# TMS-DD-037
# Thames Water PR24 DD Response
# Cost Efficiency

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# 1. Executive Summary

This document contains Thames Water's response to Ofwat's Draft Determination relating to cost assessment and should be read alongside TMS-DD-038, containing our response to the provisions for our enhancement schemes. We set out in this document a number of revisions to Ofwat's position that would make the Final Determination more balanced, accurate, deliverable and investible, while providing good value for our customers. Without these well-justified revisions, Ofwat's assessment fails to provide Thames Water with sufficient allowances to deliver our plans for AMP8, to the detriment of our customers, our communities, and the environment.

Table 1 sets out our required allowance for base expenditure compared to the allowance proposed by Ofwat. Our required allowance has been updated reflecting the following:

- An increase of c.£0.9bn to our capital maintenance having reviewed our run rates through the last two years of AMP7, recognising the true run rate to achieve consistent performance.
- An additional c.£0.1bn additional investment as part of delivering 570km of mains renewal.
- An additional c.£0.1bn in retail, predominantly relating to bad debt.

*Table 1: Our base cost position*

| Base cost expenditure | Requested in our business plan | Proposed by Ofwat at DD | Our updated need |
|---|---|---|---|
| | £12.1bn | £11bn | £13.3bn |

## A summary of our representations on the issues

In relation to the wholesale econometric models, Ofwat has opted to not make a choice between different measures of the same cost driver (e.g. density, pumping) and instead relies on triangulation as a remedy. We disagree with this approach, in particular as some measures are more appropriate than others in capturing intended cost drivers.

In particular, evidence is clear that weighted population density measures based on Middle Layer Super Output Area (MSOA) data are more appropriate than Local Authority District (LAD) or simple averages (i.e. population per length of mains), being that they are of relatively uniform size across the country and more granular. We ask Ofwat to remove the other measures in favour of MSOA. We also urge Ofwat to use average pumping head (APH) exclusively, rather than number of booster pumping stations per km, given the stronger engineering rationale for this driver, better econometric performance, and intuitive relationship with energy consumption (compared to a counter-intuitive relationship of booster pumping stations), in addition to the fact that historic concerns over data quality are now largely overcome.

We further ask Ofwat to include squared density terms within the sewage collection models. We note that the squared term is statistically robust, and the Competition and Markets Authority supported this approach during its PR19 redeterminations. We provide clear engineering evidence to further explain why the squared term is appropriate.

We also present evidence of under provision for capital maintenance in treated water distribution, stemming from a lack of important cost drivers within the models. For Thames Water, this amounts to a shortfall of around £200 million compared to our needs, evidenced with models that are statistically robust and with greater explanatory power than those without these drivers. We ask Ofwat to carefully consider the merits of this request, and the benefits this additional allowance would bring for customers. Our evidence builds on that which we have previously highlighted to Ofwat through the AMP7 London Water Improvement Conditional Allowance[1].

We support the claims of Southern Water, SES Water and Affinity Water relating to regional wages, noting that evidence is clear within the Annual Survey of Hours and Earnings (ASHE) that wages are significantly higher in our region than the national average.

Within the retail price control, we do not agree there is a compelling rationale for an absence of inflation indexing, not least given the volatility of inflation in recent years. However, we agree with the provision for a Real Price Effect (RPE) on wages within this control. In the cost assessment, we consider County Court Judgements to be an important driver of bad debt costs and ask Ofwat to include this driver in its models. We also reaffirm the importance of an adjustment to costs to recognise the significant impact of population transience on costs, and provide new evidence (addressing Ofwat's feedback) to demonstrate this relationship.

For bioresources, Ofwat's models omit key drivers of costs. There is clear evidence that costs in London are higher, due to higher population density, less farmland availability, and higher volumes of sewer sludge, and that this is outside management control. We also evidence the assumption of constant returns to scale is inappropriate. Combined, we ask Ofwat to include a squared population driver, and a measure of total work done in sludge disposal operations within its models. Ofwat should consider using a less stringent catch-up challenge alongside a glide-path to allow companies time to reach the efficiency benchmark in a service where Ofwat's view of efficiency was hitherto unknown. The price control is relatively new, and PR24 is the first review for which full reliance on separate models is made. Noting the models perform relatively weakly, we believe the approach needs to mature and companies be given time to transition.

We appreciate the principles of Ofwat's proposals for a post-modelling adjustment for energy costs and an end-of period true-up, in line with the asks in our business plans. However, we strongly disagree with the forecasts used within the RPE adjustment and observe these are significantly different from most market estimates. We urge Ofwat to either use more appropriate forecasts or implement the true-up annually rather than at the end of the five-year period given forecast uncertainty and the material cashflow implications.

With regards to business rates, we ask Ofwat to fully allow for the costs set out in our business plan. Failing this, we ask Ofwat to introduce an annual true-up, to protect cashflow and support bill smoothing, given the uncertainty companies face and the high exposure we accumulate during the period (estimated at £236m for Thames Water).

We support the RPEs on wages and materials, but ask Ofwat to reopen its consideration of an RPE on chemicals, given the persistently high prices linked in part to energy costs.

[1] TMS-DD-116 Rationale for London Additional Expenditure Factors Affecting Performance and Costs (Mott MacDonald report LWICA reference LWI.G2.E1) November 2021

Finally, we strongly reject Ofwat's assumption of a 1% frontier shift as we believe the broader evidence does not support this level. For 15 years, the country has faced a "productivity puzzle" that is well embedded and does not show signs of improving. Successive decisions on frontier shift within price reviews have further been at odds with observed changes in productivity in the sector, necessitating reductions in expenditure.

# 2. Modelled base costs: water and wastewater

## 2.1. The density measure

### Brief outline of Ofwat's position

Ofwat uses three different measures of density in the models:

- Weighted average population density – LAD;
- Weighted average population density – MSOA; and
- Properties per length of mains/sewers ("simple average"),

Ofwat refers to companies' support for different measures (some preferred one measure, others preferred another measure) to argue that each measure has its own merit and therefore concludes using them all through a triangulation approach is appropriate.

We do not consider that each measure has an equally strong merit. The simple average is not fit for purpose, and amongst the weighted average measures, the one based on MSOA more accurately captures cost challenges in densely populated areas, and in this sense is therefore more appropriate. The density measure has evolved from PR14 to PR19 through the introduction of the weighted average measure. Ofwat should continue improving its use of density measures, by refining the measure using MSOA data, rather than move backward by keeping the simple average density measure and unnecessarily amplifying the number of models.

While triangulating may appear to be a 'safe' option which generally reduces the possibility of a large error, it can also introduce an error and result in inaccurate assessment compared to a single model that uses the right measure.

### TMS argument and supporting evidence

We do not consider it is appropriate to use three different density measures.

Below we set out our evidence against the use of the simple average density (properties per km pipe) and the weighted average density on a local authority district (LAD) basis.

The objective of the density variable is to capture two things:

- Lower costs due to economies of scale – denser areas allow companies to use large assets to serve many people thereby reducing their cost per customer.
- Higher costs due to a difficult and restricted working environment – denser areas typically present a more difficult working environment in which to maintain overground and underground assets.

To capture these two effects, the models often use both the linear and squared term of density.

*The case against the simple average*

Water companies serve large geographical areas. Sub-regions within the company area will have different levels of density. The sub-regional densities will affect the size of assets and the cost of maintaining assets in the area, and therefore a company's level of efficient costs.

The simple average property density measure does not capture the presence of sparse and dense sub-areas within a company's supply area, and is consequently not fit for purpose.[2]

The simple average density across the entire supply area does not give due weight to local population centres that allow cost savings through economies of scale, on the one hand, but also involve additional costs relating to working in populous, built-up areas. Two water companies may have the same average density, but if one of them has a mix of sparse and dense regions and the other is equally populated throughout, the effect of density on their operations, and therefore on cost, can be very different. The weighted average population density measures would differentiate between these two companies, as we would expect.

We provide three pieces of evidence against the simple average:

- Its correlation with companies' treatment works' size is relatively weak, suggesting it is inferior to the weighted average density measure as a variable to capture economies of scale.
- It captures significantly less variation across companies compared to the weighted average density measures.
- By not capturing sub-regional densities, it is clearly inferior to the weighted measures in capturing the high cost of working in highly populated areas.

We discuss each in turn.

### Economies of scale

To demonstrate that the weighted densities capture companies' scope for economies of scale better than the average density, we calculate the weighted average water treatment works (WTW) size based on available industry data.[3] This metric provides evidence about companies' use of economies of scale in practice. We then considered to what extent the different measures of density are consistent with this metric. We provide two examples and a correlation analysis below that suggest the weighted densities are superior:

- South Staffs is the fourth most dense company based on the simple average measure. However, based on the weighted average MSOA measure it is the 11th ranked company. That is, on a weighted basis, it is comparatively sparse. The relative sparsity indicated by the MSOA measure fits with 'facts on the ground' - based on APR data, South Staffs treats only a small proportion of its water in large WTWs compared to the sector, consistent with its sparsity. This lends credibility to the MSOA density measure over the simple average.

[2] As an aside, we disagree with Ofwat's proposal of providing 50% weight to the simple average density measure, against a 25% weight to each of the weighted average density measures. The simple average measure should not have a greater weight than any of the weighted average measures, and in particular not greater than the MSOA density measure. However, our overriding representation is that the variable should not be used at all.

[3] The variable is similar to the WATS in wastewater.

- Severn Trent and Northumbrian have the same simple average density (9th ranked in the sector). The MSOA and LAD density measures suggests Severn Trent to be denser than Northumbrian (for example, based on the LAD density measure Severn Trent is 6th most dense and Northumbrian is 11th). Again, the weighted density measures are more consistent with 'facts on the ground': Severn Trent has the 3rd largest WTWs in the sector and Northumbrian is 5th. Further examples such as the above can be pulled out from the data.

These examples are consistent with the fact that the weighted population density (WPD) measures have a materially stronger correlation with companies' size of WTWs. This is shown in Figure 1.

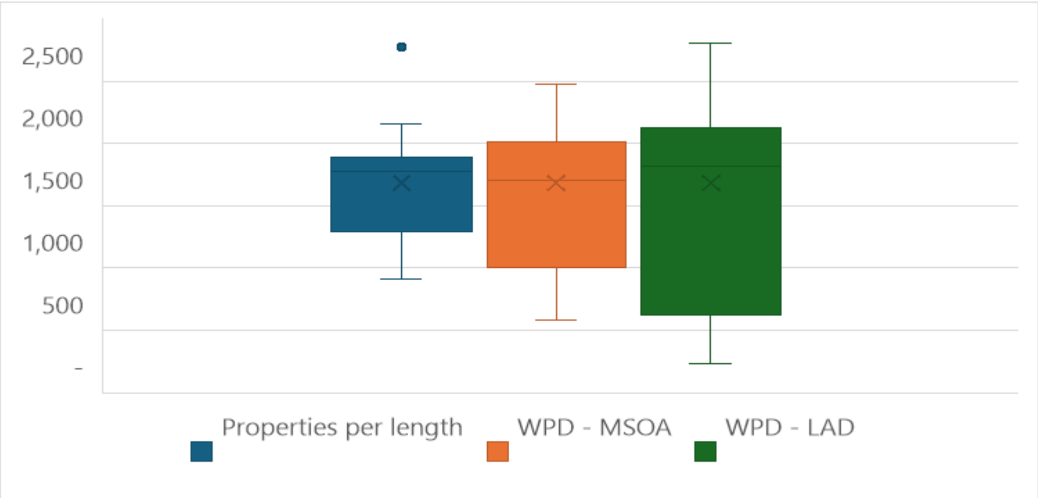
*Figure 1: correlation of density measures with weighted average WTWs size*

| Simple average | WPD - MSOA | WPD - LAD |
|---|---|---|
| 0.65 | 0.80 | 0.82 |

### Insufficient variation

The average property density has a significantly narrower range of values compared to the weighted average measures (Figure 2). By not taking into consideration the presence of localised population densities, the simple average 'homogenises' density measures across companies. A company with multiple localised population centres and a company with equally dispersed population would look similar, when they should not (if they are to achieve the objective of the cost driver). The increased variation of the weighted density indices allows us to capture the impact of density more accurately.

*Figure 2: Interquartile range for each density measure**




* The density measures have been rescaled so that the average of each measure is the same value to allow a clear comparison.

### High cost of working in highly populated areas

To capture the high cost of working in highly populated areas, the density of interest is at the local level, for example, the density of a town or a city. The density of the entire water company supply area is a relatively irrelevant measure for that purpose – it is simply not focussed on capturing what it is intended to capture.

Considering the evidence above, the average density measure is inferior to the weighted average measures and should not be used in the models.  We now compare the MSOA and LAD density measures.

*The case against the weighted average based on local authority districts (LADs)*

The weighted average measures are an improvement over the simple average. By measuring sub-regional densities and applying weights based on their underlying population base they are designed specifically for their intended purpose. For two equal sub-regional densities, the one with a larger underlying population will have a higher weight in the construction of the density measure. This is appropriate, as the larger population base would enable more scope to capitalise on economies of scale, but will also present an area which is more costly to service.

However, of the two weighted average density measure we consider that the one based on MSOA is more appropriate. This is for three key reasons:

- The definition of MSOA is more stable than LAD over time.
- The MSOA is a standardised unit of geography. LAD is not.
- The further granularity of the MSOA better captures variations of cost in areas with different densities.

We discuss each in turn.

### The definition of MSOA is more stable than LAD over time

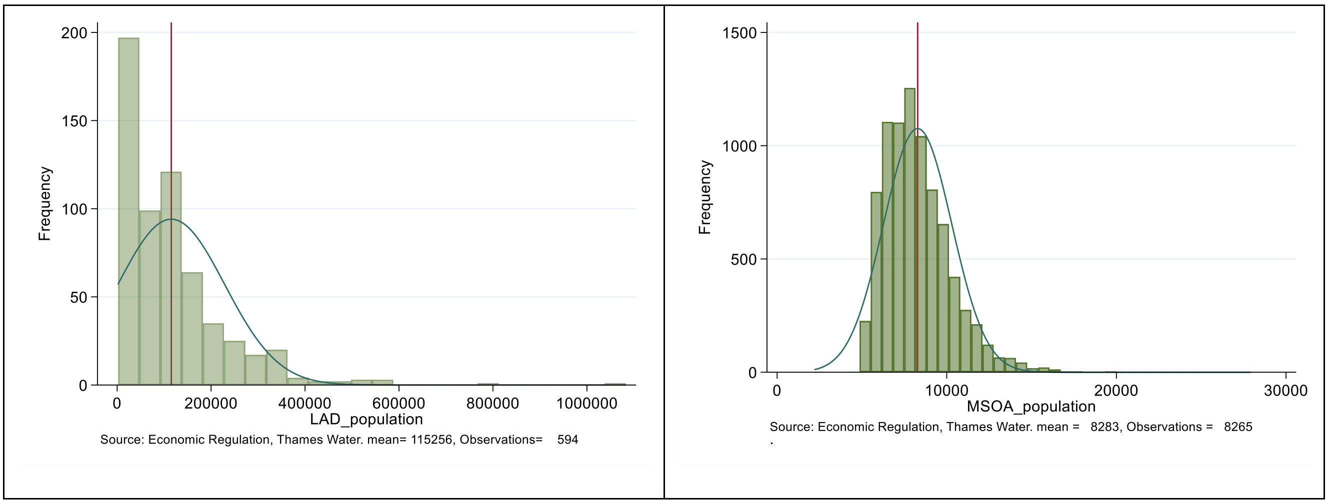
The MSOA is an established statistical unit of geography developed by the ONS. As such, its definition and boundaries are relatively stable over time, unlike the definition and boundaries of LADs, which change relatively frequently. This is acknowledged by Ofwat.

The stability of MSOAs ensures that, over time, we have a more accurate and consistent measure of density for water companies, which allows a more consistent assessment of efficient cost. This point has real and material implications on companies. If we re-assess the PR19 water models using the new LAD definitions instead of the LAD definition that prevailed during PR19 Thames Water would have received £200m less in allowances and other companies would face material differences as well. This illustrates that the changing definition of LAD brings a non-trivial inconsistency to the assessment of efficient allowances for the sector.

**The MSOA is a standardised unit of geography. LAD is not.**

The MSOA is a statistical unit of geography established by the ONS following the 2001 census. It has a relatively standard size of 5,000 to 15,000 persons.[4] LADs, on the other hand, began as a historic (1974) administrative structure, which changes from time to time to reflect administrative changes. LADs are not standardised in terms of size (e.g., in terms of land or population). The size of LADs varies widely across the country. Figure 3 compares the distribution of LAD and MSOA sizes, in terms of inhabitants.

*Figure 3: The distribution of LAD and MSOA population size*




For the purpose of comparative assessment, it is preferable to have a standardised measure that is consistent over time. LADs are neither standardised nor consistent over time. Their size varies from c. 2,000 people to over 1 million people and their definition regularly changes. MSOAs are standardised and consistent over time. MSOAs are statistical units that aim to capture a coherent population centre of a relatively standard size. The cohesion of a population centre is likely to be a relevant factor for the sizing of WTWs, hence fitting as a density measure in our models.

**The further granularity of the MSOA is advantageous for capturing high cost in dense areas.**

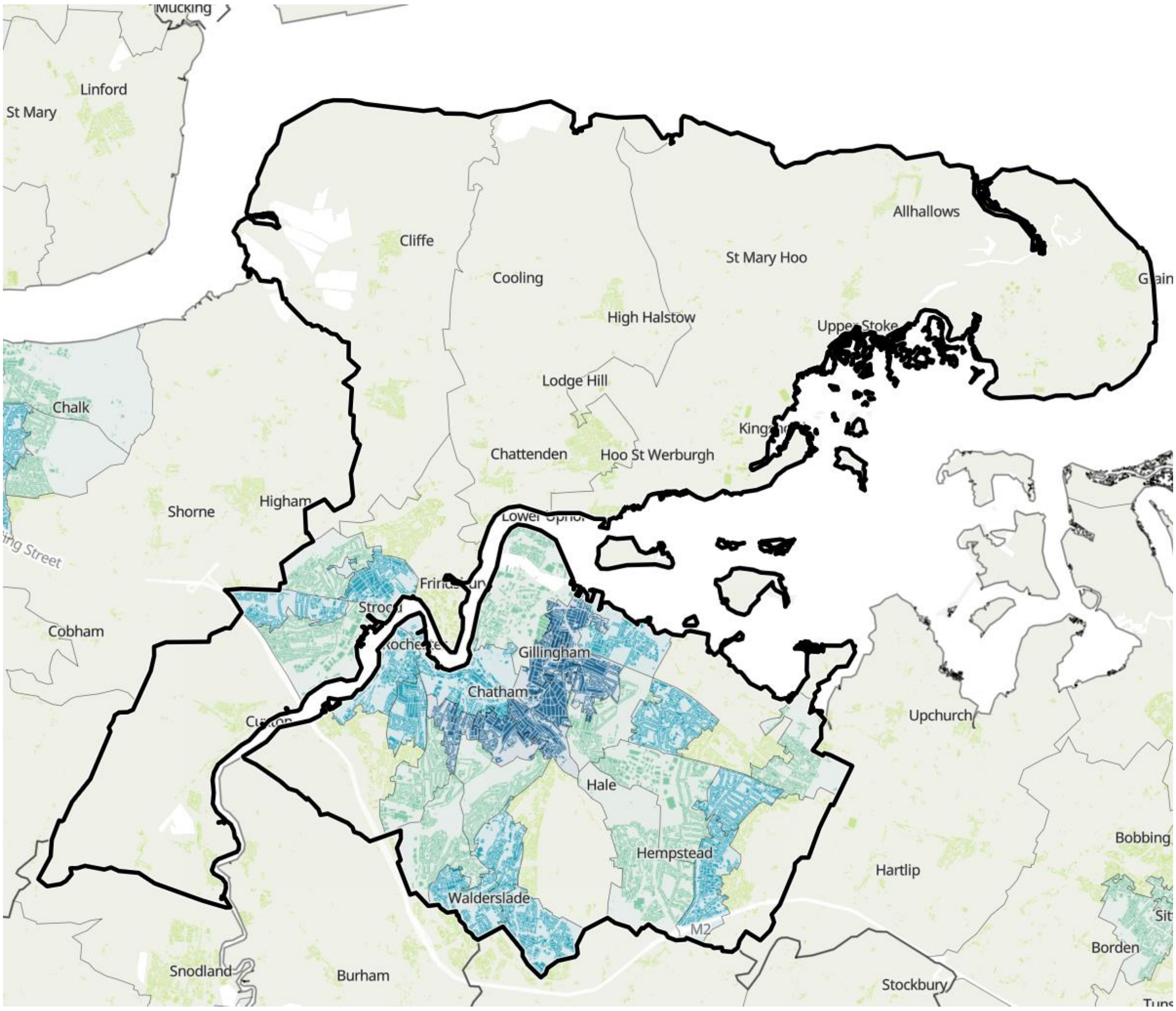
When considering the role of the variable to capture the intensity of maintaining, operating, and repairing the water network in highly dense areas, the more granular basis of the MSOA offers a clear advantage.

Simply put, the MSOA density will better capture those areas where the cost of work is high. In contrast, the LAD density will tend to dilute them. Figure 4 provides an example of the Medway LAD. It has a sparse density of 1,444 people per quare kilometre. In it, it has a few MSOAs with very low density (<500) but also a few very dense MSOAs (>7,000). The input of this LAD into a density measure should not be 1,444 (as it would be with the LAD density measure). Rather, it

[4] Source: [Statistical geographies - Office for National Statistics (ons.gov.uk)](https://www.ons.gov.uk).

should be a weighting of the MSOAs with low and high density that are included in it (as it would be with the MSOA density measure).[5] This will disentangle the high cost of working in the conurbation of Gillingham and Chatham from the lower cost of working outside of the conurbation. Examples such as these are common and are more extreme in London.

*Figure 4: Medway local authority district includes highly dense and highly sparse MSOAs*




Given the evidence above, the MSOA offers clear advantages over the other density measures.[6]

We should aim to find the most appropriate model specification for the sector, and in this case the objective choice should be to use the MSOA density as the only density measure for the sector. Triangulation has a role to play, but it does not replace the need to objectively analyse

[5] This would be consistent with engineering rationale as reflected by the squared term of density – above a certain density threshold, costs increase faster than the offsetting effect of economies of scale. To reflect this properly, the variable and its squared term must capture the appropriate density measure.
[6] We also note that CEPA suggested that "[the MSOA density] uses more granular data and may provide a more accurate picture of the relative density between company areas and may be less sensitive to changes in the dataset over time" (CEPA report to Ofwat, page 55).

and select the most appropriate cost drivers. In this case, triangulation detracts rather than adds to the robustness of the overall results.

## 2.2. Capturing pumping requirements

### Brief outline of Ofwat's position

To account for exogenous circumstances that drive water pumping costs, Ofwat uses both Average Pumping Head (APH) and Booster Pumping Stations per km of main (BPS).

