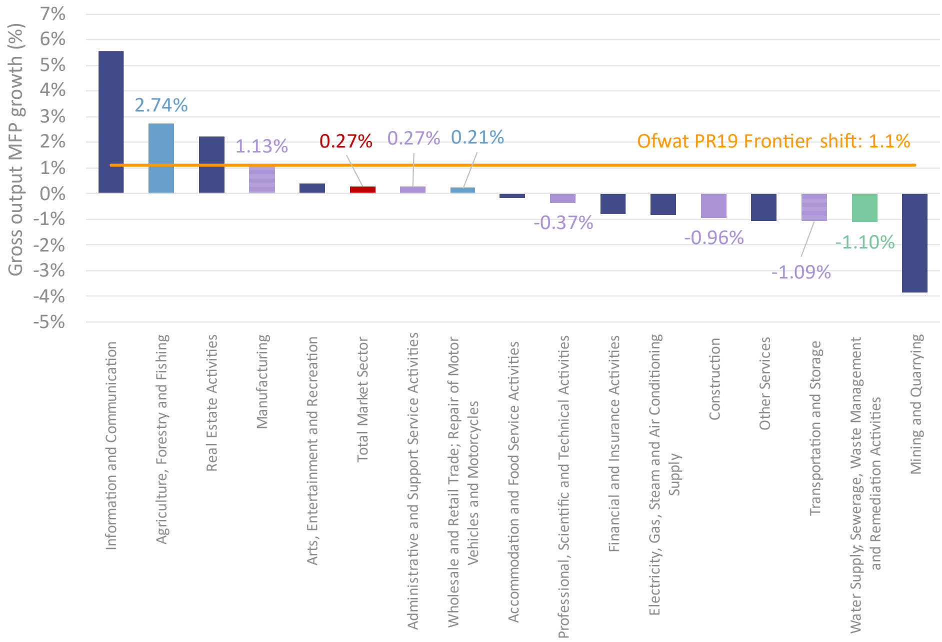
Source: Economic Insight analysis of ONS MFP data

Figure 33: Sector level productivity growth – ONS (2010 to 2019)



Source: Economic Insight analysis of ONS MFP data

Figure 34: Sector level productivity growth – ONS (2010 to 2021)



Source: Economic Insight analysis of ONS data

Despite the differences between the ONS and EU KLEMS datasets, we find that the headline takeaway from both graphs is the same. ONS MFP data also makes it clear that only a minority of sectors meet Ofwat's frontier shift challenge over the various time periods.

– Between 1970 and 2021, 5 sectors would achieve Ofwat's challenge out of the 17 considered in the dataset (as shown in Figure 32).

- Between 2010 and 2019, 5 sectors would achieve Ofwat's challenge out of the 17 considered in the dataset (as shown in Figure 33).
- Between 2010 and 2021, 4 sectors would achieve Ofwat's challenge out of the 17 considered in the dataset (as shown in Figure 34).

Therefore, for ONS MFP the implication of these results is the same as for EU KLEMS TFP – Ofwat expects that the water sector should be able to achieve productivity growth at a level well above the rate achieved for most sectors in the UK economy.

11 Annex 2: Description of ONS and KLEMS datasets

In this annex we set out a description of the datasets used in our analysis. We do this firstly for the EU KLEMS database (that we use for TFP estimates); and secondly for the ONS database (that we use for MFP estimates).

11A. EU KLEMS

The EU KLEMS dataset provides productivity information that is comparable across a range of countries, including those from the EU, UK, US, and Japan. EU KLEMS draws its source information from national statistics agencies. These bodies, such as the ONS, provide the input values used as part of the index. EU KLEMS uses this source data for its measures of output, intermediate inputs (such as energy and materials), capital and labour to develop productivity estimates. The latest iteration, released in 2021, contains data for these countries from 1995. EU KLEMS calculates TFP growth by decomposing the contribution to growth in volume terms of capital, labour and TFP. TFP is then calculated from this as a residual.[115] The sources used for each category of the TFP calculation are shown below.

- **Output.** Gross value added and gross output are both used, with figures taken from Eurostat and other national agencies. In the 2023 EU KLEMS dataset, 2015 is used as the base year.

- **Labour.** The European Labour Force Survey is used to determine the employment level and structure for most European countries. However, UK employment figures are taken from the Labour Force Survey. Wage information is taken from the Structure of Earnings Survey for EU countries. To capture variations in volume and quality of labour over time, EU KLEMS assumes that the labour force is divided into different categories based on age, gender and education level. They assume that labour services are proportional to hours worked, and that wages are based on marginal productivities. To calculate total labour services, these individual categories are aggregated and weighted based on the share of total labour compensation that each category makes up.

[115] *'EUKLEMS & INTANProd: industry productivity accounts with intangibles,' Bontadini. F (February 2023); page 7.*

- **Capital.** A combination of Eurostat information and data from national agencies is used to estimate capital formation. In the first stage of the calculation, the volume and price of the services provided by each type of asset are estimated. This assessment is undertaken using a standard neoclassical approach. In the second stage, the flows of capital services provided by each asset type are estimated. This cannot be observed, so must be measured by proxy. Consistent with accepted practice, EU KLEMS assumes that capital service flows are proportional to the volume of capital stock. We note that EU KLEMS slightly adapted its methodology for assessing capital stocks from 2017 onwards. It used to estimate capital stocks using a perpetual inventory method, but has modified its approach - estimates of capital stocks by industry are now taken directly from Eurostat.