Ofwat justifies this choice mainly in reference to companies' positions – some companies support APH, some support BPS and pros and cons were raised in respect of each variable. Ofwat's justification lacks an objective assessment of the merit of the two measures, and the extent that they achieve their intended objective.

Below we set out evidence that the BPS measure does not achieve its intended objective. In contrast, the APH does achieve its objective. We provide two pieces of evidence:

- BPS has a counter-intuitive **negative correlation with power costs and energy consumption** per km of mains; and
- BPS has a **high correlation with density**, which undermines model quality[7].

We consider that this evidence—particularly the first point—should lead to the conclusion that the BPS is not fit for purpose. Any concern about data quality of the APH are (i) mitigated by the evidence that the variable achieves its intended objective in an intuitive and plausible way, and (ii) cannot be used to counter the fundamental concern with the BPS measure.

In addition to the above, APH is largely exogenous, and performs well in the econometric models. It should be the only measure used in the models. We do not consider that concerns about potential reporting inconsistencies of APH data are equal in gravity to concerns about BPS. On the basis of the evidence set out below, BPS is not fit for purpose and is clearly inferior to APH.  Consequently, it should be dropped.

### TMS argument and supporting evidence

*BPS is not correlated with power costs or energy consumption*

APH and BPS are meant to capture energy/pumping requirements imposed by the topography in the region. To this end, we would expect them both to correlate with power costs (per main) and energy consumption (per main).

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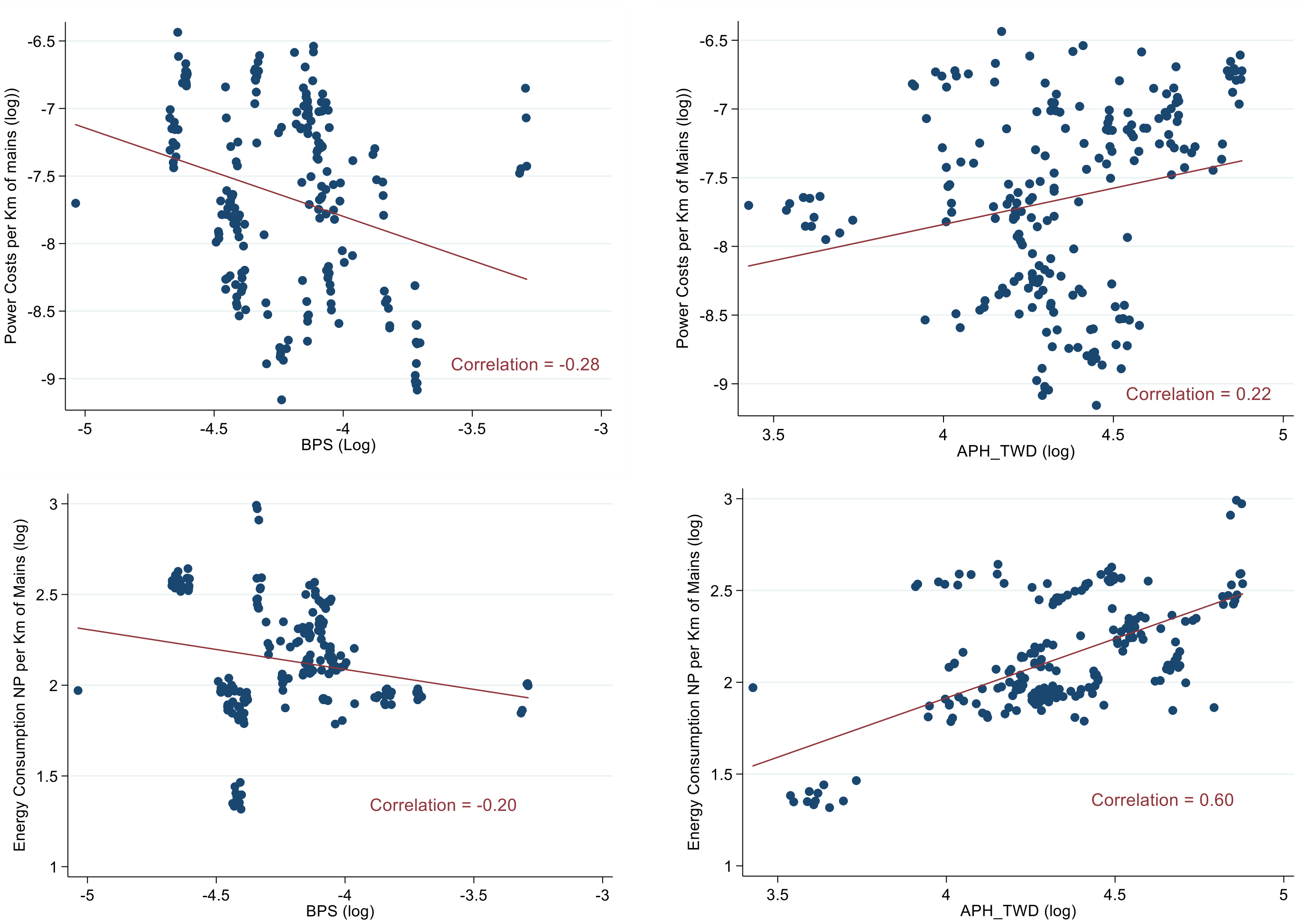
[7] High correlation undermines the reliability of the individual coefficients. For example, in all the models with BPS the estimation for density is less precise as seen by their higher standard errors than the models using APH.

Figure 5 shows that this is the case for APH, but not for BPS. The correlation of APH with power costs per km of main (0.22) or with energy consumption per main (0.60) is positive and high[8]. On the other hand, the correlation of BPS with the same variables is negative, which is counter intuitive.[9] This negative correlation suggests that the variable is not fit for purpose – it does not capture what it is intended to capture. This observation alone should remove the variable from consideration as a driver of energy usage.

*Figure 5:Correlation of APH and BPS with energy spend and consumption*




The number of booster pumping stations is the wrong proxy for energy requirements. It does not take into account the capacity of the pumping stations and therefore the overall pumping

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[8] We correlate BPS with a standardised power costs or energy consumption. If we were not standardising them by scale, then the correlation would be distorted – we do not expect a positive or negative correlation between BPS and power costs, because power costs are primarily determined by scale. The scale effect must therefore be removed.
[9] The result also holds at the wholesale level.

capacity that the company uses. The industry data reveals companies that have a small number of BPS tend to have large capacity per pumping station and vice versa.[10] Pumping capacity is a more relevant measure than the number of booster pumping stations to capture energy requirements. Any argument that using the number of booster pumping stations is appropriate for a large enough sample, where some pumps have high capacity, and some have low capacity, does not hold – there is a systematic tendency to have low capacity per pump for companies with many pumps and high capacity per pump for companies with few pumps.

The negative correlation between BPS and power costs is telling. In the past Ofwat used econometric power models to explain power costs. When BPS is included in these models[11] (alongside scale and density drivers as in Figure 6), it still has a counter-intuitive negative coefficient. The sign of BPS turns positive only when capital maintenance is added to the dependent variable. But BPS is not aimed at explaining capital maintenance costs.

*Figure 6: Power and capital maintenance costs with BPS, Scale and Density*

| | Power_Cost b/se | CM_Costs b/se |
|---|---|---|
| Ln(Mains) | 0.812*** | 1.112*** |
| | (0.184) | (0.059) |
| Ln(BPS) | -0.185 | 0.526*** |
| | (0.220) | (0.126) |
| Ln(MSOA_Density) | -1.912 | -7.238*** |
| | (8.235) | (1.719) |
| Ln(MSOA_Dsty)^2 | 0.206 | 0.497*** |
| | (0.518) | (0.106) |
| constant | -4.352 | 21.435*** |
| | (32.953) | (6.464) |
| R2_Overall | 0.593 | 0.934 |
| Observations | 204.000 | 204.000 |

Source: Economic Regulation, Thames Water. CM=Capital Maintenance.
* p<0.10, ** p<0.05, *** p<0.01

## High correlation between density and BPS

Figure 7 shows that the BPS is highly correlated with the density measures while the APH is not.

*Figure 7: Correlation of BPS and APH with density measures**

| | BPS | APH |
|---|---|---|
| LAD density | -0.67 | -0.15 |
| MSOA density | -0.61 | -0.25 |
| Property per length | -0.68 | -0.23 |

* All variables in log.

[10] The correlation between booster pumping stations per km of mains and pumping capacity per booster pumping station is –0.43.
[11] We assess Power and Capital Maintenance costs as Random Effects models.

High correlation between explanatory variables is known to have negative implications on the quality of econometric models. It increases the standard errors of the estimated coefficients, and their estimated value becomes sensitive to the sample at hand. This can have material implications to efficiency assessment and cost allowances for companies. In a similar vein Ofwat rejects the use of regional wages as a cost driver due to its high correlation with the density measures.[12]

We are not making a general claim that correlated variables should never be used in an econometric model. We understand that there are circumstances where this is appropriate on balance. However, in this case Ofwat has an alternative – the APH – which is largely uncorrelated with density (among its many advantages over the BPS), correlated with energy consumption, engineering rational and largely exogenous. APH should be used instead of BPS.

## 2.3. Wastewater: squared density term

### Brief outline of Ofwat's position

Ofwat's sewage collection models do not include the squared term of density.

Ofwat recognises that the quadratic density term is statistically significant in sewage collection models. However, it considers that the engineering rationale for including it in the model is not as strong as in treated water distribution models, and that its statistical significance may be spuriously driven by inefficiency of highly sparse and dense companies.

Below we respond to Ofwat's arguments and provide additional evidence to illustrate the non-linear impact of density on wastewater collection costs.

### TMS argument and supporting evidence

We disagree with Ofwat's decision not to include the squared term of density in wastewater. The effect of density on a company's operational and maintenance costs is similar in water and in wastewater – it is non-linear. The non-linearity reflects different cost factors (e.g., economies of scale, urbanity) that push at different directions and at different intensities across densities. There are multiple factors that drive the non-linear relationship between density and sewage collection costs. Some factors are unique to, or stronger for, wastewater (just as there may be factors that are more relevant to clean water). It is important to capture this non-linearity. Failing to capture this non-linearity through a squared term of density has **disproportionate implications** on our efficiency assessment.

**Ofwat argues that the "U-shaped" relationship in wastewater is weaker than in water and may be driven by inefficient companies**

Ofwat argues that the "U-shaped" relationship between density and the residual in sewage collection models is weak compared to the same relationship in water. It concludes that this

[12] We highlighted previously (in our response to Ofwat's econometric consultation in 2023) that the precision of the density and BPS coefficients is significantly lower in models that include these variables together compared to the precision of density in APH in models that include these two variables instead. We also highlighted that models with BPS appear to overestimate the elasticity of density.

"*shows that the economic and engineering case for a quadratic density relationship is much weaker in the sewage collection models" and that "there is also the risk that Thames Water's findings are driven by very dense and sparse companies being relatively inefficient, rather than because of an omitted cost driver*."

Whether the relationship between density and the residual in wastewater models is weak or not is irrelevant. It is not one of Ofwat's model selection criteria. If the variable is statistically significant, exogenous, stable and has engineering rationale, it should be included in the model. A weaker U-shape relationship wastewater compared to water may be due to the smaller and more homogenised sample in wastewater. In any case, it is the role of the model to reflect the strength of the non-linear relationship, through the estimation of the coefficients, and take it into account in efficiency assessment.

The same argument goes to Ofwat's claim that the U-shape may be capturing the inefficiency of sparse and dense companies. This risk exists for every variable in the model; the calibration of each variable's coefficient may be influenced by inefficient companies thus may 'reward' inefficiency. The risk of capturing inefficiency, in particular in the case of an exogenous variable like density, is again not one of Ofwat's model selection criteria and is a departure from an objective assessment of the cost driver.

Ofwat further argues, following representations from Severn Trent and United Utilities, that companies serving sparse areas should not face relatively higher costs compared to non-sparse areas. The rationale given is that the sewerage network tends to be localised, with low travel and intervention cost, it may be gravity dominated and often the company does not provide sewerage services for in rural areas.

While some of these arguments are correct to a degree, they are not completely correct. Sewerage networks tend to be localised but not always (and in any case, it is not clear why it follows that localised sewerage networks should have lower travel costs). Sewerage networks can be gravity dominated, but not always. Companies often do not collect waste in rural areas, but sometimes they do (in fact, rarely do we not collect waste from customers in rural areas). The point is that similar factors to those that increase water distribution costs in sparse areas exist in wastewater collection. In other words, economies of scale exist in the provision of sewage collection services.

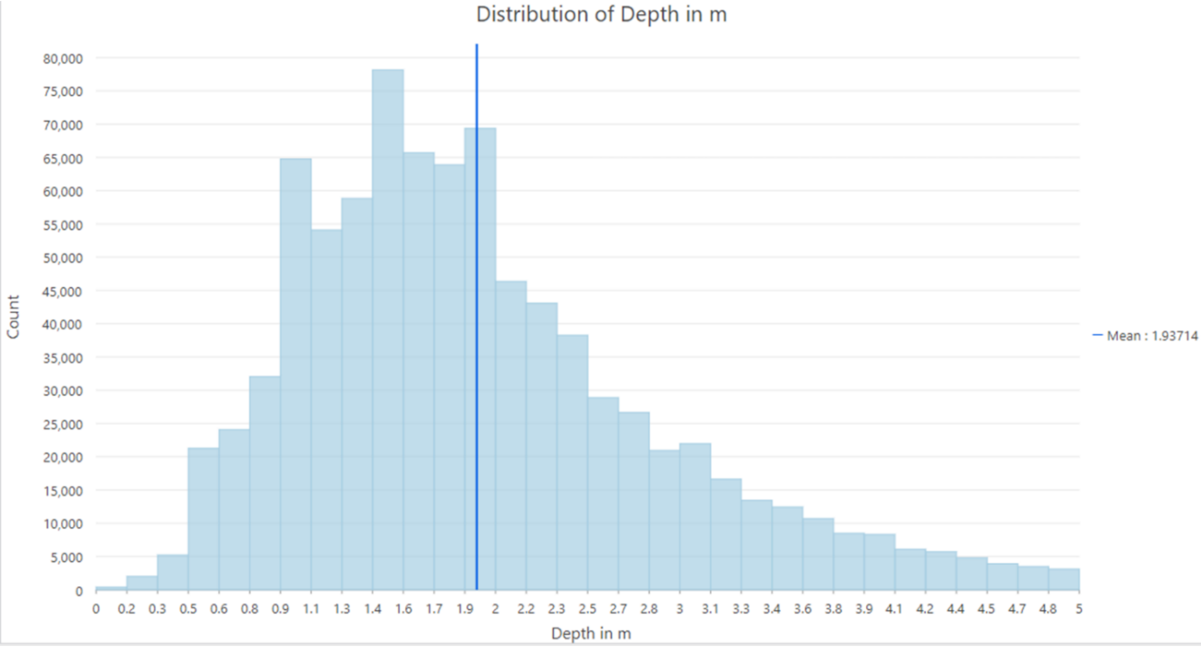
Ofwat argues that "gravity sewers tend to be deeper than water mains. So, heavy traffic loading in urban areas, which may result in greater ground movement and stresses on the pipework, likely affect water mains to a greater degree".[13] We acknowledge that gravity sewers tend to be deeper than water mains. Water mains must be at least 90cm below ground (but often deeper). Figure 8 shows that our wastewater pipes are on average 1.93m below ground. But the average masks the distribution. As the figure shows, we have many wastewater pipes that are laid at

[13] "Econometric base cost models for PR24" (page 43), Ofwat, April 2023.

depths that are similar to water mains. Traffic loading would impact these pipes similar to that on water pipes. And for deeper pipes the impact does not go away either.

In fact, in highly dense, areas the greater depth of wastewater pipes increases intervention costs to address routine maintenance, like addressing blockage incidents, compared to routine interventions in water pipes. The point is, again, that similar factors affect both water and wastewater pipes, some to a greater extent and some to a less extent.

*Figure 8: Distribution of depth of wastewater pipes across Thames Water (depth in meters)*




The strength of the relationship between density and cost may be slightly different between water and wastewater. For example, the scope for economies of scale may be more limited in one service, or the high-density cost factors may be more pronounced for the other service. Again, it is the role of the model to calibrate the strength of the non-linear relationship between density and costs, capturing both the effects (i.e., of economies of scale and high-density cost pressures, on which we elaborate below). It may calibrate the relationship between density and cost as a flatter U-shaped relationship. A flatter U-shaped relationship still has an important role to play in the model, an important role in comparative assessment, and an important role in allowance setting. Without it, the models, the comparative assessment and the allowances are less accurate.

In the PR19 re-determinations the CMA included non-linear effects in their sewage collection model. The CMA found that:[14]

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[14] CMA PR19, FD, p. 161, paragraph, 4.177 to 4.179, https://assets.publishing.service.gov.uk/media/60702370e90e076f5589bb8f/Final_Report_---_web_version_-_CMA.pdf.

- "In sewage collection population density may have two opposing effects. These effects may vary according to the level of density. One way to capture these opposing effects is to include non-linear terms of population density. Therefore, we think it makes economic and engineering sense to include the squared term of population density", and continues:
- "We found the SWC2 coefficients for both the weighted average of population density and its squared term to be statistically significant. The coefficients were also of the expected sign (the former was negative, and the latter was positive). Indeed, the population density terms in our SWC2 model suggested a similar effect to that of population density on wholesale water costs. At lower levels of density, scale economies are strong and therefore increasing density reduces costs. However, the positive effect of the quadratic term suggests that as density rises its negative impact on costs decreases, ultimately becoming positive at high values of density".

Finally, we note that Ofwat argues that the econometric evidence supports not including the squared term of density because "the squared density term is strongly insignificant when properties per sewer length is used as the density variable".[15] First, the econometric evidence from the weighted population density measures supports the inclusion of the squared term. These measures are far more suitable as cost drivers in our models than the simple average density measure (if anything, the statistical insignificance of the squared term with the simple average measure is another piece of evidence against this measure). Second, we consider that this is incorrect – the models/data have moved on and in our calculations the density squared term is statistically significant for all three density measures using draft determinations models.

Therefore, there is a strong econometric and engineering rationale to include the square term of density in the assessment of sewage collection models.

We can set out multiple 'engineering' factors that significantly increase our costs in highly dense areas, and indeed we do it below. However, economic rationale and econometrics evidence all support a squared term of density in wastewater collection models.

### Examples of engineering factors that increase wastewater collection costs in highly dense areas[9]

Managing assets across the Thames Water service area, it is evident that to maintain a comparable level of asset performance between two pipes, one in a dense and another in a sparse area, the sewer in the dense area will be subject to a more frequent regime of cleaning, inspections and interventions. Overall, the frequency and costs associated with managing assets in dense area is significantly higher than in non-dense areas.

[15] "Econometric base cost models for PR24" (page 43), Ofwat, April 2023.

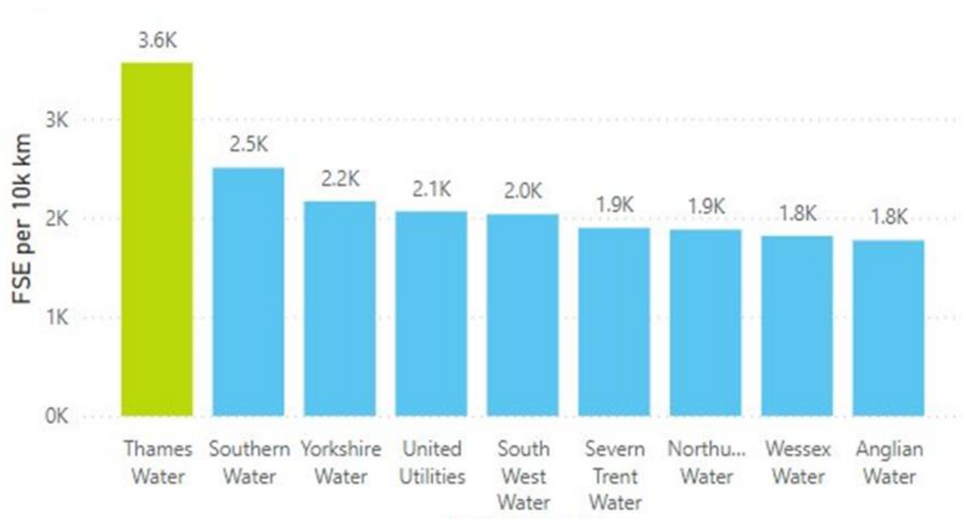
We illustrate the higher network costs in dense areas through an example of blockages. Blockages are a significant driver of wastewater network costs. Although our illustration is focussed on blockages, the same applies to other types of failure.

Blockages are more likely to occur in dense areas, and when they occur, they affect more people, and they are more costly to fix.

**Higher likelihood of failure:** blockages are more likely to occur in dense areas for several reasons:

First, densely populated areas have a greater number of people connected to a sewer, and with it, greater blockage risk associated risk from non-flushables. Second, a high concentration of Food service establishments (FSEs) and fast-food outlets is common in dense areas. FSEs are a major source of FOG (Fat, Oil & Grease) in our sewers. A high concentration of fast-food outlets will generally result in more blockages from fats and greases. This requires frequent proactive maintenance of sewage pipes and reactive fix of blockages. Figure 9 shows that Thames Water has significantly more FSEs per sewer length than the rest of the sector. Third, the level of traffic increases ground movement which in turn impacts the frequency of network damage and repairs needed generating higher labour costs and more fuel and logistics work.

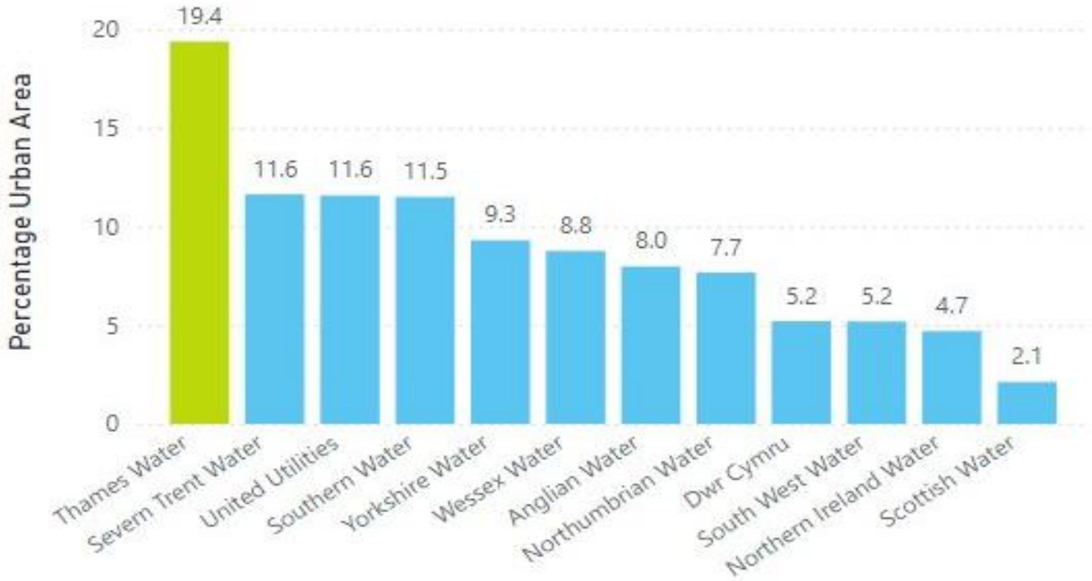
*Figure 9: Number of FSEs per 10,000 km of sewer*




**Higher consequence of failure:** in the event of a blockage in a dense area, it would affect more people and businesses than in a sparse area. The high consequence in the event of a blockage (or any other failure) requires more frequent monitoring and interventions, and the adherence to higher asset resilience standards.

**Higher costs to repair:** there are multiple reasons for higher repair costs in dense areas. One of them is the cost of access to the point of failure. Access in dense areas is more difficult and may be restricted. Commonly encountered challenges include, narrow streets, parked cars and parking areas restrictions, and the requirement for access to the rear of properties where access at best is restricted and sometimes inaccessible due to historical encroachment of buildings near to and over sewers. Red routes and taxi/bus routes carry significant restrictions and penalties for obstruction. Related to the access issue, it is more complex to dig up a street than a field, adding significant costs in dense urban areas. Figure 10 shows that Thames Water is an outlier in terms of the percentage of urban area.

*Figure 10: Percentage (%) of Urban Area*




Other notable factors that increase wastewater network intervention costs in highly dense areas:

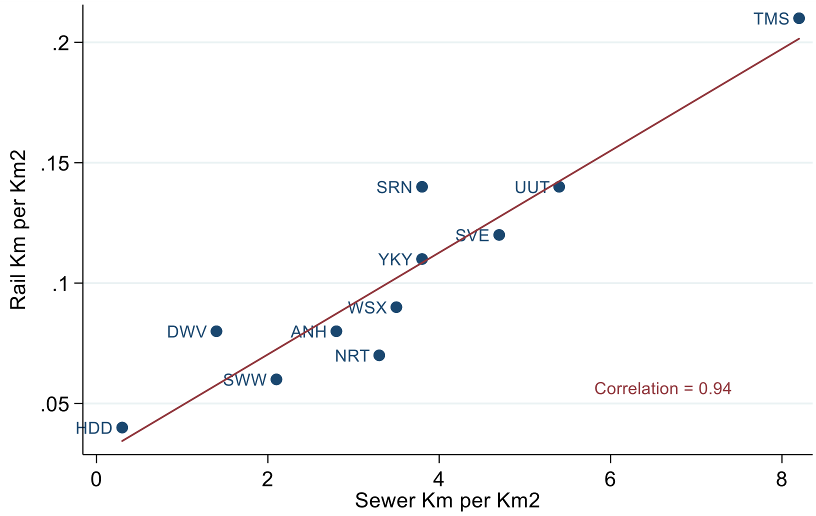
**Asset congestion**: In densely populated areas there is greater asset congestion above or below ground (e.g., transport, rail, and energy infrastructure, sewer and mains). Congestion restricts access and the efficiency at which work can be carried out at the site (e.g., repair and maintenance become more difficult, machinery used cannot be optimised, which affects the time to resolution and productivity). Congestion also increases intervention risk at the site. These factors in turn result in higher repair and maintenance costs.

Interaction of the sewage network with **railway crossing** is a case in point. Railway infrastructure is a lot more common in densely populated areas than in sparse areas (see Figure 11). There are increased costs associated with sewage pipes crossing railway tracks due to the higher consequence of failure, as well as the accelerated deterioration of sewers owing to operations by the network maintainers such as tamping of the base material that supports the tracks leading to damage of sewers. The impacts of a sewer failing in the rail environment are likely to be much more significant, not least due to disruption to rail travel[16] but also catastrophic impact should a sewer collapse lead to a derailment. These operational conditions classified the assets within this environment as critical to maintain and as such have an advanced regime of

[16] Forest Hill sinkhole: Worker lowered into sewer causing London Bridge chaos | London Evening Standard | Evening Standard

monitoring and remediation. In other words, rail operators maintain high standards of health and safety, which limited the access to sewers within the railway environment with an increasing operational cost impact.

*Figure 11: High correlation between sewer and rail densities across wastewater companies*




Source: Economic Regulation, Thames Water

## 2.4. Regional wage

### Brief outline of Ofwat's position

Three companies submitted cost adjustment claims relating to the effect of high regional wage on the level of efficient costs in their areas. These companies are all in the South East of the country: Southern Water, SES Water and Affinity Water.

Ofwat rejected these claims, arguing that the model already captures the effect of regional wages given that the variable arguably does not perform well in these models. Ofwat also suggests that evidence on regional wage from the ONS Annual Survey of Hours and Earnings (ASHE) survey "can vary significantly depending on the choice of wage measure, which questions the reliability of the regional wage differentials calculated using ONS ASHE data, and any subsequent cost adjustment claim value."

### TMS argument and supporting evidence

We disagree that the evidence from ASHE is inconclusive. The evidence is clear and consistent over time: wages in the South East, and in London in particular, are materially higher than in the rest of the country. Ofwat must not dismiss this evidence as inconclusive. Produced by the ONS, the ASHE is a large and widely used survey, conducted by a trusted independent institution.

At PR19 we submitted a CAC on regional costs. At PR24 we did not submit a region-based claim as Ofwat said that rejected CACs from PR19 must not be re-submitted unless there is new information (we do not support this approach). However, we support and believe in this claim at PR24 just as much as we did at PR19. The evidence was there then, and the evidence is there today. Labour is by far the most dominant input we use, and regional wages have a material impact on our cost base.

We also consider that the argument made by Ofwat, that the density variable sufficiently captures the effect of regional wages due to their high correlation, is not appropriate. High correlation is not a valid reason to exclude a variable in itself; excluding a highly correlated variable may mitigate collinearity issues, but could introduce omitted variable issues, with bias to a model's prediction and cost allowances. More importantly and pragmatically, the correlation between density and regional wage is not high. It is only moderate, and Ofwat has other variables in its models which are more highly correlated.

Ofgem has been recognising the effect of regional wages in all its price controls. At RIIO-ED2 it applied a 22% uplift (on the share of labour in totex) for DNOs operating in London. This was even though regional wages did not perform well as a variable in its models. The fact that the variable was not statistically significant in its models did not persuade the regulator to ignore the clear evidence that London wages are higher. It decided to put more weight on the ONS evidence on regional wage rather than ignore it due to lack of statistical significance in the model. The evidence could not be clearer – wages in London are materially higher than in the rest of the country.

We support the claims submitted by the water companies in relation to regional wage. Ofwat should consider the best approach to recognise regional cost differences in its cost assessment framework. Without recognising these differences, Thames Water and other companies in the region are subject to an unfair efficiency comparison while results in underfunding for the level of wages in the region.

## 2.5. Accounting for asset age and replacement rate

### Brief outline of Ofwat's position

Ofwat's base models do not include any direct cost driver of capital expenditure. We consider that this is an omission that materially distorts efficiency assessment and cost allowances in the sector.

Below we provide evidence from models that include two widely used capital expenditure cost drivers – asset age and replacement rate. These drivers are intuitive from an engineering perspective, they are robust and significant from an econometric perspective, and they have a material impact on the models' results.

The evidence suggests an impact of c. £200m on our wholesale water allowance. We expect Ofwat to make appropriate cost adjustments in light of evidence from models that include these factors.[17]

[17] In wastewater we do not have the same data as we do in water on asset age and replacement rates, so we cannot test these variables in the models. But a similar outcome is to be expected. We do not consider that absence of data, hence the ability to provide evidence, should preclude an adjustment to wastewater allowed cost.

## TMS argument and supporting evidence

Capital expenditure is a very material component of base costs. It includes maintenance and replacement expenditure of infrastructure and non-infrastructure assets. It is imperative that Ofwat's cost models do not interpret low levels of capital expenditure as efficiency unless drivers of capital expenditure are accounted for in the models.

Using APR data, we have extended Ofwat's treated water distribution and wholesale models with two factors that drive capital expenditure: (i) asset age, and (ii) mains replacement rate.

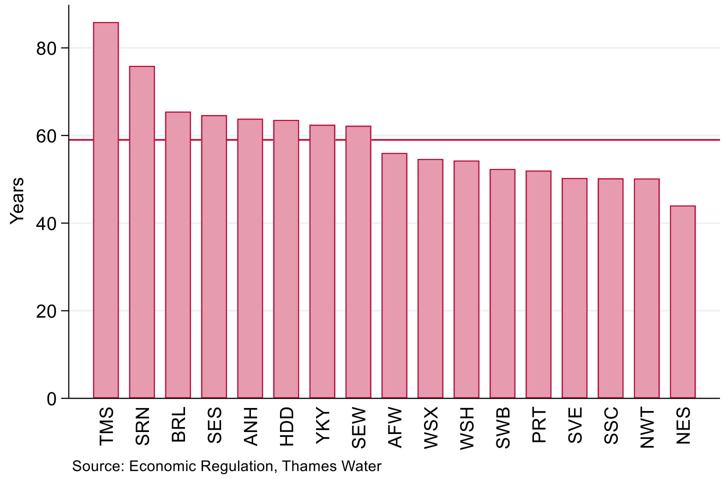
The results are provided in Figure 48 and Figure 49. The variables are statistically significant, stable, with a plausible expected sign. Compared to the same models without the two variables above (i.e. the draft determinations models) the new models' overall quality improves. The range of efficiency scores reduces marginally for TWD models (from 0.54 to 0.53) and appreciably for wholesale models (from 0.76 to 0.55).

## Why are these variables appropriate?

Thames Water has the oldest stock of assets in the sector (see Figure 12). This is largely due to historical reasons of London developing an infrastructure network earlier than other UK cities[18]. While there can be instances where old assets perform better than newer assets (e.g. due to the specific material used at different time periods), by some distance older assets perform worse than newer assets on average. Asset age is often an important input in any asset deterioration model.

The asset age variable is highly correlated (0.60) with capital maintenance costs per km of mains.

*Figure 12: Weighted age of the water network in 2023*




Asset replacement is a key activity of infrastructure companies and a key driver of capital expenditure. Mains replacement rates have gone down over the years in the sector. Each year they range from zero to about 0.6% across companies.

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18 See, Tomory, L. (2017). The History of the London Water Industry 1580 - 1820. Johns Hopkins University Press. Broich, J.(2013). London, Water and the Making of the Modern City. University of Pittsburgh Press.

One criticism may be that these variables are to some extent under management control. This argument is mainly relevant to the mains replacement variable. Asset age is not any more under management control than other variables currently in the model (e.g. booster pumping stations). It is largely based on the age of existing assets, which in turn is largely based on the evolution of demand in the region over an extended period of time, and management can influence the average age only in the margin through its asset replacement policy.

Mains replacement is to some extent under management control. Cost drivers under management control may create 'endogeneity' if they are correlated with the residual (through their correlation with efficiency - a latent variable that sits in the residual. After all, efficiency is under the control of the same management). In this situation the estimated coefficients are no longer unbiased.

In the past both Ofwat and the CMA considered[19] that, while cost drivers under management control should generally be avoided, ultimately it is subject to regulatory judgement and there may be situations where it would be appropriate to use such variables compared with the alternative. In fact, these factors have been used by Ofwat in the past. Asset replacement was used in the PR14 models and in the wider assessment at PR19, where asset age was also considered.

The question, therefore, is whether there is a good alternative to the mains replacement variable?[20] If there is no alternative exogenous variable, then it needs to be assessed against the alternative of simply excluding the mains replacement variable from the model and allow its effect on cost to be included in the residual.

But for a variable that is a material driver of costs, such as mains replacement, its exclusion can severely undermine the value of the models: an important factor does not play a role in the determination of costs. Therefore, costs cannot be estimated accurately. Moreover, the residual will 'include' the omitted variable – a material driver of costs – which makes it even more difficult to use the residual to proxy for inefficiency. In such a case the advantages of including the endogenous variable outweigh any concerns of bias.

[19] See PR24 Ofwat: https://www.ofwat.gov.uk/wp-content/uploads/2021/12/Capital-Maintenance-CAWG.pdf, or the CMA https://assets.publishing.service.gov.uk/media/60702370e90e076f5589bb8f/Final_Report_---_web_version_-_CMA.pdf, p.148.

[20] In the face of endogeneity, practitioners sometimes use the Instrumental Variable (IV) estimator. To use an IV estimator, one needs to find a variable that satisfies two conditions: (i) it must be uncorrelated with the error, and (ii) it must be correlated with the variable for which is serves as an instrument (in our case, the proportion of mains replaced). The higher the correlation the better the instrument. In practice, good instruments are hard to find. Moreover, the IV estimator is only asymptotically unbiased – it is still biased in a finite sample.

# 3. Residential retail

## Brief outline of Ofwat's position

To assess water companies' efficiency in residential retail Ofwat uses a set of econometric models. In addition, Ofwat applies a catch-up challenge based on the models' historical upper quartile level, a frontier shift challenge of 1% per year and provides a labour price inflation of 0.5% per year (equal to the expected wedge between labour inflation and the CPIH over AMP8).

Ofwat's modelling approach builds on the PR19 approach, with some changes. The proposed PR24 models exclude two variables—the proportion of metered customers and population transience—which have previously been included in the models.

In addition, we note that since Ofwat's consultation on its econometric model it has decided to remove the variable 'county court judgements per household' as a deprivation proxy to explain levels of bad debt.

Ofwat proposes to continue its policy of not indexing the retail controls to a measure of general inflation such as CPIH.

We set out our representations on Ofwat's proposal below. We provide evidence in support of using county court judgement as a measure of deprivation in the models, and comment on other aspects of the proposals.

Our key concern in relation to Ofwat's proposals for residential retail is that the cost assessment framework fails to consider the impact of high transience in our area on the level of our efficient retail costs. We set out further evidence in support of our transience cost adjustment claims in section 6.2 of the Cost Adjustments Claims section in this document.

## TMS argument and supporting evidence

### We consider that retail controls should be indexed to general inflation

As a point of policy, we consider that because inflation is beyond companies' control, the retail controls should be indexed to a measure of general inflation. This would be consistent with the approach to wholesale controls. It would also be simpler, more transparent and a more appropriate policy than the current one of no indexation to inflation (particularly in times when inflation is volatile), for which we cannot see a clear rationale.

### We disagree with the removal of the county court judgement (CCJ) driver

Ofwat states that the CCJ was less statistically significant than other deprivation drivers and slightly deteriorated in performance with the inclusion of 2022-23 data.

The driver provides an intuitive proxy for the propensity of default in the local population. While the income score is focussed on capturing customers that can't pay, the CCJ is focussed on customers that won't pay, thus offering important information not properly captured with the existing deprivation measures. The variable is sufficiently exogenous and statistically significant in bad debt models, showing a strong link between CCJ and bad debt. In the total cost models, the driver also performs well showing the expected coefficients signs and only marginally insignificant with p-values between 0.17-0.29.

Deprivation variables are used in retail models to proxy for the propensity to default in a region, which in turn affects the level of bad debt. Because propensities to default are uniformly low, it is hard to find a single deprivation variable that would provide a robust proxy for it. This is an area where triangulation is important. Considering the statistical evidence and the strong intuition of the CCJ as a proxy for the propensity to default which capture the ‘won’t pay’ dimension, it would add valuable credibility to the triangulated modelling results and provide assurance that propensity to default is captured more accurately than without it.

# 4. Bioresources

## Brief outline of Ofwat's position

Ofwat uses four unit-cost models (i.e., cost per sludge produced) to assess and set allowances for bioresources. Each model uses a single cost driver focussed on capturing economies of scale in sludge treatment (through variables such as population density, the percentage load treated in bands 1-3, or the number of sewage treatment works per property)

Ofwat does not include any explanatory variable for disposal.

Ofwat sets the Bioresources catch-up challenge based on the historical upper-quartile efficiency score resulting from its models. The challenge to sector average costs is 9%.

We have a very material gap of £263m between our forecast costs and what we were allowed.

## Thames Water's arguments and supporting evidence

Ofwat's proposed bioresources models control only for the treatment element through the cost drivers. Disposal costs, which account for c. 20% of costs, are not controlled for through a cost driver. Disposal costs are a material component of total bioresources costs. If there are exogenous factors that impact efficient disposal costs, they should be included in the models or in the wider assessment approach (similar to retail, where different components of cost have bespoke cost drivers).

Below we set out our concerns with Ofwat's proposed bioresources models and with the aggressive catch-up challenge for this price control.

### Concerns with the proposed bioresources models

We have three specific concerns with the proposed bioresources models:

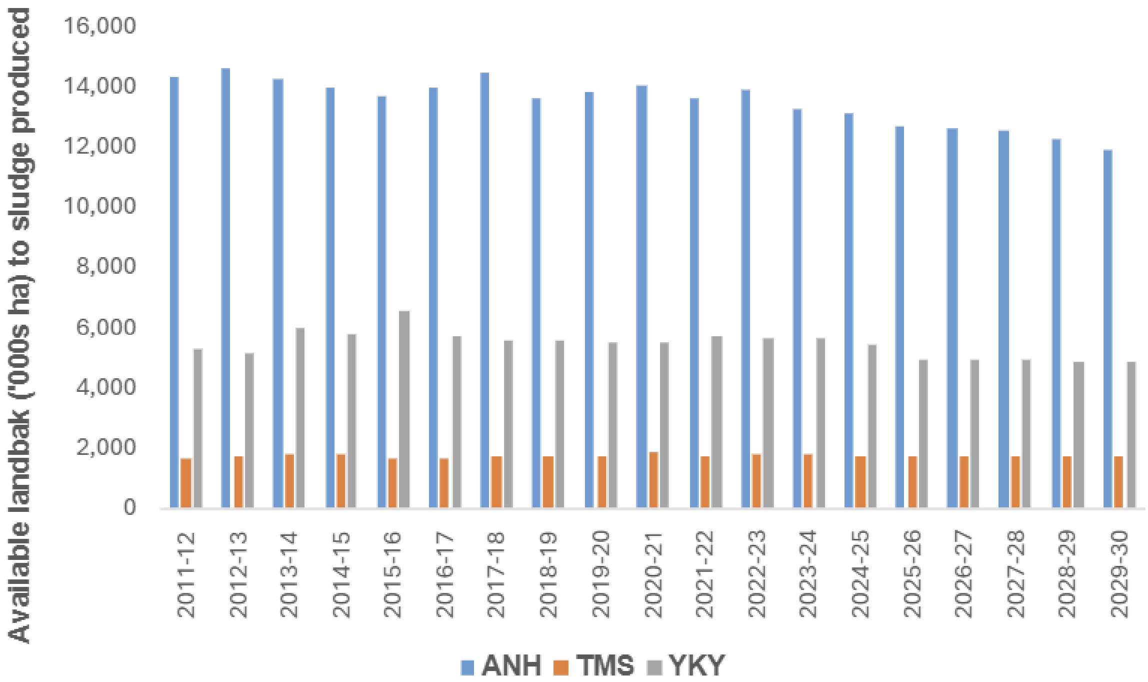
- The models do not control for landbank availability which is a material cost driver affecting the disposal costs;
- The models could benefit from including a density squared terms to more accurately capture the tension between economies of scale (in sludge treatment) and travel costs (in disposal costs).
- The assumption of constant returns to scale is not supported by engineering rationale. The models would be improved by allowing a more flexible relationship of costs with the scale driver (i.e. sludge produced) rather than imposing a constant returns to scale assumption.

## 4.1. Availability of land for disposal

Disposal is the last step in the processing of sludge. This involves transporting sludge from the Sludge Treatment Centres (STCs) to closest available farmland to be disposed of. Not all farmland is suitable, as it must meet DEFRA's requirements on statutory testing, operational testing and Potentially Toxic Element (PTE) limits in order to receive sludge.

Using data from Land Use Statistics[21] we calculated the available landbank for Thames Water and two other companies in the sector, Anglian Water and Yorkshire Water. We selected Anglian as it has very different characteristics to us, with ample landbank availability, and Yorkshire as representing a more 'average' company in the sector in terms of landbank availability.[22] Figure 13 shows that Thames Water has much less agricultural land per sludge produced compared to Anglian and Yorkshire. This means we need to transport the sludge further to reach available disposal outlets (including outside of our service area) and incur higher disposal costs.

*Figure 13: Ratio of agricultural land to volume of sludge produced[23]*




To evidence the impact of land bank availability on sludge disposal costs, we use internal sludge treatment centre (STC) haulage data, which contains information on the distance travelled and cost incurred in dry sludge disposal, to compare Thames Valley and London. Thames Valley has higher landbank availability and lower sludge volumes compared to London.

Figure 14 shows that the median distance travelled for sludge disposal to farmland is 35% higher for STCs in London compared to STCs in Thames Valley.

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[21] Source: Land Use Statistics, England 2022 (Department for Levelling Up, Housing and Communities). Available at https://www.gov.uk/government/statistics/land-use-in-england-2022
[22] We did not calculate landbank availability for every company in the sector in the interest of time and proportionality. Our point that Thames Water cannot be compared to Anglian Water without controlling to landbank availability is clear from the comparison of these two companies alone.
[23] Thames analysis of Land Use Statistics, England 2022 (Department for Levelling Up, Housing and Communities) and Base costs – wastewater model 1, PR24 Draft Determinations

*Figure 14: Median radial distance travelled from STC to disposal site (km)*


Figure 15 shows that the median unit cost of disposal per tonne of dry sludge is 25% higher for STCs in London compared to STCs in Thames Valley.

*Figure 15: Median unit cost of sludge disposal (£)*


To summarise, our analysis demonstrates that Thames Water has a lot less available land for sludge disposal than companies such as Anglian Water and Yorkshire Water, and that landbank availability has a material impact on disposal costs.

Using benchmarking models which do not control for landbank availability would not provide a good view of cost efficiency given the difference in land available for disposal.

One option that is available for Ofwat is to use the 'Total work done in sludge disposal operations carried out by truck' variable as an additional driver in the Bioresources models to improve efficiency assessment in the sector. This variable is highly correlated with the radial distance travelled reported in the dataset used for the “Within-Thames Water analysis” (coefficient of 0.75). This indicates that the ‘Total work done in sludge disposal operations carried out by truck’ adequately captures the distance travelled between STCs and disposal outlets. Including this driver in the models produces statistically significant results, a coefficient with the expected positive sign and improves the R-squared of the models as presented in Figure 16 further below.

### 4.2. Square term of density

The squared density term should be included in the bioresources models. As we argue in section 2.3, the relationship between cost and density is non-linear. Density may capture economies of scale, intersiting, landbank availability etc.

The squared term contributes to Ofwat’s existing models and would improve their accuracy to ensure that accurate efficient costs are revealed, and companies are adequately funded. We disagree with Ofwat’s argument that there is no noticeable correlation between sludge disposal costs and weighted average density. The correlation is strong at 0.64 - 0.73.