Output and input volumes are aggregated across industries using the Tornqvist quantity index. This method enables the measurement of the difference in productivity between two or more consecutive periods, or firms. To undertake the calculation, certain assumptions are required including: constant returns to scale; that inputs are paid the value of their marginal product; and that output prices reflect consumer willingness to pay.[116]

An advantage of using EU KLEMS is that the dataset is consistent with the national accounts data of the countries it reports on. This is an improvement upon the alternative of using firm-level data, which is not usually consistent with national accounts, and contains estimates that are crude. Furthermore, the EU KLEMS dataset builds upon the national accounts data of individual countries by using a common methodology to estimate the labour quality and capital.[117] This enables productivity comparisons to be drawn.

However, we note that the reliability of the data reduces when greater industry granularity is used, particularly for services industries. This is because, to increase the granularity of the data, adjustments must be made to national accounts data. These adjustments will require estimations to be made of capital and labour, that could be unreliable.

As was detailed in Section 4C, two separate datasets are available from EU KLEMS: (i) NACE I (1970-2007); and (ii) NACE II (1995-2019). We note that many of the sectors correspond 1:1 between the two datasets, but for other sectors this is not the case. Table 12 shows the industries included in the EU KLEMS database, with the NACE I sector that we have taken to correspond to that NACE II sector also listed. Where there is no equivalent to a particular sector (either in NACE I or NACE II), the corresponding row is left blank.

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116 *'Productivity improvement in the water and sewerage industry in England since privatisation.' Frontier Economics; (September 2017)*

117 *'The mystery of TFP.' Oulton, S. (October 2017).*

Table 12: Industries in EU KLEMS NACE II dataset

Industry NACE II	Industry NACE I
Accommodation and food service activities	
Activities of extraterritorial organisations and bodies	Extra-Territorial Organizations And Bodies
Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use	
Administrative and support service activities	
Agriculture, forestry and fishing	Agriculture, Hunting, Forestry And Fishing
Air transport	
Arts, entertainment and recreation	
Arts, entertainment, recreation; other services and service activities, etc.	
Chemicals; basic pharmaceutical products	Chemicals And Chemical
Computer programming, consultancy, and information service activities	
Computer, electronic, optical products; electrical equipment	
Construction	Construction
Education	Education
Electricity, gas, steam and air conditioning supply	
Electricity, gas, steam; water supply, sewerage, waste management	Electricity, Gas And Water Supply
Financial and insurance activities	Financial Intermediation
Human health activities	
Human health and social work activities	Health And Social Work
Imputed rents of owner-occupied dwellings	

Industry NACE II	Industry NACE I
Information and communication	Post And Telecommunications[118]
Land transport and transport via pipelines	
Manufacture of basic metals and fabricated metal products, except machinery and equipment	Basic Metals And Fabricated Metal
Manufacture of basic pharmaceutical products and pharmaceutical preparations	
Manufacture of chemicals and chemical products	
Manufacture of coke and refined petroleum products	Coke, Refined Petroleum And Nuclear Fuel
Manufacture of computer, electronic and optical products	Electrical And Optical Equipment
Manufacture of electrical equipment	
Manufacture of food products; beverages and tobacco products	Food , Beverages And Tobacco
Manufacture of furniture; jewellery, musical instruments, toys; repair and installation of machinery and equipment	
Manufacture of machinery and equipment n.e.c.	Machinery, Nec
Manufacture of motor vehicles, trailers, semi-trailers and of other transport equipment	Transport Equipment
Manufacture of rubber and plastic products and other non-metallic mineral products	Rubber And Plastics[119]
	Other Non-Metallic Mineral
Manufacture of textiles, wearing apparel, leather and related products	Textiles, Textile , Leather And Footwear

[118] *We note that in the NACE I database there is not a direct equivalent to "Information and communication", neither is there an equivalent in the NACE II database for "Post and Telecommunications". However, having considered the two comparators separately, we consider that they are sufficiently comparable to be considered as equivalent comparators for the purposes of our analysis.*

[119] *We note that we have taken "Rubber and Plastics" as the NACE I equivalent for the NACE II entry "Manufacture of rubber and plastic products and other non-metallic mineral products", as the exact weighting between "Rubber and Plastics" and "Other Non-Metallic Mineral" is unclear.*

Industry NACE II	Industry NACE I
Manufacture of wood, paper, printing and reproduction	Wood And Of Wood And Cork
Manufacturing	Total Manufacturing
Market economy (all industries excluding L, O, P, Q, T and U)	
Mining and quarrying	Mining And Quarrying
Non-agricultural market economy (Market economy less industry A)	
Other service activities	
Postal and courier activities	
Professional, scientific and technical activities	
Professional, scientific and technical activities; administrative and support service activities	
Public administration and defence; compulsory social security	Public Admin And Defence; Compulsory Social Security
Public administration, defence, education, human health and social work activities	
Publishing, motion picture, video, television programme production; sound recording, programming and broadcasting activities	
Real estate activities	Real Estate, Renting And Business Activities
Residential care activities and social work activities without accommodation	
Retail trade, except of motor vehicles and motorcycles	Retail Trade, Except Of Motor Vehicles And Motorcycles; Repair Of Household Goods
Telecommunications	
Total - all NACE activities	
Total industries (A-S)	Total Industries
Transportation and storage	Transport And Storage