### 4.3. Constant Returns to Scale

There is strong engineering rationale for the presence of economies of scale in sludge treatment. The density variable in Ofwat’s proposed models accounts for it only partially. For two companies with identical densities, the one with a higher volume of sludge produced will be able to capitalise on more economies of scale. Imposing an assumption of constant returns is not appropriate.

### 4.4. Alternative modelling results

Figure 16 implements our proposals above and shows improvements to Ofwat’s proposed bioresources models. The driver for disposal costs and the squared term of density are statistically significant. In these models, which are more fully specified than the ones proposed, the scale variable, sludge produces, is also statistically significant with the expected negative sign suggesting economies of scale.

Where Ofwat models have R-squared values ranging from 0.14 – 0.25, our proposed models have much higher R-squared values ranging from 0.38 – 0.51. Also, our proposed models pass the RESET test, suggesting that there is no model misspecification. In contrast, Ofwat’s models BR2 and BR3 fail this test.

The range of the efficiency scores reduces significantly compared to the Ofwat’s models. For instance, including the squared term of density, sludge produced scale driver and the proxy for availability of farmland (i.e., model BR2) has a range of 0.42 compared to Ofwat’s model BR2 with a range of 0.7.

The models are also robust to sensitivity analysis such as the removal of the most and least efficient companies, and the removal of the first and last year of the sample.

*Figure 16: Modelling results of alternative bioresources models*

| Cost driver / diagnostics | BR1 | BR2 | BR3 | BR4 |
|---|---|---|---|---|
| Sludge Produced (log) | -0.347*** | -0.401*** | -0.352*** | -0.253 {0.184} |
| Load treated in bands 1-3 (%) | 0.048** | | | |
| Weighted average density - LAD from MSOA (log) | | -3.521*** | | |
| Weighted average density - LAD from MSOA Square (log) | | 0.217*** | | |
| Weighted average density - MSOA (log) | | | -8.082*** | |
| Weighted average density – MSOA Square (log) | | | 0.472*** | |
| Number of sewage treatment works per property (log) | | | | 0.301* |
| Work Done in Sludge Disposal by Truck (log) | 0.318*** | 0.376*** | 0.361*** | 0.335*** |
| Constant | -1.76*** | 12.2*** | 32.4*** | 0.31 |
| Adjusted R-squared | 0.393 | 0.506 | 0.478 | 0.387 |
| RESET test | 0.333 | 0.453 | 0.778 | 0.384 |
| Efficiency scores range | 0.61 | 0.4 | 0.53 | 0.55 |
| Removal most efficient company | A | G | G | A |
| Removal least efficient company | G | G | G | A |
| Removal first year | G | G | G | G |
| Removal last year | G | G | G | G |

## 4.5. Catch-up challenge

While the use of an upper quartile catch-up challenge appears consistent with regulatory default, it is a stiff challenge. It is also a potentially unreliable challenge given it is based on a model fitted on a sample of 10 companies only, where the top three performing companies, as judged by the model, are taken to set the efficiency benchmark. The risk of material error is large.

Given the poor quality of the models, with a low R-squared and a wide range of efficiency scores; and given the challenge that the upper quartile presents in this case – a challenge of 9% – we consider that using the upper quartile is a flawed policy decision.

Figure 17 shows the inter-quartile range of efficiency scores across PR24 models (based on Ofwat's draft determination model 3). The range for bioresources is significantly higher than the rest. The full range of efficiency scores in bioresources is also the highest across all models at 0.74, which is considered a wide range for the base econometric models.

*Figure 17: The range of efficiency score in bioresources compared to other proposed models in PR24*

| | Wastewater N+ | Bioresources | Wholesale water | Retail |
|---|---|---|---|---|
| Lower quartile | 1.03 | 1.20 | 1.14 | 1.07 |
| Upper quartile | 1.00 | 0.91 | 0.96 | 0.90 |
| Interquartile range | 0.03 | 0.29 | 0.14 | 0.17 |

In addition, there are known interactions between wastewater treatment and bioresources, which makes it difficult to model bioresources alone. These interactions led Ofwat to combine these activities for the purpose of efficiency assessment at PR14 and PR19. While the impact of these interaction may be limited for the wastewater network plus efficiency assessment, due to its large size compared to the bioresources control, the impact on the bioresources efficiency assessment is likely to be noticeable and material.

The bioresources control is relatively new and the full reliance on separate models is new for PR24. The proposed models are not of sufficient quality maturity to use an upper-quartile challenge of 9% as a catch-up challenge.

Ofwat should consider using a less stringent catch-up challenge. In addition, Ofwat should consider using a glide-path to allow companies time to reach the efficiency benchmark in a service where Ofwat's view of efficiency was hitherto unknown.

# 5. Unmodelled base costs

## 5.1. Business rates

### Ofwat's position

Ofwat sets allowances based on the rateable values set at the 2023 revaluation and the 2023-24 multiplier set by central government. It does not reflect the revaluations due in 2026 and 2029 in its allowances or increases in business rates due to changes in wastewater asset stock in the period 2025-30.

Ofwat proposes a cost sharing arrangement of 90:10 to be trued up at the end of the five-year price control period.

### TMS argument and supporting evidence

We welcome the change to the cost sharing arrangement on business rates since PR19. The change reduces companies' and customers' exposure to a mismatch between forecast and outturn business rate costs. This is appropriate as we have very little control over the level of our business rates.

We are concerned about the cash flow implications of the mechanism. Ofwat's allowance is £236m below our forecast business plan expenditure for the period 2025-2030. This is a large and material cashflow exposure over the five-year period until the true-up takes effect. This is also a material amount that can have a large impact on bills at the end of the period.

We request that Ofwat fully allows these costs in the PR24 final determination. Failing this, we request that Ofwat implements the cost sharing true-up annually rather than at the end of the period (i.e. in 2030) to mitigate cashflow concerns and smooth the impact on customers' bills.

## 5.2. Traffic Management Act (TMA) costs

### Ofwat's position

To set a cost allowances for TMA costs, Ofwat 'accepts' companies' proposed costs subject to an efficiency challenge based on the gap between allowed and forecast modelled base costs (the 'company modelled base cost efficiency factor'). The challenge to Thames Water is 9%, which equated to £16 million.

### TMS argument and supporting evidence

We consider that it is not appropriate to apply a 9% challenge to our forecast on the basis of the models' results. If the models were more appropriately specified, in line with representations on model specification we make earlier in this document (e.g., with the appropriate density measure, squared term of density, asset age and replacement rate) our comparative efficiency would look a lot better.

We also consider that TMA costs are characterised by high uncertainty and limited management control. This combination renders it suitable for a different cost sharing arrangement. We propose that a similar cost sharing arrangement as for business rates applies to TMA costs.

# 6. Frontier shift and real price effects

## 6.1. Frontier shift

### Brief outline of Ofwat's position

Ofwat is proposing a frontier shift of 1% per year, as well as seeking views on whether this should be increased to 1.2%.

Ofwat's frontier shift estimate is based primarily on the analysis of the EU KLEMS data carried out by Cambridge Economic Policy Associates (CEPA). As part of this analysis, CEPA assessed historical Total Factor Productivity (TFP) growth in industries considered comparable to the water sector. CEPA find that the scope for frontier shift lies in the range of 0.5% to 1.2%.

### TMS argument and supporting evidence

We believe that the 0.45% frontier shift rate proposed in our business plan remains the correct target. The rate is based on the benchmarking of the EU KLEMS data carried out by Economic Insight, similar to the analysis done by CEPA. Using a slightly different industry comparator set and different time periods for assessing historical frontier shift, Economic Insight arrived at a 'PR24-focused', 'plausible' frontier shift range between 0.3% - 0.8% per year.

Ofwat's approach to determining frontier shift has three major flaws. We discuss each in turn below.

**Ofwat's assertion that the water sector is somehow decoupled from the UK economy-wide post-2008 productivity slowdown is not grounded in evidence.**

Since the 2008 financial crisis UK productivity growth decelerated significantly. According to the Office for Budget Responsibility productivity growth has fallen to around 0.5% per year since 2008, significantly lower than the 2% rate prevalent before 2008. The causes of the decline in UK productivity have been extensively studied, the 'productivity puzzle' persists, with a range of factors such as low investment, political uncertainty, Brexit, the UK's reliance on the finance sector and broader supply-side constraints among others, all thought to contribute in some way to the UK's sluggish productivity growth.

Despite the uncertainty around the causes of the slowdown in UK productivity growth, Ofwat's economic advisers assert that the UK water sector is somehow less affected by this UK-wide trend:

'The reasons suggested in the academic literature for low economy-wide productivity growth since the 2007-08 financial crisis do not apply in the water sector.'

'Ofwat is justified in aiming up within the EU KLEMS range because the "productivity puzzle" should not be fully reflected in the scope for productivity gains in regulated sectors where there is greater certainty of investment and longer planning horizons.'

The evidence to support these assertions is lacking. In practice, water companies are closely integrated into the UK economy, as a high proportion of expenditure involves work with UK based contractors and supply-chain partners that are affected by the wider macro-economic trends.

Our analysis of the Office for National Statistics (ONS) Multi-Factor Productivity (MFP) data shows that whilst the UK-wide MFP growth has averaged 0.1% per annum since 2008, the water sector has in fact experienced an average 1.4% annual decline in productivity over the same period.

In addition to this evidence from these national institutions, Economic Insight cited the findings from a survey of independent academics on the prospects for UK productivity growth: '83% of respondents consider that the water sector will perform 'similarly' or will 'underperform' UK productivity, over the next five calendar years.'

**Ofwat's assumptions of future productivity growth in the water sector are speculative and fail to take account of credible forecasts produced by macroeconomic policy institutions.**

The latest productivity forecasts by the Bank of England and the OBR show no evidence that the UK is expected to return to pre-2008 levels of productivity growth. Despite the evidence, Ofwat expected the water sector to outperform the economy over the coming years. Largely relying on the analysis produced by Europe Economics, Ofwat indeed asserts that 'evidence may support a more stretching challenge' than that implied by the performance of the UK economy.

Europe Economics' report suggests UK productivity should accelerate in the coming years due to factors such as increased use of Artificial Intelligence and Big Data. It also maintains that the water sector has scope for additional efficiency gains through the use of innovation funds.

We consider the analysis presented by Europe Economics is speculative and fails to take account of forecasts produced by credible macroeconomic policy institutions. A balanced judgement would consider that there are downside and upside risks which might mean that the water sector under or overperforms compared to UK wide productivity – noting that the actual data of historical performance shows that the sector has typically achieved lower productivity improvements and it is not clear what the clear drivers of change for the water sector are for the following five years.

**The presence of a clear overlap between the Performance Commitment framework and frontier shift means that Ofwat should aim down from the EU KLEMS benchmarks**

Europe Economics accepts that there is some overlap between applying a stretch to service improvements through the Performance Commitments, while also applying a frontier shift challenge to costs. Neither Ofwat nor Europe Economics attempt to quantify the size of this overlap but conclude that 'the overlap is likely to be much smaller than the industry suggests'.

Ofwat's central argument is that its Performance Commitments are set to reflect catch-up rather than frontier shift efficiency. However, the evidence over AMP7 suggests that this is not the case. Analysis of AMP 7 performance data to date indicates that all water and sewerage companies are currently in net penalty for the common performance targets, indicating that the regime has been calibrated to require all companies to deliver more efficient performance from base expenditure rather than selected companies achieving catch-up efficiency. For instance, based on the 2024 APR data share all 11 water and sewerage companies are underperforming relative to the water supply interruption target. If none of the companies is able to achieve a target this is clearly suggesting that the 'notional' company would need to achieve frontier shift, rather than catch-up efficiency to meet the Performance Commitment.

Overall, we agree with Ofwat's economic advisors that there is an overlap between frontier shift and Ofwat's outcomes targets; and believe that the observed data shows clearly that the calibration of the Performance Commitment regime is requiring companies to achieve frontier shift efficiency. Ofwat should take this into consideration as a factor which implies that it should aim down from the benchmarks taken from the analysis of the EU KLEMS data.

### Summary of our request for FD

We ask Ofwat to reconsider its frontier shift assumption and come to a more balanced conclusion which takes account of all the available evidence.

## 6.2. Real price effects (RPEs)

Ofwat proposes an RPE mechanism for labour and energy inflation (both ex-ante allowance and a true-up); a true-up mechanism for material price inflation on enhancement expenditure only, and no allowance or true-up for chemicals inflation over and above CPIH.

We welcome the additional inflation protection at PR24. These are costs that are largely beyond companies' control. We make three representations in this area. We consider that:

- Ofwat's choice of forecast energy prices is inappropriate;
- Chemicals should have an RPE mechanism; and
- The true-up for materials should apply to totex, not only to enhancement costs.

### The energy base adjustment mechanism

Ofwat introduced a mechanism whereby it provides an ex-ante allowance for energy inflation made up of un uplift to ensure the allowance is anchored to energy prices of 2023/24 and an RPE allowance based on forecast energy inflation over and above the CPIH during AMP8. The ex-ante allowance is complemented by a true-up mechanism at the end of the AMP.

We welcome the principles of the mechanism that Ofwat proposes, however, we first disagree with Ofwat's choice of energy inflation forecasts to calculate the ex-ante allowance and the calculation of the pre adjustment energy costs, and second believe the introduction of an annual true-up mechanism would be more appropriate.

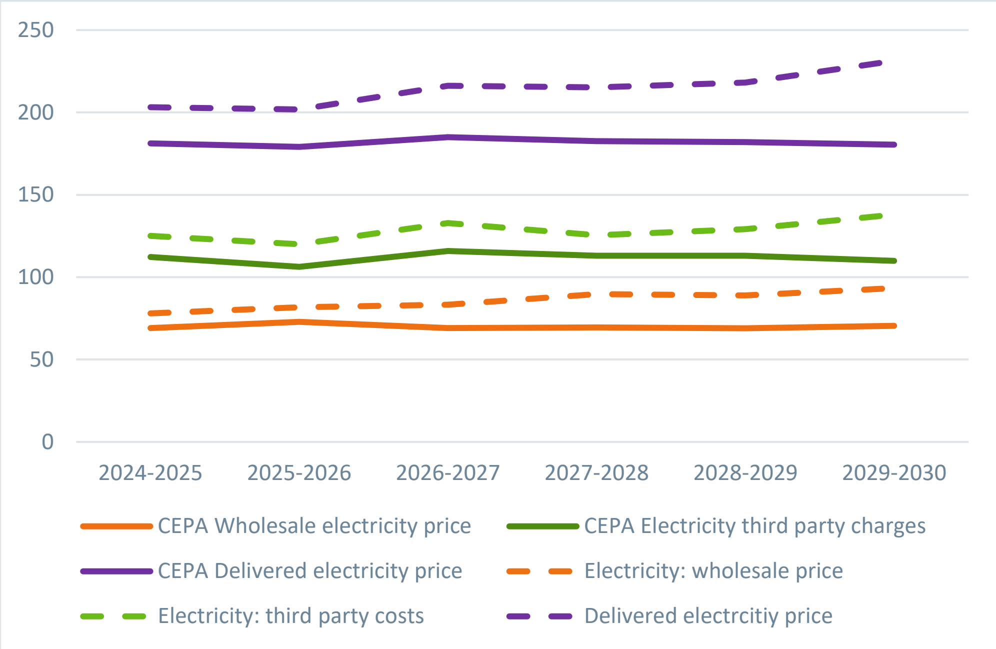
Ofwat uses energy prices based on Bloomberg indices as of March 2024 (following the advice of its consultants, *Frontier Shift, Real Price Effects and the energy crisis cost adjustment mechanism* CEPA 28th June 2024 p92 and Table 5.7 p93)[24]. We suggest this is creates unnecessary cash flow risks.

Our review of the forecasts produced by CEPA suggests that they are low relative to other market forecasts and create a significant risk of a negative cashflow impact for companies against what is predicted to be spent. We also note that there is significant uncertainty regarding energy forecasts. A more robust approach would be to triangulate more forecasts. This can be achieved by taking the average of consultants' forecasts including Cornwall, Aurora, Baringa and AFRY. This would account for a wider market view and reduce the forecasting error risk associated with relying on a single forecast. We outline the type of methodology that is required in Annex 2.

[24] Frontier Shift, Real Price Effects and the energy crisis cost adjustment mechanism (ofwat.gov.uk)

Figure 18 compares our own forecasts based on a number of industry providers[25] with the forecasts proposed by Ofwat at draft determinations (CEPA Table 5.7 p93). Ofwat's forecasts are comparatively lower. The difference in forecast prices widens from 2028.

*Figure 18: A comparison between Ofwat's and Thames Water's forecast of energy prices*




The difference in forecasts translates to a material impact on RPEs. By multiplying the difference in forecasts by our energy volume we find an impact of £178m on the RPE allowance for AMP8. This is shown in Figure 19. The impact is such that the ex-ante allowance turns from negative to positive.

*Figure 19: The financial impact on RPEs of using Thames Water's forecast energy prices instead of Ofwat's proposed energy prices*

| | 2024-2025 | 2025-2026 | 2026-2027 | 2027-2028 | 2028-2029 | 2029-2030 |
|---|---|---|---|---|---|---|
| Delivered electricity prices | 20.0 | 20.1 | 28.6 | 29.9 | 33.1 | 46.6 |
| Third Party Charges | 11.9 | 12.6 | 15.6 | 11.3 | 14.8 | 25.6 |
| Wholesale electricity prices | 8.1 | 8.2 | 13.0 | 18.6 | 18.3 | 21.0 |

We recognise that the end of period true-up will reconcile the ex-ante RPE allowance to outturn prices, however the impact of selecting RPEs based on a low forecast of energy prices has material cashflow implications given that the true-up is at the end of the AMP rather than annual. An annual true-up would also mitigate the risk of customers receiving a significant step change in bills at the end of AMP8, should the true-up be significant.

[25] Thames forecast published on the 24/7/2024 using a blended from Cornwall 3/7/2024; Aurora (and our supplier's customer position report (17/07/2024). CEPA took their forecast on 29/03/2024. Furthermore, Bloomberg forward prices on 20/8/2024 are about 30% higher than the CEPA forecast.

### Forecasting energy prices is increasingly difficult in AMP8

Energy is not as forecastable as it once was going into AMP8, which will be affected by the government's Review of Electricity Market Arrangements (REMA), increased use of Power Purchase Agreements (PPAs) and higher penetration of renewable power on Contracts for Difference (CfDs) or their successors. Figure 20 details the new forecasting challenges for electricity prices in AMP8.

*Figure 20: Forecasting challenges in AMP8*

| Driver | Additional risk relative to PR19 | How it works on prices | Impact on ability to forecast |
|---|---|---|---|
| LNG | Piracy/ LNG terminal congestion/ average age of fleet/ global new terminal building. | Disruption to LNG delivery causes shortfall for marginal generation or heating load. In the summer for example LNG can be around 4% of total supply but these small volumes will set market prices. | Market reaction across the curve likely linked to the extent that market participants think these events will be repeated in the future.<br>A second factor is the extent to which the market believes any mitigations in place (e.g. naval blockade/ congestion auctions) will work. |
| Weather | Northern / Southern hemisphere seasonal weather creating competition for LNG. | Creates higher prices- buying for storage- buying for winter or lower prices if mild winter in both north and south. | May encourage seasonal arbitrage and fuel speculative trades leading to increased volatility. |
| Network | New patterns of congestion due to renewables. | Will have an impact on settlement prices and despatch opportunities. | Long-term impact on delivered costs. Any congestion may have an impact on dispatch. |
| Settlement | Negative prices/ very high spikes. | The problem existed before the Ukrainian crisis. | Likely to reward flexible demand side response and penalise inflexible 'peaky' demand. |
| Wholesale | Wholesale prices no longer relevant. | CfD and PPA plant taken out of the commodity markets | Will make forecasting much harder as prices represent small volumes. |
| Regulatory | REMA (Reform of Electricity Market Arrangements). | Potential to alter market design itself | Long term impact on commodity markets' relevance to energy costs. |

In light of the difficulty in forecasting energy prices in AMP8, we consider that an annual true-up is more appropriate than at the end of the AMP to reduce the impact of the almost inevitable forecasting error on both companies' balance sheet and consumer bills.

### Efficient Spend, company average cost share and uplift factors

In calculating efficient spend, CEPA uses the water company's average share of its total costs. It states in Table 5.5 that Ofwat will 'multiply modelled efficient costs by a company average energy cost share based on outturn data.' We would like more detail on how this will work. CEPA's report itself provides some persuasive evidence of both the spread of prices, which casts doubt on the credibility of claiming the prices presented to us are truly the result of efficient spend (or as CEPA put it 'modelled efficient base totex' (CEPA p34). Taking each point in turn:

First, there is a significant spread in prices depending on different consumption levels according to DESNZ. This is set out for large, very large and extra-large user energy price indices in Table 2.11 and Table 2.12 of CEPA's report (p38 and p39). It follows that companies with different consumption levels are at risk of being unfairly penalised or rewarded, when it comes to allowance allocation even before they start to implement an energy purchasing strategy.

Second, differences in the spread between energy spend as a percentage of base costs is substantial. There is a 15 percentage point spread between the highest and lowest company costs in wholesale water and up to 19 percentage points in wastewater (Figure 2.3, p20 of CEPA's report).

Third we contend the differences cannot be due only to different levels of efficiency in energy costs between companies, as implied in steps one and two of the proposed post-modelling adjustment (Figure 2.15 p34). We see the interaction of portfolio, location, contractual expiry date, location, volume and risk aversion profile being component drivers of energy costs. Furthermore, energy buying inevitably leads to trade-offs between risk and reward appetite that are contained in a purchasing strategy.

Finally, differences in company performance might equally be down to pure luck which cannot be claimed to be either efficient or under management control.

We would ask that:

- Consideration be given to differences in prices between consumption bands as defined in the DESNZ index in the proposed true up mechanism and any assessment of efficient spend in setting future allowances.
- Consideration given to the drivers of energy buying not related to purchasing strategy such as the characteristics of the individual water company listed above.
- An annual true up mechanism is introduced, which reduces the extent of the problems identified above.

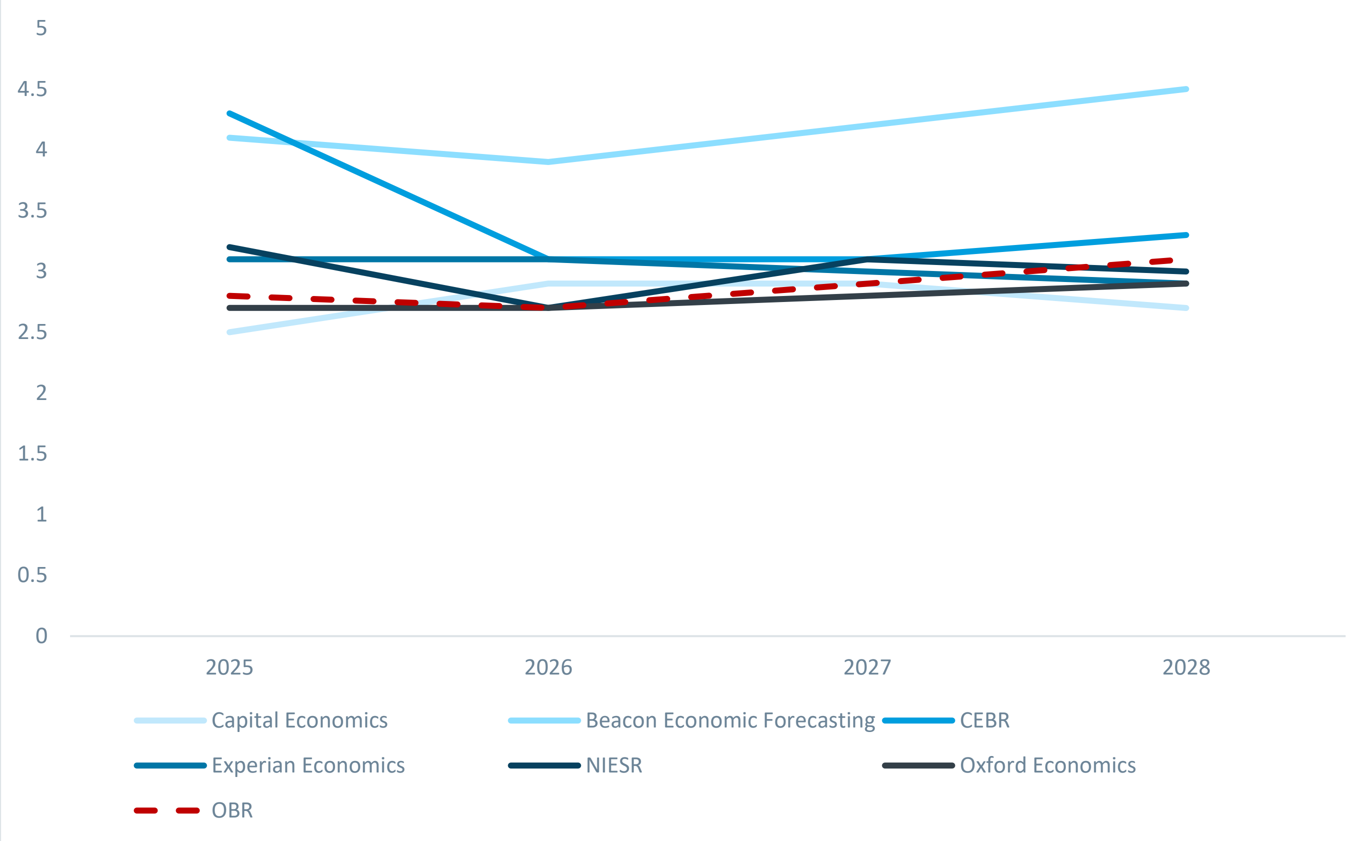
We believe an annual true-up will resolve many of the challenges. We also, however, support the proposals contained within Water UK's report 'Ofwat's PR24 Draft Determinations for the treatment of energy costs in AMP8 (Baringa 23rd August 2024) as an improvement on the Draft Determination proposals.

## Labour

We support the continuation of the true-up mechanism for the next AMP. We do however note that CEPA's medium-term wage forecasts appear to be at the lower end of what we take to be a "permissible range" of forecasts for the first three years of the control given the Treasury's survey of economic forecasts (May 2024[26]).

[26]https://assets.publishing.service.gov.uk/media/664347aaf34f9b5a56adc6aa/Forecasts_for_the_UK_economy_-_May__with_cover_.pdf

*Figure 21: Earnings forecasts to 2028 (%)*




## Chemicals

We believe Ofwat should introduce a true-up mechanism for chemicals.

Chemicals are material as a proportion of companies' costs. We disagree with setting a materiality threshold of 10%. We do not understand the rationale for setting a high materiality threshold in an area where there is no information asymmetry, and a true-up mechanism does not require disproportionate effort. While its proportion may be below the arbitrary 10% threshold now, the true-up is needed precisely for situation where chemical costs spike, in which case their share would exceed 10% (we also believe the true-up mechanism is appropriate also to protect customers should chemicals cost fall significantly). Moreover, chemicals represent a significant proportion of costs specifically within the bioresources control.

Energy is a big cost driver for chemicals. For example, one of our chemicals contracts for liquid oxygen is linked to day-ahead energy prices. Since chemicals costs are likely to move with energy prices, a similar rationale to the energy costs uncertainty mechanism proposed by Ofwat should apply to chemicals costs.

There are several commercial chemical price indices available[27] that could be suitable for creating a basket of chemicals relevant to water companies. This can be complemented by

[27]For example ICICs Chemicals, Chemical Week, Chemical industries Association Quarterly Economic Report

ONS statistics of producer price inflation[28], which can be also used to track chemical input costs.

### Materials

We support the proposed true-up mechanism for materials prices for enhancements. However, we are of the view that the Construction Output Price Indices (COPI) is not a suitable index. We suggest that other indices would be more appropriate to use to create a reference index as[29] COPI is an output price index, rather than an input price index. The proposal has the effect of double counting the productivity growth already factored into the separate frontier shift challenge.

We further consider that an ex-ante RPE component is appropriate for materials in base costs. None of the underlying issues that warranted an ex-ante allowance for materials for enhancement investment, is different in the case of base cost materials.

Ofwat's claim that long term framework contracts protect water companies from price volatility can be challenged. Long term frameworks with suppliers can be the result of preclearance processes for bid qualification for contracts under procurement policies, and in some case part of our regulated bid assessment frameworks and more generally Utilities Contract Regulations 2016 (Section 51). The contracts ease transaction costs in procuring the products but have no role in reducing volatility of prices.

## 6.3. Net zero base adjustment

### Brief outline of Ofwat's position

The net zero cost adjustment is intended to enable companies to invest in the infrastructure needed to allow the adoption of low carbon technologies critical to the reduction of greenhouse gas (GHG) emissions from the use of vehicles and heating. Ofwat benchmarked companies submitted scheme benefits for these technologies, and applied the median reduction in tonnes of $CO_2e$ (-2.5% for water and -2.5% for wastewater) to all companies to arrive at the benefits companies are expected to deliver through the net zero base cost adjustment.

The median unit cost of carbon (£757.82 per tonne) was used to determine the cost adjustment for each company, which equates to £9.96m of base adjustment for Thames Water.

### TMS argument and supporting evidence

Ofwat's allowance is insufficient to deliver the 2.5% stretch target from base and enable the transition to low carbon vehicles and heating.

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28 Producer price inflation within that ONS 7112200000: Chemicals and Chemical Products

29 For example using certain tables in the Building materials and component statistics and not include kitchen furniture but include concrete and pipes and fittings https://www.gov.uk/government/statistics/building-materials-and-components-statistics-june-2024 Also commercial indices IBIS World UK stats should usefully be used Construction Materials Price Index - United Kingdom | IBISWorld

Decarbonisation of vehicles and heating is central to our decarbonisation strategy and if fully funded, we forecast that adopting these technologies could deliver 7,748 tonnes of $CO_2e$ reduction in 2029-30. Our submission to the Net Zero challenge fund set out the significant additional costs associated with implementing low carbon vehicles and heating. Thames Water requested additional funding of £41m; £35m to enable decarbonisation of vehicles, and £6m for decarbonisation of office heating. The £10m proposed falls far short of what we believe is necessary to implement these low carbon technologies. Further, the 2.5% stretch target exceeds what we believe can be achieved if these schemes were fully funded.

*Figure 22: AMP8 Capex, Opex and carbon savings from decarbonising vehicles and office heating*

| Schemes | AMP8 Capex Total £m | AMP8 Opex Total £m | 2029/30 annual carbon savings $tCO_2e$ | 2030/31 annual carbon savings $tCO_2e$ |
|---|---|---|---|---|
| Decarbonisation of vehicles<br>Replacement of life expired vehicles with low carbon alternatives. | £40.565m | -£5.881m | 6,669 | 7,702 |
| Decarbonisation of office heating<br>Replacement of fossil fuel office boilers with low carbon alternatives. | £5.906m | £0.013m | 1,079 | 1,612 |

## Ofwat's funding and target allocations within base are not appropriate

We disagree with Ofwat's approach of only providing additional base expenditure for EV infrastructure while considering EV vehicle purchase as business-as-usual expenditure. The cost of EVs is significantly higher than their internal combustion engine (ICE) counterparts, and therefore cannot be funded on a like-for-like basis through base expenditure.

Since our PR24 submission, we have continued to engage with suppliers of Electric Vehicles and have gained further evidence of relative costs. Figure 23 below summarises pricings provided by a manufacturer in August 2024. This demonstrates that electric vans are typically 35% more expensive than their internal combustion engine (ICE) counterparts.

We recognise that there are expected savings within operational expenditure (deducted in our Net Zero challenge fund bid), arising from the cost differential of well procured electricity and fossil fuels. Further savings, for example from vehicle maintenance costs, have not been substantiable. Furthermore, the projected opex savings do not exceed the cost uplift of EV's over their lifetime and therefore additional totex is required. As additional totex for EVs has not been allowed, we cannot invest in low carbon vehicles and meet our emissions targets.

*Figure 23: Vehicle costs*

| | Small Van | | Medium Van | | Large Van | |
|---|---|---|---|---|---|---|
| Vehicle Category | ICE | EV | ICE | EV | ICE | EV |
| Vehicle Purchase Cost | £22,000 | £33,000 | £33,000 | £49,000 | £49,000 | £59,000 |
| Racking, Livery & Telematics | £9,530 | £9,530 | £12,160 | £12,160 | £15,670 | £15,670 |
| *Total Purchase Cost* | £31,530 | £42,530<br>+35% | £45,160 | £61,160<br>+35% | £64,670 | £74,670<br>+15% |

We do not support the way our response to query OFW-OBQ-TMS-183 has been applied. Whilst for accounting purposes, carbon benefits were split 50:50 between electric vehicles and charging infrastructure, it is clear that they are mutually dependent – without EVs, there is very limited benefit to EV chargers. Ofwat acknowledges the additional costs of EV infrastructure and recognises that without charging infrastructure companies cannot transition their fleet to EV's. However, the additional cost of EVs has not be recognised, and without funding for EVs companies cannot transition their fleet.

### Ofwat's industry-wide unit cost does not enable the required transition.

Ofwat identify a median cost of £757.82 per tonne of $CO_2e$ to achieve an emissions reduction of 2.5%. This unit cost is materially lower than that outlined by companies who set out the full cost of a low carbon transition in their bids. Submissions to the Net Zero Challenge fund from ANH, HDD and TMS demonstrate a median cost uplift of £1,583/t for low carbon vehicles, and £1,763/t for low carbon heating.

We firmly believe that fully funding the cost uplift of EVs and their associated infrastructure is the right approach to enable companies to reduce emissions they have direct control over as rapidly as reasonably practicable during 2025-2030. It is also required to achieve the PCL targets set. We ask that the base cost adjustment is revised to include the full cost uplift of low carbon fleet and heating. We also note that Ofgem allowed additional capex for Electric Vehicles at RIIO-2. [30]

### PCL

The £10m proposed falls far short of what we believe is necessary to implement low carbon vehicles and heating. Further, the 2.5% stretch target set exceeds what we believe can be achieved if these schemes were fully funded. The further stretch of 2.5% applied to water is unfunded, and as a point of principle, we are not comfortable with Ofwat's suggestion that performance from totex should not deteriorate or allow increases in emissions.

If our funding request for low carbon vehicles and heating, set out in our Net Zero Challenge fund, is met, we are happy to accept the additional stretch percentage applied in the draft determination. In the event that this funding request is not met, our emissions targets should be adjusted accordingly. Specifically, this would mean reversing the 2.5% challenge Ofwat has applied or only applying a stretch associated with low carbon heating (a reduction of 1,612 tonnes of CO2e in 2029-30).

### How we would spend the base cost adjustment

We outline two potential scenarios for how we would spend the base cost adjustment, that we would further define dependent on the outcome to this representation:

[30] For example Figure 94 in Cadent Gas's Final Determination shows Electric Vehicle allowances of £5.7m, £3.8m, £3.9m and £2.8m for each of its four regions. Figure 95 explains that unit costs specific for EVs were used to set these allowances.

1. Increase base cost adjustment – *if our funding request for low carbon vehicles and heating, set out in our Net Zero Challenge fund is met, this would enable a transition of life expired vehicles from ICE to EV over the period 2025-2030, and transition to low carbon heating in corporate offices.*
2. Invest in low carbon heating – *if our funding request for low carbon vehicles and heating, set out in our Net Zero Challenge fund, is not met, we would not be sufficiently funded to transition to EV's. Without funding for EV's there would be limited value in EV chargers. Therefore, we would prioritise low carbon heating.*

We do not consider a small or regionalised roll out of EVs and charging infrastructure to be an efficient option if the base cost adjustment remains unchanged. This is due to inefficiencies associated with procuring, operating and maintaining both ICE and EV vehicles and the associated management and systemisation challenges. There would be no benefit in a EV charging infrastructure roll out without EV's, as the charging infrastructure would be unused or highly underutilised, and potentially redundant by the time an EV transition was fundable.

### Summary of our request for FD

We request Ofwat to:

- Reconsider the principle that performance from totex should not deteriorate or allow increases in emissions and reverse the 2.5% challenge applied to water
- Reconsider its position on funding of electric vehicles as business-as-usual cost
- Meet our funding request for low carbon vehicles and heating, set out in our Net Zero Challenge fund
- If our funding request is met, we are happy to accept the additional stretch percentage applied in the draft determination. If TMS allowance is to remain at £10m, we propose reversing the 2.5% and only applying a stretch associated with low carbon heating (a reduction of 1,612 tonnes of $CO_2e$ in 2029-30), and/or we would be happy to work with Ofwat on a revised target.

# 7. New expenditure mid-control and uncertainty

A crucial challenge for the price control relates to how significant new expenditure will be treated mid-control. There is a credible risk that any assumptions made about expenditure in the PR24 framework will be underestimated due to regulatory change that is set to be enacted. There are two areas where this is expected to happen in some form or other: landbank availability for sludge disposal; and changes to PFAS (Perfluoroalkyl and polyfluoroalkyl substances) regulations.

We set out further details in TMS-DD-041 (Risk and Return).

## 7.1. Landbank availability for sludge disposal

We welcome the proposals for using a "Notified Item on any increase in costs to bioresources reasonably attributable to any new or changed legal requirements in relation to the application to agricultural land of fertiliser derived from sludge over the 2025-26 to 2029-30 period." (p89 Expenditure Allowances). We ask Ofwat to carefully consider definitions of trigger events, materiality thresholds and the timing of any likely market response to ensure the mechanism provides adequate protections.

## 7.2. PFAS

The removal of PFAS substances from the drinking water supply is likely to become an issue that will require further investment. This is not included in our business plan as both the knowledge of the issues and subsequent regulation has not been developed. If an aggressive implementation plan is required, this will play a part in the costs we may face.

We consider it would be appropriate to introduce an uncertainty mechanism, possibly in the form of Notified Item, in respect of any additional costs incurred during the charging period that are reasonably attributable to any new or amended regulatory or legal requirements/guidance in relation to the assessment, monitoring and reporting, mitigation or removal of PFAS in/from its water supply systems.

We encourage Ofwat to work with the sector to ensure that any PFAS-related costs are appropriately reflected in its Final Determination.

# 8. Cost adjustment claims

## 8.1. Mains renewal

### Brief outline of Ofwat’s position

We put forward a stretching but achievable plan to deliver 500km of mains rehabilitation in AMP8 (over two times the amount we will deliver during AMP7) for £999 per metre in Thames Valley and £1,458 per metre in London (an average combined unit rate of £1229 per metre). We calculated that base allowance may be able to fund 0.17% of our mains replacement programme and removed it from the net value of the CAC.

Ofwat’s Draft Determination require us to deliver circa 700km (which is more than 3 times the amount we will have delivered during AMP7) for £292 per metre in Thames Valley and £439 per metre in London (a combined unit rate of £392 per metre). This equates to an c. 70% reduction on our proposed unit rates, which are based on the current unit rates we are experiencing during AMP7. Ofwat also determines that base allowance allows us to replace 0.3% of mains per year.

Below we set out our representations in three areas:

1. **What base buys**: we set out our concerns with Ofwat’s approach to estimating what base buys and suggest alternative approaches.
2. **Unit cost**: we provide evidence to support our proposed unit costs.
3. **Volume of programme**: we propose to extend our programme from 500km to 553km. We set out why delivering 700km is not achievable for us in AMP8.

### Thames Water argument and supporting evidence

*What base buys*

**Ofwat’s approach to calculating what base buys is inconsistent between mains renewal and setting performance commitments**

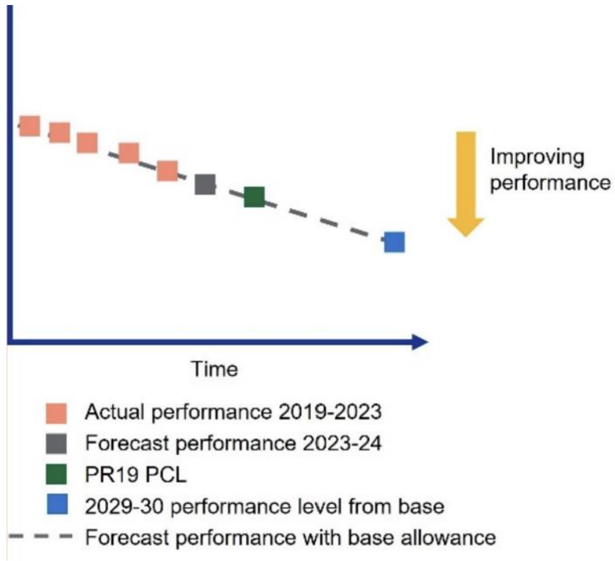
Ofwat’s approach to deriving ‘what base buys’ for mains renewal is inconsistent with its approach to calculating what base buys for performance commitments.

In setting what base buys for mains renewal, Ofwat calculates the average renewal rates over all years in the sample period (2011/12 - 2022/23) and across all years and companies. Ofwat uses this average, which is 0.30% per year, as the assumption for what base buys.

In setting performance commitment levels (PCLs), Ofwat does not simply take the average historical performance achieved by companies over the sample period. Instead, Ofwat considers what performance could be achieved from base in AMP8 given companies ongoing improvement in performance.

Ofwat’s PR24 methodology makes clear that performance commitments to be delivered from base (i.e., performance level that ‘base buys’) would be derived considering the levels of historical performance as well as the trend in performance observed over time. Figure 24, taken from Ofwat's document[31] illustrates this approach.

*Figure 24: Common performance levels - what base buys example (Ofwat)*




Source: Ofwat, Assessing base costs at PR24, December 2021

In its final methodology for PR24 Ofwat states 'performance is on an improving trend for the three common asset health performance commitments at PR19 (mains repairs / bursts, unplanned outage and sewer collapses)' and consequently explicitly states 'we expect companies to continue to make improvements from base expenditure in the future'.[32]

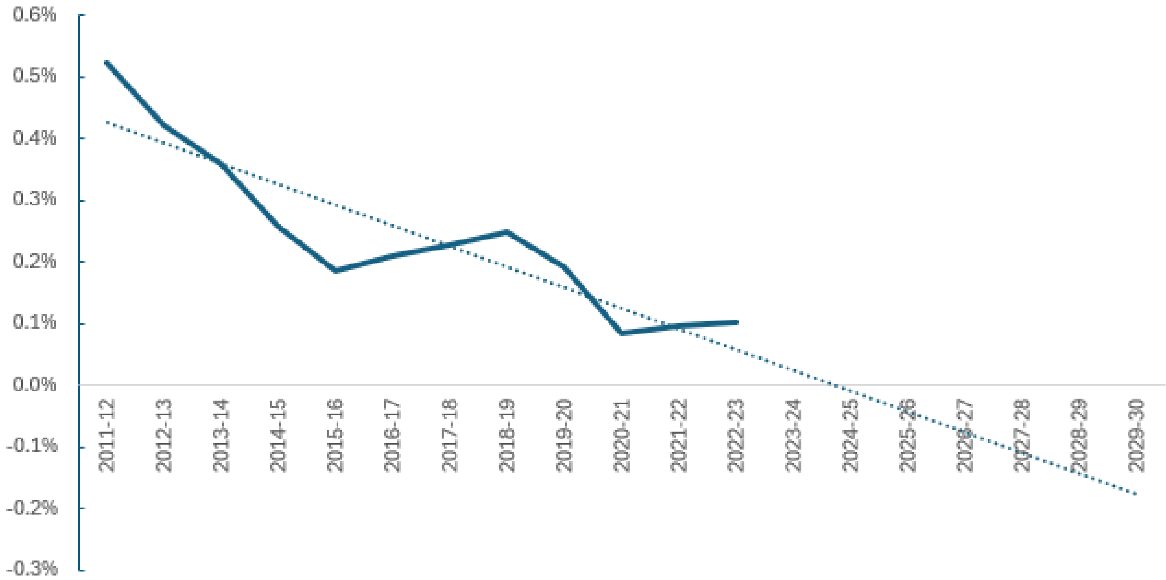
To set PCLs at draft determinations, Ofwat uses a combination of outturn and PR19 forecast performance to assess how upper quartile performance has improved over time. Ofwat then uses this estimated relationship to project forward to the expected 2029-30 level.

For example, for supply interruptions the average performance achieved from base across all companies during the sample period is 00:16:39. Ofwat could have concluded that this is the performance that base buys in a similar way to its approach for mains renewal. Instead, Ofwat extrapolated historical trends to determine that base buys a performance of 00:05:00, and has proposed it as the PCL for supply interruptions.

For mains renewal industry data shows a clear downward trend in the annual rates of mains renewal funded from base allowance (Figure 25). In determining what base buys for mains renewal Ofwat deviates from the approach applied to outcomes by disregarding the observed trend. Extrapolating the historical trend generates negative values for the AMP8 period.

[31] Assessing base costs, Ofwat, December 2021 (https://www.ofwat.gov.uk/wp-content/uploads/2021/12/Assessing-base-costs-at_PR24.pdf
[32] Appendix 9, Setting expenditure allowances, Ofwat December 2022 section 3.4.1.

*Figure 25: Linear extrapolation of the trend in the mains renewals rate achieve from base*




Source: Thames Water analysis of *Mains renewal cost adjustment model* (PR24, Draft Determinations)

We would expect Ofwat to consider the declining trends when estimating what base buys for mains renewal, which is essential for the setting of stretching but achievable performance targets.

### The unweighted averaging of historical renewal rates provides an inaccurate representation of what base buys

To calculate what base buys Ofwat averages companies' renewal rates over the sample period. Each year and each company get the same weight in the calculation of the average. We consider that this is flawed for two reasons:

- **It is not the renewal rate that matters but rather the renewal length.** For example, if a small company such as Portsmouth replaces 0.54% of its assets, which is 196km, it would not allow a large company to replace 0.5% of its assets as well – 196km of assets represents a much small proportion for the large company. Rather than an unweighted average of annual renewal rates across companies, a weighted average is appropriate. The renewal rates must be weighted by the companies' total length of mains/pipes. Re-calculating the industry average in this way produces an asset replacement rate of 0.24%.
- **Renewal rates do not consider the type of assets being renewed.** Companies whose network largely comprises of smaller diameter pipes would face lower renewal cost per/km and would therefore be able to achieve higher renewal rates from the available funding. The opposite applies to companies needing to replace a high proportion of large diameter pipes.