Industry NACE II	Industry NACE I
Warehousing and support activities for transportation	
Water supply; sewerage, waste management and remediation activities	
Water transport	
Wholesale and retail trade; repair of motor vehicles and motorcycles	Wholesale And Retail Trade
Wholesale and retail trade and repair of motor vehicles and motorcycles	Sale, Maintenance And Repair Of Motor Vehicles And Motorcycles; Retail Sale Of Fuel
Wholesale trade, except of motor vehicles and motorcycles	Wholesale Trade And Commission Trade, Except Of Motor Vehicles And Motorcycles
	Chemical, Rubber, Plastics And Fuel
	Community Social And Personal Services
	Finance, Insurance, Real Estate And Business Services
	Hotels And Restaurants
	Manufacturing Nec; Recycling
	Other Community, Social And Personal Services
	Private Households With Employed Persons
	Pulp, Paper, Paper , Printing And Publishing
	Real Estate Activities
	Renting Of M&Eq And Other Business Activities
	Transport And Storage And Communication

Source: Economic Insight analysis

11B. ONS MFP

ONS MFP is a value added measure of outputs per unit of total relevant input. It is calculated using a growth accounting framework. Its estimates cover only the market sector in the UK, which means that they exclude government and non-profit organisations. Like the EU KLEMS dataset, output and input volumes are aggregated across industries using the Tornqvist quantity index. To construct the index, the following input measures were used.[120]

- **Capital.** The ONS assesses the volume of capital services employed across the economy over a given period of time, using its volume index of capital services (VICS). The measure considers the flows of services produced by different types of assets. VICS covers 57 component industries and is collected on a quarterly basis. The primary data source for VICS is business investment (sourced from their Quarterly Acquisitions and Disposals of Capital Assets Survey). This assesses the acquisition and disposal of capital assets across the UK. This represents a different modelling choice to EU KLEMS; put simply, ONS MFP assesses the 'flow' of capital, whilst EU KLEMS TFP examines the 'stock' of capital. Whilst both modelling choices follow strong economic intuition, international comparisons cannot be drawn using ONS MFP, as business investment is not an internationally defined concept.

- **Labour.** The ONS accounts for the change in volume of labour by assessing the change in hours worked. As input data for this, the ONS uses the Labour Force Survey (which is the same to that used in EU KLEMS), and the Annual Survey of hours and earnings (ASHE). Changes in labour quality are assessed through the quality-adjusted labour input (QALI) index, which is computed using the OECD's growth accounting methodology.[121] To calculate this, the hours worked by different categories of workers are weighted by their relative income share. Workers are categorised by age, gender, industry of employment and education. This represents a slightly different set of characteristics to those used in EU KLEMS. The Labour Force Survey and ASHE are also used as the input data for labour quality.

- **Quarterly data from the national accounts is used as output data.** This is ONS GVA data of the UK market sector. Consequently, the ONS MFP index only provides an MFP figure using a value added methodology.

As a consequence of the input and output variables chosen by the ONS, its measure is slightly different to EU KLEMS. The most significant difference is that the ONS only uses a value added methodology, whilst EU KLEMS provides estimates using both a value added and gross output methodology. Due to this, when we compare ONS MFP estimates with EU KLEMS gross output results, we would expect the ONS estimates to be higher due to this modelling choice, with an explanation of this provided in Section 3B.

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120 *'Multi-factor productivity (MFP) QMI.' ONS (March 2020).*
121 *'Multi-factor productivity (MFP) QMI.' ONS (March 2020).*

Less significantly, EU KLEMS and the ONS compile their labour and capital inputs slightly differently. This input variation is likely to produce different estimates.

The industries included in the ONS database are included in Table 13.

Table 13: Industries in ONS dataset

Industry
Agriculture, Forestry and Fishing
Mining and Quarrying
Manufacturing
Electricity, Gas, Steam and Air Conditioning Supply
Water Supply; Sewerage, Waste Management and Remediation Activities
Construction
Wholesale and Retail Trade; Repair of Motor Vehicles and Motorcycles
Transportation and Storage
Accommodation and Food Service Activities
Information and Communication
Financial and Insurance Activities
Real Estate Activities
Professional, Scientific and Technical Activities
Administrative and Support Service Activities
Public Administration and Defence; Compulsory Social Security
Education
Human Health and Social Work Activities
Arts, Entertainment and Recreation
Other Services
Total Market Sector

Source: Economic Insight analysis

12 Annex 3: Full set of results – total water value chain

In this annex, we provide the full set of our results for the total water value chain, across each of: (i) our *'plausible range'*; (ii) our *'PR24 focused range'*; and (iii) our *'sensitivity analysis range'*. We also provide value added estimates across (i), (ii) and (iii); and also from the ONS MFP dataset. In addition, we extend Ofwat's set of comparators to the time periods included in our *'plausible range'*.

12A. Plausible range

Table 14: Gross output TFP estimates (plausible range)

Comparator	2010-2019	1995-2019	1970-2007
Total industries	0.2%	0.2%	0.2%
Agriculture, forestry and fishing	1.1%	1.2%	1.0%
Manufacturing	0.4%	1.1%	0.7%
Chemicals; basic pharmaceutical products	1.2%	1.9%	1.3%
Manufacture of rubber and plastic products and other non-metallic mineral products	1.0%	0.9%	0.9%
Manufacture of furniture; jewellery, musical instruments, toys; repair and installation of machinery and equipment	-0.4%	1.0%	
Wholesale and retail trade; repair of motor vehicles and motorcycles	-0.1%	-0.2%	0.1%
Transportation and storage	-0.6%	-0.1%	1.1%
Final results (average)	**0.3%**	**0.7%**	**0.8%**

Source: Economic Insight analysis of EU KLEMS data

12B. PR24 focused range

Table 15: Gross output TFP estimates (PR24 focused range)[122]

Comparator	2010-2019	1970-2019 (weighted average of 1970-2007; 1995-2019)
Total industries	0.2%	0.2%
Agriculture, forestry and fishing	1.1%	1.1%
Manufacturing	0.4%	0.9%
Chemicals; basic pharmaceutical products	1.2%	1.6%
Manufacture of rubber and plastic products and other non-metallic mineral products	1.0%	0.9%
Manufacture of furniture; jewellery, musical instruments, toys; repair and installation of machinery and equipment	-0.4%	1.0%
Wholesale and retail trade; repair of motor vehicles and motorcycles	-0.1%	-0.1%
Transportation and storage	-0.6%	0.5%
Final results (average)	**0.3%**	**0.7%**

Source: Economic Insight analysis of EU KLEMS data

122 *We note that, for some comparators in NACE II, there is no NACE I equivalent (e.g. "Manufacture of furniture; jewellery, musical instruments, toys; repair and installation of machinery and equipment"), hence there is no TFP estimate for these comparators in the 1970-2007 period. Therefore, for these comparators, the TFP estimate for 1970-2019 is equal to the 1995-2019 average. As such, the average across comparators in 1970-2019 may not equate to the average of the individual comparator TFP estimates, as it is calculated using a weighted average of the total averages across comparators in 1995-2019 and 1970-2007.*

12C. Sensitivity analysis range

Time period

Below we present the results of using the **1992-2007 (NACE I)** period on our *'preferred set'* of comparators. We include it in our *'sensitivity analysis range'* as it includes (almost) the entirety of the business cycle prior to the financial crisis (which we consider to be 1992-2009), noting that data is unavailable beyond 2007 in the NACE I database. It is not included in our *'plausible range'* or our *'PR24 focused range'* as it does not utilise all the data available in the NACE I database.

Table 16: Gross output TFP estimates – 1992-2007 (NACE I)

Comparator	1992-2007
Total Industries	0.3%
Agriculture, Hunting, Forestry And Fishing	0.6%
Total Manufacturing	0.6%
Chemicals And Chemical	1.1%
Rubber And Plastics	0.4%
Wholesale And Retail Trade	0.7%
Transport And Storage	0.9%
Final results (average)	**0.7%**

Source: Economic Insight analysis of EU KLEMS data

Comparator choice

We also include different comparators in our assessment in order to test modifications to our *'preferred set'* of comparators.

As was detailed in Section 5C, we have included **Sensitivity 1**, which adds "Mining and quarrying" to our *'preferred set'* of comparators. This is because it fulfils the conditions to be included in our *'preferred set'*, but the TFP estimates are much lower for this sector, implying it is an outlier. However, we consider it beneficial to report it under a sensitivity analysis, in order to test the robustness of our *'preferred set'* of comparators to its inclusion.

Table 17: Gross output TFP estimates (Sensitivity 1)

Comparator	2010-2019	1995-2019	1970-2007
Total industries	0.2%	0.2%	0.2%
Agriculture, forestry and fishing	1.1%	1.2%	1.0%
Mining and quarrying	-1.7%	-2.3%	-0.7%
Manufacturing	0.4%	1.1%	0.7%
Chemicals; basic pharmaceutical products	1.2%	1.9%	1.3%
Manufacture of rubber and plastic products and other non-metallic mineral products	1.0%	0.9%	0.9%
Manufacture of furniture; jewellery, musical instruments, toys; repair and installation of machinery and equipment	-0.4%	1.0%	
Wholesale and retail trade; repair of motor vehicles and motorcycles	-0.1%	-0.2%	0.1%
Transportation and storage	-0.6%	-0.1%	1.1%
Final results (average)	**0.1%**	**0.4%**	**0.6%**

Source: Economic Insight analysis of EU KLEMS data

Furthermore, as was detailed in Section 5C, we have included **Sensitivity 2**, where the assessment under Criterion 3 strengthened. Specifically, this only includes comparators for which at least two of Criteria 3a, 3b and 3c are ranked as "Green" (and thus places more weight on the similarity of sectors as regards economies of scale).

Table 18: Gross output TFP estimates (Sensitivity 2)

Comparator	2010-2019	1995-2019	1970-2007
Total industries	0.2%	0.2%	0.2%
Agriculture, forestry and fishing	1.1%	1.2%	1.0%
Manufacturing	0.4%	1.1%	0.7%
Chemicals; basic pharmaceutical products	1.2%	1.9%	1.3%
Transportation and storage	-0.6%	-0.1%	1.1%
Final results (average)	**0.4%**	**0.9%**	**0.8%**

Source: Economic Insight analysis of EU KLEMS data

Furthermore, as was detailed in Section 5C, we have included **Sensitivity 3**, where: (i) the assessment under Criterion 3 is strengthened (in the same as with **Sensitivity 2**); and (ii) aggregated sectors are excluded. We implement condition (ii) in order to test whether the implicit inclusion of some activities that are less similar to water is affecting our results.

Table 19: Gross output TFP estimates (Sensitivity 3)

Comparator	2010-2019	1995-2019	1970-2007
Agriculture, forestry and fishing	1.1%	1.2%	1.0%
Chemicals; basic pharmaceutical products	1.2%	1.9%	1.3%
Transportation and storage	-0.6%	-0.1%	1.1%
Final results (average)	**0.5%**	**1.0%**	**1.1%**

Source: Economic Insight analysis of EU KLEMS data

In addition, as is detailed in Section 5C, we have included a **Sensitivity 4**, where Criterion 2 is strengthened. We strengthen Criterion 2 in order to test the effect of including comparators that may be considered *'highly concentrated'* by the CMA (as detailed in our description of Criterion 2 in Section 5B) in our *'preferred set'* of comparators. Specifically, only comparators for which the adjusted HHI in Figure 14 is less than 2,000 are included.