Figure 26 shows that companies such as Thames Water, United Utilities and South Staffs have a significantly higher proportion of large-size pipes than companies such as Northumbrian Water, South Wast Water and Wessex Water (let alone HDD, which contributes a high renewals rate to the calculation of what base buys). As larger pipes are more expensive to replace, this information should feed into the calculation of what base buys.

*Figure 26: Network pipe composition by diameter*

| | ≤320mm | >320mm and ≤ 450mm | >450mm and ≤610mm | > 610mm |
|---|---|---|---|---|
| AFW | 92.3% | 3.7% | 2.9% | 1.1% |
| ANH | 92.3% | 4.4% | 1.7% | 1.6% |
| BRL | 92.0% | 3.7% | 2.6% | 1.7% |
| HDD | 96.4% | 3.0% | 0.6% | 0.0% |
| NES | 97.4% | 1.6% | 0.5% | 0.6% |
| NWT | 91.4% | 2.9% | 2.4% | 3.3% |
| PRT | 89.4% | 4.5% | 4.4% | 1.7% |
| SES | 91.5% | 5.0% | 2.0% | 1.5% |
| SEW | 94.1% | 3.2% | 2.0% | 0.7% |
| SSC | 88.6% | 3.8% | 3.8% | 3.9% |
| SVE | 91.9% | 4.1% | 1.9% | 2.2% |
| SWB | 94.2% | 3.1% | 2.0% | 0.6% |
| TMS | 90.4% | 2.9% | 3.4% | 3.2% |
| WSH | 93.2% | 3.3% | 1.9% | 1.6% |
| WSX | 92.0% | 4.7% | 2.6% | 0.7% |
| YKY | 92.7% | 3.1% | 2.6% | 1.6% |

*Source: Thames Water analysis based on 2022-23 APR data tables, Table 6C: Water network+ - Mains, communication pipes and other data*

Based on the arguments presented above, we ask Ofwat to revert to our proposed rate of 0.17% for mains renewals to be achieved from base funding. This is based on the average of our renewals rate over the sample period and is in line with the industry average rate of mains renewals over 2019/20-2022/23.

## Unit cost

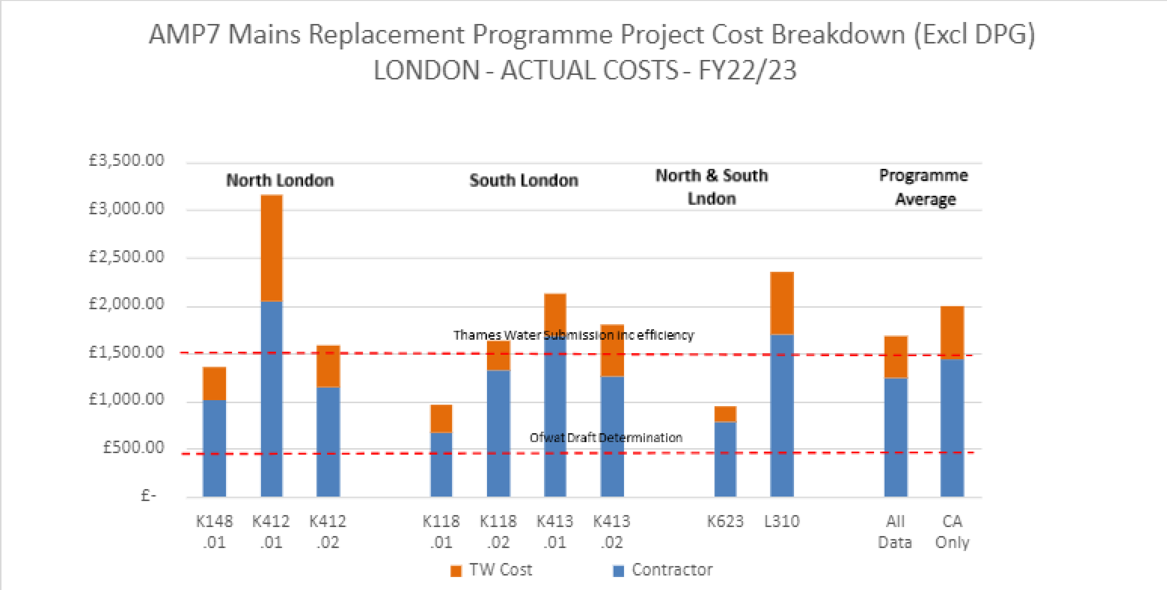
The unit cost proposed by Ofwat in the Draft Determination (£292 per metre in Thames Valley and £439 per metre in London) is too low and does not reflect the reality of the current cost of mains replacement within our operating area.

We based the unit rates proposed in our initial submission on the current costs we were experiencing during AMP7 at the time of submission and applied an efficiency challenge.

During AMP7 we have carried out a replacement programme of c. 220km. Over 100km of this has been delivered as part of the London Water Improvement Conditional Allowance (LWICA). This work has been subject to external assurance and approval by Ofwat. Ofwat has approved the delivery of mains rehabilitation schemes in London at much higher unit rates than the rates it is proposing at draft determinations. During site visits Ofwat saw first-hand the complexity of delivering these schemes in London. The programme is reported on a quarterly basis to Ofwat.

The project costs we have experienced in both London and Thames Valley have been significantly higher than those proposed by Ofwat in the draft determination. A breakdown of the AMP7 costs of our mains replacement programme in London is presented in Figure 27Figure 27 below. These reflect the most up-to-date view of our unit costs.

*Figure 27: AMP7 Mains Replacement Programme Project Cost Breakdown (Excl. D&PG) - London Actual Costs - FY22/23*




*Source: Thames Water internal data*

The current AMP7 average unit rate in London in FY22/23 is £1,684 per metre (almost four times the rate allowed by Ofwat in the draft determination). If we were to consider only those projects that have been approved by Ofwat through the gated process of LWICA, this average unit rate increases to £1,993 per metre in FY22/23 (approximately 4.5 times the rate allowed by Ofwat in the draft determination).

The cost is influenced by several factors outside our management control including (but not limited to):

- Complex construction technique - which in London is biased towards open-cut at 85%.
- Communication pipe density - comms pipes are typically replaced 1 in every 8-10m.
- High lane rental charges - this can vary between £1,000 to £2,500 (central London) per day.
- Size of pipes - 85% of the pipes we replace are greater than 100mm, with 23% greater than 150mm (Figure 28 below)

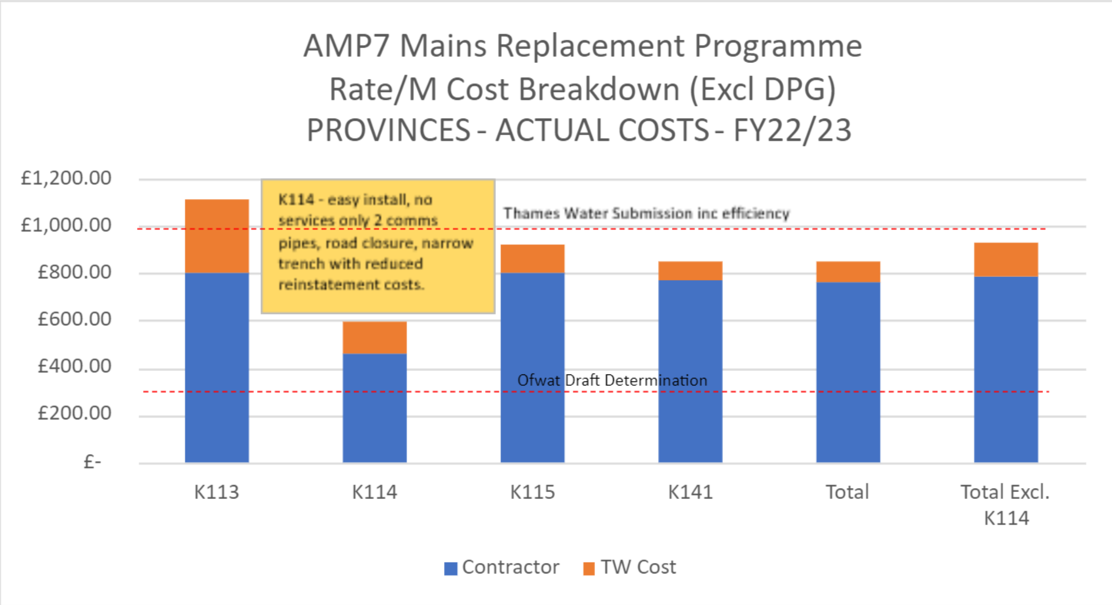
*Figure 28: FY22/23 Mains Replacement Programme in London*

| Diameter (mm) | <100 | >100 to 150 | >150 to 200 | >200 to 250 | >250 to 300 | > 300 |
|---|---|---|---|---|---|---|
| Length (km) | 11.15 | 76.04 | 19.16 | 3.35 | 0.58 | 2.83 |
| %age | 9.9% | 67.2% | 16.9% | 3.0% | 0.5% | 2.5% |

Source: Contractor data at time of compiling

Similarly, a breakdown of the AMP7 costs of mains replacement programme in Thames Valley is presented in Figure 29 below.

*Figure 29: AMP7 Mains Replacement Programme Project Cost Breakdown (Excl. D&PG) - Thames Valley Actual Costs - FY22/23*




The current AMP7 average unit rate in Thames Valley in FY22/23 is £933 per metre (over three times the rate allowed by Ofwat in the draft determination). This average excludes our project K114, which was an outlier for delivery due to project simplicity. The latest data indicates that we are seeing an improved rate per metre from our original submission of £999, which is due to the increase of no-dig techniques to 30%.

Again, the cost is influenced by several factors outside our management control including (but not limited to):

- Complex construction technique - which in Thames Valley is biased towards open-cut at 70% .
- Communication pipe density - comms pipes are typically replaced 1 in every 10m.
- Size of pipes - 78% of the pipes we replace are greater than 100mm, with 25% greater than 150mm (Figure 30 below)

*Figure 30: FY22/23 Mains Replacement Programme in Thames Valley*

**Provinces (Diameter Splits)**

| Diameter (mm) | <100 | >100 to 150 | >150 to 200 | >200 to 250 | >250 to 300 |
|---|---|---|---|---|---|
| Length (km) | 7.72 | 18.39 | 6.67 | 1.67 | 0.43 |
| %age | 22.1% | 52.5% | 19.0% | 4.8% | 1.2% |

Source: Contractor data at time of compiling

We described in detail our approach to securing Value for Money as part of our Gate 2 submission for the London Water Infrastructure Conditional Allowance (see TMS-DD-085: LWI.G2.A3 - Procurement and Value for Money Approach). All key elements of our mains replacement supply chain have been selected via a tender process compliant with Utilities Contract Regulations 2016. Our approach ensures multiple supply chain options are available to ensure the route selected offers best value for a particular project. Our supply chain model creates competitive tension, as well as incentivising contractors to maximise the value they deliver for Thames Water and our customers whilst, also ensuring there is enough capacity in the strategic supply chain to deliver programme requirements.

During AMP7 we have awarded work to three main contractors, 2 from our FA1495 Geographic Frameworks and one from our FA1488 Thames Wide Frameworks. The scope has been a mixture of burst rate driven, water quality and whole DMA replacement. Individual scope items have been bundled together prior to contract award to provide further efficiencies such that the entire AMP delivery encompassing some 520 individual schemes will be made through 20 individual contracts, with an average contract value of approximately £15m. Prior to the award of each of these contracts the contractor's proposed target cost is scrutinised against the Engineering Estimating System benchmark costs based on the detailed scope of the works and location to ensure value for money. Furthermore, the target cost submissions and value for money analysis for the 6 contracts awarded to deliver the LWICA funded Mains Replacement scope were audited and independently assured by Arup.

We recognise that costs have increased significantly during AMP7. The escalation of mains replacement unit costs were supressed at the start of AMP7, because of existing contractual arrangements used at the time. Our contracts are actual cost contracts with the contractors incentivised by a pain/gain mechanism applied to proposed costs and agreed at the time of award.

Much of the early AMP7 delivery was contracted prior to the start of AMP7, before anyone in the industry was aware of the extraordinary inflation of the past few years. As a result, all the initial contracts have concluded with the contractor absorbing the inflationary impact, and consequently we have not paid the true costs of these schemes. This suppresses the increase in mains replacement unit costs over the early part of AMP7.

More recent delivery has been contracted after the occurrence of the extraordinary inflation and consequently these factors have been included in the later proposed costs. This has resulted in a significant increase in the AMP8 £/m unit rates.

## Deliverability

We agree that we should challenge ourselves further to deliver more. However, we do not believe 700km to be deliverable in AMP8 for reasons we set out below.

By the end of AMP7 we will have installed circa 220km of new distribution mains and replaced approximately 120km of communication pipes across London and Thames Valley.
This has been a challenging programme to deliver due to:

- supply chain constraints.
- third party restrictions
- our chosen methodology to deliver the best value programme for our customers.

<u>Supply chain constraints</u>

We currently have three main contractors delivering the mains replacement programme this AMP and approximately 50 gangs working across London and Thames Valley. At the end of year 1 we only had 8 gangs operating after transitioning from our Alliance delivery model. Availability of high-quality gangs has been an issue and we've had to work with the supply chain to gradually increase these numbers and capability to current position.

We are also very concerned about the Health and Safety implications of ramping up too quickly with inexperienced gangs, with service strikes being the main concern.

We will be going into AMP8 in a good position with 50 high quality gangs operating but we will need to broaden our support from the supply chain considerably to deliver the AMP8 plan.

Third party restrictions

Local authority (LA) requirements have been a major contributor to the amount of distribution mains (and the cost) we've been able to install this AMP, particularly in central London. Requirements from the various Local Authorities vary significantly.

Below are examples of some of the requirements which significantly affect our productivity:

- Number of gangs operating in a DMA (ranges from 3 to 9)
- The LA not allowing road closures
- The amount of space we're allowed at any one time (ranges from 80m to 150m)
- Parking bay suspension charges vary considerably between LAs
- Red route / TFL restrictions and complex Traffic Management
- Works compound/pipe storage location restrictions
- Working hour restrictions
- Archaeological watching briefs
- UXO watching briefs

Methodology

As part of our mains replacement programme, we replace all communication pipes from the new main up to and including the boundary box. This includes the replacement of any lead comms pipes to address water quality concerns.

The replacement of comms pipes, whilst carrying out the main replacement programme, is deemed to be the most efficient and the least disruptive approach for our customers and delivers the long-term benefits required.

We also balance our mains replacement programme between whole DMA replacement (where we replace all the mains within a discrete area of the network that aren't already new plastic pipes) and 'burst driven' mains replacement (where we replace only the poorest performing spans of mains). The DMA programme approach we've adopted is based on the principle that the leakage benefit on the "Thames side" will be realised by replacement of both the distribution main and the comms pipe.

We understand that not all water companies adopt this approach, but we strongly believe this is the right approach for our customers. Taking this approach, together with capacity in the supply chain, restricts the amount of distribution mains we are able to replace.

As previously mentioned, we estimate we would have replaced 120km of communication pipes this AMP as well as the 220km of distribution mains.

We intend to continue with this approach, and this has been considered in the PR24 submission.

We propose to deliver 553km of mains replacement in AMP8 (375.34km in London and 177.66km in Thames Valley) at the unit rates we proposed in our original submission (£1458 per metre for London and £999 per metre for Thames Valley, equalling a combined unit rate of £1311 per metre), with an implicit allowance of 0.17% as per our original submission as well (split 50/50 London and Thames Valley).

We will therefore deliver 137.22km through base in both London and Thames Valley and will deliver 238.12km in London and 40.44km in Thames Valley through the cost adjustment claim. This reflects the percentage split of delivery between London and Thames Valley in Ofwat's draft determination.

The programme will be back-end loaded to allow the gradual ramp up of gangs required and put us in a good position to transition to deliver 1000km in AMP9.

*Figure 31: Thames Water Revised Proposal 22/23 Price Base excluding D&PG*

| | Length (km) | Unit Cost £ per metre | Total Spend £m |
|---|---|---|---|
| London | 375.34 | 1458 | 547.24 |
| Thames Valley | 177.66 | 999 | 177.49 |
| Combined | 553.00 | 1311 | 724.73 |

*Figure 32: Thames Water Revised proposal km base versus CAC*

| London Base (km) | London CAC (km) | Thames Valley Base (km) | Thames Valley CAC (km) |
|---|---|---|---|
| 137.22 | 238.12 | 137.22 | 40.44 |

*Figure 33:* Thames Water Revised Proposal Base versus CAC 22/23 Price Base excluding D&PG

| | km | £m |
|---|---|---|
| Base | 274.44 | 337.15 |
| CAC | 278.56 | 387.57 |
| Combined | 553.00 | 724.73 |

Our proposed programme of work is very stretching but deliverable, and is in the interest of customers. This work is in addition to the work we plan to complete in AMP8 as part of the London Water Improvement Conditional Allowance (LWICA), originally agreed in AMP7.

## Summary of our request for FD

- We request that Ofwat amends its calculation of what base buys and re-instates our rate of 0.17%.
- We request that Ofwat amends delivery requirement to our ambitious but deliverable target of 553km.
- Crucially, we request that Ofwat funds our mains replacement programme at a unit cost that is in line with our DD response submission.

## 8.2. Transience

### Brief outline of Ofwat's position

In PR19 Ofwat made some allowance for the costs associated with transience by capturing the effect of transience in the retail cost models. Ofwat decided to remove transience as a cost driver in the PR24 retail cost models, because it determined that 'transience does not have a material impact on bad debt costs'. As a result of this, Thames Water submitted a Cost Adjustment Claim (CAC) to enable us to recover the efficient retail costs related to transience.[33] In the Draft Determination, Ofwat rejected our transience CAC, stating that it failed both the 'need for adjustment' and 'cost efficiency' criteria.

### TMS argument and supporting evidence

We disagree with Ofwat's decision that the transience CAC fails these criteria. First, in relation to the 'need' for cost adjustment criteria, it is important to note upfront that the decision to remove transience from the cost models was motivated primarily by the discontinuation of the ONS' dataset on local area migration indicators the transience metric is based on; and Ofwat being unable to find a correctly signed and significant transience coefficient across its models. Ofwat itself noted at PR19 that 'there is strong economic and engineering rationale that transience affects efficient retail costs.'[34] There is no evidence that the engineering and economic rationale for how and why transience affects efficient retail costs has changed since PR19.

In addition, in Ofwat's assessment of our claim, it accepts that Thames has a significantly higher level of transience than the other water and sewerage companies: "*the data did show that Thames Water had the highest migration levels in the sector and is an outlier"*[35]. Ofwat also accepts that the level of transience is not controllable by management: *"Transience levels within companies' operating areas are outside of company control".*

Ofwat has accepted that there is a sound engineering and economic rationale that higher levels of transience are associated with higher retail costs. Ofwat has also accepted that Thames Water has the highest level of transience in the sector, and that the level of transience is outside of management control – we detailed the actions that we undertake to limit the impact of transience on costs in our original claim; these actions incur efficient costs which need to be recovered.

The three points above provide a compelling rationale for the need for the transience CAC submitted by Thames Water. We also provide the following econometric analysis to demonstrate why an adjustment to allowances is required:

1. We augment the analysis in Chapter 6 of our original transience CAC, to show that areas with high transience are associated with higher bad-debt related costs than areas with low transience. This analysis addresses Ofwat's request that we compare our retail costs between areas with high and low transience and draw a clearer link between the statistics and the resulting cost impact.
2. We then present analysis of Thames Water's internal premises-level data – the smallest unit of analysis possible – to provide additional bottom-up evidence on the link between

[33] Thames Water (2023), TMS19 Cost Adjustment Claim: Transience, claim-transience.pdf (thameswater.co.uk).
[34] 'PR19 Draft Determinations: Securing cost efficiency technical appendix.' Ofwat (July 2019); page 81.
[35] Ofwat (2024). Draft determination. PR – 24 – DD TMS cost adjustment claims.

transient premises and bad debt. This analysis serves two main purposes. First, related to Ofwat's comment above, we show that high transience is associated both with higher incidence and higher amount of bad debt. Second, we address Ofwat's comment regarding our failure to provide bottom-up evidence of the additional costs we incur due to transience.

### The difference between retail costs in areas with high and low transience

To show a link between retail costs and areas with high and low transience we distinguish between London (high transience) and Thames Valley (relatively lower transience) areas. In our CAC we distinguished between four different measures of transience (see Table 8 of our October submission):

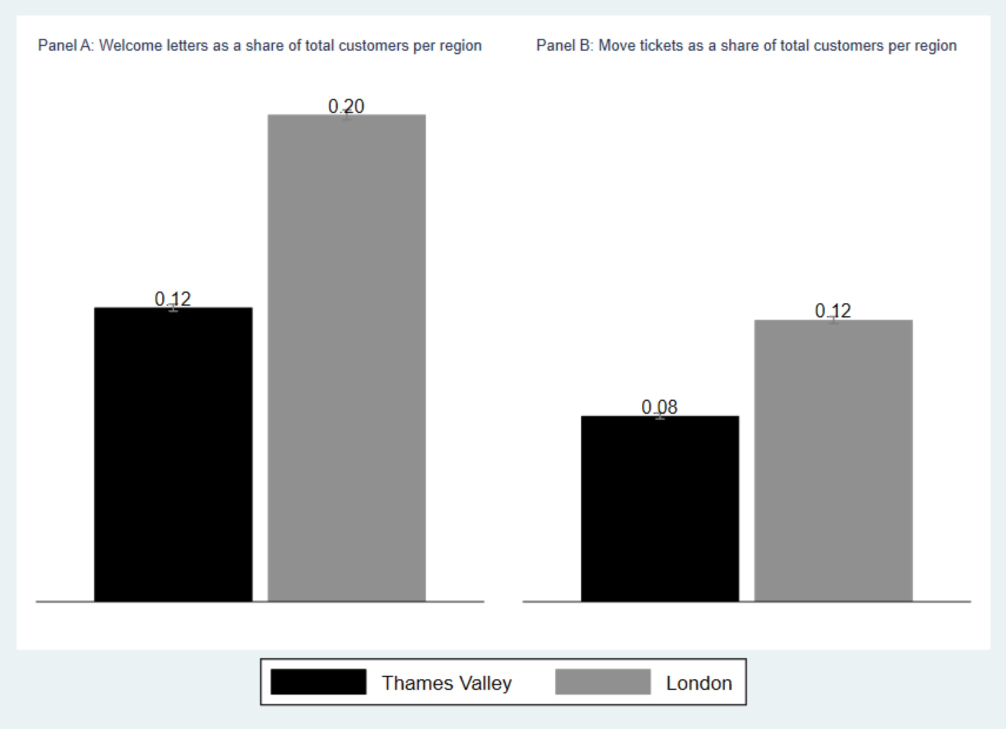
1. Log (Number of 'move' tickets)
2. Number of move tickets as a share of total customers for each postcode[36]
3. Log (Number of total welcome letters)
4. Number of welcome letters as a share of total customers for each postcode

For this analysis, we focus on the normalized (i.e. 2nd and 4th) measures of transience that account for the difference in the number of customers across the two areas. Since Thames Water serves more customers in London than Thames Valley, the transience measure in levels (i.e. 1st and 3rd measures) will be misleading. They will be by default larger in London than in Thames Valley.