Table 20: Gross output TFP estimates (Sensitivity 4)

Comparator	2010-2019	1995-2019	1970-2007
Total industries	0.2%	0.2%	0.2%
Agriculture, forestry and fishing	1.1%	1.2%	1.0%
Wholesale and retail trade; repair of motor vehicles and motorcycles	-0.1%	-0.2%	0.1%
Transportation and storage	-0.6%	-0.1%	1.1%
Final results (average)	**0.1%**	**0.3%**	**0.6%**

Source: Economic Insight analysis of EU KLEMS data

Finally, as is detailed in Section 5C, we have included a **Sensitivity 5**, in which we have added "Construction" to our *'preferred set'*. This is because, although "Construction" does not fulfil our conditions (in relation to our three Criteria) to be included in either our *'preferred set',* or our above-mentioned sensitivities, we consider that there are some activities undertaken by water companies that may be consistent with those of construction companies. Therefore, although (under our criteria) construction is not sufficiently similar to the total water value chain to be included, we consider it informative to have a sensitivity analysis that incorporates it.

Table 21: Gross output TFP estimates (Sensitivity 5)

Comparator	2010-2019	1995-2019	1970-2007
Total industries	0.2%	0.2%	0.2%
Agriculture, forestry and fishing	1.1%	1.2%	1.0%
Manufacturing	0.4%	1.1%	0.7%
Chemicals; basic pharmaceutical products	1.2%	1.9%	1.3%
Manufacture of rubber and plastic products and other non-metallic mineral products	1.0%	0.9%	0.9%
Manufacture of furniture; jewellery, musical instruments, toys; repair and installation of machinery and equipment	-0.4%	1.0%	
Construction	-0.1%	-0.2%	0.3%
Wholesale and retail trade; repair of motor vehicles and motorcycles	-0.1%	-0.2%	0.1%
Transportation and storage	-0.6%	-0.1%	1.1%
Final results (average)	**0.3%**	**0.6%**	**0.7%**

Source: Economic Insight analysis of EU KLEMS data

12D. Value added estimates

We now provide estimates using value added TFP productivity growth, rather than gross output, for each of the sets of comparators and time periods detailed above; in addition to the ONS MFP dataset.

Plausible range

Table 22: Value added TFP estimates (plausible range)

Comparator	2010-2019	1995-2019	1970-2007
Total industries	0.3%	0.3%	0.4%
Agriculture, forestry and fishing	2.2%	2.3%	2.4%
Manufacturing	1.2%	2.9%	1.9%
Chemicals; basic pharmaceutical products	2.7%	4.4%	3.9%
Manufacture of rubber and plastic products and other non-metallic mineral products	2.8%	2.2%	2.3%
Manufacture of furniture; jewellery, musical instruments, toys; repair and installation of machinery and equipment	-0.9%	2.1%	
Wholesale and retail trade; repair of motor vehicles and motorcycles	-0.2%	-0.4%	0.4%
Transportation and storage	-1.5%	-0.2%	2.2%
Final results (average)	**0.8%**	**1.7%**	**1.9%**

Source: Economic Insight analysis of EU KLEMS data

PR24 focused range

Table 23: Value added TFP estimates (PR24 focused range)[123]

Comparator	2010-2019	1970-2019 (weighted average of 1970-2007; 1995-2019)
Total industries	0.3%	0.4%
Agriculture, forestry and fishing	2.2%	2.4%
Manufacturing	1.2%	2.4%
Chemicals; basic pharmaceutical products	2.7%	4.2%
Manufacture of rubber and plastic products and other non-metallic mineral products	2.8%	2.2%
Manufacture of furniture; jewellery, musical instruments, toys; repair and installation of machinery and equipment	-0.9%	2.1%
Wholesale and retail trade; repair of motor vehicles and motorcycles	-0.2%	0.0%
Transportation and storage	-1.5%	1.0%
Final results (average)	**0.8%**	**1.8%**

Source: Economic Insight analysis of EU KLEMS data

[123] *We note that, for some comparators in NACE II, there is no NACE I equivalent (e.g. "Manufacture of furniture; jewellery, musical instruments, toys; repair and installation of machinery and equipment"), hence there is no TFP estimate for these comparators in the 1970-2007 period. Therefore, for these comparators, the TFP estimate for 1970-2019 is equal to the 1995-2019 average. As such, the average across comparators in 1970-2019 may not equate to the average of the individual comparator TFP estimates, as it is calculated using a weighted average of the total averages across comparators in 1995-2019 and 1970-2007.*

Sensitivity analysis range

1992-2007 (NACE I)

Table 24: Value added TFP estimates – 1992-2007 (NACE I)

Comparator	**1992-2007**
Total Industries	0.6%
Agriculture, Hunting, Forestry And Fishing	1.5%
Total Manufacturing	1.8%
Chemicals And Chemical	3.1%
Rubber And Plastics	1.1%
Wholesale And Retail Trade	1.4%
Transport And Storage	2.1%
Final results (average)	**1.7%**

Source: Economic Insight analysis of EU KLEMS data

Sensitivity 1

Table 25: Value added TFP estimates (Sensitivity 1)

Comparator	2010-2019	1995-2019	1970-2007
Total industries	0.3%	0.3%	0.4%
Agriculture, forestry and fishing	2.2%	2.3%	2.4%
Mining and quarrying	-2.0%	-3.5%	-0.8%
Manufacturing	1.2%	2.9%	1.9%
Chemicals; basic pharmaceutical products	2.7%	4.4%	3.9%
Manufacture of rubber and plastic products and other non-metallic mineral products	2.8%	2.2%	2.3%
Manufacture of furniture; jewellery, musical instruments, toys; repair and installation of machinery and equipment	-0.9%	2.1%	
Wholesale and retail trade; repair of motor vehicles and motorcycles	-0.2%	-0.4%	0.4%
Transportation and storage	-1.5%	-0.2%	2.2%
Final results (average)	**0.5%**	**1.1%**	**1.6%**

Source: Economic Insight analysis of EU KLEMS data

Sensitivity 2

Table 26: Value added TFP estimates (Sensitivity 2)

Comparator	2010-2019	1995-2019	1970-2007
Total industries	0.3%	0.3%	0.4%
Agriculture, forestry and fishing	2.2%	2.3%	2.4%
Manufacturing	1.2%	2.9%	1.9%
Chemicals; basic pharmaceutical products	2.7%	4.4%	3.9%
Transportation and storage	-1.5%	-0.2%	2.2%
Final results (average)	**1.0%**	**2.0%**	**2.2%**

Source: Economic Insight analysis of EU KLEMS data

Sensitivity 3

Table 27: Value added TFP estimates (Sensitivity 3)

Comparator	2010-2019	1995-2019	1970-2007
Agriculture, forestry and fishing	2.2%	2.3%	2.4%
Chemicals; basic pharmaceutical products	2.7%	4.4%	3.9%
Transportation and storage	-1.5%	-0.2%	2.2%
Final results (average)	**1.1%**	**2.2%**	**2.8%**

Source: Economic Insight analysis of EU KLEMS data

Sensitivity 4

Table 28: Value added TFP estimates (Sensitivity 4)

Comparator	2010-2019	1995-2019	1970-2007
Total industries	0.3%	0.3%	0.4%
Agriculture, forestry and fishing	2.2%	2.3%	2.4%
Wholesale and retail trade; repair of motor vehicles and motorcycles	-0.2%	-0.4%	0.4%
Transportation and storage	-1.5%	-0.2%	2.2%
Final results (average)	**0.2%**	**0.5%**	**1.3%**

Source: Economic Insight analysis of EU KLEMS data

Sensitivity 5

Table 29: Value added TFP estimates (Sensitivity 5)

Comparator	2010-2019	1995-2019	1970-2007
Total industries	0.3%	0.3%	0.4%
Agriculture, forestry and fishing	2.2%	2.3%	2.4%
Manufacturing	1.2%	2.9%	1.9%
Chemicals; basic pharmaceutical products	2.7%	4.4%	3.9%
Manufacture of rubber and plastic products and other non-metallic mineral products	2.8%	2.2%	2.3%
Manufacture of furniture; jewellery, musical instruments, toys; repair and installation of machinery and equipment	-0.9%	2.1%	
Construction	-0.3%	-0.4%	0.8%
Wholesale and retail trade; repair of motor vehicles and motorcycles	-0.2%	-0.4%	0.4%
Transportation and storage	-1.5%	-0.2%	2.2%
Final results (average)	**0.7%**	**1.5%**	**1.8%**

Source: Economic Insight analysis of EU KLEMS data

ONS MFP

Below, we present the results of our MFP growth estimates from the ONS database. We note that these are not included in our *'sensitivity analysis range'* as they are based on value added rather than gross output, and to allow for a comparison with the approach taken by Ofwat in its analysis. However, we consider it helpful to present the results from this database, as it includes data beyond 2019 (the final year that data is available in the EU KLEMS database), meaning that it includes a greater part of the most recent financial crisis (which we consider to be 2010-2020). We include three different time periods using our ONS MFP data:

- **2010-2019**, which includes almost the entirety of the most recent business, cycle, but without 2020 (which could downward bias the results due to the exogeneity of the COVID-19 pandemic).

- **2010-2021**, which includes an alternative definition of the end of the most recent business cycle (i.e. 2021 rather than 2020).

- **1970-2021**, which includes the entirety of the period for which ONS MFP data is available.

Table 30: Value added MFP estimates (ONS)

Comparator	2010-2019	2010-2021	1970-2021
Total Market Sector	0.4%	0.3%	1.0%
Agriculture, Forestry and Fishing	3.5%	2.7%	2.0%
Manufacturing	1.3%	1.1%	2.4%
Wholesale and Retail Trade; Repair of Motor Vehicles and Motorcycles	-0.1%	0.2%	0.3%
Transportation and Storage	-1.0%	-1.1%	1.7%
Final results (average)	**0.8%**	**0.7%**	**1.5%**

Source: Economic Insight analysis of ONS MFP data

12E. Ofwat's choice of comparators

Furthermore, as was detailed above, we have also extended our choice of time periods in our *'plausible range'* to Ofwat's choice of comparators. These results can be seen in the tables below, both in terms of gross output and value added.