Figure 34 compares the normalised transience measures between London and Thames Valley and shows that London has a higher level of transience.

[36] Note that this transience metric was described incorrectly in our CAC. We described it as "the number of tickets mentioning 'move' as a share of total contact tickets." However, in the analysis we used the "number of tickets mentioning 'move' as a share of total customers", which is the correct metric.
The rationale for this is that we wanted to derive a transience metric which represented the extent of the rate of movement within each area (hence the use of customers rather than the tickets).

*Figure 34: Transience measures in London vs Thames Valley*




*Source:* Thames Water calculations

To compare debt-related costs across the two areas we examine the same models as in Chapter 6 of our CAC with two additions:

- First, we introduce a London dummy, which equals 1 for London area and 0 for Thames Valley.
- Second, we interact London dummy with the two transience measures under scrutiny. A positive and significant coefficient of this interaction term would indicate that the impact of a 1% increase in the respective transience measure on debt-related costs is higher in London than in Thames Valley.

The regression specifications are depicted in equations (1)-(2) below:

1. log (Debt related costs) = $\beta_0$+ $\beta_1$ log (Average bill value) + $\beta_2$ IMD income score + $\beta_3$ Number of welcome letters as a share + $\beta_4$ London + $\beta_5$ London x Number of welcome letters as a share + $\varepsilon$
2. log (Debt related costs) = $\gamma_0$+ $\gamma_1$ log (Average bill value) + $\gamma_2$ IMD income score + $\gamma_3$ Number of move tickets as a share + $\gamma_4$ London + $\gamma_5$ London x Number of move tickets as a share + $\varepsilon$

We are interested in:

- $\beta_3$ and $\gamma_3$ that capture the impact of 1% increase of the respective transience measure on debt-related costs in Thames Valley. We hypothesize that the coefficients of these estimators will show up positive and significant.
- $\beta_5$ and $\gamma_5$ that show the difference in debt-related costs in London compared to Thames Valley associated with a 1% increase in the respective transience measure. We anticipate these estimators to be positive and significant, reflecting greater costs from each unit of transience within London compared to Thames Valley. We believe this is likely to be

reflective of a mix of factors relating to our customer base, the nature of transience, and costs of operating in the region.

Figure 35 summarizes all the variables in equations (1)-(2) for clarity, while Figure 36 summarises the regression output in the same fashion as in our transience CAC.

*Figure 35: Definition of variables used in equations (1)-(2)*

| Variable | Description |
|---|---|
| Log (Average bill value) | Thames Water's debt related costs for 2021/22 distributed by the postcode-level shares of Thames Water's customer debt write-offs. This is divided by the number of customers in the unit cost models. |
| Log (Average bill value) | Thames Water's average bill size recorded by postcode district, as provided by Thames Water. |
| IMD income score | The percentage income score as published in the Indices of Multiple Deprivation (IMD) for 2019. This is mapped onto postcode districts using the ONS' postcode district to Local Super Output Area (LSOA) mapping. |
| Number of move tickets as a share | A count of all inbound, non-automated service tickets from contacts where the ticket category is 'move', as a share of the total number of customers. |
| Number of welcome letters as a share | Count of welcome to service letters sent out between 1st April 2022 and 31st March 2023 by postcode, as a share of the total number of customers. |
| London | Binary variable that equals 1 for London and 0 for Thames Valley area. |

*Figure 36: Results summary*

| Model | | Relevant variables | Coefficient | Other control variables expected sign |
|---|---|---|---|---|
| | 1 | Number of welcome letters as a share | 0.142*** | Yes |
| | | Number of welcome letters as a share x London | 0.171*** | |
| | 2 | Number of move tickets as a share | 0.231*** | Yes |
| | | Number of move tickets as a share x London | 0.331*** | |

*Note.* OLS models estimated. Significance levels: *** p<1%, **p<5%, *p<10%.

Both models have a positive interaction term, indicating higher debt related costs because of 1% of increase in the relevant transience measure in London:

- 1% increase in the welcome to service letters as a proportion of total customers is, on average, associated with a 0.14% increase in debt-related unit costs in Thames valley and 0.31% increase in debt-related unit costs in London (model 1).
- 1% increase in the share of total contact tickets which relates to moving is, on average, is associated with a 0.23% increase in debt-related unit costs in Thames Valley and 0.56% increase in debt-related unit costs in London (model 2).

## Analysis of the premises-level data

We provide further bottom-up evidence on the importance of transience for Thames Water. More specifically, we analyse around 2 million customer contracts signed between 2021-2024.[37] First, we develop premises-level *transience and bad debt incidence scores* and calculate the monetary amount of bad debt for each premises. Second, in a formal regression framework, we explore the relationship between the transience score and the bad debt incidence score, as well as the relationship between transience score and the monetary amount of bad debt.

To develop premises-level and bad debt incidence scores, we use the fact that PREMISES ID (unique identifier for each premises) is fixed over time, while the Contract ID (unique identifier for each contract) changes with each customer. Thus:

- for each premises we can calculate how many contracts have been signed for a given time interval. **This defines our transience score.**
- Similarly, for each premises we can calculate how many contracts ended up in a bad debt collection journey. **This defines the bad debt incidence score.**

[37] The replication package that contains the data and .do files is available upon request.

The example below clears these points. Note that both the contract account number and the premises number are different from the real ones representing these customers.

*Figure 377: Example of contract data used*

| | CONTRACT_A~T | PREMISE | MOVE_IN_DATE | MOVE_OUT_D~E | UNPAID_BILLS | DEBT | N_CONTRACTS |
|---|---|---|---|---|---|---|---|
| 1 | 900057869473 | 886156241 | 2021-03-20 | 2021-12-15 | 1 | 411.44 | 3 |
| 2 | 900063798234 | 886156241 | 2021-12-16 | 2022-02-10 | . | . | 3 |
| 3 | 900071076922 | 886156241 | 2022-02-11 | | 3 | 1446.62 | 3 |
| 4 | 900059997995 | 886179130 | 2021-07-01 | 2022-06-30 | . | . | 3 |
| 5 | 900069115308 | 886179130 | 2022-07-01 | 2022-12-14 | 1 | 421.03 | 3 |
| 6 | 900074497516 | 886179130 | 2022-12-15 | | . | . | 3 |

For both premises 886156241 (in Rows 1 to 3 in the figure) and 886179130 (Rows 4 to 6) three contracts were signed between 2021-2024 (each contract is represented by a single row). Thus, the transience score for both premises shown equals 3.

Premises 886156241 ended up with bad debt incidence score of £1858.06 (contract 900057869473 has 1 unpaid bill with a debt of £411.44, while contract 900071076922 has 3 unpaid bills with debt of £1446.62).

While Premises 886179130 had a bad debt incidence score of £421.03 as a result of one unpaid bill.

Figure 38 and Figure 39Figure 39 depict the frequency distributions of transience and bad debt incidence scores across the whole dataset. Figure 40 illustrates the histogram of the amount of bad debt on a premises level. Lastly, Figure 41 depicts the average bad debt across all premises with a given transience score along with 95% confidence intervals.

*Figure 38: Frequency distribution of the transience score*

| Number of contracts from 2021-2024 | Number of premises |
|---|---|
| 1 | 871,363 |
| 2 | 321,524 |
| 3 | 108,952 |
| 4 | 27,834 |
| 5 | 6,000 |
| 6 | 1,306 |
| 7 | 308 |
| 8 | 111 |
| 9 | 62 |
| 10+ | 73 |

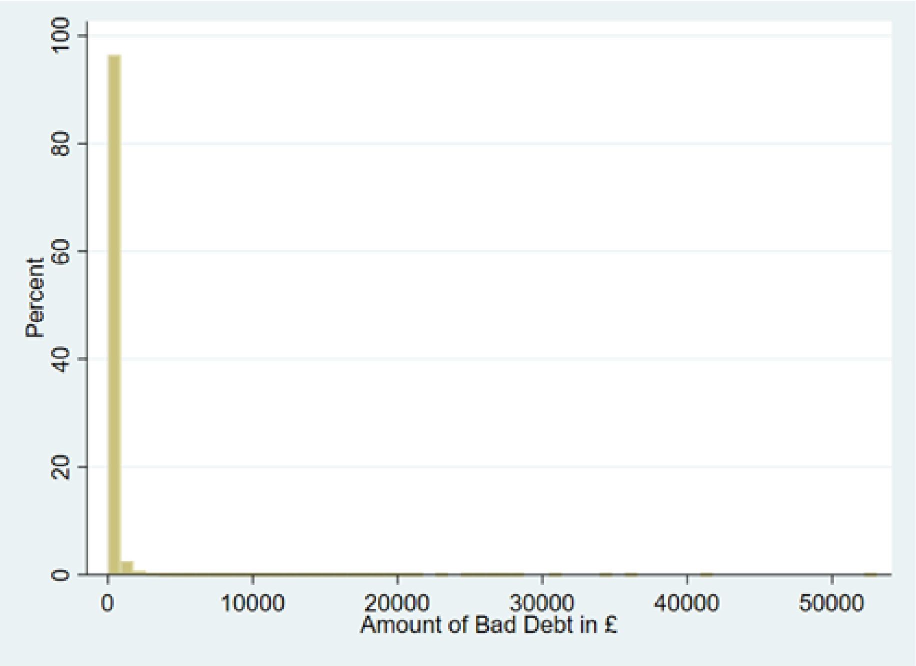
*Source:* Thames Water calculations

*Figure 39: Frequency distribution of bad debt incidence score*

| Number of contracts in bad debt recovery journey | Number of Premises |
|---|---|
| 0 | 1, 157, 581 |
| 1 | 167, 416 |
| 2 | 10,715 |
| 3 | 1,204 |
| 4 | 334 |
| 5 | 123 |
| 6 | 86 |
| 7+ | 74 |

*Source:* Thames Water calculations

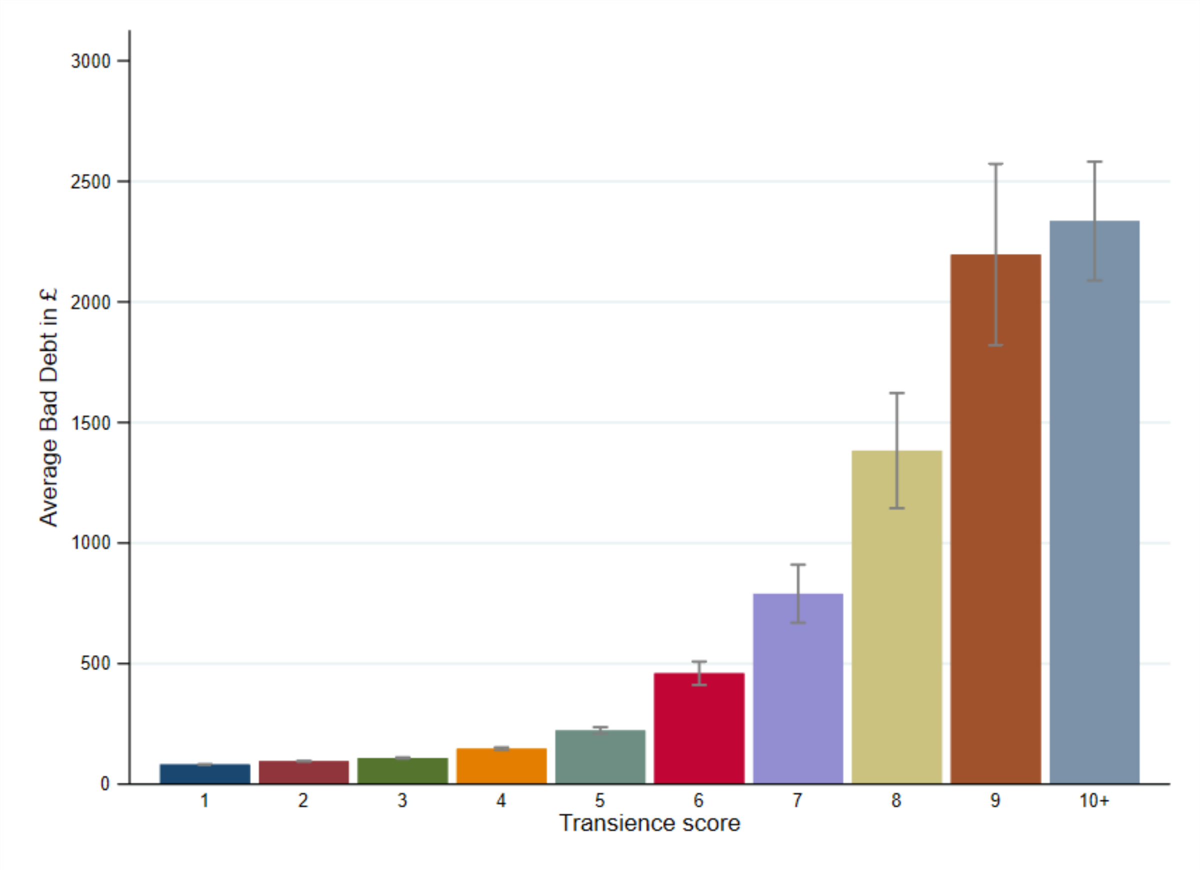
*Figure 40: Amount of bad debt*




*Note:* The distribution of the amount of premises-level bad debt from 2021-2024 in £.

*Source:* Thames Water calculations

*Figure 41: Average bad debt and the transience score*




Note. *Average bad debt by transience score.*

*Source:* Thames Water calculations

Figure 38 illustrates that 871,363 premises have 1 contract registered during 2021-2024, 321,524 premises have 2 contracts registered, etc. Similarly, Figure 39 illustrates that 1,157,581 premises have 0 contracts in bad debt recovery journey during 2021-2024, 167,416 premises have 1 contract, 10,715 premises have 2 contracts etc. Figure 40 suggests that the distribution of the bad debt is skewed toward zero, as most of the premises have no bad debt for the 2021-2024 period. Figure 41 provides clear descriptive evidence that the amount of bad debt in £ increases with the transience score.

**Econometric evidence.** Next, we proceed to formal econometric analysis to establish the hypothesized relationship between bad debt incidence score and transience score, and between bad debt amount in £ and transience score.

The dependent variables of these models are either the bad debt incidence score or the amount of debt. The independent variables of the above regression models are the same and are detailed in Figure 42 below.

Bad debt incidence score and bad debt amount both have a large share of observations with zero value (i.e., no bad debt) which can create biases in parameter estimates when using traditional least square (OLS) estimation techniques. To circumvent this problem, we use a Poisson pseudo-maximum likelihood (PPLM) model. The latter leads to consistent estimates regardless of the distribution of the data. Details on this approach can be found in Santos Silva and Tenreyo (2006, 2011).[38] This approach is used to study questions in international trade, energy economics, regulation (e.g., Zhao et al., 2013; De Groote et al., 2016)[39], and corporate finance (Cohn et al., 2022)[40] among others. The dependent variables in these contexts share similar distributional patters. For example, in trade models, abundance of zeros in the dependent variable represents no trade among countries, in corporate finance models the zeros represent no toxic emissions, 0 miles driven between cities, etc.

*Figure 42: The independent variables used in the econometric models*

| Independent Variables | Description |
|---|---|
| Transience score | Indicates how transient premises *m* is based on the number of contracts for premises m from 2021-2024. |
| log (Bill Premises) | The log-transformation of the sum of the average bills of all contracts for premises m. If premises m had 3 contracts from 2021-2024, with the following average bills £ p, n, k for each contract respectively, then log (Bill Premises) =log(p+n+k). *This independent variable is added to capture the amount of revenue at risk per premises.* |
| Social tariff score | Indicates the number of contracts on a social tariff at premises m from 2021-2024. This score is constructed exactly in the same way as the transience and bad debt incidence scores. For instance, if 2 out of 3 contracts at premises m from 2021-2024 are on a social tariff the *social tariff score* for premises m is 2. This independent variable is added to capture the propensity to default on water payments on a premises level. |
| Postcode fixed effects | Additionally, we introduce postcode fixed effects into the regressions to control for postcode-specific differences. |

Figure 43 summarises the regression output for both models.

*Figure 43: Regression results*

| | (1) Bad debt incidence | (2) Bad debt amount |
|---|---|---|
| Transience score | 0.404***<br>(0.002) | 0.145***<br>(0.003) |
| Log (Bill Premises) | 0.345***<br>(0.004) | 1.118***<br>(0.008) |
| Social Tariff Score | -0.004<br>(0.006) | -0.084***<br>(0.009) |

[38] Silva, J. S., & Tenreyro, S. (2006). The log of gravity. *The Review of Economics and statistics*, *88*(4), 641-658; Silva, J. S., & Tenreyro, S. (2011). Further simulation evidence on the performance of the Poisson pseudo-maximum likelihood estimator. *Economics Letters*, *112*(2), 220-222.

[39] Zhao, Y., Tang, K. K., & Wang, L. L. (2013). Do renewable electricity policies promote renewable electricity generation? Evidence from panel data. *Energy policy*, *62*, 887-897; De Groote, O., Pepermans, G., & Verboven, F. (2016). Heterogeneity in the adoption of photovoltaic systems in Flanders. *Energy economics*, *59*, 45-57.

[40] Cohn, J. B., Liu, Z., & Wardlaw, M. I. (2022). Count (and count-like) data in finance. *Journal of Financial Economics*, *146*(2), 529-551.

| | | |
|---|---|---|
| Constant | -3.980***<br>(0.020) | -1.467***<br>(0.045) |
| N | 943,362 | 943,362 |
| Postcode fixed effects | Yes | Yes |
| Pseudo $R^2$ | 0.135 | 0.371 |
| Wald $\chi^2$ | 50475.36*** | 30814.41*** |

*Note: Poisson Pseudo Likelihood Models (PPLM) estimated. The variables are defined in Table 5. Robust standard errors in parentheses. Significance levels: * p<10%, ** p<5%, *** p<1%. Pseudo $R^2$ cannot be interpreted in the same way as the $R^2$.*

Model 1 illustrates that a 1 unit increase in the transience score is associated with an increase in bad debt incidence rate by a factor of $e^{0.404}$=1.498. For instance, a premises with 3 contracts is expected to have on average, 1.498 times (or 49.8%) more bad debt than a premises with 2 contacts. In sum, the more frequent the contract changes at a given premises (i.e., the more transient the given premises), the higher the likelihood of bad debt. The remaining control variables have the expected signs.

Model 2 illustrates that 1 unit increase in transience score is associated with an increase in bad debt amount by a factor of $e^{0.145}$=1.156. For instance, a premises with 3 contracts generates on average 1.156 times (or 15%) more bad debt than a premises with 2 contracts. In sum, not only does the likelihood of bad debt increase with frequent contract changes, but the amount of bad debt also goes up. The remaining control variables have the expected signs.

### Summarising the results of our econometric analysis

The results of the econometric analysis that we have presented are aligned with our prior arguments that transience is an important determinant of bad debt for Thames Water. We have provided compelling evidence to demonstrate that areas with higher levels of transience experience higher retail costs as a result of higher levels of bad debt. We have demonstrated this by updating the analysis presented in our original transience CAC and we have provided additional bottom-up evidence of the additional costs Thames Water incurs due to transience.

### Efficiency of the transience claim

We consider that the approach we have taken to calculate the value of the claim is robust and consistent with the way Ofwat uses its econometric models. However, considering that Ofwat's proposed retail allowance is close to what we have requested, and that statistical modelling inevitably has some uncertainty around their results, we propose to reduce the value of the claim by 20% to £66.54m. We reiterate that transience is an important cost factor that affects our efficient bad debt and customer service costs. Thames Water is efficient in retail services, and without the allowance for transience we are not assessed fairly compared to the other companies in the sector.

## 8.3. Network reinforcement

### Brief outline of Ofwat's position

Ofwat assesses water network reinforcement expenditure as part of the modelled base cost as it shares similar cost drivers to base costs (e.g. scale and density). At PR19 Ofwat accepted that the base models may not sufficiently remunerate companies operating in higher growth areas. In the PR19 Thames Water Final Determination, this point was recognised by an adjustment in the water base modelled allowance of £27.7m.

Ofwat agrees with the need for a cost adjustment claim as Thames Water operates in a high growth area, which has been recognised by the upward adjustment in the Draft Determination.

Ofwat recognises that -

- network reinforcement costs are recovered from developer service customers through the Infrastructure Charge mechanism but acknowledge that although Thames Water is currently investing more than its PR19 Final Determination allowance in Network Reinforcement schemes, the company has historically invested less than its implicit allowance in previous regulatory periods. Ofwat believes that approving the PR24 Cost Adjustment Claim (in full) will mean that customers are paying twice.
- historically, Thames Water has optimised existing headroom within the network and/or worked in partnership with developers to accommodate additional connected properties wherever possible before delivering infrastructure solutions.

Ofwat acknowledges that Thames Water has historically experienced the highest growth in connected properties within the sector and agree that trend will continue in AMP8.

Ofwat makes no reference to the 2019 change in charging rules[41], which is a key point in Thames Water's cost adjustment case

Ofwat applied a 50% cost efficiency challenge to our cost adjustment claim:

- 20% overlap with base efficiency challenge
  - Ofwat highlighted a possible cross-subsidy between capital maintenance and enhancement of a proposed AMP8 scheme in query response 224.
  - As noted above, Ofwat was concerned that due to historic underinvestment, customers could be paying twice if the cost adjustment case was approved.
- 10% efficiency challenge based on optioneering.
- 20% cost efficiency challenge.

Ofwat proposes a price control deliverable, which we accept.

### Thames Water argument and supporting evidence

We believe that the base cost models do not provide sufficient network reinforcement allowance and that the proposed adjustment in the Draft Determination will not enable all the proposed new connections to be accommodated without a net deterioration in service.

[41] https://www.ofwat.gov.uk/publication/wholesale-charging-rules-issued-by-the-water-services-regulation-authority-under-sections-66e-and-117i-of-the-water-industry-act-1991-effective-from-april-2022/

We also note that by adding the individual challenges (20% for overlap with base, 10% optioneering and 20% cost efficiency) and applying a 50% challenge on the total value of the claim, there is a double count of the challenges. For example, if Ofwat removes 20% of the claim due to overlap with base, this component must not then be subject to the 10% optioneering and 20% cost efficiency challenge. However, by applying 50% challenge on the total value of the claim, this is in effect what happens. The rates of the individual challenges (i.e., 20%, 10% and 20%) have no meaning unless they are applied sequentially. Applying the challenges in the correct order (i.e., first 20%, then 10% optioneering and last 20% cost efficiency) would result in an allowance of c. £90m for this claim.