Table 31: Gross output TFP estimates (Ofwat's comparators)

Comparator	2010-2019	1995-2019	1970-2007
Manufacturing	0.4%	1.1%	0.7%
Chemicals; basic pharmaceutical products	1.2%	1.9%	1.3%
Manufacture of machinery and equipment n.e.c.	-0.2%	1.3%	0.5%
Manufacture of furniture; jewellery, musical instruments, toys; repair and installation of machinery and equipment	-0.4%	1.0%	
Construction	-0.1%	-0.2%	0.3%
Transportation and storage	-0.6%	-0.1%	1.1%
Professional, scientific and technical activities; administrative and support service activities	-0.1%	-0.3%	
Final results (average)	**0.0%**	**0.7%**	**0.8%**

Source: Economic Insight analysis of EU KLEMS data

Table 32: Value added TFP estimates (Ofwat's comparators)

Comparator	2010-2019	1995-2019	1970-2007
Manufacturing	1.2%	2.9%	1.9%
Chemicals; basic pharmaceutical products	2.7%	4.4%	3.9%
Manufacture of machinery and equipment n.e.c.	-0.6%	2.7%	1.3%
Manufacture of furniture; jewellery, musical instruments, toys; repair and installation of machinery and equipment	-0.9%	2.1%	
Construction	-0.3%	-0.4%	0.8%
Transportation and storage	-1.5%	-0.2%	2.2%
Professional, scientific and technical activities; administrative and support service activities	-0.2%	-0.5%	
Final results (average)	**0.1%**	**1.6%**	**2.0%**

Source: Economic Insight analysis of EU KLEMS data

13 Annex 4: Full set of results – water retail

In this annex, we provide the full set of our results for water retail, across each of: (i) the *'plausible range'*; (ii) the *'PR24 focused range'*; and (iii) the *'sensitivity analysis range'*.

13A. Plausible range

Table 33: Gross output TFP estimates (plausible range)

Comparator	2010-2019	1995-2019	1970-2007
Wholesale and retail trade; repair of motor vehicles and motorcycles	-0.1%	-0.2%	0.1%
Information and communication	3.7%	4.0%	1.8%
Financial and insurance activities	-0.6%	-0.3%	-0.2%
Real estate activities	1.3%	0.5%	-0.5%
Professional, scientific and technical activities; administrative and support service activities	-0.1%	-0.3%	
Other service activities	-0.3%	-1.2%	
Final results (average)	**0.6%**	**0.4%**	**0.3%**

Source: Economic Insight analysis of EU KLEMS data

13B. PR24 focused range

Table 34: Gross output TFP estimates (PR24 focused range)[124]

Comparator	2010-2019	1970-2019 (weighted average of 1970-2007; 1995-2019)
Wholesale and retail trade; repair of motor vehicles and motorcycles	-0.1%	-0.1%
Information and communication	3.7%	2.9%
Financial and insurance activities	-0.6%	-0.3%
Real estate activities	1.3%	0.0%
Professional, scientific and technical activities; administrative and support service activities	-0.1%	-0.3%
Other service activities	-0.3%	-1.2%
Final results (average)	**0.6%**	**0.4%**

Source: Economic Insight analysis of EU KLEMS data

[124] *We note that, for some comparators in NACE II, there is no NACE I equivalent (e.g. "Other service activities"), hence there is no TFP estimate for these comparators in the 1970-2007 period. Therefore, for these comparators, the TFP estimate for 1970-2019 is equal to the 1995-2019 average. As such, the average across comparators in 1970-2019 may not equate to the average of the individual comparator TFP estimates, as it is calculated using a weighted average of the total averages across comparators in 1995-2019 and 1970-2007.*

13C. Sensitivity analysis range

Time period

We firstly present the results of using the **1992-2007 (NACE I)** period on our *'preferred set'* of comparators. We include it in our *'sensitivity analysis range'* as it includes (almost) the entirety of the business cycle prior to the financial crisis (which we consider to be 1992-2009), noting that data is unavailable beyond 2007 in the NACE I database. It is not included in our *'plausible range'* or our *'PR24 focused range'* as it does not utilise all the data available in the NACE I database.

Table 35: Gross output TFP estimates – 1992-2007 (NACE I)

Comparator	**1992-2007**
Wholesale And Retail Trade	0.7%
Post And Telecommunications	3.2%
Financial Intermediation	0.9%
Real Estate, Renting And Business Activities	-0.1%
Final results (average)	**1.2%**

Source: Economic Insight analysis of EU KLEMS data

Comparator choice

We have also included different comparators in our assessment in order to test modifications to our *'preferred set'* of comparators.

As was detailed in Section 8A, we have included **Sensitivity 1**, which adds "Total industries" to our *'preferred set'* of comparators. This tests whether the inclusion of a metric that captures productivity changes across the entire UK 'on average' affects our results.

Table 36: Gross output TFP estimates (Sensitivity 1)

Comparator	2010-2019	1995-2019	1970-2007
Total industries	0.2%	0.2%	0.2%
Wholesale and retail trade; repair of motor vehicles and motorcycles	-0.1%	-0.2%	0.1%
Information and communication	3.7%	4.0%	1.8%
Financial and insurance activities	-0.6%	-0.3%	-0.2%
Real estate activities	1.3%	0.5%	-0.5%
Professional, scientific and technical activities; administrative and support service activities	-0.1%	-0.3%	
Other service activities	-0.3%	-1.2%	
Final results (average)	**0.6%**	**0.4%**	**0.3%**

Source: Economic Insight analysis of EU KLEMS data

Furthermore, as was detailed in Section 8A, we have included **Sensitivity 2**, where the assessment under Criterion 1 strengthened. Specifically, this only includes comparators for which Criterion 1 is defined as "Green" (and thus places more weight on the similarity of sectors).

Table 37: Gross output TFP estimates (Sensitivity 2)

Comparator	2010-2019	1995-2019	1970-2007
Wholesale and retail trade; repair of motor vehicles and motorcycles	-0.1%	-0.2%	0.1%
Information and communication	3.7%	4.0%	1.8%
Financial and insurance activities	-0.6%	-0.3%	-0.2%
Professional, scientific and technical activities; administrative and support service activities	-0.1%	-0.3%	
Final results (average)	**0.7%**	**0.8%**	**0.6%**

Source: Economic Insight analysis of EU KLEMS data

Furthermore, as was detailed in Section 8A, we have included **Sensitivity 3**, where: the assessment under Criterion 2 is strengthened. Specifically, only comparators for which the adjusted HHI in Figure 14 is less than 2,000 are included.

Table 38: Gross output TFP estimates (Sensitivity 3)

Comparator	2010-2019	1995-2019	1970-2007
Wholesale and retail trade; repair of motor vehicles and motorcycles	-0.1%	-0.2%	0.1%
Real estate activities	1.3%	0.5%	-0.5%
Professional, scientific and technical activities; administrative and support service activities	-0.1%	-0.3%	
Final results (average)	**0.4%**	**0.0%**	**-0.2%**

Source: Economic Insight analysis of EU KLEMS data

In addition, as is detailed in Section 8A, we have included a **Sensitivity 4**, where Criterion 3 is strengthened. Specifically, this only includes comparators for which at least one of Criteria 3a-3c is defined as "Green" (and thus places more weight on the similarity of sectors as regards economies of scale).[125]

Table 39: Gross output TFP estimates (Sensitivity 4)

Comparator	2010-2019	1995-2019	1970-2007
Total industries	0.2%	0.2%	0.2%
Wholesale and retail trade; repair of motor vehicles and motorcycles	-0.1%	-0.2%	0.1%
Financial and insurance activities	-0.6%	-0.3%	-0.2%
Real estate activities	1.3%	0.5%	-0.5%
Professional, scientific and technical activities; administrative and support service activities	-0.1%	-0.3%	
Other service activities	-0.3%	-1.2%	
Final results (average)	**0.0%**	**-0.2%**	**-0.1%**

Source: Economic Insight analysis of EU KLEMS data

125 *We also include "Total industries" on this basis.*

14 Annex 5: Geometric vs arithmetic mean

To estimate an annual rate of frontier shift, we have calculated the average growth rate of TFP over the time period under consideration for each of our comparators. When calculating the average growth rate in TFP (or MFP) over a period of time, two different methodologies can be selected. We have detailed each below.

- **Geometric mean.** This is the product of a series of numbers raised to the inverse of the length of the series.
- **Arithmetic mean.** This is the sum of a series of numbers divided by the count of that series of numbers.

Both methods have advantages and disadvantages. Arithmetic means are an appropriate measure when the values in a series are independent of one another; but do produce less reliable results when values are not independent. Geometric means can reliably be used when series values are not independent from one another. This means that geometric means can take account of the impact of variation that occurs in one year on future years. This is a common occurrence when analysing economic data. However, geometric means suffer from a higher degree of sensitivity to the start date selected than arithmetic means. This is because the geometric calculation requires values to be compounded based upon the start value, whereas the arithmetic calculation does not require compounding.

Based upon the advantages and disadvantages of each approach, our view is that the use of geometric (as opposed to arithmetic) means should be considered in order to assess productivity over longer time periods (e.g. about 10 years) – we note that this threshold should be taken as a guide rather than a set rule.

- When analysing TFP over a short time period, the estimate will be sensitive to the start date; and it is beneficial to examine the effect of year-on-year volatility. This points towards an **arithmetic mean** being the most suitable method.
- When calculating TFP growth over a long time period, it is beneficial to strip out year-on-year volatility in order to determine the actual long-run productivity rate. Furthermore, over a long time period, the calculation should be less sensitive to any small amount of variance in the start date. Therefore, this suggests the use of a **geometric mean** for longer time periods.

As was discussed in Chapter 7 of the main report, all our results in Chapter 7 (and in Annex 3) for the total water value chain were presented using the arithmetic mean. However, to allow for a comparison between the two approaches, we present the results of the time periods in our *'plausible range'* that exceed 10 years (1995-2019 and 1970-2007) using the geometric in addition to the arithmetic mean. As can be seen in the tables below, the estimates using the geometric mean are either the same or fractionally different to those using the arithmetic mean. As we have stated above, we believe that the geometric mean results are more suitable when considering longer time periods since, over these longer periods, a geometric mean can take account of the compounding effect on productivity growth.

Table 40: Comparison between geometric and arithmetic mean

Comparator	1995-2019		1970-2007	
	Arithmetic	Geometric	Arithmetic	Geometric
Total industries	0.2%	0.2%	0.2%	0.2%
Agriculture, forestry and fishing	1.2%	1.0%	1.0%	0.9%
Manufacturing	1.1%	1.1%	0.7%	0.7%
Chemicals; basic pharmaceutical products	1.9%	1.8%	1.3%	1.3%
Manufacture of rubber and plastic products and other non-metallic mineral products	0.9%	0.9%	0.9%	0.9%
Manufacture of furniture; jewellery, musical instruments, toys; repair and installation of machinery and equipment	1.0%	1.0%		
Wholesale and retail trade; repair of motor vehicles and motorcycles	-0.2%	-0.3%	0.1%	0.2%
Transportation and storage	-0.1%	-0.1%	1.1%	1.0%
Final results (average)	**0.7%**	**0.7%**	**0.8%**	**0.7%**

Source: Economic Insight analysis of EU KLEMS data

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