We provide additional evidence to address Ofwat's concerns below.

### Overlap with base efficiency challenge

In preparing our October 2023 business plan, we carried out a rigorous proportional allocation assessment for all growth projects included in our Cost Adjustment Claim. Not all the projects we have identified are allocated 100% to Network Reinforcement.

We provided details on proportional allocation to base in our response to Ofwat query TMS- OFW-OBQ-TMS-224. The key tables from our query response (which can be found in Section 3) are repeated below.

#### Water Projects

*Figure 44: Water strategic growth schemes and proportional allocation to base*

| Scheme | File Provided in TMS- OFW-OBQ-TMS-224 | Figure in cost build-up £k | Corrected 22/23 pb £k | % NR | Network reinforcement £k |
|---|---|---|---|---|---|
| Riverside (Area 2) | K384 Riverside 2 Brief C (PIA) IC Business Case Template.pdf<br>P0353 Riverside Network Growth - C - Northumberland Res to Tower Road - Project Brief - PJS 100621.pdf<br>Copy of B7 Costing main route | 38,921 | 47,059 | 68% | 32,000 |
| Munstead to Hydon Ball | P0788_Munstead to Hydon Ball_F909_REV.1.xls<br>P0788 PR24 TG - Munstead to Hydon ball Slide Deck Updated CM check | 26,481 | 25,100 | 100% | 25,100 |
| Riverside (Area 2) WI Growth | PR24 Riverside Growth Technical Governance Presentation Pack v1.0 Issued.pptx | 12,209 | 13,600 | 100% | 13,600 |

#### Wastewater Projects:

Newbury Growth is a complex solution that comprises many sub-projects to address a lack of capacity in the area (and around Newbury train station in particular) to accommodate growth. Without this investment, we would expect Newbury train station and the Great Western rail line between Paddington and Bristol to be flooded on regular basis. The latest capital estimate for all sub-projects is £50m of which 40.5% has been assessed as Network Reinforcement and included in this claim. The remaining totex we recognise would need to be funded from our base plan.

*Figure 45: Wastewater strategic growth schemes and proportional allocation to base*

| Scheme | File Provided in TMS- OFW-OBQ-TMS-224 | Figure in cost build-up £k | Corrected 22/23 pb £k | % NR | Network reinforcement £k |
|---|---|---|---|---|---|
| Bicester Growth Waste | L268 Bicester Growth Budget Estimate GIS Plan - Option 1 KC 04.08.2023<br><br>L268 Bicester Growth Budget Estimate GIS Plan - Option 2 KC 04.08.2023 | See above | See above | 100% | 15,000 |
| Newbury Network Growth | J090 Newbury - Funding Split and IBP Review for Newbury Inlet Works Funding - January 2023 £50m.xls | 50,000 | 50,000 | 40.5% | 21,200 |

In summary, we consider that we have demonstrated growth projects have been appropriately proportionally allocated between base and network reinforcement. We therefore consider that the 20% challenge on costs allocated to Network Reinforcement is unreasonable and the costs that we have already allocated should be reinstated in full in the Final Determination.

### Optioneering evidence

As noted in Ofwat's feedback on this Cost Adjustment Case, operational interventions to meet demand are always considered before new installations are progressed. These interventions could include the following:

- field validation of operating pressures and recording of demand within the network
- confirmation of valve status
- evaluating alternative points of connections
- optimisation of existing infrastructure such as changing pump run times

Although technical solutions to achieve additional demand caused by new developments are proposed within the Cost Adjustment Case, further solution optioneering will occur once the projects are initiated. This optioneering could include the following:

- further hydraulic detailed modelling assessments using details from approved planning permissions (and supporting documents)
- review all other developments in the area (which have full planning permission) to ensure any proposed investments are fit for purpose
- undertake multiple demand impact analysis based on the latest developer build profiles to determine when any investments will be required
- discussion with developers to better understand details on new connected properties contained within the approved planning permission rather than outline properties numbers included within outline planning permissions and Local Area Plans

Listed below are some recent examples of how proposed investments have been challenged as more detailed information on proposed new connected properties have been made available.

- K238 Faringdon – descoped and no reinforcement delivered, the model was over-predicting detriment
- K633 Swindon NEV – 5.8km of 315mm HPPE SDR17 Manifold Main for supply connections to NEV sites connecting with Axford Main – descoped; alternative supply strategy agreed with three points of connection from the Axford Main
- K703 Watlington – solution proposed does not address the main issues in the area; assessment being revised to investigate an alternative to provide a localised solution instead of a new pipework to be laid in Watlington.

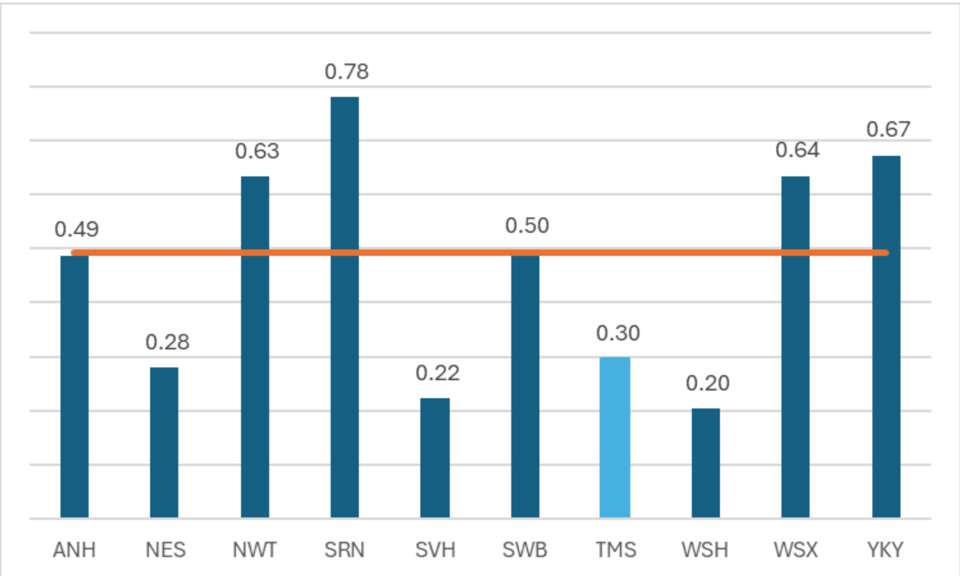
### Cost efficiency

Ofwat applies a 20% cost efficiency challenge to our proposed network reinforcement investment. The gross value of our cost adjustment claim was based on costs we currently incur for network reinforcements, plus an efficiency challenge as we applied across for all our forecasts. That is, the gross value is based on lower costs than what we are currently incurring.

Given our proposed costs are lower than our current costs and the smaller efficiency gap that we have on base efficiency (based on the econometric models – a gap which we consider should significantly reduce based on our modelling representations), we consider that applying a 20% efficiency challenge to our network reinforcement costs is not appropriate.

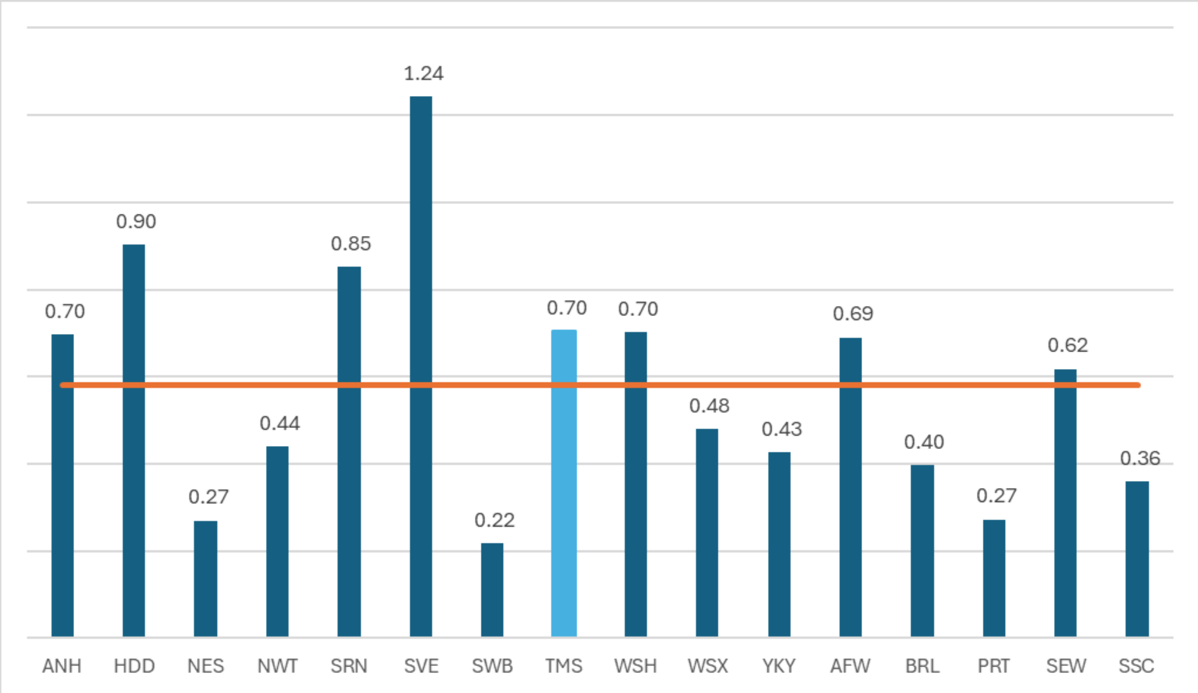
Further, our costs do not appear high compared to our peers. Comparing our network reinforcement costs to other companies, we find that in wastewater our unit cost is well below the average (Figure 46).

*Figure 46: Network reinforcement costs per new properties in AMP8 (£m/1000 properties) - wastewater*




In water, our unit cost is above the median (Figure 47). Nonetheless, we do not consider that our costs are unreasonably high as to justify a 20% challenge. Our costs are grounded in actual delivery costs in our service area. As such they reflect the higher costs we incur in London, and often in Thames Valley, compared to many other regions in the country. A simple unit cost comparison does not take into account the operating environment and so provide a partial comparative assessment compared to a well-specified econometric models. For example, factors such as density in growth areas, and regional wages, are likely to explain variations in unit costs of network reinforcements in the sector.

*Figure 47: Network reinforcement costs per new properties in AMP8 (£m/1000 properties) - water*




Given the evidence from the simple unit cost benchmarking, the evidence of our efficiency gap from the econometric models, and that our forecasts are based on actual delivery costs plus an efficiency challenge, we consider that a 20% challenge as proposed at draft determinations is unjustified.

## Summary of our request for FD

- We request that Ofwat review the cost efficiencies applied considering this additional evidence.
- We request that the challenges are applied in the correct sequential order to avoid double counting of the challenges.

# Annex 1 Estimation results from models that include asset age and mains replacement rate

*Figure 48: Treated Water Distribution models*

| | TWD1 | TWD2 | TWD3 | TWD4 | TWD5 | TWD6 |
|---|---|---|---|---|---|---|
| Lengths of Main (log) | 1.106*** | 1.082*** | 1.107*** | 1.105*** | 1.072*** | 1.092*** |
| Weighted Population Density - LAD (log) | -1.483*** | | | -1.821*** | | |
| Weighted Population Density – LAD squared (log) | 0.120*** | | | 0.141*** | | |
| Weighted Population Density – MSOA (log) | | -2.956** | | | -4.115*** | |
| Weighted Population Density – MSOA squared (log) | | 0.210*** | | | 0.282*** | |
| Properties per length (log) | | | -9.176*** | | | -11.117*** |
| Properties per length squared (log) | | | 1.177*** | | | 1.384*** |
| Booster per length of main (log) | 0.209* | 0.18 (0.128) | 0.282** | | | |
| APH TWD (log) | | | | 0.211* | 0.255** | 0.221*** |
| Age of Network (log) | 1.241*** | 1.201*** | 1.066*** | 1.213*** | 1.050*** | 1.042*** |
| Mains Replacement Rate | 0.291*** | 0.300*** | 0.289*** | 0.294*** | 0.290*** | 0.290*** |
| Constant | -5.916*** | 0.159 | 8.348 | -6.270*** | 3.658 | 10.954* |
| Adjusted R-squared | 0.962 | 0.956 | 0.968 | 0.962 | 0.962 | 0.968 |
| RESET test | 0.07 | 0.17 | 0.12 | 0.08 | 0.34 | 0.31 |
| VIF (max) | 256.5 | 616.9 | 848.8 | 289.2 | 721.4 | 893.9 |
| Pooling / Chow Test | 0.50 | 0.35 | 0.38 | 0.55 | 0.33 | 0.77 |
| LM test (Pooled OLS vs RE) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Normality of model residuals | 0.17 | 0.17 | 0.14 | 0.19 | 0.59 | 0.16 |
| Heteroskedasticity of model residuals | 0.46 | 0.14 | 0.07 | 0.72 | 0.78 | 0.36 |
| Efficiency score - minimum | 0.80 | 0.75 | 0.89 | 0.82 | 0.81 | 0.86 |
| Efficiency score - maximum | 1.35 | 1.39 | 1.24 | 1.40 | 1.41 | 1.30 |
| Efficiency score - range | 0.55 | 0.64 | 0.35 | 0.58 | 0.60 | 0.44 |
| Removal most efficient company | G | G | G | G | G | G |
| Removal least efficient company | A | A | G | G | G | G |
| Removal first year | A | A | G | G | G | G |

| | | | | | | |
|---|---|---|---|---|---|---|
| Removal last year | G | G | G | G | G | G |

*Figure 49: Wholesale Water Models*

| | WW1 | WW2 | WW3 | WW4 | WW5 | WW6 |
|---|---|---|---|---|---|---|
| Properties (log) | 1.106*** | 1.101*** | 1.112*** | 1.108*** | 1.079*** | 1.075*** |
| Pct watertreated Bands 3-6 | 0.003*** | | 0.002* | | 0.003** | |
| WAC (log) | | 0.238 (0.119) | | 0.192 (0.235) | | 0.254 (0.102) |
| Weighted Population Density LAD (log) | -0.935*** | -0.892*** | | | | |
| Weighted Population Density – LAD squared (log) | 0.058** | 0.055** | | | | |
| Weighted Population Density – MSOA (log) | | | -2.635*** | -2.627*** | | |
| Weighted Population Density – MSOA squared (log) | | | 0.153*** | 0.152*** | | |
| Properties per length (log) | | | | | -6.250*** | -6.092*** |
| Properties per length squared (log) | | | | | 0.686*** | 0.666*** |
| Booster per length of main (log) | 0.265** | 0.272** | 0.263** | 0.271** | 0.220** | 0.222* |
| Age of Network (log) | 0.962*** | 0.910*** | 1.077*** | 1.017*** | 0.919*** | 0.865*** |
| Mains Replacement Rate | 0.204** | 0.201** | 0.203** | 0.201** | 0.192** | 0.191** |
| Constant | -9.640*** | -9.632*** | -2.556 | -2.403 | 1.203 | 0.998 |
| Adjusted R-squared | 0.967 | 0.967 | 0.965 | 0.966 | 0.970 | 0.970 |
| RESET test | 0.17 | 0.15 | 0.19 | 0.18 | 0.25 | 0.20 |
| VIF (max) | 258.47 | 254.10 | 616.08 | 618.73 | 867.65 | 853.14 |
| Pooling / Chow Test | 0.77 | 0.70 | 0.85 | 0.76 | 0.69 | 0.51 |
| LM test (Pooled OLS vs RE) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Normality of model residuals | 0.08 | 0.48 | 0.19 | 0.51 | 0.25 | 0.48 |
| Heteroskedasticity of model residuals | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Observations | 204 | 204 | 204 | 204 | 204 | 204 |
| Minimum | 0.83 | 0.82 | 0.81 | 0.81 | 0.84 | 0.83 |
| Maximum | 1.30 | 1.33 | 1.34 | 1.33 | 1.29 | 1.28 |
| Range | 0.47 | 0.51 | 0.53 | 0.52 | 0.45 | 0.45 |
| Removal most efficient company | G | A | G | A | A | A |
| Removal least efficient company | A | G | G | G | G | G |
| Removal first year | A | G | G | G | G | G |
| Removal last year | G | G | G | G | G | G |

| | WW7 | WW8 | WW9 | WW10 | WW11 | WW12 |
|---|---|---|---|---|---|---|
| Properties (log) | 1.113*** | 1.111*** | 1.115*** | 1.112*** | 1.071*** | 1.068*** |
| Pct watertreated Bands 3-6 | 0.002 (0.114) | | 0.001 (0.410) | | 0.002 (0.121}) | |
| WAC (log) | | 0.152 (0.316) | | 0.114 (0.469) | | 0.187 (0.244) |
| Weighted Population Density LAD (log) | -1.311*** | -1.298*** | | | | |
| Weighted Population Density – LAD squared (log) | 0.081*** | 0.080*** | | | | |
| Weighted Population Density – MSOA (log) | | | -3.930*** | -3.946*** | | |
| Weighted Population Density – MSOA squared (log) | | | 0.230*** | 0.231*** | | |
| Properties per length (log) | | | | | -7.666*** | -7.618*** |
| Properties per length squared (log) | | | | | 0.837*** | 0.830*** |
| APH TWD (log) | 0.246** | 0.252** | 0.228* | 0.232* | 0.176 (0.134) | 0.18 (0.137) |
| Age of Network (log) | 1.085*** | 1.063*** | 1.219*** | 1.185*** | 0.995*** | 0.959*** |
| Mains Replacement Rate | 0.217*** | 0.218*** | 0.216*** | 0.217*** | 0.197** | 0.198** |
| Constant | -10.817*** | - 10.863*** | 0.209 | 0.325 | 2.67 | 2.612 |
| Adjusted R-squared | 0.959 | 0.959 | 0.955 | 0.955 | 0.965 | 0.965 |
| RESET test | 0.21 | 0.20 | 0.14 | 0.13 | 0.39 | 0.34 |
| VIF (max) | 287.25 | 289.28 | 735.87 | 754.92 | 900.64 | 893.88 |
| Pooling / Chow Test | 0.79 | 0.80 | 0.92 | 0.85 | 0.89 | 0.78 |
| LM test (Pooled OLS vs RE) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Normality of model residuals | 0.83 | 0.96 | 0.63 | 0.83 | 0.15 | 0.45 |
| Heteroskedasticity of model residuals | 0.01 | 0.02 | 0.00 | 0.01 | 0.02 | 0.05 |
| Observations | 204 | 204 | 204 | 204 | 204 | 204 |
| Minimum | 0.75 | 0.74 | 0.75 | 0.74 | 0.79 | 0.78 |
| Maximum | 1.41 | 1.41 | 1.42 | 1.42 | 1.31 | 1.29 |
| Range | 0.66 | 0.67 | 0.67 | 0.68 | 0.52 | 0.51 |
| Removal most efficient company | G | G | A | A | A | A |
| Removal least efficient company | G | G | G | G | G | G |
| Removal first year | G | G | G | G | A | A |
| Removal last year | G | G | G | G | A | A |

# Annex 2 Energy Forecasting

## Purpose

The purpose of this Annex is to outline a methodology for deriving a forward price curve for open (unhedged) electricity volume, applied in the methodology. It is used in conjunction with our arguments about the uncertainty mechanism.

We suggest if such a model were used, we would get a more realistic forecast given the state of our current knowledge of the market. This would contributing to removing revenue volatility.

## 1. The importance of Weighted Average Price

Electricity wholesale costs are presented as a Weighted Average Price (WAP). This is a product of known hedged prices obtained for the known hedged volume, and unknown market prices for remaining unhedged/open volume.

WAP = ((Volume Fixed * Purchase Price) + (Volume Open * **Derived Open Price**)) / Total Volume

The methodology for calculating the **derived open price**. This should incorporate the latest available information from quarterly/long term consultant forecasts, with short term more regularly produced forward market information, to derive a price curve.

## 2. The Approach

### Objectives:

We suggest three objectives:

1. Produce a long term forecast for power prices from multiple sources (Baringa, Cornwall Insight, Aurora and AFRY);
2. Derive a blended forecast price curve, from long, short and near term pricing data to be applied to open volumes; and
3. Provide an informed view, assessing deviations from the standard methodology to latest available data.

### Suggested Sources:

*Figure 50: Potential sources for energy forecasts*

| Nature | Examples of sources | Frequency | Risk | Note |
|---|---|---|---|---|
| Long – term | Cornwall, Aurora, Baringa and AFRY | Quarterly | Curve information is potentially out of date by up to 12 weeks | Recommended – Long term view |

| | | | | |
|---|---|---|---|---|
| Short-Term | Bloomberg Bid and Offers – wholesale market trades | Live Prices | Curve information only reflects immediate market sentiment | Short term validation only |
| Near-term | Open volume indices (N2EX or System Imbalance Price (SIP)). Any residual open volume is exposed to these prices. TWUL are able to change which indices are used. | Daily | Day-ahead (N2EX) or Post event data (SIP) which are both exposed to volatility on weather, supply and demand issues but does offer valuable insights to trends in spot markets. | Use monthly average within month and as a forecast for month+1 |

## Developing long term price forecasts

Using all price forecasts greater than 10 years, put them into monthly granularity so that they are consistent. Then they can be analysed for the maximum price scenario, the minimum price scenario and a consensus by using the medium price scenario across all forecasts.

## Weightage between different time horizon price forecasts

*Figure 51: Weightage between different time horizon price forecasts*

| Rationale | To weight near-term price towards short-term traded market costs and longer-term price towards Cornwall long-term forecast. | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Quarters | Q1 | Q2 | Q3 | Q4 | Q5 | Q6 | Q7 | Q8 | Q9 | Q10 | Q11 – Q18 | Q19 – Qn |
| Applied weighting % Long-term Forecast | 10% | 25% | 40% | 50% | 60% | 60% | 70% | 70% | 80% | 80% | 90% | 100% |
| Applied weighting % short-term forecast | 80% | 70% | 60% | 50% | 40% | 40% | 30% | 30% | 20% | 20% | 10% | 0% |
| Applied weighting % near-term forecast | 10% | 5% | | | | | | | | | | |

## Application

*Figure 52: Application of the forecasts*

| Volume | Price | Nature |
|---|---|---|
| Hedged Volume | Hedged Price | Known |
| Open Volume | Methodology Price | Derived |
| Total Volume | Weighted Average Price | Calculated |

## Mitigating risks

The methodology partially relies on data that could be up to twelve weeks old, as such there is a risk that the forecast could be over/understated, based on market movements since the issue of the last quarterly forecast. Multiple forecasts can be used to reduce this risk.

To manage a risk/opportunity position against the forecast is quantified and communicated in parallel with the forecast. The risk/opportunity needs to be managed by using the latest forward curve market data and spot market indices using an agreed methodology to incorporate more recent market changes.

It's everyone's water